Calaveras Public Utility District

Water Master Plan

October 2008

FINAL

Prepared By:

PETERSON . BRUSTAD . INC
ENGINEERING . CONSULTING

Calaveras Public Utility District

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Executive Summary

The Calaveras Public Utility District (CPUD, District) is assembling a master plan of its water system to support the development of a capital improvement plan (CIP) and to ensure adequate funding for future improvements. The CIP incorporates input from CPUD's staff based on institutional knowledge of the water system, along with the results of a computerized hydraulic model of the distribution system. The District retained the services of Peterson, Brustad, Inc. to develop a master plan for their water system. The Master Plan includes an evaluation of the water system's water supply, water demands, water treatment facilities, transmission system, distribution system, and storage facilities.

The water system currently serves approximately 1,900 service connections in the communities of San Andreas, Mokelumne Hill, Paloma, and portions of Glencoe and Railroad Flat. The Jeff Davis reservoir and water treatment plant treats Mokelumne River water. The District's maximum allowed diversion is 6,656 acre-feet per year (AFY). Raw water is pumped from the Mokelumne River to the reservoir, and flows by gravity from the reservoir to the water treatment plant. The reservoir capacity is 2,300 acre-feet (AF), and the water treatment plant's design capacity is 6 million gallons per day (MGD). The plant was constructed to allow expansion to 12 MGD capacity.

The District provided historical water usage records and number of active connections (or accounts) at the end of each calendar year for the past 10 years. The 10 years of data indicated an average daily water demand by active connection to be 664 gallons per day (gpd). Future demands were predicted utilizing a 2% growth rate to coincide with the assumed 2% population growth rate.

A hydraulic model was developed using H2OMap Water 8.0 to analyze different water supply and demand scenarios throughout the distribution system, clearwell and storage tanks, and pressure reducing valves. The scenarios created for this master planning effort include average daily flow (ADF), maximum daily flow (MDF) with fire flow demand, and maximum hourly flow (MHF). The scenarios were created for the existing distribution system (2008 system with historical demands), and for the projected future distribution system (2030 system with 2030 demands including future anticipated development). Figures of the model output are provided in Appendices A, B, and C.

The existing and future water system analyses result in a capacity that is more than adequate to serve the projected growth of 2% per year in the District. Projects recommended to expand, improve, or repair the system are included in a CIP for 2009 through 2030. The total recommended CIP includes 15 projects for a total planning cost estimate of approximately $23 million, in 2009 dollars.

CHAPTER 1

Introduction

The Calaveras Public Utility District (CPUD, District) is assembling a master plan of its water system to support the development of a capital improvement plan (CIP) and to ensure adequate funding for future improvements. The CIP incorporates input from CPUD's staff based on institutional knowledge of the water system, along with the results of a computerized hydraulic model of the distribution system.

The Master Plan assesses the system's ability to meet the District standards, general industry standards, and water regulations. The review identifies deficiencies in the system, and recommends prioritized improvements for repair of such deficiencies or changes to maintain the water system in optimum condition.

This Master Plan adds a valuable component to the master planning process, the hydraulic model. The model, constructed in H2OMap software simulates the water system operation, from the clearwell, through the distribution system and all storage tanks. The model was created to simulate the existing demands and the future demands of the system expected by 2030. Projects recommended to be made based on the hydraulic model results are included in this Master Plan along with planning cost estimates. The remainder of the Master Plan is organized into the following Chapters:

- Chapter 2 – Existing Water System – Presents a summary of the existing facilities
- Chapter 3 – Water Demands – Presents the existing demands, population projections and projected future demands
- Chapter 4 – Water Supply – Summarizes the water rights for the District's water supply
- Chapter 5 – Design / System Performance Criteria – Presents the design and performance criteria used to evaluate the water system
- Chapter 6 – Hydraulic Model Development – Discusses the process of constructing the hydraulic model, sources of information used in its development, and a listing of additional facilities installed in the scenarios of the future system
- Chapter 7 – Existing System Analysis – Presents results of hydraulic model evaluation of the existing water system under the existing demands
- Chapter 8 – Future System Analysis – Presents results of hydraulic model evaluation of the future water system under the projected demands described in Chapter 3
- Chapter 9 – Recommended Capital Improvement Program – Recommends projects based on the analyses of the existing and future water system and presents planning cost estimates and timelines for implementation of the recommended projects
- Appendices A, B, and C – Figures of model output

History and Background [1]

The Calaveras Public Utility District (CPUD) was formed in 1934 by an election held on January 16, 1934 under the California Public Utilities Code. At the time of the election, the CPUD did not own any facilities. In 1937, CPUD purchased the Mokelumne River Power and Water Company's water system of reservoirs, ditches, and flumes. The Jeff Davis WTP and reservoir, storage tanks, pipelines, and other associated improvements were constructed in 1973. Water rights used by the District were obtained January 19, 1939 from the Mokelumne River Power and Water Company. The same rights have been transferred between individuals and entities since 1852.

The District has prepared planning documents in previous years, documenting desired projects and associated costs. The most recent is a capital improvement plan developed in 2005. Some of the work identified in the 2005 CIP has been completed, while other components have not yet been completed.

[1] Also see "History of CPUD", By Gary Goffe.

CHAPTER 2

Existing Water System

The water system currently serves approximately 1,900 service connections in the communities of San Andreas, Mokelumne Hill, Paloma, and portions of Glencoe and Railroad Flat. The Jeff Davis reservoir and water treatment plant, located north of Ridge Road in the Railroad Flat area, treats Mokelumne River water. Raw water is pumped from the Mokelumne River to the reservoir, and flows by gravity from the reservoir to the water treatment plant. The reservoir capacity is 2,300 AF, and the water treatment plant's design capacity is 6 million gallons per day (MGD). The original plant design was constructed to allow expansion to 12 MGD capacity.

Treated water is currently produced and delivered by gravity from the clearwell to the transmission main, which traverses westward serving the communities of Mokelumne Hill, San Andreas, Glencoe, and Paloma. Treated water is pumped from the clearwell to the Railroad Flat storage tank to the south serving the community of Railroad Flat. The transmission main begins at 27 inches in diameter and generally follows the alignment of Highway 26; however, the pipeline diverts from the highway and crosses open country in some locations. Distribution systems extend off of the transmission main into the communities of Mokelumne Hill, Paloma, and San Andreas.

Raw Water Facilities

The raw water facilities consist of a raw water pump station, raw water pipelines, the Jeff Davis Reservoir, and the Schaads Reservoir.

Raw water Pump Station – A diversion dam on the Mokelumne River, just downstream of the confluence of the South and Licking forks of the Mokelumne River, diverts flows to the raw water pump station. The pump station has two 400 HP Floway vertical turbine pumps that were installed in 1972. Each pump has 9 stages and come designed to produce 2,000 gallons per minute (gpm) at 650 feet total dynamic head (TDH). The combined operation of both pumps produces approximately 3,300 gpm.

Raw water pipeline – The pump station pumps water into the 2-mile long 20-inch diameter steel raw water transmission pipeline that extends to the Jeff Davis Reservoir.

Jeff Davis Reservoir – The Jeff Davis Reservoir covers approximately 66 acres, and has a capacity of approximately 2,300 acre-feet (AF). The reservoir is located in a watershed of approximately 200 acres and was formed by the construction of an earthen dam.

Schaads Reservoir – The Schaads Reservoir has a capacity of approximately 1,800 AF which is currently used to supply the Calaveras County Water District with up to 200 AF per year. A hydro (power generating pressure reducing station) is used at the reservoir to generate electricity. This reservoir is not currently connected (hydraulically) to the raw water facilities at the Jeff Davis reservoir. Historically water from the Schaads reservoir moved through a diversion canal to the Licking Fork of the Mokelumne River, a tributary to the South Fork of the Mokelumne River. The existing raw water pump station is downstream of the confluence of the rivers, on the South fork of the Mokelumne River.

Treated Water Facilities

The treated water facilities of the system consist of the Jeff Davis water treatment plant (WTP), the transmission and distribution system, pressure reducing stations, pump stations, and water storage tanks.

Water Treatment Plant

The Jeff Davis WTP consists of six dual media pressure filters, each capable of producing 1 MGD of filtered water. Chlorine and polymer are added to the raw water prior to entry into the filters for disinfection and coagulation. The plant typically runs at 4 MGD, which results in a filter loading rate of less than 2 gpm per square foot. The permitted loading rate is 3 gpm per square foot, which would allow a capacity of 6 MGD. Zinc orthophosphate is fed at the common filter effluent line for distribution system corrosion control. The WTP was designed to allow for expansion to 12 MGD capacity with the addition of six pressure filters.

Transmission and Distribution System

Approximately 18 miles of transmission main carry treated water from the Jeff Davis WTP to Mokelumne Hill, Paloma, and San Andreas. Much of the transmission main consists of 16, 18, 20, and 27-inch diameter cement mortar lined and coated steel pipe. Much of the distribution system consists of 2-inch diameter to 12-inch diameter pipelines. The distribution system pipes consist of steel, PVC, HDPE, and some transite (AC) or galvanized iron. There are over 20 miles of pipelines in the CPUD water system, ranging in age from 50 plus years to new installations.

Pressure Reducing Stations

Significant drops in elevation require pressure reducing stations on the transmission main to keep water pressures at reasonable levels. Pressure zones are created due to the use of pressure reducing stations. Three large pressure reducing stations are installed on the transmission main converting water pressure into electrical energy. Other smaller local pressure reducing valves are installed on the distribution mains in the system reducing pressure locally, creating smaller pressure zones. Additional pressure zones are created at storage tanks. A map showing the pressure zones in the transmission and distribution system is provided in attachment B.

The three large pressure reducing stations that generate electricity, also known as “Hydros” are described in Table 1.

TABLE 1. CHARACTERISTICS OF POWER GENERATING PRESSURE REDUCING STATIONS

Pressure Reducing Station Name	Inlet Pressure Range (psi)	Outlet Pressure During Turbine Operation Only (psi)	Bypass Diameter (inches)	Hydro Flow Capacity Turbine Only (gpm)	Location
(#1) Ponderosa Hydro	250-255	45	6 and 2	1,300	Highway 26 at Ponderosa Way
(#2) Main Control Valve Hydro	175-195	20	6	1,300	Approximately ¾ mile north of the intersection of Highway 26 and Gill Haven Drive
(#3) Garamendi's Hydro	265-270	85	6 and 2	1,300	Approximately midway between Mokelumne Hill and Golden Hills Subdivision on Highway 26

Pump Stations

Railroad Flat Pump Station – The pump station has two 25 horsepower (HP) pumps that were installed in 2002. Each pump has 8 stages and a design capacity of 200 gpm at 290 feet TDH. Space is available for a third pump.

Water Storage Tanks

The existing water system includes the clearwell at the WTP and five water storage tanks that provide water storage for the maximum daily flow, peaking storage, and emergency storage (fire flow). Tank characteristics are summarized in Table 2.

TABLE 2. WATER STORAGE TANKS AND THEIR CHARACTERISTICS

Name	Nominal Capacity (MG)	Diameter (ft)	Height (ft)	Overflow Elevation (ft MSL)	Underflow Elevation (ft MSL)	Operating Range (ft)	Year Constructed
Jeff Davis WTP Clearwell	0.5	70	18	2743	2725	10 - 17	1972
Railroad Flat Tank	0.5	47	40	2957	2936	15-20	2002
Mokelumne Hill Tank	1.5	80	45	1847	1806	30-40	~ 1972
Golden Hills Tank	0.04	20	16	1655	1640	10-14	1980's
Paloma Tank	0.125	30	24	1658	1635	20-22	1977
San Andreas Tank	3.0	110	43	1370	1327	30-40	~ 1972
TOTAL STORAGE CAPACITY (MG)	5.66						

CHAPTER 3

Water Demands

Existing Water Demands

The District provided historical water usage records and number of active connections (or accounts) at the end of each calendar year; the data for the past 10 years is provided in Table 3.

TABLE 3. EXISTING WATER DEMANDS

Year	Number of Accounts (Meters) at End of Calendar Year [A]	Number of Inactive (Zero Use) Meters at end of Calendar Year [A]	Total Annual Water Treated (MG) [B]	Average Daily Flow (Water Treated) (MGD)	Average Daily Water Demand by Active Connection (gal/day/conn)
1998	1658	34	400.0	1.10	675
1999	1682	45	423.0	1.16	708
2000	1704	49	409.8	1.12	678
2001	1745	47	450.0	1.23	726
2002	1810	44	405.2	1.11	629
2003	1834	55	396.1	1.09	610
2004	1865	55	429.3	1.18	650
2005	1894	59	397.2	1.09	593
2006	1902	56	438.4	1.20	651
2007	1908	50	486.3	1.33	717

A – Data Source: “Usage and Loss Report” April 2008
B – Data Source: “Watershed Gallons Used .xls”

The data from the last 10 years indicates that the average daily water demand by active connection is 664 gpd.

The District also provided daily and monthly treated water reports for the years 2004 – 2007. The daily reports were searched for the highest production during any day, the maximum daily flow, for each of the years 2004 through 2007. The maximum daily flows for 2004 through 2007 are listed in Table 4.

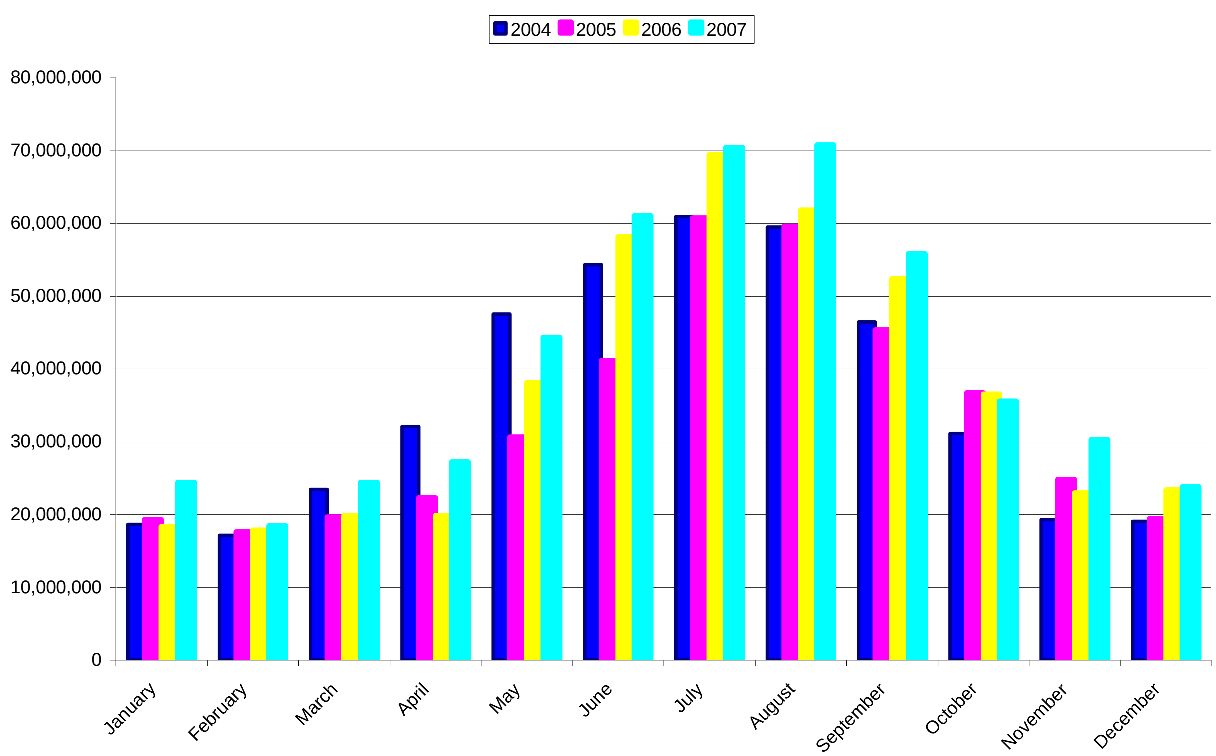
TABLE 4. MAXIMUM DAILY FLOWS, AND PEAKING FACTORS FOR 2004 - 2007

Date of Maximum Daily Flow (MDF)	Hours of Plant Operation	Water Treated (MG)	Treated Water Flow Rate (MG/hr)	Actual MDF Peaking Factor (MDF / ADF)
August 10, 2004	15	2.475	0.165	2.1
August 9, 2005	16	2.640	0.165	2.4
June 26, 2006	17.2	2.872	0.167	2.4
July 8, 2007	18.4	3.074	0.167	2.3

The maximum peaking factor may be greater or less than the actual maximum if some of the demands were met with additional storage in the tanks or if the storage increased. However, without mechanisms tracking the water flow into and out of tanks while tracking water level, such a maximum peaking factor is impossible to calculate. The industry standard maximum day multiplier is 2.0 times average day. This is relatively consistent with the maximum day peaking factors identified in Table 4. The average maximum day peaking factor is 2.3.

The monthly demand for water over the years 2004 through 2007 is shown in Figure 1. The graph reveals the typical seasonal demand highest in the summer months of July and August, and lowest in the winter months of January and February. The graph also shows that 2007 demand was higher in nine of the 12 months for all four years, suggesting an overall increase in the average demand for 2007.

FIGURE 1. MONTHLY VOLUMES OF TREATED WATER (GALLONS) FOR 2004 - 2007



Projected Future Water Demands

Projecting demands for the future expansion of the system consisted of applying a 2% annual growth rate in connections, compounded annually through 2030. The future demands are the product of the number of active connections and the historical average daily demand per active connection. The growth rate was established as a criterion to be used in constructing the hydraulic model, as described later in the report. The MDF was projected by multiplying the future average day demands by the historical average maximum day peaking factor (see Table 5, footnote C). The projected demand and meter connections over the planning period of 2030 using these growth rates are listed in Table 5.

TABLE 5. PROJECTED NUMBER OF SERVICES, ADF, MDF, AND MHF TO 2030

Year	Number of Services	Water Demand, ADF (MGD)[B]	Water Demand, MDF (MGD)[C]	Water Demand, Maximum Hourly Flow (MHF)[D] (MGD)
2008[A]	1898	1.26	2.90	4.35
2010	1975	1.31	3.02	4.52
2015	2180	1.45	3.33	4.99
2020	2407	1.60	3.68	5.51
2025	2658	1.76	4.06	6.09
2030	2934	1.95	4.48	6.72

A – Number of services in existence in March 2008.
B – ADF is equal to # of Services X 664 gal/day/conn, the historical average connection demand
C – MDF is equal to ADF x 2.3, which is the MDF peaking factor from historical data
D – MHF is equal to MDF x 1.5

Application of the demands to model nodes and potential future developments or new service areas is discussed later in the chapter titled "Hydraulic Model Development."

CHAPTER 4

Water Supply

The District obtains its water from the South Fork of the Mokelumne River at its pump station that moves water via the raw water pipeline to the Jeff Davis reservoir. The water right was obtained from the Mokelumne River Power and Water Company as deeded in January 19, 1939[2]. The State Water Resources Control Board requested a title search from an attorney documenting the paper trail to the origin of the water rights, which was discovered to have originated on March 21, 1853, as a water right originally obtained by Allen Cadwalader and Charles Cadwalader for the Mokelumne Hill Canal and Mining Company, for use in damming and mining. These individuals are suspected of being the first with interest of the water rights CPUD uses today on the Mokelumne River[3].

The District claims the water right is defined clearly in an August 16, 1940 agreement with East Bay Municipal Utility District, which stated CPUD has a right to a flow of natural and stored water of up to 15 cfs, up to a claimed amount of approximately 9,125 AF per year. Schaads reservoir storage, 1,800 AF per year, is included in that amount. However, a safe yield established in Water Right Order 16338 limits the maximum diversion to 6,656 AF per year.

The safe yield of the water right is more than adequate to supply the 2,181 AF of ADF water demands expected in 2030. At a 2% growth rate, the ADF will reach 6,656 AF in the year 2079.

[2] "Book 6 of Official Records at Page 194", presumably of the County of Calaveras Recorder.

[3] Water Right Permit for Diversion and Use of Water No. 16338

CHAPTER 5

Design / System Performance Criteria

The following assumptions and modeling criteria were used to prepare the hydraulic model and Master Plan, and were documented in a Technical Memorandum, April 15, 2008. The memorandum was approved as to its criteria and modeling approach by the District on April 18, 2008.

Some of these criteria are from the CPUD *Improvement Standards for Water Systems, Planning and Design* (Nov. 2003), and others are based on industry standards. Other assumptions or design criteria included in the CPUD Improvement standards that are not mentioned here are incorporated by reference.

Area of Consideration – The area of consideration for future service by the CPUD is the sphere of influence of the CPUD – the area where no other water district serves treated water. However, the existing distribution system serves as the backbone of such a future water system. Selected future pipelines to specific destinations, and increases in demands due to potential developments have been included in the future model scenarios with input from the District for application of future demands.

Population Projections – The population growth is assumed to increase 2% per year through the end of the planning period 2030. This value is used in lieu of the California Department of Finance population projections used in the Calaveras County General Plan. Two percent growth per year within the CPUD system is conservatively high compared to the average growth of 1.3% per year since 1995.

Water Demand Projections – The water demand is also assumed to increase proportionately with population. A Maximum Daily Flow (MDF) was developed using a maximum day peaking factor of 2.3. The projected growth of demands for 2% per year was checked against demands based on the CPUD standards using 250 gallons per person per day (with 3.5 persons per residential living unit) as applied to the projected future population. The maximum hourly flow (MHF) was calculated by multiplying MDF by 1.5.

Fire Flow Requirements – Fire flow requirements are set forth in Section 1007 of the CPUD Improvement Standards, and contact made with local fire districts resulted in using the CPUD standards. Contact was made with the Central Fire Protection District[4] (Glencoe, Rail Road Flat, and Independence), the Mokelumne Hill Fire Protection District[5] (Mokelumne Hill and Paloma), and the San Andreas Fire Protection District[6]. The application of fire flow District Improvement Standards were applied in the model on a case-by-case basis. The requirements are as follows: 500 gpm for single-family and duplex residential areas, 1,000 gpm for townhouse and multiple residential areas, and 1,500 gpm for schools and commercial areas.

Water Storage Criteria – Storage tank sizing is the sum of the three following storage calculations, but a minimum of 250,000 gallons: **Fire Storage Reservation (FSR):** Minimum volume of 4 hours times the

[4] Contact made with Central Fire Protection District Captain Terry Miller.
[5] Contact made with Mokelumne Hill Fire Protection District Chief Skip Cavalli.
[6] Contact made with San Andreas Fire Protection District Chief Don Young.

largest fire flow requirement supplied by the tank, in gallons. **System Peaking Storage (SPS):** 20% of the MDF (gpm) applied to 24 hours, in gallons. **Emergency Storage (ES):** 4 hours of MDF (gpm), in gallons.

Water Pumping Criteria – The size of any pumping station in the system is the MDF with the largest pump out of service (assuming gravity flow to services rather than pumped flow). The hydropneumatic system at Glencoe (Independence Road) is excluded from the model.

Water Distribution System Evaluation Criteria – Criteria for Transmission Lines and Distribution Lines are identified. **Transmission Lines:** size lines to pass the modeled MHF at maximum velocity of 5 feet per second (ft/s). **Distribution Lines:** Size to pass MHF at 35 psi minimum at model nodes. Maximum system pressure 115 psi at model nodes. Pressure may drop to 20 psi minimum at model nodes during fire flow demand plus MDF. Pipes shall use Hazen Williams "C" factor of 140 for new pipe, and 120 for existing pipe. Minimum size lines for future construction is 6 inches in diameter, and 8 inches or larger in some cases in accordance with the District Improvement Standards, Section 1012, paragraph C.

Water Treatment Capacity and Raw Water Supply – The water treatment plant and raw water supply system (pumps and pipes) will be sized as criteria above are applicable, and to supply the MDF. MHF will be assumed to be supplied from system storage. Clearwell capacity will be sized to meet MDF, but will include additional storage for Water Treatment Plant (WTP) backwash operations and filter outages.

CHAPTER 6

Hydraulic Model Development

A hydraulic model was developed using H2OMap Water 8.0, a GIS-enabled hydraulic modeling software package. The model was created by importing MapWindow™ GIS files created by the District into the H2OMap Water software ("modeling software"). Layers of data in the MapWindow™ GIS were imported to layers in the modeling software. For example, lines representing pipelines were translated directly to pipes in the modeling software. The H2OMap Water software can export the hydraulic model into EPANET format, for convenience of modeling the water system using EPANET software. However, many of the GIS features in H2OMap Water are not exportable in EPANET software, such as background aerial photographs, topographic contours, and road mapping.

The result is a hydraulic model including the distribution system, clearwell and storage tanks, pressure reducing valves, and fire hydrants. The model was run under different water supply and demand scenarios. The scenarios created for this master planning effort include average daily flow, maximum daily flow with fire flow demand, and maximum hourly flow. The scenarios were created for the existing distribution system (2008 system with 2007 demands), and for the projected future distribution system (2030 system with 2030 demands). The raw water system and the water treatment plant process are not modeled.

Nodes are created in the modeling software where pipe segments intersect. Such intersections, or nodes, were kept intact from the importing process. The result is the model contains 837 pipe segments and 813 nodes. The number of pipes and nodes is inconsequential to the accuracy of the modeling calculations, but is an administrative feature in functionality of the modeling software. Pipes in the model vary in length from less than 1 foot to longer than 10,500 feet. Every node in the model is assigned an elevation, and elevations were obtained by purchasing a Digital Terrain Model (DTM) from INTERMAP™ Technologies covering a 30 square kilometer area including the District's water system. The DTM elevation data are said to have a mean accuracy of plus or minus 3 feet, which is more than adequate for water system modeling. The DTM data were added to the model then interpolated by the model to assign elevations to model nodes. Nodes in the model vary in elevation from 772 feet to 2,947 feet. Elevations for water storage tanks were not interpolated, but taken from District records.

The water treatment plant is represented in the model as a reservoir with unlimited supply and a fixed head of 2,735 feet elevation, an elevation of half the height of the clearwell.

Existing System

For creation of the model, water services were assigned to the nearest model node based on GIS service locations provided by the District. Each water service is then assigned a demand (as discussed in Chapter 3) in order to develop the total demand for each node.

Applying specific metered demands, from District records for example, could produce a more accurate means of applying demands in the model; however, such detailed analysis generally is unnecessary in master planning and was not accomplished in this model and Master Plan.

Pressure reducing valves were installed where indicated in the District's MapWindow™ GIS files, along with the indicated outlet pressure settings.

Future System

The future system was constructed using the existing system as the basis then adding specific features to the model based on District opinion of future development. Specific features included:

- Adding 500 units northeast of the intersection of Highway 12 and Highway 49, represented by a single node served from the Garamendi's Hydro Pressure Zone
- Adding 150 units northeast of the intersection of Mountain Ranch Road at Pope Street, at W. Murray Creek Road, represented by a single node served from the San Andreas Tank Zone
- Adding 100 new units along the Mountain Ranch Road Corridor, represented by a single node served from the Railroad Flat Zone
- Adding 100 new units in the Toyon area, represented by a single node served from the San Andreas Tank Zone
- Adding 200 new units in Phase II of the Saddleback subdivision north of Saddleback Drive and east of highway 49, represented by a single node served from the San Andreas Tank Zone

The combined demands of the specific features exceeded the projections of demand for 2,934 service connections in 2030. The excess demand was kept in the model as conservative measure to slightly overestimate demand by 2%. The District's standard demands were not used, but historical demands were used to project future demands as discussed previously[7].

[7] The District's standards indicate an ADF between 600 gpd per unit and 700 gpd per unit. The standard demand was compared to the ADF, MDF, and MHF values stated previously, and is commensurate with the historical demand.

CHAPTER 7

Existing System Analysis

The performance of the existing water system was simulated using the modeling software under three scenarios:

- Average Daily Flow
- Maximum Daily Flow (including fire flow)
- Maximum Hourly Flow[8]

The calculated results were checked to meet the performance criteria discussed previously. Results of the analysis on the existing system are presented in the following subsections.

System Pressures

System pressures are highest during the low demand periods represented by the ADF scenario, and lowest during the MHF scenario. High and low pressure areas are discussed below.

High Pressure Areas modeled in the ADF scenario

High pressure areas were discussed with District staff and conclusions drawn that the highest pressure areas exceeding the District standard of 115 psi maximum are already known by the District or are used by the Hydros to generate electricity.

The modeled high pressure areas of the system include:

1. Along the transmission main in Highway 26, prior to the Ponderosa Hydro modeled pressures exceed 220 psi
2. Along the transmission main in Highway 26, prior to the MCV Hydro modeled pressures exceed 210 psi
3. Along the transmission main toward the Mokelumne Hill tank and prior to Garamendi's Hydro, modeled pressures approach 250 psi
4. Near the intersection of Easy Bird Road and Center Street in Mokelumne Hill, modeled pressures exceed 155 psi
5. East of the intersection of Highway 49 and Highway 26, modeled pressures exceed 120 psi

[8] The Maximum Hourly Flow is calculated to check the water velocity against the District's standard in transmission mains as discussed previously.

6. At the dead end of Miwok Trail beyond Victor Court in Mokelumne Hill, modeled pressures exceed 165 psi

7. Along Center Street and Highway 49 in Mokelumne Hill modeled pressures approach 150 psi at the westernmost end of the pipeline

8. The pipeline extension from Highway 49 to the Mokelumne Hill Campo Seco Turnpike west of Howard Lane, modeled pressures exceed 156 psi

9. The Pipeline to Paloma from Mokelumne Hill, pressures are up to 200 psi at the low point in the Highway 26

10. Along Gwin Mine Road, north of Paloma Road, modeled pressures exceed 135 psi

11. Along Paloma Road, south of Goodell Road, modeled pressure exceed 125 psi

12. Along Highway 49 near Lombardi Drive, at the Golden Hills Subdivision entrance, and along Hallas Drive, modeled pressures approach 180 psi

13. Along Highway 49 south of the Garamendi Hydro and onto Gold Strike Road near Leonard Road, modeled pressures exceed 220 psi, with the highest pressure approaching 265 psi near Howard Road

14. Along Gold Strike Road north of Cemetery Avenue modeled pressures exceed 150 psi.

15. Along Lewis Ave south toward Pope Street, pressures approach 150 psi

16. The area encompassed by Toyon Court / Toyon Drive, and Mountain Ranch Road from Highway 49 to Park Drive, pressures exceed 120 psi.

Some of these high pressures have existed for many years, and may pose no problem to the integrity of the transmission or distribution systems. The San Andreas tank depends on the high pressures in the transmission main due to its elevation. The model indicates a residual pressure of approximately 20 psi under the ADF condition. This pressure drops during MDF or MHF, so the high pressures in the pipelines to the tank are necessary to fill the tank by gravity alone. Reducing pressures along the transmission route would reduce pressure to the storage tanks in the system, and also to the one low pressure area along Sunset Street, Mariposa Street, and Oak Street in the Church Hill pressure zone.

Reducing pressure into the Golden Hills subdivision would reduce the low residual pressure (modeled as approximately 6 psi) at the Golden Hills Tank that is already experienced during high demand periods. A similar low pressure condition exists at the southern end of Saddleback Drive (approximately 23 psi during high demand). Reductions in the San Andreas Tank Zone pressure mains to reduce high pressure areas will result in a further reduction in the Saddleback Drive pressure.

A pressure reducing station, could be installed along the pipeline to Paloma to reduce the pressure leading to the Paloma tank. It could be installed to reduce up to approximately 60 - 70 psi[9]. The pressure at the Paloma tank decreases to less than 10 psi on the inlet during the existing MHF condition, but installation of a pressure reducing station may only reduce the pressure at the tank by a few psi during the MHF condition.

Other local high pressures not along the transmission route will be reduced, as well as high pressures at residences. Maintenance and operation of the PRVs becomes problematic if the District owns and maintains many PRVs, or if PRVs are placed on select customer services rather than the water main.

Low Pressure Areas modeled in the MHF scenario

Areas of low pressure modeled in the MHF scenario include areas near the water tanks[10], and at higher elevations in the distribution system. Specific locations include:

1. The area on the discharge side of the Railroad Flat tank, including to the east on Ridge Road, modeled pressures are less than 20 psi near the tank, and less than 30 psi east on Ridge Road

2. The area in the immediate vicinity of the suction side of the Glencoe pump station, modeled pressures are less than 15 psi

3. The transmission pipeline immediately downstream of the MCV hydro, modeled pressure is less than 25 psi

4. The inlet and outlet pipelines from the Mokelumne Hill tank, modeled pressures are approximately 15 psi

5. The immediate vicinity of the outlet side of the Paloma tank, modeled pressures are approximately 10 psi.

6. The inlet/outlet of the Golden Hills tank, modeled pressures are approximately 6 psi

7. The immediate vicinity of the inlet and outlet side of the San Andreas tank, modeled pressures are less than 25 psi.

8. The area along Sunset Street, Mariposa Street, and Oak Street in the Church Hill pressure zone, modeled pressures are approximately 30 psi

9. The southern end of Saddleback drive, modeled pressures are less than 25 psi

[9] At the time of writing of this document, the District was in the process of installing a pressure reducing station on the pipeline to Paloma.
[10] Low water pressures in the system near water storage tanks are typical for all water systems; there is not enough elevation difference between the tank and the nearby residences to generate higher pressures.

The low pressures in the immediate vicinity of storage tanks are generally expected, and frequently accepted. However, the low inlet side pressure of the Golden Hills Tank causes concern, especially if future demands cause a further reduction in pressure, causing an inability to fill the tank for the subdivision. The 6 or 7 psi pressure is insufficient to fill the tank completely, especially during the hottest times of the year when water demand is highest. A local pump station can be constructed to boost pressure to the storage tank. A local booster pump station on Lyle Court could be constructed to fill the tank during times of highest demand; however, the added pressure would cause pressures south on Lombardi Drive at Golden Hills Court to exceed the District's standard of 115 psi. Alternatively a pump station with a dedicated fill line to the tank could be constructed, which would avoid over-pressurizing any of the Golden Hills subdivision. However, installation of such a pump is not necessary when considering the excess storage volume available from the Mokelumne Hill tank as discussed later. Also, since the Golden Hills tank is "floating" on the water pressure of the system, installing a pump system would introduce capital and operating costs that are not necessary.

The preferred solution to low pressures on dead end pipelines is to upsize the pipe; however, dead end pipelines could be equipped with hydropneumatic systems if low pressures are unacceptable and/or problematic and funds for main replacement are not available. Other customers within the San Andreas Tank zone could be equipped with a local hydropneumatic system, because attempting to increase pressure in the San Andreas Tank zone would prove to increase pressures in areas with already high pressures.

The Church Hill zone in San Andreas is another area experiencing low pressure. The pressures are approximately 30 psi, within 5 psi of the District standard. The District may consider relaxing or reducing its low pressure standard for this pressure zone. However, the existing distribution system piping is shown to be as small as 2 or 3-inch in some parts of the Church Hill zone. This piping can be upsized and, if needed, PRV settings can be modified in order to boost pressure to this area.

Low pressures on the main transmission line between the WTP and the Ponderosa hydro, the Glencoe pump station area, are difficult to increase without making major modifications to the clearwell system (e.g. elevating the clearwell). Individual hydropneumatic systems for local customers is appropriate for boosting the pressure off of the transmission line near the Glencoe pump station.

Storage Tank Capacity

The storage tanks were evaluated for capacity in accordance with the District standards presented previously. The standards are:

- **Fire Storage Reservation (FSR, gallons):** Minimum volume of 4 hours times the largest fire flow requirement supplied by the tank.
- **System Peaking Storage (SPS, gallons):** 20% of the MDF (gpm) applied to 24 hours.
- **Emergency Storage (ES, gallons):** 4 hours of MDF (gpm).

To calculate volumes for the storage requirements, the hydraulic model was run in the MDF scenario, and demands drawn from the storage tank were tabulated, and requirements calculated. The storage requirements for each of the tanks in the water system, excluding the clearwell are provided in Table 6.

TABLE 6. STORAGE TANK CAPACITY ANALYSIS BASED ON EXISTING MDF

Storage Tank Name	Nominal Capacity (gallons)	Existing MDF Demanded From the Tank (gpm)	Highest Fire Flow Requirement in the Tank Zone (gpm)	Fire Storage Reservation (gallons)	System Peaking Storage (gallons)	Emergency Storage (gallons)	TOTAL Storage Tank Volume Requirement (gallons)
Railroad Flat Tank	500,000	48	1,500 School	360,000	13,801	11,501	385,302
Mokelumne Hill Tank	1,500,000	495[A]	1,500 Commercial	360,000	142,376	118,646	621,022
Golden Hills Tank	40,000	48	500 Residential	120,000	13,792	11,494	145,286
Paloma Tank	125,000	104	500 Residential	120,000	30,047	25,039	175,086
San Andreas Tank	3,000,000	1,070	1,500 Commercial	360,000	308,146	256,788	924,934
TOTAL STORAGE CAPACITY	5,165,000						

A – The Mokelumne Hill tank directly serves the demands for Mokelumne Hill and all services downstream along Hwy. 49 prior to the San Andreas Tank (excluding the Northern Golden Hills area).

The capacity analysis for the existing MDF demands indicates that storage volume requirements are met per the District standards. The calculations reveal a deficit for the Golden Hills and Paloma Tank; however, excess storage capacity in the Mokelumne Hill Tank can be accounted against those deficits, leaving the Mokelumne Hill tank with a remaining excess of 723,606 gallons. The District also has an additional 500,000 gallons of available upstream storage at the Jeff Davis WTP clearwell.

Velocity of Water in Transmission Lines at MHF

All transmission lines in the water system meet the District criteria of passing the existing MHF with the velocity of the water at 5 feet per second or less. Flow velocity in the largest 27-inch diameter transmission lines is less than 1 foot per second and in the 16-inch diameter transmission lines is less than 4.25 feet per second during the existing MHF. The highest velocities occur in the 16-inch diameter transmission line downstream of the Mokelumne Hill tank because of the system demands in San Andreas. The MHF flows occur seldom, and rarely require pipeline replacement to stay within a standard velocity. In this case, the velocity is less than the standard, so no replacement is recommended.

Pump Stations

The existing raw water pump station includes two 400 HP pumps designed to pump 2,000 gpm at 650 feet TDH individually, and approximately 3,360 gpm at 740 feet TDH. The maximum flow rate is approximately 4.8 MGD, more than the existing MDF. However, the volume of storage in the terminal reservoir, 2,300 AF (749 MG) is abundant and will temper the fluctuations in instantaneous demand between the raw water supply and treated water demands. The existing raw water pumps are adequate in capacity for the District’s existing needs.

The Railroad Flat water pump station includes two 25 HP pumps designed to pump 200 each gpm at 290 feet TDH. The MDF of the Railroad flat area is 60 gpm, less than one-third the capacity of the pumps. The existing treated water pumps are adequate in capacity for the District's existing needs.

The Glencoe pump station was excluded from the hydraulic model; however, the demands on the pipeline were modeled at approximately 27 gpm, MDF. Water is pumped into a 20,000 gallon hydropneumatic tank. Hydropneumatic system sizing is not included here; however, a consideration of system reliability is included. Power loss at the Glencoe pump station occurs multiple times a year, according to the Department of Public Health (DPH) inspection report from 2007 and District staff concurrence. The reliability of keeping customers in water on the Glencoe pump station can be improved by finding an alternate means of providing water at higher pressures to the system. Options include serving water to the Glencoe customers from the Railroad Flat area. A pipeline of approximately 7,750 feet in length could be constructed in Ridge Road to serve water at up to approximately 90 psi to the customers. The additional demand would turn over the water in the Railroad Flat tank more often, which is desirable due to its large size, and current low demand. Construction of a 6-inch diameter pipeline would cost approximately $135 per linear foot, resulting in a total construction cost of approximately $1.0 million[11]. Additional customers may be inclined to purchase water from the system if a new pipeline were constructed in Ridge Road.

Alternatively, the reliability of the Glencoe system could also improve by installation of a storage tank on the hydropneumatic system. Purchase of additional land, and site preparation and construction of a 50,000 gallon at-grade steel storage tank would cost approximately $500,000.

A third option for adding power supply reliability would be to install a backup power generator. Construction and installation of a pad-mounted generator, fuel tank, and ancillary facilities would cost approximately $160,000.

Hydros

The existing Hydros as mentioned previously in Table 1 have a capacity of 1,300 gpm, excluding the use of any bypasses. Use of the turbine and the bypass, results in passing flows of up to 2,700 gpm, according to District staff. Furthermore the use of the turbines and the bypasses, only converts a portion of the pressure energy into electricity. If the turbines (1,300 gpm capacity each) were replaced with those of twice the capacity, 2,600 gpm, they could pass the full existing MDF, all the time generating up to twice the electricity for CPUD that would have otherwise been lost by water moving through the bypass.

By comparison, the ADF is expected to reach 1.94 MGD by 2030. The capacity of the hydros is approximately 1.9 MGD. By 2029, the hydros would be operating full-time with regular use of the bypass during hot dry seasons.

[11] Costs are presented in 2009 dollars unless noted otherwise.

Estimating revenue from additional electricity sold suggests an additional $10,000 to $15,000 per year could be made by passing more flow through the three existing turbines[12]. Over a 10 year period, additional revenue of $100,000 to $150,000 could be made to help offset re-construction costs, or maintenance costs. A feasibility study of re-construction and economics to increase the capacity of the existing turbines is recommended.

Fire Flow Analysis

A fire flow analysis was performed on the model, calculating many locations in the model for available fire flow based on a minimum residual pressure of 20 psi at the hydrant (node) and a minimum pressure of 20 psi anywhere in the system. The fire flow analysis ignored low pressure nodes near tanks and at extreme elevations, such as at the southern end of Saddleback Drive in San Andreas. The results indicate approximately one-third of the nodes cannot serve their assigned fire flow demand without reducing pressure at the hydrant node or somewhere else in the system below 20 psi.

Fire flow demands were assigned to model nodes based on the District standards as identified in Chapter 5. The fire flow analysis results for each general area are as follows:

- The Railroad Flat area generally has available fire flows ranging from approximately 500-1,000 gpm. Increased fire flows above this range results in low pressures along Ridge Road.

- Fire flows are adequate for both the Paloma and Golden Hills areas.

- Fire flows for the Glencoe area were not analyzed.

- The Mokelumne Hill area has approximately 12 out of 57 nodes that could not meet their assigned fire flow demand.

- The San Andreas area has approximately 42 out of 108 nodes that could not meet their assigned fire flow demand.

The fire flow analysis identifies a lower level of fire protection than is standard; however, the re-construction of the distribution system simply for fire flow availability is expensive and not required by the Department of Public Health. Coordination with the local fire districts informing them of available fire flows within the water system is recommended to allow them to make appropriate measures to ensure fire protection for the community. Upgrades to distribution pipelines to increase fire flow are identified in the model results and shown in Appendix C. The upgrades include approximately 25,488 linear feet of pipeline replacements which are recommended to be implemented with future main replacement projects. In addition, it is recommended to replace any normally closed valves in the distribution system with PRV's in order to add additional fire flow supply sources. Some existing PRV's settings' were changed to help increase fire flow. Those changes include the following:

[12] Calculation assumes flow of approximately 2.5 MGD generating electricity in proportion to the current generating rate, for 6 months of the year, 12 hours per day, and sold at $0.10 per kWh.

- Church Hill PRV #1 – increase pressure setting from 19 psi to 30 psi
- Angels Road PRV – decrease pressure setting from 72 psi to 60 psi
- Grammar School PRV – increase pressure setting from 75 psi to 95 psi
- Ken James PRV – reverse direction to deliver water north and east, set pressure at 75 psi.
- Replace the normally closed valve along Gold Strike Rd with a new PRV flowing towards the San Andreas Tank Pressure Zone, set pressure at 165psi.
- Replace the normally closed valve at Hwy 49 & Fahily Cir. with a new PRV flowing towards the Angels Rd. Pressure Zone, set pressure at 80psi.

Making these PRV changes would increase fire flow, yet act as PRVs or normally closed valves under normal system pressures.

Water Treatment Plant

The WTP treats water from the Jeff Davis Reservoir using the following treatment train:

- Pretreatment, using polymer addition for coagulation
- Filtration, using anthracite coal and sand media pressure filter loaded up to 3 gpm/sf
- Disinfection, using chlorine gas addition pre- and post-filtration
- Corrosion Protection, using zinc orthophosphate addition

The filtration process is not considered conventional since it lacks the treatment steps for flocculation and sedimentation included in a conventional filtration process. Because of this, California Department of Health Services (CDPH) considers the CPUD WTP filtration process to be an alternative filtration technology under the Surface Water Treatment Rule (SWTR).

Regulatory Compliance

Under the most recent version of the SWTR, the Long-Term 2 Enhanced SWTR, Cryptosporidium, Giardia and virus removal credits are a function of the treatment process. The removal credits are divided into two processes: filtration and disinfection. Compliance with the Long-Term 2 Enhanced SWTR is predicated on compliance with combined and individual filter effluent turbidity standards and disinfection "CT" requirements. The CPUD WTP is scheduled to begin monitoring for the Long-Term 2 Enhanced SWTR in October 2008 and must comply with any Cryptosporidium treatment requirements that are identified during the monitoring by October 2014.

Based on the good raw water quality (low turbidity and low total coliform counts), the treatment requirements for the CPUD WTP are set at 3-log Giardia removal and 4-log virus removal. The "alternative" filter technology used at the CPUD is granted 2-log removal credits for Giardia and 1-log removal credit for viruses. The remainder of the treatment requirements are met through disinfection: 1-log Giardia and 3-log virus removal. Table 7 summarizes these treatment requirements.

TABLE 7. WTP SWTR TREATMENT REQUIREMENTS AND REMOVAL CREDITS

	Giardia Removal	Virus Removal
Total Treatment Requirements	3-log	4-log
Granted Filter Removal Credits	2-log	1-log
Disinfection Removal Requirements	1-log	3-log

Currently, the only limitation on the WTP's capacity is the ability to provide disinfection. The disinfection removal requirements for Giardia and viruses are based on the disinfectant concentration (C) and the contact time (T) – or "CT." Required CT values are a function of water temperature, pH, and disinfectant concentration. The worst case disinfection requirements usually occur during the spring, when water temperatures are low and water demand can be high. CT values for these conditions are about 60 min-mg/L. Based on a chlorine residual level of 1.4 mg/L, the required contact time is 43 minutes.

At the current operating capacity of 4 MGD, the contact time is 45 minutes total. The contact time is the sum of the contact time in the clearwell (at minimum water depth) and the 3500-feet of 27-inch pipeline from the clearwell to the first customer. Therefore, the WTP is limited to a capacity of 4 MGD until either the disinfectant concentration or the contact time is increased. Increasing the disinfectant concentration is not considered a long-term solution since higher chlorine levels lead to higher disinfection by-product formation in the distribution system.

The problem is that the clearwell is not baffled. CDPH only gives about 7 minutes of contact time credit for the clearwell at 4 MGD. Adding baffles to the clearwell could increase the contact time to about 20 minutes at 6 MGD, which would provide a total contact time of about 45 minutes at 6 MGD.

CHAPTER 8

Future System Analysis

The performance of the future water system was simulated using the modeling software under three scenarios:

- Average Daily Flow
- Maximum Daily Flow including fire flow
- Maximum Hourly Flow

The calculated results were checked to meet the performance criteria discussed previously. Results of the analysis on the future system are presented in the following subsections.

System Pressures

System pressures are highest during the low demand periods represented by the ADF scenario, and lowest during the MHF scenario.

High Pressure Areas modeled in the ADF scenario

High pressure areas identified previously for the existing ADF scenario are tempered by the increase in ADF. Overall the higher pressures drop by a few psi due to increased head losses due to the projected increase in ADF by more than 50% by 2030. Pressure reducing stations that are installed to reduce pressures based on existing ADF can be adjusted in the future to increase pressure downstream due to head losses because of the increased ADF projected for 2030.

Low Pressure Areas modeled in the MHF scenario

Areas of low pressure modeled in the future MHF scenario continue to include areas near the water tanks and at higher elevations in the distribution system. Pressures decrease only by few psi at maximum. The existence of sufficient pressure in the transmission main and in other areas of the system prevents the loss of more pressure under higher MHF demands. In addition, the multiple tanks across the system supply those higher MHF demands, keeping major head losses lower than if the transmission main was the sole supply of the higher MHF.

Storage Tank Capacity

The storage tanks were re-evaluated for capacity in accordance with the District standards presented previously, but using the future MDF demands. The standards are:

- **Fire Storage Reservation (FSR, gallons):** Minimum volume of 4 hours times the largest fire flow requirement supplied by the tank.
- **System Peaking Storage (SPS, gallons):** 20% of the MDF (gpm) applied to 24 hours.
- **Emergency Storage (ES, gallons):** 4 hours of MDF (gpm).

The results of the re-evaluation of the tanks in the water system, based on the future MDF scenario, excluding the clearwell are provided in Table 8.

TABLE 8. STORAGE TANK CAPACITY ANALYSIS BASED ON FUTURE MDF

Storage Tank Name	Nominal Capacity (gallons)	Future MDF Demanded From the Tank (gpm)	Highest fire flow Requirement in the Tank Zone (gpm)	Fire Storage Reservation (gallons)	System Peaking Storage (gallons)	Emergency Storage (gallons)	TOTAL Storage Tank Volume Requirement (gallons)
Railroad Flat Tank	500,000	159	1,500 School	360,000	45,671	38,059	443,730
Mokelumne Hill Tank	1,500,000	1,178[A]	1,500 Commercial	360,000	339,181	282,650	981,831
Golden Hills Tank	40,000	52	500 Residences	120,000	15,005	12,504	147,509
Paloma Tank	125,000	114	500 Residences	120,000	32,679	27,233	179,912
San Andreas Tank	3,000,000	1,345	1,500 Commercial	360,000	339,181	322,718	1,069,980
TOTAL STORAGE CAPACITY	5,165,000						

A – The Mokelumne Hill tank directly serves the demands for Mokelumne Hill and all services downstream along Hwy. 49 prior to the San Andreas Tank (excluding the Northern Golden Hills area).

The future capacity analysis for the future MDF demands indicates that storage volume requirements are met per the District standards. The calculations reveal a deficit for the Golden Hills and Paloma Tank. However, excess storage capacity in the Mokelumne Hill Tank can be accounted against those deficits, leaving the Mokelumne Hill tank with a remaining excess of 355,748 gallons. The District also has an additional 500,000 gallons of available upstream storage at the Jeff Davis WTP clearwell.

Velocity of Water in Transmission Lines at MHF

All transmission lines in the water system are modeled to meet the District criteria of passing the future MHF with the velocity of the water at 5 feet per second or less. Flow velocity in the largest 27-inch diameter transmission lines is less than 1 foot per second in the future MHF scenario, and in the 16-inch diameter transmission lines is approximately 4.4 feet per second during the future MHF. The highest velocities occur in the 16-inch diameter transmission line downstream of the Mokelumne Hill tank because of the system demands in San Andreas. The MHF flows occur seldom, and rarely require pipeline replacement to stay within a standard velocity. In this case, the velocity is less than the standard, so no replacement is recommended.

Pump Stations

As discussed previously, the existing raw water pumps' capacity, in conjunction with the storage in the Jeff Davis reservoir, is more than sufficient to meet the District's raw water pumping needs well beyond 2030.

The Railroad Flat pump station capacity is 400 gpm, well above the 238 gpm MHF demand projected for 2030 in the Railroad Flat area.

The reliability of power and water to the Glencoe pump station, as discussed previously is the key aspect of its evaluation. Any improvements made would last beyond 2030 as significant increases in demand at Glencoe or from new customers along Ridge Road are not anticipated.

Pipelines

One of the specific features of the future hydraulic model includes potential service to Toyon. The route extending a pipeline to Toyon can be made from the Paloma system, or the San Andreas system.

Extending a pipeline from the Paloma system to Toyon would be made prior to the Paloma tank, so demands would be served from the Mokelumne Hill Tank. Furthermore, during the MHF, pressures at the Paloma tank, near the potential point of connection, are less than 10 psi. Adding demands will decrease that pressure further during the MHF. The pipeline would be approximately 3.75 miles long along Highway 26 to its intersection with Highway 12. At $135 per linear foot for 6-inch diameter pipe, the cost is $2.7 million.

An alternate route may be along Highway 12 into San Andreas. The San Andreas tank has excess storage capacity into 2030, and all water traveling to Toyon would move through all three Hydros, instead of just two if connected to the Paloma pipeline. The total length is approximately 1.5 miles longer, however. At $135 per linear foot for 6-inch diameter pipe, cost to construct a pipeline 5.25 miles long to San Andreas would cost $3.7 million.

Head losses in a 6-inch diameter pipe to Toyon are approximately 8.5 psi per mile of new pipeline (C=140), so head from the San Andreas tank (1,361 feet) or the Paloma system from the Mokelumne Tank (1,634 feet) could deliver sufficient pressure to Toyon (elev. 1,000 feet). More options would be available to serve gravity water to areas in higher elevation if connected to the Paloma system. Pressure reducing stations would be necessary if connected to the Paloma system to reduce the pressure down from approximately 240 psi. Storage considerations in Toyon should also be made for reliability due to the long pipeline route from the water source.

Hydros

Evaluation of increasing capacity of the Hydros, as mentioned previously, should consider future demands and economics for sale of electricity into the foreseeable future and useful life of the hydros. Installation of additional hydros is not economical for any pipeline except the transmission main, which is already at capacity for hydros. No additional hydros are recommended for installation.

Raw Water Reservoirs

As mentioned previously the Jeff Davis reservoir has more than adequate capacity to serve the demands of the District. However, all water used by the District's Jeff Davis WTP is pumped water. There is an opportunity to re-construct all or a portion of the middle fork Mokelumne River diversion canal to bring water by gravity to the existing pump station or to the Jeff Davis WTP.

The Schaads reservoir is approximately 6.25 miles northeast of the Jeff Davis reservoir in a straight line. The Schaads Reservoir is at approximately 2,910 feet, where the Jeff Davis reservoir is at approximately 2,760 feet. Moving water through the Schaads reservoir to the Jeff Davis Reservoir may be feasible using a ditch and tunnel. The terminus could be the existing raw water pump station, offering additional suction side head for the existing pump station, reducing pumping costs.

Alternatively, a dedicated canal / tunnel may also be hydraulically feasible. Either option would require a tunnel or pipeline to cross higher elevations with the gravity water. The available head of 150 feet appears more than adequate to carry all the District's water to the Jeff Davis reservoir by gravity, potentially eliminating the need for pumped water. The largest challenge with such a project would be to obtain right of way and to overcome the initial capital expense.

The existing contract between CPUD and CCWD for the sale of up to 200 AF/yr of raw water to CCWD reduces the overall yield from the reservoir, but it still retains a majority of its capacity for use by CPUD.

Preliminary calculations of power savings from eliminating pumped water from the Mokelumne River indicate a cost savings of approximately $100,000 per year[13]. Such savings would be offset by capital costs to construct a canal / tunnel. Construction of a canal / tunnel from Schaads reservoir would have a long payback period. Assuming a price of $500 per linear foot for a 6.25 mile tunneled pipeline, the cost is $16.5 million. Savings from pumping costs at the Mokelumne River offer a payback in 165 years. Adding revenues from increased power generation at the Schaads reservoir of $300,000 per year[14] reduces the payback period to approximately 42 years. If such a canal / tunnel directly to the Jeff Davis WTP were constructed, the raw water pump system could be maintained as a backup system when water from Schaads is poorer in quality or quantity. Because of the long payback period, the construction of the canal / tunnel is not recommended.

Water Treatment Plant

The maximum daily flow for the WTP is anticipated to be 4.5 MGD in 2030. This will not exceed the WTP's current capacity of 6 MGD. Therefore, the overall plant will not require expansion before 2030. Planning for expansion of the WTP beyond 6 MGD should begin when the maximum daily flow reaches 5.1 to 5.4 MGD (85-90% of the WTP capacity), which is anticipated to occur in about 2037. Issues to be addressed during the expansion of the WTP include:

- **Filtration technology selection:** The current pressure filtration technology is an acceptable alternative technology at the present time.

- **Additional treated water storage:** Storage volume to meet both disinfection contact time requirements and peak hour distribution system demands.

- **Avoid in-plant pumping:** The current WTP configuration uses the water elevation in Jeff Davis Reservoir force the raw water through the filters and up into the clearwell via gravity. Most other

[13] Preliminary calculations assume 3,836 hours of operation per year of one 400 HP pump, purchasing electricity at the cost of $0.10 per kWh.

[14] Assuming a hydro producing 225 kW of power, while flowing 2,900 gpm, an approximate ADF in the year 2054, with power sold at $0.15 per kWH.

filtration technologies would require pumping into the clearwell including membranes and conventional filtration.

The WTP is scheduled to begin monitoring for the Long-Term 2 Enhanced SWTR in October 2008 and must comply with any Cryptosporidium treatment requirements that are identified during the monitoring by October 2014. The monitoring data collected will assign a “BIN” number to the WTP. Based on the good raw water quality (low turbidity and low total coliform counts), the Cryptosporidium treatment requirements for the WTP are expected to be BIN 1. This means that no additional treatment is required – even for direct filtration facilities such as the Jeff Davis WTP.

The WTP staff has found that replacing the pressure filter media every 10-12 years is necessary. The last time the filter media was changed was in 2005. Provisions should be made to replace the media again in 2015 and 2025.

CHAPTER 9

Recommended Capital Improvement Plan

Selected projects mentioned in the analyses above are brought forward into a Capital Improvement Program (CIP). The CIP is provided in detail for 6 years, and beyond 2010 in 5 year increments. Projects are included in the CIP, despite the possibility of funding provided by an assessment district; however, such funding should be reviewed prior to finalizing the plan. Such an approach provides for the worst case scenario (most expensive) CIP to the District.

Some other projects that have been desired by the District, that are not specifically evaluated or mentioned in this report, are included in the CIP where possible. Other projects, where the payback period is excessive (e.g. a period longer than the useful life of the equipment) have been excluded from the CIP.

An annual repair and replacement of distribution pipelines in the system is included, intending to cover costs associated with newly leaking pipes that require regular replacement. The annual cost assumes approximately 25% of the system pipelines are at or near their useful life, and will require replacement in the next 22 years through 2030. The costs are evenly distributed over the 22 year period, assuming dollars per unit identified in Table 9.

TABLE 9. UNIT COSTS FOR REGULAR REPAIR AND REPLACEMENT OF PIPELINES

New Pipe Diameter (in)	To Replace Pipes of existing diameter (in)	Planning Construction Cost per linear foot[A] ($/lf)	Existing System Linear Footage from Model (lf)	25% of linear footage to be replaced (lf)	Total cost annualized through 2030 ($000)
6	2, 3, 4, 6	135	371,416	92,854	12,500
8	8	150	28,428	7,107	1,000
12	10, 12	170	92,699	23,175	4,000
TOTAL				123,136	17,500

A – Includes engineering design, administration, contingency, and construction costs.

The entire CIP, shown in Table 10, includes eight categories, with a total of 15 projects, and an estimated construction for design, administration, and construction of approximately $23 million in 2009 dollars.

TABLE 10. CAPITAL IMPROVEMENT PLAN FOR 2009 – 2030 ($000, 2009)

INSERT EXCEL TABLE

APPENDIX A

Figures from Hydraulic Model

APPENDIX B

Pressure Zone Map

APPENDIX C

Fire Flow Analysis and Recommendations