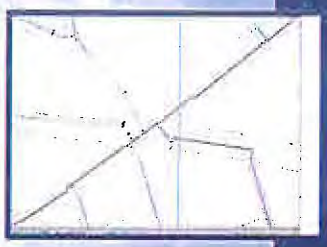
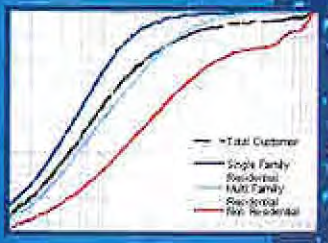
Water System Master Plan





final report

City of Beverly Hills

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Black & Veatch Corporation

August 23, 2002

Robert Beste, P.E.
Assistant City Engineer
Public Works, Engineering Division
City of Beverly Hills, California
455 North Rexford Dr.
Beverly Hills, CA 90210-4817

Subject: Final Report – Water System Master Plan

Dear Mr. Beste:

Enclosed are fifteen (15) copies of the final report for the Water System Master Plan.

The report goals have included verifying the integrity of the Beverly Hills water system and providing a prioritized plan to year 2025. The report includes the results of facility inspections and assessments; system inventory and GIS mapping; water distribution system modeling; operations review; pipe replacement planning; water department communications planning; a phased capital improvements planning; and financial planning. The report will help guide the City in ensuring continued reliable and conservative water supply for its customers.

We have enjoyed working with the City of Beverly Hills, yourself, and other members of the City staff during the preparation of this report. Please let us know if there is anything else needed for this project. We look forward to continued opportunities for Black & Veatch and the City of Beverly Hills to work together.

EbertsRt@BV.com

Sincerely,

BLACK & VEATCH CORPORATION

Ralph T. Eberts, Principal-in-Charge
Pacific Southwest Region

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Jonathan P. Gray, Project Manager
Infrastructure Planning Department

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Acknowledgements

Black & Veatch gratefully acknowledges the cooperation and assistance of many people in the execution of this project. The names of the people who participated in the study and who were instrumental in executing the project are presented below.

Beverly Hills

Dave Gustavson ..... City Engineer
Rob Beste ..... Assistant City Engineer
Ed Otsuka ..... Operations Manager
Randy Cox ..... Systems Operations
Edwin DeYoung ..... Information Technology

Black & Veatch

Ralph Eberts ..... Principal in Charge
Jon Gray ..... Project Manager
Lynne Putnam ..... Deputy Project Manager
Jim Lorenz ..... Hydraulic Analysis and Operations Review
Jerry Edwards ..... Hydraulic Analysis/GIS
Brian Lendt ..... GIS
Albert Chen ..... Seismic Review
John Johnson ..... Safety Review
Randy Fiorucci ..... Infrastructure Review
Sudhir Pardiwala ..... Rate Analysis
Bruce Gockle ..... Telecommunications
Pam Smith ..... Document Coordinator

And the support staff of both Beverly Hills and Black & Veatch.

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Appendix 1 City of Beverly Hills Data Dictionary

Appendix 2 Memoranda

Executive Summary

The City of Beverly Hills (City) authorized Black & Veatch to develop a Water System Master Plan through the Year 2025. This report presents the results of the Master Plan and recommends a program of system improvements.

1. Project Background and Scope

The project Study Area consists of approximately 4,010 acres – 3,642 acres within the Beverly Hills city limits and 368 acres comprising the study portion of West Hollywood. Master Plan preparation included a review of land use, population, and water requirements; creation of a water system geographic information system (GIS) and mapping capabilities; a review of existing water system facilities, an analysis of the distribution system; an evaluation of communication needs; and a financial plan. A valuation assessment of the water utility was provided separately. Following these evaluations, Black & Veatch developed recommendations for:

- Priority I and Priority II infrastructure improvements
- Pipeline replacement and rehabilitation
- Water Department communications system upgrades
- Capital Improvement Program
- Financial Plan

2. Land Use, Population, and Water Requirements

Current land use in the Study Area is largely residential (about 90 percent). Other uses include commercial, light industrial, and municipal. The Study Area will be nearly fully developed by Year 2025. Additional growth will largely come from redevelopment and densification. No additional future land use categories were considered in the evaluations. The Study Area Year 2025 population is about equal to the population for Year 2000 at approximately 34,000 for Beverly Hills and 8,000 for West Hollywood.

Annual metered water sales were reviewed, and total sales were classified by customer type and pressure zone. Over the last 22 years, average day water use has been stable, varying between 10.4 million gallons per day (mgd) and 13.7 mgd with a mean value of 12.2 mgd. Design Year 2025 annual water requirements were established at 12.6 mgd, based on current metered sales, a 10 percent unaccounted for water allowance,

and no significant anticipated population increases. A 24-hour pumping test was completed to determine typical peak demands, and to select demand ratios of 2.0 for maximum day to annual average day, and 3.0 for maximum hour to annual average day. The Design Year 2025 maximum day water use was established at 25.0 mgd, and maximum hour use at 37.5 mgd.

3. Water System GIS/Mapping

A detailed Geographical Information System (GIS) of the existing water distribution system was prepared to provide a modern mapping system, to maintain up-to-date information on the water system, and to integrate to the City's Hansen maintenance management software.

The GIS was built using the GIS basemap of parcels, and the hand-drawn Water Service Maps, Water Detail Maps, and Service Detail Maps. Additional as-built drawings were scanned and linked to the GIS. The GIS includes 901,746 feet of distribution pipe, 9,168 point features such as valves and hydrants, pumping stations, reservoirs, and valve vaults, and 10,473 water meter locations.

4. Existing Water System Facilities

The primary source of water supply for the City is imported water from the Metropolitan Water District of Southern California (MWD). In addition to two service connections to MWD, the City also has two emergency water service connections to the Los Angeles Department of Water and Power (LADWP). The water system is divided into 13 pressure zones that are established to provide acceptable pressures across the system. The system currently includes 10 pumping stations with a total of 27 pumps, nine reservoirs with a nominal capacity of 40.2 million gallons (MG), and a network of distribution pipelines.

5. Distribution System Analysis

The City's water distribution system was evaluated using computer modeling to simulate flows through the distribution system under a variety of conditions. The distribution system model was prepared and hydraulic analyses were conducted using the H2ONET software 4000-pipes version. The analysis results identified deficiencies in the existing system, evaluated capability to meet projected water demands through the Year

2025, and evaluated operational or improvement alternatives. In general, analyses were performed for two critical demand conditions:

- Maximum day, which determines the ability of the system to maintain full storage facilities during maximum day demands.
- Maximum hour, which determines the ability of the system to maintain adequate residual pressure during periods of peak demand.

The evaluation concluded that the Coldwater Canyon Reservoir should be replaced with a new 9.1 MG reservoir. As part of that project a new 1.8 MG reservoir is required at the nearby Booster Station No. 2 Site to provide storage while rebuilding the Coldwater Canyon Reservoir. Additional storage may be required in the future if the criteria change or an existing reservoir is removed from service. Space is available for an additional 1.0 MG storage at the Reservoir 4B site.

Black & Veatch conducted a physical assessment of the major observable water system facilities with regard to the following parameters: civil and water system reliability, structural and seismic protection needs, electrical and equipment reliability needs, and security and public safety. Site surveys and subsequent assessments resulted in the identification of facilities improvements. A two-level priority system was utilized to rank the recommended improvements in order of importance. Priority I improvements include repair or rehabilitation items determined to be critical and/or immediately necessary to maintain operational reliability of the facility. Priority II improvements include less critical repairs, which are not required immediately. Priority I and Priority II improvements are presented in Tables 1 and 2, respectively.

Between Santa Monica Boulevard and Sunset Boulevard many of the water lines are in alleys and the Fire Department reports that access to hydrants in alleys is inadequate. As recommended in the 1985 Master Plan, new mains with hydrants should be installed in the street rights-of-way and the existing mains in the alleys with their service connections should be maintained in service. This will require a total of 42,000 feet of 8-inch and 12-inch main, for a total capital cost of $7,833,000.

Table 1
Summary of Water System Facility Improvements, Priority I

Facility	Priority I Recommendations
Metropolitan Water District (MWD)	• Install an overhead portable crane. • Provide drainage sump for blow off valve discharge. • Install a security device for the roll-up door and secure building roof access.
Reservoir 3A and Pump Station	• Clean pump building as soon as possible to remove dirt and oil and provide a clean and safe environment for City staff. • Install insulation in the diesel exhaust system to reduce the temperature fluctuations. • Repair or replace pipe supports where needed. • Install anchors for reservoir. • Repair reservoir access hatch and replace corroded bolts. • Implement vegetation and weed abatement at the facility property. • Take down the ladder hook when not in use to avoid unnecessary injuries. • Replace barbed wire to prevent public access to the facility. Complete fencing around site. • Label the entry cover for the pump station manifold and secure it in place.
Sunset Reservoir and Pump Station	• Repair the sprinkler system for the landscaping around pump station. Remove weeds and grass from paved areas. • Cover exposed raw fiberglass insulation in the pump station building. • Repair and seal damaged louvers and roof flashing. Seal cracks in roof. • Install some form of access prevention in the chemical storage building. • Repair chemical storage building door and secure other avenues of access. Properly post hazard warning signs inside building. • Secure transformer storage and post hazard warning signs. • Install a fence and signage around the reservoir is recommended to deter public entrance. Secure all covers and hatches with locks. •
Greystone Reservoir and Pump Station	• Repair and seal base of corroded pump housing. • Install double containment for the day tank. • Install guards on several of the moving parts of both the pump motor and two of the pumps. • Repair and seal skylights and building flashing. Repair damaged ceiling. • Replace temporary light on the building with a permanent lighting fixture.
Reservoir 4A	• Modify the two ladder accesses to the reservoir to bring them into compliance with current OSHA safety standards. • Reinstall the "No Trespassing" sign. • Install railings around the reservoir structure to ensure the safety of the employees. • Install intrusion alarms on the reservoir hatch covers. • Repair and replace fencing around the perimeter of the facility. • Fence off the lower level of the reservoir to prevent trespassing.

Table 1

Summary of Water System Facility Improvements, Priority I

Facility	Priority I Recommendations
Reservoir 4B and Pump Station	• Trim Eucalyptus trees surrounding the site to prevent them from causing damage to the facility in the event of a high windstorm or seismic event. • Replace pipe supports inside the building. • Repair and seal reservoir bottom plate. Install seismic anchors. • Replace broken roof tiles. • Replace fencing behind the electrical building. • Install "No Trespassing" signs on the two side fence gates. • Install an adequate security system including a motion sensor and ladder cage is recommended for the tank access ladder. • Initiate vegetation and weed abatement to maintain a clear fence line.
Reservoir 5 and Pump Station	• Repair corrosion damage to pumps. • Install "No Trespassing" signs on side gates. • Repair fencing behind the tank to prevent public access. • Establish vegetation and weed abatement to maintain a clear fence line. • Secure accessible valves outside the facility gate.
Reservoir 6 and Pump Station	• Trim landscaping to provide adequate site distance from this driveway. • Install handrail on the equipment ramp to prevent accidents. • Replace pipe supports throughout this pump station. • Repair the fence on the back of the property. • Repair and seal reservoir bottom plate. Inspect interior of reservoir. Replace epoxy coating if necessary. Install seismic anchors.
Reservoir 7 and Pump Station 8	• Replace several of the glass blocks in the pump station windows for security reasons. • Repair and seal reservoir bottom plate. Install seismic anchors. • Remove excess vegetation and weeds. • Install warning signs near the monopole, entrance gates, and diesel tanks, and the telecommunications tower. Install fencing around the telecommunications tower. • Replace 10-lb. Fire extinguishers with 20-lb. fire extinguishers.
Booster Station No. 2	• Install pipe supports at this location. • Post a sign stating the rating of the breakers on the equipment. • Install hazard warning signs. • Install locks for the facility doors.
Coldwater Canyon Reservoir	• Clear the fence line along the perimeter of this facility of vegetation and miscellaneous objects. • Install signs to ensure proper public warning around the facility.
Green Acres Pump Station	• Install a ventilation fan to provide cooling and air flow inside the pump station. • Provide secondary containment for diesel/oil spills in pump station. • Replace or adjust pipe supports as needed. • Install signs warning of confined space hazards.

Table 2

Summary of Water System Facility Improvements, Priority II

Facility	Priority II Recommendations
Metropolitan Water District (MWD)	• Update the rate-of-flow control electrical system to operate by SCADA during times of SCE power failure.
Reservoir 3A and Pump Station	• Replace pump check valves with Cla-Val valves. • Evaluate possible shortcomings according to the current AWWA D100-96 based earthquake design method. • Install drainage system at site. Construct retaining wall to prevent landslide damage to reservoir.
Sunset Reservoir and Pump Station	• Repair and seal damaged concrete block walls. • Repair/replace asphalt pavement and base material outside the pump station. • Secure the water sprinkler power supply electrical cabinet to prevent tampering of this component.
Greystone Reservoir and Pump Station	• Monitor stairs leading to the bottom of the reservoir. If cracking should continue, initiate repairs. • Install a different lighting configuration at the front gate to make security video more effective. • To comply with the NEC requirements, relocate the RTU. The vacant wall to the right of the pump station doorway has adequate room to mount the RTU. • Install site fencing and signage to prevent trespassing.
Reservoir 4A	• Repair or replace upper retaining wall. Cracks on top of the lower retaining wall were visible and additional inspection and evaluation is recommended. • Install barbed wire at the top of the entrance gate fence to prevent trespassing.
Reservoir 4B and Pump Station	• Repair or replace damaged pavement and base material. • Install a Modicon PLC or equivalent. • Replace the fencing barbed wire to ensure facility security.
Reservoir 5 and Pump Station	• Repair or replace site asphalt paving. • Equip the Caterpillar generator with a shroud over the intake. • Replace the UPS or connect the batteries to the 24-volt direct pump battery. • Inspect reservoir interior. Repair or replace epoxy coating if needed. • Install remotely operated gates for convenience and security purposes (Recommendation of City personnel). • Repair or replace barbed wire on the fencing.
Reservoir 6 and Pump Station	• Repair or replace site asphalt and base material.
Reservoir 7 and Pump Station 8	• Repair or replace site asphalt and base material. • Clear the 12-inch butterfly valve orientation such that the shaft of the valve is in a horizontal position to reduce the wear on the valve. • The UPS system equipment must be on to operate the PLCs in the event of a power failure. Investigate supplying an additional backup power supply to the UPS. • Replace razor wire with barbed wire.
Booster Station No. 2	
Coldwater Canyon Reservoir	• Relocate inlet/outlet piping to ensure full drainage and circulation through the reservoir. • Repair and/or replace barbed wire to maintain security of the premises.
Green Acres Pump Station	• Install fencing to inhibit public access.

6. Pipeline Replacement/Rehabilitation

Recommended pipeline replacement / rehabilitation projects were identified based on the City's main break experience and an economic analysis. The City experienced 207 main breaks from late 1989 and 2000, or an average rate of 0.133 breaks per mile per year. This rate is low in comparison with a national average rate of 0.25. The analysis determined that pipe replacement should focus on pipes that have experienced two or more breaks. Pipe replacement projects were defined and included in the capital improvements program.

7. Water Department Communications

The City's Water Department currently uses leased services from Pacific Bell (Pac Bell) to provide control and surveillance for 19 sites. Six additional sites will be brought into the network. The City will be upgrading its communications network and asked Black & Veatch to evaluate upgrade alternatives based upon general technology characteristics and specific circuit requirements, including use of state-of-the-art products, redundancy, ethernet networking capability, and high system availability.

Black & Veatch developed and evaluated three alternatives:

- Alternative A, Add New Circuits to Existing Monitoring System.
- Alternative B, Expand Pac Bell or Another Provider Services via Fiber
- Alternative C, Build City System

It was recommended that the Water Department work with the City to implement the fiber-based alternative (Alternative B) and to take advantage of the conduit installation concurrent with the street lighting program.

8. Capital Improvement Program

The recommended improvements to the water distribution system are presented on Figure ES-1. These improvements will provide the required capacity and reliability to meet projected water demands through Year 2025. The recommended improvements have been phased into two Fiscal Year construction periods: Phase 1 from 2003 to 2007 and Phase 2. from 2008 to 2012.

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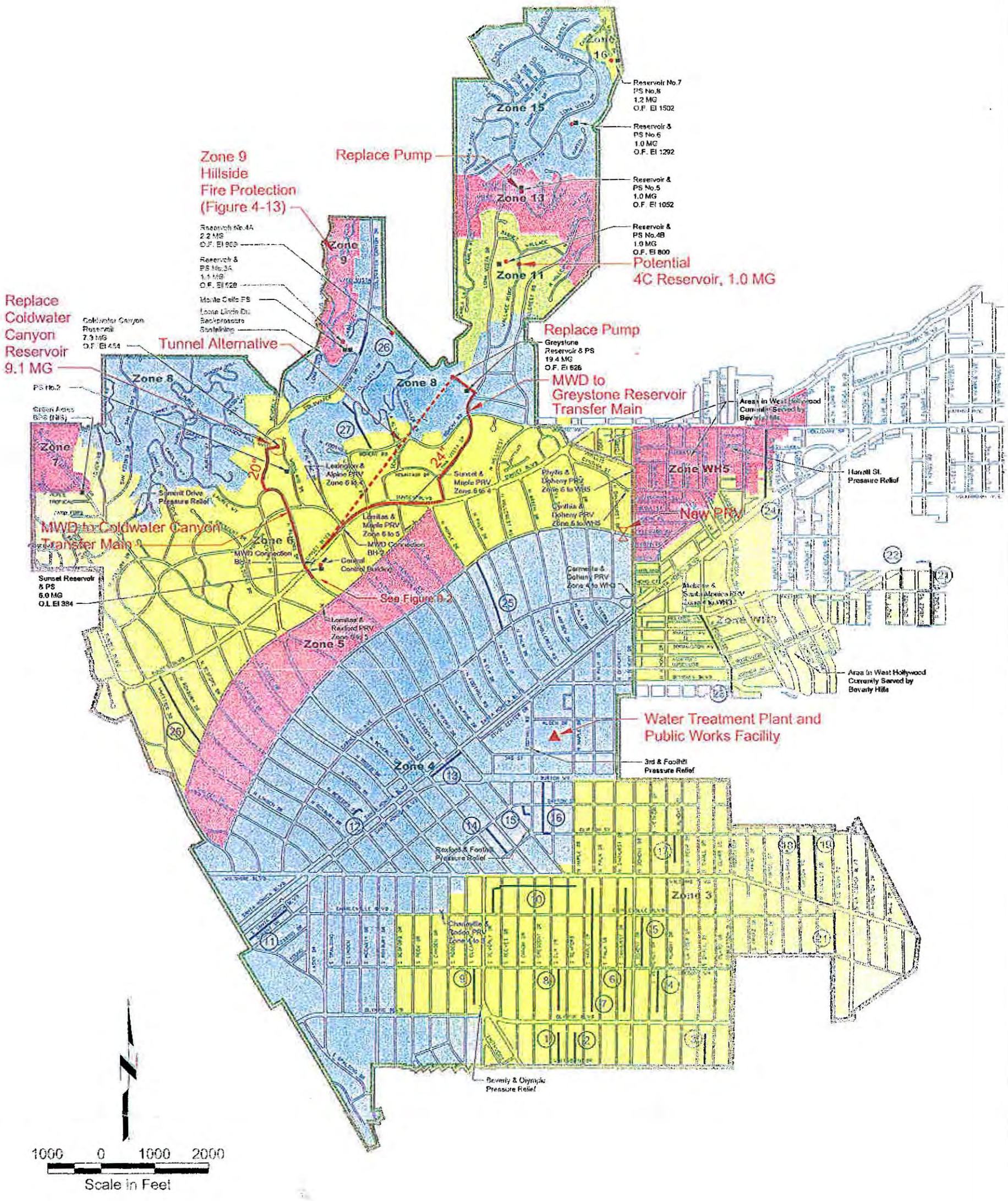


Legend

- Pressure Zone
- Beverly Hills City Limits
- 24" Proposed Pipes and Sizes
- (8) Proposed Pipe Replacement

Note:
See Table 5-1 for Infrastructure Condition, Reliability, and Safety Improvements

Beverly Hills, California
Water System Master Plan

Recommended Improvements

BLACK & VEATCH

Figure 1

The improvements were further categorized by facility type: pump station and storage reservoir improvements, infrastructure improvements, valve improvements, distribution main improvements, and miscellaneous improvements. These are shown in Tables 3 through 8, respectively.

The probable capital costs for the improvements are $25,589,000 for Phase 1 and $16,119,000 for Phase 2, for a total of $41,708,000. A breakdown of costs is presented in Table 9.

Table 3
Pumping Station and Storage Reservoir Improvements

Phase	Reservoir	Description	Probable Capital Cost ($)
1	Coldwater	New 9.1 MG	11,700,000
	Booster Station 2	New 1.8 MG	3,000,000
	Subtotal Reservoirs		**14,700,000**
	Greystone	Replace Pump	650,000[1]
	Sunset	Replace Pump	100,000[2]
	Green Acres	Replace Pump	25,000[2]
	5	Replace Pump	28,000
	Subtotal Pumping Stations		**803,000**
2	4B	New 1.0 MG	600,000
		Total All Phases	**$16,103,000**

(1) Probable cost based on installing new pump unit piping and electrical work.
(2) Probable cost allowance for replacing existing pump units.

Table 4
Water System Facility Inspection Improvement Costs

Phase	Facility[1]	Costs $
1	Reservoir 3A and Pumping Station	18,000
	Monte Cielo Pumping Station	
	Sunset Reservoir and Pumping Station	31,000
	Greystone Reservoir and Pumping Station	7,000
	Reservoir 4A	30,000
	Reservoir 4B and Pumping Station	44,000
	Reservoir 5 and Pumping Station	9,000
	Reservoir 6 and Pumping Station	47,000
	Reservoir 7 and Pumping Station 8	33,000
	Booster Station No. 2	9,000
	Green Acres Pumping Station	10,000
	Total Phase I	$238,000
2	Reservoir 3A and Pumping Station	72,000
	Sunset Reservoir and Pumping Station	11,000
	Greystone Reservoir and Pumping Station	48,000
	Reservoir 4A	41,000
	Reservoir 4B and Pumping Station	95,000
	Reservoir 5 and Pumping Station	114,000
	Reservoir 7 and Pumping Station 8	23,000
	Green Acres Pumping Station	12,000
	Total Phase II	$416,000
	Total All Phases	**$654,000**

[1] See Chapter 5 for detailed descriptions.

Table 5
Valve Improvements

Phase	Description	Size (inch)	Costs ($)
1	PRV Zone 6 to 4[1]	12	43,000
	MWD Valve modification	20	21,000
		Total	**$64,000**

[1] Alternative location for this PRV is between Zone WH5 to WH3. (Figure 4-8)

Table 6
Distribution Main Improvements

ID No.	Description	Size (inch)	Length (feet)	Cost ($)
	New Main Projects – Phase 1			
	Greystone Reservoir	24	5,400	2,940,000
	Coldwater Canyon Reservoir	20	3,000	1,402,000
	3A Pumping Station and Reservoir	12, 14	600	275,000
	Subtotal New Main Projects			$ 4,617,000
	Pipe Replacement Projects – Phase 1			
1	S.Rexford Dr.	6	590	111,000
2	S. Maple Dr.	6	590	111,000
3	S. Swall Dr.	6	590	111,000
4	S. Weatherly	6	800	151,000
5	S. Doheny	6	970	183,000
6	S. Doheny	6	2,200	415,000
7	S. Palm	6	2,200	415,000
8	S. Rexford	6	600	124,000
9	Beverly and S. Reves Dr	6	2,000	377,000
10	Wilshire Blvd	8	900	176,000
11	Santa Monica Blvd	8	250	49,000
12	N of Santa Monica Blvd	12	750	204,000
13	Civic Center Dr	8	650	127,000
14	N Crescent Rd	8	650	127,000
15	Foothill Rd	6	200	38,000
16	N Elm Dr	8	950	186,000
17	N La Peer Dr	8	600	118,000
18	N Carson Dr	8	1,300	255,000
	Subtotal Pipe Replacement Projects			$ 2,905,000
	Total Phase 1			$ 7,349,000
	New Main Projects – Phase 2			
	4A Pumping Station and Reservoir	16	1,000	$ 465,000
	Pipe Replacement Projects – Phase 2			
19	N Stanley Dr	8	1,350	265,000
20	S.Le Doux Rd	8	800	157,000
21	N.Flores St., Rosewood Ave W.H.	8	2,000	392,000
22	N Orlando	8	500	98,000
23	Robertson Blvd W.H.	6	1,500	283,000
24	Hancock Ave W.H.	8	1,350	265,000
25	N Palm	8	1,350	265,000
26	N Roxbury Dr	8	1,500	294,000
27	Calle Vista	8	1,400	274,000
	Subtotal Pipe Replacement Projects			$ 2,983,000

Table 9-5
Distribution Main Improvements

ID No.	Description	Size (inch)	Length (feet)	Cost ($)
	Fire Protection Mains – Phase 2			
26-024	Bedford Dr. between Benedict Canon Dr. and Sunset Blvd.	8	700	127,400
31-025	Crescent Dr. between Sunset Blvd. and Lomitas Ave.	8	800	145,600
37-027	Foothill Rd. between Sunset Blvd. and Lomitas Ave.	8	900	163,800
37-028	Elm Dr. between Sunset Blvd. and Lomitas Ave.	8	600	109,200
35-029	Oakhurst Dr. between Cynthia St. and Elevado Ave.	8	1,000	182,000
--------	Trenton Dr. and Whitter Dr.	FH	--	4,200
31-034	Crescent Dr. between Lomitas Ave. and Elevado Ave.	8	100	182,000
31-036	Foothill Rd. between Sunset Blvd. and Lomitas Ave.	8	1,100	200,200
31-037	Elm Dr. between Lomitas Ave. and Elevado Ave.	8	1,200	218,400
25-041	Trenton Dr. between Elevado Ave. and Wilshire Blvd.	FH	--	4,200
25-042	Crescent Dr. between Elevado Ave. and Alley North of Santa Monica Blvd.	8	1,900	345,800
31-043	Alpine Dr. between Elevado Ave. and Alley North of Santa Monica Blvd.	8	2,300	418,600
24-044	Foothill Rd. between Elevado Ave. and Alley North of Santa Monica Blvd.	8	2,300	418,600
30-045	Elm Dr. between Elevado Ave. and Alley North of Santa Monica Blvd.	8	2,300	418,600
20-050	Walden Dr. between Elevado Ave. and Alley North of Santa Monica Blvd.	8	1,700	309,400
20-051	Linden Dr. between Elevado Ave. and Alley North of Santa Monica Blvd.	8	1,700	309,400
30-052	Hillcrest Rd. between Carmelita Ave. and Alley North of Santa Monica Blvd.	8	900	163,800
15-053	Spaulding Dr. between Gregory Way and Charleville Blvd.	8	1,000	182,000
15-054	McCarty Dr. between Charleville Blvd. And Alley North of Olympic Blvd.	8	1,800	327,600
15-055	Roxbury Dr. between Charleville Blvd. And Gregory Way	8	1,000	182,000
15-056	Roxbury Dr. between Gregory Way and Alley North of Olympic Blvd.	FH	--	4,200
15-057	Bedford Dr. between Charleville Blvd. and Alley South of Olympic Blvd.	12	1,900	505,400
14-058	Peck Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
14-059	Camden Dr. between Charleville Blvd. And Gregory Way	8	1,000	182,000
16-060	Rodeo Dr. between Charleville Blvd. and Gregory Way.	8	1,000	182,000
14-061	El Camino Dr. between Charlevile Blvd. and Gregory Way	8	1,000	182,000
14-063	Canon Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
14-064	Crescent Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
14-065	Elm Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
13-067	Maple Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
13-068	Palm Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
13-069	Oakhurst Dr. between Charleille Blvd. and Gregory Way	8	1,000	182,000
13-070	Wetherly Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
13-071	Almont Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
13-072	Lapeer Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
13-073	Swall Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
29-075	Santa Monica Blvd. Between Doheny Dr. and Almot Dr.	12	700	186,200
29-076	Keith Ave. between Almont Dr. and Hilldale Ave.	8	1,100	200,200
20-078	Almont Dr. between Nemo St. and Santa Monica Blvd.	12	100	26,600
	Subtotal Fire Protection Mains		42,000	$ 7,883,000
	Total Phase 2			$ 11,331,000
			Total All Phases	**$18,873,000**

Table 7 Miscellaneous Improvements		
Phase	Description	Cost ($)
1	Zone 9 Fire Protection	
	LADWP Connection	1,300,000
	Distribution Mains	860,000
	Sprinkler System	20,000
	Total Zone 9 Fire Protection	$ 2,180,0000
	MWD Control Station Miscellaneous Improvements (1)	53,000
	Total Phase 1	$ 2,223,000
2	MWD Control Station Electrical Upgrade	$56,000
	Total All Phases	**$2,279,000**
(1)See Table 5-1.		

Table 8 Capital Improvement Plan		
Phase (Year)	Description	Costs ($)
1 (2007)	Pumping Stations	803,000
	Storage Reservoirs	14,700,000
	Valves	64,000
	Distribution Mains	
	New Mains	4,617,000
	Replacement Projects	2,905,000
	Water System Facility Inspection and Miscellaneous Improvements (1)	2,500,000
	Total Phase 1	$25,589,000
2 (2012)	Storage Reservoir	600,000
	Distribution Mains	
	New Mains	465,000
	Replacement Projects	2,983,000
	Fire Protection Mains	7,883,000
	Easement Pipe Evaluation and Rehabilitation	1,688,000
	Water System Facility Inspection and Miscellaneous Improvements (1)	2,500,000
	Total Phase 2	$16,119,000
	Total All Phases	**$41,708,000**
(1)This includes the facility inspection improvements from Table 9-3, miscellaneous improvements from Table 9-6 and an allowance for additional projects to be identified by the City.		

9. Financial Plan

A Financial Plan was developed to assist the City in planning for project financing over the next 10 years. Projected revenues for operating and managing the City's water system under existing rates were reviewed, and revenues under existing rates were projected for the Fiscal Years 2002 through 2012. Rate adjustments are needed in

Fiscal Years 2003-2008 primarily to finance capital projects and maintain fund balances. No rate adjustments are needed in Fiscal Years 2009 -2012.

Costs for projects scheduled for Phase 1 were distributed over the five Fiscal Years from 2003 through 2007. Similarly, Phase 2 project costs were distributed over five years from 2008 through 2012. These costs were then assessed with respect to revenue requirements and operating and capital financing requirements. Annual increases in water revenues to meet projected revenue requirements were then calculated.

Funding options were reviewed including State Revolving Fund (SRF) loans, Department of Water Resources (DWR) funding, California Infrastructure Economic Development Bank (CIEDB) funding, and California WateReuse Financing Authority loans. Also reviewed were general obligation bonds, revenue bonds, Certificates of Participation (COPs), capital reserves, and pay-as-you-go funding.

10. Abbreviations and Acronyms

The following abbreviations and acronyms are used in this report:

AD	average day
AIN	area identification number
AWWA	American Water Works Association
bps	Bits per second
CCB	Central Control Building
ccf	Hundred cubic feet
cfs	cubic feet per second
CIEDB	California Infrastructure Economic Development Bank
City	City of Beverly Hills
CMU	concrete masonry unit
COPs	Certificates of Participation
DSOD	Division of Safety of Dams
DWR	Department of Water Resources
FDDA	Four dimensional data aquisition
ft	feet
GIS	geographic information system
gpm	gallons per minute
HGE	hydraulic gradient elevation
hp	horsepower
ICI	industrial-commercial-institutional
IT	Information Technology
ITS	Intelligent Traffic System
LADWP	Los Angeles Department of Water and Power
LAN	Local Area Network

Mbps	Million bits per second
MCC	Motor Control Center
MCP	Main Control Panel
MD	maximum day
MG	million gallons
mgd	million gallons per day
MH	maximum hour
MWD	Metropolitan Water District of Southern California
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
O&M	operations and maintenance
Pac Bell	Pacific Bell
PLC	Programmable Logic Controller
PRV	pressure reducing valve
PS	pump station
psi	pounds per square inch
RES	residential
rpm	revolutions per minute
RTU	remote telemetry unit
SCADA	supervisory control and data acquisition
SCAG	Southern California Association of Governments
SCE	Southern California Edison
SDWA	Safe Drinking Water Act
SFR	single-family residential
SRF	State Revolving Fund
TDS	total dissolved solids
UPS	uninterruptible power supply
VFD	variable frequency drive
WH	West Hollywood

1.0 Land Use/Population/Water Requirements

1.1 General

The purpose of this chapter is to provide the City of Beverly Hills (City) with an analysis of the current and future water demands on the existing water system. Existing and projected populations, historical water use, and metered water use were used to estimate water demand for Year 2000 and Year 2025 for the City for portions of West Hollywood.

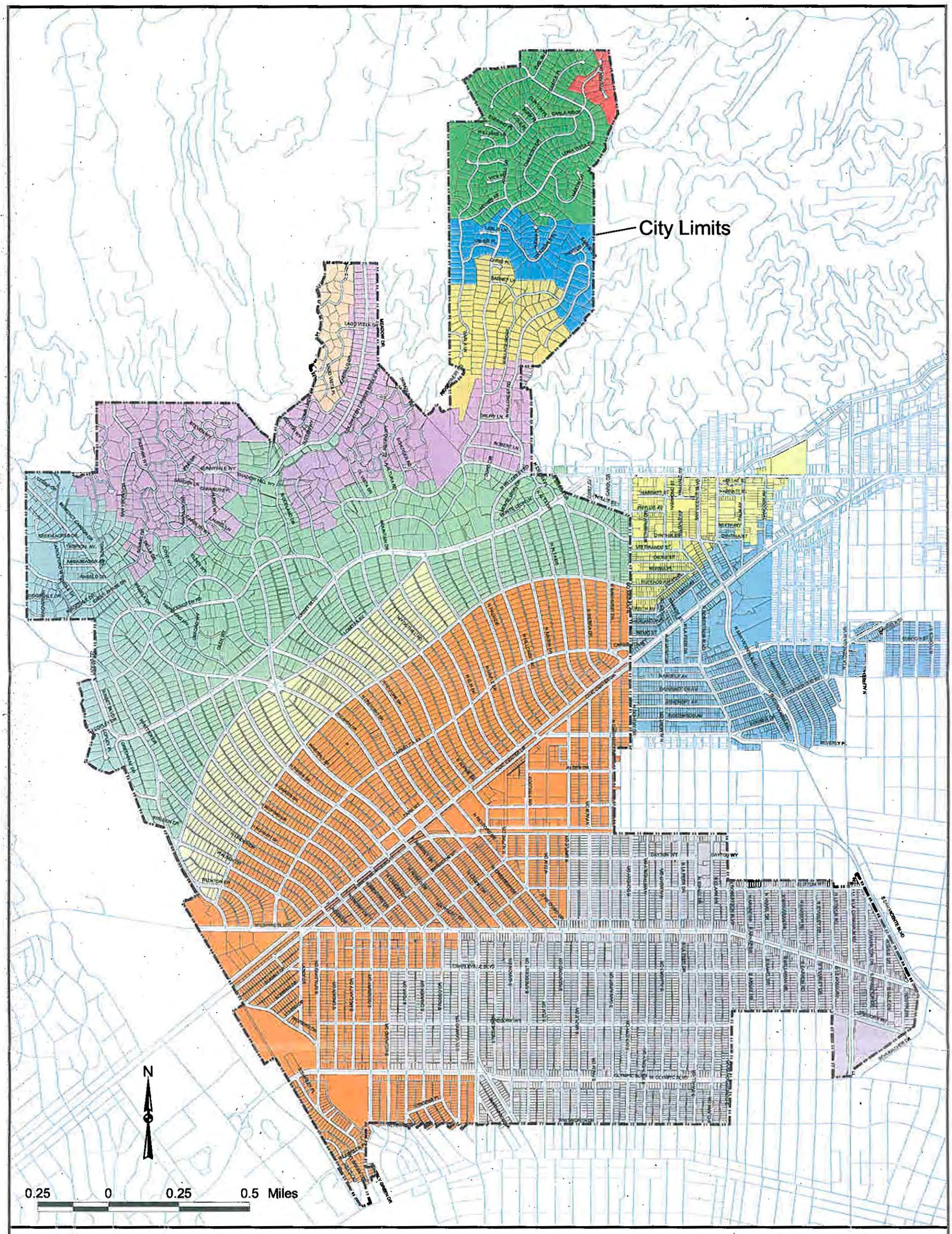
1.2 Land Use

1.2.1 Current Land Use

The City is unique among the communities of Los Angeles County, in that it is primarily composed of high value single and multi-family residences with a centralized business and commercial district.

The general land-use pattern in the City is expected to maintain the present form with very little change. However, some change is expected in the "Planned Development Area" consisting primarily of light industrial property. The growth trends are expected to be concentrated in the residential areas. This concentration will slightly increase the dwelling unit densities of multi-family residential areas.

The Study Area consists of approximately 4,010 acres, of which 3,642 acres are within the Beverly Hills City limits. The remaining 368 acres comprise the study portion of West Hollywood. The City is divided into 11 pressure zones, and West Hollywood is divided into two pressure zones. Figure 1-1 shows the Study Area by pressure zones. Figure 1-2 shows land use categories and zoning classifications of the City of Beverly Hills General Plan and the West Hollywood Community Plan. The following paragraphs describe the land-use categories in terms of zoning classifications.



Pressure Zones

3	11
4	13
5	15
6	16
7	WH3
8	WH5
9	

Beverly Hills, California
Water System Master Plan
2002

STUDY AREA

BLACK & VEATCH

FIGURE 1-1

1.2.1.1 Residential Areas

Approximately 90 percent of the City is zoned for residential use. Residential areas consist of low, medium, and high-density dwelling units. Lower and medium density dwelling units are located primarily to the north of Santa Monica Boulevard, and a significant amount of higher density single-family dwelling units are intermingled with multi-family residential areas to the south of Santa Monica Boulevard.

In West Hollywood, single-family residential areas consist of one and two-family residences located primarily south of Santa Monica Boulevard. Multi-family residential areas include some single-family residential in higher densities, but mostly two or more family residences. These areas are located primarily north of Santa Monica Boulevard with a portion located west of La Cienega Boulevard.

1.2.1.2 Commercial Areas

The commercial area in the City is concentrated in the principal business district, which is located in a triangular area at the intersection of Wilshire Boulevard and Santa Monica Boulevard. There are commercial areas along both sides of Wilshire Boulevard, Santa Monica Boulevard, Beverly Drive, Robertson Boulevard, and La Cienega Boulevard.

In West Hollywood, the commercial areas are located along both sides of Santa Monica Boulevard, Melrose Avenue, Robertson Boulevard, La Cienega Boulevard, and Sunset Boulevard.

1.2.1.3 Light Industrial

There is very little industrial land in the City. The current zoning for industrial land use consists of a portion of the City bounded by Santa Monica Boulevard, Maple Drive, and Burton Way.

In West Hollywood, industrial land use areas are located within a triangular area bounded by Santa Monica Boulevard, Melrose Avenue, and Robertson Boulevard. Other industrial land uses are mixed with commercial uses along Santa Monica Boulevard, La Cienega Boulevard, and Sunset Boulevard.

1.2.1.4 Municipal Areas

Municipal land use areas include public land uses such as parks, schools, public buildings, and designated open spaces such as park strips and City reservoir sites. These areas are typically located throughout the City adjacent to areas zoned for residential use and along major streets such as Sunset Boulevard and Santa Monica Boulevard.

In West Hollywood, the public area land use is located south of Santa Monica Boulevard and along both sides of San Vicente.

1.2.1.5 Other Land Use Areas

Other land use areas consist of parking and transportation right-of-way. These areas are designated in the land use plan between commercial and residential areas throughout both cities and around the City's Civic Center.

1.2.2 Future Land Use

The Study Area will be nearly fully developed by Year 2025; additional growth will largely come from redevelopment and densification. Based on a review of both of the City's General Plans regarding future land use, neither Beverly Hills nor West Hollywood anticipates major changes in land use distribution. Therefore, no future land use categories were considered.

1.3 Population

A water system Master Plan begins with an evaluation of the historical population trends and projected growth patterns within the Study Area. Prediction of future water demands requires a rational estimation of the magnitude, location, and characteristics of future population growth.

Since the City is very close to Year 2025 population and has a high influx of people associated with business activities during the day, current and future employment estimates were also prepared.

1.3.1 City of Beverly Hills

The 1990 United States Census reported the City's population at 31,971. The Year 2000 census population was 35,100. However, the estimated daytime population, which includes employees, shoppers, tourists, and hotel users, includes an additional 70,000, for a total daytime population of 104,000.

1.3.2 City of West Hollywood

The population of West Hollywood within the Study Area is estimated to be 20 percent of the City's population. The population for West Hollywood within the Study Area is presented in Table 1-1.

Table 1-1
Historical City of West Hollywood Population

Year Tract	Population	Percent in Study Area[1]	Study Area
1990	36,118	20	7,224
2000	38,913	20	7,783

[1] Estimated

1.3.3 Study Area Population

Total population for the City and that portion of West Hollywood within the Study Area is presented in Table 1-2.

For the purposes of this study, Year 2025 populations were determined based on preliminary forecasts prepared by Southern California Association of Governments (SCAG) in February 2000. The projection for the portion of West Hollywood within the Study Area is based on 20 percent of the SCAG forecast.

Table 1-2
Study Area Population

Year	City of Beverly Hills	West Hollywood	Total Population in Study Area
1990	31,971	7,224	39,195
2000	33,824	7,783	41,607
2025	33,993	7,658	41,651

Source: Year 1990 - City of Beverly Hills and West Hollywood Demographics Website
Year 2000 - Dept. of Finance, (West Hollywood), Planning Dept. (City of Beverly Hills)
Year 2025 – Southern California Association of Governments (SCAG)

As shown above, the SCAG Year 2025 population is almost equal to the population for Year 2000, at about 34,000 for Beverly Hills and 8,000 for West Hollywood.

1.3.4 Allocation of Population and Households

Based on a review of parcel maps, and structures shown on a planimetric map, the number of households was estimated for each of the 13 pressure zones in the Study Area. The population for each zone was then estimated based on a density of about 2.5 people per household, except for Zones 3, 4, WH3, and WH5. Year 2025 population and number of households by pressure zone are shown in Table 1-3.

Table 1-3
Estimated Population and Households by Zone

Zone	Population	Households
3	14,500	7,000
4	12,300	6,000
5	1,250	500
6	3,500	1,500
7	25	10
8	1,125	450
9	75	30
11	325	130
13	400	160
15	450	200
16	50	20
Subtotal	34,000	16,000
WH3	5,600	3,500
WH5	2,400	1,500
Subtotal	8,000	5,000
Total	**42,000**	**21,000**

1.4 Water Requirements

A water utility must be able to supply water at many flow rates, which fluctuate over a wide range. Yearly, monthly, daily, and hourly variations in water use are to be expected. Water use typically follows a diurnal pattern, low at night and peaking in the early morning and late afternoon. Average day (AD), maximum day (MD), and maximum hour (MH) are the rates most important to design and operation of a water system.

AD use is the total annual water use divided by the number of days in the year. The AD rate is used primarily as a basis for estimating MD and MH demands. The AD rate is also used to estimate future supply requirements, revenues, and operating costs.

MD use is the maximum quantity of water used on any one day of the year. The MD rate is used to size water treatment and supply facilities.

MH use is the maximum quantity of water used on any one hour of the year. Since minimum distribution system pressures are usually experienced during MH, the sizes and locations of distribution facilities are generally determined based on this condition. MH water requirements are partially met through the use of strategically located system storage. The use of system storage minimizes the required capacity of transmission mains and permits a more uniform and economical operation of the water supply, treatment, and pumping facilities.

1.4.1 Historical Metered Sales

A review of the annual metered sales by customer type for Beverly Hills indicates that residential water use averaged about 70 percent of total water sales in 1999. The total metered use was 11.3 million gallons per day (mgd). Metered sales in West Hollywood accounted for about 11 percent of the total, or 1.3 mgd, in 1999. Table 1-4 shows the 1999 metered sales by customer type for Beverly Hills, West Hollywood, and Los Angeles.

Table 1-4
1999 Metered Sales Summary by Customer Type

Customer Type	Total (mgd)	Beverly Hills (mgd)	West Hollywood (mgd)
Commercial	2.958	1.982	0.976
Industrial	0.026	0.022	0.004
Municipal	0.295	0.294	0.001
Private/Fire	0.092	0.000	0.092
Residential-double	0.162	0.123	0.039
Residential-multi	1.973	1.823	0.151
Residential-single	5.817	5.723	0.090
Total	**11.322**	**10.061**	**1.261**
Percent Residential	70.2	76.2	22.2

The City provided metered sales data for each customer for the years 1997, 1998 and 1999. Since the total sales for each year are similar, the most recent year's data was used for this study. Using database and geographical information system (GIS) techniques, the total sales for each customer for the year 1999 were summarized by pressure zone. The original metered sales data contained numerous use classes, which were classified into the seven customer types shown above. These seven classes were further summarized into two categories, residential and non-residential, by combining the customer types as shown below:

Residential	**Non-residential**
R-single Sales	Commercial Sales
R-double Sales	Industrial Sales
R-multi Sales	Municipal Sales
	Private/Fire

1.4.1.1 Unaccounted-for Water

The difference between the average day use and the metered water sales to all customers is the unaccounted-for water use. Unaccounted-for water use may be due to leakage from the mains, main breaks, inaccuracies in meters from the Metropolitan Water District of Southern California (MWD), customer meter under-registration, and various actual uses such as fire-fighting or main flushing. The 1999 unaccounted-for use was about 0.94 mgd, or 7.7 percent of the 1999 AD use. This value is reasonable and represents a system in good condition. For projecting future water demands, a design unaccounted-for water allowance of 10 percent of average day use was selected.

1.4.1.2 Beverly Hills Allocation

The metered sales data provided by the City included the parcel area identification number (AIN) for most of the customers located in Beverly Hills. Using the AIN, , the customer was geographically related to the corresponding parcel AIN in the City's GIS database. Where there were missing or non-matching AIN, the billing address was used for locating the customer, and an appropriate parcel AIN was assigned to replace the original. A detailed water demand allocation could then be provided in the computer model by allocating each parcel to the nearest model node. The metered sales for each pressure zone were then summarized by residential and non-residential categories.

1.4.1.3 West Hollywood Allocation

The metered sales data included West Hollywood sales, but did not include AINs for any West Hollywood customers. Therefore, it was not possible to geographically locate customers using AIN matching techniques. The total sales for West Hollywood were summed by residential and non-residential categories and then split to the two West Hollywood pressure zones according to past high demand day flows, as described below.

The "Zone Daily Report" provided by the City for July 31 and August 14, 2000 indicated that about 57 percent of the total West Hollywood demand was being used in Zone 5WH, with the remainder being used in Zone 3WH, as shown in Table 1-5.

Table 1-5
Historical West Hollywood Usage

	August 14, 2000		July 31, 2000		Design
	(mgd)	(% of Total)	(mgd)	(% of Total)	(% of Total)
WH3	0.733	41.5%	0.748	43.4%	43%
WH5	1.034	58.5%	0.976	56.6%	57%
Total	**1.767**		**1.724**		

1.4.1.4 Summary of Metered Sales Allocation

The 1999 customer metered sales were summarized by pressure zones as shown in Table 1-6. An allowance for unaccounted-for use was then assigned equal to 10 percent of the total use.

Table 1-6
Metered Sales Allocation

Pressure Zone	Residential (mgd)	Non-Residential (mgd)	Unaccounted-for (mgd)	Total (mgd)
3	1.921	0.641	0.285	2.848
4	2.247	1.529	0.420	4.196
5	0.447	0.014	0.051	0.512
6	1.655	0.176	0.203	2.035
8	0.688	0.046	0.082	0.816
9	0.048	0.000	0.005	0.053
11	0.165	0.000	0.018	0.184
13	0.149	0.000	0.017	0.166
15	0.334	0.000	0.037	0.371
16	0.024	0.000	0.003	0.027
WH3	0.118	0.414	0.059	0.591
WH5	0.156	0.548	0.077	0.781
Total	**7.952**	**3.370**	**1.257**	**12.579**

1.4.2 Historical Average Day and Maximum Month Water Use

Historical water use data were provided from MWD. Table 1-7 shows AD, AD for the maximum month, and the corresponding demand ratio between the maximum month and AD. Table 1-7 indicates that over the last 22 years the AD water use has been stable, varying between 10.4 mgd and 13.7 mgd, with a mean value of 12.2 mgd. A regression analysis showed that the upper 95 percent confidence level for the mean average day is 12.6 mgd.

1.4.3 Historical Peak Demands

The City conducted a 24-hour pumping test on July 31, 2000 (midnight to midnight) to evaluate typical peak demands. The demands for the entire system and for each pressure zone were calculated for this study based on the resulting Supervisory Control and data Acquisition System (SCADA) data, and daily operating report data.

Neither pressure zone 16 nor 9 contains floating storage, and the pumps are operated at all times. For purposes of evaluation, the demands in the closed zones 16 and 9 were considered to be a portion of the demands within the zone from which they receive supply.

The calculation of total daily water use for July 31, 2000 is summarized in Table 1-7. The calculation of maximum hour water demands, which occurred from 8:00 a.m. to 9:00 am, is summarized in Table 1-8. Only these facilities that operated during the pumping test are included in the tables.

Table 1-7
July 31, 2000
Peak Day Demand by Pressure Zone

Pressure Zone & Water Source	Begin	End	Rate (mgd)	Data Source
ZONE 15 and 16				
Res. No. 7 Vol. (gal)	1,077,459	544,603	0.53 (+)	Daily Zone Usage Report
Total			0.53 mgd	
ZONE 13				
Res. No. 6 Vol. (gal)	847,418	567,692	0.28 (+)	Daily Zone Usage Report
Total			0.28 mgd	
ZONE 11				
Res. No. 5 Vol. (gal)	793,482	562,405	0.23 (+)	Daily Zone Usage Report
Total			0.23 mgd	
ZONE 8 and 9				
Res. No. 4A Vol. (gal)	1,110,90183	521,159	0.28 (+)	Daily Zone Usage Report
Res. No. 4B Vol. (gal)	1,605	59,854	0.06 (+)	Daily Zone Usage Report
Greystone Pumps	8.20 hrs @ 1,150 gpm		0.57 (+)	Daily Pump Report
PS No. 3A Pumps	9.09 hrs @ 1,150 gpm		0.62 (+)	Daily Pump Report
Total			1.53 mgd	
ZONE 6				
Res. No. 3A Vol. (gal)	655,485	513,594	0.14 (+)	Daily Zone Usage Report
Greystone East Vol. (ft)	7,075,984	6,443,348	0.63 (+)	Daily Zone Usage Report
Greystone West Vol. (ft)	7,621,306	6,975,571	0.65 (+)	Daily Zone Usage Report
MWD Supply (mgd)			0.65 (+)	Daily Zone Usage Report
Lomitas & Maple PRV (mgd)	6,975,571		0.76 (-)	Daily Zone Usage Report
Cynthia & Doheny PRV (mgd)			0.98 (-)	Daily Zone Usage Report
Greystone Pumps	8.20 hrs @ 1,150 gpm		0.57 (-)	Daily Pump Report
PS No. 3A Pumps	9.09 hrs @ 1,150 gpm		0.62 (-)	Daily Pump Report
Total			2.93 mgd	
ZONE 5				
Lomitas & Maple PRV (mgd)			0.76 (+)	Daily Zone Usage Report
Total			0.76 mgd	
ZONE 4				
Coldwater Res. Vol. (gal)	4,002,978	5,753,300	1.75 (-)	Daily Zone Usage Report
MWD Supply (mgd)			7.40 (+)	Daily Zone Usage Report
Carmelita & Doheny PRV (mgd)			0.18 (-)	Daily Zone Usage Report
Melrose & Doheny PRV (mgd)			0.57 (-)	Daily Zone Usage Report
Total			4.90 mgd	
ZONE 3				
Sunset Res. Vol. (gal)	4,124,335	2,436,338	1.69 (+)	Daily Zone Usage Report
MWD Supply (mgd)			1.68 (+)	Daily Zone Usage Report
Total			3.37 mgd	
ZONE 5WH				
Cynthia & Doheny PRV (mgd)			0.98 (+)	Daily Zone Usage Report
Total			0.98 mgd	
ZONE 3WH				
Carmelita & Doheny PRV (mgd)			0.18 (+)	Daily Zone Usage Report
Melrose & Doheny PRV (mgd)			0.57 (+)	Daily Zone Usage Report
Total			0.75 mgd	
Total Daily Demand on July 31, 2000			**16.26 mgd**	

Table 1-8
July 31, 2000 – 8:00 am to 9:00 am
Peak Hourly Demand by Pressure Zone

Pressure Zone & Water Source	8:00 am	9:00 am	Rate (mgd)	Data Source
ZONE 15 and 16				
Res. No. 7 Vol. (gal)	908,057	856,255	0.24 (+)	Daily Storage Report
Total			0.24 mgd	
ZONE 13				
Res. No. 6 Vol. (gal)	733,917	752,776	0.51 (+)	Daily Storage Report
Total			0.51 mgd	
ZONE 11				
Res. No. 5 Vol. (gal)	727,913	711,521	0.39 (+)	Daily Storage Report
Total			0.39 mgd	
ZONE 8 and 9				
Res. No. 4A Vol. (gal)	969,258	922,377	1.13 (+)	Daily Storage Report
Res. No. 4B Vol. (gal)	705,705	659,700	1.10 (+)	Daily Storage Report
Total			2.23 mgd	
ZONE 6				
Res. No. 3A Vol. (gal)	950,528	964,007	0.32 (+)	Daily Storage Report
Greystone East Level. (ft)	34.86	34.87	0.05 (+)	SCADA Printout[1]
Greystone West Level (ft)	34.13	34.14	0.05 (+)	SCADA Printout[1]
MWD Supply (cfs)	11.97	11.97	7.74 (+)	Daily MWD Report
Lomitas & Maple PRV (gpm)	693	821	1.09 (-)	SCADA Printout
Cynthia & Doheny PRV (gpm)	1,206	1,008	1.59 (-)	SCADA Printout
Total			4.63 mgd	
ZONE 5				
Lomitas & Maple PRV (gpm)	693	821	1.09 (+)	SCADA Printout
Total			1.09 mgd	
ZONE 4				
Coldwater Res. Vol. (gal)	4,712,685	4,542,878	4.08 (-)	Daily Storage Report
MWD Supply (cfs)	7.06	7.06	4.56 (+)	Daily MWD Report
Carmelita & Doheny PRV (gpm)	226	315	0.39 (-)	SCADA Printout
Melrose & Doheny PRV (gpm)	464	522	0.71 (-)	SCADA Printout
Total			7.54 mgd	
ZONE 3				
Sunset Res. Vol. (gal)	3,954,952	3,896,543	1.40 (+)	Daily Storage Report
MWD Supply (cfs)	6.92	6.94	4.49 (+)	Daily MWD Report
Total			5.89 mgd	
ZONE 5WH				
Cynthia & Doheny PRV (gpm)	1,206	1,008	1.59 (+)	SCADA Printout
Total			1.59 mgd	
ZONE 3WH				
Carmelita & Doheny PRV (gpm)	226	315	0.39 (+)	SCADA Printout
Melrose & Doheny PRV (gpm)	464	522	0.71 (+)	SCADA Printout
Total			1.09 mgd	
Total Demand 8:00 to 9:00 July 31, 2000			**26.21 mgd**	

[1]SCADA printout used for Greystone Reservoir because of questionable Daily Storage Report data

The observed peak day and peak hour demands and peaking factors by pressure zone are summarized in Table 1-9.

Table 1-9
July 31, 2000 – Observed Demands by Zone

Pressure Zone	Allocated Sales and Unaccount (mgd)	Observed 7/31/00 Daily Total (mgd)	Observed 7/31/00 Demand 8-9 am (mgd)	Observed Peak Day to AD Ratio	Observed Peak Hour to Peak Day Ratio	Observed Peak Hour to AD Ratio
3	2.848	3.37	5.89	1.18	1.75	2.07
4	4.196	4.91	7.54	1.17	1.54	1.80
5	0.512	0.76	1.09	1.48	1.43	2.13
6	2.035	2.93	4.63	1.44	1.58	2.28
8 & 9	0.869	1.53	2.23	1.76	1.46	2.57
11	0.184	0.23	0.39	1.25	1.70	2.12
13	0.166	0.28	0.51	1.69	1.82	3.07
15 & 16	0.398	0.53	1.24	1.33	2.34	3.11
3WH	0.591	0.75	1.10	1.27	1.47	1.86
5WH	0.781	0.97	1.59	1.24	1.64	2.03
Total	**12.58**	**16.26**	**26.21**	**1.30**	**1.60**	**2.08**

1.4.4 Design Year 2025 Water Requirements

Table 1-6 shows the design AD use is established at 12.6 mgd, based on the current metered sales, the 10 percent unaccounted-for water allowance, and no significant difference between the projected Year 2025 population and the existing population.

The conditions during the July 31, 2000 pumping test were similar to a maximum month average day condition. Actual MD and MH demands will be greater than recorded during the pumping test. The SCADA records indicate that the 1999 MD demand was about 20 mgd, for a 1999 MD:AD ratio of 1.64. For this report, a design MD:AD ratio of 2 was selected to provide a conservative hydraulic analysis. The selected design MH:AD ratio was 3, corresponding to an MH:MD ratio of 1.5.

Design water demands are summarized in Table 1-10.

Table 1-10
Design Water Demands, mgd

Average Day	MD/AD	Maximum Day	MH/MD	Maximum Hour	MH/AD
12.6	2	25	1.5	37.5	3

1.4.5 Water Demands by Pressure Zone

Water demands by pressure zone were calculated by applying by-class peaking factors to each water use classification's average use, as previously shown in Table 1-6. Considering the overall design factors in Table 1-10 and the observed peaking factors by pressure zone in Table 1-9, design peaking factors and peak demands by service level were developed for use in the computer model as shown in Tables 1-11 and 1-12.

Table 1-11
Design Maximum Day Demands by Pressure Zone

Pressure Zone	Residential		Non-residential		Unaccounted	Total	MD:AD
	factor	(mgd)	factor	(mgd)	(mgd)	(mgd)	Ratio
3	2.0	3.842	1.7	1.090	0.285	5.218	1.83
4	2.3	5.168	1.7	2.600	0.420	8.188	1.95
5	2.3	1.028	1.7	0.024	0.051	1.102	2.15
6	2.3	3.807	1.7	0.300	0.203	4.310	2.12
8 & 9	2.6	1.913	1.7	0.079	0.087	2.079	2.39
11	2.6	0.429	1.7	0.000	0.018	0.448	2.44
13	2.6	0.387	1.7	0.001	0.017	0.404	2.44
15 & 16	2.6	0.930	1.7	0.001	0.040	0.971	2.44
3H	2.0	0.235	1.7	0.703	0.059	0.998	1.69
5H	2.0	0.312	1.7	0.932	0.077	1.322	1.69
Avg. Factor	2.3		1.7		1.0		2.0
Total		**18.1**		**5.7**	**1.2**	**25.0**	

Table 1-12
Design Maximum Hour Demands by Pressure Zone

Pressure Zone	Residential		Non-residential		Unaccounted	Total	MH:MD	MH:AD
	factor	(mgd)	factor	(mgd)	(mgd)	(mgd)	Ratio	Ratio
3	2.8	5.379	2.5	1.603	0.285	7.268	1.39	2.55
4	3.6	8.090	2.5	3.824	0.420	12.333	1.51	2.94
5	3.6	1.609	2.5	0.035	0.051	1.694	1.54	3.31
6	3.6	5.958	2.5	0.441	0.203	6.602	1.53	3.24
8 & 9	4.3	3.164	2.5	0.116	0.087	3.366	1.62	3.87
11	4.3	0.710	2.5	0.001	0.018	0.729	1.63	3.97
13	4.3	0.640	2.5	0.001	0.017	0.658	1.63	3.96
15 & 16	4.3	1.539	2.5	0.001	0.040	1.580	1.63	3.97
3H	2.8	0.330	2.5	1.034	0.059	1.423	1.43	2.41
5H	2.8	0.437	2.5	1.371	0.077	1.885	1.43	2.41
Avg. Factor	3.5		2.5		1.0		1.5	3.0
Total		**27.8**		**8.4**	**1.3**	**37.5**		

2.0 Water System GIS/Mapping

2.1 General

This project involved development of a detailed GIS of the existing water distribution system of the City, including the system in West Hollywood owned and maintained by the City. The maps created from the water system GIS will replace the hand-drawn maps on mylar currently used by the City. The water system GIS will also be used to maintain up-to-date information on the water distribution system.

In previous projects, the City created GIS sets for the storm drainage and sanitary sewer systems. In addition, the City has developed or obtained GIS sets developed by others of property parcels, rights of way, pavement (curb lines), ground elevation contours, and City limit boundaries. The City has previously purchased aerial photographs, which are registered and can be viewed behind any of the GIS sets. The City made this information available, and some of it was used in the water system maps created for this project.

2.2 Development of Water System GIS

2.2.1 GIS Design

Each group of facilities (mains, valves, pumps, tanks, etc.) of the water system GIS created for this project consisted of two distinct components. The first was a spatial representation of each element in the distribution system, such as a symbol representing a pump or a valve, a line representing a water main, or a closed polygon representing a pressure zone boundary. Each element had a unique identifier and a defined spatial location. The second component associated with each of these drawn elements was a list of data that describe, define, and present information about the element. A technical manual describing the water system GIS, titled *GIS Database Design*, is included in Appendix A of this report.

To ensure consistency among the various GIS sets created and used by the City, a set of 'Digital Data Capture Standards' was developed. These standards were used to ensure that the water system GIS created for this project was compatible with other GIS sets used by the City.

Prior to this project, the City had purchased a software package for tracking and storing maintenance information on the water distribution system. The City's maintenance management software of choice was *Hansen 7 Software for Water* by Hansen Information Technologies. The water system GIS was designed to be compatible with and to allow integration of the Hansen maintenance management software.

2.2.2 Information Used To Create GIS

Mapping of the water distribution system is currently maintained on a set of hand-drawn maps on mylar. This information was provided and used to create the water system GIS. Three sets of maps comprise the current City mapping as described below:

- Water Service Maps consisting of 56 individual 24"x36" sheets (including cover sheet). This set of maps shows the distribution system mains, valves, fire hydrants, reservoirs, and pumping stations at a scale of 1"=100'.
  - Individual valve and hydrant numbers are shown.
  - Valve size and type are often shown.
  - Fire hydrant type is indicated.
  - Main size and pressure zone are shown.
  - Material, date, and lining are shown for some of the mains.
  - Closed valves are identified.
  - Several fire service and large user connections are shown.
  - Distance from property line to main are indicated at numerous locations.
- Water Detail Maps consisting of 35 individual 24"x36" sheets. In general, this set of maps contains details at congested intersections, pumping stations, reservoirs, and pressure reducing vaults. The details are referenced to the 'Water Service Maps' and contain information similar to that included on the Water Service Maps.
- Service Detail Maps consisting of 56 individual 24"x36" sheets (including cover sheet) at a scale of 1"=100'. This set of maps identifies all the service water meters installed in the distribution system.
  - Location of service line (at property line) is shown.
  - Service line size and material are shown.
  - Meter size and account number are shown.

Additional information and details of the water distribution system and facilities are available on copies of construction drawings, or 'as-builts,' maintained and stored in the City's records. These drawings were reviewed, and electronic images were 'scanned' for this project. They were used to provide additional information and to refine and correct data on the City's maps, when necessary.

2.2.3 Creation of GIS

Using digitizing techniques, the Water Service Maps were "re-drawn" in electronic format. Initially, all the electronic information was "re-drawn," with separate files corresponding to each of the Water Service Maps. The information was then merged to a single set of information corresponding to the entire system. Information on the original maps was then entered into the associated databases. The captured data for the overall system were organized into separate file sets as summarized below:

- Water mains.
- Nodes (pumping stations, reservoirs, and connections of two or more pipes).
- Valves.
- Fire hydrants.

Detailed quality-control steps were undertaken to verify that the information in the newly created water system GIS accurately represented the information shown on the City's maps. Summary tables of captured data were reviewed to identify and correct discrepancies, plots made from the GIS were reviewed and compared against the original City maps, and as-built drawings were reviewed to verify the accuracy of the GIS information.

Additional GIS files were created to represent and map the following elements of the water distribution system:

- Water service meters.
- Distance of main from property line.
- Pressure zone boundaries.
- Sheet index corresponding to original Water Service Maps.
- As-built Image Linking.

2.3 Components of Water System GIS

2.3.1 Distribution System Mains

The Water Service Maps showed the diameters of all the mains, but sometimes did not show the date of installation and/or water line material.

Information concerning the size and material of the water mains in the GIS is summarized in Table 2-1. There were about 30,000 feet (5.7 miles) of pipe (3.3 percent of the total) for which the material was not determined.

Table 2-1
Summary of Mains by Size and Material

Size (inches)	Feet of Main							
	Asbestos Cement	Cast Iron	Copper	Ductile Iron	Galvanized Steel	Steel	No Material	Total
1							619	619
2		145	178		390	101	569	1,384
3							27	27
4		84,528		381		5,249	678	90,836
6		116,643	176	3,795		5,103	25,789	151,505
8		133,272		264,722		13,849	1,699	413,541
10	479	28,940		2,282		5,523	272	37,496
12		12,776		101,871		12,085	282	127,015
14		4,369		1,386		6,238	38	12,031
16		13,134		14,005		4,550		31,689
18				2,649		1,168	29	3,846
20				4,131		2,043		6,174
24				5,384		20,200		25,584
Total	**479**	**393,807**	**354**	**400,605**	**390**	**76,109**	**30,001**	**901,746**
%of Total	0.1%	43.7%	0.0%	44.4%	0.0%	8.4%	3.3%	100%

Dates of installation ranged from 1912 through 1999. For about 195,000 feet (36.9 miles) of water line, the installation date could not be determined (21.6 percent of the total). About 29,000 feet (3.2 percent of the total) of water line lacked both date of installation and material. Information concerning the installation date and material of the water mains in the GIS is summarized in Table 2-2.

Table 2-2
Summary of Mains by Material and Year Installed

Year	Feet of Main							
	Asbestos Cement	Cast Iron	Copper	Ductile Iron	Galvanized Steel	Steel	No Material[1]	Grand Total
None	479	125,490	354	408	390	38,693	28,859	194,673
1912						3,835		3,835
1922						1,755		1,755
1924		53,846				6,022		59,868
1925		35,332						35,332
1926		4,295						4,295
1927		8				712	8	728
1930		6,029						6,029
1931		3,458						3,458
1932		3,337				454		3,791
1933		2,605						2,605
1935		31,670						31,670
1936		4,958					8	4,966
1937		1,524				1,626		3,151
1938		189						189

Table 2-2
Summary of Mains by Material and Year Installed

Year	Feet of Main							
	Asbestos Cement	Cast Iron	Copper	Ductile Iron	Galvanized Steel	Steel	No Material[1]	Grand Total
1940		663						663
1946		1,973						1,973
1949		448						448
1953		8,509						8,509
1954		543				7,829	9	8,381
1955						2,228		2,228
1956		12,636				3,615	14	16,265
1957		9,932				272		10,205
1958		27,056				30	56	27,142
1959		13,637				2,470	21	16,128
1960		7,243						7,243
1961		1,566						1,566
1962		6,280						6,280
1963		1,260				262		1,522
1965						380		380
1966		3,003						3,003
1967		1,701						1,701
1968		715				2,539	54	3,309
1969		429						429
1970		5,048						5,048
1971		1,478						1,478
1972		1,540		904				2,444
1973		3,639		21,113			76	24,829
1974		3,112						3,112
1975		7,771		47,953			93	55,817
1976		780		32,247				33,027
1977				44,407		30	38	44,475
1978		103		11,314		36	58	11,511
1979				2,614			12	2,626
1981				1,380				1,380
1982				5,934				5,934
1983				18,193			123	18,315
1984				2,047				2,047
1985				14,764			64	14,828
1986				17,087			42	17,129
1987				8,113			61	8,174
1988				4,702				4,702
1989				5,442				5,442
1990				17,101			34	17,136
1991				11,408		3,287	11	14,706
1992				16,936			84	17,021
1993				12,296				12,296
1994				1,580				1,580
1995				16,335			178	16,513
1996				27,892		35	40	27,967
1997				13,555				13,555
1998				13,865				13,865
1999				31,016			55	31,071
Total	**479**	**393,807**	**354**	**400,605**	**390**	**76,109**	**30,001**	**901,746**

[1] All mains with date but no material identification are ancillary lines at air relief and blow-off valves, where no material is indicated or "Water Service Maps".

Some existing water lines in the Beverly Hills system have been rehabilitated by relining of the interior and are identified on the Water Service Maps. Where this information was identified, the date and type of relining were included in the water system GIS. About 19,300 feet of rehabilitated water line was identified (2.1 percent of the total). All water lines identified as rehabilitated were either cast iron or steel. Information on relined water mains in the GIS is summarized in Tables 2-3, 2-4, and 2-5.

Table 2-3
Relined Main by Year

7	Feet of Relined Main
0	493
1954	2,565
1970	520
1973	305
1974	3,402
1975	6,445
1982	2,849
1985	2,736
Total	**19,316**

Table 2-4
Relined Main by Diameter

Diameter (inches)	Feet of Relined Main
4	14
6	493
8	7,567
10	3,585
12	4,904
16	2,565
18	189
Total	**19,316**

Table 2-5
Relined Main by Material

Material	Feet of Relined Main
Cast Iron	2,439
Steel	16,877
Total	**19,316**

2.3.2 Junctions, Valves, Fire Hydrants, Pump Stations, and Reservoirs

The single file containing all hydraulic elements represented by a single point, such as pumping stations, reservoirs, tees and crosses, and valves, was created from the information on the Water Service Maps. This file also contained points representing changes in pipe material, pipe age, and pipe size, as well as points representing fire and large service connection and pipe caps. As a part of quality assurance and control, this file was used to create a summary of 'point-type' water distribution system elements as shown in Table 2-6.

Table 2-6
Count of Point Features including Valves, Hydrants and Nodes

SUBTYPE	Fire Hydrants	Water Meters[1]	Junctions[2]	Valves	Reservoirs	Misc.	Pump Stations	Total
Air Release Valve (AR)				93				93
Butterfly Valve(BF)				1,496				1,496
Blow Off Valve (BO)				32				32
End Cap (C)			278					278
Fire Service (FS)			6					6
Gate Valve (GV)				2,259				2,259
Jones Hydrant (J)	1,305							1,305
Material Change Point (M)						1		1
Not Defined (ND)				285				285
Pressure Regulator (PRV)				34				34
Plug Valve (PV)				2				2
Reducer (R)			545					545
Large Service Connection (SC)			11					11
Blank[3]		17	2,780		10		14	2,821
Total	**1,305**	**17**	**3,620**	**4,201**	**10**	**1**	**14**	**9,168**

[1]Water meters shown in this table are distribution system meters located at pumping and pressure reducing stations. They are not service water meters.

[2]Junctions represent several items in this table. End caps were always located at the end of a dead end main. Fire service and large service connections are located at the end of a main, where indicated on the 'Water Source Maps'. Reducers are located between two pipe segments of differing diameter. Junctions identified as 'blank' represent locations where two or more pipes are connected by a wye, tee, or cross in the distribution system.

[3]Except for junctions (see note 2), 'Blank' represents information which is not defined by other than the major type of component that it represents, such as water meters, pumping stations, reservoirs. For example, reservoirs are not further defined in the GIS as steel or concrete.

2.3.3 Fire Hydrant Types and Numbering

The Water Service Maps identified fire hydrants by the type (number and size of nozzles) and listed a unique number for each hydrant. However, the information shown on those maps was outdated. The City has recently instituted a major fire hydrant replacement program, and all the fire hydrants are being replaced with consistently-sized hydrant of a single type, manufactured by the Jones Company. All fire hydrants in the water system GIS were identified as 'Jones' fire hydrants.

The fire hydrant numbering has recently been revised, but has not been updated on the Water Source Maps. The City provided a separate figure showing the locations and new numbers of the fire hydrants. The water system GIS contains both the old numbers from the Water Source Maps and the new numbers shown on the figure provided by the City. After detailed quality control review, including reference to available 'as-built' construction drawings, the following issues were noted relative to the new valve numbers:

- Fifteen fire hydrants shown on the City exhibit of new fire hydrant numbers were not shown on the Water Service Maps and could not be identified in any of the available as-builts. These 15 hydrants are not included in the water system GIS and have the following 'new numbers': 31, 241, 252, 697, 742, 837, 906, 907, 934, 935, 961, 970, 1014, 1019, and 1020.
- After correcting for the discrepancies, 20 fire hydrants were shown with a new number of 000 on the City provided figure, and these new numbers were retained for the water system GIS.
- Five fire hydrants located at the Beverly Hills High School were not shown on the City figure with the new numbers. A new number of 'P' was entered for these five hydrants.
- The fire hydrants located in West Hollywood were not shown on the City's figure with the new numbers. A new number of 'WH' was entered for all fire hydrants located in West Hollywood.

2.3.4 Details at Pumping Stations, Reservoirs, and Valve Vaults

Detailed information on pumping stations, reservoirs, and valve vaults was simplified in the water system GIS. However, the water system GIS contains scanned images of detailed drawings of these facilities which can be viewed as described in Section 2.4 'An example of typical information for a pumping station is shown on Figure 2-1, and a detail of the same location in the water system GIS is shown on Figure 2-2.

Figure 2-1
Detail from 'Water Service Maps' at Pumping Station 4B

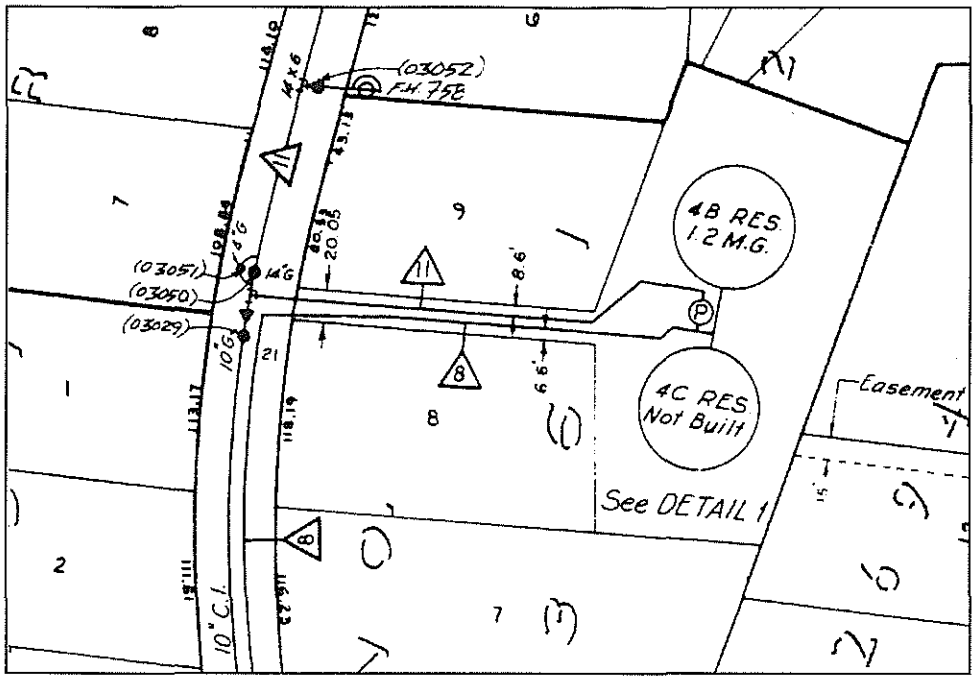
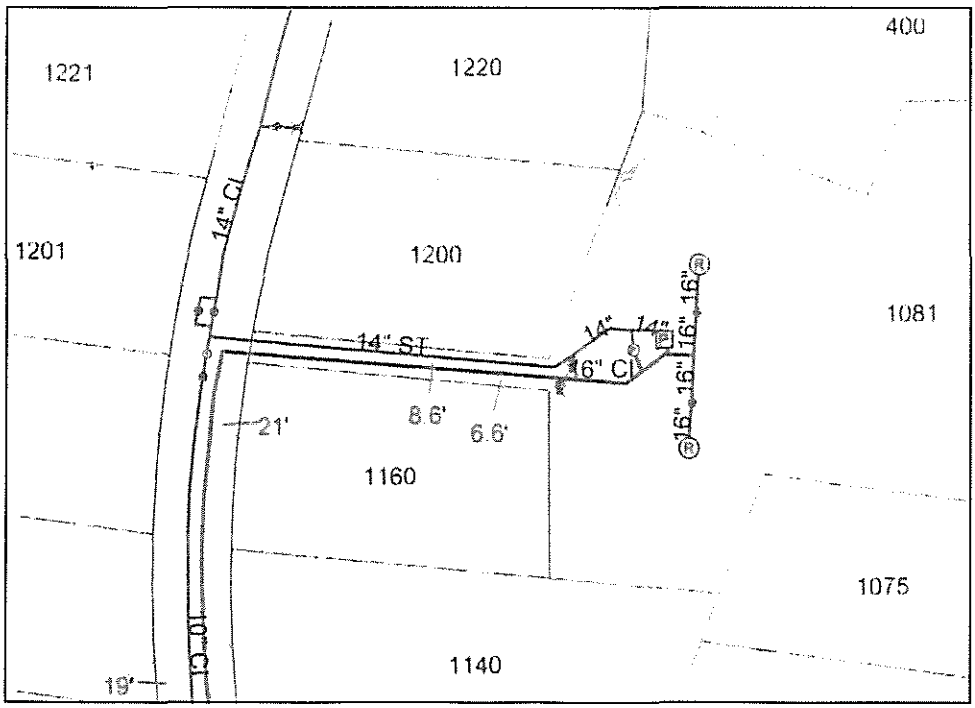


Figure 2-2
Detail from Water System GIS Mapping at Pumping Station 4B



2.3.5 Water Service Meters

The locations of water service meters for the water system GIS were taken from the Service Detail Maps. A total of 10,473 service meters are included in the water system GIS; 8,534 of these meters are located in Beverly Hills; the remaining 1,939 are in West Hollywood.

Each water service meter is spatially related in the water system GIS to a single property parcel. Property parcel GIS data for use on this project was provided by the City, and each parcel was identified by the AIN. The City provided an electronic file of meter sizes with the corresponding AIN for the meters located in Beverly Hills. Using this electronic file and GIS techniques, the water system GIS was updated to include meter size for most of the water service meters located in Beverly Hills. Of the 8,534 water service meters in Beverly Hills, a total of 8,058 (94 percent were updated to include meter size. Additional information, such as service size and account number, will be filled in by the City. Missing information on meter sizes in Beverly Hills and all of West Hollywood will also be filled in by the City.

2.4 As-built Drawings and Detailed Image Linking

An application was developed to enable the City to organize and display scanned as-built and detailed drawings. This application was incorporated into the water system GIS.

An image library of scanned as-built and detailed drawings was created and delivered with the water system GIS. The image library contains 549 scanned images of pertinent as-built construction drawings, 35 scanned images of the Water Detail Maps, and one scanned image of the Water Service Map that contained a detail. Images of cover sheets and general details were not included in the image library.

A special file set in the water system GIS was prepared with attributes for "hot linking" to the scanned images. When viewing the water system GIS, a number of red and blue asterisks are visible along the length of a water main or at specific locations. When one of these asterisks is clicked on, an image of the as-built or detailed drawing for that area appears on the screen. Blue symbols are linked to the Water Detail Map images, and red symbols are linked to the as-built images.

2.5 Mapping

The water system GIS contains two applications for plotting maps of the system. One application allows maps to be plotted on 11"x17" paper at a scale of 1"=250'. The other application allows maps to be plotted on 22"x36" paper at a scale of 1"=100'.

The plotted maps are identified using the same numbering system and sheet arrangement as the original Water Service Maps. Since six of the original Water Service Maps were for abandoned facilities outside the current city limits and were not included in the water system GIS, the mapping for the water system GIS consists of 49 sheets. The plotting applications allow plotting individual sheets or consecutively plotting all (49) sheets

In addition to the files created specifically for this project, the plotted maps display information contained in other GIS files provided by the City, including the following:

- Property parcels with address in Beverly Hills.
- Property parcels for West Hollywood.
- Curblines/edge-of-pavement for streets located in Beverly Hills.
- Street names in Beverly Hills and in West Hollywood.

An example of the 1"=250' scale plot is included on Figure 2-3 on the following page.

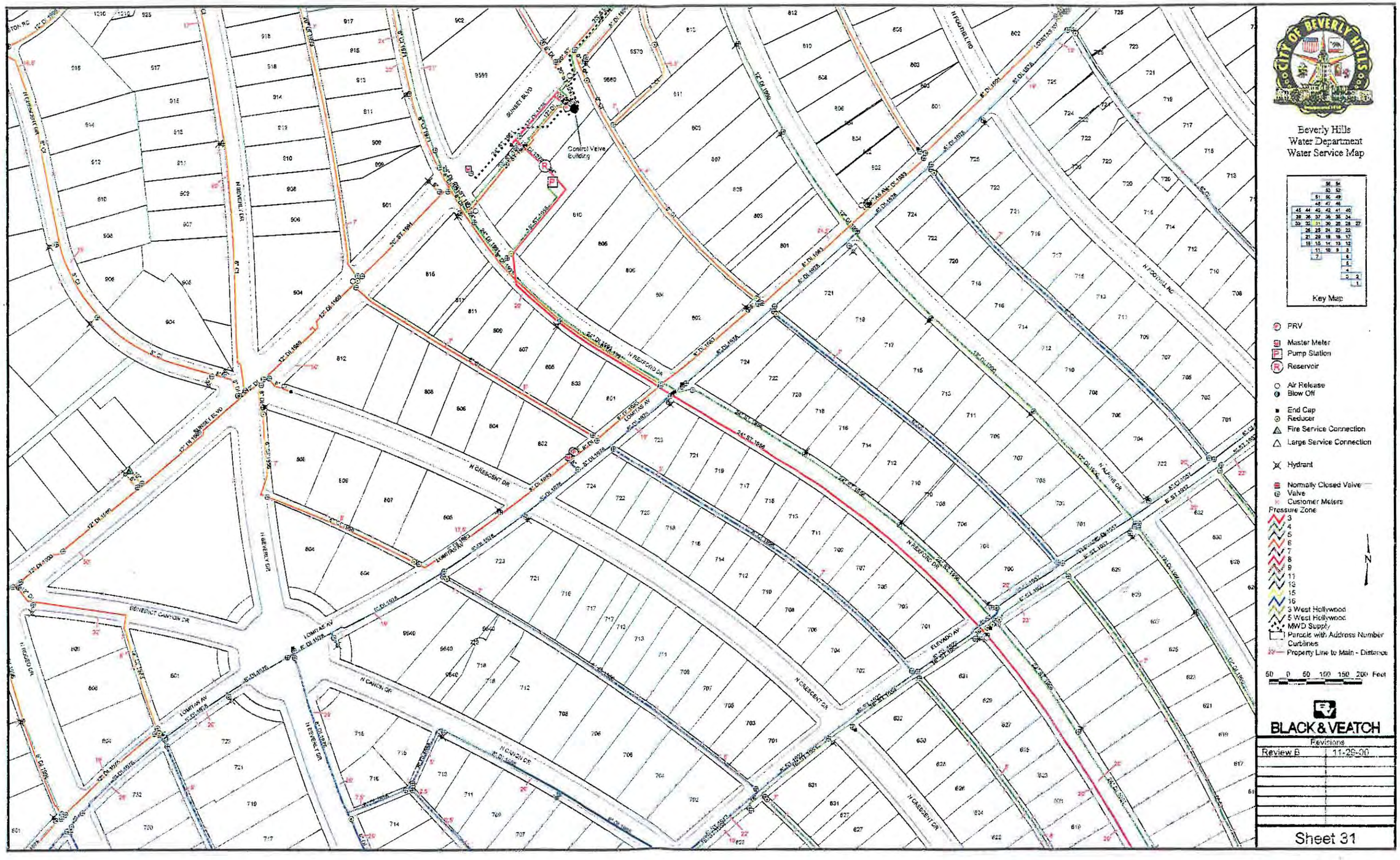

Beverly Hills
Water Department
Water Service Map
Key Map
PRV
Master Meter
Pump Station
Reservoir
Air Release
Blow Off
End Cap
Reducer
Fire Service Connection
Large Service Connection
Hydrant
Normally Closed Valve
Valve
Customer Meters
Pressure Zone
3
4
5
6
7
8
9
11
13
15
16
3 West Hollywood
5 West Hollywood
MWD Supply
Parcels with Address Number
Curblines
Property Line to Main - Distance
50 0 50 100 150 200 Feet
N
BLACK & VEATCH
Revisions
Review B 11-29-00
Sheet 31
Control Valve Building
SUNSET BLVD
N BEVERLY DR
N CRESCENT DR
N REXFORD DR
N CANYON DR
LOMITAS AV
ELEVADO AV
BENEDICT CANYON DR
N HEDGE DR
N PORTLAND DR
N ALPINE DR

Figure 2-3

3.0 Existing Water System Facilities

3.1 General

This chapter describes the City's major sources of water supply and discusses the pressure zones, pumping stations, reservoirs, and distribution system facilities comprising the City's water system.

3.2 Water Supply

The primary source of water supply for the City and the West Hollywood distribution system is from a 54 inch MWD pipeline on Sunset Boulevard. The water supply from the MWD 54 inch pipeline enters the Beverly Hills Central Control Building (CCB), located in the alley east of Rexford Drive at Sunset Boulevard.

The water enters the CCB from two MWD connections, designated BH-1 and BH-2, as shown on Figure 3-1. Each has a flow capacity of 40 cubic feet per second (cfs) (26 mgd), for a total of 80 cfs (52 mgd). The City is required to take a minimum daily flow of 8 cfs (5 mgd) from MWD. The normal operating pressure for these connections is 154 pounds per square inch (psi), and serves Pressure Zones 3, 4, and 6 by gravity. The supply lines for Zones 3, 4, and 6 have two control valves each, which can be adjusted individually to supply varying flow rates to the zones without changing the total flow from MWD. Normally, the 54 inch MWD pipeline is supplied from the east via MWD's Santa Monica feeder. The City is required to give MWD 12 hours' advance notice regarding the quantity of water needed. Under special conditions, MWD allows the City to make flow adjustments with only 6 hours' advance notice.

In the event of a Santa Monica feeder outage, MWD can supply the 54 inch pipeline from the Sepulveda Feeder. Under this condition, the operating pressure from the Sepulveda Feeder to the metered connections is only 85 psi. The Sepulveda Feeder has sufficient hydraulic gradient elevation to supply only Pressure Zones 3 and 4 by gravity. Also, when this feeder is used, Zone 6 needs to be supplied by pumping from Booster Station No. 2, which takes suction from Zone 4.

Beverly Hills also has two emergency water service connections to the Los Angeles Department of Water and Power (LADWP) water system. These connections are located near the Booster Station No. 2 site and adjacent to Reservoir No. 7. The maximum flow allowable from LADWP near Booster Station No. 2 is 21 cfs (13.5 mgd), which may be conveyed to Zone 4 by pressure reducing valves or to Zone 6 by pumping from Booster Station No. 2. The design capacity from the LADWP connection adjacent to Reservoir No. 7 is 3.4 cfs (2.2 mgd).

City Limits

West Hollywood Land Use is based on exhibit in previous study by others.

N

0.25 0 0.25 0.5 Miles

Land Use

- Single Family Residential
- Multi-Family Residential
- Commercial/Municipal
- Schools
- Parks and Reservoir Sites

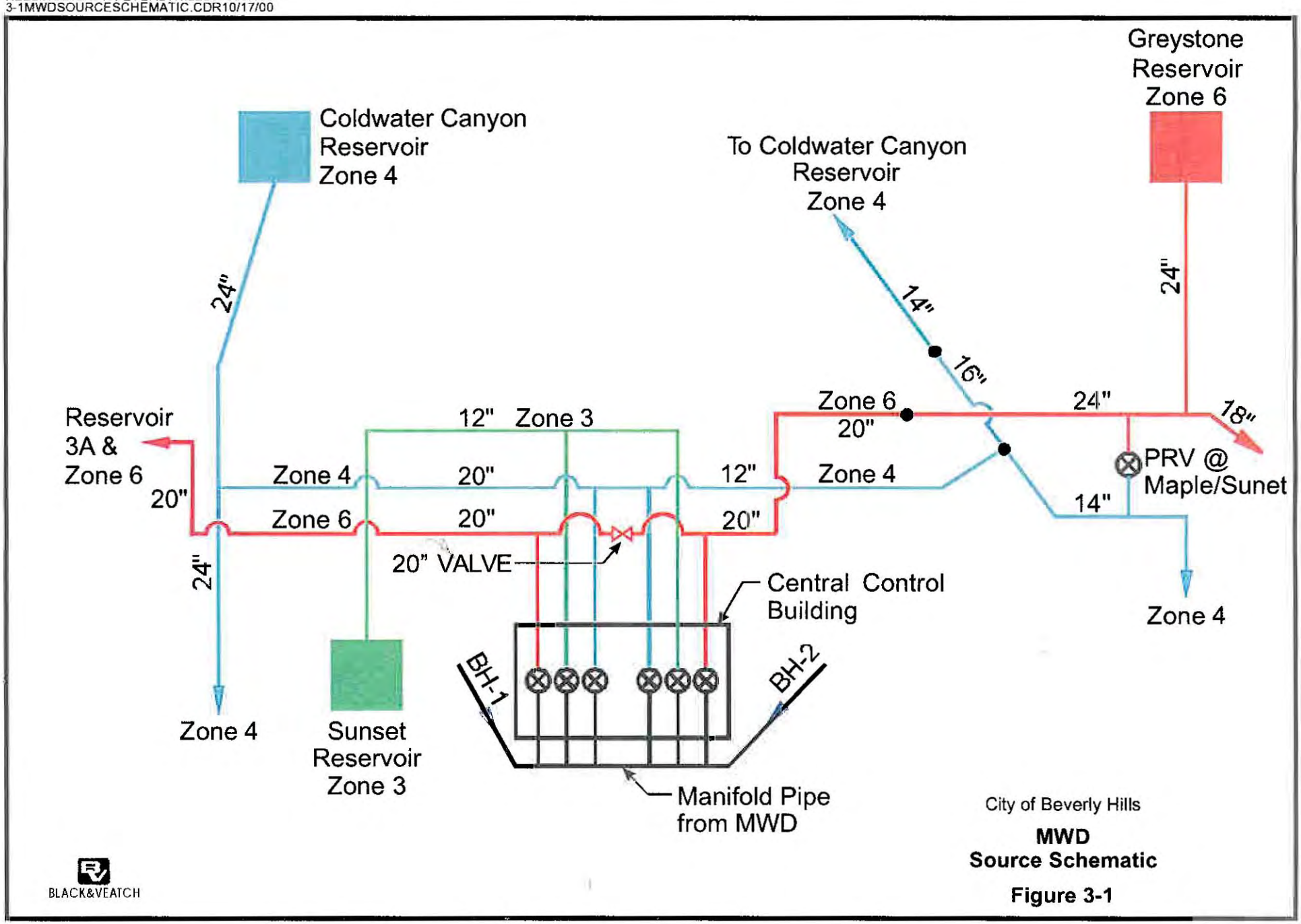
Beverly Hills, California
Water System Master Plan
2002

LAND USE

BLACK & VEATCH

FIGURE 1-2

KEELINGDISK849BEVERLYHILLS97033.100
3-1MWDSOURCESCHEMATIC.CDR10/17/00



City of Beverly Hills

MWD
Source Schematic

Figure 3-1

BLACK&VEATCH

3.3 Pressure Zone

The Beverly Hills water distribution system is divided into 13 pressure zones that are established to provide acceptable pressures across the system. Figure 3-2 shows the pressure zones and existing facilities. Figure 3-3 is an overall water system schematic. Eleven pressure zones are located within the Beverly Hills City limits; the remaining two pressure zones are located within a portion of the West Hollywood City limits. Table 3-1 lists the pressure zones, maximum hydraulic gradients established by the reservoirs serving these zones, and range of ground elevations served.

Table 3-1
Pressure Zones

Pressure Zone	Reservoir Serving Zone	Maximum HGE[1] Elevation (ft)	Ground Elevation	
			Maximum (ft)	Minimum (ft)
16	7 (via PS No. 8)[2]	1610	1470	1360
15	7	1502	1350	1080
13	6	1293	1120	850
11	5	1052	920	640
9	3A (via Monte Cielo PS)[2]	1050	940	680
8	4A,4B	800	720	440
7	Greystone (via Green Acres PS)	711	550	445
6	3A/Greystone	628	480	260
5	PRV via Greystone[3]	499	420	240
4	Coldwater	454	330	205
3	Sunset	384	260	150
WH3	Coldwater (via PRV)[3]	364	240	165
WH5	Greystone (via PRV)[3]	487	405	245

[1]Hydraulic Gradient Elevation
[2]Pump Station
[3]Pressure Reducing Valves

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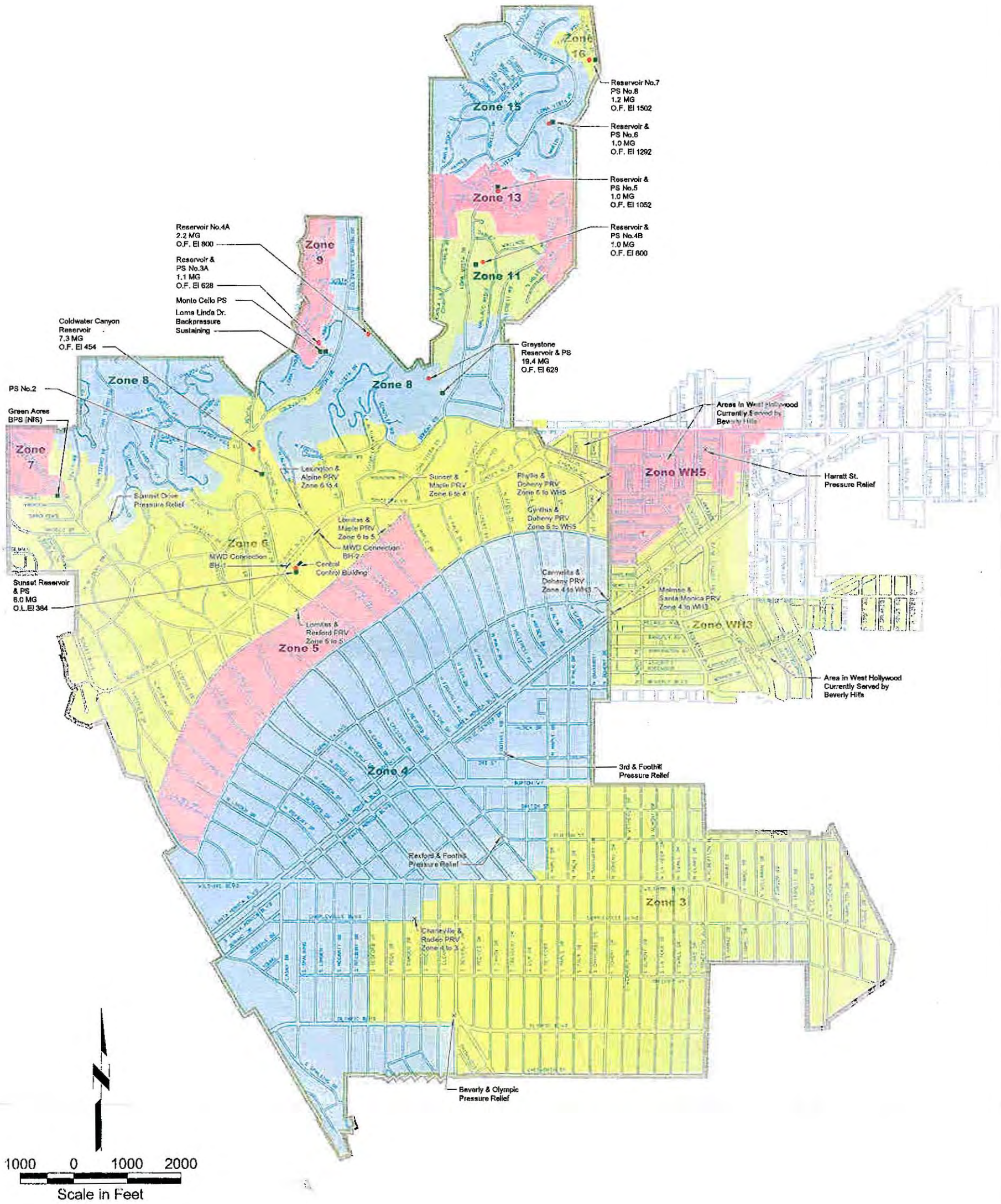
97033-00001-C-H000015JE



Legend

Pressure Zone

Beverly Hills City Limits

Beverly Hills, California
Water System Master Plan

Existing Facilities

BLACK & VEATCH

FIGURE 3-2

Table 3-2 describes the water supply for each pressure zone.

Table 3-2
Water Supply for Pressure Zones

Pressure Zone	Source of Water Supply
3	Water supply to Zone 3 is from the two MWD connections. Zone 3 receives water by gravity from the Sunset Reservoir. A pressure reducing station can also supply Zone 3 from Zone 4 at Charleville & Rodeo, 3rd Street & Foothill, and Rexford & Foothill.
3WH[1]	Zone 3 WH receives water by two pressure reducing stations from Zone 4. They are located at Carmelita Avenue & Doheny Drive and Melrose Boulevard & Doheny Drive.
4	Zone 4 receives water from the Coldwater Canyon Reservoir. Water supply to Zone 4 is from both MWD connections, BH-1 and BH-2. Water can also be received through three pressure reducing stations from Zone 6: one at Booster Station No. 2, one at Lexington & Alpine, and one at Maple Drive & Sunset Boulevard. The Sunset Pump Station, currently out of service, pumps water to Zone 4 from the Sunset Reservoir (Zone 3).
5	Zone 5 is supplied by two pressure reducing stations from Zone 6, one at Rexford Drive and Lomitas Avenue and one at Sunset Boulevard and Maple Drive.
5WH	Zone 5WH of the West Hollywood portion of the service area is supplied water through two pressure reducing stations from Zone 6. They are located at Phyllis Street & Doheny Drive and Cinthia Street & Doheny Drive.
6	Zone 6 is supplied water by gravity from Reservoir No. 3A and Greystone Reservoir. Water supply to Zone 6 is from MWD connections BH-1 and BH-2. Pump Station No. 2 (Coldwater) can also pump water from Zone 4 to Zone 6.
7	Zone 7 consists of the area known as Green Acres, including services along Green Acres Drive, Leona Drive, and the uppermost portion of Benedict Canyon Drive. This zone is served by the Green Acres Pump Station, which takes suction from Zone 6. The pump station is currently out of service. When operational, Zone 7 is a closed distribution system with no floating reservoir storage.
8	Zone 8 is served by gravity from two reservoirs, Reservoir Nos. 4A and 4B. Water is supplied by the Greystone Pump Station and Pump Station No. 3A.
9	Zone 9 (Monte Cielo System) includes service along Lago Vista Drive and Monte Cielo Drive. This zone is supplied water from Pump Station 3A (Zone 8). Zone 9 is a closed distribution system with no floating reservoir storage.
11	Zone 11 is supplied by gravity from Reservoir No. 5. Water is pumped to Zone 11 from Pump Station No. 4.
13	Zone 13 is supplied by gravity from Reservoir No. 6. Water is pumped to this zone from Pump Station No. 5.
15	Zone 15 is supplied by gravity from Reservoir No. 7. Water is pumped to this zone from Pump Station No. 6.
16	Zone 16 is served by Pump Station No. 8, which obtains water from Reservoir No. 7. Zone 16 is a closed distribution system with no floating reservoir storage.

[1] WH - West Hollywood

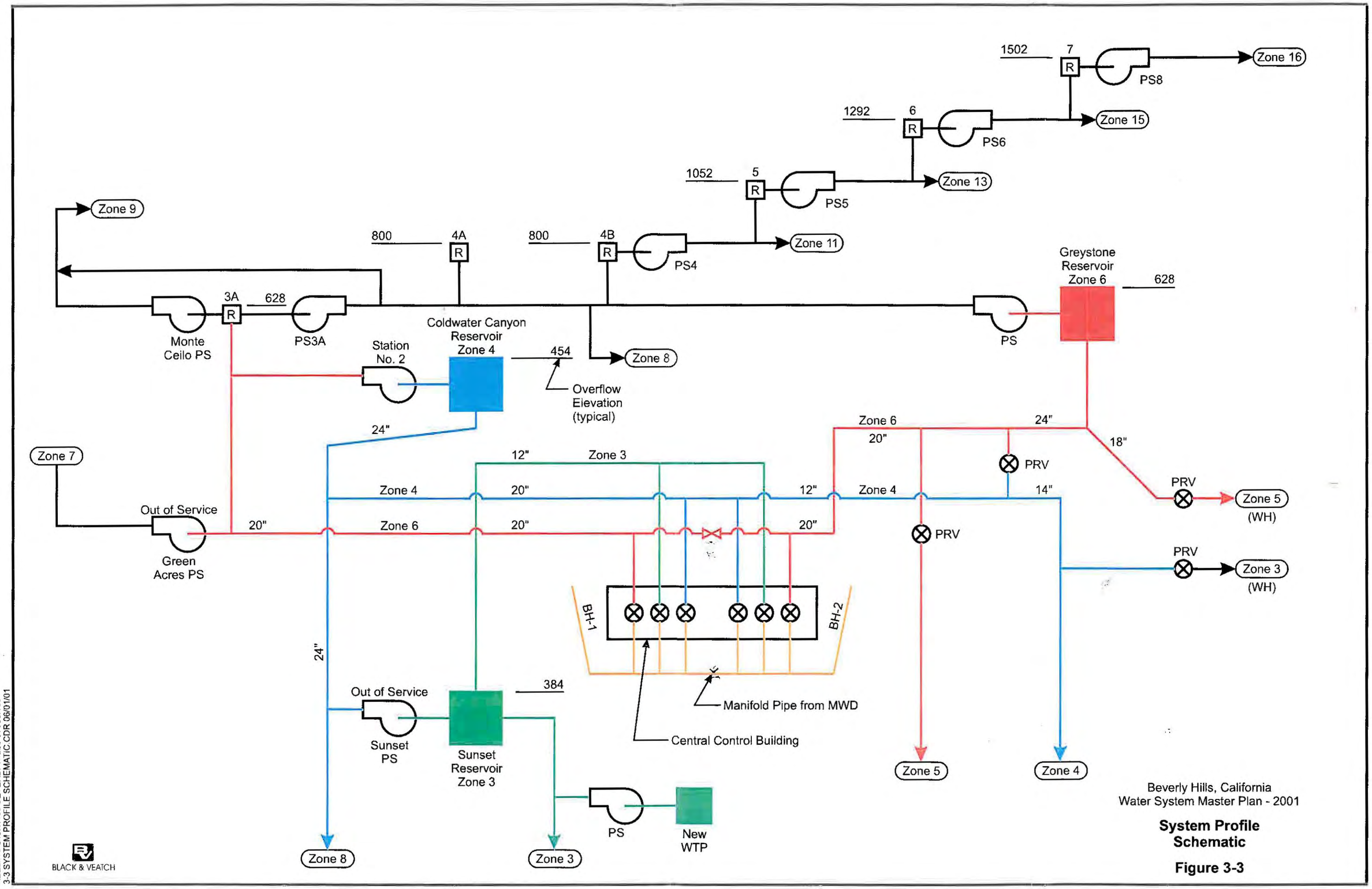
3.4 Pumping Stations

There are currently 10 pumping stations, with a total of 27 pumps, in the Beverly Hills water system. Information on the existing pumps was derived from previous reports and compared with recent testing data provided by Operations staff. Data conflicts were resolved and adjusted in cooperation with staff. Table 3-3 shows data for the existing pumping stations.

Table 3-3
Data For Existing Pumping Stations

Pumping Station	Unit No.	Zone Served	Power (hp)	Capacity (gpm)	Head (ft)
Sunset[1]	1	4	100	2,750	80
	2		100	2,750	80
Coldwater (PS 2)	1		200	2,750	185
	2	6	200	2,750	185
Green Acres[1]	1		10	240	100
	2		10	240	100
	3	7	75	2300	100
3A	1		125	1,150	210
	2	8	125	1,150	210
Greystone	1		75	1,150	180
	2		75	1,150	180
	3	8	247	2,000	280
Monte Cielo	1		20	120	310
	2		20	120	310
	3	9	250	1,200	465
4B	1		125	1,500	265
	2		125	1,500	265
	3	11	195	2,000	280
5	1		75	800	270
	2		75	800	270
	3	13	200	2,000	280
6	1		75	750	235
	2		75	750	235
	3	15	195	2,000	280
8	1		10	120	140
	2		10	120	140
	3	16	188	2,100	130

[1]Sunset and Green Acres pumping stations are not currently in service. At the time of this report, Green Acres pumping station is being rehabilitated to be placed back in service.



Beverly Hills, California
Water System Master Plan - 2001

System Profile Schematic

Figure 3-3

KEELING DISK1135 BEVERLY HILLS 97033.100
3-3 SYSTEM PROFILE SCHEMATIC.CDR 06/01/01

3.5 Reservoirs

There are currently nine reservoirs within the Beverly Hills water system, as shown in Table 3-4. Of these, five are aboveground, circular steel tanks, and the others are either buried or partially buried concrete reservoirs.

Table 3-4
Existing Reservoir Data

Reservoir No.	Nominal Volume (MG)	Overflow Elevation (ft)	Depth (ft)	Zone Served
Sunset	6.0	384	21	3
Coldwater	7.3	454	16	4
3A	1.1	628	31	6
Greystone	19.4	628	43	6
4A	2.2	800	22	8
4B	1.0	800	31	8
5	1.0	1,052	31	11
6	1.0	1,292	31	13
7	1.2	1,502	31	15
Total Volume	**40.2**			

3.6 Distribution System

As shown on Figure 3-4, the Beverly Hills water distribution system has a complex network of transmission and distribution pipelines up to 24 inches in diameter. Most of the mains consist of lined and unlined steel, cast iron, and ductile iron pipe.

3.6.1 Service Connections and Meters

The City currently serves its customers through approximately 10,600 metered connections. Table 3-5 shows the service connections by size and location based on metered sales records.

Table 3-5
Metered Water Service Connections

Size (inches)	Beverly Hills	West Hollywood	Total Service
1/2	1	0	1
5/8	1,923	1,152	3,075
3/4	1,220	140	1,360
1	2,250	209	2,659
1 1/2	1,744	155	1,899
2	820	123	943
2 1/2	0	0	0
3	116	22	138
4	189	36	225
6	78	21	99
8	11	2	13
NA	181	56	237
Total	**8,735**	**1,916**	**10,649**

3.6.2 Pressure Reducing and Relief Stations

Table 3-6 shows the location of nine pressure reducing stations and five pressure relief stations that operate within the City's distribution system. The pressure reducing valves (PRVs) deliver water at a regulated pressure from the upper to the lower pressure zones. The pressure relief valves open only when necessary to prevent excessive pressure in the upper pressure zones. PRVs are also used for pump protection in Booster Stations 4B, 5, 6, 8, and at the Greystone Booster Station. Additional pressure relief stations, which would discharge to the atmosphere if operated, are located at South La Cienega Boulevard and Gregory Way, Lago Vista Drive and Lago Vista Place, 341 North Foothill Road and Rosewood Avenue and Flores Street (WH).

Table 3-6
Existing Pressure Reducing Stations

Location	Pressure Zone	Size (inches)	Elevation	Setting (psi)	Setting (HGL-ft)
Pressure Reducing Valves (Settings refer to lower pressure zones)					
Lomitas and Maple	6 to 5	8	351	64	499
Lomitas and Crescent (Rexford)	6 to 5	8	361	53	483
Sunset and Maple	6 to 4	12	378	29	445
Lexington and Alpine	6 to 4	10	403	23	442
Booster Station 2	6 to 4	6,8,10	433	9,6,3	433-440
Charleville and Rodeo	4 to 3	6	228	58	362
Cynthia and Doheny	6 to WH5	8	337	62	487
Carmelita and Doheny	4 to WH3	10	233	60	360
Phyllis and Doheny	6 to WH5	10	337	62	480
Melrose and Santa Monica	4 to WH3	10	226	62	364
Pressure Relief Valves (Settings refer to upper pressure zones)					
Loma Linda Dr	9 to 8	4	650	214	1156
Summit Drive	8 to 6	4	428	191	846
Harratt Street	WH5 to WH3	4	306	87	507
Rexford and Foothill[1]	4 to 3	10	229	120	507
3rd Street and Foothill[1]	4 to 3	8	No Data	No Data	No Data
Beverly and Olympic	4 to 3	4			

[1]Dual Function – Pressure Reducing and Relief.

3.6.3 Telemetering and Remote Control Facilities

Present system operations include the monitoring of all major storage reservoirs within the City's system; control of water sources and booster pumping stations based on these reservoir levels; indication and recording of critical flows and elevations; reporting of critical system alarms; and manual override control from the Central Control Panel to each remote pumping facility.

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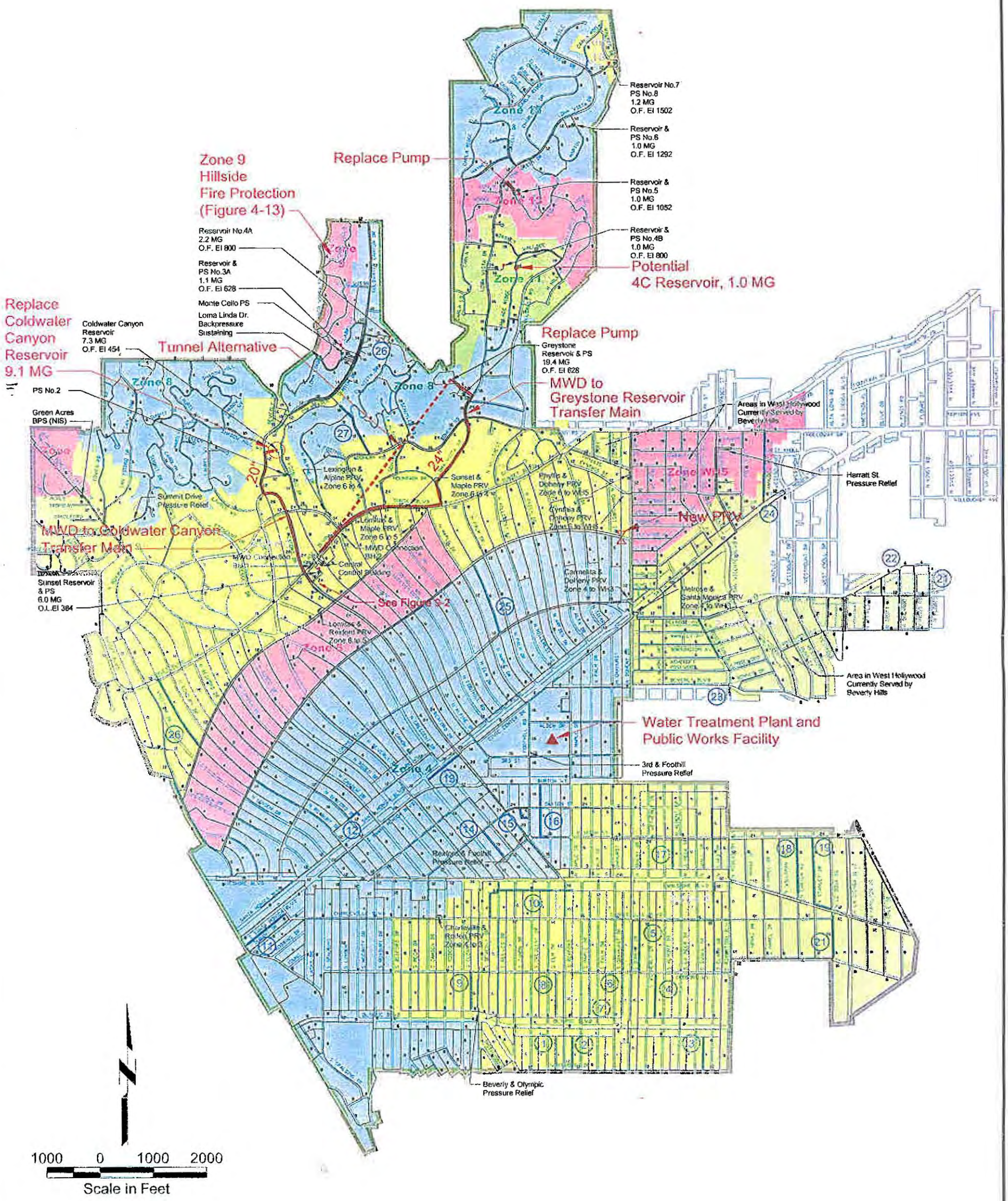


Legend

- Pressure Zone
- Beverly Hills City Limits
- Existing Pipes and Sizes

Beverly Hills, California
Water System Master Plan

Existing Distribution System

BLACK & VEATCH

Figure 3-4

4.0 Distribution System Analysis

4.1 General

The Beverly Hills water distribution system was evaluated using computer modeling to simulate flows through the distribution system under a variety of conditions. In general, the flow and gradient patterns through a pipe network depend upon the magnitude and location of system inputs and demands and on the characteristics of the water mains and other facilities in the distribution network. The head loss through each main is a function of flow rate and pipe characteristics, including diameter, length, and interior roughness. The residual pressure at any point in the network is the difference between the hydraulic gradient elevation and the ground elevation.

The distribution system model was prepared and hydraulic analyses were conducted using the H_2ONET software 4000-pipes version. The analysis results identified deficiencies in the existing Beverly Hills system, evaluated capability to meet projected water demands through the Year 2025, and evaluated operational or improvement alternatives. Various combinations of improvements and modifications were investigated to identify those most appropriate and effective in meeting the projected future water demands.

4.2 Model Development

The distribution network portion of the hydraulic model was developed using the City of Beverly Hills Water System GIS, as discussed in Chapter 2 and as presented in the Appendix section of this report. The Water System GIS database contains information on the diameters and lengths of all water mains within the existing distribution system. To provide the City with a comprehensive model, all of the pipes in the GIS were included except for fire hydrant leads. A skeletonization process was performed to reduce the detail from the full GIS to a level suitable for modeling, without eliminating any pipe length. The resulting hydraulic model network includes approximately 2500 pipe segments and 2000 nodes.

After the network was completed, interior roughness coefficients were assigned to each pipe segment. In the Hazen-Williams empirical equation for water flow through a pipe, the interior pipe roughness is expressed in terms of a coefficient referred to as the C-value. Higher C-values represent lower pipe wall friction, which corresponds to greater flow capacities through the pipe. Using experience gained from previous water

system studies and comparison of model results with SCADA data, friction coefficients were assigned to the mains in the hydraulic model based on pipe diameter, material, and age as listed in the Appendix.

The hydraulic model network was completed by adding pressure settings for pressure regulating valves, closing of division valves that separate the various pressure zones, and incorporating the detailed piping within each pumping station and in close proximity to each reservoir. Head-capacity relationships for the individual pumps were then added to the model as well as the volume and elevations for each reservoir. Ground elevations were determined for all distribution network nodes in order to calculate residual pressures. The facility details, pump curves, and valve settings are included in the Model Development Memorandum (Appendix).

4.3 Demand Allocation

Projected average day demands were allocated to the model network junctions by user class. The City provided metered sales data for each customer class and for meter reading cycles during the years 1997, 1998, and 1999. Since usage for all three years was substantially the same, the most recent year (1999) was selected for the demand allocation. Using database and GIS techniques, the total 1999 sales for each customer class were summarized and assigned to the closest model node, and then the total nodal demands were input into the computer model. Demands were classified as either residential (RES) or industrial-commercial-institutional (ICI) water use. A detailed description of the demand allocation is included in the Model Development Memorandum (Appendix). Unaccounted-for water use was also allocated throughout the distribution system as a percentage of the total retail demand. Maximum day and maximum hour scenarios were developed in the model from the average day allocation by applying the appropriate demand ratios as described in Chapter 3.

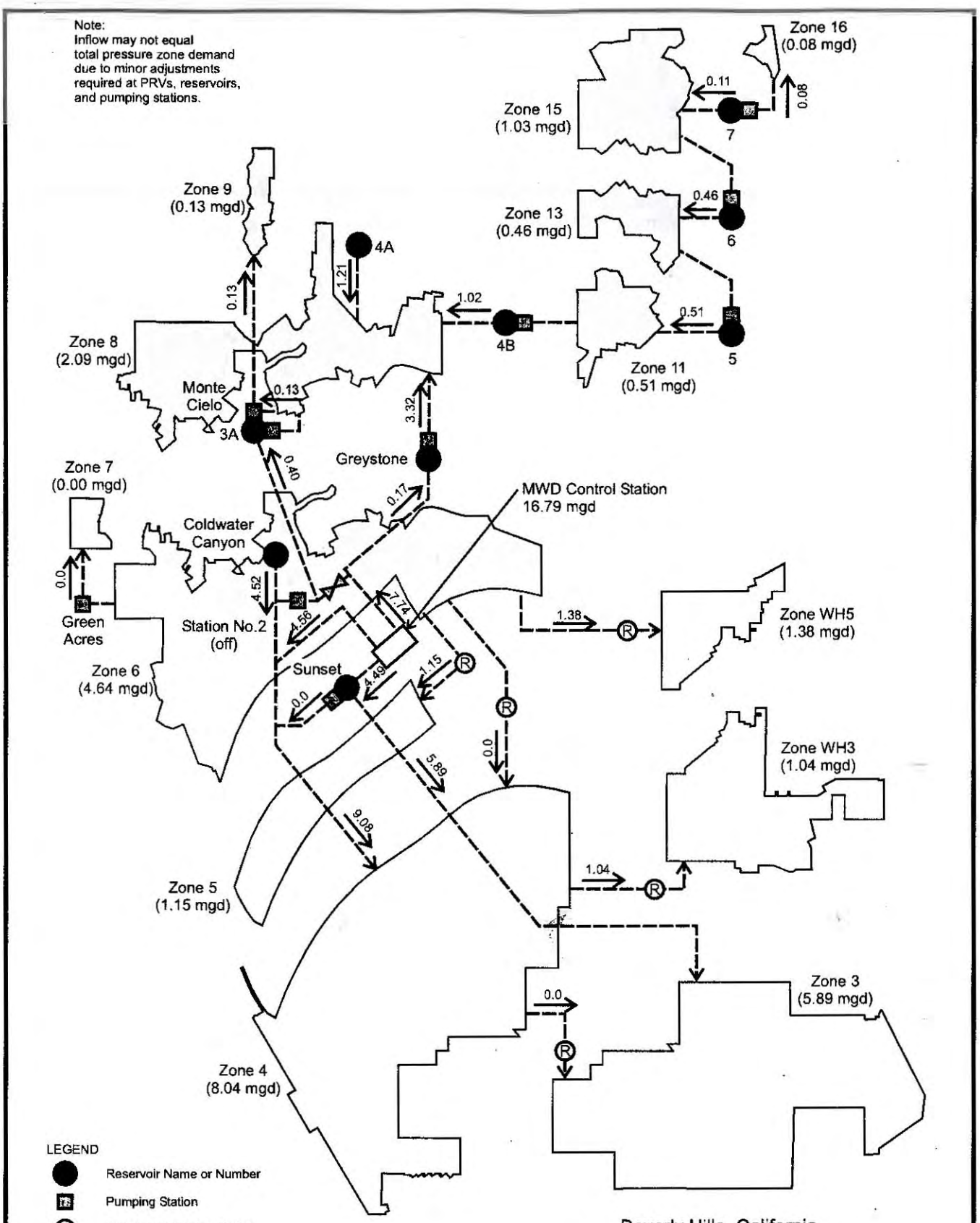
4.4 Calibration Analysis

Before commencing the design hydraulic analyses, calibration analyses were performed to confirm that the hydraulic model provides an accurate representation of the actual distribution system. The calibration process simulated a known peak demand condition using data from the City's SCADA and Daily Reports. The system condition between 8 and 9 am on July 31, 2000 was selected for the calibration analysis. As described in Chapter 1, the maximum hourly demand for the day was 26.2 mgd.

The demand factors in the distribution system model were adjusted so that the allocated demands matched the actual calibration hour demands. The actual facility operation recorded on the SCADA system and field tests was input into the model, including production rates from the MWD control station, pump on/off status, PRV settings, and varying reservoir levels. The hydraulic analysis then determined the resulting pumping rates, PRV flows, reservoir flows, and pressures for comparison with the historical values. For the final analysis, the model was considered to be calibrated as the calculated and actual values were substantially the same. The final calibration analysis included the following observations:

- All reservoirs were emptying during the maximum hour demand scenario, except for Greystone and 3A Reservoirs.
- MWD control station control valves were simulated as PRVs; these are controlled from the operations center. The flows recorded on the SCADA system for these valves were achieved by adjusting the PRV pressure settings.
- PRV pressure setting adjustments were needed so that PRV flows in the hydraulic model matched actual flow through the PRVs to Zone 5 and West Hollywood Zones as measured by the SCADA system.

The final calibration analyses closely reproduced the actual conditions. Figure 4-1 (CALIB Scenario) shows the system inputs for the maximum hour calibration analysis. Following calibration, the hydraulic model was further adjusted to represent the Year 2025 demand conditions.



Beverly Hills, California
Water System Master Plan - 2002

System Inputs for Calibration Analysis CALIB Scenario

Figure 4-1

CYGNET 06/01/01
97033-00001-C-H000015JH

4.5 Hydraulic Analyses

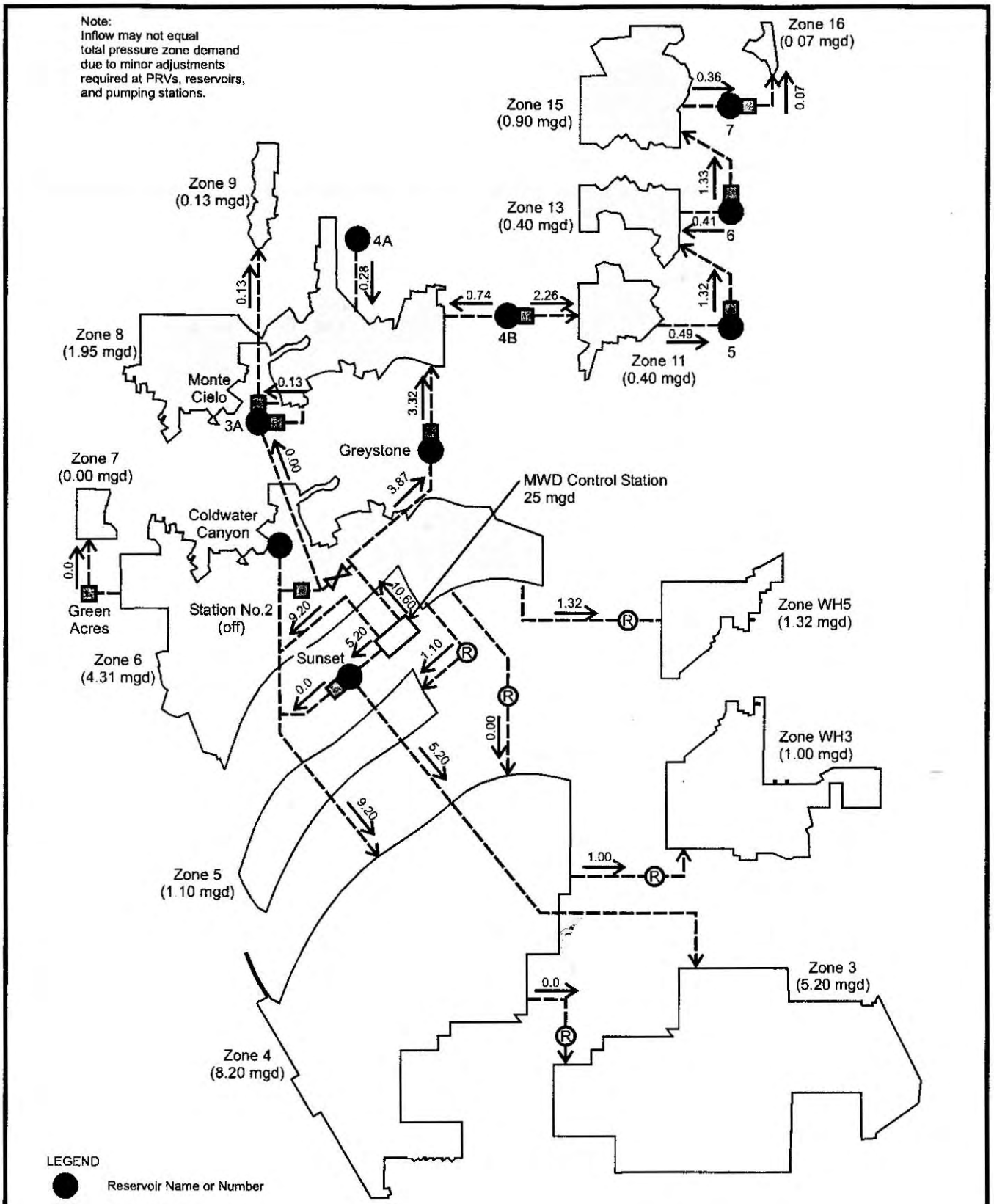
Using the calibrated hydraulic model, alternative operations and system configurations were evaluated. Hydraulic analyses were performed for Year 2025. In general, analyses were performed for two critical demand conditions:

- Maximum day, which determines the ability of the system to maintain full storage facilities during maximum day demands.
- Maximum hour, which determines the ability of the system to maintain adequate residual pressures during periods of peak demand.

In order to illustrate anticipated supply rates from the MWD control station, pumping rates, and reservoir status under design demand conditions, a series of schematic diagrams were prepared and included as Figures 4-2 through 4-12. For each demand condition, the schematics show the demand within each pressure zone, the inputs from MWD, the pumping rate at each pumping station, the rate of contribution from each reservoir, and flow rates through pertinent pressure reducing stations. Computer plots of each analysis were furnished to the City staff separately.

The hydraulic analyses performed during this study were intended primarily for evaluating system capabilities and operating scenarios and for developing water distribution system improvements. Thus, each schematic illustrates one potential combination of MWD inputs, pumping conditions, and reservoir utilization, which would be capable of meeting the projected water demands. There would certainly be other viable combinations of facilities and operating scenarios that could be used to accomplish the same goal. However, it was not the intention of this study to evaluate and assess every possible operating procedure.

Water use within a distribution system typically follows a 24-hour diurnal pattern, being low at night and peaking in the early morning and late afternoon. It should be recognized, however, that each of the analyses depicted on the schematics in this chapter represents an instantaneous condition within the distribution system and provides, in essence, a snapshot of the distribution system operation at a particular instant.



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System Inputs for Maximum Day Analysis MD25A Scenario

Figure 4-2

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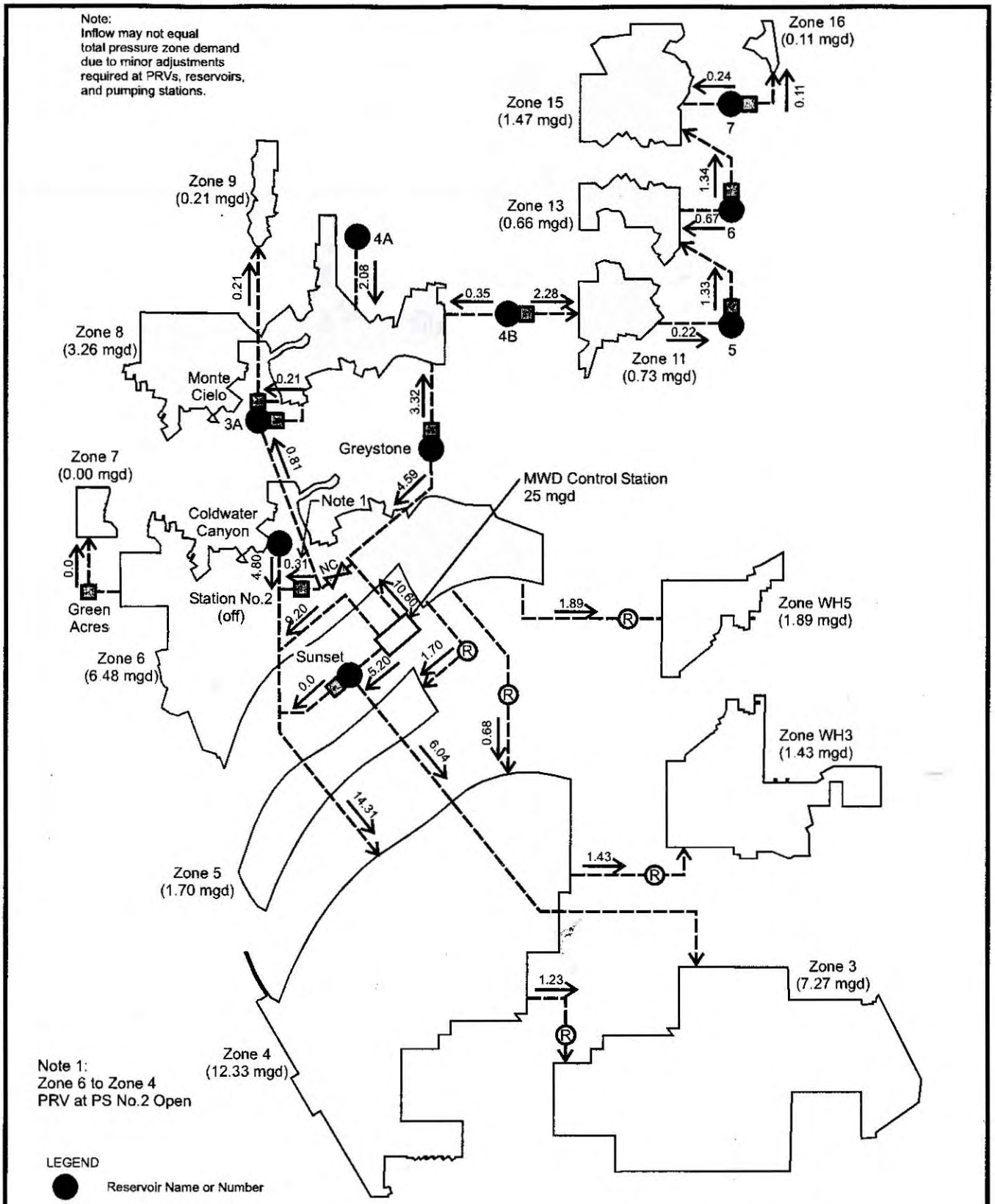

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System Inputs for Maximum Hour Analysis MH37A Scenario

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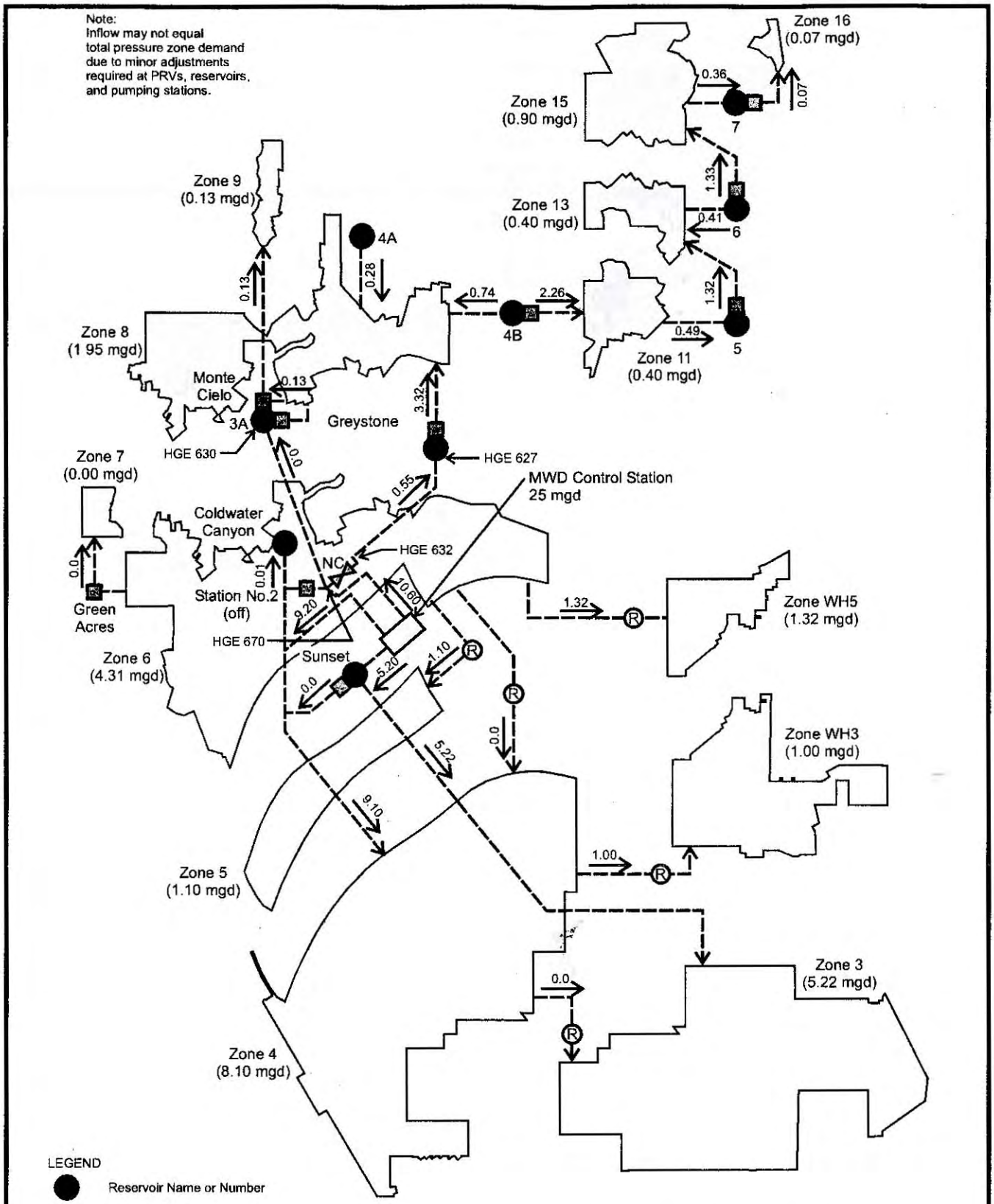
Figure 4-3



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System Inputs for Maximum Day Analysis MD25B Scenario

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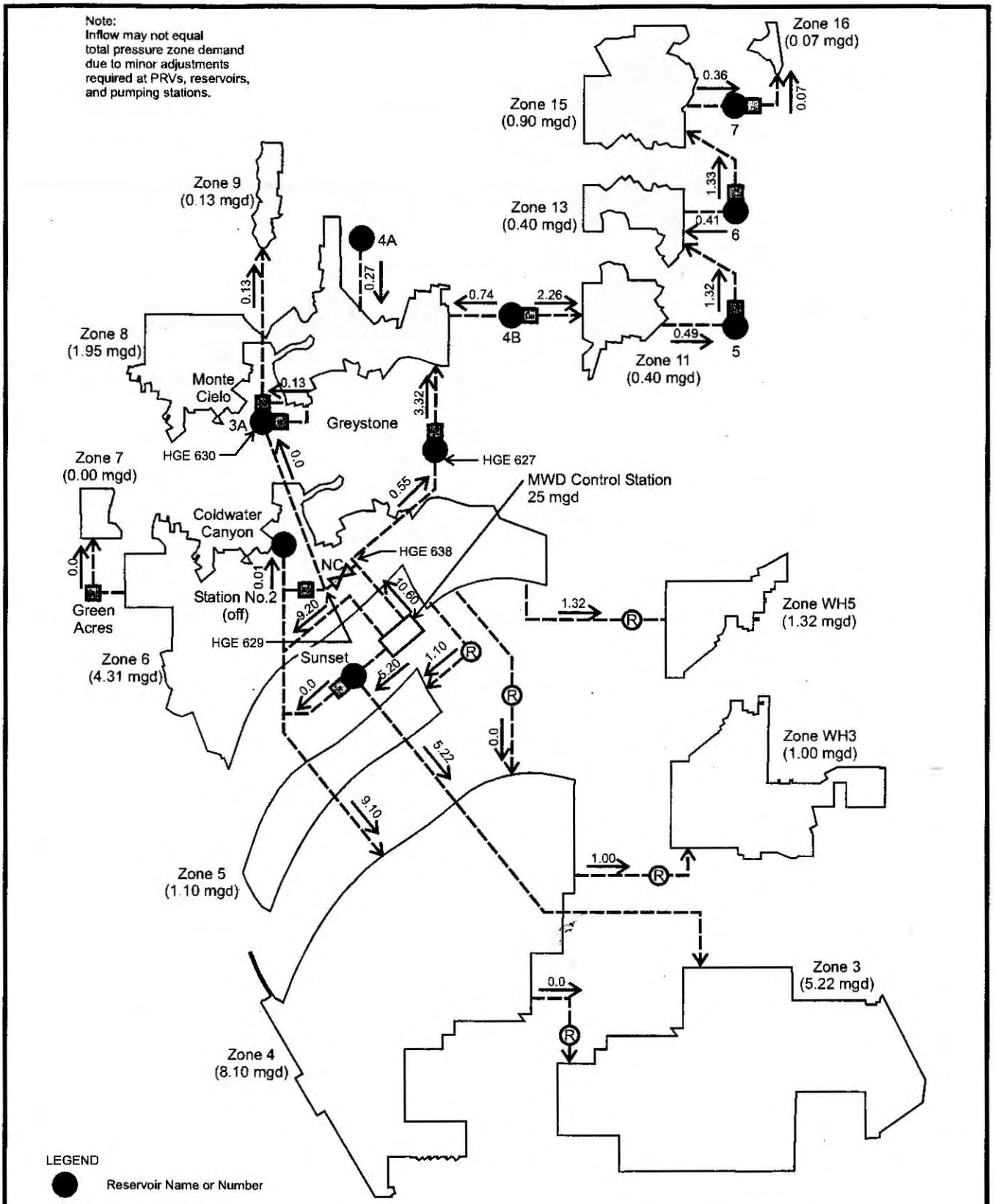
97033-0001-C-H000015JN

Figure 4-4



Beverly Hills, California
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System Inputs for Maximum Day Analysis MD25C Scenario

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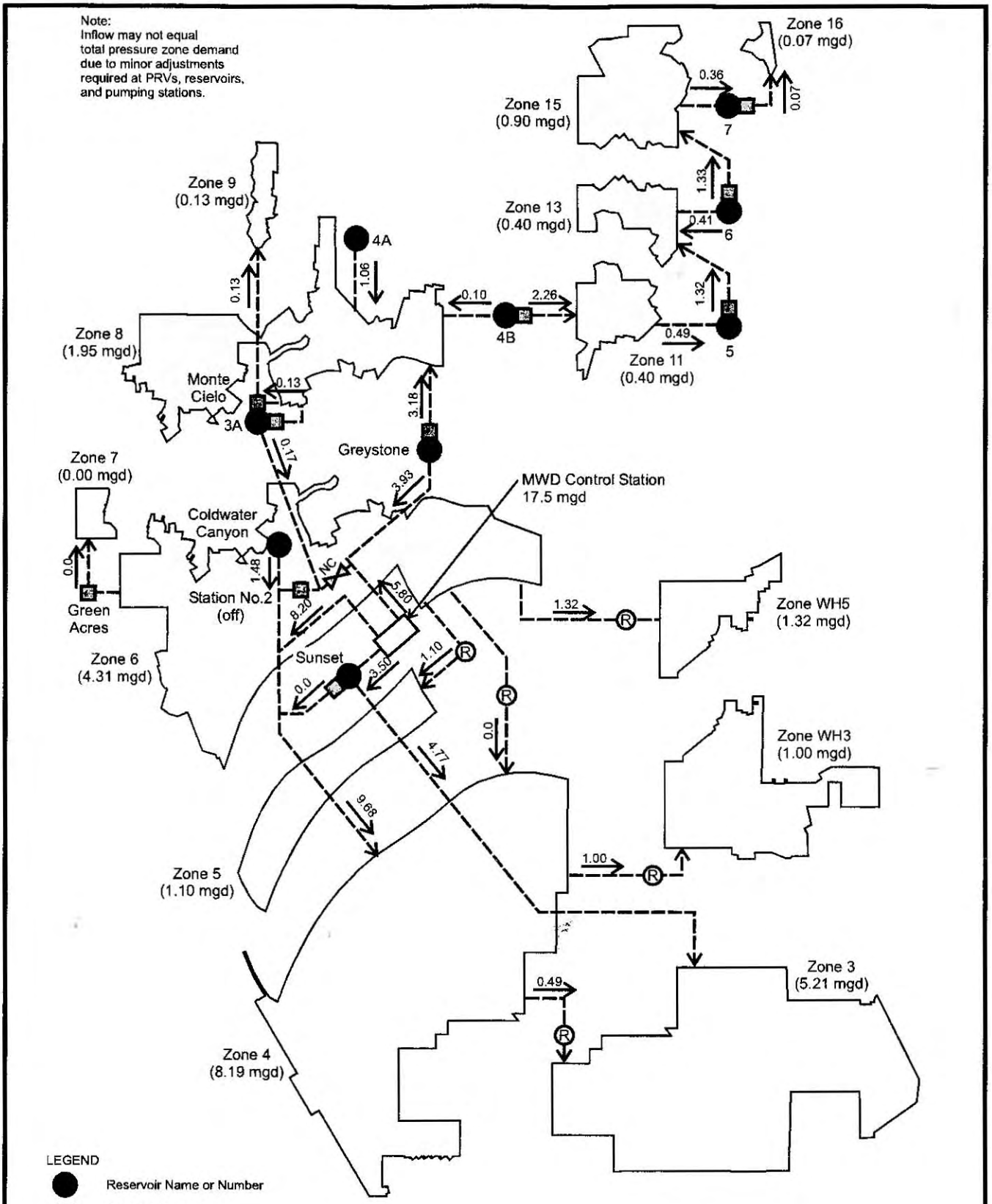
Figure 4-5



Beverly Hills, California
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System Inputs for Maximum Day Analysis MD25_0P Scenario

Figure 4-6

CYGNET 06/01/01
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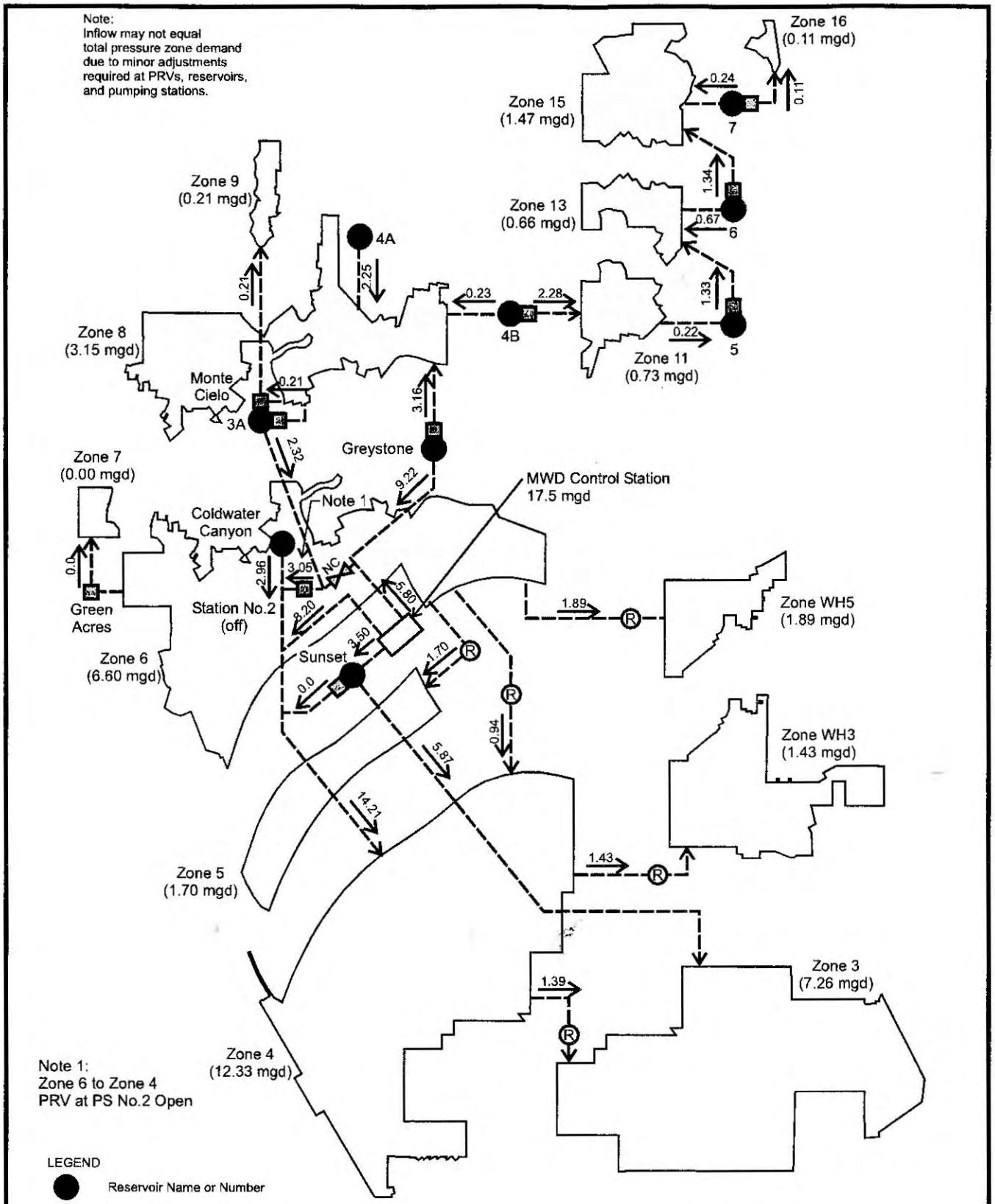
Note:
Inflow may not equal total pressure zone demand due to minor adjustments required at PRVs, reservoirs, and pumping stations.
Zone 16 (0.11 mgd)
Zone 15 (1.47 mgd)
Zone 13 (0.66 mgd)
Zone 11 (0.73 mgd)
Zone 9 (0.21 mgd)
Zone 8 (3.15 mgd)
Zone 7 (0.00 mgd)
Zone 6 (6.60 mgd)
Zone 5 (1.70 mgd)
Zone 4 (12.33 mgd)
Zone 3 (7.26 mgd)
Zone WH5 (1.89 mgd)
Zone WH3 (1.43 mgd)
Monte Cielo
Coldwater Canyon
Greystone
Sunset
Green Acres
Station No.2 (off)
MWD Control Station 17.5 mgd
Note 1
4A
4B
3A
7
6
5
0.24
0.11
1.34
0.67
1.33
0.22
0.23
2.28
2.25
0.21
0.21
3.16
2.32
9.22
0.0
2.96
3.05
NC
8.20
5.80
3.50
0.0
1.70
1.89
0.94
5.87
14.21
1.43
1.39
Note 1:
Zone 6 to Zone 4
PRV at PS No.2 Open
LEGEND
Reservoir Name or Number
Pumping Station
Pressure Reducing Station
5.2
Flow in mgd
Pressure Zone
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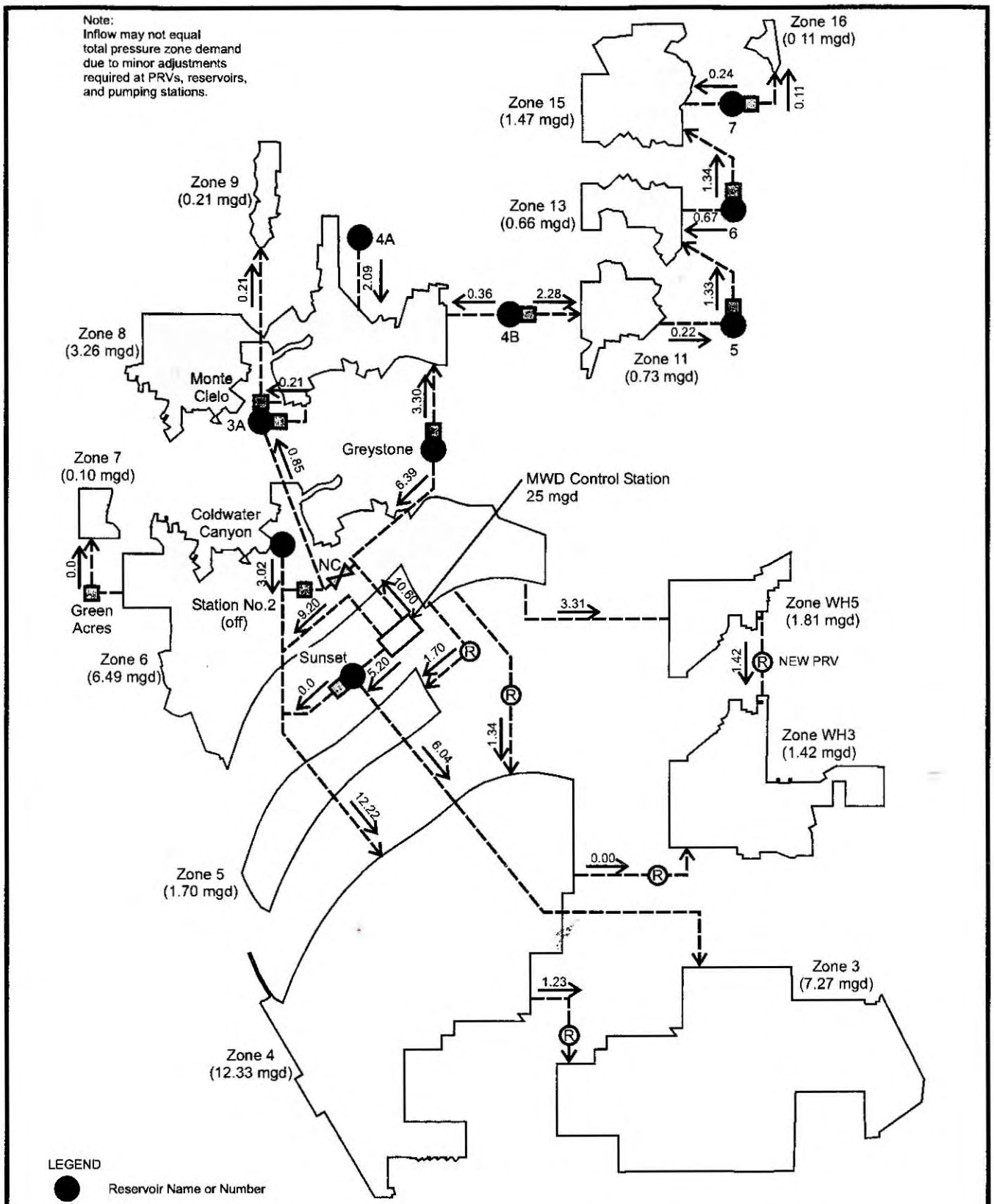
Water System Master Plan - 2002
System Inputs for
Maximum Hour Analysis
MH37_0P Scenario
CYGNET 06/01/01
97033-0001-C-H0000015JP

Figure 4-7



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System Inputs for Maximum Hour Analysis MH37_MODWH Scenario

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Figure 4-8

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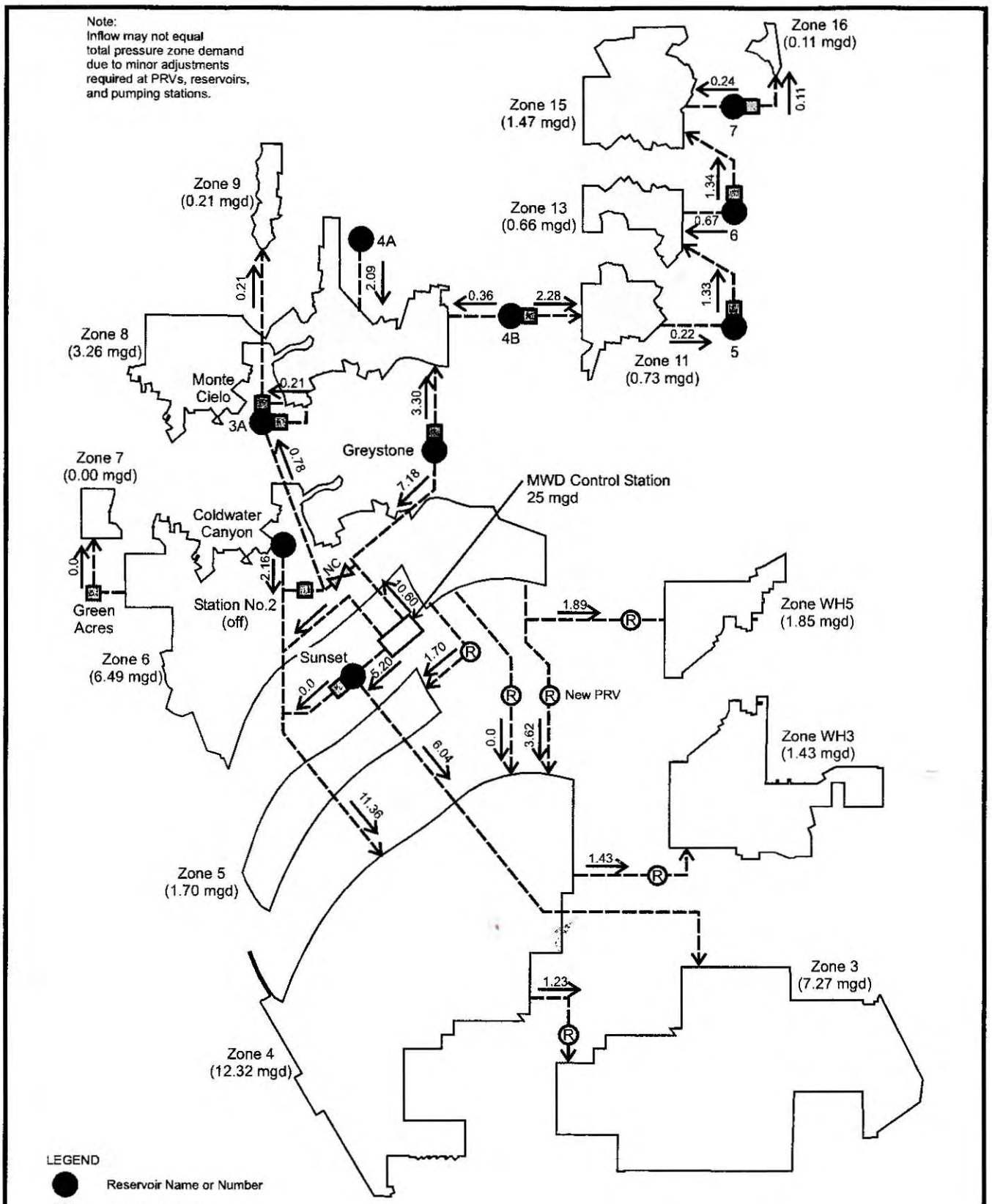

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System Inputs for Maximum Hour Analysis MH37_64PRV Scenario

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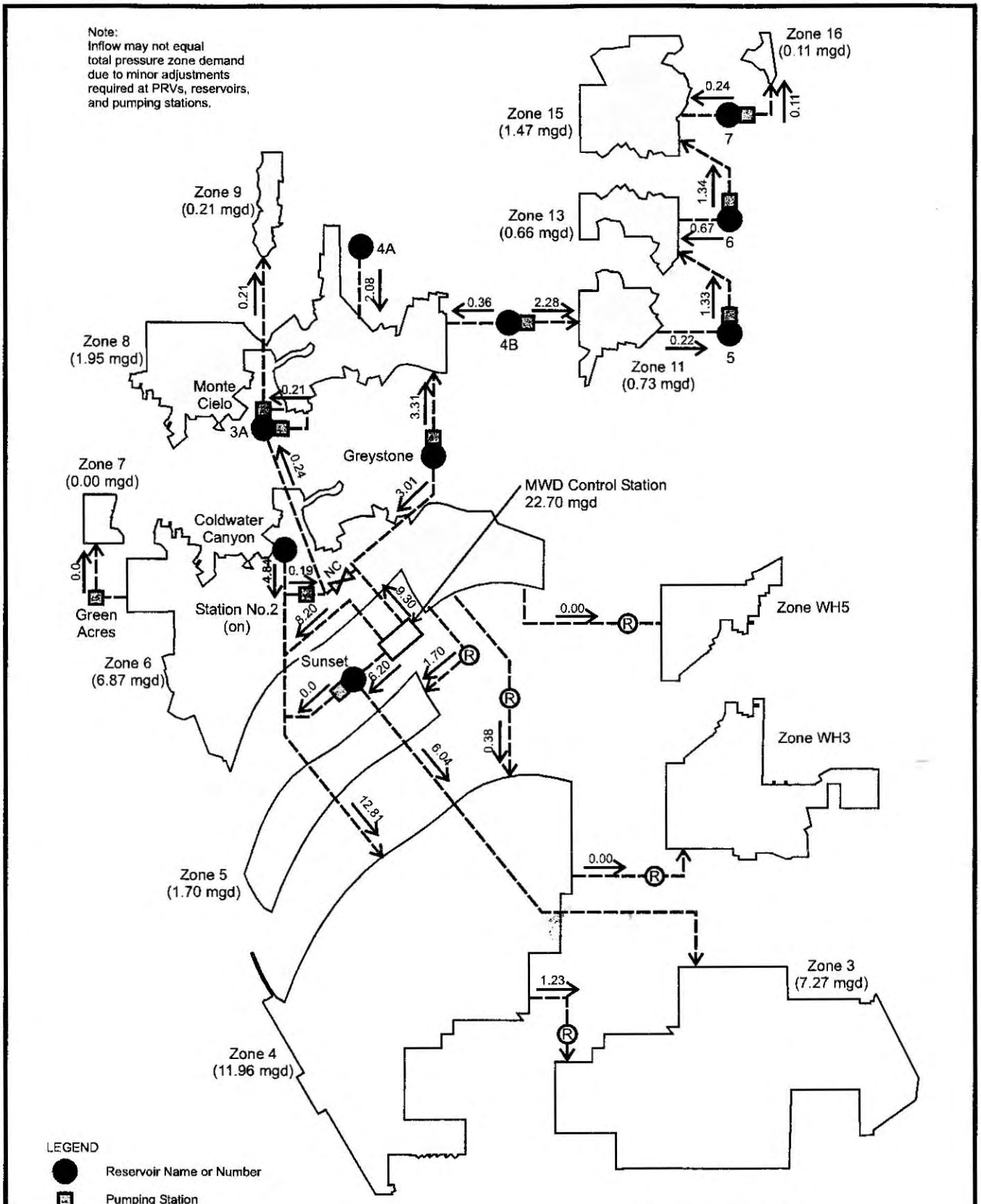
Figure 4-9



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System Inputs for Maximum Hour Analysis MH37_NOWH Scenario

Figure 4-10

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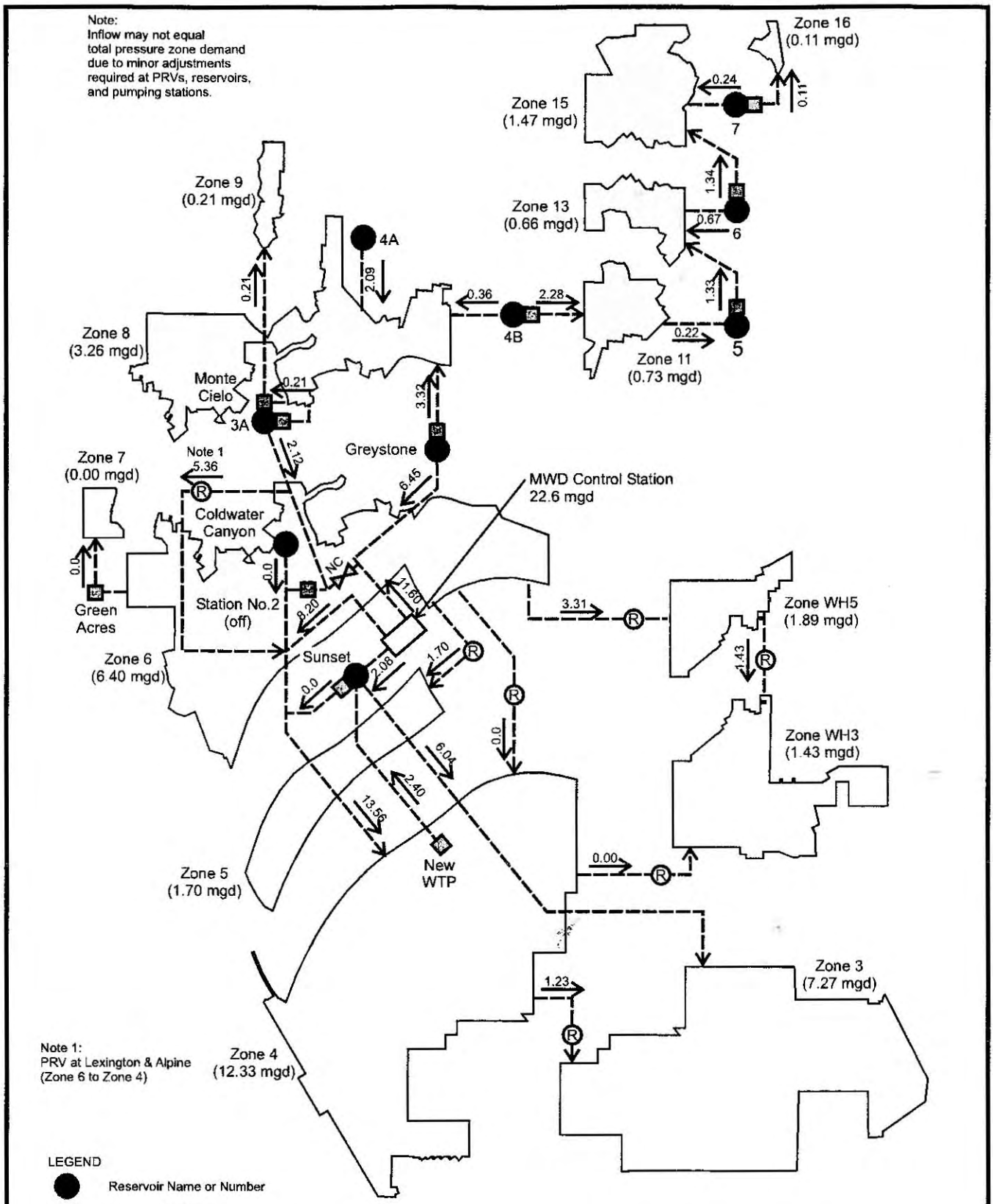

Beverly Hills, California
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System Inputs for Maximum Hour Analysis MH37_LEX Scenario

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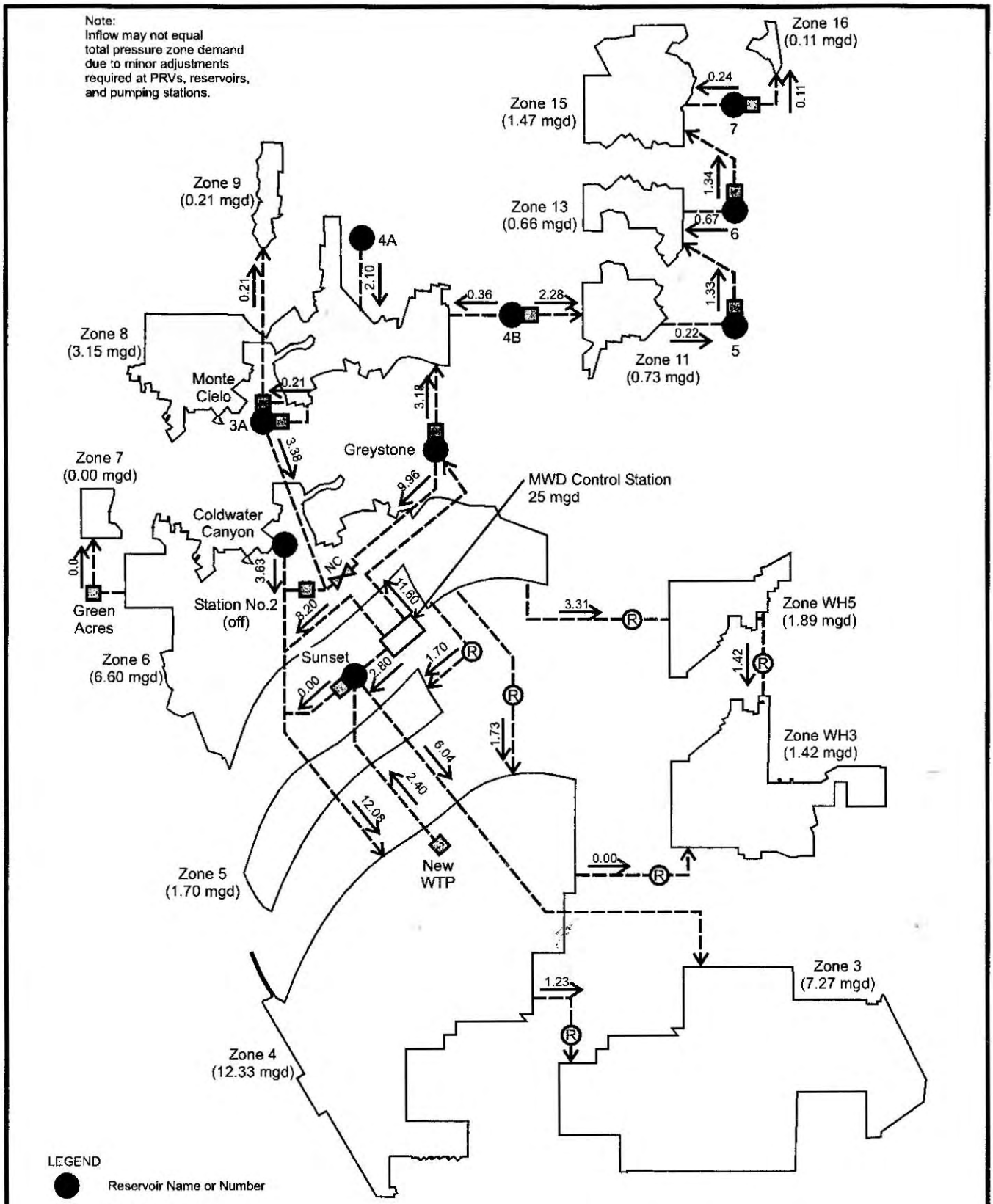
Figure 4-11



Beverly Hills, California
Water System Master Plan - 2002

System Inputs for Maximum Hour Analysis MH37_GREY Scenario

Figure 4-12

CYGNET 06/01/01
97033-0001-C-H000015.JR

For discussion purposes, it is generally assumed that each maximum day analysis represents a time during the early morning, just before the start of the maximum hour demand period. Ideally, the distribution system reservoirs should be full or nearly full at this time of day, and the reservoir contribution rates should be essentially zero. It is desirable to have full system reservoirs at this time of day, to ensure that the maximum volume of water is available for meeting demands during the upcoming maximum hour demand period. In other words, the distribution system reservoirs should not be drafting during the time when the instantaneous demand rate is equal to the average demand rate for the day. Conversely, the reservoirs should begin to draft once the water demand rate begins to exceed the average rate for the day. The rate at which the reservoirs are drafting can be expected to reach its maximum during the peak instantaneous demand period, as simulated by the maximum hour analyses.

As can be seen on the distribution system schematics in this chapter, there are instances when some reservoirs are drafting under maximum day demand scenarios. It is not always possible to select a combination of production and pumping rates which will precisely equal the instantaneous water demand within the affected pressure zone. Thus, one combination of inputs will cause the reservoirs in the pressure zone to fill, whereas a different combination of inputs will cause the reservoirs to draft. In this case, pumps would be cycled on-and-off to maintain full reservoirs.

4.5.1 Maximum Day and Maximum Hour Analyses

An initial maximum day analysis (MD25A Scenario-Figure 4-2) and a maximum hour analysis (MH37A Scenario-Figure 4-3) were conducted using the existing system configuration and the Year 2025 demand conditions, to evaluate system performance without improvements. The 20 inch valve at the Central Control Station was open for MD25A and closed for MH37A. The pumping stations were operated to meet the upper Pressure Zone demands. Generally, one pumping unit was shown to be adequate to meet the demand in each zone. For Pressure Zone 8, to avoid drafting Reservoirs 4A and 4B throughout the day, it is necessary to operate both of the Greystone units and one pumping unit at Station 3A. Under the critical maximum hour analysis, all the residual pressures provided to customers throughout the system met a minimum of at least 30 psi. It was noted that, due to the hilly terrain, customers on the lower portions of most of the service zones experience pressures over 100 psi, potentially requiring individual customer PRVs for each service.

Under MH37A, the flow from MWD was 25 mgd, and 12 mgd was supplied from the system's reservoirs. Sunset, Coldwater, and Greystone Reservoirs contributed a total

of about 10 mgd, or 85 percent, of the total flow from system storage. Reservoirs were set at half-full for the maximum hour analysis.

4.5.2 Maximum Day MD25B and MD25C Analysis

Two separate maximum day analyses shown on Figures 4-4 and 4-5 were conducted to show the impact of closing the 20 inch valve at the MWD Control Station with MWD flows entering the Zone 6 distribution system from either BH-1 (west) or BH-2 (east). When flow is conveyed to Zone 6 from BH-1 (west). After Reservoir 3A is full and its altitude valve is shut, the hydraulic gradient elevation on the west side of the closed 20 inch valve increases by about 40 feet, or 17 psi. This analysis (MD25B) demonstrates the sensitivity of closing the 20 inch valve when MWD flow is from BH-1. Under this operational scenario, the Zone 6 mains west of the control station become over-pressurized. The resulting pressure on low ground in western Zone 6 increases to about 135 psi.

The MD25C analysis simulated a closed 20-inch valve and supply from the eastern BH-2 MWD connection. The analysis showed that over-pressurization is avoided. These analyses illustrate that the pressures seen in western Zone 6 are sensitive to 20 inch valve and MWD flow control operations.

4.5.3 Maximum Day and Maximum Hour Operational Analysis

These two analyses (MD25_OP and MH37_OP Scenarios), shown on Figures 4-6 and 4-7, were conducted with the reservoirs 40 percent full and MWD Control Station inflows reduced to 17.5 mgd. These analyses showed that, if MWD supply rates are selectively reduced over a peak demand period, the major reservoirs can be forced to draft without operation of the 20 inch valve. Greystone Reservoir supplied 7.1 mgd and 12.4 mgd under maximum day and maximum hour demands, respectively. Coldwater Canyon Reservoir contributed 1.5 mgd and 3.0 mgd under maximum day and hour demands, respectively. These rates of outflow from the reservoirs would significantly address the problems of turning over the stored water, thereby avoiding nitrification.

4.5.4 Modified West Hollywood Analysis

The MH37_MODWH Scenario, shown on Figure 4-8, transfers water supply from Zone 6 to West Hollywood and from Zone 5 and Zone 3 through a new PRV station located in West Hollywood. This analysis demonstrated that, by increasing the demands supplied to Pressure Zone 4 through the eastern portions of Zone 6 with PRV revisions, utilization of Greystone storage can be improved. Greystone Reservoir contributed 9.8 mgd to this demand condition.

4.5.5 New PRV from Zone 6 to Zone 4 Analysis

A special maximum hour analysis (MH37_6/4 PRV Scenario) shown on Figure 4-9 is similar to the Modified West Hollywood Analysis shown on Figure 4-8, but utilized a new PRV in Beverly Hills instead of the potential PRV in West Hollywood. This analysis showed a slightly higher total flow from the Greystone Reservoir to supply Zones 6 and 4, for a total reservoir outflow of 10.5 mgd.

4.5.6 Analysis without West Hollywood

A special maximum hour analysis (MH37_NOWH Scenario) shown on Figure 4-10 was conducted to evaluate the hydraulic impact of deleting the West Hollywood system from the Beverly Hills system. No Beverly Hills distribution system problems were noted. Without the need to meet water demands of West Hollywood, the utilization of water storage from the Greystone Reservoir is decreased. For this analysis, 6.3 mgd total flow was drafted from the reservoir.

4.5.7 Lexington/Alpine PRV Analysis

This maximum hour analysis (MH37_LEX Scenario) shown on Figure 4-11 was conducted to determine the effectiveness of the Lexington/Alpine PRV increasing the utilization of water stored in the Greystone Reservoir. The Lexington/Alpine PRV could serve Zone 4 when the Coldwater Reservoir is out of service for repairs or reconstruction. Greystone Reservoir outflows totaled 9.8 mgd.

4.5.8 MWD to Greystone Transfer Analysis

A special maximum hour analyses (MH37_GREY Scenario) shown on Figure 4-12 was conducted to maximize the circulation of water through Greystone Reservoir. This analysis included a separate transmission main from the MWD control station to the Greystone Reservoir. The proposed main would convey all MWD flows to eastern Zone 6 directly to Greystone. The new line would provide a separate inlet to the reservoir, and the existing line would serve as the outlet for flow to Zone 6 and to the Greystone pumping station. Greystone Reservoir would then be the major source of water supply to Zone 6 and other zones. With this transmission main, the reservoir could be maintained at nearly full capacity, and the daily turnover of stored water would equal the water supplied through the main. The 11.6 mgd transmission main flow for this analysis would equate to approximately a 2-day residence time for the reservoir.

4.6 West Hollywood Segregation

Technical and economical aspects of separating the West Hollywood portion of the water system from the Beverly Hills system were evaluated.

From a technical standpoint, the presence of West Hollywood water demands imposed on the Beverly Hills system actually improves system operations. A separate analysis (MH37_6/4 PRV Scenario), shown on Figure 4-9, was conducted with all flow to West Hollywood from Zone 6. This analysis showed that the flow to the West Hollywood system is primarily supported by the Greystone Reservoir. The system has no hydraulic problems supplying the West Hollywood level of demands. No system improvements are required within the Beverly Hills system during the design period of this report to meet these demands.

From an economic viewpoint, the benefits of retaining the West Hollywood system should be based on a cost/benefit study. The revenue from water sales to West Hollywood should produce sufficient funds to maintain the system and to make a reasonable return on the City's investment.

4.7 Hillside Fire Protection for Zone 9

A previous hydraulic study of Zone 9 was prepared for the City in 1999 to investigate fire protection for Zone 9 during potential brush fires coming up the hillside of the canyon running along Lago Vista Drive. The design basis for that report was to supply a flow rate of 6,000 gpm (8.6 mgd) to hydrants along Lago Vista Drive during a fire. Four alternative plans were evaluated. System improvements for the four alternatives to meet the fire flow requirements established by the study ranged in cost from $2,600,000 to $4,400,000. The recommended plan included a new emergency connection to the Los Angeles Department of Water and Power (LADWP) system, along with replacement of all Zone 9 mains, at a total cost of about $2,600,000. However, this plan was based on the assumption that the LADWP system can provide a fire flow rate up to 6,000 gallons per minute (gpm) during the emergency. For fighting brush fires, a flow of 6,000 gpm from multiple hydrants is desirable. It is believed that this flow requirement would be difficult to meet without major system modifications.

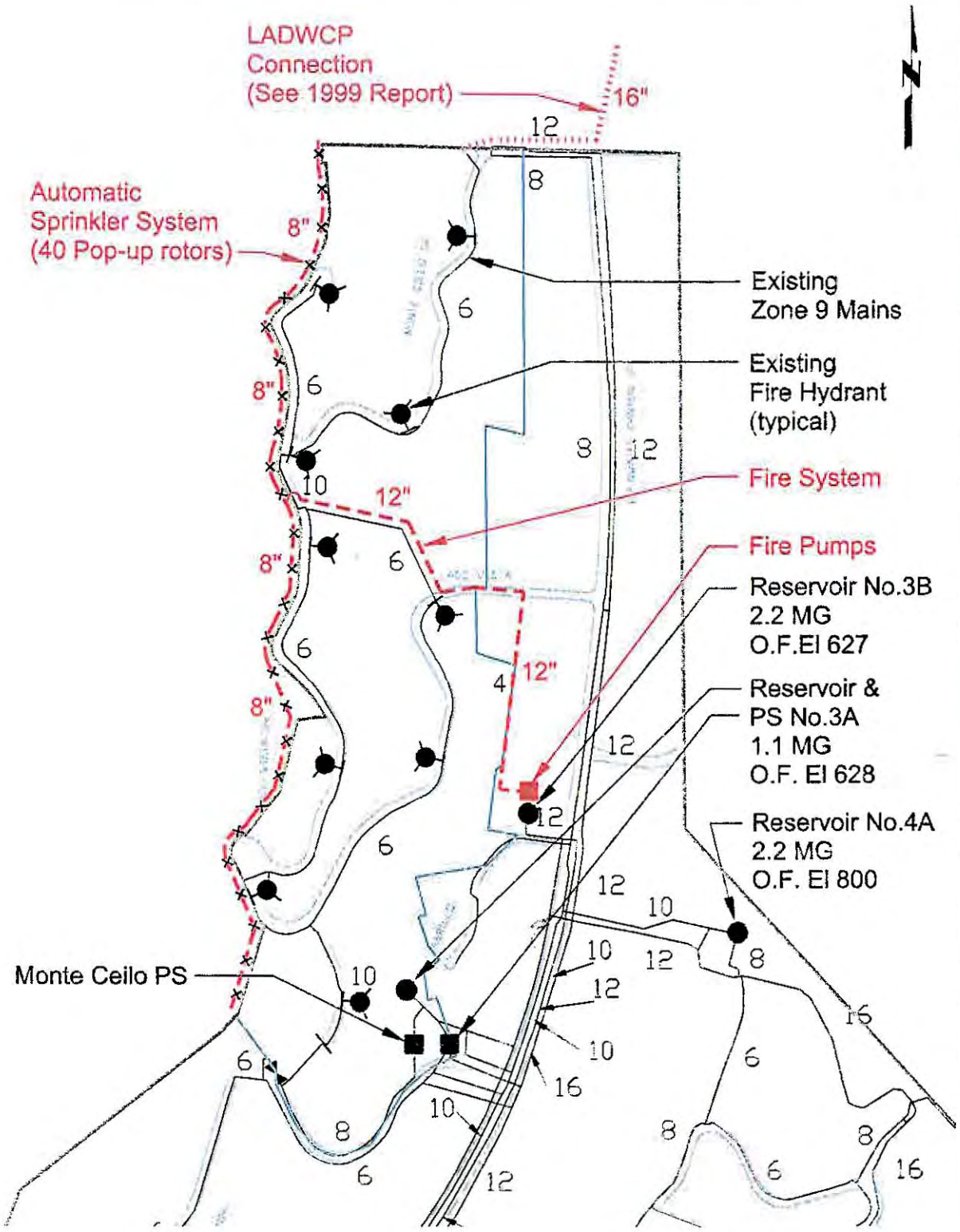
A meeting with the Beverly Hills Fire Chief and water department personnel was held to review the emergency supplies and flow rates needed to protect the City against the potential fire. Actual flow rate requirements are not known with certainty, but it was concluded that a rate of 3,000 gpm would provide an adequate level of protection. Subsequent to the 1999 Study, the Beverly Hills Public Works Department has begun negotiating with LAPWD to install a dual system for Zone 9 with fire protection being

supplied by the City of Los Angeles at a reduced flow rate of 3000 gpm and domestic water provided by the City of Beverly Hills.

This report considers an alternative to the plan recommended in the 1999 Study and the current plan being negotiated between the Cities of Los Angeles and Beverly Hills. The alternative would be to convert Reservoir 3B (currently out of service) to a nonpotable water supply with a dedicated distribution system to be used only for fire fighting. Vertical turbine pumping units would be installed at the 3B Reservoir and would discharge fire flows to a dedicated hillside fire fighting pipe system located along Lago Vista Drive. Instead of providing fire hydrants on the nonpotable system, consideration could be given to installing an automatic sprinkler system along the hillside using a series of rotary pop-up sprinklers. The sprinklers would be pressurized by a jockey pump, and during a fire, the pumping units could be started manually or remotely. A sprinkler system could more effectively use the available fire flow. The length of piping on the hillside along Lago Vista Drive would be about 2,000 feet. Assuming sprinklers spaced at about 100 feet on-center, approximately 40 sprinkler heads would be required, as shown on Figure 4-13. The flow for a single 1-¼ inch pop-up rotor is about 50 gpm, or a total of 2,000 gpm flow rate along the hillside. Higher design flow rates, if desired, could be accommodated in the final design.

4.8 Pipes in Easements

Figure 4-14 shows the locations of water mains installed in easements. The City has expressed an interest in eliminating water mains in private easements, if feasible, because of limited maintenance access and potential damage to an adjacent residence resulting from a water main break. For the 31 easement pipes currently existing, three water main breaks have been recorded. The easement lines were used to eliminate dead ends and to provide better circulation of water throughout the various pressure zones. Table 4-1 tabulates the easement mains and recomendations by size, length, material, date of installation, and individual meters, if any. The maximum hour flows through the easement mains are also tabulated in Table 4-1 from the MH37A scenario. The total length of the eleven mains recommended for retirement is 4,440 feet. The total length of the 20 mains that should be maintained in service is 8,475 feet.



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Hillside Protection For Zone 9

Figure 4-13

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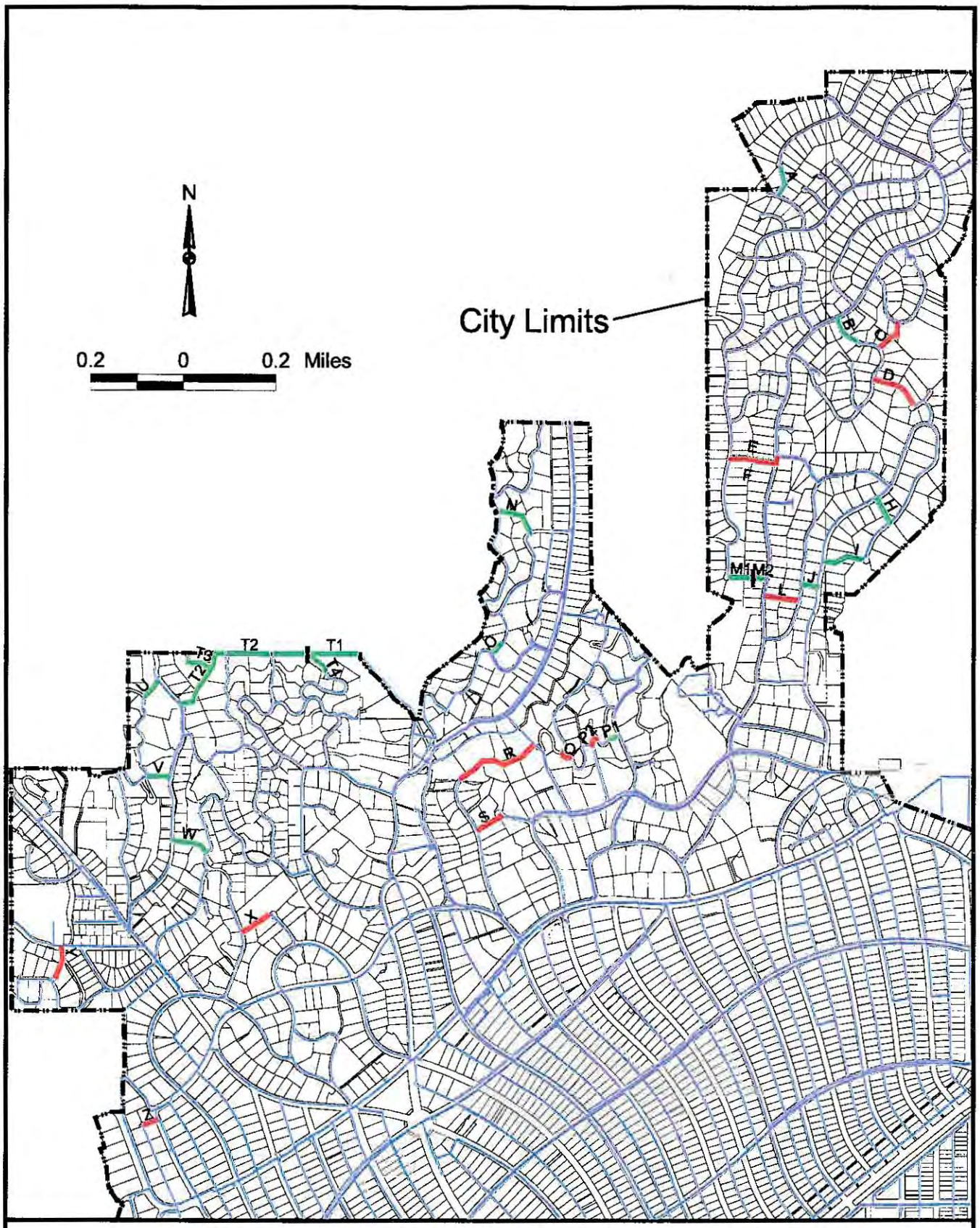
KEELING DISK1135 BEVERLY HILLS
4-13 HILLSIDE PROTECTION FOR ZONE 9.DWG 05/31/01



Legend

- Maintain in Service
- Propose for Retirement
- Pipes not in Easements
- Parcels

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PIPES IN EASMENT

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FIGURE 4-14

Table 4-1
Pipes in Easements

ID	Proposal	Length (ft)	Size (in)	Material	Date Installed	No. of Breaks	Flow (mgd)	No. of Meters
A	Maintain	430	8	Steel	1960		0.02	
B	Maintain	485	8	Steel	1959		0.17	
C	Retire	220	8	Steel	1959		0.22	
D	Retire	585	8	Steel	1959		0.09	
E	Retire	545	8	Steel	1960		0.01	
F	Maintain	510	8	Steel	1960		0.01	
G	Maintain	280	8	Cast Iron	1960		0.05	
H	Maintain	325	8	Cast Iron	1956		0.02	
I	Maintain	490	8	Cast Iron	1960		0.06	
J	Maintain	200	10	Cast Iron	1960		0.15	
K	Maintain	180	8	Cast Iron	1956	1	0.10	
L	Retire	415	10	Cast Iron	1956		0.24	
M1	Maintain	250	8	Cast Iron	1960		0.11	
M2	Maintain	165	10	Cast Iron	1956		0.11	
N	Maintain	495	6	Cast Iron	1960		0.02	1
O	Maintain	175	6	Cast Iron	1960	1	0.21	
P1	Maintain	445	8	Ductile Iron	1977		0.10	2
P2	Retire	135	8	Ductile Iron	1977		0.07	
Q	Retire	175	8	Ductile Iron	1983		0.01	
R	Retire	995	8	Ductile Iron	1977		0.10	
S	Retire	310	6	Cast Iron	1980		0.11	
T1	Maintain	560	10	Steel	1920		0.61	
T2	Maintain	1,815	8	Steel	1924		0.49	
T3	Maintain	325	6	Cast Iron	1950		0.00	
T4	Maintain	350	6	Cast Iron	1953	1	0.12	
U	Maintain	270	8	Steel	1957		0.14	
V	Maintain	270	6	Cast Iron	1950		0.03	
W	Maintain	455	8	Ductile Iron	1977		0.05	
X	Retire	420	8	Ductile Iron	1977		0.11	
Y	Retire	455	6	Cast Iron	1924		0.01	2
Z	Retire	185	6	Cast Iron	1990		0.04	
Total		**12,915**						
Total to Retire		**4,440**						
Total To Maintain		**8,475**						

4.9 Storage Evaluation

Storage facilities in a distribution system serve multiple purposes, including flow equalization, fire reserve, and emergency supply. Without storage facilities, the MWD supply facilities and Beverly Hills pumping and transmission facilities would need to deliver instantaneous peak demands (maximum hour). The availability of sufficient water storage reduces the maximum demand on the supply, pumping, and transmission facilities to the maximum day rate.

Storage requirements are determined as the total of operational, fire protection, and emergency volume requirements, as described in the following paragraphs.

4.9.1 Operational Storage

Operational storage should be adequate to supply the maximum hour rate in excess of the maximum day rate for at least a 6-hour peak period. For Beverly Hills demand ratios, this equates to about 15 percent of the maximum day use of 25 mgd. On a maximum demand day, storage facilities will generally contribute water when demands are greater than the instantaneous average daily rate and will refill when demands are less than the instantaneous average daily rate. Chapter 7 describes current operation of the Greystone and hillside reservoirs, in which more than half of the total volume is used over a multiple day fill and drain cycle. This operating mode is to avoid nitrification in the stored water and to maintain system water quality. Therefore, a more conservative operating volume allowance is established at 30 percent of the maximum day demand.

4.9.2 Fire Storage

Fire storage is based on supplying fire flow and duration requirements. Fire storage requirements, established in the 1985 Master Plan report and confirmed by the City's Fire Department, vary by service level as shown in Table 4-2:

Table 4-2
Fire Storage Requirements

Land Use Type	Service Levels	Fire Flow (gpm)	Duration (Hours)	Fire Volume (MG)
Residential	5 to 16	2,000	2	0.24
Commercial and Institutional	3 and 4	5,500	5	1.65
Commercial – Institutional	West Hollywood	5,000	5	1.50

4.9.3 Emergency Storage

Emergency storage provides a reserve supply source in the event that the water supply is disrupted by water main breaks, equipment failures, power outages, or natural disasters. The amount of emergency storage required is a City policy issue, considering the risk of supply disruption and the desired degree of reliability. The required volume to meet demands during an outage depends on the system demand, the duration of outage, and the alternative water supply. The basis for estimating emergency storage needs is described below:

- A critical emergency for the City of Beverly Hills would be the loss of MWD supply. MWD recommends that its member agencies plan for a complete

outage lasting 7 days and occurring during off-peak months (October through March). MWD schedules repair and maintenance work during this period. Major MWD water pipeline shutdowns of a week or longer do occur, such as a recent 6-day shutdown of the Orange County pipeline.

- The highest historical ratio of monthly to average day (AD) MWD supply to Beverly Hills from October to March for years 1980 to 2000 was 1.15. The estimated maximum daily demand during these months is 1.3 times the maximum monthly rate, or 1.5 times the average daily demand. At Year 2025, 1.5 times AD is a daily demand of 18.9 mgd.

- During an outage, alternative supply should be available from two sources. The new water treatment plant's ultimate capacity is 2.7 mgd. LADWD emergency connections have a reported capacity of 12,500 gpm (17.85 mgd). An assumed 70 percent of the LADWP connection capacity will provide 12.5 mgd emergency supply. The total alternative supply is thus 15.2 million gallon (MG).

- The supply shortfall is thus 18.9 mgd less 15.2 mgd, or 3.7 mgd. For a 7 day period the minimum required emergency storage is 25.9 MG. This volume represents 104 percent of the Year 2025 maximum day (MD) demand.

Table 4-3 presents the calculation of storage availability for the pressure zones served by each reservoir and for the total system. Unlike equalization and fire storage, which should be available at all reservoir sites, emergency storage may be located at any site. After accounting for fire and operational volume requirements, the existing storage reservoirs provide emergency storage of 99 percent of the MD use. In order to provide emergency storage of 104 percent of MD, a minimum additional 1.2 MG emergency storage would be required.

Table 4-3
Water Storage Requirements

Pressure Zone	MD (MG)	Existing Reservoir	Existing Volume	Fire Volume Requirement (MG)	Operational Volume Requirement (MG)	Available Emergency Volume (MG)	Emergency Volume (% of MD)
3	5.218	Sunset	6.0	1.65	1.57	2.78	53.4
4	8.188	Coldwater	7.3	1.65	2.46	3.19	
3H	0.998	None		1.50	0.30	-1.80	
Subtotal	9.19		7.30	3.15	2.76	1.39	15.2
6	4.31	3A	1.1	0.24	1.29	-0.43	
		Greystone	19.4				
5	1.102	None		0.24	0.33	-0.57	
5H	1.322	None		1.50	0.40	-1.90	
Subtotal	6.734		20.5	1.98	2.02	16.50	245.0
8 & 9	2.079	4A	2.2	0.24	0.62	2.20	105.8
		4B	1.0				
Subtotal	2.079		3.2	0.24	0.62	2.20	105.8
11	0.448	5	1.0	0.24	0.13	0.63	139.6
13	0.404	6	1.0	0.24	0.12	0.64	158.1
15 & 16	0.971	7	1.2	0.24	0.29	0.67	68.9
Total System	**25.0**		**40.20**	**7.74**	**7.51**	**24.81**	**99.1**

The City of Beverly Hills, in general, maintains a philosophy of more conservative and more reliable public services for the benefit of its residents than do most other cities. Maintaining a conservative water supply to safeguard against water outages in the event of an emergency is consistent with that philosophy.

Coldwater Canyon Reservoir is currently planned for replacement, and its volume will be increased 9.1 MG. As part of that project, a 1.8 MG supplemental reservoir will be built near booster station No. 2 before demolition of the existing Coldwater Canyon reservoir. This project would provide 3.6 MG additional emergency storage, for a total of 114 percent of MD. Additional storage may be required in the future if the criteria change for either MWD outages or LADWP emergency supply rates, or if an existing reservoir is removed from service. Space is available for additional storage for a future Reservoir 4-C at the Reservoir 4B site. This could provide an additional 1.0 MG storage and a total of 118 percent of MD volume for emergency storage.

Locating and permitting additional water facilities is difficult in Beverly Hills. The City should consider securing additional reservoir sites should they become available.

5.0 Infrastructure Evaluation

5.1 General

This chapter provides a physical assessment of the major observable water system facilities with regard to their condition, reliability, seismic anchoring, site security and public safety. The assessment developed with a prioritized list of recommendations to correct deficiencies and to improve safety and operational reliability. The assessment considered the following areas:

1. Civil and Water System Reliability
   Site inspections of major water facilities were conducted concerning their general condition, repair access, and their reliability of service under extreme events (i.e. earthquake, fire). The inspections included a review of critical pieces of equipment including standby power, back-up pumps, and bypass piping.

2. Structural and Seismic Protection Needs
   A structural review was performed based on the State of California, Department of Health Services requirements for reliability, seismic anchoring, and above ground tank integrity. The review considered the use and applicability of flexible couplings and automatic shut-off valves and provided an engineering assessment of work activities required to bring each facility into compliance with current construction and retrofit standards.

3. Electrical and Equipment Reliability Needs
   Site inspections and City staff interviews were conducted to determine the reliability needs (standby generators, back-up pumps, or bypass piping) for each facility in the water system. Facilities were reviewed to ensure compliance with the National Electrical Code (NEC).

4. Security and Public Safety
   A security survey of each facility was conducted. Facilities were reviewed to determine compliance with occupational safety and health regulations and ensure public safety. Basic security mechanisms, such as lighting, fencing, and signage, were evaluated. This survey did not include recommendations regarding terrorist activities.

The site visits took place during July and August 2000. Recommendations are based on observations and the facility status during this period. These recommendations may not reflect the City's efforts to implement upgrades or deterioration changes in conditions since the date of inspection.

These evaluations were used to recommend upgrades to provide the City with a water system with improved reliability and structural integrity, and provide for enhanced public safety and security. Recommendations are discussed in detail throughout this chapter.

The City is located in the foothills of the Santa Monica Mountains and south of the San Fernando Valley. This region of Southern California is seismically active and therefore the water system facilities merit a seismic analysis. The 1994 Northridge Earthquake that measured 6.7 on the Richter Scale seriously damaged the City's Coldwater Canyon reservoir. The damages were repaired in 1997, and the reservoir is again in service. The Northridge Earthquake did not cause serious damage to any other water system facilities in the City.

The facility surveys undertaken were limited to observing damages to structural elements in the probable seismic loading path and any other apparent structural damage. The intent of the evaluation was to determine whether detailed seismic calculations, beyond the scope of this evaluation, are required to ensure satisfactory performance in a major earthquake. Facility drawings were not reviewed for seismic anchoring and load paths, and detailed structural calculations were not completed.

Standards applicable to detailed seismic adequacy calculations include the following:

- FEMA 310 (1998) for buildings.
- AWWA D100-96 for steel water storage tanks.
- AWWA D110-95 and D115-95 for concrete water storage tanks.
- FEMA 302 / NEHRP for equipment anchorage.

5.2 Overview of Prioritized Infrastructure Improvements

The emergency pump engines at Reservoirs 4B, 5 and 6 pump stations are started manually. The engines at Greystone, Reservoir 7 and Monte Cielo start automatically in the event of a power failure or loss of pressure within the Zone. All of the engines are started independently of the Remote Telemetry Unit (RTU) except for Reservoir 7.

The City experiences an estimated four to five electrical outages per month due to loss of utility power, with the longest outage lasting two to three hours. The SCADA and control systems should be provided with continuous, uninterruptible power supply.

An item reviewed for the City was the use and applicability of flexible couplings and automatic shut-off valves. Flexible couplings commonly used in the water industry have become very expensive and not entirely reliable during large seismic events in that they develop leaks that need to be repaired immediately. The same is true of automatic shut-off valves, which are not typically designed for severe shaking. It is recommended that the City investigate using an emerging technology that provides three-dimensional movement between aboveground tanks and buried pipelines. This system uses welded steel pipe to provide stress relief during a seismic event. The system must be designed by a seismic engineer for proper spacing and sizing at each facility to be protected. This system, coupled with the seismic anchoring for the tanks recommended throughout this chapter, should provide adequate seismic strengthening to the water reservoirs.

The facility improvements determined during the facility surveys and subsequent assessments are summarized in this section. A two level priority system was utilized to rank the recommended improvements in order of importance.

- Priority I improvements include repair or rehabilitation items determined to be critical and/or immediately necessary to maintain operational reliability of the facility.
- Priority II improvements include repairs identified as less critical to the reliability of the facility and not required immediately. Tables 5-1 and 5-2 list the Priority I and Priority II recommendations, respectively. The site observations and evaluations that support the recommendations are presented in detail in the following sections.

Table 5-1

Summary of Infrastructure Improvements, Priority I

Facility	Priority I Recommendations
Metropolitan Water District (MWD)	• Install an overhead portable crane. • Provide drainage sump for blow off valve discharge. • Install a security device for the roll-up door and secure building roof access.
Reservoir 3A and Pump Station	• Clean pump building as soon as possible to remove dirt and oil and provide a clean and safe environment for City staff. • Install insulation in the diesel exhaust system to reduce the temperature fluctuations. • Repair or replace pipe supports where needed. • Install anchors for reservoir. • Repair reservoir access hatch and replace corroded bolts. • Implement vegetation and weed abatement at the facility property. • Take down the ladder hook when not in use to avoid unnecessary injuries. • Replace barbed wire to prevent public access to the facility. Complete fencing around site. • Label the entry cover for the pump station manifold and secure it in place.
Sunset Reservoir and Pump Station	• Repair the sprinkler system for the landscaping around pump station. Remove weeds and grass from paved areas. • Cover exposed raw fiberglass insulation in the pump station building. • Repair and seal damaged louvers and roof flashing. Seal cracks in roof. • Install some form of access prevention in the chemical storage building. • Repair chemical storage building door and secure other avenues of access. Properly post hazard warning signs inside building. • Secure transformer storage and post hazard warning signs. • Install a fence and signage around the reservoir is recommended to deter public entrance. Secure all covers and hatches with locks. •
Greystone Reservoir and Pump Station	• Repair and seal base of corroded pump housing. • Install double containment for the day tank. • Install guards on several of the moving parts of both the pump motor and two of the pumps. • Repair and seal skylights and building flashing. Repair damaged ceiling. • Replace temporary light on the building with a permanent lighting fixture.
Reservoir 4A	• Modify the two ladder accesses to the reservoir to bring them into compliance with current OSHA safety standards. • Reinstall the "No Trespassing" sign. • Install railings around the reservoir structure to ensure the safety of the employees. • Install intrusion alarms on the reservoir hatch covers. • Repair and replace fencing around the perimeter of the facility. • Fence off the lower level of the reservoir to prevent trespassing.
Reservoir 4B and Pump Station	• Trim Eucalyptus trees surrounding the site to prevent them from causing damage to the facility in the event of a high windstorm or seismic event. • Replace pipe supports inside the building. • Repair and seal reservoir bottom plate. Install seismic anchors. • Replace broken roof tiles. • Replace fencing behind the electrical building.

Table 5-1
Summary of Infrastructure Improvements, Priority I

Facility	Priority I Recommendations
	• Install "No Trespassing" signs on the two side fence gates. • Install an adequate security system including a motion sensor and ladder cage is recommended for the tank access ladder. • Initiate vegetation and weed abatement to maintain a clear fence line.
Reservoir 5 and Pump Station	• Repair corrosion damage to pumps. • Install "No Trespassing" signs on side gates. • Repair fencing behind the tank to prevent public access. • Establish vegetation and weed abatement to maintain a clear fence line. • Secure accessible valves outside the facility gate.
Reservoir 6 and Pump Station	• Trim landscaping to provide adequate site distance from this driveway. • Install handrail on the equipment ramp to prevent accidents. • Repair or replace standby pump motor drive shaft and pump inlet and outlet. • Replace pipe supports throughout this pump station. • Repair the fence on the back of the property. • Repair and seal reservoir bottom plate. Inspect interior of reservoir. Replace epoxy coating if necessary. Install seismic anchors.
Reservoir 7 and Pump Station 8	• Replace several of the glass blocks in the pump station windows for security reasons. • Repair and seal reservoir bottom plate. Install seismic anchors. • Remove excess vegetation and weeds. • Install warning signs near the monopole, entrance gates, and diesel tanks, and the telecommunications tower. Install fencing around the telecommunications tower. • Replace 10-lb. fire extinguishers with 20-lb. fire extinguishers.
Booster Station No. 2	• Install pipe supports at this location. • Post a sign stating the rating of the breakers on the equipment. • Install hazard warning signs. • Install locks for the facility doors.
Coldwater Canyon Reservoir	• Clear the fence line along the perimeter of this facility of vegetation and miscellaneous objects. • Install signs to ensure proper public warning around the facility.
Green Acres Pump Station	• Install a ventilation fan to provide cooling and air flow inside the pump station. • Provide secondary containment for diesel/oil spills in pump station. • Replace or adjust pipe supports as needed. • Install signs warning of confined space hazards.

Table 5-2

Summary of Infrastructure Improvements, Priority II

Facility	Priority II Recommendations
Metropolitan Water District (MWD)	• Update the electrical system to include current technology.
Reservoir 3A and Pump Station	• Replace pump check valves with Cla-Val valves. • Evaluate possible shortcomings according to the current AWWA D100-96 based earthquake design method. • Install drainage system at site. Construct retaining wall to prevent landslide damage to reservoir.
Sunset Reservoir and Pump Station	• Repair and seal damaged concrete block walls. • Repair/replace asphalt pavement and base material outside the pump station. • Secure the water sprinkler power supply electrical cabinet to prevent tampering of this component.
Greystone Reservoir and Pump Station	• Monitor stairs leading to the bottom of the reservoir. If cracking should continue, initiate repairs. • Install a different lighting configuration at the front gate to make security video more effective. • To comply with the NEC requirements, relocate the RTU. The vacant wall to the right of the pump station doorway has adequate room to mount the RTU. • Install site fencing and signage to prevent trespassing.
Reservoir 4A	• Repair or replace upper retaining wall. Cracks on top of the lower retaining wall were visible and additional inspection and evaluation is recommended. • Install barbed wire at the top of the entrance gate fence to prevent trespassing.
Reservoir 4B and Pump Station	• Repair or replace damaged pavement and base material. • Install a Modicon PLC or equivalent. • Replace the fencing barbed wire to ensure facility security.
Reservoir 5 and Pump Station	• Repair or replace site asphalt paving. • Equip the Caterpillar generator with a shroud over the intake. • Replace the UPS or connect the batteries to the 24-volt direct pump battery. • Inspect reservoir interior. Repair or replace epoxy coating if needed. • Install remotely operated gates for convenience and security purposes (Recommendation of City personnel). • Repair or replace barbed wire on the fencing.
Reservoir 6 and Pump Station	• Repair or replace site asphalt and base material.
Reservoir 7 and Pump Station 8	• Repair or replace site asphalt and base material. • Clear the 12-inch butterfly valve orientation such that the shaft of the valve is in a horizontal position to reduce the wear on the valve. • The UPS system equipment must be on to operate the PLCs in the event of a power failure. Investigate supplying an additional backup power supply to the UPS. • Replace razor wire with barbed wire.
Booster Station No. 2	
Coldwater Canyon Reservoir	• Relocate inlet/outlet piping to ensure full drainage and circulation through the reservoir. • Repair and/or replace barbed wire to maintain security of the premises.
Green Acres Pump Station	• Install fencing to inhibit public access.

5.3 MWD Facility Analysis

The MWD facility is physically accessed from the alley east of Rexford Drive at Sunset Boulevard. The MWD control building is adjacent to Sunset Reservoir, and is constructed of concrete masonry unit (CMU) walls, a concrete roof slab, and interior concrete beams and columns. There are two MWD connections (turnouts) at this facility, designated BH-1 and BH-2. Water supplied through these two turnouts flows through a bank of control valves and supplies the City's primary reservoirs (e.g., the Sunset, Coldwater, and Greystone Reservoirs). The MWD connections have a capacity of 40 cfs each, although the City is required to take only a minimum daily flow of 8 cfs from MWD.

The MWD facility receives water from their Santa Monica Feeder. This feeder provides a normal operating pressure of 154 psi at the inlet side of the City's control valves, which is sufficient to serve Zones 3, 4, and 6 (all three reservoirs). A secondary source of water is available through MWD's Sepulveda Feeder in the event of an outage on the primary Santa Monica Feeder. However, this secondary feeder's normal pressure is only 85 psi, which does not provide a sufficient hydraulic gradient to adequately supply Zone 6's Greystone Reservoir.

5.3.1 Civil Analysis

The CMU control building has not been painted on the inside or outside, and there are visible signs of chemical corrosion and chemical staining on the block walls. The valves in this station include 16-inch Pratt butterfly valves, 16-inch Cla-Val diaphragm metering valves, and several smaller valves with no manufacturer identification. During the site visit, a significant volume of water had collected in the bottom of the structure and was most likely a result of blowoff valve discharge and leaks around the valves. A continually wet atmosphere has allowed some corrosion to develop, especially at piping penetrations through the floor and at locations where metal grating is used to cover floor openings.

5.3.2 Structural Analysis

The MWD building showed no evidence of deterioration, cracking, or spalling of concrete in the walls or roof. All elements in the seismic loading path appeared to be in good condition.

5.3.3 Electrical Analysis

The valve structure containing the two MWD turnouts includes 10 Cla-Val valves that perform one of the following functions:

1. Rate of flow control
2. Pressure reducing and rate of flow

The Programmable Logic Controller (PLC) at the MWD turnouts was installed in November 1997.

Located at this facility is a Motorola UDS 202T modem, which is used to send data. The electric power supply for this unit has failed occasionally, requiring the use of manual control of the valves. All electrical controls for the valves are operated on alternating current; however, the telemetry in this facility operates on direct current. This system should be updated to current technology.

5.3.4 Safety Analysis

The City currently uses a portable mechanical lifting device to remove equipment from the control building basement as needed.

The roll-up doors do not currently include security devices. The accessibility of the building roof presents the hazard for falling.

5.3.5 Recommendations

The following is a list of items and recommendations for action to enhance the operational reliability of the facility:

- Update electrical system to current technology.
- Provide drainage sump for blowoff valve discharge.
- Install a portable crane.
- Install a security device for the roll-up door and secure access to the building roof.

5.4 Reservoir 3A and Pump Station Facility Analysis

Reservoir 3A is a circular, above ground, steel tank constructed in 1964, with an interior diameter of 75 feet and a height of 32 feet. The bottom of the reservoir is at elevation 594 feet, and the overflow elevation is 628 feet. The storage capacity of the reservoir is 1.2 MG.

5.4.1 Civil Analysis

The pump check valves, located on the discharge side of the pumps, are tilting disk valves and prevent the backflow of water into the pump. The City has stated that parts necessary for rebuilding these valves are difficult to procure and that they would therefore like to replace the valves with Cla-Val valves. An air compressor located inside the pump building recently suffered a catastrophic failure. The failure discharged a quantity of oil, dirt, and other material inside the pump building.

Located at this facility are two buildings: the electrical building constructed of concrete walls and a concrete roof and the pump building constructed of concrete block walls with a steel roof. Housed in the pump building are two 20 hp, 11-stage vertical can pumps, which are used solely to increase pressure for Zone 9, and a fire pump. Pump Station 3A which supplies water to Zone 8 and Reservoir 4A consists of two 75 hp 4 stage, 12 inch pumps located outside the pump building, with a capacity of about 1150 gallons per minute (gpm) each. Space is available for an additional pump at this location. ClaVal valves are used for pump control, and 12 inch Pratt butterfly valves are used for shutoff. Each electric motor is rated for 480 volts at 87.1 amperes and 1,780 revolutions per minute (rpm). These pumps can be operated manually or automatically.

The emergency Caterpillar diesel pump motor has a 500 gallon fuel storage tank located outside the pump building. Because the diesel exhaust system does not have any insulation except for a shroud over the intake and radiator, the pump station interior becomes overheated whenever the diesel pump operates.

Corrosion is visible around the reservoir access hatch gasket and on several bolts. Pipe supports at this reservoir are in poor condition, as is the portland cement concrete pavement around the site.

A small retaining wall constructed of concrete block around the front of the reservoir shows no apparent drainage. City personnel have stated that, during the rainy season, standing water has accumulated to the bottom of the tank. (The earth bank does not have a retaining wall, and the fence line does not completely surround the site).

5.4.2 Structural Analysis

Reservoir 3A appeared to be in good condition and showed no signs of deterioration. However, the edges of the reservoir's bottom plate showed evidence of corrosion in some locations. The reservoir top and interior were not visually inspected.

The reservoir sits on asphaltic concrete pavement. There are no anchors between the tank and the concrete footing. There was evidence of landslide activity from the hills above, which buried the bottom of the reservoir. According to City personnel, soil removal around the tank has been necessary in the past.

The Reservoir 3A electrical building is constructed of both concrete walls and concrete masonry unit walls, with a metal deck roof. Other than minor corrosion on the inside face of the roof deck and supporting steel beams, the structure appeared to be in good condition. No serious structural cracks were visible in the walls. This building showed no signs of damage from the Northridge earthquake. The exposed portion of the pump station building appeared to be in good condition.

5.4.3 Electrical Analysis

A field investigation of this site revealed that the electrical equipment is adequately rated for the service load and rated to meet the 5,000 ampere available short circuit current noted by Southern California Edison.

In addition to the two 75 hp booster pumps, there are two 20 hp Monte Cielo pumps with variable frequency drives (VFD). According to City personnel, there have been several maintenance problems with this equipment, including blown fuses during high load events. Some of the control switches showed smoke damage, indicating that an overload may have occurred.

The duplexing VFD panel was manufactured by Power Systems, which is no longer in business. The VFD appears to have a full voltage across the line bypass contactor, allowing the motor to turn without going through the VFD. The contactor does not have motor overload protection, which is an NEC violation and also a potential safety problem when the motor is operated through the contactor instead of the VFD. City personnel indicated that plans for replacing or revising this VFD arrangement are underway.

5.4.4 Safety Analysis

A field investigation of this facility revealed safety problems, which should be corrected. The facility's perimeter fencing should be repaired in several locations. Although the pump suction manifold has a cover, it is not labeled or secured in place. During the site inspection, it was noted that, when not in use, the hook should be removed from the ladder and properly stored in order to prevent injury.

5.4.5 Recommendations

The following is a list of recommendations for enhancing the operational reliability of the facility:

- Replace pump check valves with Cla-Val valves.

- Clean the pump building as soon as possible to remove dirt and oil and provide a clean and safe environment for City staff.
- Install insulation in the diesel exhaust system to reduce the temperature fluctuations.
- Repair or replace pipe supports where needed.
- Install anchors for reservoir and evaluate possible shortcomings according to the current AWWA D100-96 based earthquake design method.
- Repair reservoir access hatch and replace corroded bolts.
- Remove weeds and other vegetation from the facility site.
- Install drainage system on the site. Construct retaining wall to protect reservoir against landslides.
- Remove ladder hook when not in use to avoid injuries.
- Replace barbed wire to prevent access to the facility. Complete the fencing around site.
- Label and secure the cover of the pump station manifold.

5.5 Sunset Reservoir and Pump Station Facility Analysis

Sunset Reservoir is a buried concrete reservoir constructed in 1955 and has a storage capacity of approximately 6 MG. Located adjacent to the reservoir is the pump station building constructed of concrete block walls and a concrete roof. The condition assessment at this facility identified moderate chemical corrosion of the concrete block walls and the conduit inside the pump station.

5.5.1 Civil Analysis

The Sunset Reservoir pumping station, which supplies water to Zone 4 consists of two 100 hp pumps. The corrosion of the concrete block may be due to a lack of sealant and paint. During wet weather, there is a potential for ground water to enter the structure and soak the unprotected concrete block. If this occurs often, eventually the block may degrade, rendering the building structurally unsound.

Several heads have been broken off the sprinkler system that provides water for landscaping at the pump station. The broken sprinkler heads allow streams of water to cause visible erosion and runoff in the landscaped areas. Weeds are encroaching onto the paved area and into other areas that could be negatively affected. The top of the reservoir is overgrown with grass.

An apparent failure of the base rock or base material under the pavement has caused heaving of the asphalt outside the pump station. However, there does not appear to be differential settlement in any location throughout this pump station.

5.5.2 Structural Analysis

The reservoir is buried and not exposed to view. Therefore, visual observation of the reservoir could not be performed adequately during the site visit.

The pump station is constructed of concrete masonry unit walls and a concrete roof slab. A portion of the interior is covered with sound insulation. The roof top was not inspected. Cracking near the edges of the roof slab is visible from below. However, these cracks are probably not a structural concern. Minor corrosion is apparent on the ventilation louvers and roof flashing edges.

Overall, the elements in the seismic loading path appear to be in good condition. The chemical storage building is constructed of concrete masonry unit walls with a concrete roof. The walls and roof did not show any cracking and appeared structurally sound.

5.5.3 Electrical Analysis

The Sunset Reservoir Pump Station was out of service at the time of the site inspection. According to City personnel, this facility is planned to be rehabilitated and returned to service in approximately one year. Therefore, a detailed observation of the pump station was not completed. Many items appeared to have been removed for use at other sites while the station has been out of service, and there appeared to be an abundance of loose wiring. The pump station has a 480 volt service from Southern California Edison (SCE).

The reservoir's SCADA system monitors reservoir level and the pump station intrusion protection system. The SCADA inputs are wired to an RTU in the adjacent MWD valve building. This station has its own phone line separate from the MWD building. A single Pacific Bell leased telephone line is used for SCADA communications. The pump station will be included in the SCADA system when operational.

The valve structure housing the MWD turnouts and the chemical storage building have 120 volt services from SCE. The 100-kVA transformer feeds 120/240 single-phase three wire panel boards in these buildings. The available short circuit current is estimated to be 9,000 amperes at 120 volt, and the breakers are adequately rated at least 10,000 amperes at 120 volt. The GE panel LPB in the fluoride structure has GE THQL breakers

rated for 22,000 SC amperes, which is more than adequate. The short circuit rating of the electrical equipment at the pump station was not reviewed.

The galvanized steel conduit in the chemical feed area was observed to be corroded.

5.5.4 Safety Analysis

A field investigation of this facility revealed the following safety concerns that should be corrected:

- **Doors to the Chemical Storage Building.** The bottom pin holding the door in place is broken, leaving only the top pin to secure the door. Bulk quantities of sodium fluoride are stored inside this building without proper signage identifying this hazardous chemical. There are potential access routes through the ventilation louvers and the skylights.
- **Transformer Storage.** The transformer facility is apparently not live, but will be energized in the future. Therefore, a new hazard sign should be installed before this facility is operational. The top sill is damaged and the locks require inspection.
- **Reservoir and Building.** All covers over hatches large enough to be entered need to be locked with an appropriate device. Conduits and wiring not being used need to be removed. The light fixture on top of the building is not working; the bulb should be replaced and the unit inspected to determine operational status.

5.5.5 Recommendations

The following are recommendations enhancing the operational reliability of the facility:

- Repair and seal damaged concrete block walls.
- Repair the sprinkler system for the landscaping around this pump station. Remove weeds and grass from paved areas.
- Cover exposed raw fiberglass insulation in the pump station building.
- Repair/replace asphalt pavement and base material outside the pump station.
- Repair and seal damaged louvers and roof flashing. Seal cracks in roof.
- Install access prevention devices in the chemical storage building.
- Repair chemical storage building door and secure other avenues of access. Post hazard warning signs inside building.

- Secure the water sprinkler power supply electrical cabinet to prevent tampering.
- Secure transformer storage and post hazard warning signs.
- Install a fence and signage around the reservoir to prevent unauthorized access. Secure all covers and hatches with locks.

5.6 Greystone Reservoir and Pump Station Facility Analysis

Greystone Reservoir was constructed in the 1970s of reinforced concrete with a dividing wall separating the East and West basins. The East Basin and West Basin have capacities of 9.2 and 10.2 MG, respectively, for a combined capacity of 19.4 MG. The reservoir is located below ground with a bottom elevation of 583.9 feet and an overflow elevation of 623 feet. Each basin can be operated independently.

The pump station consists of two 1200 gpm, 4 stage, can type pumps operated with 75 hp, vertical turbine, electric motors. The electric motors are rated for 460 volts, 89 amperes, and 1780 rpm. These pumps can be operated either automatically or manually.

5.6.1 Civil Analysis

The pump station houses two Vertiline pumps manufactured by Aurora (no model number was visible) and a Peerless (Model No. 6AE16) emergency pump. A Caterpillar emergency pump motor is directly coupled to the Peerless pump. Severe corrosion was visible at the base of one of the pumps. The remaining pumps had been recently serviced, including removal of rust and the application of a rust-inhibitor paint.

The visible condition of the building was fair. Several leaks in and around two large skylights have contributed to water damage of the ceiling, its architectural finishes, and some of the equipment inside the building.

5.6.2 Structural Analysis

Observation of this underground reservoir was difficult and was limited to viewing from inside the access building. According to City personnel, the reservoir is inspected annually by the Division of Safety of Dams (DSOD). The DSOD has performed a structural engineering assessment of the safety of the reservoir. The only correctional measure mandated for the continued operation of this reservoir by DSOD was a heavy traffic load limit for the roof. It is therefore assumed that DSOD's assessment included the structural safety of the reservoir for compliance with seismic

loading codes. In addition, City personnel reported that, after the Northridge Earthquake, cracks developed under both stairways leading to the bottom of the reservoir. There is a retaining wall in good condition on the lower perimeter of the reservoir.

The reservoir access building is constructed of concrete masonry unit walls with a concrete roof slab. No serious structural cracks were visible in the walls or roof. There was no evidence of deterioration, cracking, or spalling of concrete in either the walls or roof. All elements in the seismic loading path appeared to be in good condition.

The pump station building was built in 1986. The building wall facing the access road is constructed of concrete masonry units, and the remaining three walls are concrete, functioning as a retaining wall. The roof slope is very steep, 12 horizontal to 10 units vertical. The roof is constructed of 2 x 6 wood rafters and ½ inch plywood diaphragm, which support slates. The perimeter walls and a W18 x 35 steel beam at the ridge of the roof support the rafters. The W18 x 35 steel beam is supported at each end of the gabled wall.

On the interior face of the northeast wall at the corner of the louver opening, there was a visible crack, which was not considered a structural concern. The ceiling showed signs of water leakage on the gypsum board around the skylight. The building flashing was damaged, leaving plywood and wooden members exposed at the backside of the building near the roof. All visible elements appeared to be in good condition structurally. The roof was not observable.

5.6.3 Electrical Analysis

During the site review, an NEC violation for working clearance was identified. NEC Article 110 requires the main switchboard to have full height, horizontal-working clearance of 3½ feet extending out to any grounded surface. The RTU for the SCADA system is mounted less than 3 feet in front of the switchboard.

5.6.4 Safety Analysis

A field investigation of this facility revealed some safety problems that should be corrected. Greystone Reservoir's security office has very limited working space. The lighting at the front gate was too bright, rendering the video image ineffective. During normal operating hours, the public can gain access to the reservoir from the parking lot on top of the reservoir and can park cars around the reservoir. A temporary light installed off the building was powered by an extension cord routed through the door. A day tank appears to have no containment provisions.

5.6.5 Recommendations

The following are recommendations for enhancing the operational reliability of the facility:

- Repair and seal base of corroded pump housing.
- Install double containment for the day tank.
- Install guards on the moving parts of both the pumps and motors
- Repair and seal skylights and building flashing. Repair damaged ceiling.
- Monitor stairs leading to the bottom of the reservoir. If cracking continues, initiate repairs.
- Install a different lighting configuration at the front gate to make security video more effective.
- To comply with the NEC requirements, relocate the RTU. The vacant wall to the right of the pump station doorway has adequate room to mount the RTU.
- Install site fencing and signage to prevent trespassing.
- Replace temporary light on the building with a permanent lighting fixture.

5.7 Reservoir 4A Facility Analysis

Reservoir 4A, constructed in 1954, is a partially buried reinforced concrete structure. The roof is constructed of precast panels and, according to City personnel, was damaged during the Northridge Earthquake. The City hired consultants to perform the structural assessment and retrofit work. The roof was repaired and a geomembrane installed on the top surface for leak prevention. The structural assessment report states that the reservoir is structurally sound. This reservoir has a storage capacity of 2.2 MG with a bottom elevation of 777.5 feet and a top elevation of 795.5 feet. The reservoir is divided into North and South basins, each of which can be operated independently. Two inlet/outlet pipes are located on the west side of the reservoir and two inlet/outlet pipes on the east side.

5.7.1 Civil Analysis

The control building located on top of the reservoir is a wooden structure with asbestos cement wall panels. There are two ladder accesses into this reservoir.

5.7.2 Structural Analysis

Retaining walls are located on one side of the reservoir roof and on two sides of the reservoir foothill. The wall contiguous with the reservoir roof is constructed of concrete masonry units and some cracks were visible. In addition, the wall appeared to be out of plumb. The lower retaining wall was not entirely accessible, and only limited inspection was possible from the roof of the reservoir.

5.7.3 Electrical Analysis

This facility has a 120 volt, single-phase power source and is equipped with a battery for backup power to the Modicon PLC, which is the RTU. All the wall-mounted starters are no longer required and are out of service. Most of the equipment installations, except for the PLC, appeared to be over 40 years old, consistent with the 1954 construction date. Despite its age, the equipment appeared to be in reasonably good condition. The SCADA system monitors the room intrusion alarm and reservoir level. The reservoir level at this location and other locations is typically determined using a KPSI 5600 pressure transducer.

5.7.4 Safety Analysis

This facility is constructed on a steep embankment, and there are several gaps in its perimeter fencing. The recommendations stated below are for the upper level of the reservoir. The lower level of the reservoir is adjacent to residential development and should be fenced to prevent trespassing.

5.7.5 Recommendations

The following are recommendations for action to enhance the operational reliability of the facility:

- Bring the two ladder accesses to the reservoir into compliance with current OSHA safety standards.
- Repair or replace upper retaining wall. Cracks on top of the lower retaining wall were visible, and additional inspection and evaluation is recommended.
- Install barbed wire at the top of the entrance gate fence to prevent trespassing.
- Reinstall the "No Trespassing" sign.
- Install railings around the reservoir structure to ensure the safety of employees.
- Install intrusion alarms on the reservoir hatch covers.

- Repair and replace fencing around the perimeter of the facility.
- Fence off the lower level of the reservoir to prevent trespassing.

5.8 Reservoir 4B and Pump Station Facility Analysis

Reservoir 4B is an above ground circular, steel tank constructed in 1956. The tank has a storage capacity of 1.2 MG, with an interior diameter of 75 feet and a height of 32 feet. The reservoir bottom elevation is 769 feet, and the overflow elevation is 800 feet. This reservoir receives water from Greystone Reservoir and serves as a water supply to Zone 8 by gravity and to Reservoirs 5, 6, 7, and Zone 16 through pump stations 4, 5, 6, and 8, respectively.

Pump Station 4B consists of two 125 hp vertical turbine electrical pumps located outside of a concrete masonry unit building with a Spanish-tiled mansard roof. Housed in this building is an emergency standby diesel-drive pump rated at 2,000 gpm at 280 feet of head.

5.8.1 Civil Analysis

On the north side of this reservoir, outside of the fence line but still on City property, there are five eucalyptus trees with trunk diameters of approximately 10 to 12 inches. These trees lean toward the reservoir and have been trimmed back in the past to remove branches that were touching and/or scraping the side of the reservoir.

The pavement at this site was observed to be in poor condition and should be replaced. At several locations, roots of large trees have lifted the pavement. At other locations, the pavement is not suitable for traffic due to base failure and "alligatored" surface.

There are two Lane and Boles Vertiline, 4 stage pumps with mechanical seals installed outside the pump station. These pumps are powered by 125 hp motors and appear to be old, which may be a result of their exposure to the elements. Several ancillary valves are installed outside to aid in control of the pumps, including Nordstrom plug valves, Cla-Val diaphragm valves, and Pratt butterfly valves. City personnel are considering removal and replacement of several of the old valves, including the gate and plug valves, with more current equipment. The Caterpillar pump motor at this pump station has a cardboard shroud around the radiator to direct the cooling air.

The pipe supports installed on the pump station piping do not work effectively. Several of the supports are not in contact with the pipe, and others have been adjusted with wooden wedges. As a result, stress points may have been introduced to the pipe, especially at mechanical joints and flange bolts.

5.8.2 Structural Analysis

Reservoir 4B appeared to be in good condition and showed no signs deterioration. At some locations along the edge of the reservoir's bottom plate, evidence of corrosion was observed. According to City personnel, measures have been taken in the past to correct corrosion observed inside the tank near its center. The reservoir roof was not observed.

Reservoir 4B sits on asphalt concrete pavement and does not have anchors between the tank and the concrete footing. City personnel also reported that there is about a 1 inch differential settlement at one corner inside the reservoir.

The corners of some of the mansard roof tiles on the pump station building were broken. Otherwise, this structure appeared to be in good condition.

5.8.3 Electrical Analysis

This site has a 400 ampere, 480 volt, 3-phase service with a Topaz 24 volt, uninterruptable power supply (UPS) to feed a battery in the RTU. Based on operation and maintenance experience, City personnel expressed the desire to replace all the UPS units and to power the RTU with the standby pump's battery. A battery charger charges some of the pump batteries, and others are charged by an alternator on the engine. This site uses a solid state Digifire starter for one of the 125 hp pumps, which replaced Square D Model 8660 solid state starters in a Square D Model 5 motor control center (MCC). The second pump still uses the Square D solid state starter. The City prefers the Digifire starters since replacement parts are more readily available and less expensive than the Square D equipment.

This site has one of the older Square D Symax PLC, which were installed in 1990 and are still used as RTUs. Since the Square D type PLC requires a network interface, communications are relatively slow. Also, this equipment does not communicate as well as the newer Modicon PLC due to the incapability of remote programming or remote monitoring of its functions. Analog signals are not accepted by the Square D PLC from the control room; only discrete signals such as on-and-off can be accepted. Additionally, this PLC has no fuzzy logic functionality, which might be used to program time of day usage or signals to turn the pumps on and off.

5.8.4 Safety Analysis

The fencing behind the electrical building was observed to be washed out and should be replaced to properly secure the facility and prevent public access. The tank access ladder has no ladder cage.

5.8.5 Recommendations

The following are recommendations for action to enhance the operational reliability of the facility:

- Trim eucalyptus trees surrounding the site to prevent them from causing damage to the facility in the event of a high windstorm or seismic event.
- Repair or replace damaged pavement and base material.
- Replace pipe supports inside building.
- Repair and seal reservoir bottom plate. Install seismic anchors.
- Install a Modicon PLC or equivalent.
- Replace broken roof tiles.
- Replace fencing behind the electrical building.
- Install No Trespassing" signs on the two side fence gates.
- Install an adequate security system ,including a motion sensor and ladder cage for the tank access ladder.
- Cut down the weeds to maintain a clear fence line.
- Replace the barbed wire fencing to ensure facility security.

5.9 Reservoir 5 and Pump Station Facility Analysis

Reservoir 5, constructed in 1956, is an above ground circular steel tank with an interior diameter of 75 feet and a height of 32 feet, equaling a storage capacity of 1.2 MG. The reservoir bottom and overflow elevations are 1021 and 1052 feet, respectively. This reservoir supplies water to Reservoir 6, and ultimately to Reservoir 7 and Zone 16 through Pump Stations 5, 6, and 8. Additionally, a standby diesel driven pump rated at 2,000 gpm at 280 feet of head is installed in the pump station.

5.9.1 Civil Analysis

Reservoir and Pump Station 5 are in fairly good condition. The mechanical systems on the site are adequate with the exception of the pipe supports. The pumps, manufactured by Aurora (Model No. 180A217), are 6 x 8 x 18 and develop approximately 280 feet of head at 1800 rpm. Some repairable corrosion was identified at the base of these pumps. City personnel indicated that maintenance is scheduled to repair the corrosion damage.

The pump station building exhibits poor cooling conditions. There is a concern that excess heat generated by the Caterpillar standby pump motor may accumulate in the building due to the poor cooling. The station has a 150 gallon day tank, which has been double contained. The mechanical piping and valves associated with this pump station appeared to be in good condition. The asphalt paving at this site is in poor condition.

5.9.2 Structural Analysis

Reservoir 5 appeared to be in generally good condition and showed no signs of deterioration. However, the edges of reservoir's bottom plate showed evidence of corrosion in some locations. The reservoir top was not observed.

Reservoir 5 sits on asphalt concrete pavement and does not have anchors between the tank and the concrete footing. According to City personnel, some corrosion has been visible inside the tank near the center, and some measures have been taken to correct the problem. In addition, City personnel reported that the epoxy coating inside the reservoir has bubbles in some locations.

5.9.3 Electrical Analysis

This facility has a 400 ampere, 480 volt, 3 phase electrical service. The solid state starters are Square D Alpha Pak Model 8660 NG040, rated for 128 amperes maximum. The starters for the 75 hp pumps are rated at 25kVA short circuit and 480 volt.

City personnel reported that at one time the pump station electrical supply went into single phasing from the SCE utility supply before blowing a fuse. All the components were subsequently inspected, and items were repaired.

5.9.4 Safety Analysis

"No Trespassing" signs were not posted on side gates, and barbed wire on the perimeter fencing was damaged and broken in some locations. Vegetation and weeds were overgrown near the fence line.

5.9.5 Recommendations

The following are recommendations for action to enhance the operational reliability of the facility:

- Repair corrosion damage to pumps.
- Repair or replace asphalt paving.
- Equip Caterpillar pumps with a shroud over the intake.

- Replace the inverter or connect the batteries to the 24 V direct pump battery.
- Inspect reservoir interior. Repair or replace epoxy coating if needed.
- Install "No Trespassing" signs on side gates.
- Replace or repair barbed wire on the fencing.
- Repair fencing behind the tank to prevent public access. Keep the fence line clear of vegetation and weeds.
- Secure accessible valves outside the facility gate.

5.10 Reservoir 6 and Pump Station Facility Analysis

Reservoir 6, similar to Reservoirs 5 and 4B, is a 1.2 MG ground level circular steel tank constructed in 1956. The tank has an interior diameter of 75 feet and a height of 32 feet, with a bottom elevation of 1,022 feet, a top elevation of 1,052 feet, and an overflow elevation of 1,050 feet. This reservoir receives water from Pump Station No. 5 (Reservoir 5) and serves pressure Zone 13. The pump building, similar to the pump building at Reservoir 5, is constructed of cement mortar units with a concrete roof. The pump station contains two 75 hp, 1,000 gpm vertical turbine electric pumps; however, manufacturer information is not apparent on either pump. The emergency standby motor at this pump station is a Caterpillar diesel engine and is connected to an Aurora pump (Model Number 180A217).

5.10.1 Civil Analysis

Access to the pump station is through a very narrow driveway, and visibility in either direction from this driveway is impaired due to overgrown landscaping bushes. The asphalt around the site was in extremely poor condition, most likely the result of tree roots. A ramp is available for moving of equipment into and out of the pump station building. However, the ramp was physically too small and did not have a handrail.

Severe corrosion was visible on the standby pump drive shaft and at both the pump inlet and outlet connections. The fuel supply for the standby motor includes a dual-walled 150 gallon capacity day tank. The pipe supports throughout this pump station were in extremely poor condition.

The fence on the back side of the property has a large hole, which could permit public access.

5.10.2 Structural Analysis

Reservoir 6 appeared to be in good condition and showed no visible deterioration. However, the edges of the reservoir's bottom plate show evidence of corrosion in some locations, and the reservoir top was not observed. Reservoir 6 sits on asphalt concrete pavement and does not have anchors between the tank and concrete footing. According to City personnel, some corrosion has been visible inside the tank near the center, and measures have been taken to correct the problem. In addition, City personnel have identified bubbles in the tank's interior epoxy coating.

Pump station 6 is constructed of concrete masonry unit walls and mansard roof with Spanish roof tiles. The structure appeared to be in good condition.

5.10.3 Electrical Analysis

No electrical analysis was done for this facility.

5.10.4 Safety Analysis

Portions of the site perimeter fencing and barbed wire were damaged and in need of repair. Vegetation and weeds are overgrown at the site, and abatement should be considered. The swing gate allowing access to the site needs to be repaired and a light should be installed. A security system should be installed to monitor visitors to the facility.

5.10.5 Recommendations

The following are recommendations for action to enhance the operational reliability of the facility:

- Trim landscaping to provide better visibility from the driveway.
- Repair or replace site asphalt and base material.
- Install handrail on the equipment ramp to prevent accidents.
- Repair or replace standby pump motor drive shaft and pump inlet and outlet.
- Replace pipe supports throughout the pump station.
- Repair the fence on the back of the property.
- Repair and seal reservoir bottom plate. Inspect interior of reservoir. Replace epoxy coating if necessary. Install seismic anchors.

- Repair gate and install a light at entrance.
- Install security system to monitor site visits.

5.11 Reservoir 7 and Pump Station 8 Facility Analysis

Reservoir 7, constructed in 1958, is a 1.2 MG ground level circular steel, tank with an interior diameter of 75 feet and a height of 32 feet. The reservoir bottom elevation is 1,471 feet; the top elevation is 1,503 feet with an overflow elevation of 1,501 feet. This reservoir routinely receives water from Pump Station 6 (Reservoir 6) and has an emergency supply of water from LADWP stored in a small reservoir above this facility.

5.11.1 Civil Analysis

Pump Station 8 is a concrete masonry building with a concrete roof. There are two Aurora pumps (Model No. 180A019) that discharge 120 gpm against a head of 140 feet. The pumps are powered by 10 hp motors (no manufacturer was apparent). The emergency standby pump motor at this location is a Detroit diesel and is connected to a 1,000 gallon fuel tank located outside the building. The building housing Pump Station 8 has windows made of glass blocks. Several of these glass blocks are broken and should be replaced to maintain security at the facility. The old pumping scheme included two large hydropneumatic tanks, which are no longer in use. The fuel tank is manufactured by Convault Tank and appears to be in good condition and sufficiently monitored. The pavement at this site is in extremely poor condition. The steel reservoir is in reasonably good condition. Located at the tank discharge point is a vertical 12 inch butterfly valve. In order to reduce wear and extend the life of the valve, its shaft orientation could be changed to a horizontal position.

5.11.2 Structural Analysis

Reservoir 7 appeared to be in good condition and showed no signs of deterioration. However, the edges of the reservoir's bottom plate showed evidence of corrosion in some locations. The reservoir roof was not observed.

Reservoir 7 sits on asphalt concrete pavement and does not have anchors between tank and concrete footing. According to City personnel, some corrosion has been visible inside the tank near the center, and some measures have been taken to correct the problem.

Pump Station 8 is constructed of concrete masonry unit walls and precast concrete roof panels. There is no visible evidence of deterioration, cracking, or spalling of

concrete in the walls and roof. All elements in the seismic loading path appear to be in good condition.

5.11.3 Electrical Analysis

The Topaz unit has a 12 volt direct input which City personnel would like to have replaced. The two 10 hp booster pumps have circuit breakers rated for 25 kVA at 480 volt.

An important operational procedure for the standby pump includes a one-minute cool down period for the engine before shutoff. One of the reasons for automatically starting this pump is due to a problem with starting the pump through the PLC in the Main Control Panel (MCP). Since there are often power failures in this zone, the UPS system equipment must be on to operate the PLCs in the event of a power failure. The inverter does not charge the PLC batteries.

5.11.4 Safety Analysis

The facility's lighting systems are not working and should be repaired. Razor wire was installed on the perimeter fencing and should be replaced with barbed wire for increased safety. Fencing and signage should be installed around the telecommunications tower for mitigating safety concerns and limiting access. In addition, there is a lack of signage near the monopole, entrance gates, and at the diesel tanks.

Excessive diesel fuel should not be stored at this facility due to potential fire hazards, and overgrown vegetation and weeds should be trimmed. Stored on-site are 10 pound fire extinguishers; however, 20 pound fire extinguishers are probably necessary considering the fire danger.

5.11.5 Recommendations

The following are recommendations for action to enhance the operational reliability of the facility:

- Repair glass blocks in the pump station windows for security reasons.
- Repair or replace asphalt and base material.
- Change the 12 inch butterfly valve orientation so that the shaft of the valve is in horizontal position to reduce the wear on the valve.
- Repair and seal reservoir bottom plate. Install seismic anchors.

- The UPS system equipment must be on to operate the PLCs in the event of a power failure. Investigate supplying an additional backup power supply to the UPS.
- Remove excess vegetation and weeds.
- Install warning signs near the monopole, entrance gates, an diesel tanks, and the telecommunications tower. Install fencing around the telecommunications tower.
- Replace razor wire with barbed wire.
- Replace 10 pound. fire extinguishers with 20 pound fire extinguishers.

5.12 Booster Station 2 Facility Analysis

Booster Station 2 was constructed to serve as a secondary source of water to Zone 6. Booster Station 2 includes two pumps that supply water through Zone 4 to Zone 6. There are two 200 hp vertical turbine pumps (manufacturer information was not available) with 3,000 gpm pumping capacity each. There are a series of three pressure reducing and sustaining valves (a 6 inch, an 8 inch and a 12 inch, Cla Val) located on the discharge header serving Zone 4 from Zone 6.

5.12.1 Civil Analysis

The electrical building at this location consists of a concrete block wall and a concrete roof. The piping seems to be supported from two locations, at the pump can and at the point where the pipe goes underground. Additional pipeline support is required and should be installed.

5.12.2 Structural Analysis

No structural observation was performed.

5.12.3 Electrical Analysis

This pump station has 1,200 ampere, 3 phase, 480 volt service. This service replaced an older ITE main breaker and metering switchboard, which had a 1600 ampere main rated 50,000 ampere (short circuit probably at 480 volts). The short circuit rating and transformer size needs to be confirmed with SCE.

The switchboard has a 65,000 amperes short circuit rating, a Digifire solid state reduced voltage starter manufactured by DNH Harbor City, CA in 1999, and, 480 volt breakers rated 35,000 amperes SC at 480 volts.

Current National Electrical Manufacturers Association (NEMA) requirements mandate that electrical equipment show the short circuit rating, which is normally determined by the lowest rated component. Equipment older than 5 to 10 years was usually not labeled with short circuit ratings. One manufacturer now typically assembles the entire piece of equipment. However, the rating can be circumvented later by adding components with a lower rating than the original switchboard. Thus, determining the rating can be difficult if much lower rated breakers are used than the original equipment. If so, it may not be possible to determine the modified equipment's true rating.

5.12.4 Safety Analysis

The facility doors are secured with hardware rather than with locks. In addition, hazard signs have not been installed.

5.12.5 Recommendations

The following is a list of items and recommendations for action to enhance the operational reliability of the facility

- Install pipe supports at this location.
- Post a sign stating the rating of the breakers that should be used should be posted on the equipment.
- Install hazard warning signs.
- Install locks for the facility doors.

5.13 Coldwater Canyon Reservoir Facility Analysis

Coldwater Canyon Reservoir, an underground reinforced concrete structure, was originally constructed in 1928. Since its construction, it has undergone two major rehabilitation projects (in 1968 and 1996). The reservoir is currently in service. The storage capacity of this reservoir is 6.8 MG with a bottom elevation of 436 feet, top elevation of 454 feet, and an overflow elevation of 452 feet.

5.13.1 Civil Analysis

Until recently, the Coldwater Canyon Reservoir had a soil cover over the top. The soil was removed entirely after the Northridge Earthquake, and a membrane cover was installed. In the early 1970s the reservoir was drained and lined with Gunnite to prevent leakage. The City is considering constructing a new 9 MG reservoir at this site.

The existing reservoir cannot be drained below 2 feet of depth due to the elevations of both influent and effluent connections. The reservoir is rectangular and does not have any mixing equipment. The City has expressed concern that there may be dead or stagnant zones within this reservoir that could affect water quality.

5.13.2 Structural Analysis

Since the existing reservoir may be removed in the future and replaced with a new reservoir, a site inspection was not performed.

5.13.3 Electrical Analysis

This facility has a 120 volt service panel that does not meet the NEC requirements. Much of the electrical conduit extends up into the panel for protection of the wiring. A means to disconnect service, via a main disconnect plug or a utility meter, was not apparent. The nameplate on the panel was inscribed with Greystone, so it is probable that the equipment came from that location.

The PLC is manufactured by Modicon and is used to monitor the reservoir level and panel entry/intrusion alarms.

5.13.4 Safety Analysis

The fence line along the perimeter of this facility was overgrown with vegetation and cluttered with miscellaneous objects. The barbed wire on this fencing has been damaged and is in need of repair. Signage was not present at this site to ensure proper public warning around the facility.

5.13.5 Recommendations

The following are recommendations for action to enhance the operational reliability of the facility:

- Relocate inlet/outlet piping to ensure full drainage and circulation through the reservoir.
- Clear the fence line along the perimeter of this facility of vegetation and miscellaneous objects.
- Repair and/or replace barbed wire to maintain security of the premises.
- Install signs to ensure proper public warning around the facility.

5.14 Green Acres Pump Station Facility Analysis

The Green Acres Pump Station is an all concrete underground facility. The pump station is approximately 25 feet square, and has a one- man accessway through a very narrow stairway.

This pump station is currently not in use; however the City intends to reactivate this facility during 2002. An equipment access hatch is available to install or remove equipment. The two 10 hp, four stage vertical turbine pumps are capable of pumping 240 gpm each and were manufactured by Aurora (no model number was visible). A 75 hp Waukesha diesel emergency pump is located at this site and is connected to a PACO pump (Model No. 99C02559C. This pump is rated for approximately 2,300 gpm. The upstream and downstream pump check and shutoff valves have not been exercised.

5.14.1 Civil Analysis

The radiator on the standby motor does not have a shroud. City personnel reported that, when the motor comes on line, the engine coolant gets too hot and trips off line because of insufficient water flow and cooling in the pump station.

Water infiltration or pump leakage drains by gravity into a local sump, is pumped out through a curb discharge, and flows down the gutter to the storm drain system. This presents a possible hazard due to the absence of secondary containment. Spilled diesel fuel and other petroleum products could wash into the storm drain system. The pipe supports in this pump station were in generally good shape; however, a few supports need to be replaced or adjusted.

5.14.2 Structural Analysis

The pump station is constructed of concrete walls and slab and has a removable cover. The pump station is buried under ground to the top of the slab. There was no visible evidence of deterioration, cracking, or spalling of concrete in the walls and ceiling. All elements in the seismic loading path appeared to be in good condition.

5.14.3 Electrical Analysis

This facility has a 125 ampere main breaker with a 3 phase, 480 volt service. The circuit breakers are rated 14,000 amperes short circuit at 480 volts. The VFDs for the pumps are Safetronics Yaskawa with ABB breakers rated for 25,000 amperes at 480 volts. The 25 kVA transformer and 1500 amperes short circuit listed by SCE appear to be extremely low and confirmation is required.

5.14.4 Safety Analysis

Site perimeter fencing is not present, and public access to the site is therefore possible. Entrance to the pump station represents a confined space hazard and appropriate signage to this effect is required.

5.14.5 Recommendations

The following are recommendations for action to enhance the operational reliability of the facility:

- Install a ventilation fan to provide cooling and air flow inside the pump station.
- Provide secondary containment for diesel fuel and oil spills in the pump station.
- Replace or adjust pipe supports as needed.
- Install fencing to inhibit public access.
- Install signs warning of confined space hazards.

6.0 Pipeline Replace/Rehabilitation

6.1 General

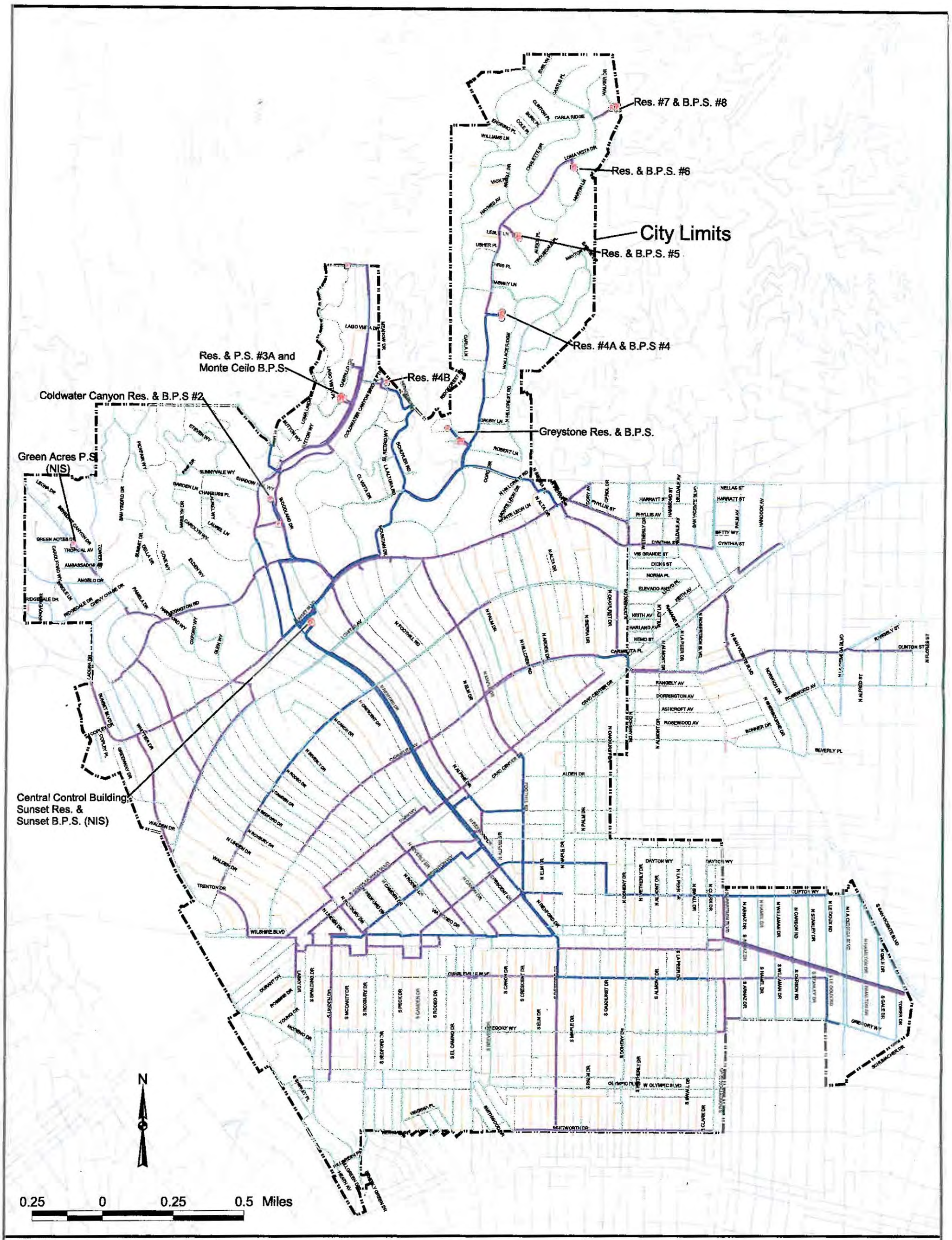
The Beverly Hills water distribution system represents a major capital and operating investment. As pipes deteriorate and begin to fail, a program to cost-effectively replace deteriorated pipelines is an important part of system maintenance. The 1985 Master Plan recommended a program of flow testing and structural testing for pipes installed without protective cement mortar lining (or before about the late 1940's), to determine replacement needs. A total of 276,400 feet of pipe was identified for testing.

This report considers the City's actual experience with main breaks as a positive indication of pipe condition, to identify deteriorating pipes that should be scheduled for replacement.

The pipe information stored in the GIS system and the City's historical main break records were imported to the Water Distribution Management System (WDMS), a software tool developed by Black & Veatch for developing pipeline replacement/rehabilitation programs. WDMS provides users with an engineering-oriented database application to organize the pipeline information, analyze historical main break data, perform economic evaluations, and develop a replacement plan.

6.2 Pipeline Age and Material Evaluation

Chapter 2 presents the development of the distribution pipe inventory in the GIS system, and provides tables that summarize the pipes by size, material, and installation year. Figures 6-1, 6-2 and 6-3 show graphically the existing system pipe diameters, pipe materials, and installation decades, respectively. The pipe length comprised of steel pipe is 8.4 percent of the total system, cast iron is 43.7 percent, ductile iron is 44.4 percent, and pipes without a material recorded are 3.4 percent of the total. A total of 168,482 feet of pipe is identified in the GIS as installed prior to 1950, or 18.6 percent of the total length. The installation date for an additional 216,162 feet of pipe, or 24.0 percent of the total, was not available. Actual main breaks occurred on only 154 specific pipe segments in the GIS representing 69,392 feet of pipe.



Pipe Diameter (Inches)

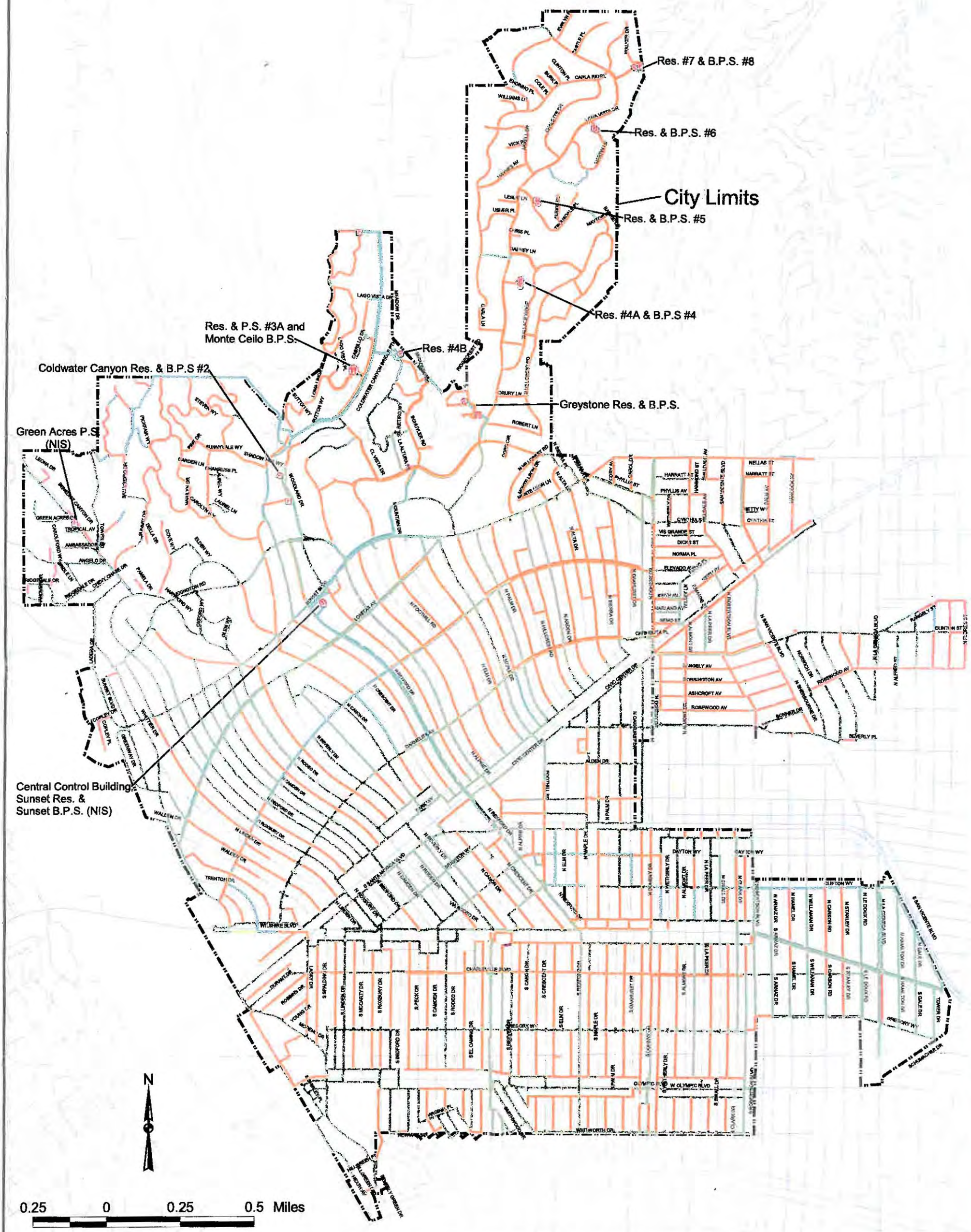
- < 4
- 4
- 6
- 8 - 10
- 12 - 14
- 16 - 24

Beverly Hills, California
Water System Master Plan
2002

PIPE DIAMETER

BLACK & VEATCH

FIGURE 6-1



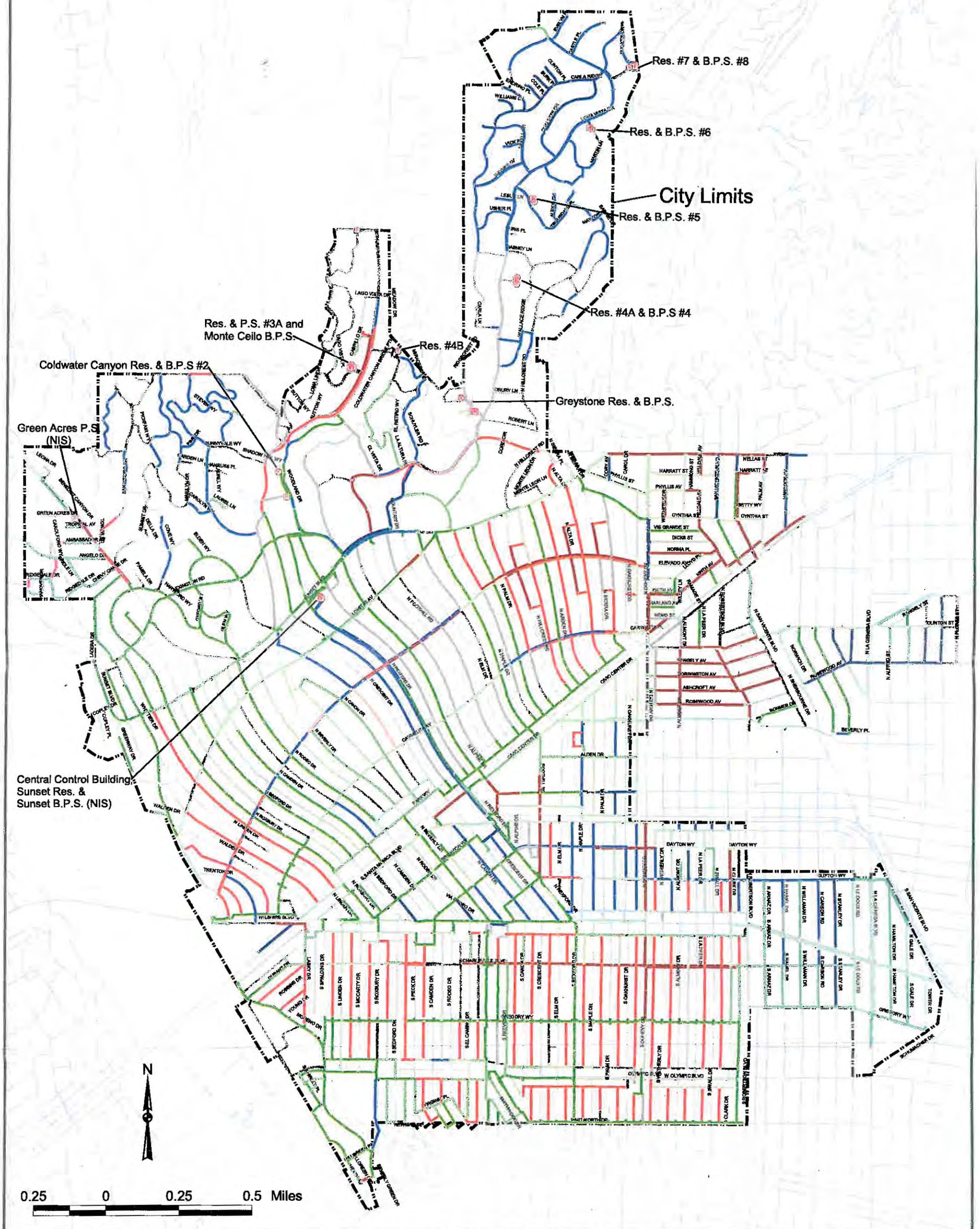
Pipe Material
- Asbestos Cement
- Cast Iron
- Copper
- Ductile Iron
- Steel
- Galvanized
- Unknown

Beverly Hills, California
Water System Master Plan
2002

PIPE MATERIAL

BLACK & VEATCH

FIGURE 6-2



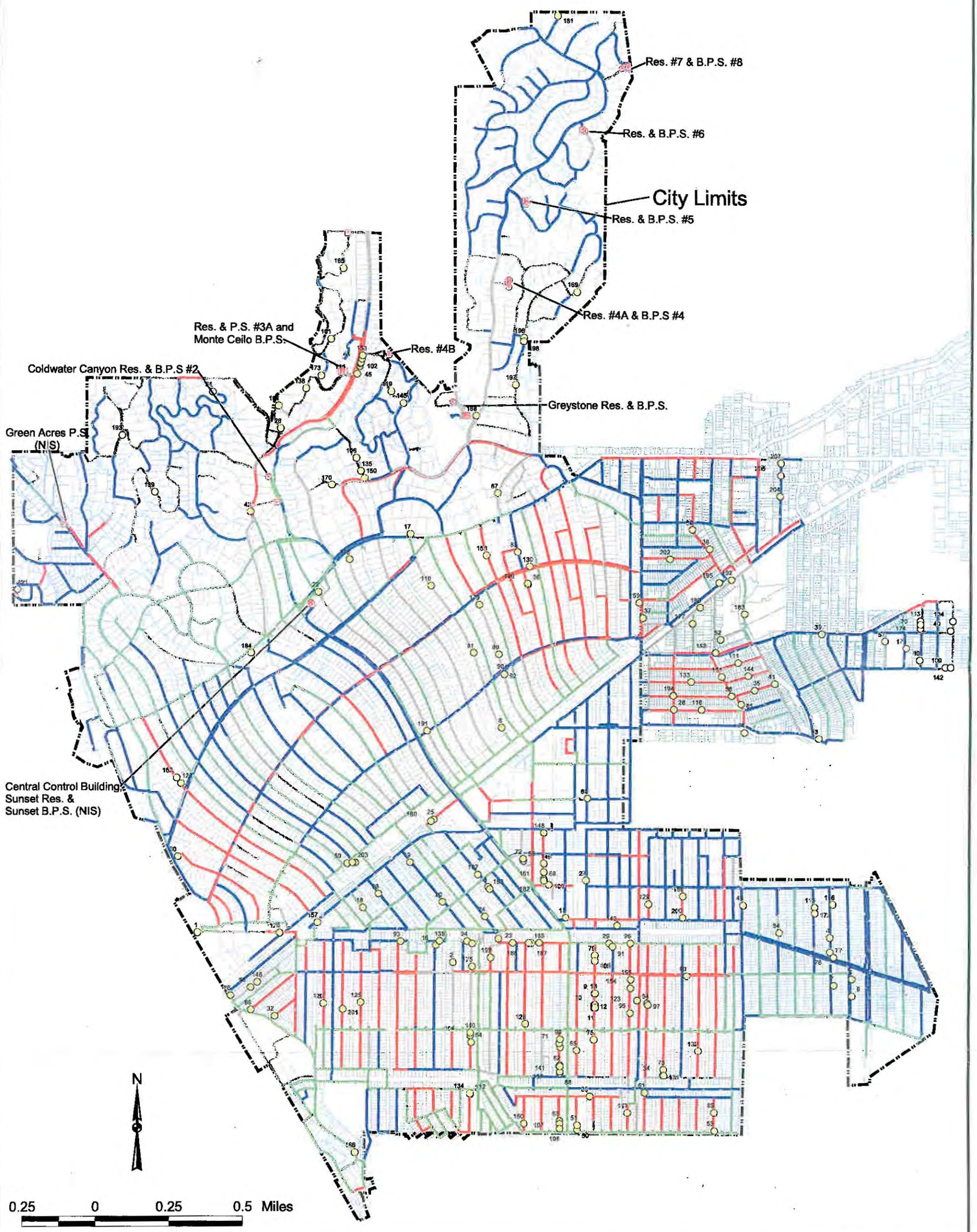
Decade Installed
- 1910
- 1920
- 1930
- 1940
- 1950
- 1960
- 1970
- 1980
- 1990
- Unknown

Beverly Hills, California
Water System Master Plan
2002

PIPE INSTALLATION DECADE

BLACK & VEATCH

FIGURE 6-3



108 Main Break Location and Number

Year Installed

- Unknown
- Before 1950
- 1950 - 1984
- 1985 - 2000

Beverly Hills, California
Water System Master Plan
2002

MAIN BREAKS
1990-2000

BLACK & VEATCH

FIGURE 6-4

6.3 Main Break History Evaluation

6.3.1 Summary

Water main breaks occur in all types of pipes and in every distribution system. A program of main replacement or rehabilitation for problematic mains can minimize the effects of broken mains, including repair costs and unplanned service interruptions. The possibility that main break rates will increase as different groups of pipe approach the end of their service lives, is a concern.

The frequency of main breaks is often directly related to pipe location, age, material, and break history. Break frequency is used to determine which pipes will be included in the replacement program.

6.3.2 Existing Main Break Records Review

The City provided a data file of 207 recorded breaks that occurred from late 1989 to late 2000, for a total period of record of 10.7 years. The parcel record in the GIS that matched each recorded break address was determined, and then the appropriate pipe record in the GIS was determined. The number of breaks successfully matched to pipes in the GIS was 205. Pipe size, material, and age data for the breaks were extracted from the GIS records. Figure 6-4 shows the locations of recorded breaks.

The break history shows an average of 19.3 breaks per year since 1989. This represents a break rate of 0.113 breaks per mile of pipe per year. The City has a low overall rate of main breaks in comparison to the national average value of approximately 0.25 breaks per mile per year.

The historical breaks were associated with 69,392 feet of GIS pipe segments, which is 7.7 percent of the total pipe length. The remaining 92.3 percent of the system did not experience any main breaks. The break rate for the pipes that experienced breaks averaged 1.46 breaks per mile per year. Pipe segments that experienced one break accounted for 117 of the total breaks; the remaining breaks occurred on pipes that experienced from 2 to 8 breaks over the period of record.

To evaluate the main break history and determine whether any classfications of pipe experience higher break rates, the following tables were prepared:

- Table 6-1 shows the history of main breaks by pipe size. The Table indicates that the 6-inch and smaller mains generally experienced somewhat higher break rates than the larger mains.

- Table 6-2 shows the history of breaks by pipe material. The Table indicates that the ductile iron pipes experienced the lowest break rates, which would be expected since these are generally the newer pipes. The highest break rates were associated with pipes that did not have material recorded in the GIS, which are likely to be older pipes. The annual total breaks has decreased over the decade, from an average of 0.167 breaks per mile per year for 1989 through 1994, and 0.066 breaks per mile per year for 1995 and later. This reduction in rate may be partly attributable to pipe replacement projects completed by the City.

- Table 6-3 summarizes the break history by pipe installation dates. As shown, pipes installed during the decades 1920's, 1930's, 1940's, and 1960's experienced the higher break rates, with an average rate of 0.32 breaks per mile per year. Pipes installed in the 1950's, 1970's, 1980's, and 1990's averaged 0.08 breaks per mile per year.

Table 6-1
Main Break History by Pipe Size

Year	Pipe Diameter (inches)									Total System
	2	4	6	8	10	12	14	16	18	
1989				1						1
1990		6	2	10	1	2				21
1991		4	8	6		3				21
1992	1	12	5	5	1	2				26
1993		7	3	3		2			1	16
1994	1	16	11	3	1	2	1			35
1995		9	3	2	2			8		24
1996		4	1	1		1				7
1997		2	3	1	2					8
1998		3	7	6				1		17
1999			1	6		2				9
2000	2	6	4	7		1				20
Grand Total	**4**	**69**	**48**	**51**	**7**	**15**	**1**	**9**	**1**	**205**
Pipe Length	1,384	90,836	151,505	413,541	37,496	127,015	12,013	31,689	3,846	901,746
Break Rate	1.426	0.375	0.156	0.061	0.092	0.058	0.041	0.140	0.128	0.113

Table 6-2
Main Break History by Pipe Material

Year	Pipe Material				
	Cast Iron	Ductile Iron	Steel	Unknown	Grand Total
1989		1			1
1990	14	7			21
1991	12	7	1	1	21
1992	14	3	7	2	26
1993	10	3	3		16
1994	32	1	1	1	35
1995	16		8		24
1996	5	1		1	7
1997	7	1			8
1998	12	2	3		17
1999	7	2			9
2000	13	2	3	2	20
Grand Total	**142**	**30**	**26**	**7**	**205**
Pipe Length	393,804	400,605	76,109	30,238	900,746
Break Rate (Bk/M/Y)	0.178	0.037	0.169	0.115	0.113
Break Rate - 1990 to 1994	0.207	0.055	0.157	0.133	0.133
Break Rate - 1995 to 2000	0.134	0.018	0.162	0.088	0.083

Table 6-3
Main Break History by Decade of Installation

Decade Installed	Grand Total	Pipe Length (ft)	Break Rate (Bk/Mi/Yr)	Break Rate for 1990-1994 (Bk/Mi/Yr)
1920	76	101,990	0.368	0.611
1930	27	55,860	0.239	0.378
1940	2	3,084	0.320	0.685
1950	18	88,858	0.100	0.154
1960	18	25,431	0.349	0.540
1970	19	184,364	0.051	0.092
1980	8	78,466	0.050	0.067
1990	1	166,825	0.003	0.000
Blank	36	197,615	0.090	0.075
Total	**205**	**900,746**	**0.112**	**0.166**

6.4 Economic Analysis

This section develops the criteria for selecting pipelines to include in the recommended rehabilitation/replacement program.

Assumptions used in the economic analysis includes the following:

- Annual system-wide growth in main breaks without replacement = 2.5 %.
- Discount rate = 3.0 %.
- Cost of main breaks per event ranging from $7,565 for a 4-inch pipe, to $10,200 for a 20-inch pipe.
- Pipe replacement costs as provided in Chapter 9.
- Annual excess maintenance costs of mains left in service, including leakage = $2,000 per mile of pipe.

6.4.1 Break Even Analysis

The break-even analysis equation applied herein is from the AWWARF report "Water Main Evaluation for Rehabilitation/Replacement."[1] The break-even analysis compares the present worth of future costs associated with maintaining an existing pipe in service to the cost of replacing or rehabilitating the pipe. The present worth of costs to keep a main in service is the sum of present worth for future main breaks, plus any excess maintenance costs for the existing pipe over a new pipe. After determining the cost to

replace or rehabilitate a main and the present worth of excess maintenance costs and of future main breaks, a break-even break rate is determined to indicate the break rates which, when exceeded, should prompt pipeline replacement or rehabilitation. Break-even occurs when the following equation is true:

$$1 = C / (E + R)$$

where: C = Replacement or rehabilitation cost, per mile of pipe
E = Present worth of excess maintenance costs, per mile of pipe
R = Present worth main break costs, per mile of pipe

The critical break rate that results in break-even is determined by reorganizing the above equation as follows:

$$B' = (C - E)/(U * P2)$$

where: B′ = Break-even break rate
C = Replacement or rehabilitation costs, per mile of pipe
E = Present worth of excess maintenance costs, per mile of pipe
U = Cost of a single main break repair
P2 = Present worth equivalency factor for an exponential growth rate

Pipelines or groups of pipelines that exceed the critical break rate would justify improvements at some time during the analysis period.

The calculated critical break rate ranges from 3.25 to 4.85 breaks per mile per year. Comparison of this break rate with the rates shown in Tables 6-1, 6-2, and 6-3 shows that none of the categories of pipe considered experienced break rates greater than the critical rate. This analysis indicates that a system-wide program to replace or rehabilitate any of these classifications is not merited. All categories of pipe are indicated by the break-even analysis to be not cost effective to correct at this time.

[1] "Water Main Evaluation for Rehabilitation/Replacement," by D. Kelly O'Day, et. al., prepared for the American Water Works Research Foundation and the United States Environmental Protection Agency, p. 88-92, 1995.

6.4.2 Optimum Year to Replace Analysis

The economically optimum future year to schedule a specific pipe's rehabilitation or replacement can be determined based on the following equation[2]:

$$T = (1/b) * \ln[(rC_r) / (JC_b + D)]$$

where: T = Optimal year to replace (number of years from current year)

b = Rate of increase in breaks per year

r = interest rate

C_r = Cost of new or rehabilitated pipe, $/mile (Table 6-5)

J = Current pipe break rate, breaks/mile/year

C_b = Cost of break, $

D = Existing pipe maintenance & water leakage costs, less new pipe maintenance & water leakage costs

The economic equation is applied for both the complete replacement options and for rehabilitation options, since the two equations result in different break-even points.

The equation defines the optimal year (T) as the year when the cost to replace or rehabilitate a specific pipe or group of pipes is equaled by the costs of ongoing break repairs plus other continuing costs. Costs are compared on a present worth basis. The equation does not directly include a value of length, since the rates used are costs/event and events/mile of pipe/year. The cost of break repairs in a given year equals the cost of a break times the break rate per mile. For future years, the cost per break increases at the interest rate and the frequency of breaks increases at the indicated rate.

An optimum year to replace analysis was conducted for the pipe classes presented in Tables 6-1, 6-2, and 6-3. The optimum year to replace was beyond the 20 year planning period for all of the pipe classes. Therefore, for Beverly Hills, a program to replace all of any pipe class is not warranted. Rather, individual pipes would be cost-effective to replace depending on their specific break rates.

An optimum year to replace analysis was also conducted for each pipe segment that recorded one or more breaks over the 10.7-year record. When focused on specific pipes, a history of two or more breaks results in break rates that make the pipe cost effective to replace.

[2] Thomas Walski, et.al., "Economic Analysis of Water Main Breaks," Journal American Water Works Association, March 1987.

6.5 Selection of Pipe Replacement / Rehabilitation Projects

A similar process can be used to update the projects list as additional main break information is collected. The economic analysis indicated that the criteria for including pipelines in a replacement program should be each pipe's specific main break history. No categories of the pipes by diameter, material, or age merited a system-wide replacement program. The break-even analyses indicated critical break rates, above which replacement is economically justified, between 3.25 and 4.85 breaks/mile/year depending on pipe material and diameter.

Proposed pipe replacement or rehabilitation projects were selected to include all multiple break pipes plus adjacent pipes to make up logical replacement projects. An ArcVIEW GIS view as shown in Figure 6-4 was used to review the historical main break data and location, along with the existing pipe data. The view was used to select contiguous sections of pipe that could merit replacement as specific projects. This selection considered the break rates of individual segments and the presence of multiple breaks. Then, an on-screen review of the break and pipe information in the GIS was performed to confirm and adjust the project definitions. The proposed replacement projects are presented in Chapter 9.

The replacement projects list should be updated periodically, preferably annually, to include future break records, cost information and experience with pipeline conditions in the City's distribution system.

Unlined cast iron pipes that do not have a break history could be considered for a lining program, instead of replacement, in order to prolong their useful life. Cleaning and cement mortar lining any structurally sound pipes that have become tuburculated can improve flow capacities and minimize future corrosion. A program of flow testing and pipe wall testing would be required to locate tuberculated mains and determine their structural conditions.

7.0 Existing Water System Operations

7.1 General

The purpose of this chapter is to summarize the existing water distribution system operations.

7.2 Background

The current water system consists of two service connections to the MWD, two emergency connections to LADWP, nine reservoirs, ten pump stations, nine pressure reducing stations, and a network of transmission and distribution mains. Table 7-1 lists the nine reservoirs currently in service and their respective capacities.

Table 7-1
Reservoir Capacities

Reservoir	Depth ft	Actual Volume MG	Nominal Volume MG
7	31.0	1.217	1.2
6	31.0	1.019	1.0
5	31.0	1.019	1.0
4A	22.0	2.202	2.2
4B	31.0	1.019	1.0
3A	28.5	1.062	1.1
Coldwater	14.0	7.264	7.3
Sunset	21.1	5.984	6.0
Greystone (West Side)	43.1	10.204	10.2
Greystone (East Side)	43.1	9.198	9.2

The Study Area is divided into 13 pressure zones with limits as shown on Figure 3-2. Eleven of the pressure zones are located within the City, and the remaining two pressure zones serve West Hollywood. Table 7-2 lists each pressure zone and the associated reservoir serving the zone. Table 7-2 also shows the range of static pressure for each zone, based on the ground elevation in Table 3-1 and the maximum hydraulic gradient elevation (HGE).

Table 7-2
Pressure Zones

Pressure Zone	Reservoir Serving Zone	Maximum HGE[1] Elevation ft	Static Pressure Range Maximum psi	Static Pressure Range Minimum psi
16	Pump Station 8 via 7	1610	108	61
15	7	1502	183	66
13	6	1293	192	75
11	5	1052	178	57
9	Monte Ceilo PS via 3A	1050	160	48
8	4A, 4B	800	156	35
7	Green Acres PS via Greystone	711	115	70
6	3A/Greystone	628	159	64
5	PRV via Greystone	499	112	34
4	Coldwater	454	108	54
3	Sunset	384	112	65
WH3	PRV via Coldwater	364	86	54
WH5	PRV via Greystone	487	104	35

[1] Hydraulic Gradient Elevation

7.3 Greystone Reservoir and Hillside Reservoir Operation

Maintaining optimum water quality is the basic philosophy that governs the operations for the Beverly Hills water distribution system. Greystone Reservoir with a capacity of 19.4 MG is the largest storage facility in the distribution system. Therefore, the operational procedures necessary to maintain acceptable water levels and water quality are of critical importance. Greystone Reservoir is monitored closely for signs of nitrification and the conversion of ammonia to nitrite. This chemical process may occur in chloraminated water supplies if the water resides in a reservoir for extended periods. The Greystone and Hillside reservoirs are operated on a multiple-day cycle to ensure continuous turnover of the storage volume. There are two different cycle operations, designated as a single cycle and a double cycle. The winter operation uses the single cycle, which drains and refills the reservoirs over a 7-day, Sunday to Sunday cycle. The summer operation uses the double cycle, which drains and refills the reservoirs over a two-to-three-day period. The critical days for operator actions are usually Monday, Wednesday, and Friday. However, when a holiday falls on Monday, then Tuesday, Wednesday, and Friday are the critical operating days.

The methodology currently used to cycle the reservoir water levels requires the operation of a 20-inch valve (located in the Zone 6 main at the MWD control station), water deliveries, transfers, and selective operation of the hillside booster pumping stations. The operating water level range for Greystone reservoir is between 10 and 38

feet of depth. Typically, the cycle is to begin draining the reservoirs when Greystone Reservoir level reaches 38 feet and to fill the reservoirs when the Greystone level drops to 10 feet. Figure 3-3 is a schematic diagram of these water system facilities.

Additional operator actions that accelerate the demand on Greystone Reservoir include the following:

- The PRV between Zone 6 and Zone 4, located at Sunset Boulevard and Maple Drive, is opened to increase the water demand supplied through Zone 6. This PRV may pass flows at a rate of up to 3,500 gpm.
- When the hillside reservoirs are full (Reservoirs 4B, 5, 6, and 7), all hill pumping stations, except for Booster Station 8, are turned off. With the pumps off, demands in Pressure Zones 8, 11, 13, 15, and 16 are met from reservoir storage, allowing all hillside reservoirs to drain.

The 20-inch valve is open until Greystone Reservoir drains to a level of 20 feet. When the 20-inch valve is closed, Zone 6 is essentially divided into Zone 6 east (Greystone) and Zone 6 west (Reservoir 3A). Water flows from the MWD BH-1 Zone 6 connection to raise or lower the water level in Reservoir 3A. Greystone Reservoir level can then be lowered without completely emptying Reservoir 3A.

The 20-inch valve remains closed while Greystone Reservoir drains to 10 feet. The flow at BH-2 Zone 6 is increased to start the fill cycle of Greystone Reservoir. When Greystone has filled to 20 feet, the 20-inch valve is opened. Greystone and 3A continue to fill to the desired levels. The Sunset and Maple PRV is then closed to eliminate the demand it places on Pressure Zone 6. Also, the hillside booster pumping stations are restarted once Reservoir 7 water level approaches 10 feet.

By closing the 20-inch valve, Reservoir 3A is maintained at an adequate level. Reservoir 3A has a float-controlled butterfly valve (acting as an altitude valve) that closes when the reservoir becomes full. If this butterfly valve is closed at the same time as the 20-inch valve, western Pressure Zone 6 could become overpressurized.

7.4 MWD

The MWD facility is located in the alley east of Rexford Drive at Sunset Boulevard. The two MWD connections, BH-1 and BH-2, have a capacity of 40 cfs (25.9 mgd) each. MWD connections are the primary source of water supply to the City and its major reservoirs, including Sunset, Coldwater, and Greystone. The City is required to take a minimum combined daily flow of 8 cfs from the BH-1 and BH-2, MWD service connections.

The MWD facility receives water primarily from MWD's Santa Monica Feeder, which operates at a normal pressure of 154 psi. This pressure is sufficient to supply Pressure Zone 6 and lower zones by gravity flow. A secondary source of water supply is MWD's Sepulveda Feeder. Typically, MWD activates this source of water supply to perform maintenance-related work or emergency repairs to the Santa Monica Feeder. However, this feeder has a lower operating pressure (85 psi), sufficient to supply only Pressure Zones 3 and 4. When the Sepulveda Feeder must be used, limited supply to Pressure Zone 6 may be transferred from Pressure Zone 4 (Coldwater Canyon Reservoir) using Booster Pumping Station 2.

7.5 Reservoir 3A and Pump Station (Pressure Zones 6 and 9)

Water is supplied to Reservoir 3A in various ways; however, the primary supply is received from the MWD Control Station and by gravity through Greystone Reservoir (Zone 6). A secondary supply is received through Booster Pump Station 2 from Coldwater Reservoir (Zone 4). Reservoir 3A has a float-controlled butterfly valve that operates as an altitude valve, thereby preventing overflow. Reservoir 3A supplies water by gravity to Pressure Zone 6.

7.6 Sunset Reservoir and Pump Station (Pressure Zone 3)

Water supply to Sunset Reservoir is supplied through the BH-1 and BH-2, Zone 3, MWD connections. A secondary supply of water for this reservoir can be received through PRVstations that connect Pressure Zones 4 and 3. Sunset Reservoir has a dedicated fill pipeline from the MWD facility. Water is sent directly to the reservoir before serving customers through the dedicated pipeline. Under certain operating conditions, Sunset Pump Station pumps water from Sunset Reservoir to Coldwater Canyon Reservoir and Pressure Zone 4; however, the pump station is currently out—of-service.

7.7 Greystone Reservoir and Pump Station (Pressure Zone 6)

Greystone Reservoir receives water from MWD connections BH-1 and BH-2 through rate-of-flow valves. These valves supply water directly into Zone 6, thereby conveying water to Reservoir 3A and Greystone Reservoir. A 24-inch valve, located between Greystone Reservoir inlet and Greystone Pump Station, is used to direct the MWD supplies to either Reservoir 3A or Greystone Reservoir. When this valve is

completely open, flow is conveyed to Greystone; when the valve is closed, water is conveyed to Reservoir 3A.

7.8 Reservoir 4A (Pressure Zone 8)

Reservoir 4A receives water primarily through the Pressure Zone 8 distribution mains that connect it to Reservoir 4B. A secondary source of water can be pumped from Reservoir 3A by Pump Station 3A.

7.9 Reservoir 4B and Pump Station (Pressure Zone 8)

Reservoir 4B receives water from Greystone Reservoir (Zone 6) through Greystone Pump Station. The pump station control is dependent on the water level in Reservoir 4B. This reservoir supplies water to Zone 8 by gravity and by pumping to Zones 11 through 16 through Pump Stations 4, 5, 6, and 8.

7.10 Reservoir 5 and Pump Station (Pressure Zone 11)

Reservoir 5 obtains water from Reservoir 4B through Pump Station 4B. This reservoir supplies water to Zone 11 by gravity and to Reservoir 6 and Zone 13 through Pump Station 5.

7.11 Reservoir 6 and Pump Station (Pressure Zone 13)

Reservoir 6 receives water from Reservoir 5 through Pump Station 5. This reservoir supplies water to Zone 13 by gravity and to Reservoir 7 (Zone 15) through Pump Station 6.

7.12 Reservoir 7 and Pump Station 8 (Pressure Zones 15 and 16)

Reservoir 7 is supplied water from Reservoir 6 through Pump Station 6. This reservoir supplies water to Zone 15 by gravity and to the closed pressure Zone 16 via Pump Station 8. Reservoir 7 has an emergency supply of water from LAWPD stored in a small reservoir located above this facility.

7.13 Booster Station 2

Booster Station 2 is a pump station consisting of two pumps. The water from this pump station is supplied to Zone 6 through Zone 4. There are also a series of three pressure reducing valves (a 6 inch, an 8 inch, and a 12 inch Cla-Val) located on the discharge header. These valves can be utilized in emergency situations to ensure that water can be supplied to Zone 4 from Zone 6.

7.14 Coldwater Canyon Reservoir (Pressure Zone 4)

Coldwater Canyon Reservoir receives water from MWD's BH-1 and BH-2 supply connections through flow control valves. These valves supply water directly into Zone 4, which conveys water to Coldwater Canyon Reservoir. The reservoir sustained damage in the 1994 Northridge Earthquake and has been temporarily rehabilitated and operates with reduced volume.

7.15 Green Acres Pump Station (Pressure Zone 7)

This pump station which serves Zone 7 is currently out-of-service due to problems with overheating and with the emergency standby diesel engine controller. Until the Green Acres Pump Station is returned to service, Zone 7 is being served by Zone 6.

8.0 Water Department Communications

8.1 General

This section identifies the Water Department's communication requirements, describes some technology alternatives that may be implemented, and recommends an alternative that will meet the Water Department's requirements.

8.2 Summary

The City's of Beverly Hills Water Department currently uses leased services from Pacific Bell (PAC Bell) to provide control and surveillance for 19 sites. Six additional sites will be brought into the network. In addition, the City's primary goal is to upgrade its network to include full redundancy, emergency backup power, and Local Area Network (LAN) connectivity to all the existing and new sites. As part of the upgrade process, the Water Department will be upgrading the remainder of its existing monitoring equipment to modern programmable logic controllers (Modicon PLCs).

8.3 Existing Water Department SCADA Communications

The SCADA system consists of a computer located in the Department's trailer facilities. The computer communicates via a single communications port to the water facilities. These data are carried as Bell 202T modem tones to the existing sites via a multi-drop arrangement; that is, all of the data circuits leased from Pacific Bell are effectively in parallel on one "data channel" and are physically implemented as multiple leased lines that are joined within Pacific Bell facilities. These are 4-wire circuits: one pair is used to transmit from the SCADA computer, and the other pair is used for transmitting (sequentially or as directed by the SCADA host computer) from the PLCs at the various sites. Since the host computer controls which remote site transmits, data collisions are avoided. The data rate is 1200 bps.

The host computer is connected to the City's ethernet. This ethernet connection is implemented via multi-mode fiber optic links. This connection provides access to data within the host computer for other City uses. Additionally, the host computer is capable of being remotely programmed via this ethernet interface. The host computer is equipped with a dial-up port that also can be used for these purposes.

8.4 Requirements Identification

The following paragraphs identify the requirements of the Water Department in terms of general technology characteristics and specific circuit requirements. The general technology characteristics include increased use of state of the art products, redundancy, ethernet networking capability, and high system availability.

8.4.1 State of the Art Technology

New sites will be added to the Water Department communications requirements. Additionally, an upgrade will be made to several of the existing sites to add new PLCs for site monitoring. Newer technology could provide higher bandwidth, which is required to enable high-speed LAN connectivity and video surveillance as required. Newer technology could permit redundancy in the communication links, primarily through the implementation of self-healing ring architectures.

8.4.2 Redundancy For All Sites Monitored

Redundancy in the communications links to all major sites will prevent down time associated with cable and with some communication equipment failures. The overall quality of service would be improved.

8.4.3 Ethernet LAN Connections

This provision will provide high-speed network connectivity from all major sites to the host computer. It will allow changes to the water management system files to be made from any of the remote locations and would offer increased flexibility in managing and operating the SCADA system. The current LAN operates at 10 Mbps. The ethernet protocol can be carried at slower speeds, such as at T-1 data rates (1.5 Mbps); however, if the bandwidth could be made available, 10 Mbps is desired.

8.4.4 Availability

All circuits used for monitoring of the water system must be continuously available with no interruptions. This availability of service requires a redundant network which reaches to all sites and, to protect against widespread power loss, battery backup for the electronics at each site. The desired availability for each host computer to remote PLC has not been stated by the City. High availability is needed because down time due to restoration priority (by outside service providers) may be unacceptably too high (typically measured in hours). Most outside maintenance or service providers under

contract will guarantee response to any alarm or outage within one to two hours, with restore time of four hours. This is typically part of a standard contract with any customer.

8.4.5 Circuit Requirements

From the host computer, the following existing circuits (served by Pacific Bell (Pac Bell) using 2.4 KB FDDA, 4- wire circuits), or their equivalent, must be maintained:

Service Drop	Pacific Bell No.
PRV station Rexford Dr and Lomitas Ave	34FDDA510774
Sunset reservoir and pump station	34FDDA803405
MWD turnout Rexford and Sunset	34FDDA809989
Green Acres Pump station on Benidict Cyn and Green Acres Dr	34FDDA803404
PRV station on Sunset at alley between Elm and Maple	34FDDA809989
PRV station on Lomitas at alley between Elm and Maple	34FDDA809989
Pump station 2 at 1025 Woodland Dr.	34FDDA803402
Coldwater reservoir Woodland and Beverly Dr.	34FDDA803402
Reservoir 3A Loma Linda and Coldwater Cyn.	34FDDA803402
Greystone Reservoir 905 Loma Vista Dr.	34FDDA803628
Reservoir 4b 1180 Loma Vista	34FDDA803628
Reservoir 5 495 Trousdale Pl.	34FDDA803629
Reservoir 6 1820 Loma Vista Dr.	34FDDA803629
Reservoir 7 405 Walker Dr.	34FDDA803629
Reservoir 4a Top of Miradero Dr.	34FDDA803628
PRV station at Melrose Blvd and Doheny Dr.	34FDDA803403
PRV station at Carmalita and Doheny Dr	34FDDA803403
PRV station at Cynthia and Doheny Dr.	34FDDA803403
PRV station at Phyllis and Doheny Dr.	34FDDA803403

Six additional circuits from the host computer to the following sites are needed:

Water well in median on Burton Way.
Water Treatment Plant at 331 N. Foothill Rd.
Water well on Santa Monica Blvd at Palm Dr.
Water well on Oakhurst at Doheny Dr.
PRV station on Lexington at Alpine.
Water well on Santa Monica Blvd. at Canon

8.5 Alternatives

Three alternatives were developed:

- Alternative A. Add New Circuits to Existing Monitoring System
- Alternative B. Expand Provider System(s) Via Fiber
- Alternative C. Build City System

These alternatives, their primary advantages and disadvantages, and preliminary costs are described below.

Alternative A: This alternative is an expansion of PAC Bell non-redundant FDDA circuits operating at 1200 bps. This alternative is an extension of the status quo and provides for one of the requirements, added circuits. Six additional sites will be added to the existing Water Department SCADA network using additional FDDA circuits leased from P Bell. The new circuits will terminate through modems at each PLC, like the existing circuits, and would connect to the circuit which serves the host computer located at the Water Department.

These circuits are not redundant.

The expected cost for this alternative is an additional $895.00 per month, based upon each additional circuit costing an average of $179.00 per month from PAC Bell. All costs in this chapter are year 2000 costs and could increase due to inflation. No additional capital costs are expected for this alternative.

Two options to this alternative should be considered. One option (Option 1) is to provide dial-up modems that would automatically dial out and report alarms in the event the PAC Bell FDDA circuits were lost. Option 1 addresses the redundancy issue for loss of specific FDDA circuits. It does not address redundancy for possible damage to PAC Bell's switching facilities or copper cable that may be in common to both circuits. The SCADA host computer will need to be capable of accepting data from a given PLC via the dial-up port. The expected cost for this option is an additional $780.00 per month, based upon 30 additional dialup circuits at $26.00 per circuit per month. No additional capital costs are expected for Option 1.

Option 2 is to obtain additional FDDA circuits that are physically separate from the existing PAC Bell circuits to each facility. This would require PAC Bell to install additional copper cable using an alternate route into the major sites as requested by the Water Department. The Water Department would have to grant PAC Bell additional site access to accommodate the new cables. The new cables may or may not originate in

different switching facilities, but would, at a minimum, protect from a single cable cut that would put the network in jeopardy.

In discussions with PAC Bell, some of the alternate copper cable routes would come from outside the Beverly Hills serving area and be linked back to the Water Department host computer via inter-switch trunks through the PAC Bell network.

Option 2 does not address redundancy for possible damage to PAC Bell's switching facilities that may be common to both circuits which are otherwise physically separated. This option provides greater protection against cable damage than Option 1.

The expected cost for Option 2 is an additional $5,370.00 per month, based upon 30 additional FDDA circuits at an average cost of $179.00 per circuit per month. The Water Department could elect to implement this option on a selected subset of sites to reduce the cost. No additional capital costs are expected for this option.

Alternative B: Under this alternative, the City would negotiate with PAC Bell or another provider (such as RCN) for a fiber network that would provide services to the Water Department, as well as any or all City-related telecommunication services. In providing these services, utilization of trenches or conduits provided by the street light program upgrade would be the first choice for the city as well as the fiber provider. Water Department facilities may be on the desired fiber route. In these cases, equipment can and should be placed in the facilities to avoid underground installation of electronics.

Based on this proposal, the fiber provider would install the fiber using its conduit or conduit placed under the street light program. The services required by the Water Department could be managed by the fiber provider, which also supplies ongoing maintenance of all facilities. The cost of these services is negotiable based on how much conduit the provider places, or how much of the conduit is leased from the street light plan.

If the provider leases conduit from the City under the street light plan, some of the services provided can be subtracted from the lease cost of the conduit.

The provider will want access to its fiber at multiple locations that involve other customers, but it will always guarantee the proper services to the Water Department and any possible City services. The street light program will pass all the city facilities, communications for other City services could be added to the network being requested by the Water Department. This would not only save money over leased services today, but would allow for redundancy of all networks, which means less down time or missed calls.

This option also fulfills the requirements given to Black & Veatch by the Water Department, to provide a LAN based connection at every site that communicates to the

host computer. This would allow all the Water Department maintenance staff to log into the host computer from any site in the network and make changes to any other site.

This would save drive time as well as possible major outages based on the ability to make changes to the network immediately from any site.

Looped communications could provide automatic re-routing of communications. This capability also means individual fiber transceivers may be taken out of service for replacement or repair without adversely affecting the message traffic, so maintenance activity of this sort does not affect service availability.

The expected cost to construct the entire fiber network for this alternative should be higher than the other alternatives since a City-wide system would be built. The actual cost to the City and to the Water Department for the required services will depend on negotiations with the selected provider, but should be higher than Alternative A due to the higher level of service. Variations are possible regarding ownership or leasing of the fiber and lighted bandwidth. The City's water and IT Departments stated a preference that the provider of these new services would manage and perform all required maintenance for a set monthly price.

The management and maintenance of the above mentioned alternative would be a customized contract between the customer and the provider. Maintaining a very high level of service is a requirement for a public water utility such as Beverly Hills. In developing the service agreement, the City and its counsel should consider special clauses to address:

- Provider's continuous monitoring and alarms for system faults.
- Prioritization of service responses to meet the City and Water Department's critical needs.
- Emergency response times.
- Reliability and availability criteria.

These typical service contracts are negotiable with service providers like PAC Bell or other fiber providers like RCN. These standard contracts have negotiable items that may not be offered if the customer does not ask for them.

Alternative C: The City could build its own network. This alternative was described in detail in the Telecommunications Master Plan prepared by Media Connections Group (pages 28 through 36) and thus won't be repeated here. The estimate provided in the plan is $4,308,144 and is the total cost for two-fiber optic rings totaling 27.2 miles. This alternative would meet the City's requirements. A significant point made in the Master Plan is that the savings from moving existing leased circuits to a City-

owned network will not adequately justify the costs; the network is an investment for the future.

The management and maintenance of a City owned fiber network would be through a customized contract between the City and a service provider. Typically, for management of the system, the City would have a terminal in its office that allows making all system changes and updates and monitoring the system for alarms. The service provider would have a duplicate system in its control center for monitoring the alarms, however the provider would not have the ability to make system changes to the overall Water Departments circuits. The provider would monitor the alarms at all times, and dispatch maintenance personnel as required. In the maintenance contract, the City should stipulate specific clauses such as:

- A local maintenance office should be located no more than one hour's drive from Beverly Hills.
- The service office should fully stock at all times every device, module, card, cable, or component that is a replaceable device.
- A direct swap and repair approach should be provided.
- The maintenance and service staff should be available at all times for emergency telephone calls, and typical response times should be a maximum of two hours.
- Non-urgent maintenance should be completed the same day the service call comes in. Periodic maintenance should be part of the negotiated contract and cover testing and replacing any.

These typical service contract items are negotiable and can be provided through many outside service vendors. These are basically customized contracts for service and maintenance, and the pricing is dependent on service requested by the customer.

8.5.1 Alternatives and Requirements

Table 8-1 shows how each alternative meets the stated requirements. Also shown is the relative cost.

Table 8-1
Comparison of Alternatives

Requirement	A	B	C
Technology	No	Yes	Yes
Redundancy	Partial	High	High
Ethernet	No	Yes	Yes
Availability	Low	High	High
Added circuits	Yes	Yes	Yes
Cost	Low	High	Highest

8.6 Vulnerabilities

Some realistic scenarios could significantly affect the Water Department's communications including facilities, power supply, and system survivability. These possible situations are described below and the impact to each alternative is discussed.

8.6.1 Earthquake

The region is subject to earthquakes of various magnitudes. With these quakes comes the possibility of soil liquefaction and significant wave motion through the soil. Buried facilities are generally quite vulnerable to damage in multiple locations and to various degrees. Some instances of severe breakage of conduit should be expected with corresponding fiber cable breakage. Other instances may show crushing or deformation of the conduit, with or without fiber and conductor damage.

8.6.2 Large Fires

Large fires also pose a serious threat, particularly given the potential for extremely dry conditions that often occur. In this situation, underground facilities are better able to survive. Supporting electronics, located in buildings which are subject to being burned may be at risk. In fighting fires, distribution power circuits are subject to being de-energized; hence, battery power is important. Overhead distribution through wooded areas would be severely damaged, particularly if wood pole construction is used. Metal pole structures, such as light poles, may suffer heat damage to the point of collapsing (depending on loads), but these may or may not be placed in areas subject to such fires and in close proximity to wooded areas. Radio-based units that use these structures may survive a large fire.

8.6.3 Aircraft Crash

Aircraft crashes are possible. Though wreckage is normally somewhat confined, the local area may suffer damage ranging from moderate to severe, as if a large explosion had occurred. In this scenario, the City could expect to lose structures and possibly some shallow-buried facilities. If communication devices and circuits were involved, they would likely be destroyed. Power may be interrupted due to the crash or fire and rescue efforts.

8.6.4 Terrorist Acts

Terrorist activities are a possibility. If the communications facilities are hidden or are not very obvious, the facilities themselves are less of a target. More probable is the scenario whereby City facilities are attacked with the subsequent loss of some of the supporting communications equipment or lines. Redundancy in the links will lessen the impact of this situation.

8.6.5 Vulnerability Summary

Table 8-2 shows, for each alternative, the relative ranking of the ability to withstand the listed vulnerability scenarios.

Table 8-2
Survivability Capability of Alternatives

Vulnerability	A	B	C
Earthquake	Low	Moderate	Moderate
Large Fire	Low	Moderate	Moderate
Aircraft Crash	Low	High	High
Terrorist Acts	Low	High	High

As can be seen in the table above, Alternative A, the telephone-based alternative, even with various options, is relatively low in survivability when compared to the fiber-based alternatives. This is due primarily to the ring-configurations that would be implemented with fiber optic networks. The rating of "moderate" was given to the fiber alternatives (B and C) for earthquakes because the cable plant would be buried. Movements in the soil could cause cable and conduit to break. Similarly, large fires may consume network node facilities which could result in breakup of the rings.

8.6.6 Advantages and Disadvantages - Summary

Table 8-3 presents a summary of the advantages and disadvantages for each alternative.

Table 8-3
Advantages and Disadvantages

	Alternative 1	Alternative 2	Alternative 3
Advantages	• Inexpensive. • Quick to implement.	• Cost for conduit may be incremental to existing project. • Less disruption to streets than Alt. 3. • Maintenance may be negotiated as partially provided by network provider. • Ring technology provides greater redundancy and reliability.	• Offers most control of network and project to the City. • Presents possibility of additional community services. • Ring technology provides greater redundancy and reliability.
Disadvantages	• Does poorly in meeting requirements. • Low reliability.	• Requires close coordination with potentially numerous providers. • Requires ongoing contract administration.	• Very expensive. • Would require City to provide maintenance or contract maintenance with an outside service provider

8.7 Recommendation

Black & Veatch recommends that the Water Department work with the City to implement the fiber-based alternative and to take advantage of the conduit installation concurrent with the street lighting program (Alternative B). Alternative B meets all the Water Department requirements and has a relatively high resistance (or low vulnerability) to emergency scenarios. The Water Department's costs would be only incremental to the overall City costs for a fiber-based network. Alternative C, similar to Alternative B in terms of media, is at a cost disadvantage when compared to Alternative B and should only be pursued if Alternative B would become impossible to implement.

8.8 Other Issues

8.8.1 Underground Facilities

The City has raised questions concerning whether facilities for implementing the fiber based network alternative can be placed underground.

For aesthetic reasons, the City does not desire additional above ground equipment cabinets if it is possible to avoid them. Black & Veatch investigated sources of pre-fabricated underground vaults. Our findings indicate that such vaults are available. The typical small size of such a vault is 8 x 6 x 10 feet (hwd) and can be made watertight. There may be difficulties in placing such a vault in City right of way, given the presence of other utility pipes and cables.

It would also be possible to construct customized vaults for specific locations. While this approach is relatively more expensive, it may permit installation underground that may otherwise not be possible.

For a fiber-based system, equipment can be placed in customer premises, and the splicing containers may consist of small underground hand pits. The number and location of larger equipment that may require either above ground or below ground vaults, such as interconnection facilities to the service providers, will depend on the final design of the system.

8.8.2 Analog and Digital Video

The City has video cameras in various facilities and garages. These cameras are connected via links comprising amplifiers and leased twisted pair circuits, which carry the video signals to their monitoring locations. This is an analog transmission technology. As such, it is subject to noise and mis-adjustment or drift of the amplifiers. For the relatively short distances within the city limits, this technology provides acceptable results.

Digital technology, that is, the digitization of the picture, compression via standard compression algorithms, and transmission via digital media (microwave, fiber optics, leased T1 copper circuits), is better suited for very high quality systems that could be transmitted long distances or to multiple locations via digital switching. This switching could occur in a digital video switch or via the transmission facilities themselves, such as in ATM systems. Digitized video transmission capability offers opportunities for the City to implement cameras in an Intelligent Traffic System (ITS), if the City should decide to participate in regional ITS networks. Selected digital camera views could also be made available to the citizens of Beverly Hills. For example, streaming video of town meetings or selected court hearings may be linked to the internet or a local cable channel, thus creating a flexible avenue for citizen awareness of local issues. Surveillance of public properties, correctional institution facilities, and important water/wastewater facilities are examples of video applications, which are internal to City operations. Other applications may come forth once the transmission bandwidth is made available.

The City should consider digital video, for Water Department and other City uses, if a fiber-based alternative is implemented, to take advantage of the newer technology.

9.0 Capital Improvement Program

9.1 General

The recommended improvements to the water distribution system are shown on Figure 9-1. These improvements will provide the required capacity and reliability to meet projected water demands through the year 2025. The location and scheduling of the distribution system improvements are presented on a master plan basis that incorporates system needs and periodic City staff review. Current development patterns and growth expectations were reviewed and considered in developing these recommendations. In addition, a large proportion of the recommended projects is tied to maintaining and improving the City's current distribution system, regardless of growth.

The City is currently nearly at build-out condition, therefore most of the growth during the planning period is projected to occur before year 2010. The phasing assigned to specific recommended improvements is based on the City's current capital improvement program, the hydraulic analyses, and available information concerning probable development. The recommended improvements on Figure 9-1 have been phased into the following construction periods, for Fiscal Years ending June 30.

- Phase 1 – 2003 to 2007
- Phase 2 – 2008 to 2012

The locations shown for new mains and other recommended improvements were generalized for hydraulic analyses. Specific locations and alignments will have to be determined as part of the detailed design. Recommended improvements are subject to realignment and adjustment to conform to actual development. The construction timetable for recommended improvements will depend on local considerations such as street paving and repair schedules, availability of rights-of-way, construction of other utilities, City staff commitments, and development schedules.

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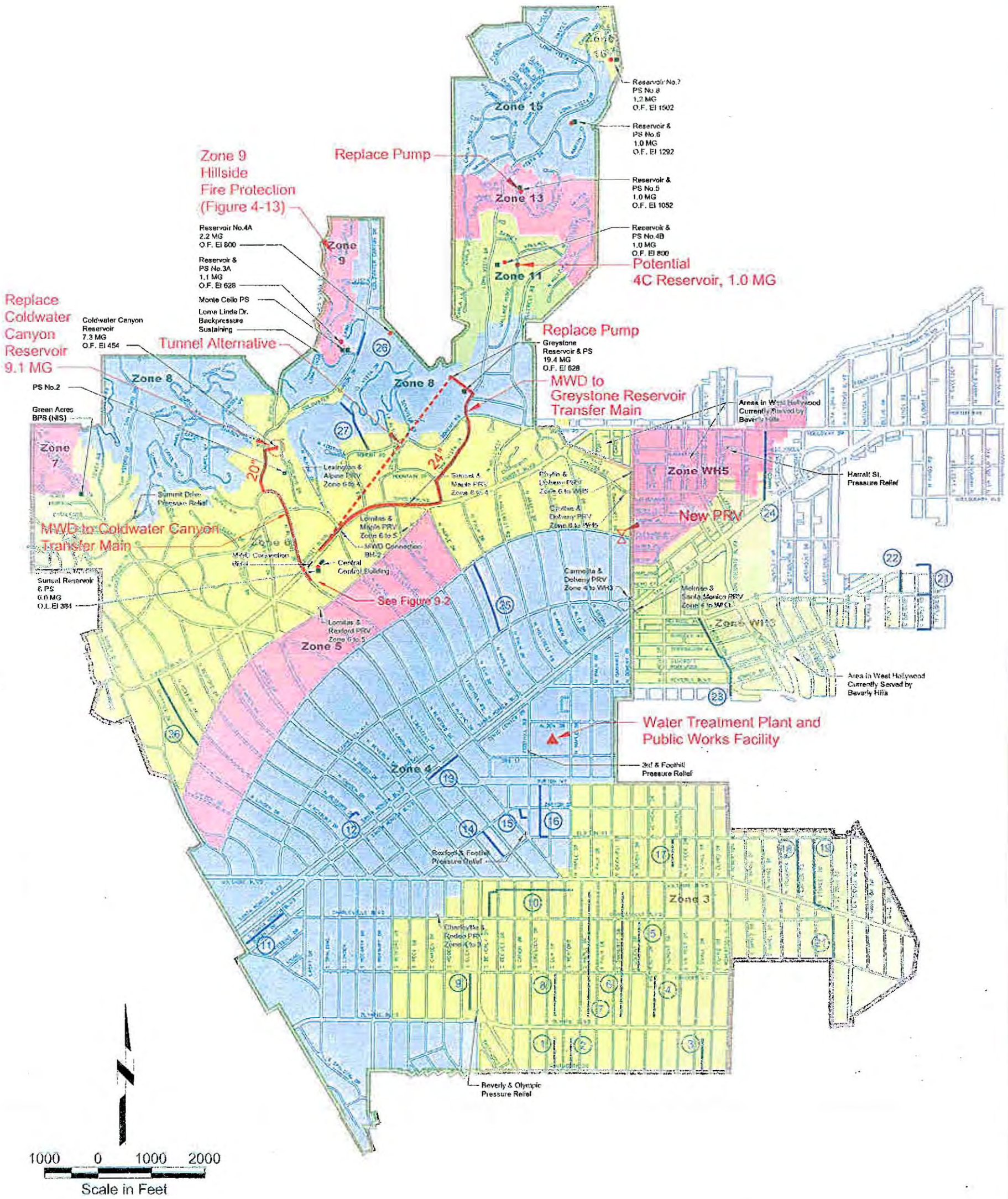

Legend

- Pressure Zone
- Beverly Hills City Limits
- 24" Proposed Pipes and Sizes
- (8) Proposed Pipe Replacement

Note:
See Table 5-1 for Infrastructure Condition, Reliability, and Safety Improvements

Beverly Hills, California
Water System Master Plan

Recommended Improvements

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Figure 9-1

9.2 Costs

All improvement costs in this chapter are based on May 2001 prices. Based on the ENR-BCI cost factors, the May 2001 costs are about 50 percent higher than 1985 costs. Therefore, the unit costs developed for the previous Master Plan are increased by 50 percent for this report. Unit cost for transmission and distribution mains are given in Table 9-1. The planning level probable capital costs provided in this chapter includes the construction costs plus allowances of 50 percent for contingencies and engineering, legal, and administrative costs. Costs for land, rock excavation, or rights of way are not included.

Table 9-1
Unit Construction Costs for Distribution Main Installation

Size (inches)	Costs Per Linear Foot $
6	125
8	130
10	150
12	180
16	245
20	310
24	360

9.3 Water Treatment Plant and Public Works Facility

The City of Beverly Hills currently relies solely on imported water from the Metropolitan Water District of Southern California (MWD) for its water supply. Increased peak demands, water supply contracts and new rate structure design by the MWD have caused the City to initiate planning for the development of a groundwater supply to increase reliability and reduce the City's reliance on MWD imported water.

The City evaluated the feasibility of using groundwater to supplement its existing imported water supply. Based upon this research, a preferred project concept was developed for groundwater production. This concept includes the construction of a new Water Treatment Plant utilizing reverse osmosis for the removal of total dissolved solids (TDS), removal of iron and manganese, air stripping for hydrogen sulfide, and odor control.

The Water Treatment Plant located on the City-owned parcel at 345 N. Foothill Road will house both the water treatment plant and the Public Works Department utilities and general administration offices within a single structure. The facility will house. The Public Works Facility will include administration offices, employee services and public

lobby, shops, and field offices. The total square footage of the building will be about 39,000 square feet on two floors.

The Water Treatment Plant will provide regulatory compliance, water quality improvements, and increase the reliability of the City's existing water system by supplementing its imported water supply, supplied by four wells owned and operated by the City. The groundwater will be conveyed to the treatment plant through a transmission main also owned and maintained by the City. The treated water will be conveyed to the City's distribution system via a transmission main that will connect the Water Treatment Plant to the City's Sunset Reservoir. The plant will produce about 2.4 to 2.7 million gallons per day.

The specific requirements for the Water Treatment Plant potable water are as follows:

- Meeting all federal and state drinking water regulations
- Reducing the TDS (total dissolved solids) of the groundwater
- Reducing the hardness of the groundwater
- Reducing the odor resulting from the hydrogen sulfide in the groundwater
- Producing water that is non-corrosive to the distribution system

Construction of the Water Treatment Plant started in March 2001 and will take about two years for completion.

9.4 Pumping and Storage Improvements

9.4.1 Pumping Improvements

9.4.1.1 Greystone Pumping Station

The total maximum day demand for pressure zones higher than Zone 6 is about 4 mgd of which about 2 mgd is for Zone 8. It is recommended that one of the existing 1150 gpm pumping units be increased to 2100 gpm to allow for a single pump operation under maximum day conditions.

9.4.1.2 Pumping Station No. 5

To allow for a single pump operation at Station No. 5, one of the existing 800 gpm pumping units should be increased to 1000 gpm. The total maximum day demand for Zones 13, 15, and 16 is slightly less than 1000 gpm.

9.4.1.3 Sunset Pumping Station

The two 2750 gpm pumping units should be rehabilitated and returned to service. These pumping units will allow the transfer of Zone 3 water supply from the Sunset Reservoir to Coldwater Canyon Reservoir. The head/capacity relationship as shown in Table 3-2 is taken from previous reports. No data was available to verify the head/capacity. A pump inspection test should be conducted as part of the rehabilitation.

9.4.1.4 Green Acres Pumping Station

Currently Zone 7 is being served from Zone 6, however, if residual pressures are not adequate, then the Green Acres Station should be put back in service. The head/capacity relationship of the existing pumping units appears to be satisfactory to meet system water demands in Zone 7. The pumping units are below ground in a vault. The vault can fill with water if the sump pump has a power failure. The City should investigate if a gravity drain could be installed.

9.4.1.5 Booster Station No. 2

The head/capacity relationship as shown in Table 3-2 is taken from previous reports. No data was available to verify the head/capicity. A pump test should be conducted as part of any rehabilitation work performed at Station No. 2.

9.4.2 Storage Reservoirs

Chapter 4, Paragraph 4-8 discussed the need of equalization, fire reserve, and emergency storage requirements. Based on this evaluation, it is recommended that existing Coldwater Canyon Reservoir be replaced with a new 9.1 MG reservoir. As part of the Coldwater Canyon project, a new 1.8 MG reservoir is required at the nearby Booster Station No. 2 site to provide storage while rebuilding the Coldwater Canyon reservoir. Additional storage may be required in the future if criteria changes or an existing reservoir is removed from service. Space is available at Reservoir 4B to construct a second 1.0 MG storage, if needed.

Costs for pumping station and reservoir improvements are shown in Table 9-2.

Table 9-2
Pumping and Storage Reservoir Improvements

Phase	Reservoir	Description	Probable Capital Cost ($)
1	Coldwater	New 9.1 MG	11,700,000
	Booster Station 2	New 1.8 MG	3,000,000
	Subtotal Reservoirs		**14,700,000**
	Greystone	Replace Pump	650,000[1]
	Sunset	Replace Pump	100,000[2]
	Green Acres	Replace Pump	25,000[2]
	5	Replace Pump	28,000
	Subtotal Pumping Stations		**803,000**
2	4B	New 1.0 MG	600,000
		Total All Phases	**$16,103,000**

[1]Probable cost based on installing new pump unit piping and electrical work.
[2]Probable cost allowance for replacing existing pump units.

9.5 Infrastructure Improvements

A physical assessment of the major observable water system facilities with regard to their condition, reliability, seismic anchoring, site security and public safety is presented in Chapter 5. The assessment provides the City of Beverly Hills with a prioritized list of recommendations to correct deficiencies and to improve safety and operational reliability. These improvements and costs are summarized in Table 9-3.

Table 9-3
Water System Facility Inspection Improvement Costs

Phase	Facility[1]	Costs $
1	Reservoir 3A and Pump Station	18,000
	Monte Cielo Pump Station	
	Sunset Reservoir and Pump Station	31,000
	Greystone Reservoir and Pump Station	7,000
	Reservoir 4A	30,000
	Reservoir 4B and Pump Station	44,000
	Reservoir 5 and Pump Station	9,000
	Reservoir 6 and Pump Station	47,000
	Reservoir 7 and Pump Station 8	33,000
	Booster Station No. 2	9,000
	Green Acres Pump Station	10,000
	Total Phase I	$238,000
2	Reservoir 3A and Pump Station	72,000
	Sunset Reservoir and Pump Station	11,000
	Greystone Reservoir and Pump Station	48,000
	Reservoir 4A	41,000
	Reservoir 4B and Pump Station	95,000
	Reservoir 5 and Pump Station	114,000
	Reservoir 7 and Pump Station 8	23,000
	Green Acres Pump Station	12,000
	Total Phase II	$416,000
	Total All Phases	$654,000

[1] See Chapter 5 for detailed descriptions.

9.6 Valve Improvements

9.6.1 New Zone 6 to Zone 4 PRV

If West Hollywood water system is retained by the City of Beverly Hills then it is recommended that a new 10 inch PRV be installed between the two 8 inch mains in Zone 6 and the 12 inch main in Zone 4 at Elevado Avenue just east of N. Oakhurst Drive. As shown on Figure 4-9 in Chapter 4, the valve would transfer about 3.6 mgd from eastern Zone 6.

An alternative to Figure 4-9 location would be a new 10 inch PRV installed in an abandoned PRV vault between WH Zone 5 and WH Zone 3 at Palm Avenue and Cynthia Street in West Hollywood as shown on Figure 4-8 in Chapter 4.

9.6.2 20 inch Valve Operation (Zone 6)

A 20 inch valve located in the Zone 6 main at the MWD control station is adjusted manually. The 20 inch valve essentially divides Zone 6 into an East Zone 6 (Greystone) and a West Zone 6 (Reservoir 3A). As currently planned by the City, the 20 inch valve should be equipped with a motorized operator and controlled remotely from the Operations Control Center.

These improvements are summarized in Table 9-3 .

Table 9-4
Valve Improvements

Phase	Description	Size (inch)	Costs ($)
1	PRV Zone 6 to 4	12	43,000
	MWD Valve modification	20	21,000
		Total	**$64,000**

9.7 Distribution Main Improvements

9.7.1 MWD to Greystone Reservoir Main

A dedicated transmission main from the MWD control station to the Greystone Reservoir, as shown on Figures 9-1 and 9-2 is recommended for consideration to maximize the use of the Greystone Reservoir storage volume and provide adequate turnover of water storage to maintain good water quality. An alignment along Sunset Boulevard, Mountain Drive, Loma Vista Drive to the Greystone Reservoir would require about 5,400 feet of 24 inch main. An alternative construction method should consider trenchless technology such as conventional tunneling or micro-tunneling between the MWD control station and the reservoir. The ground elevation is 375 feet and 600 feet

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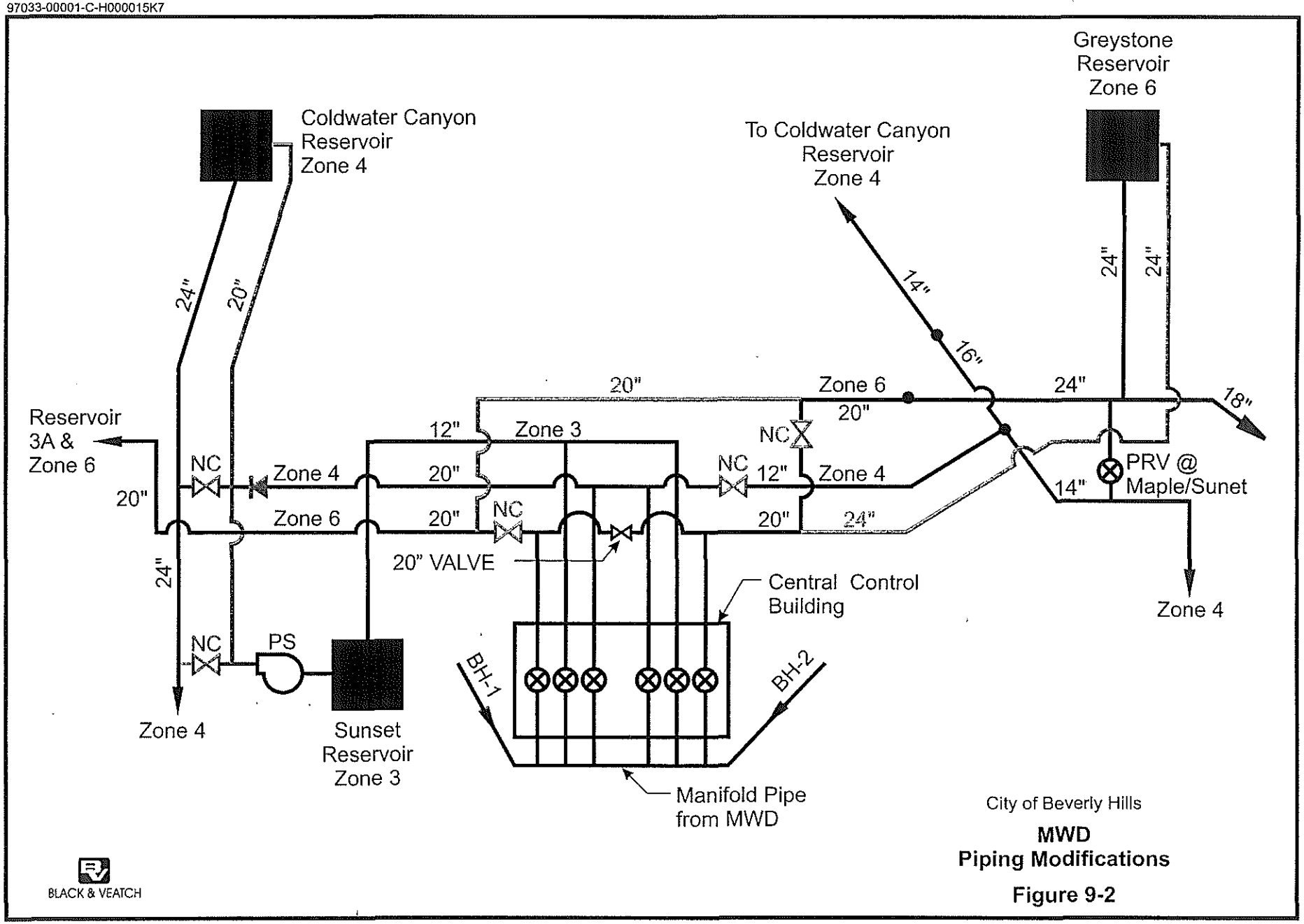

City of Beverly Hills

MWD
Piping Modifications

Figure 9-2

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between the MWD control station and the reservoir, respectively. A preliminary design study is recommended initially to determine the feasibility of constructing either alternative. Additionally, special piping details will be required at both the MWD control station and the Greystone Reservoir.

9.7.2 MWD to Coldwater Canyon Reservoir Main

A dedicated transmission main from the MWD control station to the Coldwater Canyon Reservoir, as shown on Figures 9-1 and 9-2, is recommended for consideration to maximize the use of the Reservoir storage volume and provide adequate turnover of water storage to maintain good water quality. Special piping modifications will be required at the MWD control station as shown on Figure 9-2.

9.7.3 Pipe Rehabilitation/Replacement

Chapter 6 examines the methods to determine pipe replacement and rehabilitation and describes the pipelines which appear to need replacement. However, there are current trenchless technologies which could be used to advantage, particularly in the alley pipes and in busy intersections. Techniques such as cementitious lining or epoxy coating, NASF and AWWA approved for potable water systems, should be considered as alternatives to regular open-trench construction in order to minimize traffic and constructability issues. These techniques could be pilot tested in one or two discrete locations in order to determine their usefulness for the City. Costs for pipe lining versus replacement could be less than open trenching, depending on many variables, such as depth, number of connections, desired coating thickness, and general condition of pipe.

These improvements are shown on Figure 9-1 with an Identification Number.

9.7.4 Pipe in Easements

An evaluation of existing pipes in easements is provided in Chapter 4, Paragraph 4-7 and is shown on Figure 4-14. The evaluation considered the possibility of retiring each water main in an easement through private property. Pipe in easements should be part of the City's pipe replacement program as discussed in Chapter 6. As shown on Figure 4-14, eleven of the 31 existing easement pipes could be considered for abandonment, and the remaining 20 pipes should be kept in service for looping and reliability needs. However, each of the 20 lines to be kept in service should be evaluated individually by City staff to determine needs for rehabilitation such as concrete encasement, or trenchless rehabilitation methods such as pipe bursting. The probable cost, based on the cost of new pipe, for evaluating and renovating the lines to be kept in service, is $1,668,000.

9.7.5 Fire Protection Mains

Between Santa Monica Boulevard and Sunset Boulevard many of the water lines are in alleys and the Fire Department considers the hydrant access to be inadequate. As recommended in the 1985 Master Plan, new mains with hydrants should be installed in the street rights-of-way and the existing mains in alleys with their service connections should be maintained in service. The required mains were identified in the 1985 Master Plan. The mains that remain to be installed are listed in Table 9-5.

9.7.6 4-A Pumping Station and Reservoir

To improve the water supply to and from the 4-A reservoir, separate inlet/outlet lines should be provided. Design and construction of approximately 500 linear feet each of 16-inch inlet and outlet piping to the reservoir is needed. Existing piping, presently located in a utility easement between properties, will be abandoned. The new pipe alignment is to be located within the bridle path that is contiguous to the reservoir.

9.7.7 3-A Pumping Station and Reservoir

Piping improvements are required to increase the capacity of the existing piping into the 3-A reservoir, to improve pumping efficiency, and to relocate piping from utility easements into the public right-of-way for future Zone 9 improvements. Design and construction of approximately 200 linear feet each of 12-inch C.I. (Zone 6), and 12-inch C.I. (Zone 8), and 14-inch C.I. (Zone 6) transmission and distribution piping into the public right-of-way is needed. Construction of the two Zone 6 lines must be completed in concert with the Greystone pumping station pipe improvements.

The recommended distribution main improvements by phase plus the probable capital costs are listed in Table 9-5.

Table 9-5
Distribution Main Improvements

ID No.	Description	Size (inch)	Length (feet)	Cost ($)
	New Main Projects – Phase 1			
	Greystone Reservoir	24	5,400	2,940,000
	Coldwater Canyon Reservoir	20	3,000	1,402,000
	3A Pumping Station and Reservoir	12, 14	600	275,000
	Subtotal New Main Projects			$ 4,617,000
	Pipe Replacement Projects – Phase 1			
1	S.Rexford Dr.	6	590	111,000
2	S. Maple Dr.	6	590	111,000
3	S. Swall Dr.	6	590	111,000
4	S. Weatherly	6	800	151,000
5	S. Doheny	6	970	183,000
6	S. Doheny	6	2,200	415,000
7	S. Palm	6	2,200	415,000
8	S. Rexford	6	600	124,000
9	Beverly and S. Reves Dr	6	2,000	377,000
10	Wilshire Blvd	8	900	176,000
11	Santa Monica Blvd	8	250	49,000
12	N of Santa Monica Blvd	12	750	204,000
13	Civic Center Dr	8	650	127,000
14	N Crescent Rd	8	650	127,000
15	Foothill Rd	6	200	38,000
16	N Elm Dr	8	950	186,000
17	N La Peer Dr	8	600	118,000
18	N Carson Dr	8	1,300	255,000
	Subtotal Pipe Replacement Projects			$ 2,905,000
	Total Phase 1			$ 7,349,000
	New Main Projects – Phase 2			
	4A Pumping Station and Reservoir	16	1,000	$ 465,000
	Pipe Replacement Projects – Phase 2			
19	N Stanley Dr	8	1,350	265,000
20	S.Le Doux Rd	8	800	157,000
21	N.Flores St., Rosewood Ave W.H.	8	2,000	392,000
22	N Orlando	8	500	98,000
23	Robertson Blvd W.H.	6	1,500	283,000
24	Hancock Ave W.H.	8	1,350	265,000
25	N Palm	8	1,350	265,000
26	N Roxbury Dr	8	1,500	294,000
27	Calle Vista	8	1,400	274,000
	Subtotal Pipe Replacement Projects			$ 2,983,000

Table 9-5
Distribution Main Improvements

ID No.	Description	Size (inch)	Length (feet)	Cost ($)
	Fire Protection Mains – Phase 2			
26-024	Bedford Dr. between Benedict Canon Dr. and Sunset Blvd.	8	700	127,400
31-025	Crescent Dr. between Sunset Blvd. and Lomitas Ave.	8	800	145,600
37-027	Foothill Rd. between Sunset Blvd. and Lomitas Ave.	8	900	163,800
37-028	Elm Dr. between Sunset Blvd. and Lomitas Ave.	8	600	109,200
35-029	Oakhurst Dr. between Cynthia St. and Elevado Ave.	8	1,000	182,000
--------	Trenton Dr. and Whitter Dr.	FH	--	4,200
31-034	Crescent Dr. between Lomitas Ave. and Elevado Ave.	8	100	182,000
31-036	Foothill Rd. between Sunset Blvd. and Lomitas Ave.	8	1,100	200,200
31-037	Elm Dr. between Lomitas Ave. and Elevado Ave.	8	1,200	218,400
25-041	Trenton Dr. between Elevado Ave. and Wilshire Blvd.	FH	--	4,200
25-042	Crescent Dr. between Elevado Ave. and Alley North of Santa Monica Blvd.	8	1,900	345,800
31-043	Alpine Dr. between Elevado Ave. and Alley North of Santa Monica Blvd.	8	2,300	418,600
24-044	Foothill Rd. between Elevado Ave. and Alley North of Santa Monica Blvd.	8	2,300	418,600
30-045	Elm Dr. between Elevado Ave. and Alley North of Santa Monica Blvd.	8	2,300	418,600
20-050	Walden Dr. between Elevado Ave. and Alley North of Santa Monica Blvd.	8	1,700	309,400
20-051	Linden Dr. between Elevado Ave. and Alley North of Santa Monica Blvd.	8	1,700	309,400
30-052	Hillcrest Rd. between Carmelita Ave. and Alley North of Santa Monica Blvd.	8	900	163,800
15-053	Spaulding Dr. between Gregory Way and Charleville Blvd.	8	1,000	182,000
15-054	McCarty Dr. between Charleville Blvd. And Alley North of Olympic Blvd.	8	1,800	327,600
15-055	Roxbury Dr. between Charleville Blvd. And Gregory Way	8	1,000	182,000
15-056	Roxbury Dr. between Gregory Way and Alley North of Olympic Blvd.	FH	--	4,200
15-057	Bedford Dr. between Charleville Blvd. and Alley South of Olympic Blvd.	12	1,900	505,400
14-058	Peck Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
14-059	Camden Dr. between Charleville Blvd. And Gregory Way	8	1,000	182,000
16-060	Rodeo Dr. between Charleville Blvd. and Gregory Way.	8	1,000	182,000
14-061	El Camino Dr. between Charlevile Blvd. and Gregory Way	8	1,000	182,000
14-063	Canon Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
14-064	Crescent Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
14-065	Elm Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
13-067	Maple Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
13-068	Palm Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
13-069	Oakhurst Dr. between Charleille Blvd. and Gregory Way	8	1,000	182,000
13-070	Wetherly Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
13-071	Almont Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
13-072	Lapeer Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
13-073	Swall Dr. between Charleville Blvd. and Gregory Way	8	1,000	182,000
29-075	Santa Monica Blvd. Between Doheny Dr. and Almot Dr.	12	700	186,200
29-076	Keith Ave. between Almont Dr. and Hilldale Ave.	8	1,100	200,200
20-078	Almont Dr. between Nemo St. and Santa Monica Blvd.	12	100	26,600
	Subtotal Fire Protection Mains		42,000	$ 7,883,000
	Total Phase 2			$ 11,331,000
			Total All Phases	**$18,873,000**

9.8 Miscellaneous Improvements

9.8.1 Hillside Zone 9 Fire Protection

A 1999 Study prepared by Montgomery Watson recommended fire flow connection to the LADWP water system north of Zone 9 to deliver 6,000 gpm to the Hillside in Zone 9 for a cost of $2,600,000. This amount also included replacing all existing 6 inch mains with 12 inch mains. The City of Beverly Hills is currently negotiating with LADWP to install a separate fire protection system at a reduced fire flow rate of 3,000 gpm.

If the LADWP separate fire protection system is not implemented, then an alternative plan to the 1999 Study would be to install an irrigation sprinkler system along Lago Vista Drive using Reservoir 3B as a nonpotable water supply. The layout of the system is discussed in Chapter 4, Paragraph 4-6 and shown on Figure 4-13.

The probable costs for the LADWP connection and associated distribution facilities are included in Table 9-6.

9.8.2 MWD Control Station

The inspections performed and reported under Chapter 5 noted that several improvements to the MWD control station on Sunset Blvd. should be made. These include a drainage sump and installation of a portable crane under Phase 1 and updating the electrical system under Phase 2.

These improvements are summarized in Table 9-6.

Table 9-6
Miscellaneous Improvements

Phase	Description	Cost ($)
1	Zone 9 Fire Protection	
	LADWP Connection	1,300,000
	Distribution Mains	860,000
	Sprinkler System	20,000
	Total Zone 9 Fire Protection	$ 2,180,0000
	MWD Control Station Miscellaneous Improvements[1]	53,000
	Total Phase 1	$ 2,223,000
2	MWD Control Station Electrical Upgrade	$56,000
	Total All Phases	**$2,279,000**

[1]See Table 5-1

9.9 Capital Improvement Plan

A summary of the Capital Improvement Plan as described in previous paragraphs and tables is shown in Table 9-7.

Table 9-7
Capital Improvement Plan

Phase (Year)	Description	Costs ($)
1 (2007)	Pumping Stations	803,000
	Storage Reservoirs	14,700,000
	Valves	64,000
	Distribution Mains	
	New Mains	4,617,000
	Replacement Projects	2,905,000
	Water System Facility Inspection and Miscellaneous Improvements [1]	2,500,000
	Total Phase 1	$25,589,000
2 (2012)	Storage Reservoir	600,000
	Distribution Mains	
	New Mains	465,000
	Replacement Projects	2,983,000
	Fire Protection Mains	7,883,000
	Easement Pipe Evaluation and Rehabilitation	1,688,000
	Water System Facility Inspection and Miscellaneous Improvements [1]	2,500,000
	Total Phase 2	$16,119,000
	Total All Phases	**$41,708,000**

[1] This includes the facility inspection improvements from Table 9-3, miscellaneous improvements from Table 9-6 and an allowance for additional projects to be identified by the City.

10.0 Financial Plan

10.1 General

The preceding section summarizes the recommended improvements to the water distribution system to meet projected water demands through the year 2025. The recommended improvements, indicated on Figure 9-1, have been phased into the following construction periods, for Fiscal Years ending June 30.

Phase 1 – 2003 to 2007
Phase 2 – 2008 to 2012

As a component of the Master Plan, this Financial Plan is developed to assist the City to plan for financing this project over the next 10 years.

10.2 Revenue Under Existing Rates

The principal revenue for operating and managing the City's water system is derived from rates and charges for water service. Other revenue sources include miscellaneous revenue and interest income. The level of future revenue the City can expect to receive is a function of the number of customers served, the water sales volume, and water rates. The City is essentially built out, and very little growth is expected over the next few years. In the absence of rate adjustments, the City's revenue base for water service fees will essentially remain constant. The projected revenue under existing rates for the Current Year and Fiscal Years 2003 through 2012 is listed in Table 10-1.

Table 10-1
Projected Revenue Under Existing Rates

Revenues	Fiscal Year Ending June 30										
	Budget 2002	Projected 2003	Projected 2004	Projected 2005	Projected 2006	Projected 2007	Projected 2008	Projected 2009	Projected 2010	Projected 2011	Projected 2012
Service Charges	15,080,482	15,080,482	15,080,482	15,080,482	15,080,482	15,080,482	15,080,482	15,080,482	15,080,482	15,080,482	15,080,482
Interest Earnings	1,412,000	1,214,800	861,300	722,200	757,200	822,100	897,300	959,000	997,300	988,600	926,700
Lease of Property	59,670	61,460	63,304	65,203	67,159	69,174	71,249	73,387	75,588	77,856	80,191
Miscellaneous	80,677	80,677	80,677	80,677	80,677	80,677	80,677	80,677	80,677	80,677	80,677
Total	**$16,632,829**	**$16,437,419**	**$16,085,763**	**$15,948,562**	**$15,985,518**	**$16,052,433**	**$16,129,708**	**$16,193,546**	**$16,234,047**	**$16,227,615**	**$16,168,050**

10.3 Capital Funding Alternatives

Chapter 9 proposes capital projects for the water system to bolster, reinforce, and expand the capacity of its existing infrastructure facilities. These capital projects can be funded on a pay-as-you-go basis through rates, reserves, and, to a lesser degree, capital improvement fees. Facilities that have long useful lifetimes may be financed over 20 to 30 years on a pay-as-you-use basis by incurring debt. In addition to conventional funding such as revenue bonds and certificates of participation, the City has the option to obtain funding from state and local sources. Brief descriptions of some possible financing sources are included below:

- **State Revolving Fund (SRF) Loans.** The 1996 Safe Drinking Water Act (SDWA) amendments authorize federal grants to the states to establish revolving funds. Congress must still appropriate the funds and the states must match the grants. The revolving funds, provide subsidized loans to "facilitate compliance with national primary drinking water regulations... or otherwise further the health protection objectives of the SDWA." The loans cannot be used to subsidize operation and maintenance or to expand system capacity to serve growth. The City should investigate obtaining the loans if needed in the future, since they will have lower costs than market rate loans.

- **Department of Water Resources (DWR).** Under Proposition 82 passed in 1988, DWR will lend up to $5 million for water supply projects. The loans may be made for a period of up to 20 years, and the interest rate is equal to the State's rate on the most recent general obligation bond sale, which is currently 5.2 percent.

- **California Infrastructure Economic Development Bank (CIEDB).** The CIEDB was established in 1994 to promote economic revitalization in California, and was given the authority to issue tax-exempt and taxable revenue bonds, provide financing to public agencies, and leverage state and federal funds. Applicants may be eligible for up to $10 million for a period of up to 30 years or the life of the project, whichever is less. The interest rate for these loans is approximately 67 percent of the market rate.

- **California WateReuse Financing Authority.** In June 1998, the Authority issued $200 million in variable rate bonds to create the California WateReuse Variable Rate Loan program. Without Federal or State funds, the Authority created a low cost means for the WateReuse Association membership to advance their capital projects, reduce financing costs, and avoid delays due to SRF processing requirements. Funds are available for projects ranging from $1 million to $100 million. Terms of the loans include a 30-year repayment schedule and an interest rate of approximately 3 percent. Approval can be obtained in as little as 60 days.

- **General Obligation Bonds.** These bonds have lower issuance costs than other forms of debt financing, since they are easier to structure and analyze. They also do not require debt service reserve funds or interest during construction. However, they do require the approval of two-thirds of the electorate.

- **Revenue Bonds**. These bonds are secured solely by revenues, so they require a coverage pledge. This means that service charge revenues less expenses must be greater than a multiple of the annual bond service. The multiple is often set at 125 percent. Revenue Bonds also require the approval of a majority of the voters.

- **Certificates of Participation (COPS).** COPs provide long-term financing through a lease, installment sale agreement. COPs typically have slightly higher interest rates than revenue bonds, but do not require voter authorization.

- **Capital Reserves.** Capital reserves may be used to fund ongoing capital refurbishments. A replacement capital reserve should be used to set aside funds to replace equipment as it wears out. Capital Improvement Fee proceeds must be deposited into an expansion capital reserve. All expansion-related capital costs and debt service must be paid from this fund.

- **Pay-As-You-Use Funding.** This type of funding (bonds and other debt) is considered especially fair when financing long-lifetime facilities, since by paying debt service, future customers pay for the facilities that benefit them. Moreover, pay-as-you-use funding avoids large variations in the user charges as the capital program waxes and wanes. COPs remain the most practical of these funding mechanisms for the general needs of the water utility. However, current service charges must fund all or a portion of the Master Plan projects to meet the debt and coverage requirements of the COPs.

Factors that should be considered in determining the most feasible mechanism include the amount of funding needed, the availability of grants or low-interest loans, and methods of paying off debt in an equitable manner.

10.4 Capital Program

As shown in Table 10-2, costs for projects scheduled for Phase I are shown for the five Fiscal Years from 2003 through 2007. Similarly, Phase II project costs are shown over five Fiscal Years from 2008 through 2012. A summary of the capital improvement program, which reflects the planned expenditures for each year during the study period, is presented in Table 10-2. Current years costs and Phases I and II for fiscal years 2003 through 2012 are estimated to total $46,448,700 in 2002 dollars.

Table 10-2
Proposed Major Capital Improvement Program

Project	Fiscal Year Ending June 30											
	Budget 2002	Projected 2003	Projected 2004	Projected 2005	Projected 2006	Projected 2007	Projected 2008	Projected 2009	Projected 2010	Projected 2011	Projected 2012	Future Total
Major Capital Improvements												
Pumping Stations		160,000	160,000	160,000	160,000	163,000						803,000
Storage Reservoir - Coldwater Cyn		5,850,000	5,850,000									11,700,000
Storage Reservoir - Booster St. 2		3,000,000										3,000,000
Storage Reservoir - Reservoir 4B										300,000	300,000	600,000
Valves			64,000									64,000
New Distribution Mains		275,000	1,085,000	1,085,000	1,086,000	1,086,000				230,000	235,000	5,082,000
Pipe Replacement		581,000	581,000	581,000	581,000	581,000	597,000	597,000	597,000	596,000	596,000	5,888,000
Fire Protection Mains							1,577,000	1,577,000	1,577,000	1,576,000	1,576,000	7,883,000
Easement Pipes							337,600	337,600	337,600	337,600	337,600	1,688,000
Pipe Replacements												0
Improvements	1,707,100	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	500,000	6,707,100
Total CIP- No Inflation	1,707,100	10,366,000	8,240,000	2,326,000	2,327,000	2,330,000	3,011,600	3,011,600	3,011,600	3,539,600	3,544,600	43,415,100
Total CIP- With Inflation	1,707,100	10,366,000	8,404,800	2,420,000	2,469,400	2,522,100	3,325,000	3,391,600	3,459,400	4,147,200	4,236,100	46,448,700

10.5 Revenue Requirements

To provide for the continued operation of the City's water enterprise on a sound cash flow basis, annual revenue must be sufficient to meet the City's annual revenue requirements. Revenue requirements include operation and maintenance expense, debt service, cash financing for capital projects, and expenditures for routine capital outlays. Table 10-3 summarizes the projected O&M expenses over the planning period.

The forecasted expenditures are based upon the City's fiscal year 2002 budget and the effect of annual inflation of 3 percent in future years. Total operation and maintenance expense is projected to increase from $12,651,836 in fiscal year 2002 to $17,003,158 by 2012.

10.5.1 Debt Service

Annual debt service for the study period consists of scheduled principal and interest payments on the 1973 and 1976 General Obligation Bonds ending in 2004, the 1993 Refunding Bonds, and the 1998 Water Revenue Bonds. The bonds issued have a debt service coverage requirement of 125 percent, and the City must generate adequate water service revenues to meet this bond covenant. Over the planning period, the City's projected debt service coverage is greater than 125 percent. In fiscal year 2002, debt service totals $1,940,600.

10.5.2 Routine Capital Outlay

Routine annual capital outlays, which are financed from annual system earnings, include estimates for relatively small additions and replacements to system facilities and replacements for office/technical equipment. An annual allowance of $75,200 is estimated for 2002. Future expenditures for routine capital outlays are increased by an inflationary factor of 3 percent.

10.5.3 Revenues to Finance Capital Projects

The amount estimated to be financed from annual revenue in FY 2002 totals $1,707,100. This includes money already spent on capital projects as well as encumbrances for the year. Rates must be sufficient to finance related capital improvement projects scheduled for each year.

Table 10-3
Projected Operation and Maintenance Expense

Description	Fiscal Year Ending June 30										
	Budget 2002	Projected 2003	Projected 2004	Projected 2005	Projected 2006	Projected 2007	Projected 2008	Projected 2009	Projected 2010	Projected 2011	Projected 2012
Personnel Services	1,748,000	1,800,500	1,854,500	1,910,100	1,967,400	2,026,400	2,087,200	2,149,800	2,214,300	2,280,800	2,349,200
Materials and Supplies	7,505,100	7,730,300	7,962,200	8,201,100	8,447,100	8,700,500	8,961,500	9,230,400	9,507,300	9,792,500	10,086,300
Contractual Services	819,100	843,700	869,000	895,100	921,900	949,600	978,100	1,007,400	1,037,600	1,068,800	1,100,800
Capital Outlay	75,200	77,400	79,800	82,100	84,600	87,200	89,800	92,500	95,200	98,100	101,000
Maintenance FD Svc Charges	297,600	306,500	315,700	325,200	335,000	345,000	355,400	366,000	377,000	388,300	400,000
IT Fund Svc Charges	156,800	161,500	166,300	171,300	176,400	181,700	187,200	192,800	198,600	204,500	210,700
Reprographics User Charges	13,900	14,400	14,800	15,200	15,700	16,200	16,600	17,100	17,700	18,200	18,700
Liab. Ins. Fund Charges - ent	37,900	39,100	40,200	41,500	42,700	44,000	45,300	46,700	48,100	49,500	51,000
Other Charges	159,000	163,800	168,700	173,700	179,000	184,300	189,900	195,500	201,400	207,500	213,700
Other Contractual Services	1,835,100	1,890,200	1,946,900	2,005,300	2,065,400	2,127,400	2,191,200	2,256,900	2,324,700	2,394,400	2,466,200
Total	12,651,836	13,031,660	13,422,488	13,825,120	14,239,855	14,667,100	15,107,139	15,560,187	16,027,139	16,507,997	17,003,158

10.6 Operating and Capital Financing Plan

To provide for the continued operation of the City's water enterprise on a sound financial basis, revenue must be sufficient to meet operating and capital requirements. This section of the report analyzes the adjustments in revenue needed to meet future revenue requirements.

Table 10-4 presents an analysis of the City's Water Fund cash flow for FY 2002 through 2012. In order to meet projected revenue requirements, annual increase in water revenues are indicated as follows:

Effective Date	Increase
July 1, 2003	4.5 percent
July 1, 2004	5 percent
July 1, 2005	5 percent
July 1, 2006	5 percent
July 1, 2007	5 percent
July 1, 2008	5 percent
July 1, 2009	0 percent
July 1, 2010	0 percent
July 1, 2011	0 percent
July 1, 2012	0 percent

Estimated water sales revenue under existing rates is shown on Line 1 of Table 10-4. Additional operating revenues from the proposed rate adjustments are shown on Lines 2 through 12. Other revenues and interest income are shown on Lines 14 through 16.

O&M expenses, debt service payments, transfers to the Capital Replacement Fund, and annual capital outlays and are shown on Lines 18 through 31. Line 30 shows the amount needed to cash finance capital projects scheduled for each year.

Table 10-4 shows that rate adjustments are needed in fiscal years 2003-2008 primarily to finance capital projects and to maintain a fund balance of at least $15 million. The City does not need to issue additional debt to fund capital projects as reserves are being drawn down to meet capital needs over the planning period. With the proposed rate adjustments in fiscal years 2003 through 2009, the City will maintain reasonable reserves over the 10-year planning period, with approximately $17.7 million in reserves projected in 2012.

Table 10-4
Operating Fund Cash Flow

Line No.	Description			2002 $	2003 $	2004 $	2005 $	2006 $	2007 $	2008 $	2009 $	2010 $	2011 $	2012 $
				Fiscal Year Ending June 30:										
Revenue														
1	Revenue Under Existing Rates			15,080,482	15,080,482	15,080,482	15,080,482	15,080,482	15,080,482	15,080,482	15,080,482	15,080,482	15,080,482	15,080,482
	Additional Revenue Required:													
	Year	Percent	Months Effective											
2	2002	0.0%	12	0	0	0	0	0	0	0	0	0	0	0
3	2003	4.5%	12		678,600	678,600	678,600	678,600	678,600	678,600	678,600	678,600	678,600	678,600
4	2004	5.0%	12			788,000	788,000	788,000	788,000	788,000	788,000	788,000	788,000	788,000
5	2005	5.0%	12				827,400	827,400	827,400	827,400	827,400	827,400	827,400	827,400
6	2006	5.0%	12					868,700	868,700	868,700	868,700	868,700	868,700	868,700
7	2007	5.0%	12						912,200	912,200	912,200	912,200	912,200	912,200
8	2008	5.0%	12							957,800	957,800	957,800	957,800	957,800
9	2009	0.0%	12								0	0	0	0
10	2010	0.0%	12									0	0	0
11	2011	0.0%	12										0	0
12	2012	0.0%	12											0
13	Total Revenue From Rates			15,080,482	15,759,082	16,547,082	17,374,482	18,243,182	19,155,382	20,113,182	20,113,182	20,113,182	20,113,182	20,113,182
14	Lease of Property			59,670	61,460	63,304	65,203	67,159	69,174	71,249	73,387	75,588	77,856	80,191
15	Miscellaneous			80,677	80,677	80,677	80,677	80,677	80,677	80,677	80,677	80,677	80,677	80,677
Non-Operating Revenue														
16	Interest - Operating Fund			1,412,000	1,214,800	861,300	722,200	757,200	822,100	897,300	959,000	997,300	988,600	926,700
17	Total Revenue			16,632,829	17,116,019	17,552,363	18,242,562	19,148,218	20,127,333	21,162,408	21,226,246	21,266,747	21,260,315	21,200,750

Table 10-4
Operating Fund Cash Flow

Line No.	Description	Fiscal Year Ending June 30: 2002 $	2003 $	2004 $	2005 $	2006 $	2007 $	2008 $	2009 $	2010 $	2011 $	2012 $
Revenue Requirements												
18	Personnel Services	1,748,000	1,800,500	1,854,500	1,910,100	1,967,400	2,026,400	2,087,200	2,149,800	2,214,300	2,280,800	2,349,200
19	Materials and Supplies	382,924	394,459	406,283	418,506	431,028	443,946	457,249	471,022	485,141	499,676	514,691
20	Water Purchases	7,122,176	7,335,841	7,555,917	7,782,594	8,016,072	8,256,554	8,504,251	8,759,378	9,022,159	9,292,824	9,571,609
21	Contractual Services	819,100	843,700	869,000	895,100	921,900	949,600	978,100	1,007,400	1,037,600	1,068,800	1,100,800
22	Maintenance FD Svc Charges	297,600	306,500	315,700	325,200	335,000	345,000	355,400	366,000	377,000	388,300	400,000
23	IT Fund Svc Charges	156,800	161,500	166,300	171,300	176,400	181,700	187,200	192,800	198,600	204,500	210,700
24	Reprographics User Charges	13,900	14,400	14,800	15,200	15,700	16,200	16,600	17,100	17,700	18,200	18,700
25	Liab. Ins. Fund Charges - ent	37,900	39,100	40,200	41,500	42,700	44,000	45,300	46,700	48,100	49,500	51,000
26	Cable TV Charges	4,136	4,260	4,388	4,520	4,655	4,795	4,939	5,087	5,239	5,397	5,558
26	Other Charges	159,000	163,800	168,700	173,700	179,000	184,300	189,900	195,500	201,400	207,500	213,700
27	Other Contractual Services	1,835,100	1,890,200	1,946,900	2,005,300	2,065,400	2,127,400	2,191,200	2,256,900	2,324,700	2,394,400	2,466,200
24	Total O&M & Purchased Water Costs	12,576,636	12,954,260	13,342,688	13,743,020	14,155,255	14,579,895	15,017,339	15,467,687	15,931,939	16,409,897	16,902,158
25	**Net Revenue**	4,056,193	4,161,759	4,209,675	4,499,543	4,992,963	5,547,438	6,145,070	5,758,559	5,334,808	4,850,418	4,298,592
Debt Service												
26	1998A Water Revenue Bonds	1,035,700	1,333,300	1,284,800	1,281,900	1,039,000	1,023,000	1,022,500	1,020,700	1,022,500	1,022,600	1,016,100
27	1993 Refunding Bonds, Series A	359,700	359,600	359,300	358,600	358,000	362,400	252,600	237,700	242,000	446,600	559,000
28	1973 & 1976 GO Bonds	545,200	247,800	0	0	0	0	0	0	0	0	0
29	Total Debt Service	1,940,600	1,940,700	1,644,100	1,640,500	1,397,000	1,385,400	1,275,100	1,258,400	1,264,500	1,469,200	1,575,100
30	Capital Projects Financing	1,707,100	10,366,000	8,404,800	2,420,000	2,469,400	2,522,100	3,325,000	3,391,600	3,459,400	4,147,200	4,236,100
31	Routine Capital Outlay	75,200	77,400	79,800	82,100	84,600	87,200	89,800	92,500	95,200	98,100	101,000
32	Total Revenue Requirements	16,299,536	25,338,360	23,471,388	17,885,620	18,106,255	18,574,595	19,707,239	20,210,187	20,751,039	22,124,397	22,814,358
Operating Fund Balance												
33	Net Annual Cash Balance	333,293	(8,222,341)	(5,919,025)	356,943	1,041,963	1,552,738	1,455,170	1,016,059	515,708	(864,082)	(1,613,608)
34	Beginning Fund Balance	28,074,000	28,407,293	20,184,952	14,265,927	14,622,870	15,664,833	17,217,571	18,672,740	19,688,799	20,204,507	19,340,425
35	Net Cumulative Fund Balance	28,407,293	20,184,952	14,265,927	14,622,870	15,664,833	17,217,571	18,672,740	19,688,799	20,204,507	19,340,425	17,726,817
36	Debt Service Coverage [1]	205%	210%	251%	269%	351%	394%	475%	450%	414%	323%	266%
	City Calculated Coverage [2]	154%	159%	190%	208%	280%	322%	396%	371%	335%	255%	203%

[1] Minimum bond coverage requirement is 125%.
[2] Includes $1,000,000 required for capital. Minimum bond coverage requirement is 125%.

10.7 Water Rate Structure

The City's current water rates consist of a bimonthly service charge based on meter size and a three-tiered water commodity rate structure. The first tier includes usage up to 10 ccf; the second tier includes water use from 10 ccf up to 55 ccf; and the third tier includes water use beyond 55 ccf. This three tiered rate structure encourages conservation, as use in the first tier is at a 10 percent discount from the second tier. Excess use or use above 55 ccf is charged almost 50 percent more than the second tier. Many agencies, including the City of Santa Monica, use a three-tiered rate structure to encourage water conservation. The City's current rate structure provides an appropriate incentive to encourage water conservation.

Many agencies in California are implementing multi-tiered rate structures. Typically the tiers are set up to provide lifeline use at the lowest rate and between 80 and 90 percent of the total water use at the second tier rate. The remaining 10 to 20 percent is charged the third-tier rate. Where an agency has multiple sources of water, the tiered rates may be tied to the cost of producing that water. For example, if a city has local supply which costs less to produce than the water purchased from MWD, the tiers can be set accordingly. Since this is not the case in Beverly Hills, one method of deriving the first-tier rate would be to exclude some capital costs from the Tier 1 rate to reflect the low demand in that group. Alternatively, the first-tier rate could be a percentage of the cost of service rate. The second-tier rate could be used to reflect the cost of service. The third-tier can be set to recover a larger portion of the capital costs to reflect the higher demand placed on the system by high water users, or it could be used to recover the revenue lost through discounts on the first tier rate. Some agencies set a fourth-tier rate which is a penalizing rate for the so-called abusive users. The revenue derived from the fourth-tier rate could be used to implement water conservation programs, etc.

The tiers in the City's current rate structure are set as follows:

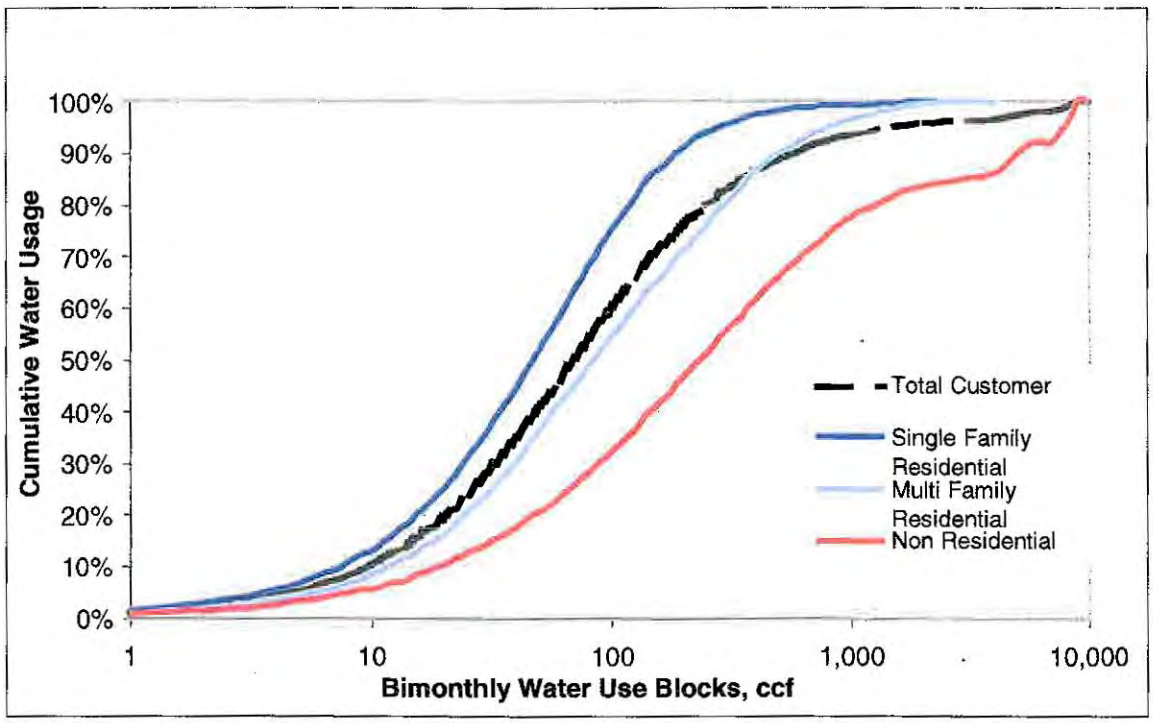
- First tier at 5 ccf per month.
- Second tier between 5 and 27.5 ccf per month.
- Third tier is greater than 27.5 ccf per month.

Many agencies use 5 ccf per month (10 ccf bimonthly) in the first tier. Alternatively, a first tier user of 7 ccf per month is used to provide basic domestic use for an average single-family residence. The second tier is set at 80 to 90 percent of the total water use and the third tier for greater water use. Figure 10-1, shows the water use by block for the different types of customer classes and for all customers. At 10 ccf bimonthly, single-family residential (SFR) use is 13 percent of the total SFR use and 55

ccf represents about 55 percent of the SFR use. The SFR curve becomes steeper at about 10 ccf and begins to level off at about 160 ccf. Typically, the S-curves are sharper so that they begin to level off at lower use rates; this indicates that the use in the City is higher than normal. If the second tier was increased to reflect the 80 to 90 percent usage, the revenues derived from the third block would decrease and would require a higher rate in the second tier and correspondingly in the third tier.

Given the water use characteristics, the City may consider a four-tier rate structure. The same analysis on the total water use from all customer types shows that the curve is even flatter, requiring greater allowances in the lower tiers. A detailed analysis of the monthly water use patterns for different customer classes is recommended to fine-tune the City's existing rate structure. This would help identify the water consumption for the different tiers and the rates to be charged for each tier.

Figure 10-1
Total Customers Usage by Blocks (%)



It should be noted that the City applies the tiered rate structure to all customers, including non-residential customers. Many agencies do not apply the same tiers to non-residential customers, because, for the larger customers, the rate would become punitive. To mitigate this, the tiers may be set based on meter size so that larger meters get a proportionately larger allowance in the first and second tiers. Alternatively, there may

not be any tiers for nonresidential customers under the rationale that they are motivated to cut costs and would not waste water.

10.8 Survey of Fees for Nearby Agencies

Table 10-5 shows the current inside City bimonthly water bill for 1-inch meter size for Beverly Hills as well as for several nearby agencies. The total charges assume a bimonthly water consumption of 40 ccf. This is based on Black & Veatch's 2001 Water Rate survey. Total charges include a bimonthly meter charge and commodity charges based on water use.

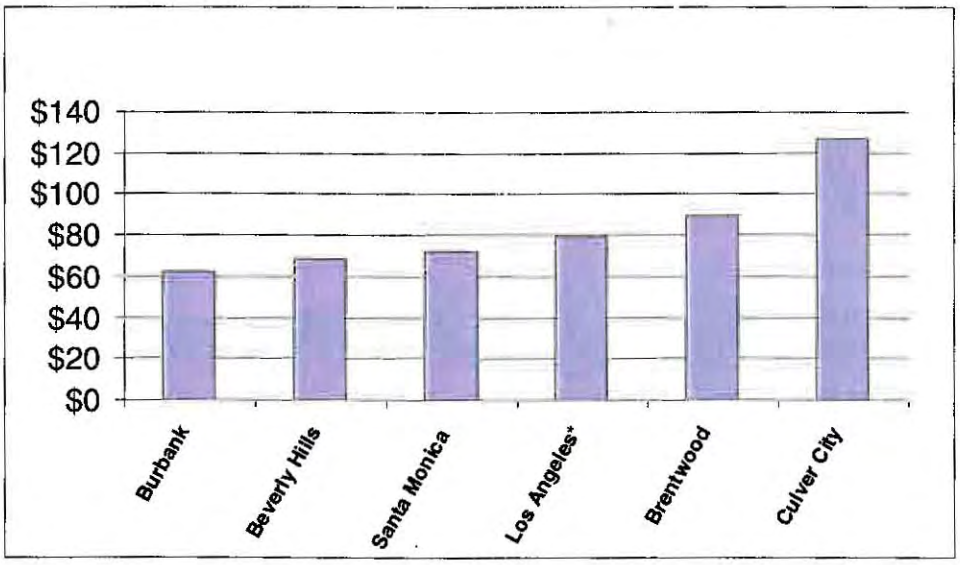
As shown on Figure 10-2, the City of Beverly Hills currently has the second lowest bill among the five agencies, with a bimonthly bill totaling $68.65 for a 1-inch meter. The City with the lowest bill is Burbank, with an average bill totaling $62.08.

Table 10-5
Comparison of Nearby Agencies Rates
Based on 37 ccf Bi-Monthly Use

	City of Burbank	City of Beverly Hills	City of Santa Monica	City of Los Angeles[1]	City of Brentwood	City of Culver City
1 Inch Meter	62.08	68.65	71.95	79.00	89.30	126.92

[1] Assumed first tier rate and average of all low season and high season rates.

Figure 10- 2
Rates Comparison
(Based on 40 CCF Bi-Monthly)



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Introduction

Data Dictionary

The GIS Data Dictionary documents spatial and tabular data. The intent of the data dictionary is to provide information about data, or what is referred to as, "metadata." The dictionary provides a reference to the structure and content of the GIS database to assist users in judging the fitness of the data for a specific use.

ArcView Documentation

Environmental Systems Research Institute's (ESRI) ArcView GIS software was selected by the City for use as a geographic database repository and application environment. ESRI provides a wealth of documentation regarding the use of ArcView and GIS theory and practice. These documents are useful in understanding GIS and ArcView and are available from ESRI. One good document is *Introduction to ArcView GIS* that is included in ArcView training. Additionally, ESRI provides extensive on-line documentation that is easy to use.

Definition of Selected ArcView Terms

The following selected terms are used throughout this memo to describe the metadata for this project:

Attribute	A characteristic of a geographic feature typically stored in tabular format, and linked to the feature by a user-assigned identifier (e.g., the attributes of a road, represented by an line, might include surface type, name, and jurisdiction).
Feature class	The type of graphical entity used to represent a geographic object: line, point, polygon, or node.
Item	A column of information in an attribute table.

Line	A shapefile feature class used to represent linear features as well as polygon boundaries. A line is comprised of a sequence of x,y coordinate pairs (vertices), beginning at a "from node" and ending at a "to node."
Node	A node is the beginning and ending locations of an arc, or the point where two or more arcs connect. ArcView does not use nodes as a feature class.
Point	A shapefile feature class used to represent geographic features too small to be displayed as a line or area. A point is a single x,y coordinate location.
Polygon	A homogeneous area defined by the lines, which make up its boundary. This can include lines defining an "island" inside a polygon.
Record	A single row of thematic descriptors in an attribute table. Includes all items about a single entry in a table. In a feature attribute table, the record represents the attributes for a single graphic feature.
Shapefile	A digital representation of a map forming the basic unit of geographic data storage in ArcView. The shapefile stores primary map features such as lines, polygons, and points, as well as the map extent.
Table	Refers to any table used by ArcView to store data. Tables are either data files or feature attribute files. Tables may also be referred to as joined or linked tables or look-up tables defined by the user. A dBase IV (.dbf) file is used to store attribute information for a specific shapefile feature class.

Definition of Water Distribution ArcView Items

Each shapefile created in ArcView has attribute items in its dbase format (*.dbf) database table. The types of the items written to the table depend on the definition of the shapefile.

The standard item definitions for the feature attribute tables are defined in the following tables. The definitions of the standard item names are:

Item	Item name;
Format	Field type. For characters the number of spaces are indicated, for numbers, the number of digits;
Description	A brief description of the item;
Domain	The range of values allowed for the item;
Input	The method of input where User means the user defines the values and System means software defines the values; and
Table	Reference to attributes in joined or linked tables or programs.

Projection of ArcView Shapefiles

All shapefiles created for the city are in the same projection. This projection is State Plane – 1983, California, Zone 5 with units of feet.

ArcView Project Files

Three applications were developed for the City. Each of the applications was embedded into itow own ArcView Project file as follows:

plot11by17.apr	Plots tiles on 11 in. by 17 in. sheets
plot22by36.apr	Plots tiles on 22 in. by 36 in. sh
watergis.apr	Hot links to scanned images of As-Builts and Details

plot11by17.apr and plot22by36.apr:

The plot11by17.apr and plot22by36.apr projects are very similar, except for the plot size each produces. The ArcView plotting scripts in each of these projects was latered to [print either a single tile or all tiles automatically. Regardless of how the print command is accessed, in layout or view mode, the "print" dialog box presentsw the user with a dropdown list including each tile and "All Tiles." The "All Tiles" option will print tiles 7 through 56 in a batch style process, one tile per sheet.

The ploting scripts are limited to printing only the "Water Service" view and "Plot 11 x 17" or "Plot 22 x 36" layouts at a predetermined scale.

The plot11by17.apr and plot22by36.apr projects require the following data files and directory structure:

data\shapefile\firehyd.shp
data\shapefile\fromcity\curblines.shp
data\shapefile\fromcity\parcels.shp
data\shapefile\fromcity\whparcel.shp
data\shapefile\mains.shp
data\shapefile\meter.shp
data\shapefile\nodes.shp
data\shapefile\pltomain.shp
data\shapefile\pltomain_lblpnt.shp
data\shapefile\tiles.shp
data\shapefile\valve.shp
data\tables\prcladd.dbf

watergis.apr

The watergis.apr project includes hot links to the scanned images of As-Built or Detail drawings. The hot linking script was altered to use only the "Image links" theme in the "Image Links" view. The hot link tool was modified to always be enabled.

Linked images are displayed by selecting the hot link tool button (button on the tool bar embazoned with a lightning bolt) and cliking on any of the blue or red asterisk-like symbols. Blue symbols are linked to Detail images. Red symbols are linked to As-Built images.

Parcel address numbers are labeled in this project by joining the prcladd.dbf file to the parcels.dbf file by the AIN field and autolabeling with the joined Add_number field.

The watergis.apr project requires the following data files and directory structure:

data\shapefile\firehyd.shp
data\shapefile\fromcity\curblines.shp
data\shapefile\fromcity\parcels.shp
data\shapefile\fromcity\whparcel.shp
data\shapefile\image.shp
data\shapefile\mains.shp
data\shapefile\meter.shp
data\shapefile\nodes.shp
data\shapefile\pltomain.shp
data\shapefile\pltomain_lblpnt.shp
data\shapefile\tiles.shp
data\shapefile\valve.shp
data\tables\prcladd.dbf

Hansen Software Data

The database design incorporates the data requirements of Hansen Software for Water as obtained from the City's IT department and Hansen representatives. Items required by Hansen Software for Water are flagged "Hansen SW" in the **Related Table** field of the **.DBF** tables, below. Communications with a Hansen representative determined that the following items were required by Hansen Software for Water (See Tables for field definitions):

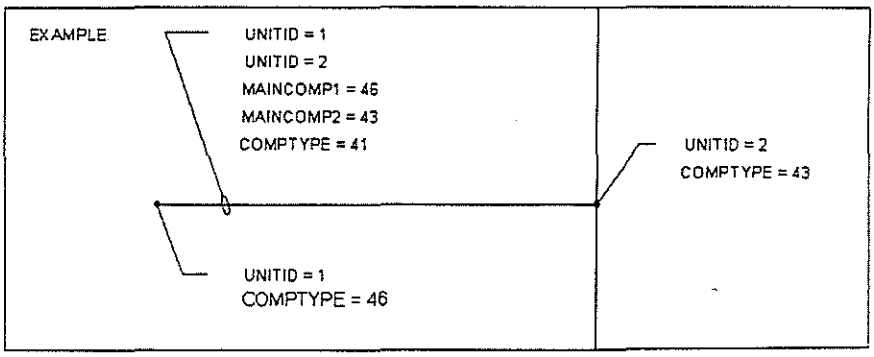
- For Water Lines: Item names COMPTYPE, UNITID, UNITID2, MAINCOMP1, and MAINCOMP2. (PARLINENO is required only for

identifying two lines that begin and end on the same nodes, no lines of this type were created during development of the Beverly Hills water system GIS);

- For all Points: Item names UNITID, and COMPTYPE.

According to the Hansen representative, the above fields are sufficient for relating the GIS data to Hansen Software for Water, when properly attributed. All pipes in Hansen Software for Water are identified by the UNITID of the point of beginning of the line ("from node") and the UNITID2 (UNITID of the end of the line at the "to node"). MAINCOMP1 is the COMPTYPE of the "from node" and MAINCOMP2 is the COMPTYPE of the "to node." COMPTYPE is the type of line (mains are identified by "41"). For all point and line features, the COMPKEY is an identification number created and maintained exclusively by the Hansen Software. Hansen Software for Water automatically generates the actual COMPKEY values. The COMPKEY field will not be populated by Black & Veatch.

Figure 1-1
Beverly Hills Water Distribution GIS Design
Hansen Software for Water Item Definitions


EXAMPLE
UNITID = 1
UNITID = 2
MAINCOMP1 = 46
MAINCOMP2 = 43
COMPTYPE = 41
UNITID = 2
COMPTYPE = 43
UNITID = 1
COMPTYPE = 46

After the GIS information is imported to Hansen Software for Water, specific additional data for the reservoirs, pump stations, and pressure reducing valves that may originate in data tables or field inspections will be entered to the data in Hansen.

Future maintenance of the data is intended to be done using the Hansen software. The version 7.5 of Hansen Software for Water permits ArcView display of facility attributes stored in Hansen databases.

The following table shows the Comptypes as defined by the Hansen Software.

Hanses Software Comptype Codes

COMPCODE	DESCRIPTION	COMPTYPE
HY	Hydrant	12
WBF	Water Backflow	38
WELL	Well	40
WMN	Water Main	41
WMTR	Water Meter	42
WMS	Water Miscellaneous	70
WND	Water Node	43
WP	Water Pump	44
WPL	Water Treatment Plant	99
WPS	Water Pump Station	78
WSL	Water Service Line	45
WSU	Water Storage Unit	67
WV	Water Valve	46

Beverly Hills Database Structure

The following tables show the structure of the databases that comprise the ArcView shapefiles for the Beverly Hills water system GIS.

Mains - Line Shapefile

Source: Digitized from Source Map

MAINS.DBF					
Item	**Format**	**Description**	**Domain**	**Input**	**Related Tab**
COMPKEY	NUM(9)	Unique Water Line ID	>0 unique sequential	System	Hansen SW
COMPTYPE	NUM(9)	Feature Type Code	COMPTYPE *	User	Hansen SW
UNITID	CHAR(16)	From Node ID	>0 unique sequential	System	Hansen SW
UNITID2	CHAR(16)	To Node ID	>0 unique sequential	System	Hansen SW
MAINCOMP1	NUM(9)	COMPTYPE of From Node	COMPTYPE *	User	Hansen SW
MAINCOMP2	NUM(9)	COMPTYPE of To Node	COMPTYPE *	User	Hansen SW
PARLINENO	NUM(9)	Used for Lines that share both To and From Nodes	>0 unique sequential	System	Hansen SW
NUMBER	NUM(9)	The unique ID of the Water Line	>0 unique sequential beginning at 1	System	
SIZE	NUM(4)	The diameter of the Water Line expressed in inches.	None	User	
MATERIAL	CHAR(2)	The material of the Water Line.	Pipe_Mat *	User	
PRESSURE_Z	CHAR(3)	The Pressure Zone Name	None	User	
DATE	NUM(4)	Water Line Install Year	Date	User	
CONSTDATE	NUM(4)	The date of the last construction activity.	Date	User	
CONSTTYPE	CHAR(2)	Type of last construction activity	Const_Type *	User	
STNAME	CHAR(30)	The street segment closest to the waterline	None	GIS Query	
Label	CHAR(12)	Field for labeling Mains		GIS Query	

* See Domain Tables.

The following Comptypes are included in the database MAINS.DBF:

Waterline Comptype Codes

COMPCODE	DESCRIPTION	COMPTYPE
WMN	Water Main	41
WSL	Water Service Line	45

Node Comptype codes and description are shown in the following section, Water Node ArcView Point Shapefile.

Several existing waterlines in the Beverly Hills system have been rehabilitated by relining of the interior, and were identified on the 1:1200 scale source documents. Where this information was identified, the date and type of relining was captured in the water system GIS as fields CONSTDATE and CONSTTYPE. The following lining rehabilitation codes were defined for inclusion in the waterline database:

Waterline Rehabilitation Codes

DESCRIPTION	CONSTTYPE
Not Defined	ND*
Calcite Lining	LC*
Epoxy Lining	LE*
Cement Mortar Lining	LM
Slip Lining	LS*
Not Rehabilitated	NR

* These codes were not used in the intitial creation of the Beverly Hill Water System GIS.

The following waterline pipe material codes were defined for inclusion in the waterline database.

Waterline Material Codes

DESCRIPTION	MATERIAL
Not Defined	ND
Cast Iron	CI
Brass	BR*
Steel	ST
Ductile Iron	DI
Reinforced Concrete	RC*
Asbestos Cement/Trancite	AC
Copper	CO
Plastic	PL*
Galvanized Steel/Black Iron	GA

* These codes were not used in the intitial creation of the Beverly Hill Water System GIS.

TIF Image Linking - Point Shapefile

Source: Heads-Up digitized from Source Map

As-built construction drawings and the 1:1200 scale source detail sheets were scanned and saved as TIF images. A series of linked points were created in the GIS that when appropriately used will open a separate window to show the scanned image. The TIFLINK point shapefile was created for this purposes and provides the link to the scanned images.

IMAGE.DBF					
Item	**Format**	**Description**	**Domain**	**Input**	**Related Table**
FNAME	CHAR(20)	The link to the TIF image file	Unique	System	
ANNO	CHAR(12)	Label Field		User	
Type	CHAR(10)	Image Type	"As-Built" or "Detail"	User	
X-Coord	NUM(9)	X-coordinate of feature in CA SPCS Zone 5 NAD83		System	
Y-Coord	NUM(9)	Y-coordinate of feature in CA SPCS Zone 5 NAD83		System	

Water Nodes - Point Shapefile

NODES.DBF					
Item	Format	Description	Domain	Input	Related Table
COMPKEY	NUM(9)	The unique ID of the Node	Unique, Not Null	System	Hansen SW
UNITID	NUM(9)	The unique ID of the Node	Unique, Not Null	System	Hansen SW
OLDNUM	CHAR(6)	Valve ID as it appears on the 1:1200 scale source documents	NONE	User	
COMPTYPE	NUM(9)	Hansen Water Software Junction Type	Comptype *	User	Hansen SW
SUBTYPE	CHAR(3)	Node Sub-type	Node_Subtype *	User	
DATE	NUM(4)	Date installed or last maintained.	Date	User	
X-Coord	NUM(9)	X-coordinate of feature in CA SPCS Zone 5 NAD83		System	
Y-Coord	NUM(9)	Y-coordinate of feature in CA SPCS Zone 5 NAD83		System	
Number	NUM(9)	The unique ID of the Node	Unique, Not Null	System	

* See Domain Tables

The following Comptypes were defined for inclusion in the node database:

Node Comptye Codes

COMPCODE	DESCRIPTION	COMPTYPE
WBF	Water Backflow Vault	38*
WELL	Well	40 *
WMS	Water Miscellaneous	70 *
WND	Water Node	43
WP	Water Pump	44 *
WPL	Water Treatment Plant	99 *
WPS	Water Pump Station	78
WSU	Water Storage Unit	67

*These codes were not used in the intitial creation of the Beverly Hill Water System GIS.

The following node_subtypes were defined for inclusion in the node database:

Node Subtype Codes

DESCRIPTION	SUBTYPE
Not defined	
End Cap	C
Reducer	R
Large Service Connection	LS
Fire Service Connection	FS
Date change	D
Material change	M

Water Valve - Point Shapefile

Source: Digitized from Source Map

VALVE.DBF					
Item	Format	Description	Domain	Input	Related Table
COMPKEY	NUM(9)	The unique ID of the Valve	Unique, Not Null	System	Hansen SW
UNITID	CHAR(16)	The unique ID of the Valve	Unique, Not Null	System	Hansen SW
OLDNUM	CHAR(6)	Valve ID as it appears on the 1:1200 scale source documents	NONE	User	
COMPTYPE	NUM(9)	Hansen Water Software Junction Type	Comptype *	User	Hansen SW
SUBTYPE	CHAR(3)	Valve Sub-type	Valve_Subtype *	User	
DATE	NUM(4)	Date installed or last maintained.	Date	User	
X-Coord	NUM(9)	X-coordinate of feature in CA SPCS Zone 5 NAD83		System	
Y-Coord	NUM(9)	Y-coordinate of feature in CA SPCS Zone 5 NAD83		System	
NUMBER	NUM(9)	The Unique ID of the Node	Unique, Not Null	System	
OPEN	NUM(1)	Opened/Closed valve flag	Opened=1, Closed=0	User	Valve Trace

* See Domain Tables

All records in valve database are Comptype 46, water valve.

The following valve subtypes were defined for inclusion in the valve database:

Valve Subtype Codes

DESCRIPTION	SUBTYPE
Not defined	ND
Air Release Valve	AR
Altitude Valve	AV*
Ball Valve	B*
Blow Off Valve	BO
Butterfly Valve	BF
Cone	CN*
Check Valve	CV*
Flow Control Valve	FL*
Plug Valve	PV
Pressure Regulator	PRV
Globe Valve	GL*
Gate Valve	GV

*These codes were not used in the intitial creation of the Beverly Hill Water System GIS.

Fire Hydrant - Point Shapefile

Source: Digitized from Source Map

FIREHYD.DBF					
Item	Format	Description	Domain	Input	Related Table
COMPKEY	NUM(9)	The unique ID of the Fire Hydrant.	Unique, Not Null	System	Hansen SW
UNITID	CHAR(16)	The unique ID of the Fire Hydrant.	Unique, Not Null	System	Hansen SW, Static Pressure Tables, Flow Test Data Tables
OLDNUM	CHAR(6)	The old ID of the Fire Hydrant as it appears on source maps.		User	
COMPTYPE	NUM(9)	Hansen Water Software Junction Type	Comptype *	User	Hansen SW
SUBTYPE	CHAR(3)	Fire Hydrant Sub-type	FH_Type *	User	
DATE	NUM(4)	Date installed or last maintained.	Date	User	
X-Coord	NUM(9)	X-coordinate of feature in CA SPCS Zone 5 NAD83		System	
Y-Coord	NUM(9)	Y-coordinate of feature in CA SPCS Zone 5 NAD83		System	
NEWNUM	CHAR(6)	The new ID of the Fire Hydrant as it provided by City.		User	
NUMBER	NUM(9)	The unique ID of the Node	Unique, Not Null	System	

* See Domain Tables

All records in fire hydrant database are Comptype 12, Fire Hydrant.

The following fire hydrant subtypes were defined for inclusion in the fire hydrant database:

Fire Hydrant Subtype Codes

DESCRIPTION	SUBTYPE
Not Defined	ND*
Jones	J
4"x(2)2.5" Nozzles	A*
6"x4"x2.5" Nozzles	B*
6"x4"x(2)2.5" Nozzles	C*
6"x(2)2.5" Nozzles	D*

*These codes were not used in the intitial creation of the Beverly Hill Water System GIS. Due to the ongoing fire hydrant replacement program and the lack of updated source information, all fire hydrants were captured as Subtype J, Jones.

Water Meter - Point Shapefile

Source: Digitized from Source Maps

METER.DBF					
Item	Format	Description	Domain	Input	Related Table
ADDNUMBER	CHAR(6)	Address Number of meter	NONE	GIS Query	Meter Replacement Database
ADDSTREET	CHAR(30)	Address Street Name of meter	NONE	GIS Query	Meter Replacement Database
ADDZIP_4	CHAR(10)	Address Zip Code plus 4 of meter	NONE	GIS Query	Meter Replacement Database
AIN	CHAR(12)	City ID of Meter	NONE	GIS Query	Meter Replacement Database
DISTANCE	NUM(2)	Distance of Meter from Property Line	≥0	User	
X-Coord	NUM(9)	X-coordinate of feature in CA SPCS Zone 5 NAD83		System	
Y-Coord	NUM(9)	Y-coordinate of feature in CA SPCS Zone 5 NAD83		System	
NUMBER	CHAR(5)	The unique ID of the Water Meter Theme	Unique, Not Null	System	
SIZE	CHAR(10)	Size of the Water Meter	NONE	GIS Query	Meter Replacement Database

Property Line to Main - Line Shapefile

Source: Heads-Up Digitized from Source Maps

PLTOMAIN.DBF					
Item	Format	Description	Domain	Input	Related Table
DISTANCE	NUM(5.2)	Distance from Property Line to Main according to source maps	≥0	User	

Property Line to Main Label Point - Point Shapefile

Source: Heads-Up Digitized from Source Maps

PLTOMAIN_LBLPNT.DBF					
Item	Format	Description	Domain	Input	Related Table
ANNO	CHAR(8)	Text for Labeling End Point of Property Line to Main	≥0	GIS Query	

Tiles - Polygon Shapefile

Source: Digitized from Source Maps

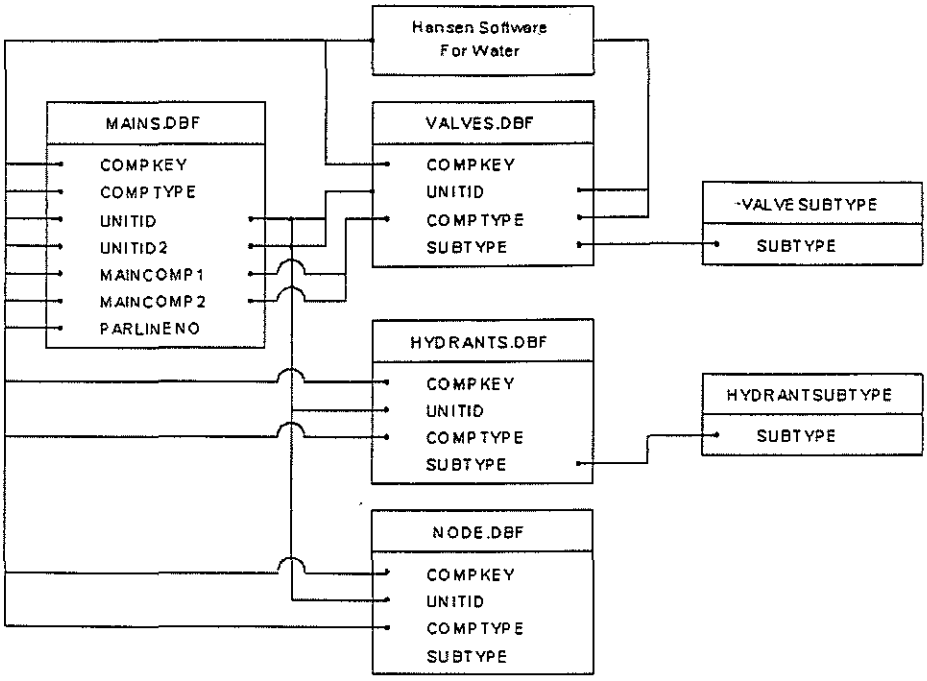
TILES.DBF					
Item	Format	Description	Domain	Input	Related Table
INDEX	NUM(11)	Index Grid		User.	

Pressure Zone - Polygon Shapefile

Source: GIS Query, Dissolve of Parcels by Pressure Zone

PREZONE.DBF					
Item	Format	Description	Domain	Input	Related Table
ZONENUM	CHAR(3)	Zone number according to source maps	≥0	User	

Figure 1-2
Beverly Hills Water Distribution GIS Design



Beverly Hills, California
Water Master Plan, 2000
Entity Relationship Diagram

BLACK AND VEATCH CORPORATION

MEMORANDUM
Beverly Hills, California
Water System Master Plan
Water Distribution Model - Development

B & V Project: 97033.100
February 21, 2001

GENERAL

The purpose of this technical memorandum is to summarize the process used for preparing the hydraulic model and the approach used for incorporating the GIS data into the model.

The hydraulic model is to include pipes that are 4 inches diameter and larger as represented in the Beverly Hills Water System GIS. The model also includes all of the pumping station, water storage, and control valve facilities present in the system.

Black & Veatch has purchased 3 copies of H2Onet Version 3.0, 4,000 pipes version, for use on this project. At project completion, the software and documentation will be delivered to the City.

NETWORK TOPOLOGY

A Water System GIS was created as another task of this project. The GIS was created from scratch from existing maps and details (1:1200 scale), and review of record drawings ("as-builts") maintained by the City. The Water System GIS was used as the basis to create the initial network connectivity for the water distribution system model.

The initial network in the GIS consisted of 9,791 pipe segments, and 9,169 node elements. Wyes, tees, and crosses; system valves; blow off and air relief valves; large user and fire service connections; and pumping stations and reservoirs are all identified as node elements in the GIS. The model network was constructed from the GIS Mains and Nodes coverage using a B&V written ArcView extension, database and spreadsheet queries, and selected "hand-on" modifications, to create an simplified model network as described in the following steps:

1. **Step 1 - 1st "Reduce":** Using the B&V written ArcView extension, "Reduce" reduced excessive pipe segmentation caused by valves, hydrant leads, etc. The "reduce" step does not eliminate any pipe length from the network; rather it combines pipes of the same diameter and material into a longer pipe so that the total number of modeled nodes and pipe segments becomes more manageable. The results of the 1st "Reduce" are summarized below:

	Input	Output
Pipe Segments	9,791	5,723
Node Elements	9,169	5,101

2. **Step 2 – Modify Short Lengths of Varying Diameter Pipe:** Using database and spreadsheet tools, short lengths of pipe which differed in diameter from the adjacent pipe were modified by to make the diameter of the short piece equal to the diameter of the longer piece of pipe. This process was completed only where the short piece of pipe was larger in diameter than the longer piece of pipe. A maximum length of 20' was used for modifying short pipe segments. No pipe segments over 20' were modified in this step.

3. **Step 3 – 2nd "Reduce:** The "Reduce" process was initiated a second time to combine the modified short pipe segments with the adjacent longer pipe segments. The results of the 2nd "Reduce" are summarized below:

	Input	Output
Pipe Segments	5,723	5,442
Node Elements	5,102	4,821

4. **Step 4 – "Trim":** Using the B&V written ArcView extension, "Trim" short pipe segments that are dead ends and small diameter (such as hydrant leads, blow off lines, and air relieve valve lines) were removed from the network. All 8" and smaller pipes segments less than 200' in length were removed from the network during this step. The results of the "Trim" are summarized below:

	Input	Output
Pipe Segments	5,442	3,766
Node Elements	4,821	3,141

5. **Step 5 – "Manual" GIS Edits:** The network was edited in ArcView to further reduce short lengths of pipe, which differed in diameter from the adjacent pipe. Diameters of shorter segments of pipe were modified and then combined with longer segments to reduce the total number of pipe segments and nodes. Selection of pipe segments to be modified was based on engineering judgement to provide a simplified model with insignificant impact on the modeling results. Piping at PRV stations were simplified, and additional pipe segments and node elements were added at pumping stations for later addition of pump and pressure reducing valve elements.

6. **Step 6 – 3rd "Reduce":** The "Reduce" process was initiated a third time to combine short pipe segments with the adjacent longer pipe of the same diameter that were remaining after the manual edit step. The results of the 3rd "Reduce" are summarized below:

	Input	Output
Pipe Segments	3,504	2,870
Node Elements	2,870	2,823

Upon completion of the GIS network topology steps described above, ground elevations were assigned to each remaining node. The City provided GIS ground contour information at 1-foot intervals. Network node elevations were captured by GIS spatial query by assigning the node an elevation equal to the closest ground contour.

H2ONet's shapefile import functionality was then used to bring the completed network and data into the software. H2Onet's network quality control steps included creating check plots of the total system and of the key facilities, and GIS queries to check for successful data import and elimination of redundant or lost nodes.

7. **Step 7 – Manual Reduce:** After import of the reduced GIS data to the modeling software, a detailed manual evaluation of the remaining nodes and junctions was undertaken. Many lengths of pipe less than 130 feet were combined with adjacent longer pipes of the same diameter. Main and node connectivity was checked in detail. The end result was a further simplified model. Nodes were added at facilities as required for modeling pumps and control valves (pressure reducing and pressure relief), and elements that had been imported to the model as pipes were replaced with pumps and control valves where appropriate. After a series of quality control reviews, elimination of some abandoned pipe along Calle Vista Dr., and addition of facilities details (described below), the computer hydraulic model of the existing water distribution system contained the following:

	Base Model*
Pipe Segments	2,587
Junction Nodes	2,003
Flow Control Valves	6
Pressure Reducing Valves	10
Pressure Relief Valves	9
Pumps	26
Reservoirs	9

*Base model of existing water distribution system.

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FACILITY DETAILS, PUMP CURVES & VALVE SETTINGS

After import of the network topology from GIS, facility data was entered into the model. The input facility information is described in this section. Details of modeled facilities are attached to this memorandum.

Reservoirs were modeled as "fixed head reservoirs". Input data consists of "bottom elevation" and "initial water level". The "initial water level" indicates the depth of the water in the tank, and sets the hydraulic grade line for each analysis. The input bottom elevations, and "initial water level" equal to a full tank are summarized below:

Reservoirs	Bottom Elevation (USGS)	Full Depth Water Level (feet)	Overflow Elevation (feet)
Sunset Reservoir	363	21	384
Coldwater Reservoir	440	14	454
Greystone Reservoir	585	43	628
Reservoir 3A	599	29	628
Reservoir 4A	778	22	800
Reservoir 4B	769	31	800
Reservoir 5	1021	31	1052
Reservoir 6	1261	31	1292
Reservoir 7	1471	31	1502

Rate of control valves were modeled at the Central Control Building. The rate of flow is the input value and adjusted based on the demand conditions to control the flow from MWD into the system.

Flow Control Valves	Downstream Elevation	Supply/ Upstream Zone	Flow Setting* (mgd)
Central Control Building			
To Zone 3 (east)	378	BH-1	Varies
To Zone 3 (west)	378	BH-2	Varies
To Zone 4 (east)	380	BH-1	Varies
To Zone 4 (west)	380	BH-2	Varies
To Zone 6 (east)	383	BH-1	Varies
To Zone 6 (west)	383	BH-2	Varies

Piping within the pumping facilities was modeled based on reference to the source map details, record drawing images, and other data that had been collected during the course of the Master Planning Study. All pumping units at the pump stations were included in the model. Details for each of the pump stations are attached. Pump curves as input into the model are attached. Input data at the pump stations is summarized below:

Pumps	Elevation (USGS)	Curve Used
Sunset Reservoir PS		
Pump 1 & 2	391	Curve 1, Sunset BPS
Coldwater PS		
Pump 1, 2, & 3	440	Curve 10, Coldwater (No. 2)
Greystone PS		
Pump 1 & 2	560	Curve 7, Greystone BPS
Pump 3, Diesel	560	Design Point Curve (2,000 gpm @ 280')
PS 3A (at Reservoir 3A)		
Pump 1 & 2	590	Curve 8, No. 3A PS
Monte Cielo PS (at Res. 3A)		
Pump 1 & 2	600	Curve 6, Monte Cielo BPS
Pump 3, Diesel	600	Design Point Curve (1,200 gpm @ 465')
PS 4B (at Reservoir 4B)		
Pump 1 & 2	770	Curve 5, No. 4B PS
Pump 3, Diesel	770	Design Point Curve (2,000 gpm @ 280')
PS 5 (at Reservoir 5)		
Pump 1 & 2	1020	Curve 4, No. 5 PS
Pump 3, Diesel	1020	Design Point Curve (2,000 gpm @ 280')
PS 6 (at Reservoir 6)		
Pump 1 & 2	1260	Curve 3, No. 6 PS
Pump 3, Diesel	1260	Design Point Curve (2,000 gpm @ 280')
PS 8 (at Reservoir 7)		
Pump 1 & 2	1470	Curve 2, No. 8 PS
Pump 3, Diesel	1470	Design Point Curve (2,100 gpm @ 130')
Green Acres BPS		
Booster No. 1	448	Curve 9, Green Acres BPS

All PRV stations were modeled. The model was simplified at the PRV stations as shown on the attached details. In some cases, the actual PRV stations contained a smaller, bypass PRV valve in addition to the larger valve. Only one PRV was modeled at each PRV station. PRVs located at booster pump stations were also included in the model. Pumping Station No. 3 (Coldwater) contains 3 PRVs of varying diameter and downstream pressure setting. The model includes only one PRV at PS No. 2 with a setting equal to the lowest reported setting. Select input data at PRV stations and locations is summarized below:

Pressure Reducing Valves	Downstream Node Elevation	Downstream HGL [1]	PRV Setting (psi) [2]	HGL (USGS)
From Zone 6 to Zone 5				
Lomitas & Maple	351	500 [3]	60	490
Lomitas & Crescent	361	500	60	500
From Zone 6 To Zone 4				
BPS No. 2 (Coldwater)	438	454	3	445
Sunset & Maple	378	454	28	443
Lexington & Alpine	403	454	17	443
From Zone 4 to Zone 3				
Charleville & Rodeo	228	384	58	362
From Zone 6 to Zone WH5				
Cynthia & Doheny	314	487 [3]	75	487
Phyllis & Doheny	337	487	62	480
From Zone 4 to Zone WH3				
Carmelita & Doheny	233	367 [3]	58	367
Melrose & Santa Monica	226	367	60	365

[1] Static hydraulic grade line of the downstream zone based on full reservoir in the downstream zone.
[2] PRV settings shown are those used in the initial design maximum day and maximum hour analyses. The PRV settings may vary between scenarios.
[3] Zones 5, WH5, and WH3 do not contain storage. Downstream HGL based on the higher of the two PRV set point HGLs.

Pressure relief valves between zones were included in the computer model. However, pressure relief valves to atmosphere are not included in the model. Pressure relief valves are model as a pipe element that is normally closed. Adjustable control settings then allow the model to open the pipe if the upstream pressure exceeds the input set point. The modeled pressure relief valves and their set points are summarized in the following table:

Pressure Relief Valves	Upstream Node Elevation	Upstream HGL [1]	Control Setting (psi)	HGL (USGS)
From Zone 16 to Zone 15				
BPS No. 8 (at Reservoir 7)	1470	1655[2]	120	1747
From Zone 15 to Zone 13				
BPS No. 6 (at Reservoir 6)	1260	1502	125	1548
From Zone 13 to Zone 11				
BPS No. 5 (at Reservoir 5)	1020	1292	138	1338
From Zone 11 to Zone 8				
BPS No. 4 (at Reservoir 4B)	770	1052	138	1098
From Zone 9 to Zone 8				
Loma Linda Dr.	650	1105[2]	214	1156
From Zone 8 to Zone 6				
Greystone BPS	560	800	124	846
Summit Drive	428	800	191	846
From Zone 4 to Zone 3				
Rexford & Foothill	229	454	120	507
From Zone WH5 to Zone WH3				
Harratt St.	306	487[3]	87	507

[1] Static hydraulic grade line of the upstream zone based on full reservoir in the upstream zone.
[2] Zones 16 and 9 do not contain storage. Upstream HGL based on typical pumping gradient to the zone.
[3] Zone WH5 does not contain storage. Upstream HGL based on downstream pressure setting at supply PRV to zone.

C-VALUES

Hazen-Williams friction factors "C-values" were assigned to each pipe segment based on the age and material of the pipe. Age and material information was available from the GIS database for each segment and imported for the model creation. A summary table of the main information for the existing system, exported from the computer model, is attached. The table shows the length of main by size and material in the model of the existing system.

In the complete GIS (prior to reducing and trimming) about 3% of the total pipe length was of unknown material classification, and about 20% was of unknown construction date. Most of the mains of unknown material were removed from the model network in the steps described previously in this memorandum. By this process, it was determined that the mains of unknown material consisted mainly of the hydrant leads, blow-off, and air-relieve valve lines. In the completed model data of the existing system, the percent of mains of unknown construction date was reduced to 17%.

The C-values for pipes of unknown construction data was based on adjacent pipe ages and materials. The installation date is unknown for about 17% of the modeled pipe. Of pipes with unknown date, approximately 80% (14% of total length) is CIP, and 19% (3% of total length) is steel. A large amount of the undated CIP is located in the upper pressure zones, and was likely constructed in the post-war period of the 1950's. The remaining undated CIP is located in the older section of town south of Sunset Boulevard. This pipe was considered to be much older with construction dates back to the 1920's.

A portion of the steel pipe has been relined, and this information also was available from the GIS database. The C-value for steel pipe was based on the date of relining, when known. If no relining date was available, the C-value for steel pipe was based on the installation date. The majority of undated, unlined steel pipe is located in the upper pressure zones, and was likely constructed in the post-war period of the 1950's.

Two significant date breakpoints are discussed below with regard to estimating the interior condition of the existing mains:

- First, prior to about 1952, all cast iron pipe (CIP) was unlined. After about 1952, cement-mortar-lining of CIP became standard. Ductile iron pipe (DIP) replaced CIP during the 1970s. All ductile-iron pipe is standard cement-mortar-lined.
- Second, in the past the City operated two lime-softening water treatment plants that treated groundwater from City wells. In addition to the treatment plants, the City purchased water from the Metropolitan Water District of Southern California (MWD). The City first received water from MWD in 1941. In 1976, the City, by Council resolution, established the present policy of exclusive use of imported water from MWD.

The C-values assigned to the pipe segments in the network model are summarized below:

Construction Date	C-Value 24"	8"-20"	6" and Smaller	Comments
Future Pipes	120	120	120	
1990 – new	120	120	110	
1975 - 1990	110	110	100	
1950 – 1974	110	100	80	All undated pipes north of Sunset Blvd
Before 1950		70	60	All undated pipes south of Sunset Blvd.

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DEMANDS/ALLOCATION

The City provided metered sales data for each customer for each meter reading cycle for the years 1997, 1998 and 1999. Using database and GIS techniques, the total sales for each customer for the year 1999 were summarized and allocated to the computer model. The metered sales data was converted to average annual day usage in mgd, before allocation to the model (original metered sales data was in 100 cubic feet).

Use Classes: Seven classes were provided in the original metered sales data. Only two sales classes were allocated to the computer model, residential (RES) and industrial-commercial-institutional (ICI), by combining the seven original class as shown below:

RES	ICI
R-single Sales	Commercial Sales
R-double Sales	Industrial Sales
R-multi Sales	Municipal Sales
	Private Sales

A third class, unaccounted-for water (UNF) is also included in the computer model. Unaccounted-for water was calculated as 10% of the total sales at each node for allocation.

Beverly Hills Allocation: The data provided by the City included the parcel AIN number for most of the customers located in Beverly Hills. Using the AIN number, the customer was geographically located (using GIS) within the system. Where there were missing or non-matching AIN numbers, the billing address was used for locating the customer, and the AIN number from the GIS system was re-assigned to replace the original.

An ARCView shapefile was exported from the computer model for further demand processing. This shapefile included only those nodes that were to have demand allocation. It excluded nodes at facilities, and nodes which on mains in the front of a street when all the services were identified to be in the alley.

A field was created in the parcel database for junction identification. This field was filled with the closest model node number. The automated node to parcel allocation was visually checked using a series of maps, to verify that the parcels had been assigned a reasonable node number (based on pressure zone and customer meter location).

The demands for each node were then summarized for each use class (RES, ICI). Unaccounted-for water (UNF) was then assigned to each node equal to 10% of the total allocation at each node.

West Hollywood Allocation: The GIS data provided by the City and used for the Water System Master Plan did not include AIN numbers for any parcels in West Hollywood. Therefor, it was not possible to geographically locate water sales customers using AIN matching techniques.

The total sales for West Hollywood were summed for each of the classes RES and ICI. The "Zone Daily Report" provided by the City for July 31 and August 14, 2000 indicated that about 57% of the total West Hollywood demand was being used in Zone 5WH with the remainder being used in Zone 3WH, as shown below:

	August 14, 2000		July 31, 2000		Design
	(mgd)	(%)	(mgd)	(%)	(%)
WH5	1.034	58.5%	0.976	56.6%	57%
WH3	0.733	41.5%	0.748	43.4%	43%
Total	1.767		1.724		

Based on this information, 57% of the total sales in West Hollywood were allocated to Zone WH5 and 43% to Zone WH3. The demand was allocated uniformly to each node within each of the two West Hollywood pressure zones. After allocation of the metered sales, unaccounted-for use was allocated to each node equal to 10% of the allocated sales.

Summary of Metered Sales Allocation: The allocated 1999 metered sales and unaccounted-for water in the computer model are summarized below:

Pressure Zone	RES (mgd)	ICI (mgd)	UNF (mgd)	Total (mgd)
3	1.921	0.641	0.285	2.848
4	2.247	1.529	0.420	4.196
5	0.447	0.014	0.051	0.512
6	1.655	0.176	0.203	2.035
8	0.688	0.046	0.082	0.816
9	0.048	0.000	0.005	0.053
11	0.165	0.000	0.018	0.184
13	0.149	0.000	0.017	0.166
15	0.334	0.000	0.037	0.371
16	0.024	0.000	0.003	0.027
WH3	0.118	0.414	0.059	0.591
WH5	0.156	0.548	0.077	0.781
TOTAL	**7.952**	**3.370**	**1.257**	**12.579**

Calibration Demands: The model was verified by matching existing maximum hour conditions which occurred between 8:00 and 9:00 a.m. on July 31, 2000. Peaking factors were applied to each user class to increase the allocated demands to match the observed maximum hour demands by pressure zones. The demands within each pressure zone were determined based on the SCADA and Daily Report data provided by the City.

None of the pumps were operating during the calibration hour except for those supplying the closed pressure zones 16 and 9. Neither of these two zones contains floating storage and the pumps must remain on at all times. The Monte Cielo BPS supplies Zone 9 and PS No. 8 supplies Zone 16. The "Daily Zone Usage Report" provides a daily flow at these two pump stations which greatly exceeds the anticipated demand in their respective zones. For calculation evaluation, the demands in the closed zones are considered to be a portion of the demands within the zone from which they receive supply. Since only the two pump stations to the closed zones were operating during the calibration hour, as verified from the Daily Pump Report, no pump flows are shown in the following table.

Active PRVs, those that are open and allowing flow transfer between zones, are included in the table of maximum hour demands. In addition, several PRVs were not active at any time during the day and are not shown in the table. Inactive PRVs on July 31, 2000 are summarized below:

PRVs Not Activated – July 31, 2000
Charleville & Rodeo PRV (Zone 4 to Zone 3)
Phyllis & Doheny PRV (Zone 6 to Zone 5WH)
Lomitas & Crescent PRV (Zone 6 to Zone 5)
Sunset & Maple PRV (Zone 6 to Zone 4)
Alpine & Lexington PRV (Zone 6 to Zone 4)
Pump Station No. 2 PRV (Zone 4 to Zone 6)

The demand in each zone during the observed maximum hour condition was determined based on the recorded flow at control valves and the change in reservoir water levels, as summarized in the following table. Schematic diagrams of the observed flow for each pressure zone for the maximum day of July 31, 2000 and the maximum hour on that day are attached to this memorandum.

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Hourly Demand – July 31, 2000 – 8:00 to 9:00 am

	8:00 am	9:00 am	Rate (mgd)	
ZONE 15 and 16 COMBINED				
Res. No. 7 Vol. (gal)	908,057	856,255	1.24 (in)	Daily Storage Report
Total			**1.24 mgd**	
ZONE 13				
Res. No. 6 Vol. (gal)	773,917	752,776	0.51 (in)	Daily Storage Report
Total			**0.51 mgd**	
ZONE 11				
Res. No. 5 Vol. (gal)	727,913	711,521	0.39 (in)	Daily Storage Report
Total			**0.39 mgd**	
ZONE 8 and 9 COMBINED				
Res. No. 4A Vol. (gal)	969,258	922,377	1.13 (in)	Daily Storage Report
Res. No. 4B Vol. (gal)	705,705	659,700	1.10 (in)	Daily Storage Report
Total			**2.23 mgd**	
ZONE 6				
Res. No. 3A Vol. (gal)	950,528	964,007	0.32 (out)	Daily Storage Report
Greystone East Level (ft)	34.86	34.87	0.05 (out)	SCADA Printout [1]
Greystone West Level (ft)	34.13	34.14	0.05 (out)	SCADA Printout [1]
MWD Supply (cfs)	11.97	11.97	7.74 (in)	Daily MWD Report
Lomitas & Maple PRV (gpm)	693	821	1.09 (out)	SCADA Printout
Cynthia & Doheny PRV (gpm)	1206	1008	1.59 (out)	SCADA Printout
Total			**4.63 mgd**	
ZONE 5				
Lomitas & Maple PRV (gpm)	693	821	1.09 (in)	SCADA Printout
Total			**1.09 mgd**	
ZONE 4				
Coldwater Res. Vol. (gal)	4,712,685	4,542,878	4.08 (in)	Daily Storage Report
MWD Supply (cfs)	7.06	7.06	4.56 (in)	Daily MWD Report
Carmelita & Doheny PRV (gpm)	226	315	0.39 (out)	SCADA Printout
Melrose & Doheny PRV (gpm)	464	522	0.71 (out)	SCADA Printout
Total			**7.54 mgd**	
ZONE 3				
Sunset Res. Vol. (gal)	3,954,952	3,896,543	1.40 (in)	Daily Storage Report
MWD Supply (cfs)			4.49 (in)	Daily MWD Report
Total			**5.89 mgd**	
ZONE 5WH				
Cynthia & Doheny PRV (gpm)	1206	1008	1.59 (in)	SCADA Printout
Total			**1.59 mgd**	
ZONE 3WH				
Carmelita & Doheny PRV (gpm)	226	315	0.39 (out)	SCADA Printout
Melrose & Doheny PRV (gpm)	464	522	0.71 (out)	SCADA Printout
Total			**1.09 mgd**	

Total Demand 8:00 to 9:00 July 31, 2000 26.21 mgd

[1] Daily Tank Report and SCADA report do not report same information. SCADA report used for Greystone because Daily Tank Report presents inconsistent level and volume for Greystone.

Peaking factors and demands by zone and by class, as used in the computer model for model verification are shown in the following table:

July 31, 2000 Maximum Hour
Model Verification Peaking Factors – Demands by Zone and Class

Pressure Zone	RES factor	RES (mgd)	ICI factor	ICI (mgd)	UNF (mgd)	Calculated Peak Hour (mgd)	Observed 7/31/00 Demand 8-9 am (mgd)
3	2.2	4.226	1.75	1.122	0.285	5.634	5.89
4	2.2	4.944	1.75	2.677	0.420	8.040	7.54
5	2.4	1.072	1.75	0.024	0.051	1.148	1.09
6	2.5	4.138	1.75	0.308	0.203	4.649	4.63
8 & 9	2.8	2.060	1.75	0.081	0.082	2.223	2.23
11	3	0.495	1.75	0.000	0.018	0.514	0.39
13	3	0.446	1.75	0.001	0.017	0.464	0.51
15 & 16	3	1.073	1.75	0.001	0.037	1.112	1.24
3H	2.2	0.259	1.75	0.724	0.059	1.042	1.10
5H	2.2	0.344	1.75	0.959	0.077	1.380	1.59
TOTAL	2.397	19.059	1.750	5.898	1.249	26.206	26.21

The summary of allocated demands and model verification peaking factors validates the allocation of metered sales and substantiates that residential peaking factors increase as elevation increases.

Design Demands: As described in the report, the City is nearly at build-out. Design demands in the computer model are based on those presented in the report. The design demands are achieved in the computer model be applying appropriate peaking factors to the allocated 1999 metered sales.

For evaluation of the design peaking factors, the July 31, 2000 maximum day demand by pressure zone was calculated similar to the maximum hour demand as described above. The most significant difference is that although only the two closed system pumping stations where operating during the maximum hour, at other times during the day, pumps were operated at Reservoir 3A and at Greystone. The flow transfers as a result are included in the following table showing the total daily demand by pressure zone on July 31, 2000.

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July 31, 2000	**Begin**	**End**	**Rate (mgd)**	
ZONE 15 and 16				
Res. No. 7 Vol. (gal)	1,077,459	544,603	0.53 (in)	Daily Zone Usage Report
Total			**0.53 mgd**	
ZONE 13				
Res. No. 6 Vol. (gal)	847,418	567,692	0.28 (in)	Daily Zone Usage Report
Total			**0.28 mgd**	
ZONE 11				
Res. No. 5 Vol. (gal)	793,482	562,405	0.23 (in)	Daily Zone Usage Report
Total			**0.23 mgd**	
ZONE 8 and 9				
Res. No. 4A Vol. (gal)	1,110,901	831,605	0.28 (in)	Daily Zone Usage Report
Res. No. 4B Vol. (gal)	521,159	59,854	0.06 (in)	Daily Zone Usage Report
Greystone Pumps	8.20 hrs @ 1,150gpm		0.57 (in)	Daily Pump Report
PS No. 3A Pumps	9.09 hrs @ 1,150gpm		0.62 (in)	Daily Pump Report
Total			**1.53 mgd**	
ZONE 6				
Res. No. 3A Vol. (gal)	655,485	513,954	0.14 (in)	Daily Zone Usage Report
Greystone East Vol. (ft)	7,075,984	6,443,348	0.63 (in)	Daily Zone Usage Report
Greystone West Vol. (ft)	7,621,306	6,975,571	0.65 (in)	Daily Zone Usage Report
MWD Supply (cfs)			4.44 (in)	Daily Zone Usage Report
Lomitas & Maple PRV (gpm)			0.76 (out)	Daily Zone Usage Report
Cynthia & Doheny PRV (gpm)			0.98 (out)	Daily Zone Usage Report
Greystone Pumps	8.20 hrs @ 1,150gpm		0.57 (out)	Daily Pump Report
PS No. 3A Pumps	9.09 hrs @ 1,150gpm		0.62 (out)	Daily Pump Report
Total			**2.93 mgd**	
ZONE 5				
Lomitas & Maple PRV (gpm)			0.76 (in)	Daily Zone Usage Report
Total			**0.76 mgd**	
ZONE 4				
Coldwater Res. Vol. (gal)	4,002,978	5,753,300	1.75 (out)	Daily Zone Usage Report
MWD Supply (cfs)			7.40 (in)	Daily Zone Usage Report
Carmelita & Doheny PRV (gpm)			0.18 (out)	Daily Zone Usage Report
Melrose & Doheny PRV (gpm)			0.57 (out)	Daily Zone Usage Report
Total			**4.90 mgd**	
ZONE 3				
Sunset Res. Vol. (gal)	4,124,335	2,436,338	1.69 (in)	Daily Zone Usage Report
MWD Supply (cfs)			1.68 (in)	Daily Zone Usage Report
Total			**3.37 mgd**	
ZONE 5WH				
Cynthia & Doheny PRV (gpm)			0.98 (in)	Daily Zone Usage Report
Total			**0.98 mgd**	
ZONE 3WH				
Carmelita & Doheny PRV (gpm)			0.18 (in)	Daily Zone Usage Report
Melrose & Doheny PRV (gpm)			0.57 (in)	Daily Zone Usage Report
Total			**0.75 mgd**	
Total Demand on July 31, 2000			**16.3 mgd**	

The observed maximum day and maximum hour demands and peaking factors by service level are summarized in the following table:

July 31, 2000
Observed Demands by Zone

Pressure Zone	Allocated Sales and Unaccont. (mgd)	Observed 7/31/00 Demand 8-9 am (mgd)	Observed 7/31/00 Daily Total (mgd)	Observed MD:AD Ratio	Observed MH:MD Ratio	Observed MH:AD Ratio
3	2.848	5.89	3.37	1.18	1.75	2.07
4	4.196	7.54	4.91	1.17	1.54	1.80
5	0.512	1.09	0.76	1.48	1.43	2.13
6	2.035	4.63	2.93	1.44	1.58	2.28
8 & 9	0.869	2.23	1.53	1.76	1.46	2.57
11	0.184	0.39	0.23	1.25	1.70	2.12
13	0.166	0.51	0.28	1.69	1.82	3.07
15 & 16	0.398	1.24	0.53	1.33	2.34	3.11
3H	0.591	1.10	0.75	1.27	1.47	1.86
5H	0.781	1.59	0.97	1.24	1.64	2.03
TOTAL	**12.579**	**26.21**	**16.26**	**1.30**	**1.60**	**2.08**

Based on the observed peaking factors, design peaking factors and demands by service level were developed as shown in the following tables:

Design Peaking Factors and Demands by Zone
Design Maximum Day Demand = 25 mgd

Pressure Zone	RES factor	RES (mgd)	ICI factor	ICI (mgd)	UNF (mgd)	Total (mgd)	MD:AD Ratio
3	2.0	3.842	1.7	1.090	0.285	5.218	1.83
4	2.3	5.168	1.7	2.600	0.420	8.188	1.95
5	2.3	1.028	1.7	0.024	0.051	1.102	2.15
6	2.3	3.807	1.7	0.300	0.203	4.310	2.12
8 & 9	2.6	1.913	1.7	0.079	0.087	2.079	2.39
11	2.6	0.429	1.7	0.000	0.018	0.448	2.44
13	2.6	0.387	1.7	0.001	0.017	0.404	2.44
15 & 16	2.6	0.930	1.7	0.001	0.040	0.971	2.44
3H	2.0	0.235	1.7	0.703	0.059	0.998	1.69
5H	2.0	0.312	1.7	0.932	0.077	1.322	1.69
TOTAL	2.270	18.053	1.700	5.730	1.257	25.040	1.99

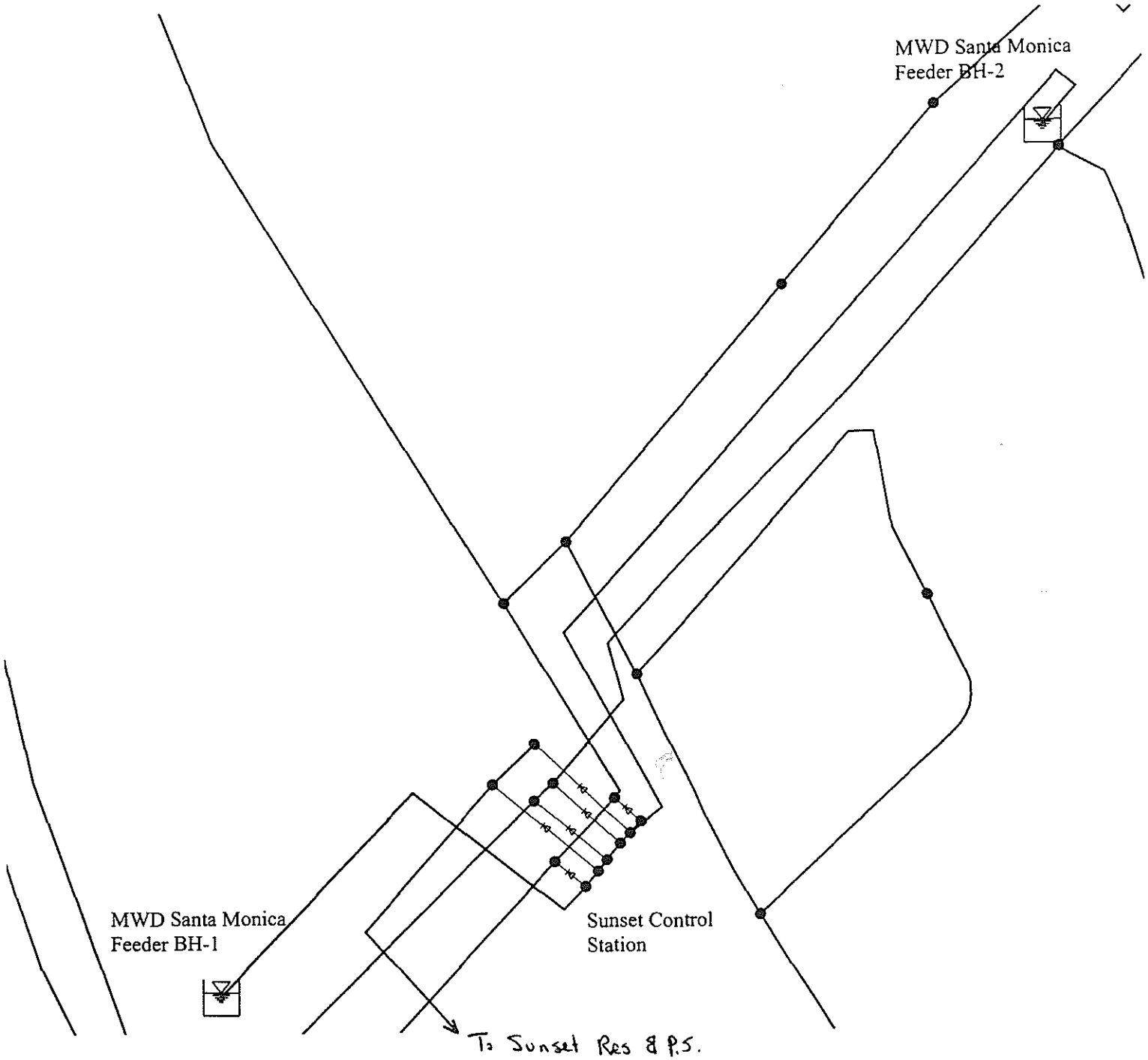
BLACK AND VEATCH CORPORATION

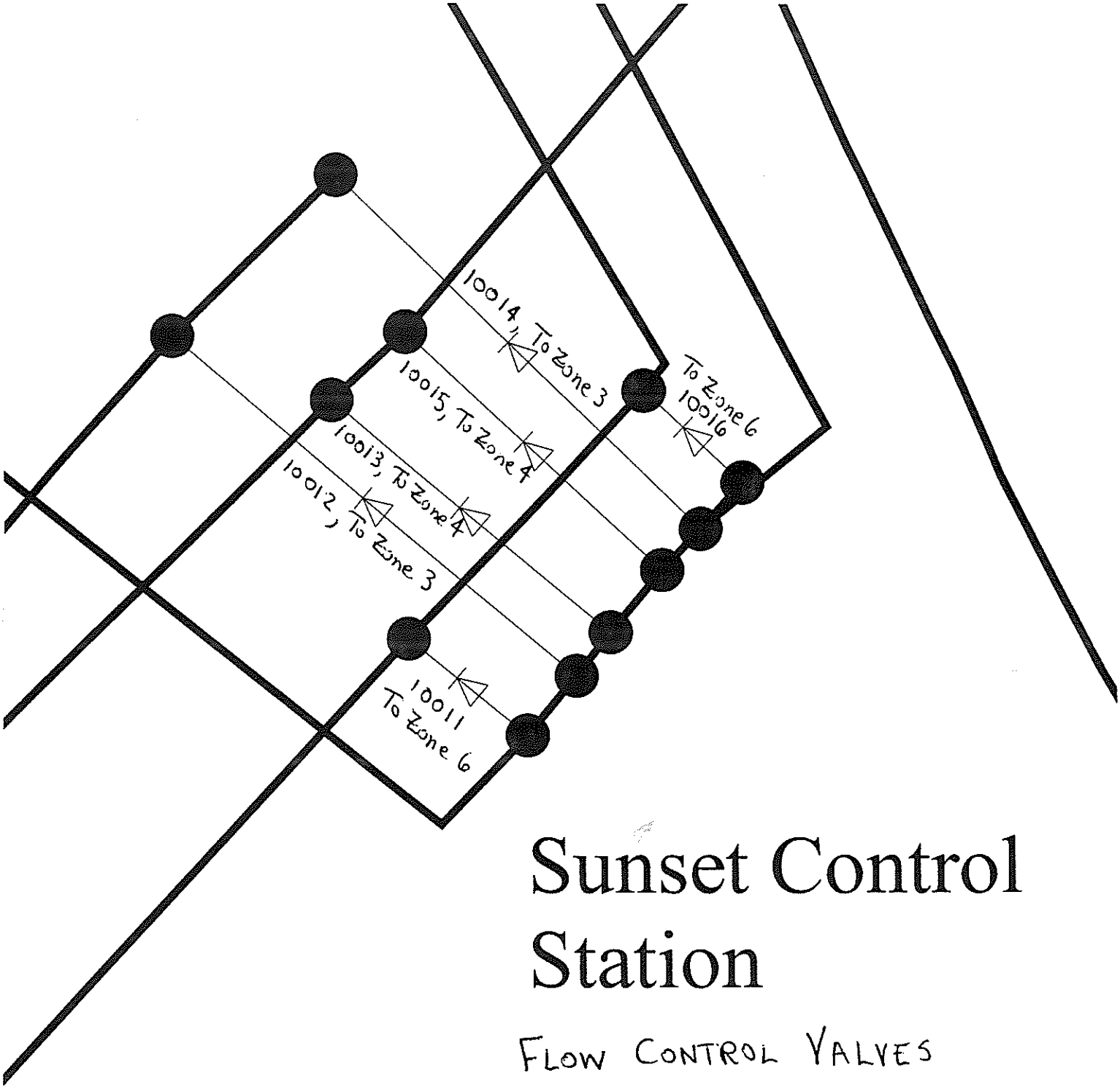
MEMORANDUM
Beverly Hills, California
Water System Master Plan
Water Distribution Model - Development

B & V Project: 97033.100
February 21, 2001

Design Peaking Factors and Demands by Zone
Design Maximum Hour Demand = 37.5 mgd

Pressure Zone	RES factor	RES (mgd)	ICI factor	ICI (mgd)	UNF (mgd)	Total (mgd)	MH:MD Ratio	MH:AD Ratio
3	2.8	5.379	2.5	1.603	0.285	7.268	1.39	2.55
4	3.6	8.090	2.5	3.824	0.420	12.333	1.51	2.94
5	3.6	1.609	2.5	0.035	0.051	1.694	1.54	3.31
6	3.6	5.958	2.5	0.441	0.203	6.602	1.53	3.24
8 & 9	4.3	3.164	2.5	0.116	0.087	3.366	1.62	3.87
11	4.3	0.710	2.5	0.001	0.018	0.729	1.63	3.97
13	4.3	0.640	2.5	0.001	0.017	0.658	1.63	3.96
15 & 16	4.3	1.539	2.5	0.001	0.040	1.580	1.63	3.97
3H	2.8	0.330	2.5	1.034	0.059	1.423	1.43	2.41
5H	2.8	0.437	2.5	1.371	0.077	1.885	1.43	2.41
TOTAL	3.503	27.855	2.500	8.426	1.257	37.539	1.50	2.98

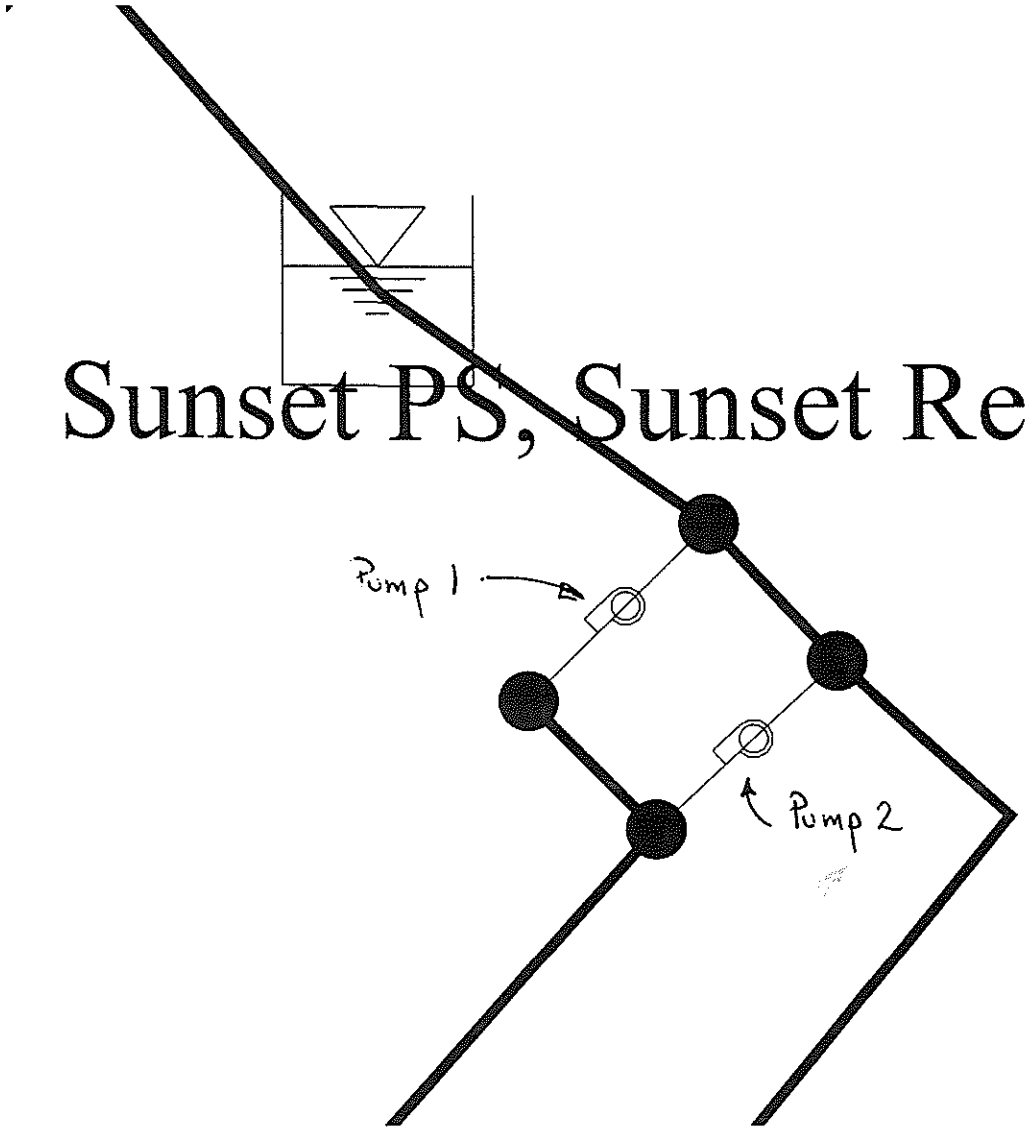

MWD Santa Monica
Feeder BH-2
MWD Santa Monica
Feeder BH-1
Sunset Control
Station
To Sunset Res & P.S.

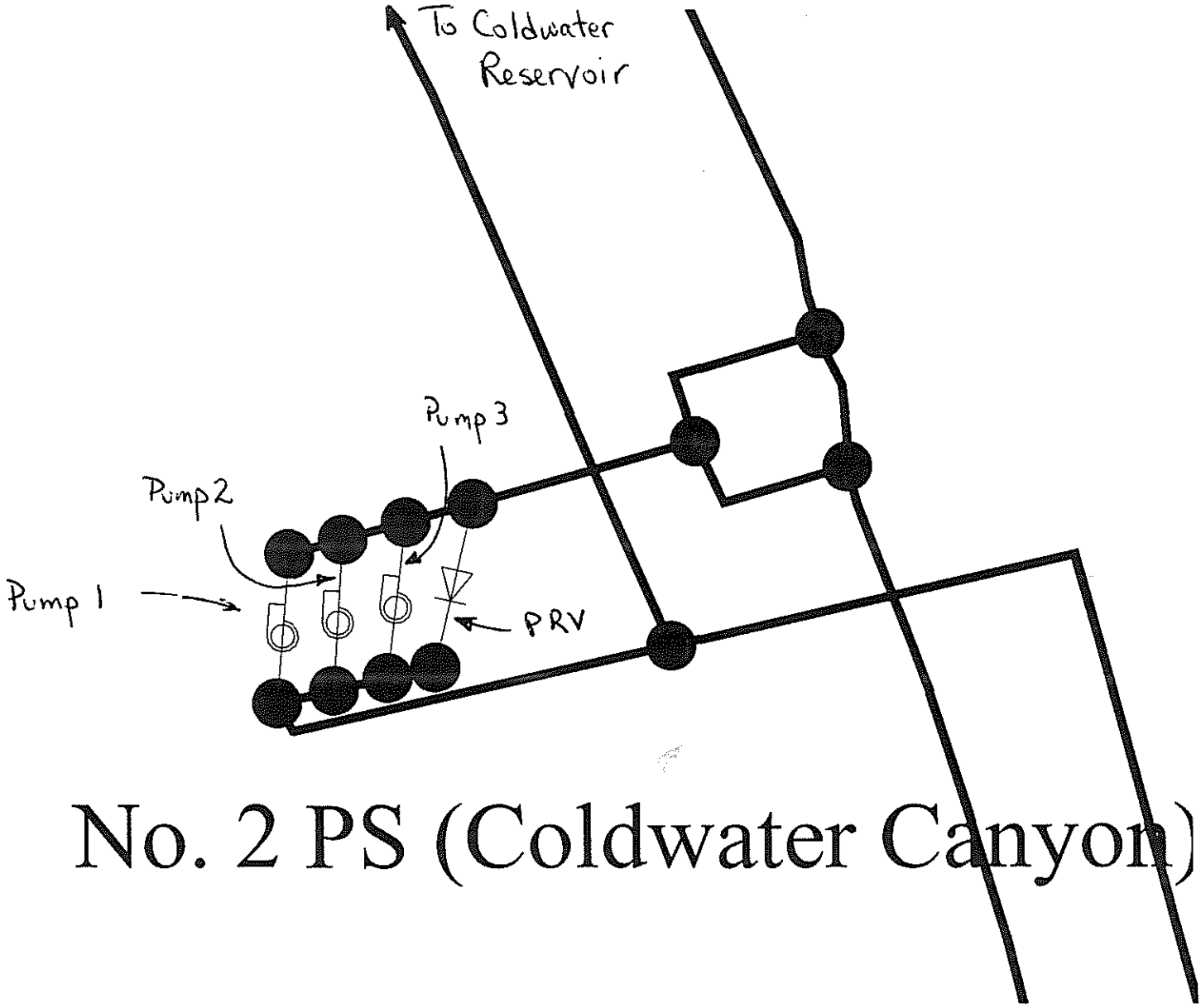


Sunset Control Station

FLOW CONTROL VALVES

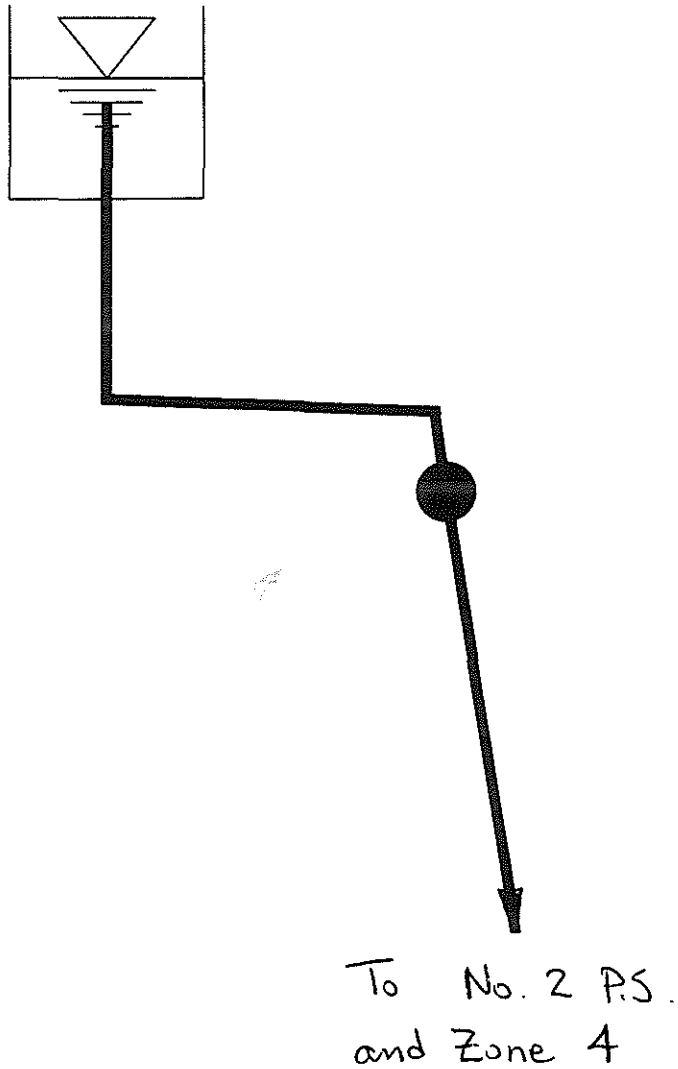
Sunset PS, Sunset Reservoir

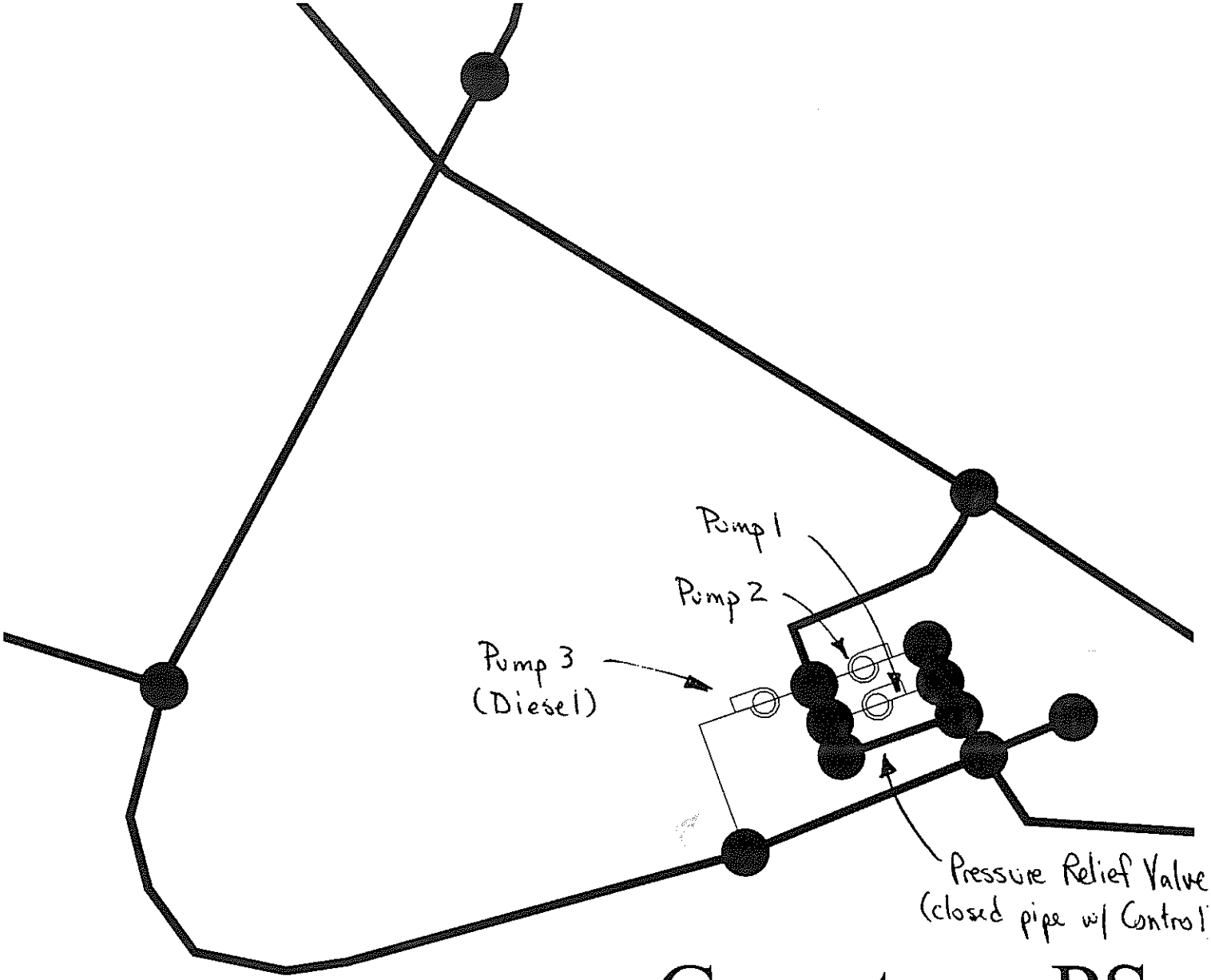




No. 2 PS (Coldwater Canyon)

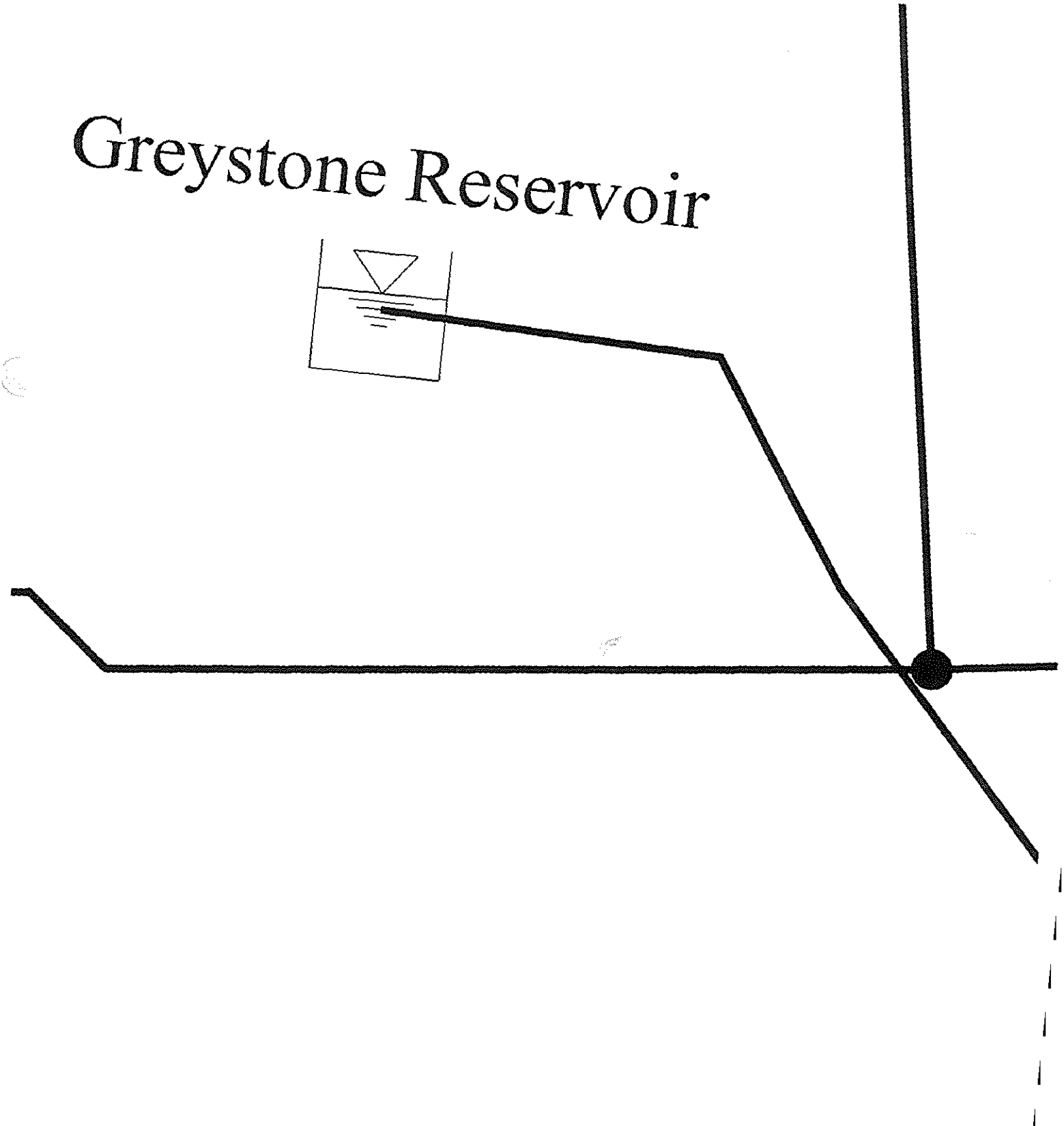
Coldwater Canyon Reservoir

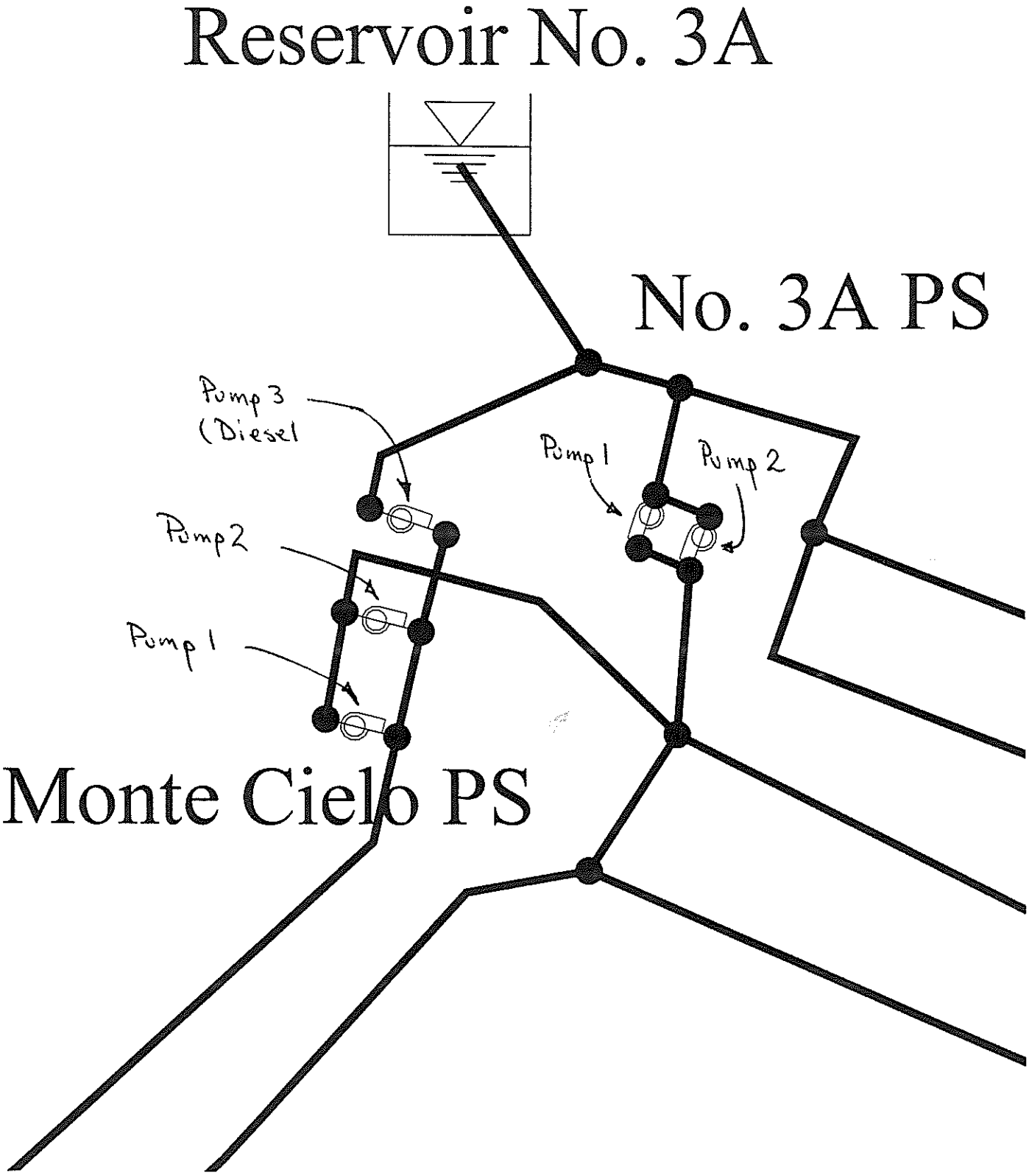


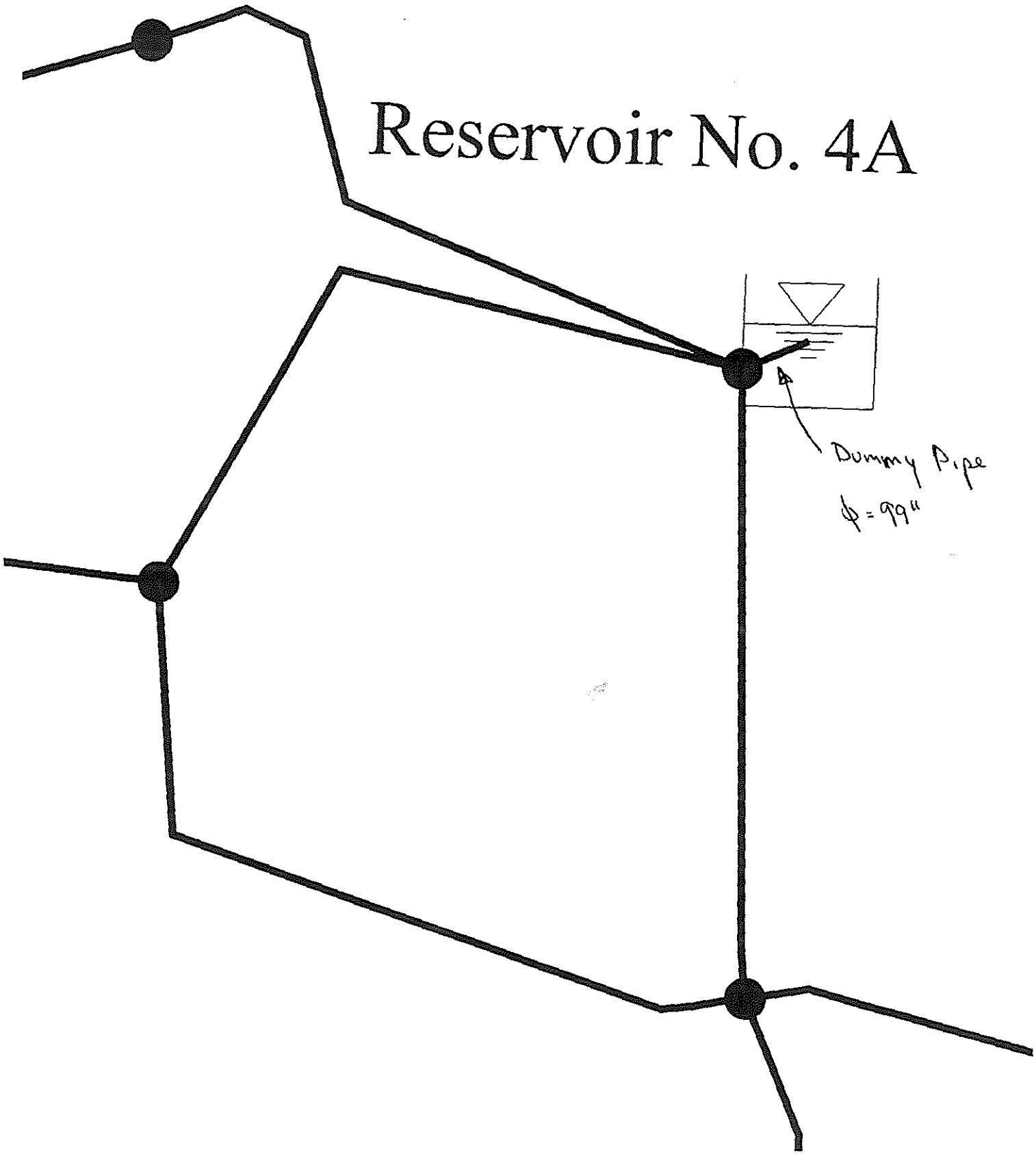


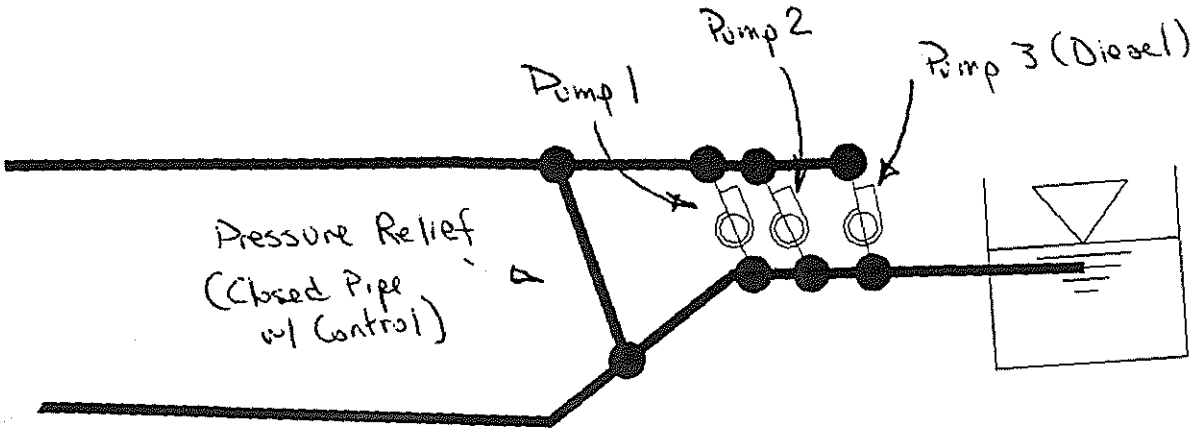
Greystone PS

Greystone Reservoir

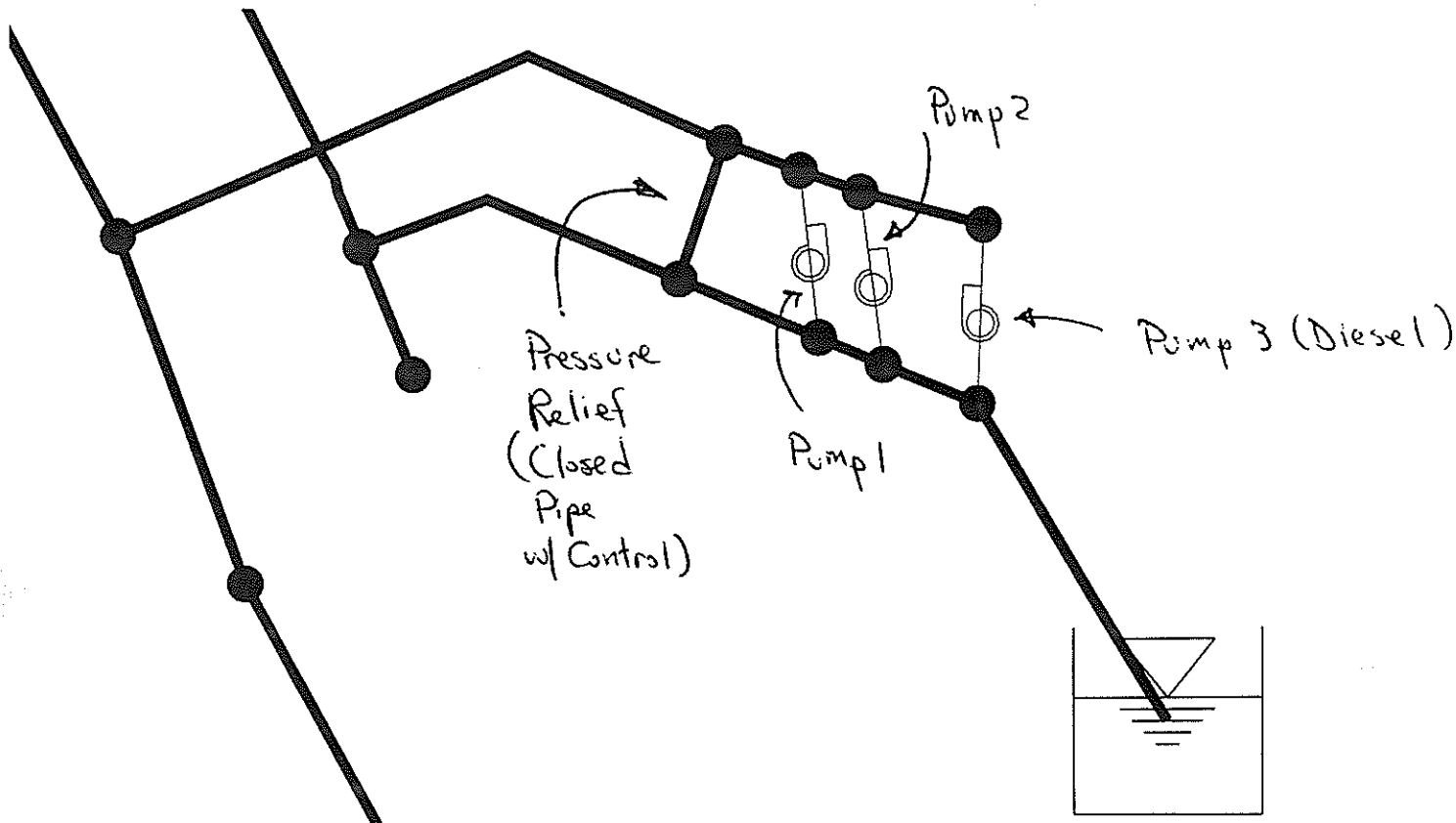



Reservoir No. 3A
No. 3A PS
Pump 3
(Diesel
Pump 1
Pump 2
Pump 2
Pump 1
Monte Cielo PS

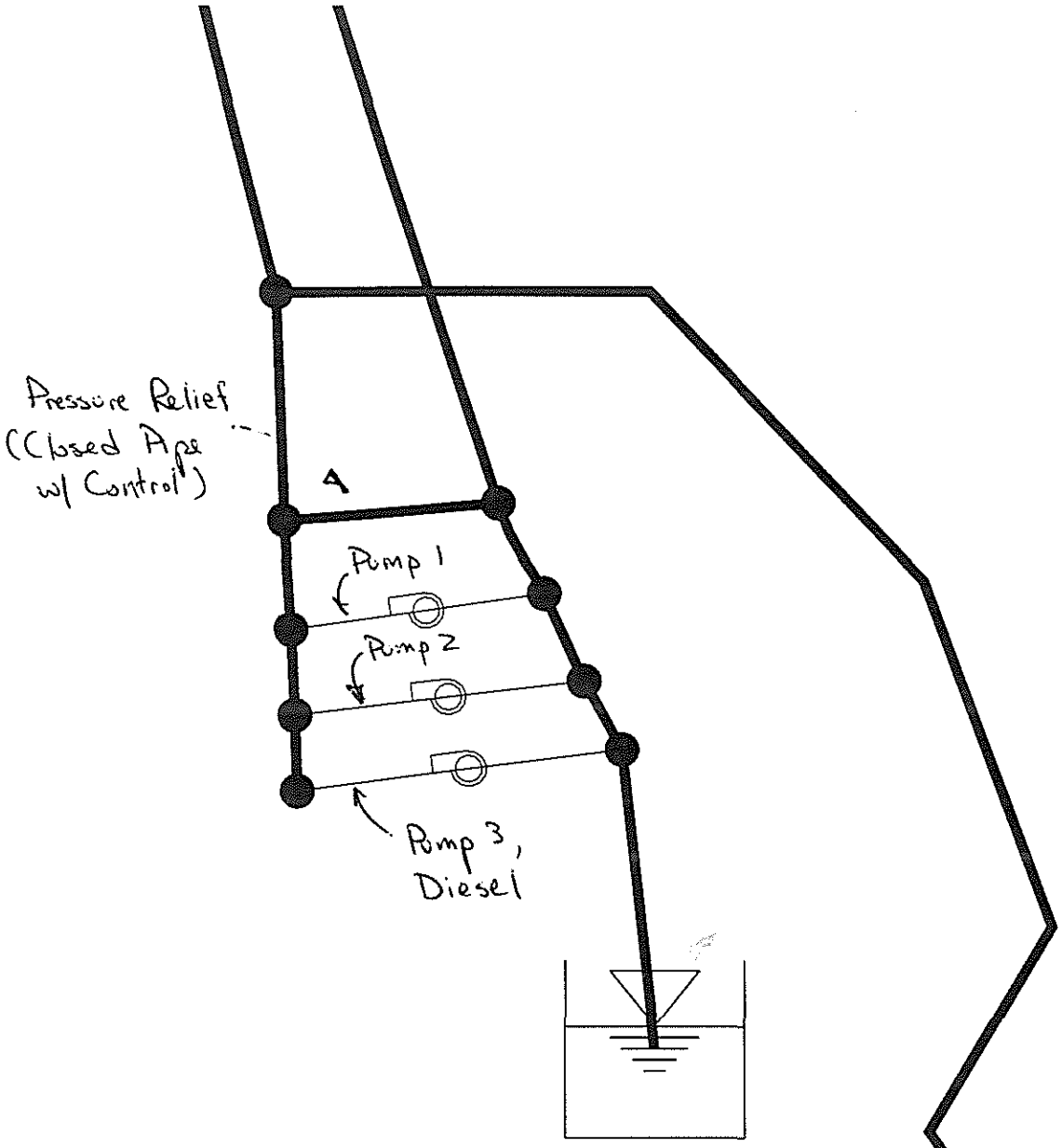

Reservoir No. 4A
Dummy Pipe
ϕ = 99"



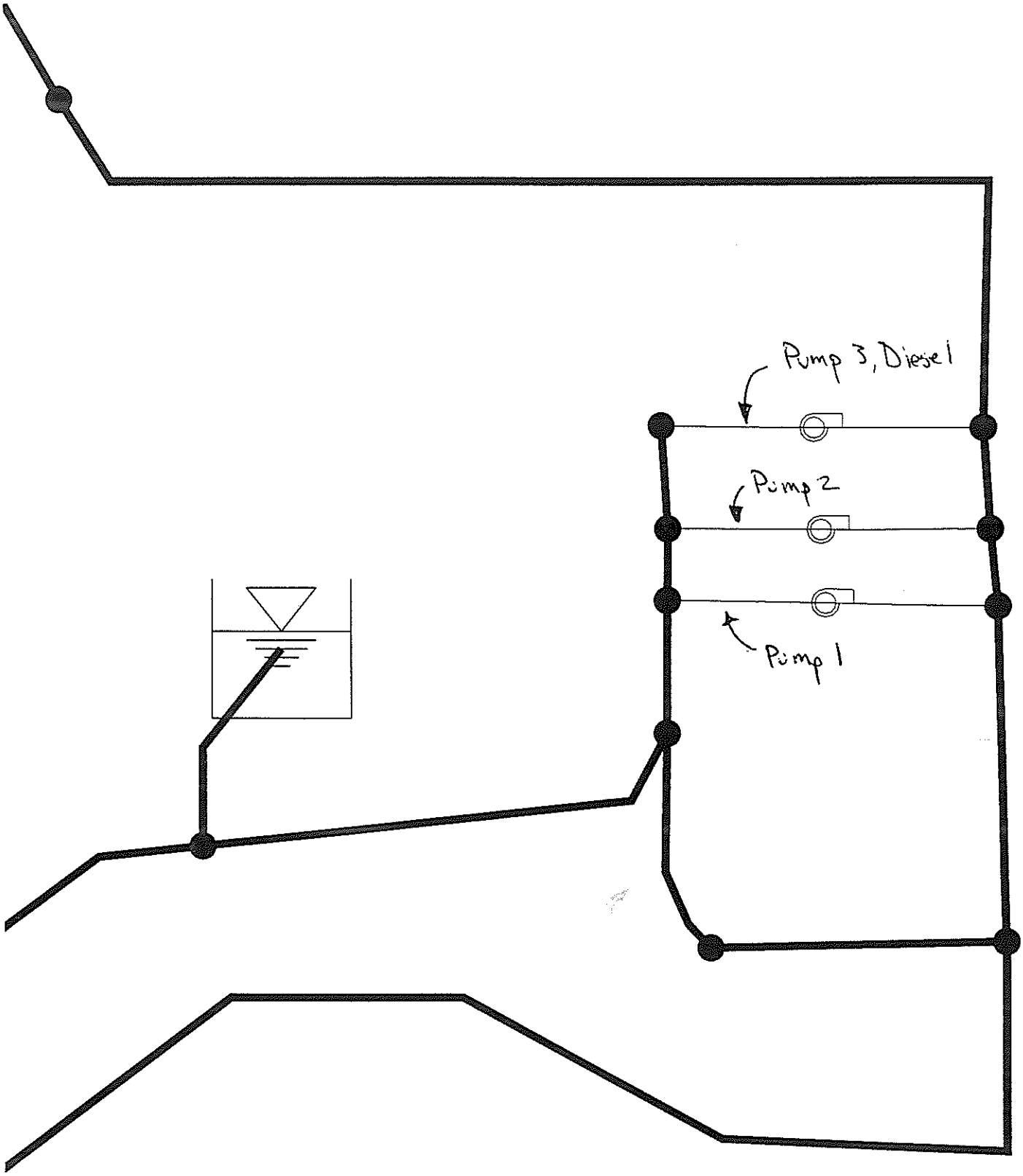
No. 4B PS, Reservoir No. 4B



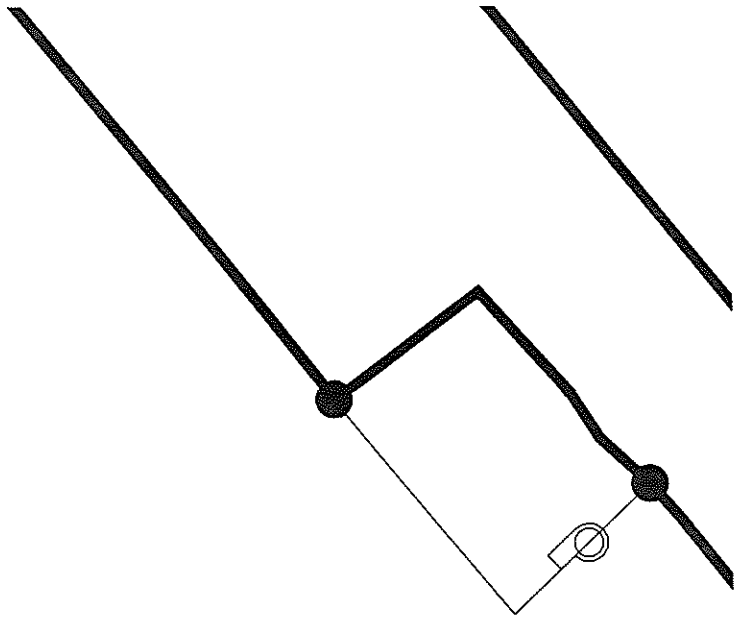
No. 5 PS, Reservoir No. 5



No. 6 PS, Reservoir No. 6

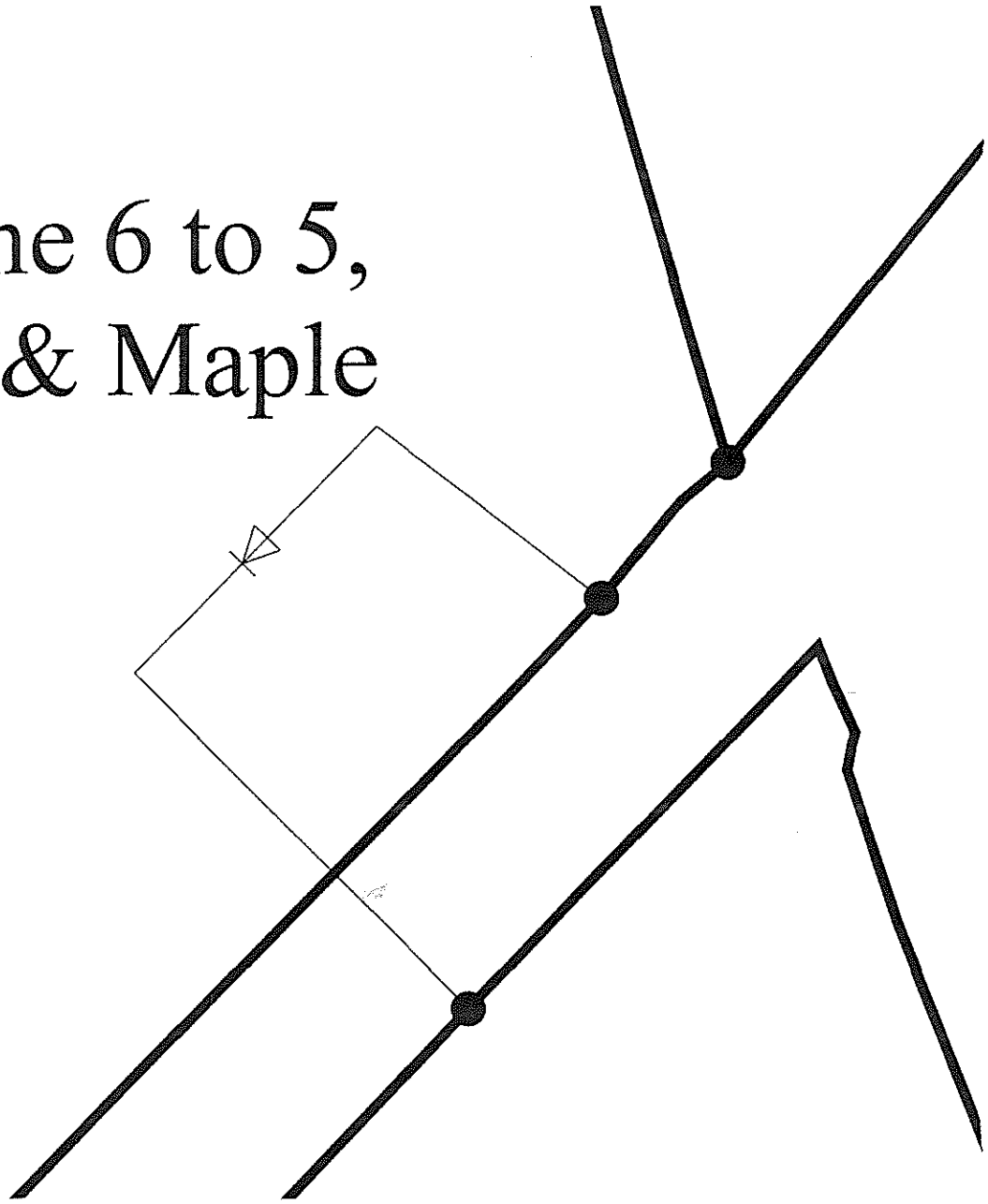


No. 8 PS, Reservoir No. 7

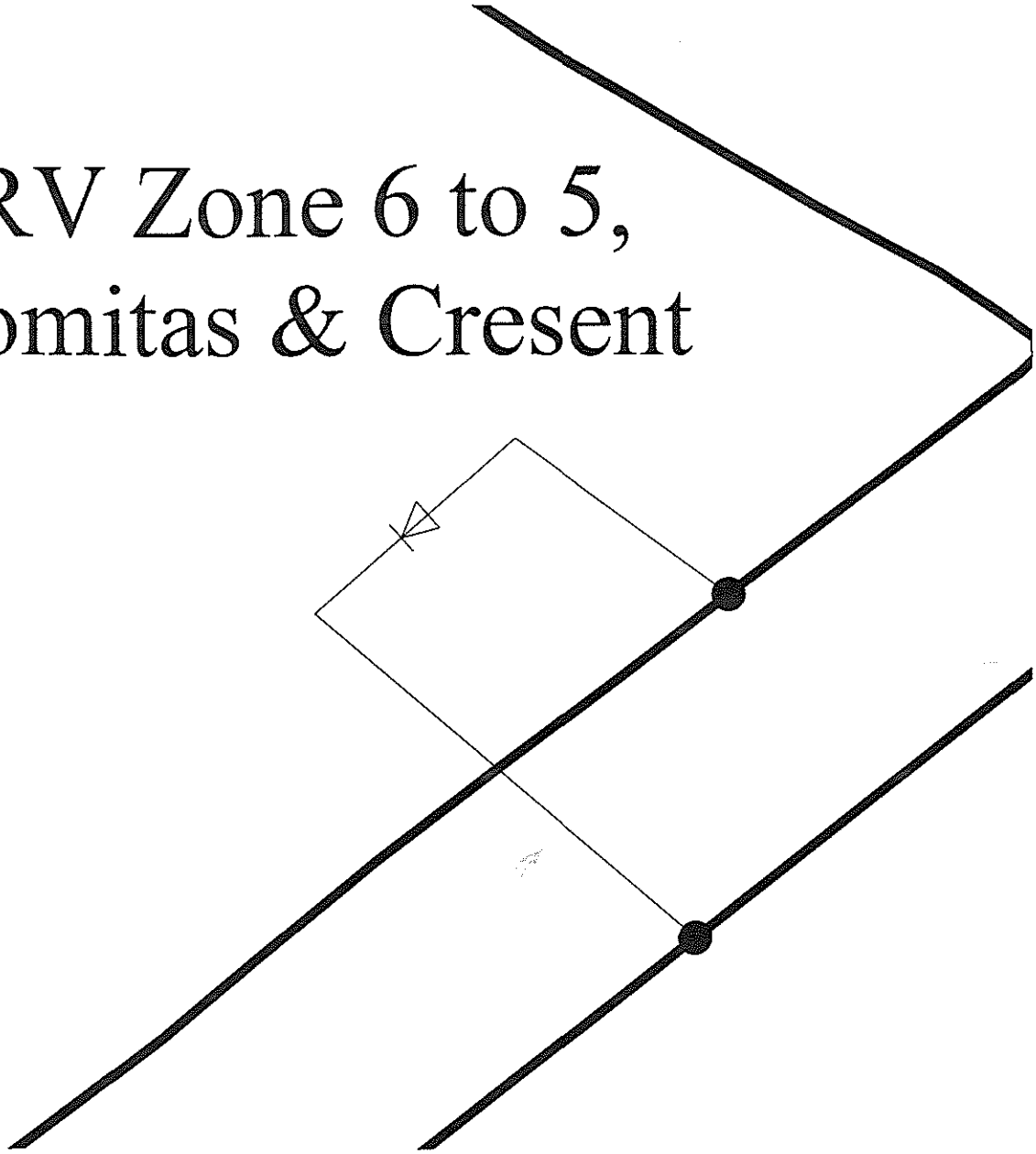


Green Acres BPS

PRV Zone 6 to 5, Lomitas & Maple

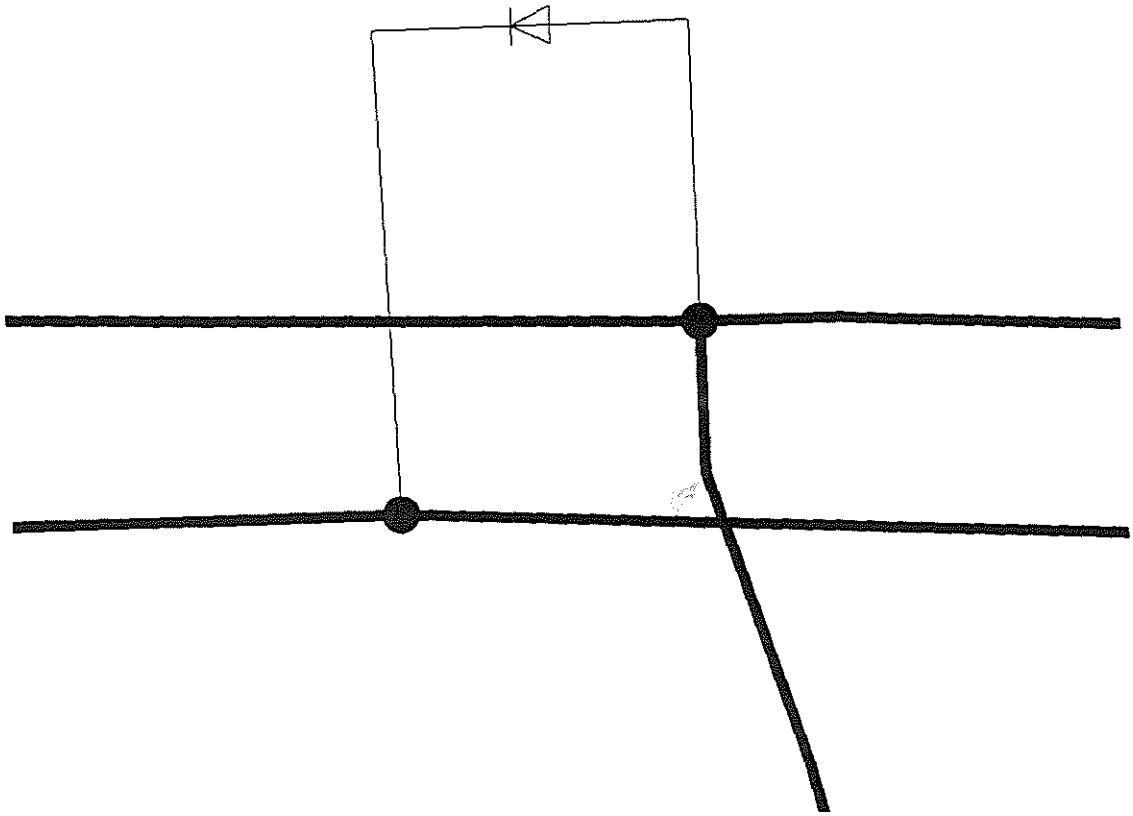


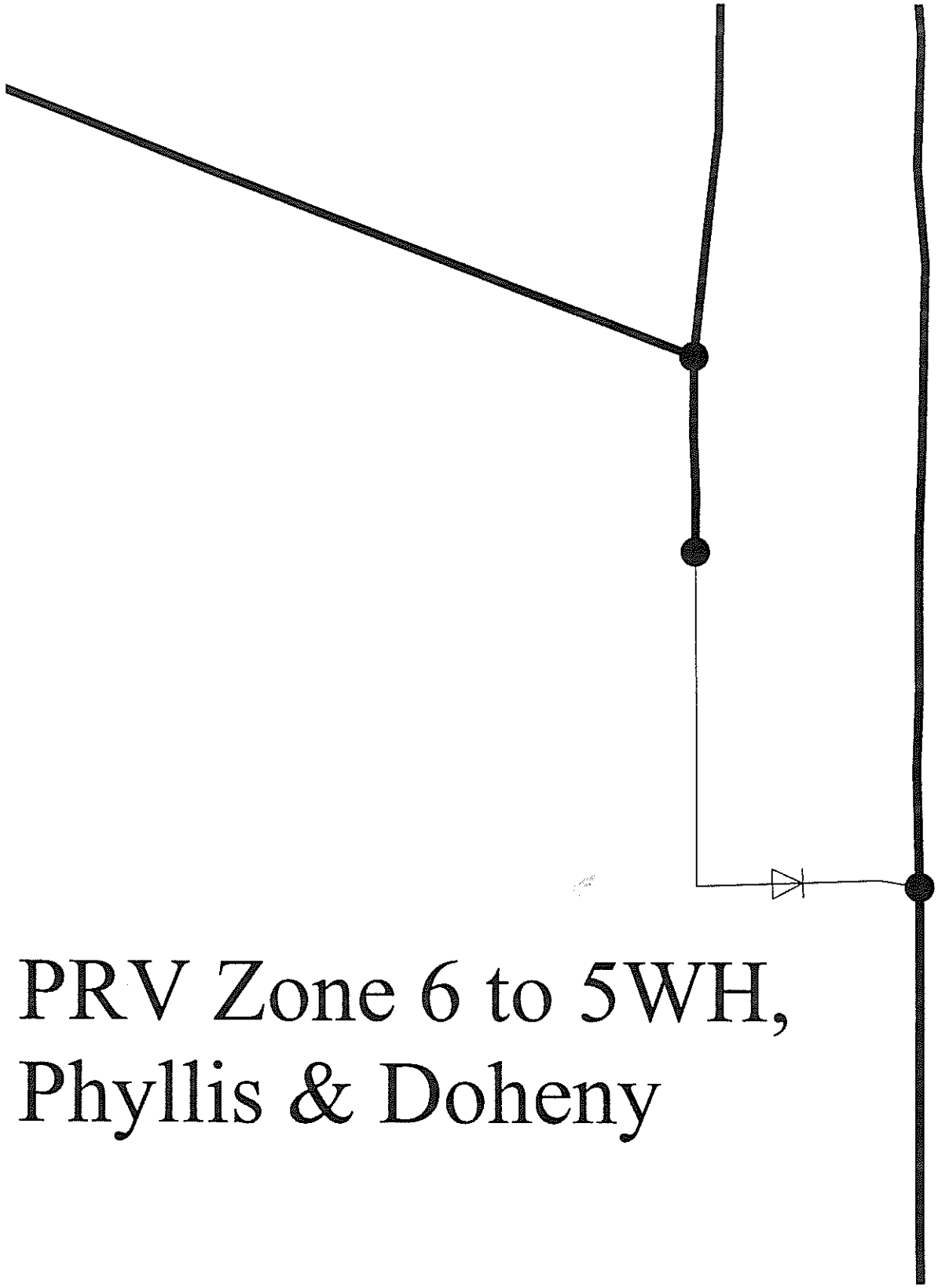
PRV Zone 6 to 5, Lomitas & Cresent



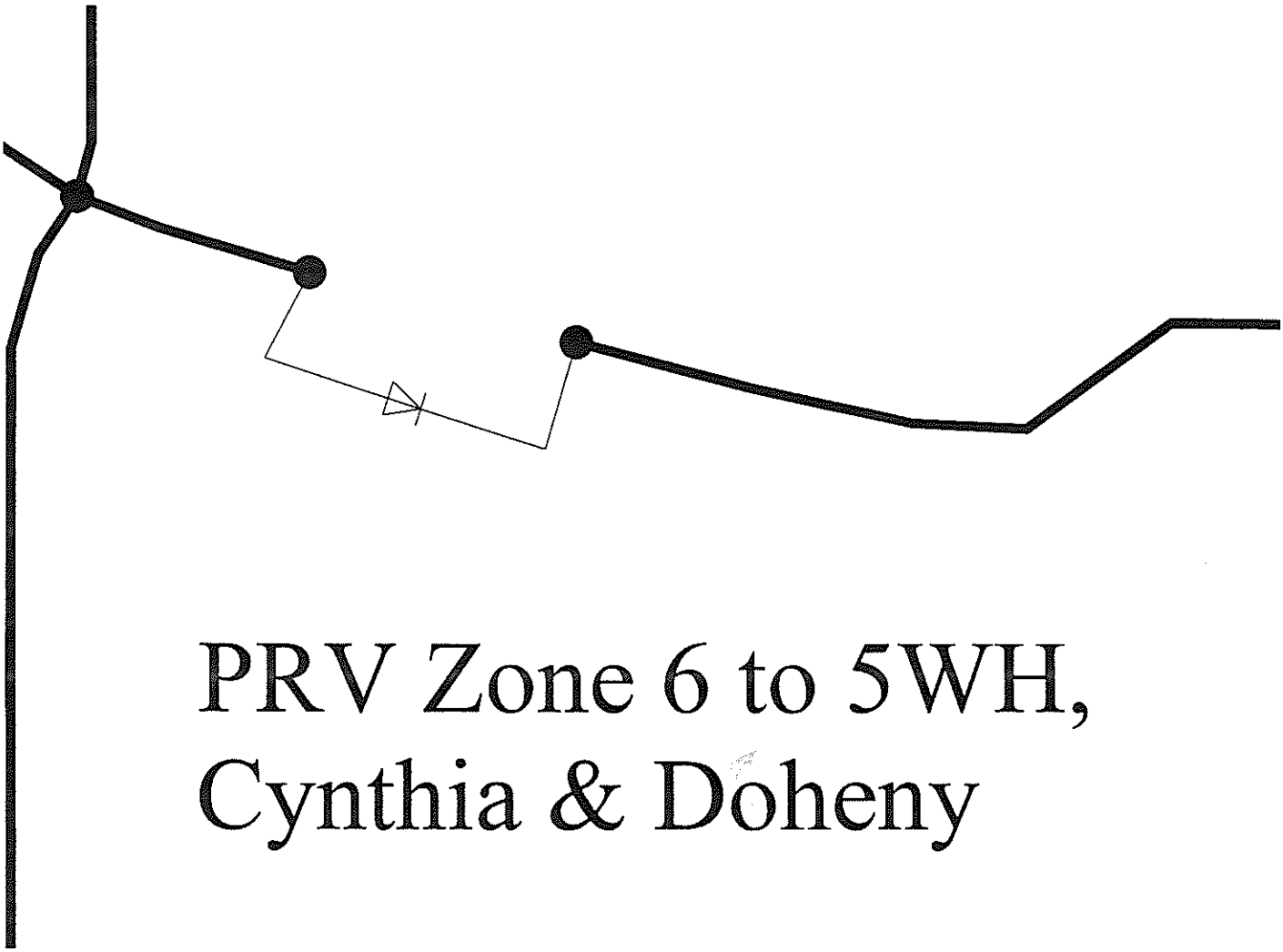
PRV Zone 6 to 4, Lexington & Alpine

PRV Zone 6 to 4, Sunset & Maple



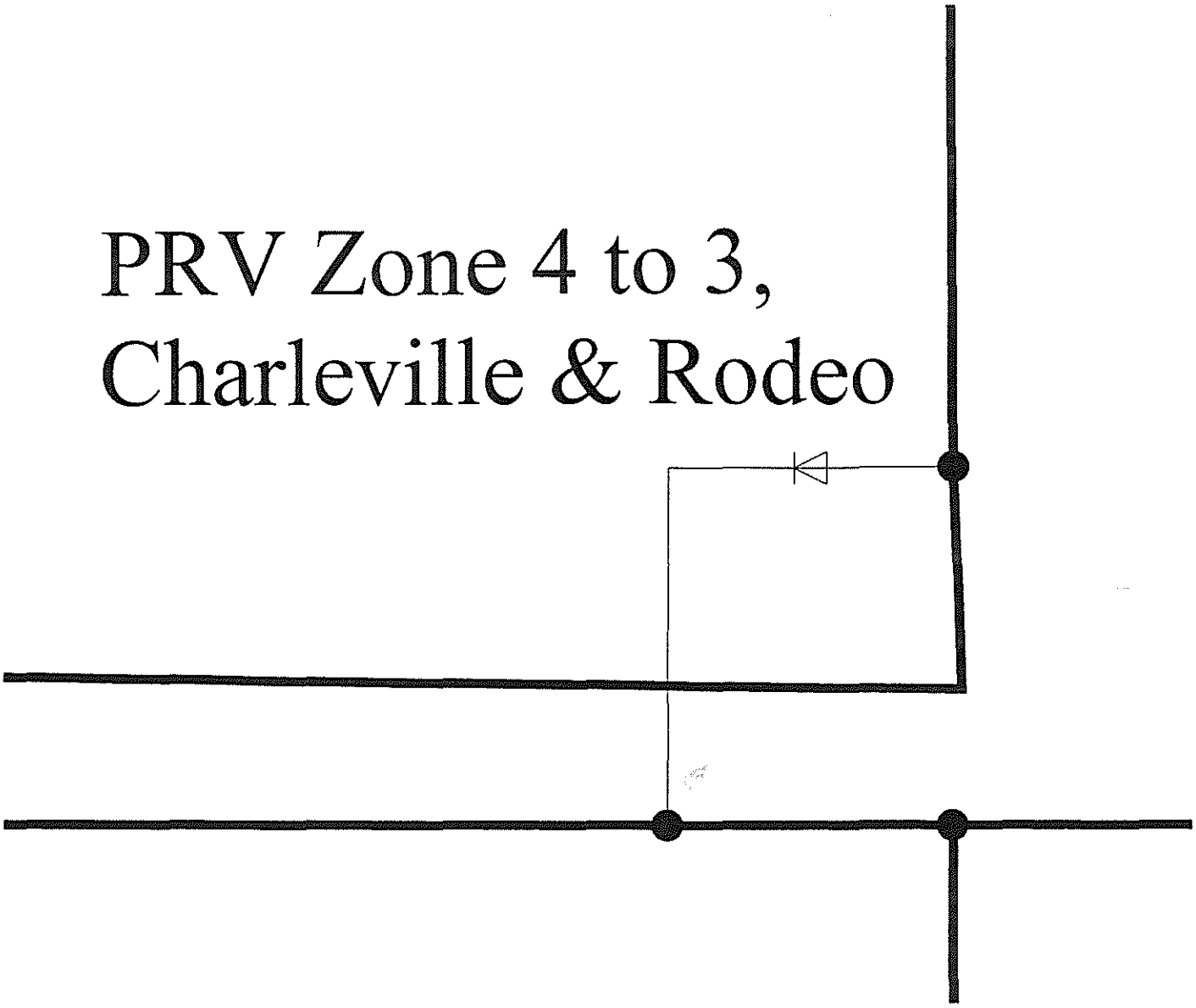


PRV Zone 6 to 5WH, Phyllis & Doheny

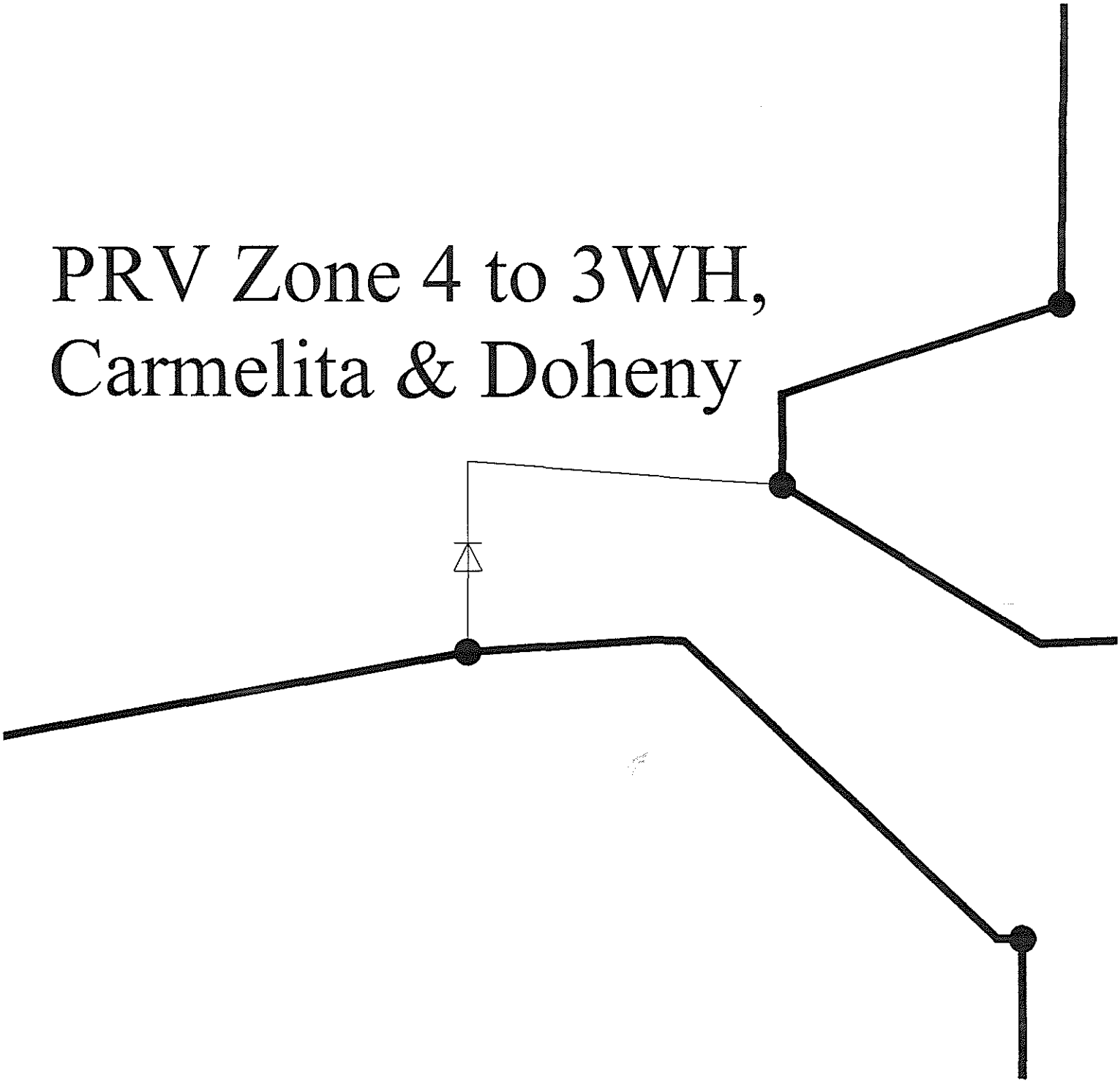


PRV Zone 6 to 5WH, Cynthia & Doheny

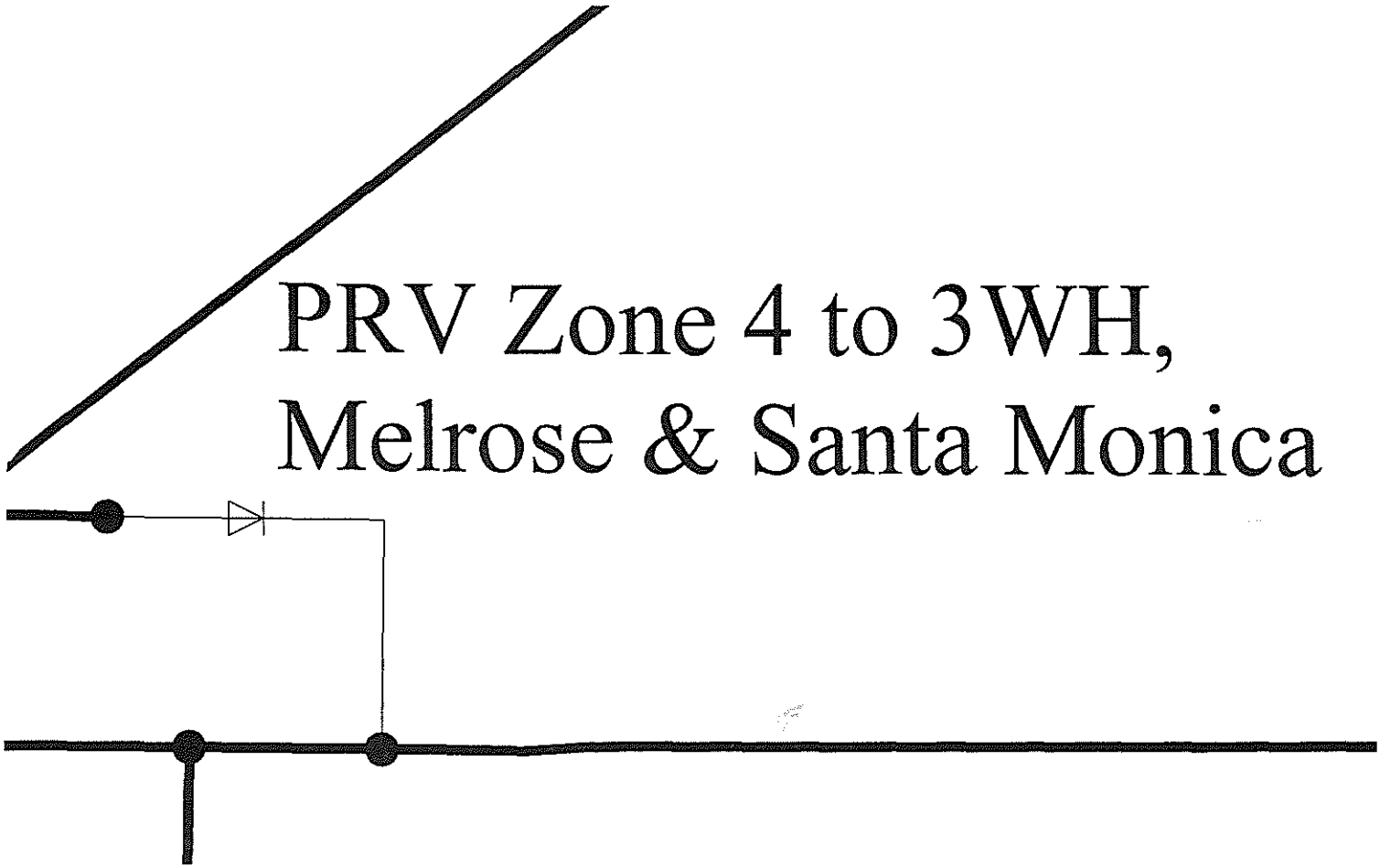
PRV Zone 4 to 3, Charleville & Rodeo



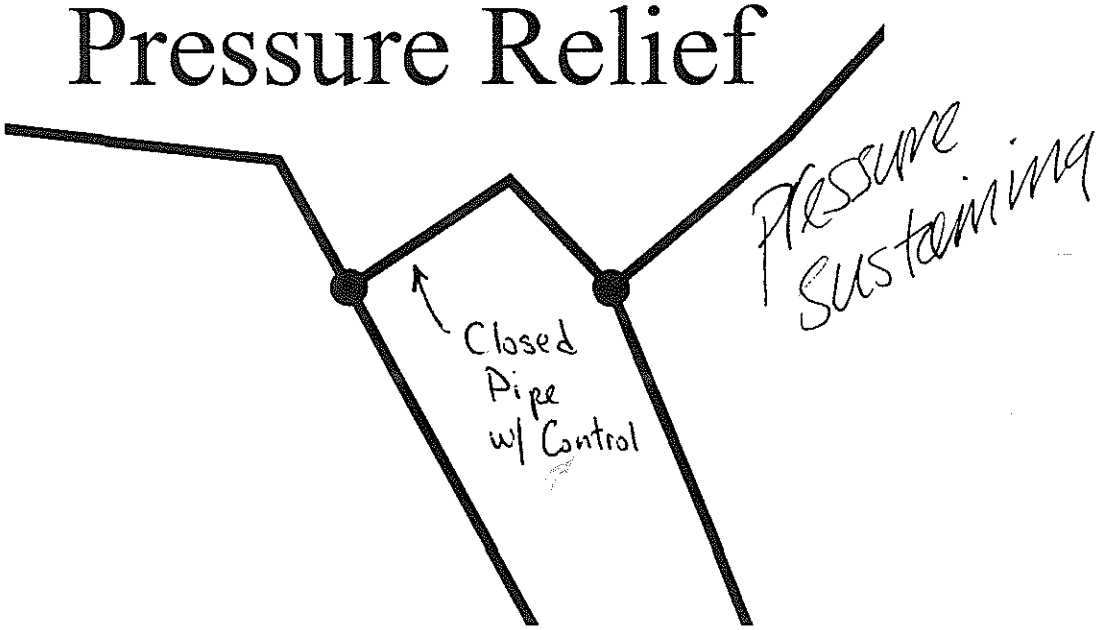
PRV Zone 4 to 3WH, Carmelita & Doheny



PRV Zone 4 to 3WH, Melrose & Santa Monica

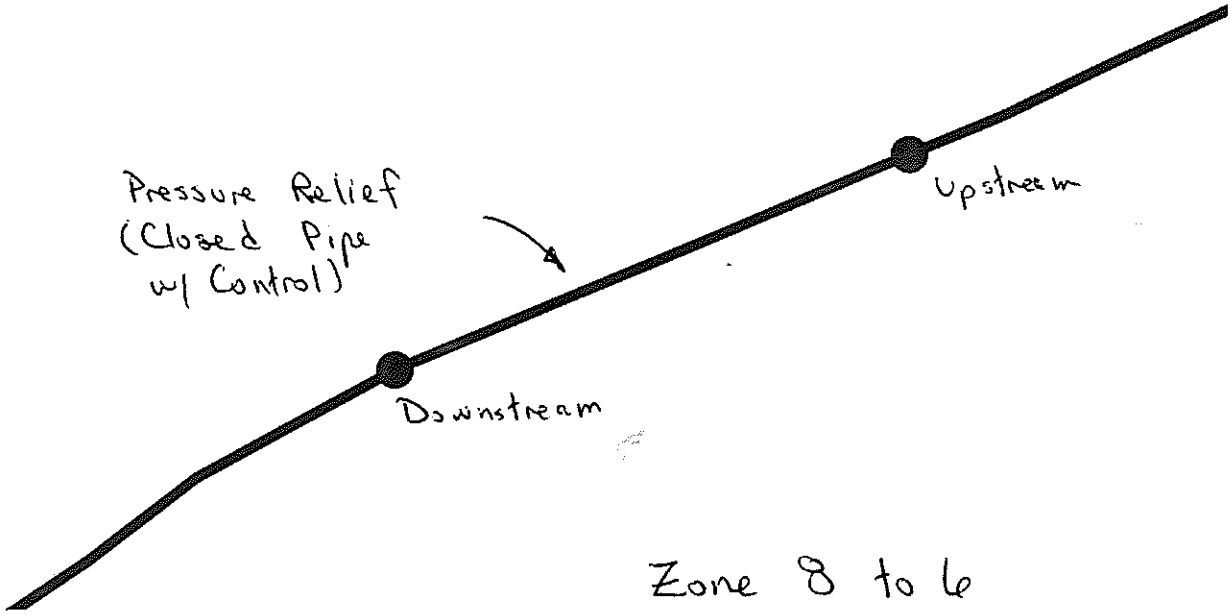


Loma Linda Dr.
Pressure Relief

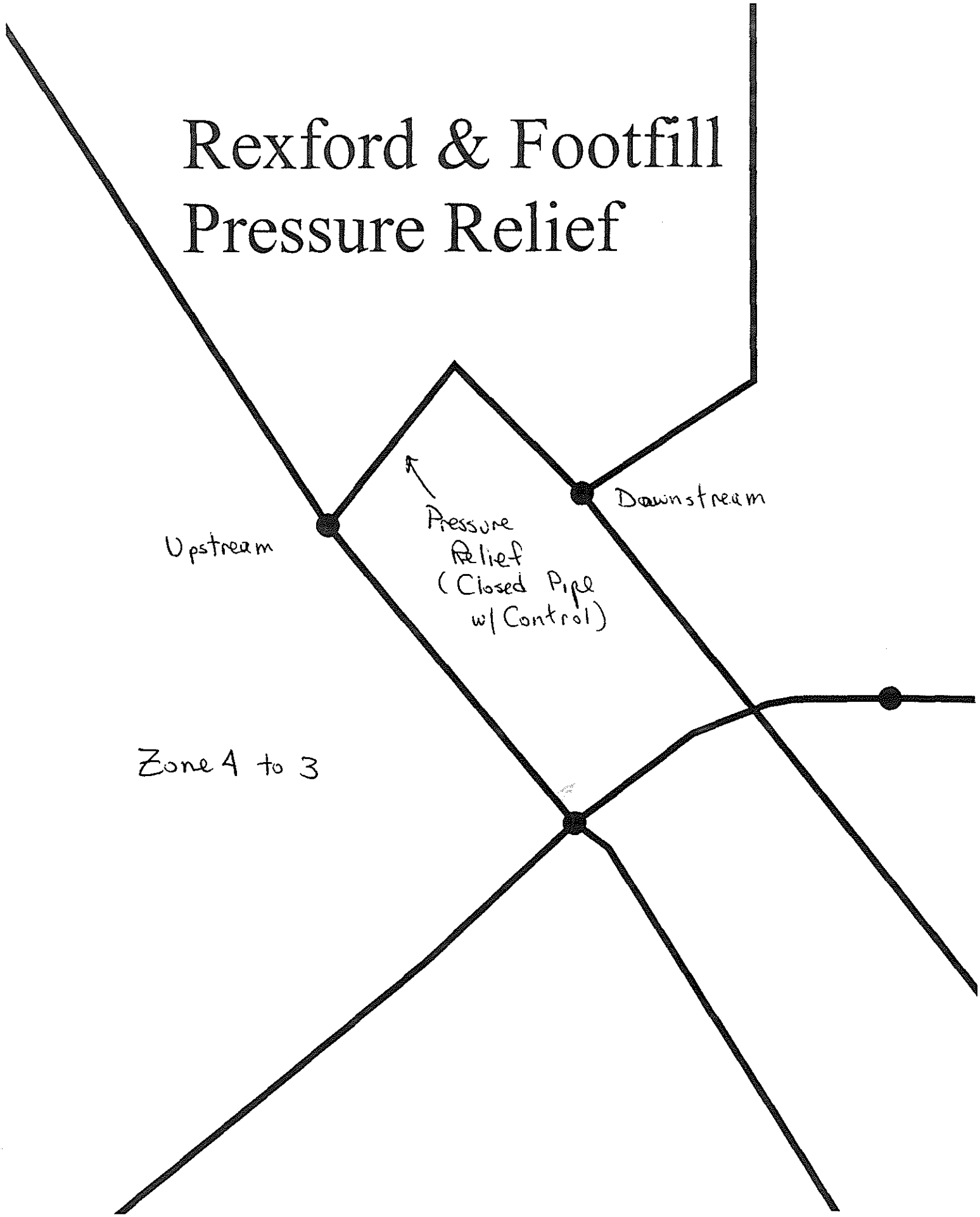


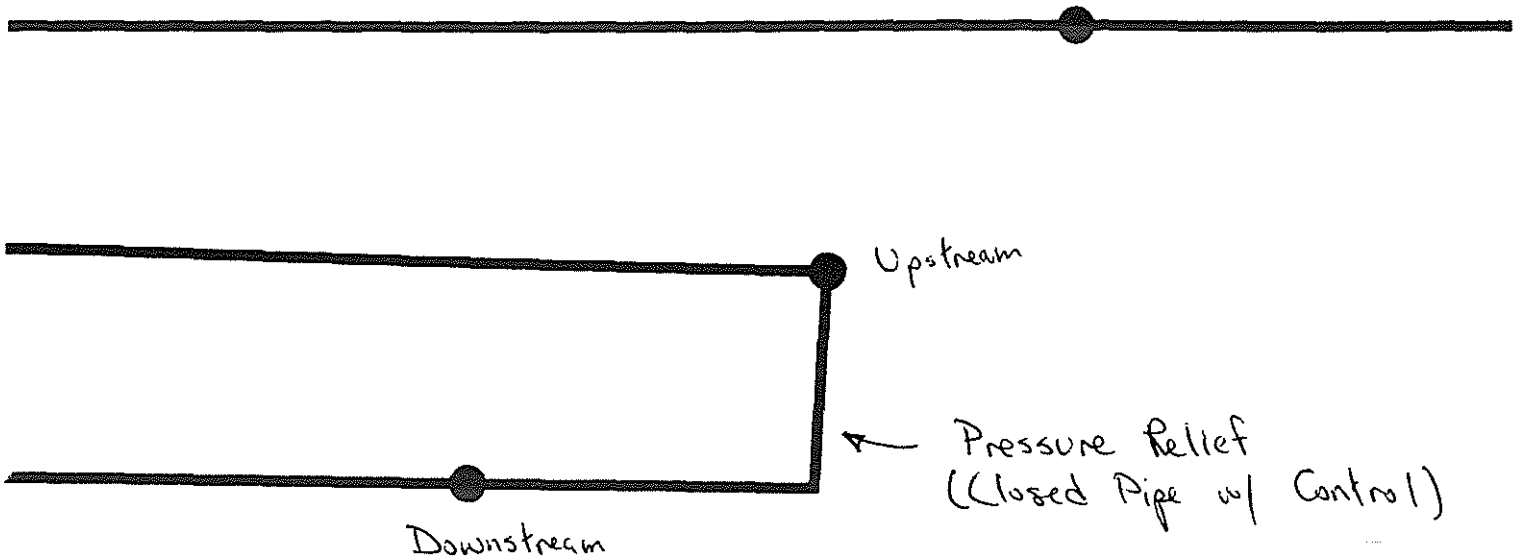
Zone 9 to 8

Summit Dr. Pressure Relief



Rexford & Footfill Pressure Relief

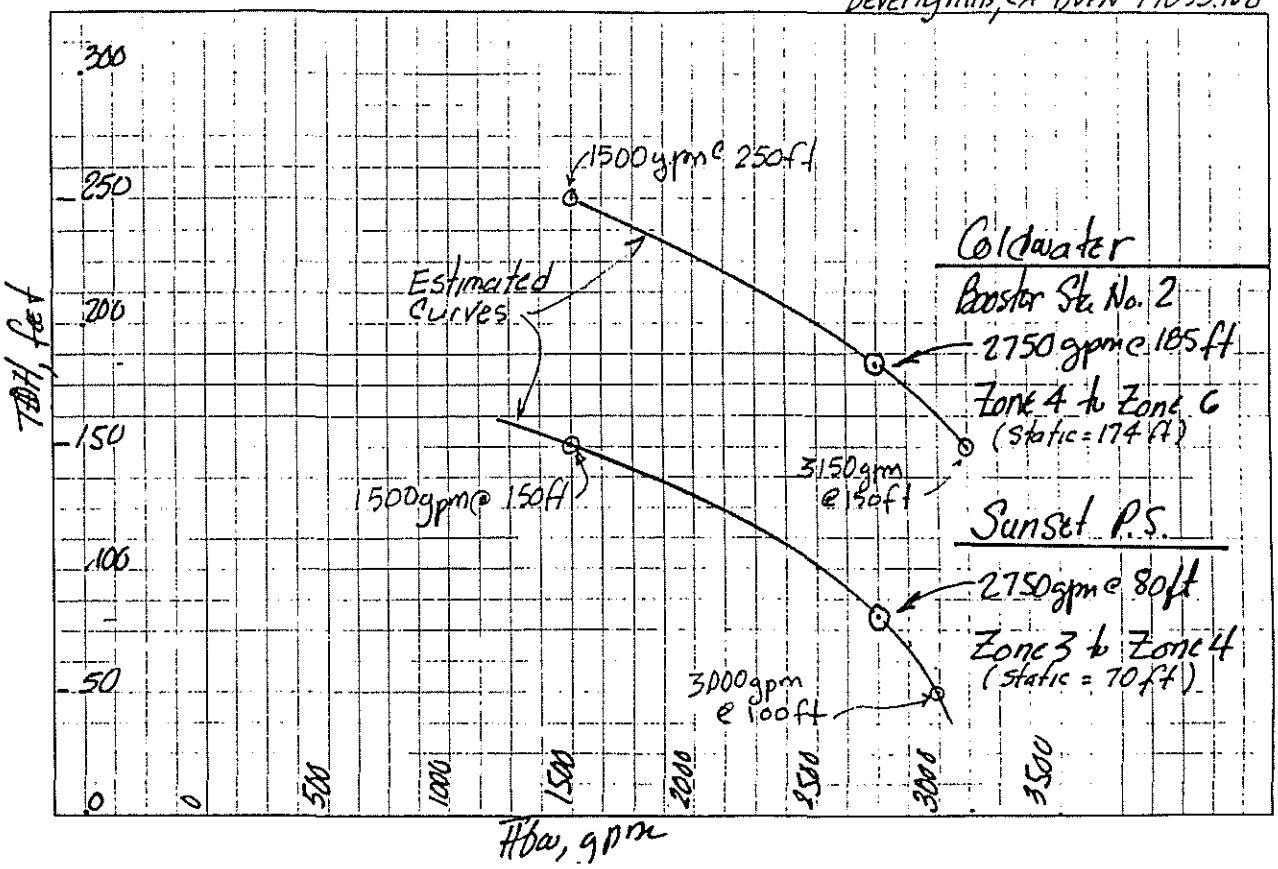


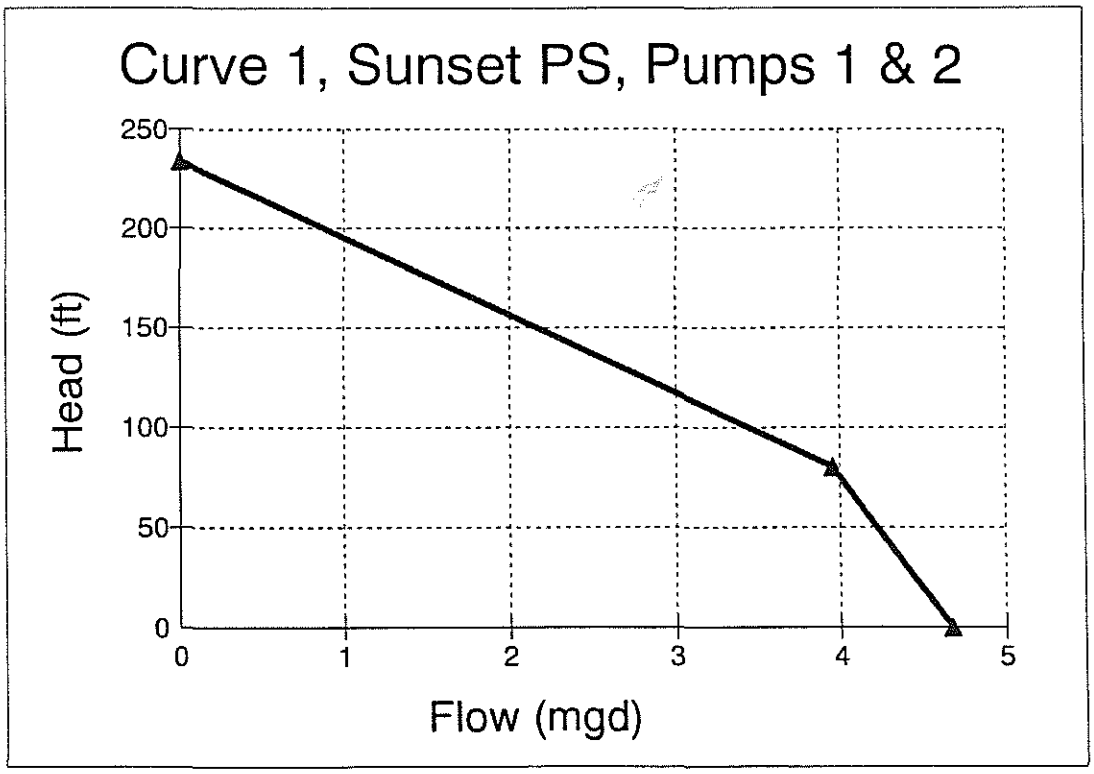


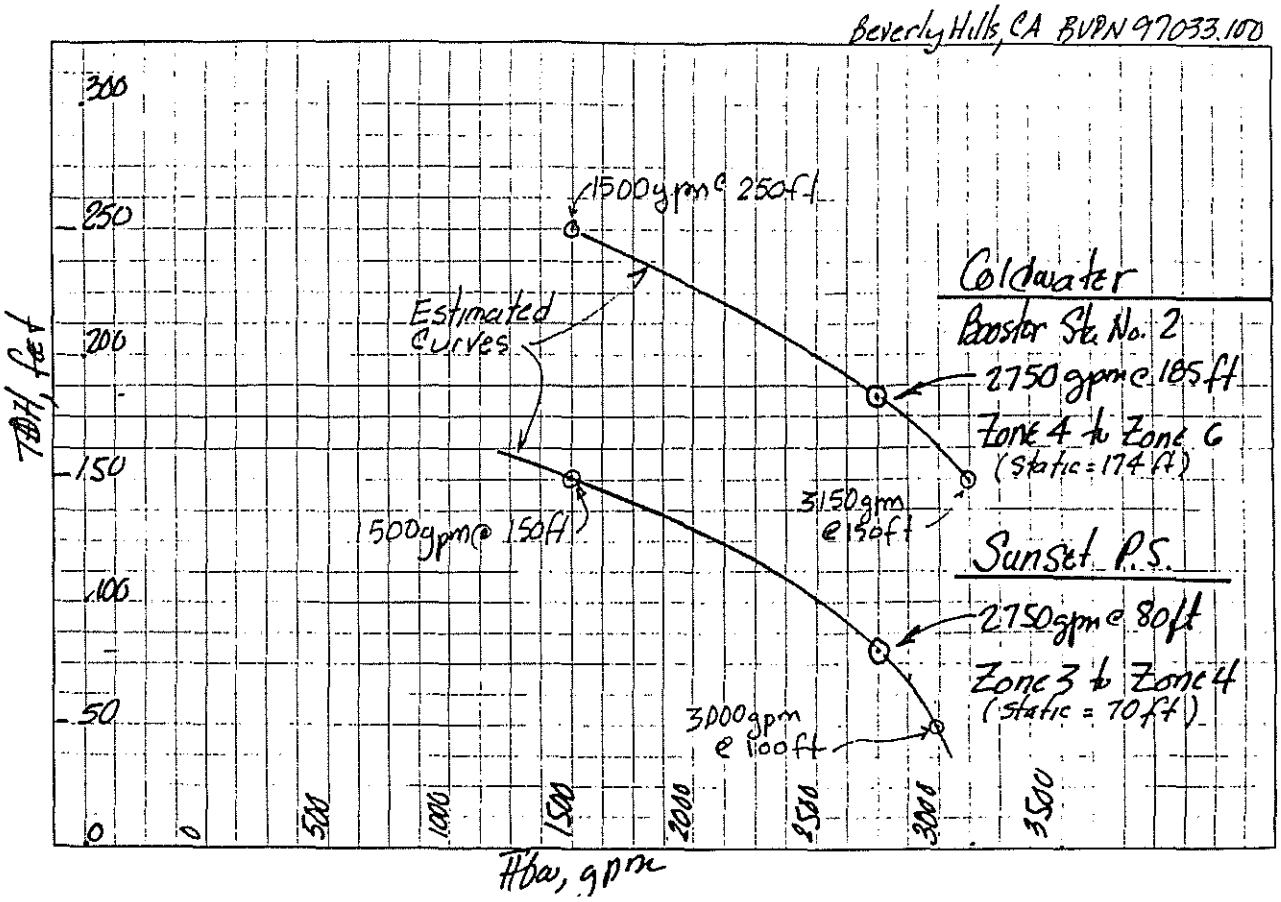
Harratt St. Pressure Relief

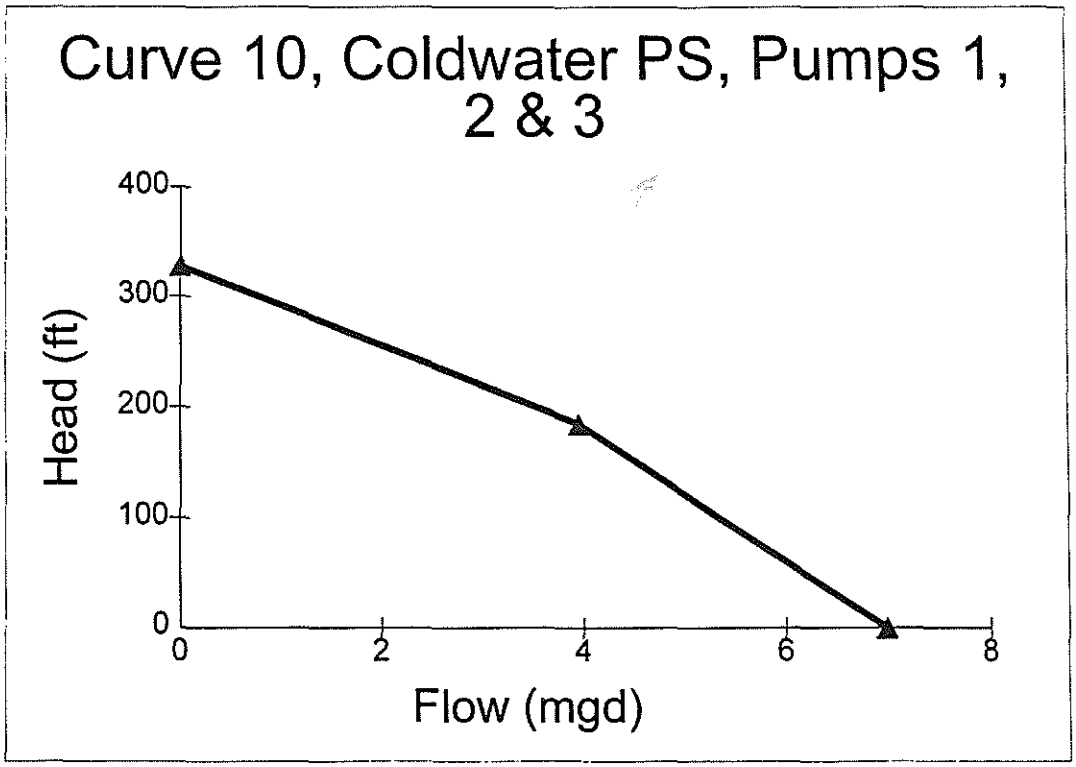
Zone WH5 to WH3

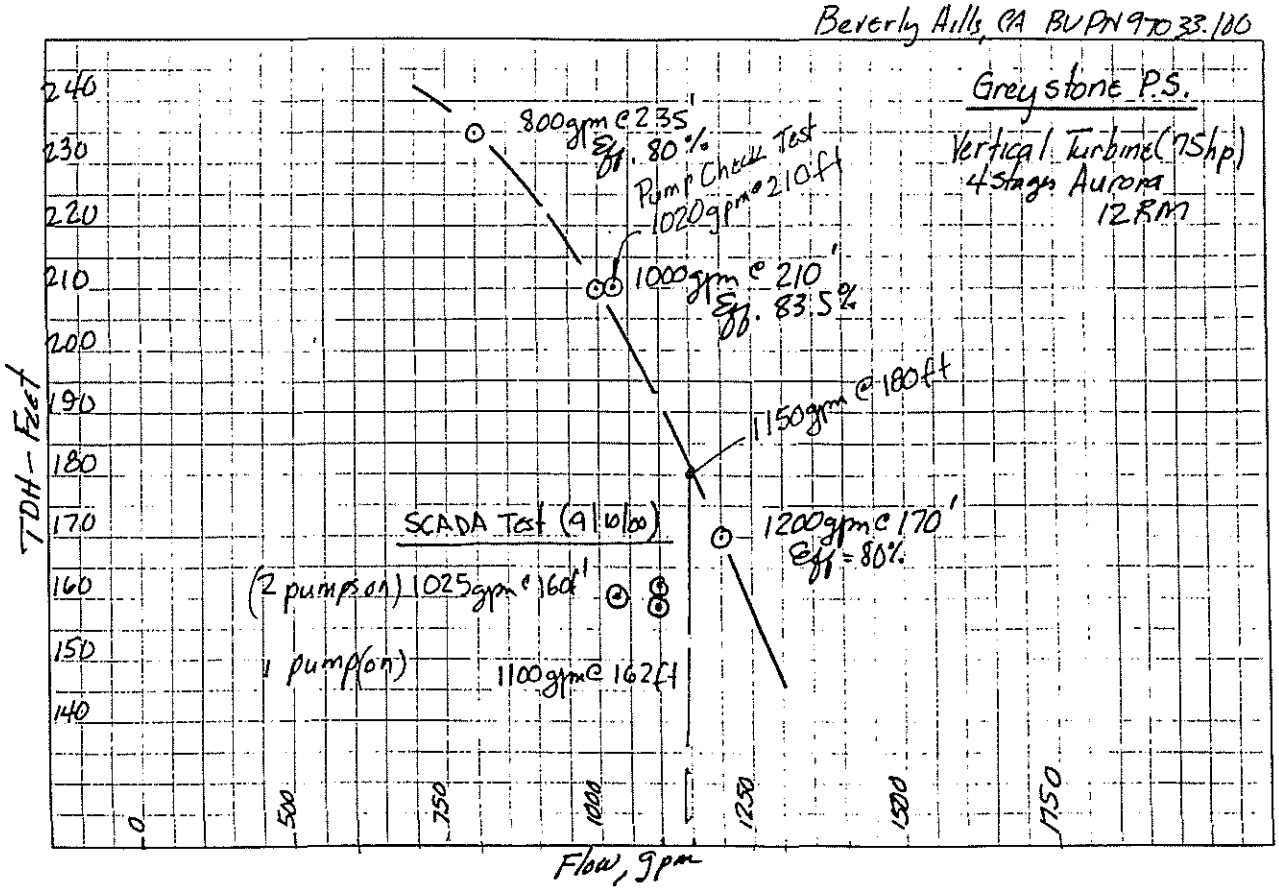
Beverly Hills, CA BVPN 97033.100

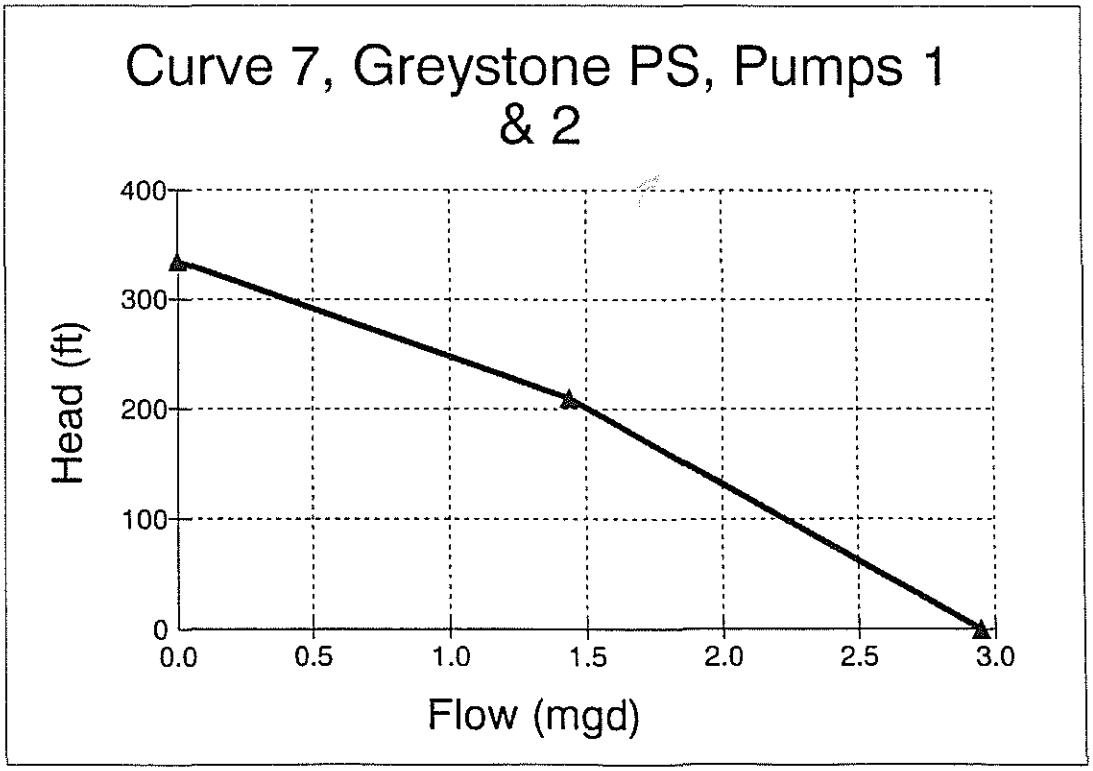


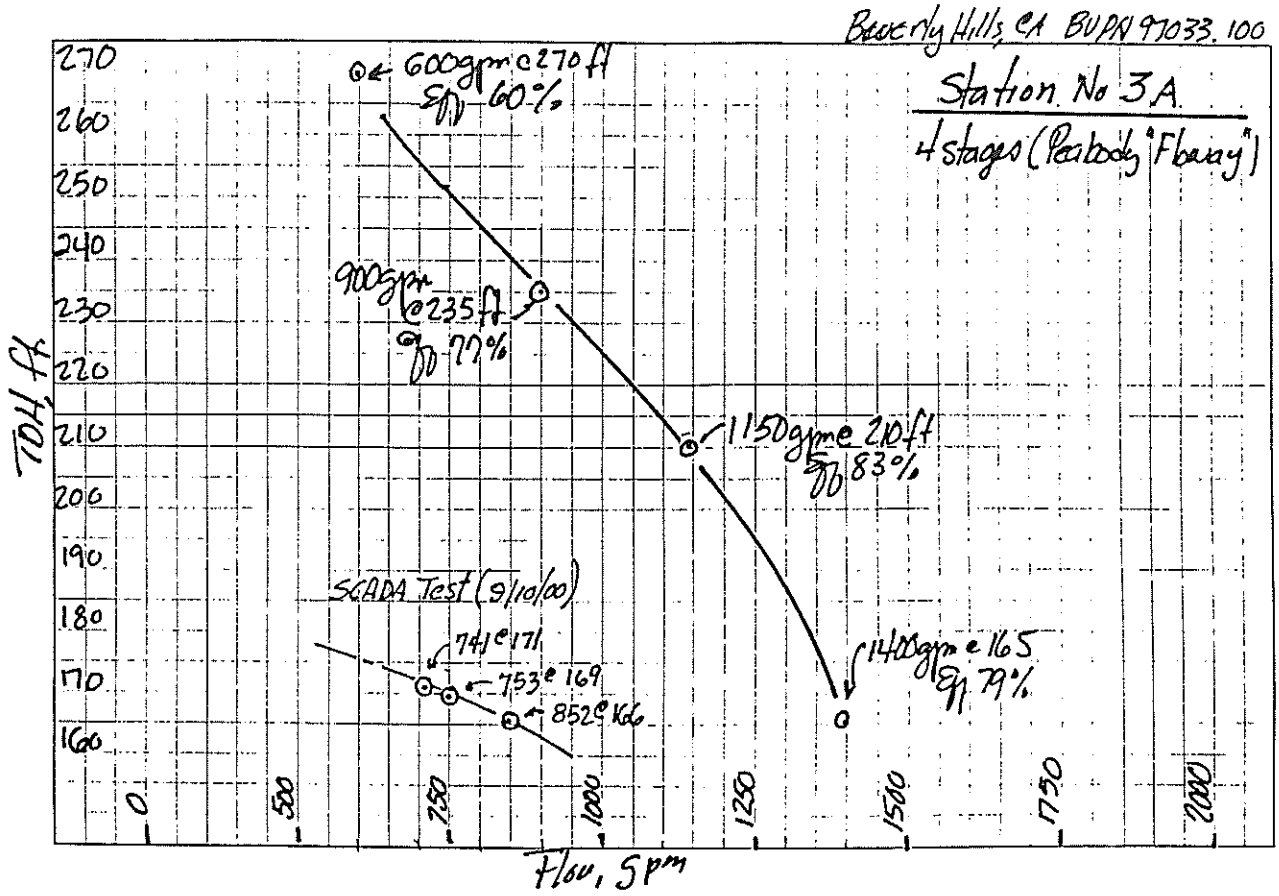


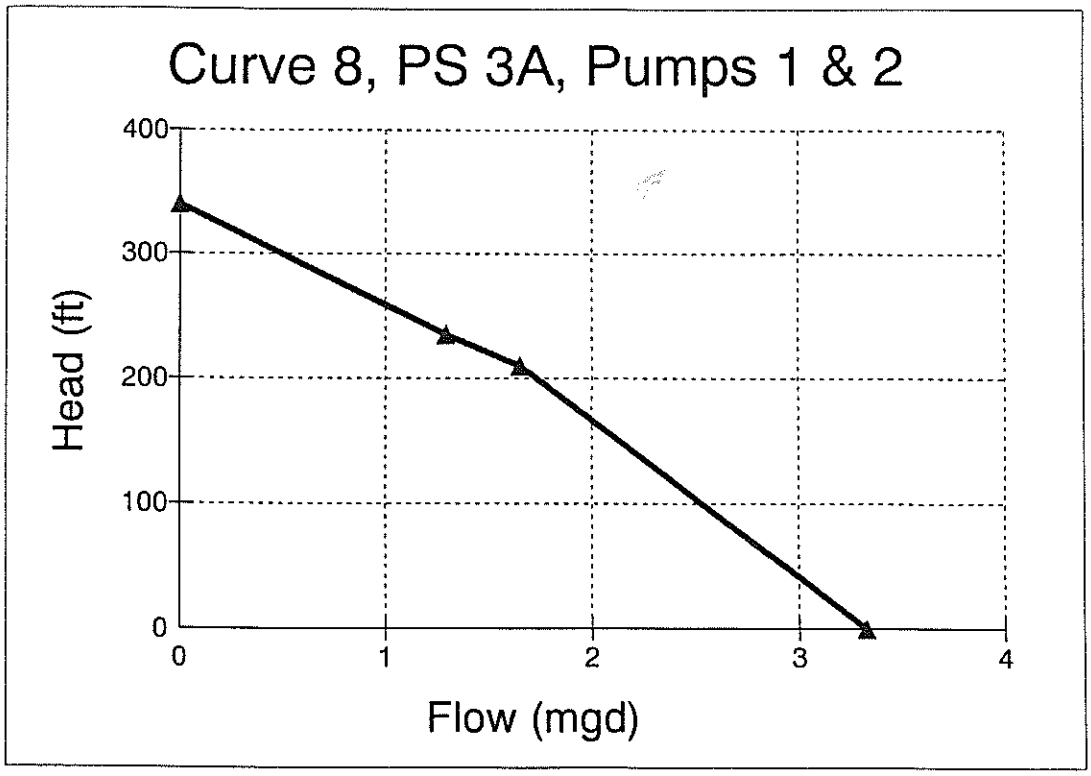

Beverly Hills, CA BVPN 97033.100
TDH, feet
Hbw, gpm
1500gpm @ 250ft
Estimated Curves
Coldwater Booster Sta. No. 2
2750 gpm @ 185ft
Zone 4 to Zone 6
(Static = 174 ft)
3150gpm @ 150ft
1500gpm @ 150ft
Sunset P.S.
2750gpm @ 80ft
Zone 3 to Zone 4
(Static = 70 ft)
3000gpm @ 100ft

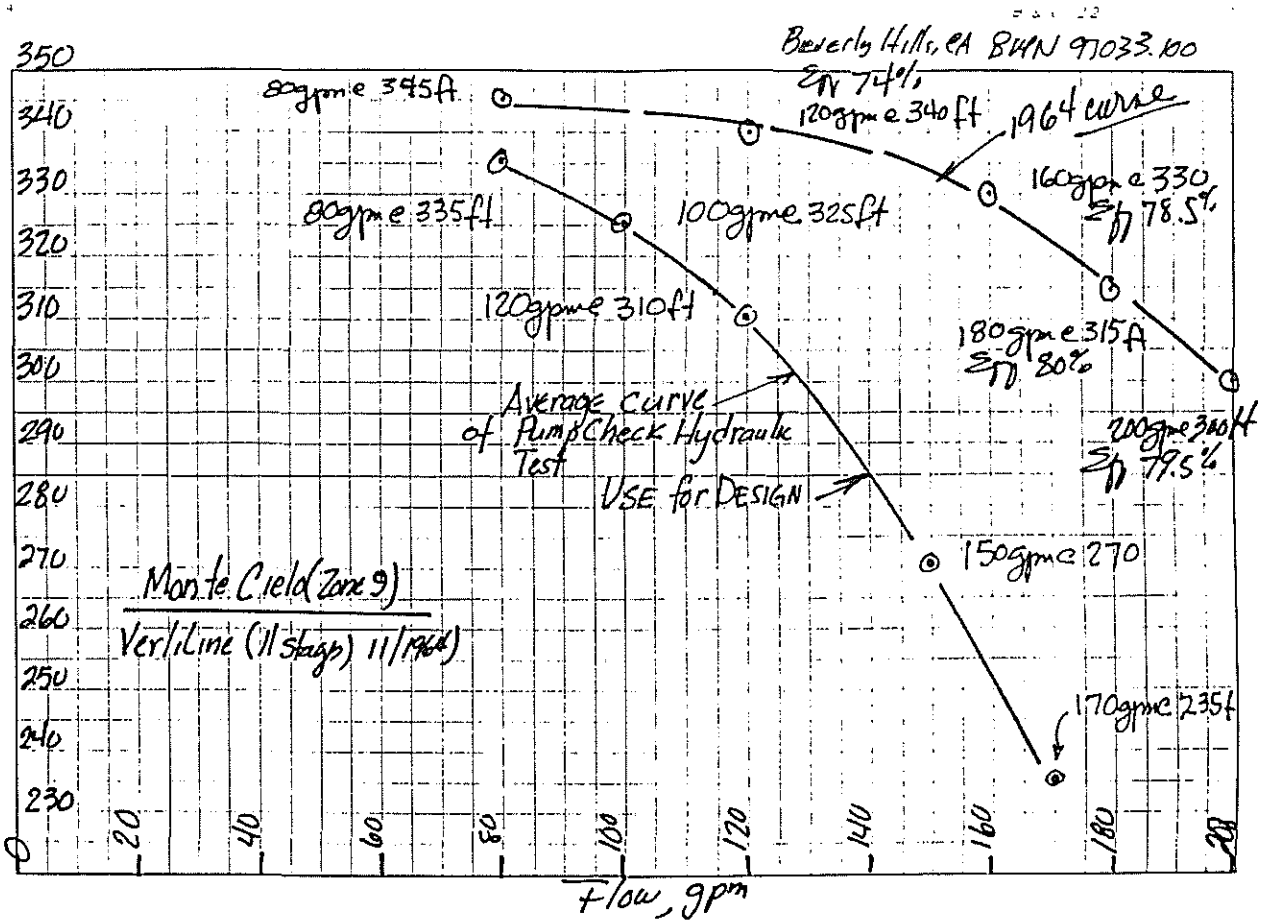

Curve 10, Coldwater PS, Pumps 1, 2 & 3
Head (ft)
Flow (mgd)

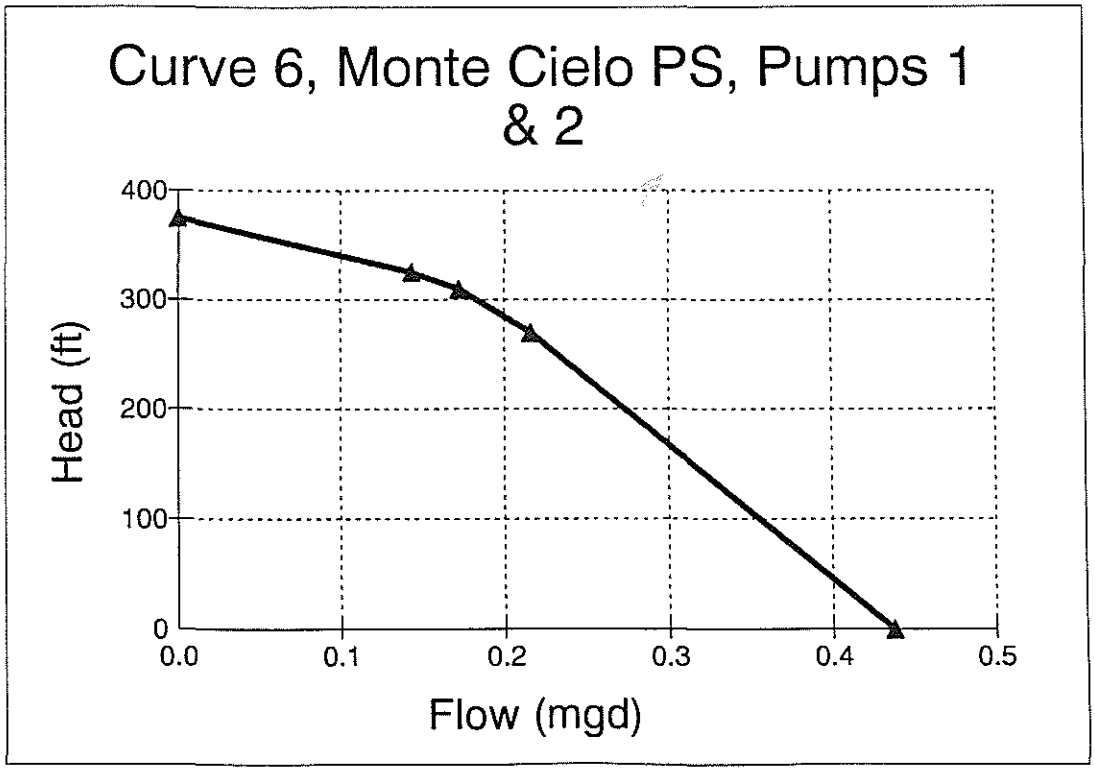

Beverly Hills, CA BUPN 9T033.100
Greystone P.S.
Vertical Turbine (75hp)
4 stage Aurora
12RM7
800gpm @ 235'
Eff. 80%
Pump Check Test
1020gpm @ 210ft
1000gpm @ 210'
Eff. 83.5%
1150gpm @ 180ft
1200gpm @ 170'
Eff = 80%
SCADA Test (9/10/00)
(2 pumps on) 1025gpm @ 160'
1 pump (on) 1100gpm @ 162ft
TDH - Feet
240
230
220
210
200
190
180
170
160
150
140
0
500
750
1000
1250
1500
1750
Flow, gpm

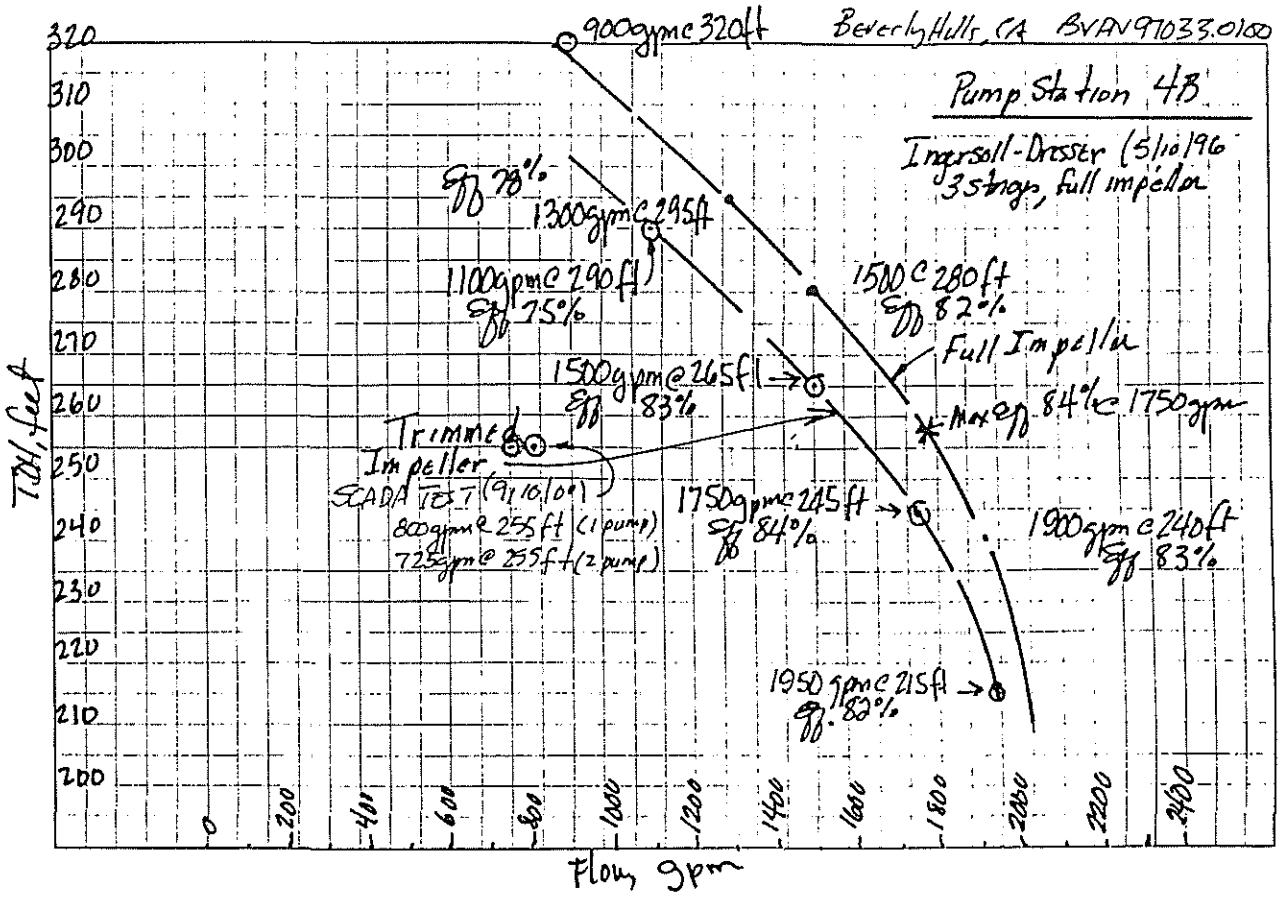

Curve 7, Greystone PS, Pumps 1 & 2
Head (ft)
400
300
200
100
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Flow (mgd)

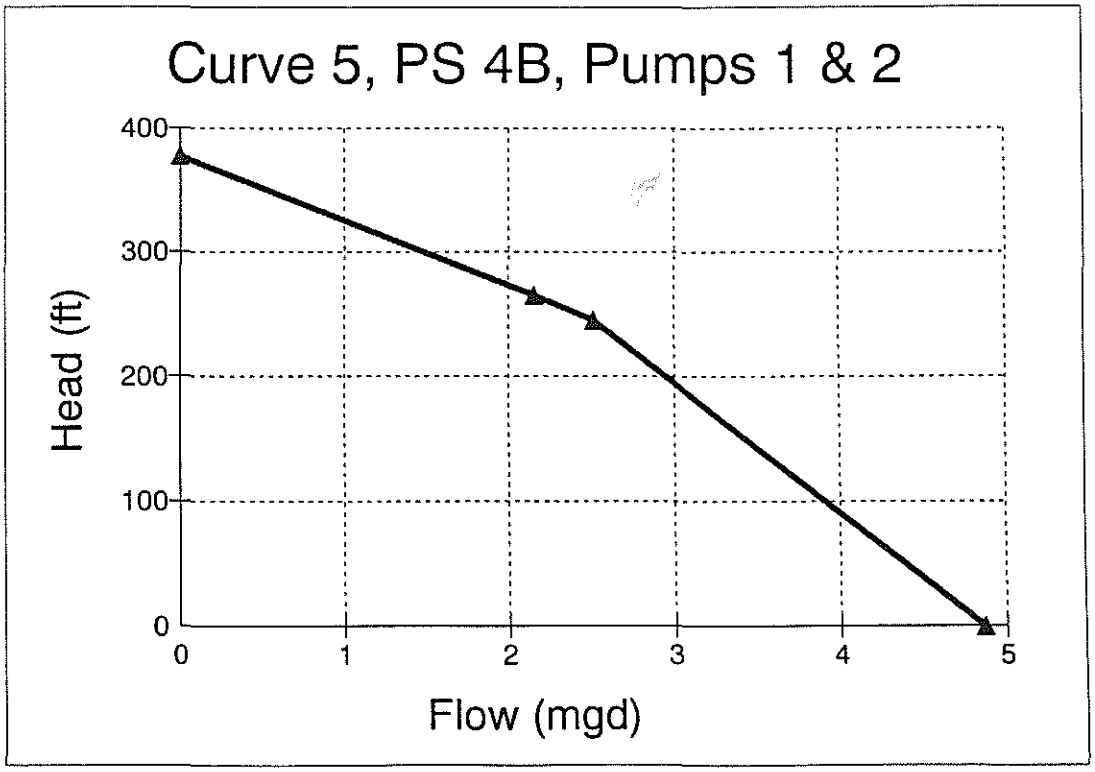

Beverly Hills, CA BUPN 97033.100
Station No 3A
4 stages (Peabody "Fleury")
600gpm @ 270 ft
Eff 60%
900gpm @ 235 ft
Eff 77%
1150gpm @ 210 ft
Eff 83%
1400gpm @ 165
Eff 79%
SCADA Test (9/10/00)
741 @ 171
753 @ 169
852 @ 166
TDH, ft
Flow, gpm

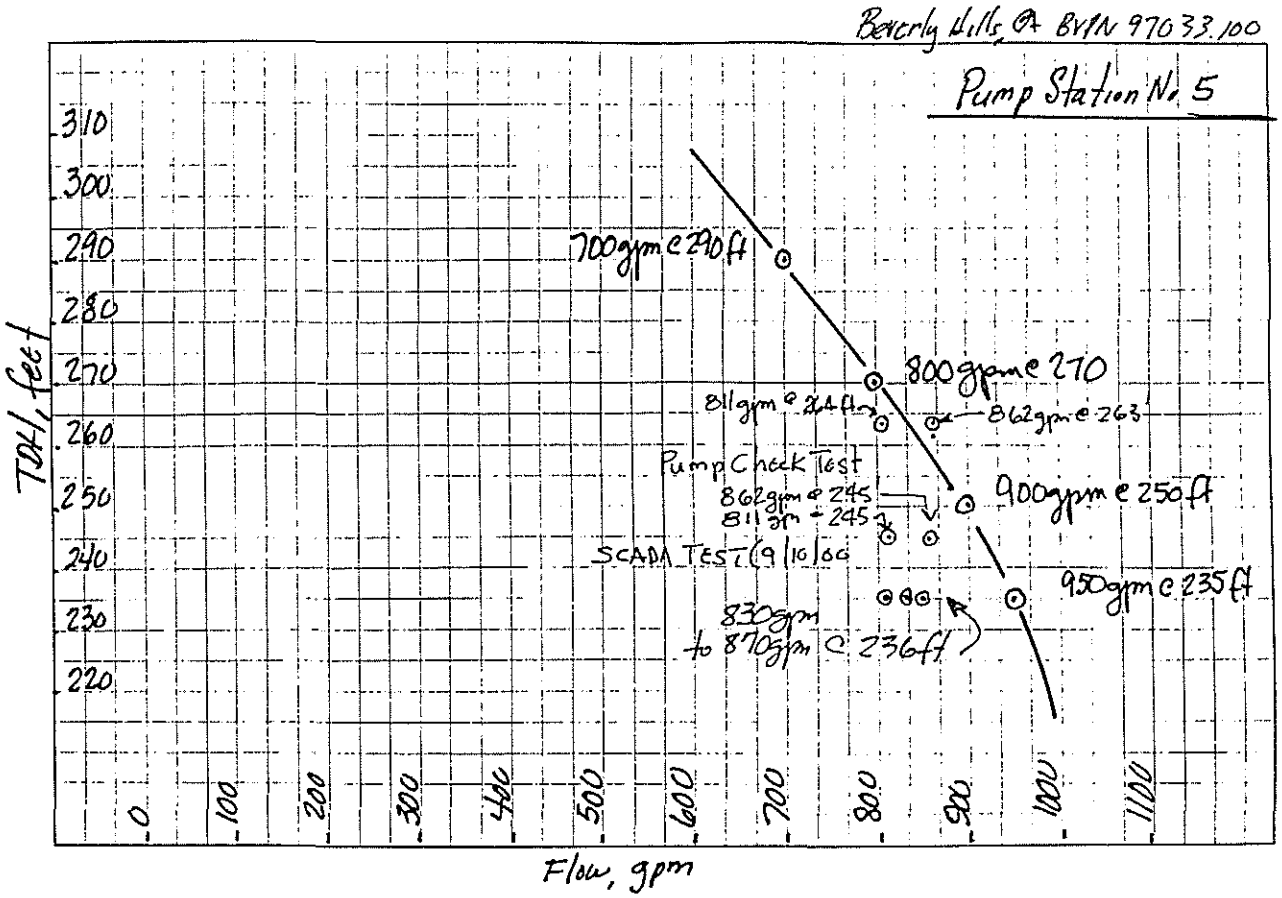

Curve 8, PS 3A, Pumps 1 & 2
Head (ft)
Flow (mgd)

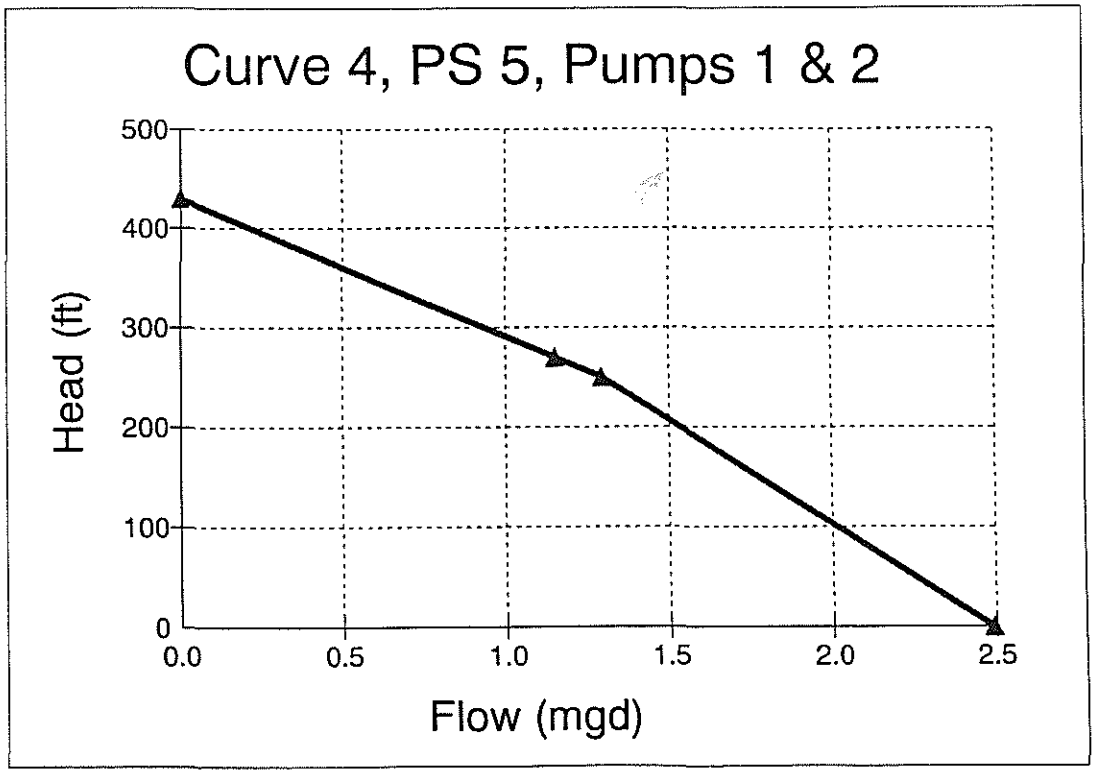

Beverly Hills, CA BHN 97033.100
80gpm @ 345ft
Eff 74%
120gpm @ 340ft
1964 curve
160gpm @ 330
Eff 78.5%
80gpm @ 335ft
100gpm @ 325ft
120gpm @ 310ft
180gpm @ 315ft
Eff 80%
Average curve of PumpCheck Hydraulic Test
200gpm @ 300ft
Eff 79.5%
USE for DESIGN
150gpm @ 270
Monte Cielo (Zone 9)
Vertiline (11 stage) 11/1964
170gpm @ 235ft
Flow, gpm

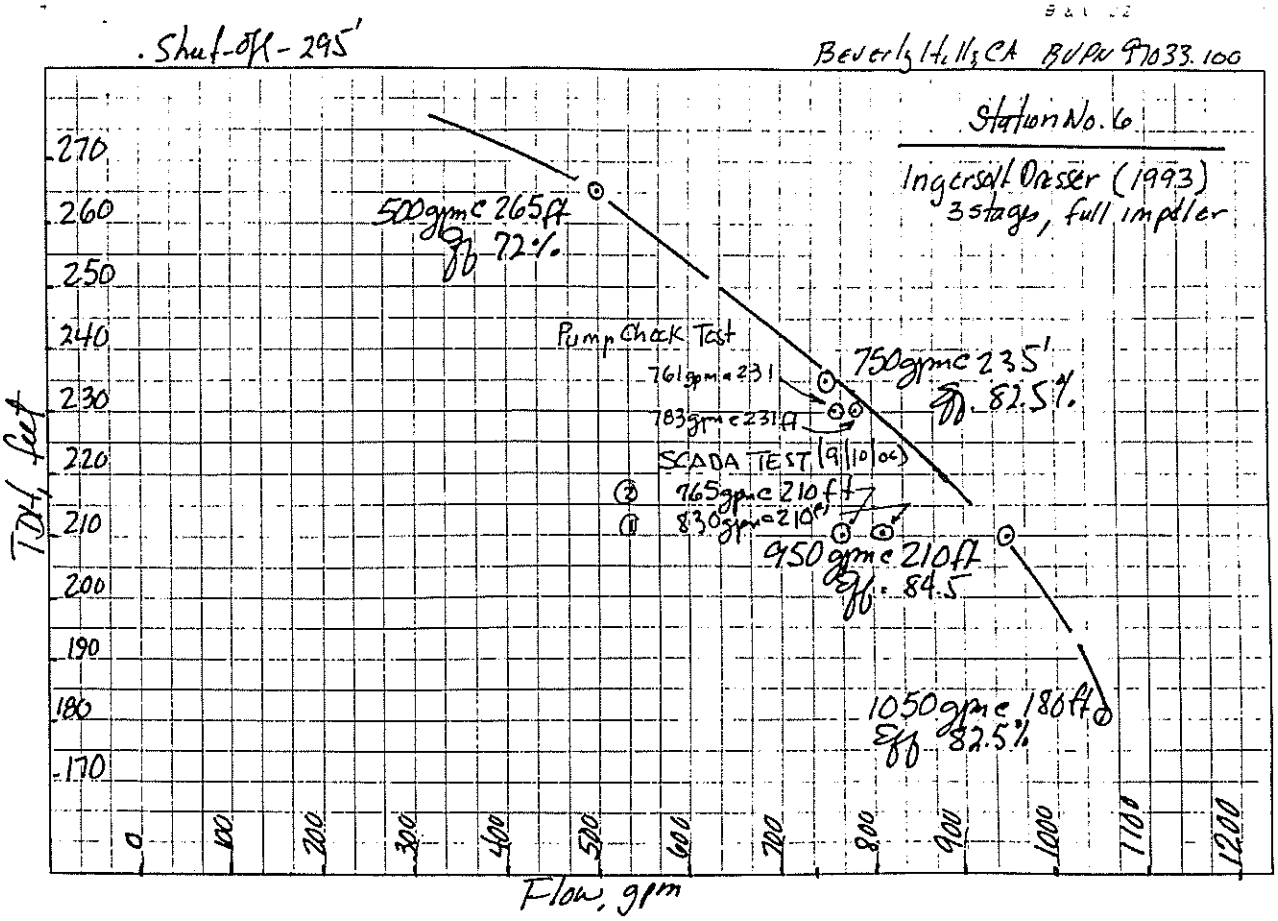

Curve 6, Monte Cielo PS, Pumps 1 & 2
Head (ft)
Flow (mgd)

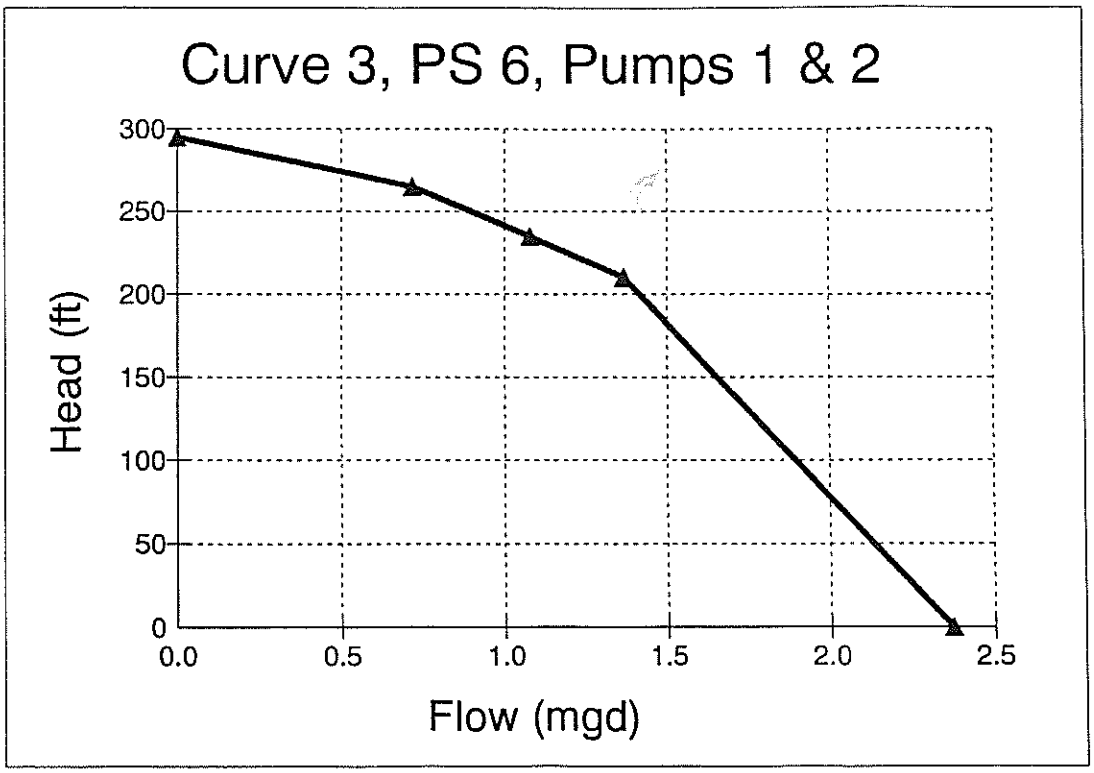

Beverly Hills, CA BVAN97033.0100
Pump Station 4B
Ingersoll-Dresser (5/10/96)
3 stage, full impeller
900gpm@320ft
Eff 78%
1300gpm@295ft
1100gpm@290ft
Eff 75%
1500@280ft
Eff 82%
Full Impeller
1500gpm@265ft
Eff 83%
Max eff 84%@1750gpm
Trimmed Impeller
SCADA TEST (9/10/00)
800gpm@255ft (1 pump)
725gpm@255ft (2 pump)
1750gpm@245ft
Eff 84%
1900gpm@240ft
Eff 83%
1950gpm@215ft
Eff 82%
TDH, feet
Flow, gpm

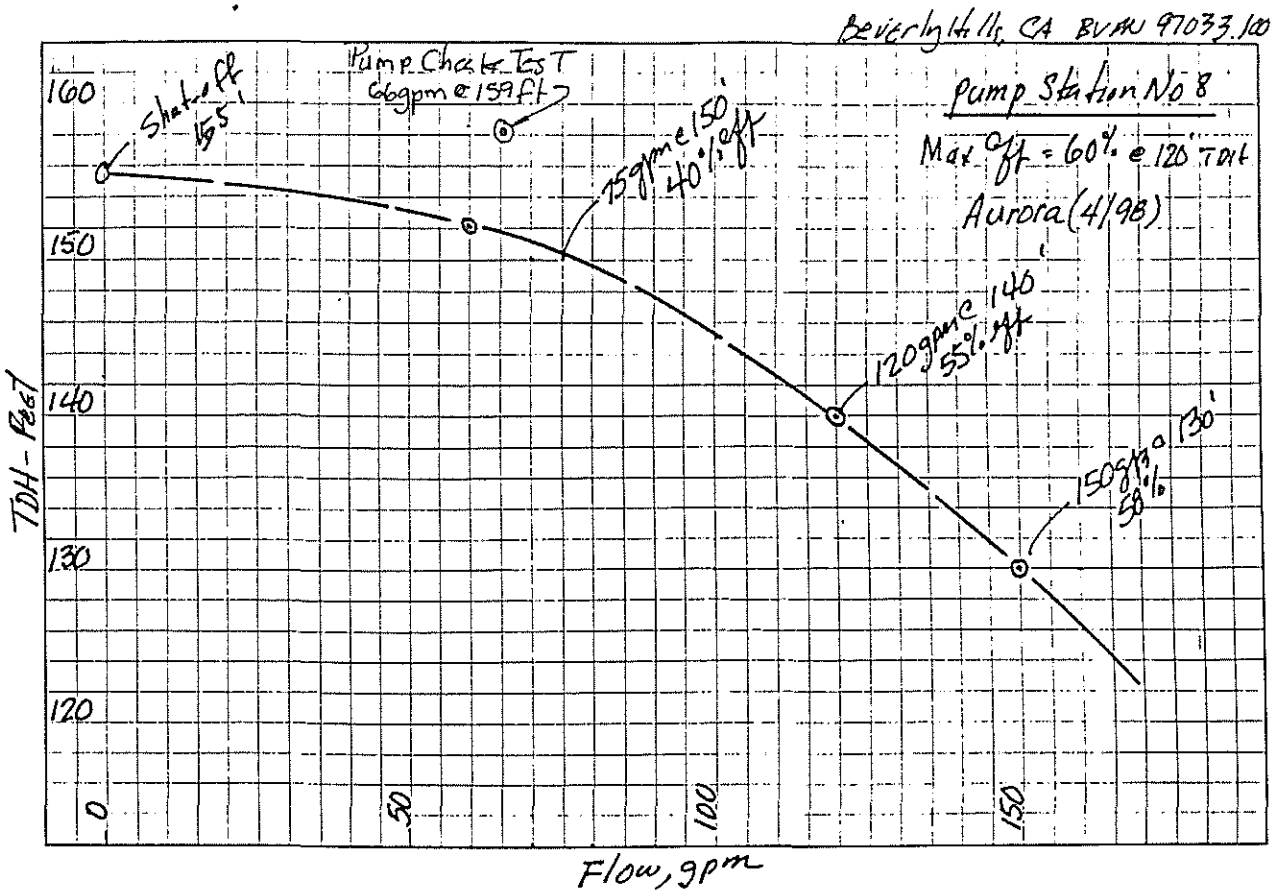

Curve 5, PS 4B, Pumps 1 & 2
Head (ft)
Flow (mgd)

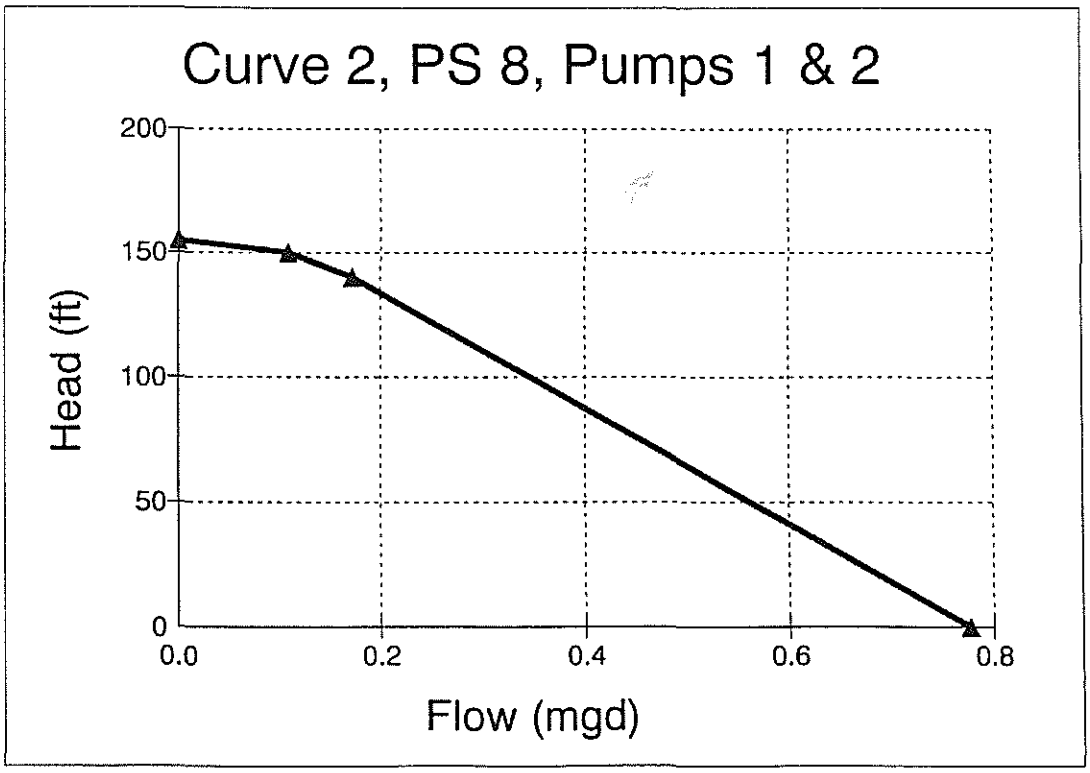

Beverly Hills, CA BVN 97033.100
Pump Station No. 5
TDH, feet
310
300
290
280
270
260
250
240
230
220
700gpm @ 290ft
800gpm @ 270
811gpm @ 264ft
862gpm @ 263
Pump Check Test
862gpm @ 245
811gpm @ 245
900gpm @ 250ft
SCADA TEST (9/10/06)
950gpm @ 235ft
830gpm
to 870gpm @ 236ft
0
100
200
300
400
500
600
700
800
900
1000
1100
Flow, gpm

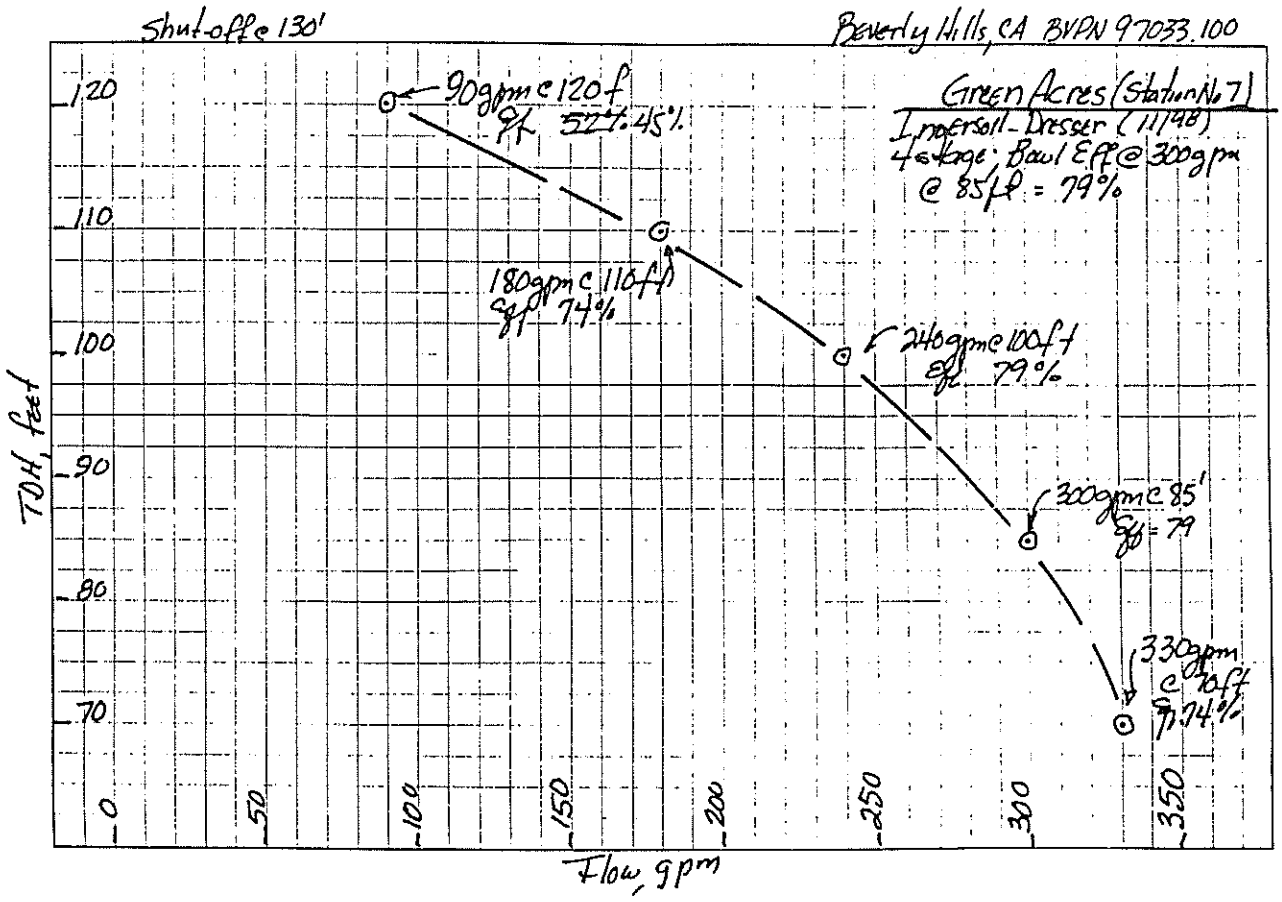

Curve 4, PS 5, Pumps 1 & 2
Head (ft)
500
400
300
200
100
0
0.0
0.5
1.0
1.5
2.0
2.5
Flow (mgd)

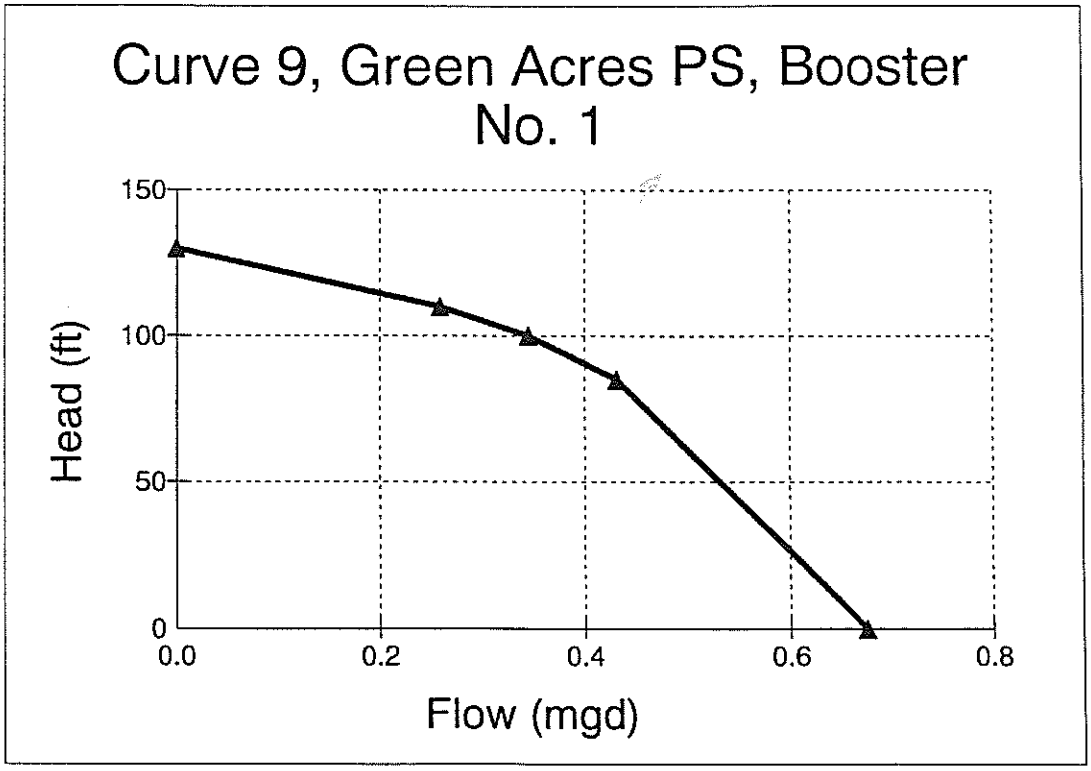

Shut-off - 295'
Beverly Hills, CA BUPN 97033.100
Station No. 6
Ingersoll Dresser (1993)
3 stage, full impeller
500 gpm @ 265 ft
Eff 72%
Pump Check Test
761 gpm @ 231
783 gpm @ 231 ft
750 gpm @ 235'
Eff. 82.5%
SCADA TEST (9/10/00)
765 gpm @ 210 ft
830 gpm @ 210'
950 gpm @ 210 ft
Eff. 84.5
1050 gpm @ 180 ft
Eff 82.5%
TDH, feet
Flow, gpm


Curve 3, PS 6, Pumps 1 & 2
Head (ft)
Flow (mgd)


Beverly Hills, CA BVAW 97033.100
Pump Station No. 8
Max Eff = 60% @ 120' TDH
Aurora (4/98)
Pump Check Test
66gpm @ 159 ft
Shut off 155'
75gpm @ 150' 40% eff
120gpm @ 140' 55% eff
150gpm @ 130' 50%
TDH - Feet
160
150
140
130
120
0
50
100
150
Flow, gpm

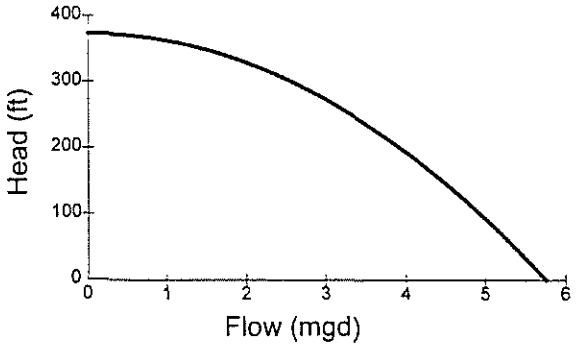

Curve 2, PS 8, Pumps 1 & 2
Head (ft)
200
150
100
50
0
0.0
0.2
0.4
0.6
0.8
Flow (mgd)


Shut-off @ 130'
Beverly Hills, CA BVPN 97033.100
Green Acres (Station No. 7)
Ingersoll-Dresser (11/98)
4 stage: Bowl Eff @ 300 gpm
@ 85 ft = 79%
90 gpm @ 120 ft
Eff 52% 45%
180 gpm @ 110 ft
Eff 74%
240 gpm @ 100 ft
Eff 79%
300 gpm @ 85'
Eff = 79
330 gpm
@ 70 ft
Eff 74%
TDH, feet
120
110
100
90
80
70
0
50
100
150
200
250
300
350
Flow, gpm

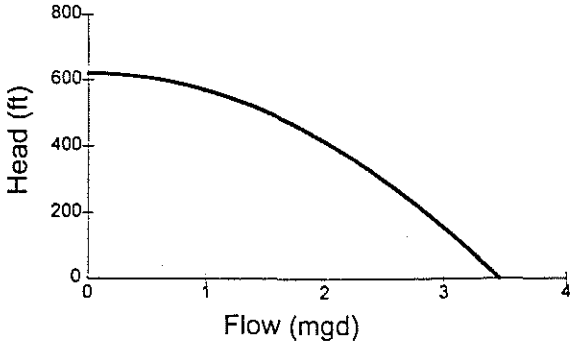

Curve 9, Green Acres PS, Booster No. 1
Head (ft)
150
100
50
0
0.0
0.2
0.4
0.6
0.8
Flow (mgd)

DESIGN POINT CURVES

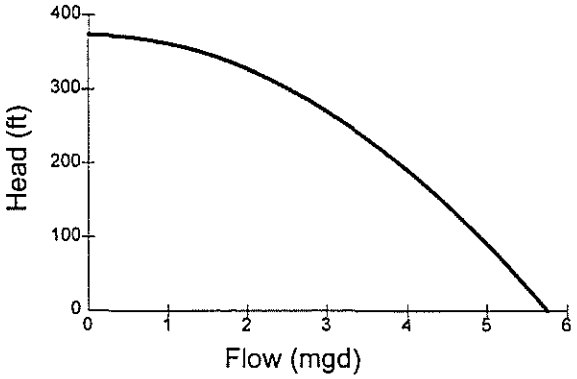
DPC, Greystone PS, Pump 3 (Diesel)



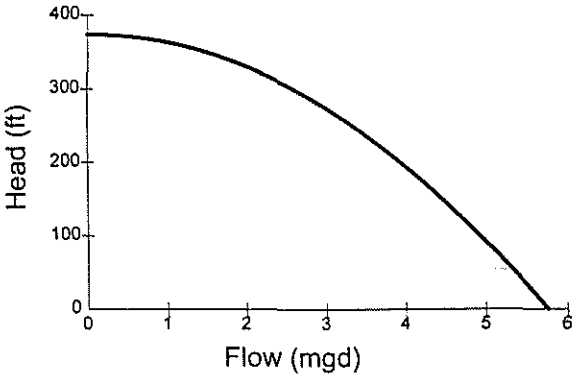
DPC, Monte Cielo PS, Pump 3 (Diesel)



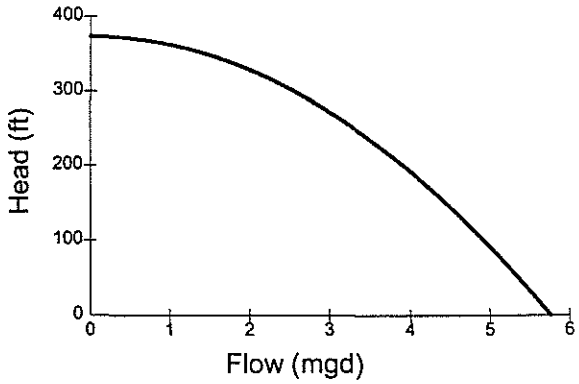
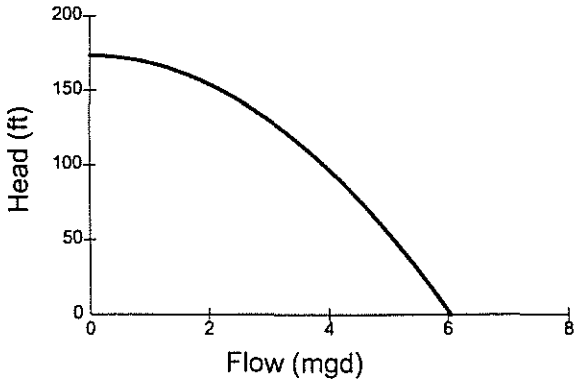
DPC, PS 4B, Pump 3 (Diesel)



DPC, PS 5, Pump 3 (Diesel)



DPC, PS 6, Pump 3 (Diesel)



DPC, PS 8, Pump 3 (Diesel)