# 2018 NOVATO WATER SYSTEM MASTER PLAN UPDATE

## North Marin Water District

## FINAL REPORT

## September 2019

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## ES 1 INTRODUCTION - PURPOSE OF UPDATE

The North Marin Water District (NMWD) has prepared this 2018 update of the Novato Water System Master Plan to guide immediate and planned future system improvements. The previous Master Plan was most recently updated in 2012. This Master Plan Update identifies necessary system improvements for both current operation and as water demands increase in the future, as well as incorporating replacement metrics related to asset age and material. The Master Plan Update includes a proposed Capital Improvement Plan that identifies the improvement projects and required funding throughout the planning period through FY 2035.

Projects contained in the Capital Improvement Plan are separated by budget category utilized in the District budgeting process. Projects are identified for the following categories.

- Pipeline Replacement/Additions (Category No. 1)
- System Improvements (Category No. 2)
- Storage Tanks/Pump Stations (Category No. 4)

Proposed projects related to water conservation and proposed projects falling within Building/Yard/Stafford Water Treatment Plant (Category No. 3) and Recycled Water (Category No. 5) are beyond the scope of the master plan and are not included herein.

### ES 1.1 Major Modifications Since Previous Plans

The 2002 Novato Water System Master Plan was undertaken by the District in an attempt to develop a long-range strategic plan for identifying and implementing necessary capital improvement projects in the water transmission and distribution system. The effort, including consolidation of various recent planning efforts, development and calibration of hydraulic network models of the most critical pressure zones, a procedure and approach for developing current water consumption by zone, and for monitoring new development within the District boundaries and projecting water demands through buildout. The result of the work was a Capital Improvement Plan that identified a phased plan for implementing recommended improvement projects.

The 2007 Master Plan Update built on the original master plan, with updated historical water production records, updated development and water demand projections, and an updated hydraulic analysis utilizing the hydraulic models incorporating new system facilities that had been constructed since 2002. In addition, an asset management section was added to summarize the District’s efforts to collect data on existing infrastructure and create a reasonable plan to replace aging facilities.

The 2012 Master Plan Update has again built on the original (2002) master plan with updated water production records, updated development and buildout water demand projections, and incorporated a skeletonized hydraulic model using open-platform modeling software (EPANET) for analysis. A more comprehensive asset management section was included to reflect the District’s shift in focus from new development to infrastructure replacement, and provided metrics related to historic maintenance and replacement costs.

Most notably, the 2018 Master Plan Update incorporates a fully developed hydraulic model of the entire Novato Service Area. The model includes the entire pipe and valve network in the Novato Service Area, and detailed information on the water storage tanks, pump stations, and pressure regulating devices. This was possible since in 2018, NMWD completed (over a multi-year period) the development of a Geographic Information System (GIS) for the Novato Service Area. Previous Master Plan Updates were based on less robust modeling information, but the current Update will provide greater detail granularity necessary for making more informed decisions on how to spend limited capital funds to greatest benefit.

## ES 2 PERFORMANCE AND EVALUATION CRITERIA

The performance and evaluation criteria used to evaluate the Novato Water System are presented in Section 2. Development of peaking factors and performance criteria are listed in Table ES-1.

**Table ES-1**
**Performance and Evaluation Criteria**

| Item | Criteria |
|---|---|
| Peaking Factors | • Average day peak month (ADPM) demand = annual average day x 1.65<br>• Maximum day demand (MDD) = annual average day x 1.77<br>• Peak hour demand (PHD) = annual average day x 2.8 |
| Minimum pressure | • 40 psi under average day demand<br>• 30 psi under maximum day demand<br>• 20 psi at fire hydrant under fire event |
| Maximum pressure | • 80 psi (services with greater static pressure require a pressure regulator) |
| Maximum pipeline velocity | • 8 fps under average day demand (less than 16-inch diameter)<br>• 5 fps under average day demand (16-inch or greater diameter)<br>• 10 fps under maximum day or fire demand |
| Maximum pipeline head loss | • 3 feet per 1,000 feet under average day demand<br>• 10 feet per 1,000 feet under maximum day demand |
| Fire flow/storage goals | • 3,500 gpm for three hours (parcels designated as commercial/industrial/institutional or multi-family within Zone 1, Zone 2, and Airbase, Zones)<br>• 3,500 gpm for two hours (Buck Zone)<br>• 1,500 gpm for two hours (Crest, Black Point, Cherry Hill, Half Moon, Wild Horse Valley, Garner, Old Ranch Rd, Dickson, Winged Foot, Ponti, San Andreas, San Antonio and Nunes Zones) |
| Storage capacity goals | • Storage capacity goal per zone is sum of operational, fire and emergency storage volumes<br>• Operational storage = 25% of maximum day demand<br>• Fire storage = see above<br>• Emergency storage = 100% of maximum day demand |
| Pumping capacity goals | • Station firm capacity is equal to maximum day demand pumped over 16 hour duration<br>• Firm capacity = station capacity with largest pump out of service<br>• Pump stations sized for firm capacity equal to maximum day demand |

## ES 3 NOVATO WATER SYSTEM OVERVIEW

The existing water system is presented in Section 3. The Novato Water System serves primarily the City of Novato and surrounding unincorporated areas in Marin County, encompassing approximately 75 square miles. As of June 30, 2018, the Novato Service area had approximately 19,645 active service connections serving approximately 23,099 dwelling units. The estimated service area population is 61,381[1].

### ES 3.1 Water Supply Sources

The North Marin Water District (NMWD) water supply for the Novato Service area is derived from two sources: 1) surface water stored in Stafford Lake; and 2) Russian River water supplied by Sonoma County Water Agency (SCWA).

**Stafford Lake:** Stafford Lake lies four miles west of downtown Novato and collects runoff from 8.3 square miles of watershed land adjacent to the upper reaches of Novato Creek. The lake has a surface area of 230 acres and holds 4,400 AF of water at a maximum water surface elevation of 196 feet above sea level. Water from Stafford Lake is drawn by an intake tower and fed by gravity or by pumping (depending on the lake level) into the Stafford Treatment Plant (STP) located just below the Stafford Lake (Novato Creek) dam. Treated water from STP is pumped to the Zone 1 system by the high-lift pump station, which houses two 125 hp and one 75 hp pumps. A 360 kW solar power facility at the Stafford WTP was installed in FY 2012.

Located at the base of Stafford Lake Dam, the STP is designed to treat water to meet current and anticipated future water quality regulatory standards, improve system reliability, and enhance the aesthetic attributes of Novato's local water supply. The old treatment plant, built in 1954, underwent a major upgrade as its filters were retrofitted with granular activated carbon to polish the water, further improving taste and odor. The old treatment plant clarifier was converted to a solids thickener, consolidating the material removed from the lake water. STP is capable of producing 5.4 mgd and is operated seasonally to reduce peak summer demands from the SCWA Russian River transmission system. Stafford Lake provides about 2,300 AF (750 mg per year), or approximately 20% of Novato's annual water demand.

**Russian River (Sonoma County Water Agency) Supply:** The primary water supply source for the Novato Water System is Russian River water delivered by SCWA. Water is delivered to NMWD via the 9.4 mile long North Marin Aqueduct, consisting of 42-inch and 30-inch diameter (I.D.) mortar-lined and cement-coated steel transmission main extending from the Kastania Pump Station near Petaluma to the connection to the NMWD transmission/distribution system located north of San Marin Dr. The North Marin Aqueduct was originally constructed in 1961 and was relocated as part of the Highway 101 road widening project, and upsized to transition to a gravity fed system thereby eliminating operation of the Kastania Pump Station. In 1999, SCWA acquired the northernmost portion of the North Marin Aqueduct (from the Kastania Pump Station to the intersection of Petaluma Boulevard South and McNear Avenue) from NMWD, and the Kastania Pump Station from MMWD.

Russian River water originates in Mendocino County and is derived from both the Eel River (via Pacific Gas and Electric's Van Arsdale diversion at Cape Horn Dam feeding water through a 1.6 mile tunnel to the Potter Valley Powerhouse on the east fork of the Russian River) and the 1,485 square mile Russian River watershed, which includes most of Sonoma County and extends into Mendocino County to the northeast of the City of Ukiah. Just downstream of the PG&E Potter Valley powerhouse, the Eel River diversions and winter runoff from the local watershed are impounded by

Coyote Dam in Lake Mendocino, which is owned and operated by the U.S. Army Corps of Engineers.

The Potter Valley Project, owned and operated by Pacific Gas and Electric (PG&E), is a hydroelectric project that provides an interbasin water transfer to the East Fork of the Russian River. Its operations are not coordinated with the operation of Coyote Valley Dam at Lake Mendocino. PG&E releases water from Lake Pillsbury to meet minimum instream flow requirements on the Eel River and to divert water through the Potter Valley Project to generate electricity and maintain minimum instream flow requirements in the East Fork Russian River. The water diverted through the Potter Valley Project flows into the East Fork of the Russian River. The Potter Valley Irrigation District diverts a portion of the released water for irrigation, with the remaining eventually flowing to Lake Mendocino. PG&E's license to operate the hydroelectric facility is issued by the Federal Energy Regulatory Commission, and expires in 2022.

Over many years, PG&E has evaluated various options concerning the future of the Project for the benefit of its electric ratepayers. That effort, and years-long discussions with stakeholders, led to PG&E's May 10, 2018 written and public announcement that it intended to auction the Project but was open to discussions with any local, county or state governmental entity that had an interest in possibly transferring the Project to a local or regional entity as a possible alternative to the auction. Discussions are ongoing, and an Ad Hoc Committee formed by Congressman Jared Huffman has been formed for the purpose of identifying possible areas of agreement among a diverse group of stakeholders. Subsequently in January 2019, PG&E filed for bankruptcy, and in a separate action, withdrew its relicensing application with the Federal Energy Regulatory Commission.

Since 1961, NMWD has received water supply from the Russian River under a contractual arrangement with SCWA. The District is a contractual partner (water contractor) with seven other retail water providers (cities of Santa Rosa, Rohnert Park, Cotati, Petaluma, Sonoma, Windsor and Valley of the Moon Water Districts) receiving Russian River water supply from the Sonoma County Water Agency. The current Restructured Agreement for water supply executed by SCWA in June 2006 replaces the Eleventh Amended Agreement for Water Supply executed by SCWA in January 2001 and provides for water delivery entitlements to meet demand projections based on current general plans within each water contractor's service area, including NMWD. NMWD's contractual entitlement under the restructured agreement provides for a delivery capacity of 19.9 mgd and total delivery of 14,100 AF during any fiscal year.

### ES 3.2 Recycled Water Supply

The Recycled Water Implementation Plan identifies potential recycled water customers and phasing of the recycled water expansion program by dividing the Novato Service Area in to North, Central and South service areas. The supply is being expanded incrementally with an ultimate goal of approximately 700 AF for the three service areas (North, Central and South) and is scheduled for completion by the year 2035.

The existing North Service Area pipelines convey recycled water from the Deer Island RWF to the StoneTree Golf Course and Novato Fire Department. The additional pipelines in the North Service Area, completed in September 2012, include an interconnection between the Deer Island RWF and the Davidson Street RWF to improve the reliability of recycled water supplies. In addition to the pipelines, the North Service Area includes an above ground recycled water storage tank, the Plum Street Tank, with 0.5 mg of operational storage. The Central Service Area proposed pipelines will initiate at the NSD Davidson Street RWF to serve the areas to the south and west.

The South Service Area includes pipelines in the south portion of the City of Novato (aka Hamilton Area). Recycled water will be conveyed north from the LGVSD RWF to customers in the South Service Area via a main transmission pipeline. The South Service Area includes a concrete recycled water storage tank with a timber roof, the Reservoir Hill Tank, with 0.5 mg of operational storage. The storage tank and approximately 3.8 miles of pipeline was constructed by September, 2012.

Recycled water distribution system expansion to the Central Service Area was completed in early 2018. The project included 5.7 miles of new pipeline, an undercrossing of Highway 101, repurposing and upgrade of the unused 0.5 MG Norman tank for recycled use, as well the connection of approximately 40 new recycled water users (public and private) including homeowner associations, Marin Country Club, and Vintage Oaks Shopping Center.

### ES 3.3 Water Conservation

NMWD maintains a comprehensive and innovative Water Conservation Program aimed at improving water use efficiency for residential, commercial, and large landscape customers. Each water conservation program element is analyzed to assure that it will efficiently produce long-lasting water savings, mutually worthwhile to the customer and the District. The District's water conservation programs saved over 1,579 AF in FY 2017.

### ES 3.4 Distribution System Characteristics

The District has four separate pressure zones based on ground surface elevations. Each pressure zone has one or more water storage tanks that establish the maximum water surface elevation for that zone. The main pressure zone is Zone 1, which comprises the lower elevations (up to approximately 60 feet above sea level). This area covers most of the City of Novato and the area along Highway 101 on both sides of the freeway. Zone 2 serves elevations between 60 and 200 feet. Zone 3 serves elevations roughly between 200 and 400 feet and covers mostly the extreme western hills, pockets in the Atherton area, and smaller areas directly east of downtown and U.S. Highway 101. Zone 4 serves elevations above 400 feet and includes two small isolated areas.

Each pressure zone has gravity storage capacity in one or more storage tanks. There are a total of 31 storage tanks throughout the Novato Water System, totaling almost 37.3 MG. Zone 1 has a storage capacity of 14.3 MG. Zone 2 has a total storage capacity of 18.8 MG. Zones 3 and 4 combined have a total storage capacity of 4.1 MG. Tank sizes range from 5,500 gallons to 5 MG.

The transmission system consists of 16- through 30-inch diameter pipelines strategically located to convey water supply to the distribution system. The primary transmission mains include the 30-inch diameter (28.5-inch inside diameter) main connecting the North Marin Aqueduct to Zone 1 and the 18-inch pipeline delivering water from the Stafford Treatment Plant to Zone 1.

The majority of the distribution system is comprised of 6-, 8-, 10- and 12-inch diameter pipelines to distribute water from the transmission mains. Distribution system pipelines are constructed primarily of PVC, asbestos cement, and cast iron. Pipelines in the older sections of town were constructed over 60 years ago, and are constructed of cast iron pipe. As of June 2018, the distribution system totals approximately 321 miles of pipeline, based on data obtained from the District's GIS.

## ES 4 HISTORICAL WATER DEMANDS AND FORECASTS

Section 4 examines historical and current water demands, and projects buildout water demands.

### ES 4.1 Water Production

Historical annual water production since FY 1955 for both water supply sources is shown in Table ES-2. Historically, approximately 10 to 25 percent of the annual water supply was obtained from the Stafford Lake water source through the Stafford Treatment Plant (STP). In 2005, STP was shut down for renovations. The upgraded plant was opened in 2007 and has been producing 15 to 30 percent of the annual water supply since. The relatively recent implementation of recycled water has resulted in peak load reduction on the potable water system.

**Table ES-2**
**Historical Potable Water Supply Production**

| Fiscal Year | Stafford WTP (AF) | SCWA (AF) | Annual Total (AF) | Annual Total (MG) | Annual Daily (mgd) | ADPM (mgd) |
|---|---|---|---|---|---|---|
| 1955 | 1,019 | | 1,019 | 332.0 | 0.91 | 1.35 |
| 1956 | 1,355 | | 1,355 | 441.5 | 1.21 | 2.15 |
| 1957 | 1,389 | | 1,389 | 452.6 | 1.24 | 1.98 |
| 1958 | 1,579 | | 1,579 | 514.5 | 1.41 | 2.34 |
| 1959 | 2,162 | | 2,162 | 704.4 | 1.93 | 3.03 |
| 1960 | 2,173 | | 2,173 | 708.0 | 1.94 | 3.30 |
| 1961 | 2,128 | 11 | 2,139 | 696.9 | 1.91 | 3.19 |
| 1962 | 1,830 | 404 | 2,234 | 727.9 | 1.99 | 3.39 |
| 1963 | 1,704 | 916 | 2,620 | 853.7 | 2.34 | 3.86 |
| 1964 | 1,939 | 988 | 2,927 | 953.7 | 2.61 | 4.08 |
| 1965 | 1,994 | 1,499 | 3,493 | 1,138.1 | 3.12 | 4.88 |
| 1966 | 2,111 | 1,940 | 4,051 | 1,319.9 | 3.62 | 5.94 |
| 1967 | 1,992 | 2,034 | 4,026 | 1,311.8 | 3.59 | 5.78 |
| 1968 | 2,223 | 2,625 | 4,848 | 1,579.6 | 4.33 | 6.97 |
| 1969 | 1,929 | 2,888 | 4,817 | 1,569.5 | 4.30 | 7.06 |
| 1970 | 1,955 | 3,650 | 5,605 | 1,826.3 | 5.00 | 7.50 |
| 1971 | 1,953 | 3,668 | 5,621 | 1,831.5 | 5.02 | 8.02 |
| 1972 | 1,870 | 4,539 | 6,409 | 2,088.2 | 5.72 | 8.52 |
| 1973 | 1,792 | 4,553 | 6,345 | 2,067.4 | 5.66 | 9.25 |
| 1974 | 1,253 | 5,284 | 6,537 | 2,129.9 | 5.84 | 9.37 |
| 1975 | 2,080 | 4,830 | 6,910 | 2,251.5 | 6.17 | 9.31 |
| 1976 | 1,690 | 5,946 | 7,636 | 2,488.0 | 6.82 | 10.03 |
| 1977 | 1,020 | 5,306 | 6,326 | 2,061.2 | 5.65 | 10.11 |
| 1978 | 2,022 | 3,324 | 5,346 | 1,741.9 | 4.77 | 8.68 |
| 1979 | 2,118 | 4,883 | 7,001 | 2,281.1 | 6.25 | 10.14 |
| 1980 | 1,414 | 6,135 | 7,549 | 2,459.7 | 6.74 | 10.23 |
| 1981 | 604 | 7,903 | 8,507 | 2,771.8 | 7.59 | 12.33 |
| 1982 | 2,030 | 6,153 | 8,183 | 2,666.3 | 7.30 | 11.58 |
| 1983 | 2,575 | 5,541 | 8,116 | 2,644.4 | 7.25 | 11.06 |
| 1984 | 2,532 | 6,721 | 9,253 | 3,014.9 | 8.26 | 12.05 |
| 1985 | 684 | 8,623 | 9,307 | 3,032.5 | 8.31 | 12.75 |
| 1986 | 1,028 | 8,324 | 9,352 | 3,047.2 | 8.35 | 12.70 |
| 1987 | 1,902 | 7,901 | 9,803 | 3,194.1 | 8.75 | 12.81 |
| 1988 | 974 | 8,918 | 9,892 | 3,223.1 | 8.83 | 12.57 |
| 1989 | 1,188 | 8,361 | 9,549 | 3,111.3 | 8.52 | 12.44 |
| 1990 | 1,157 | 8,386 | 9,543 | 3,109.4 | 8.52 | 13.09 |
| 1991 | 1,217 | 8,852 | 10,069 | 3,280.8 | 8.99 | 12.92 |
| 1992 | 1,438 | 8,008 | 9,446 | 3,077.8 | 8.43 | 11.50 |
| 1993 | 1,952 | 7,169 | 9,121 | 2,971.9 | 8.14 | 12.25 |
| 1994 | 1,917 | 7,914 | 9,831 | 3,203.2 | 8.78 | 13.18 |
| 1995 | 1,065 | 8,714 | 9,779 | 3,186.3 | 8.73 | 13.59 |
| 1996 | 2,039 | 8,289 | 10,328 | 3,365.2 | 9.22 | 13.49 |
| 1997 | 2,136 | 8,503 | 10,639 | 3,466.5 | 9.50 | 13.92 |
| 1998 | 2,323 | 6,888 | 9,211 | 3,001.2 | 8.22 | 14.08 |
| 1999 | 2,502 | 7,687 | 10,189 | 3,319.9 | 9.10 | 13.67 |
| 2000 | 2,029 | 8,757 | 10,786 | 3,514.4 | 9.63 | 14.05 |
| 2001 | 2,241 | 9,065 | 11,306 | 3,683.8 | 10.09 | 15.05 |

**Table ES-2 (Continued)**
**Historical Potable Water Supply Production**

| **Fiscal Year** | **Stafford WTP** (AF) | **SCWA** (AF) | **Annual Total** (AF) | **Annual Total** (MG) | **Annual Daily** (mgd) | **ADPM** (mgd) |
|---|---|---|---|---|---|---|
| 2002 | 1,762 | 9,255 | 11,017 | 3,589.7 | 9.83 | 15.06 |
| 2003 | 2,762 | 7,867 | 10,629 | 3,463.2 | 9.49 | 15.72 |
| 2004 | 2,006 | 9,499 | 11,505 | 3,748.7 | 10.27 | 15.60 |
| 2005 | 734 | 9,326 | 10,060 | 3,277.8 | 8.98 | 14.78 |
| 2006 | 0 | 10,797 | 10,797 | 3,518.0 | 9.64 | 15.58 |
| 2007 | 1,071 | 10,103 | 11,174 | 3,640.8 | 9.97 | 15.60 |
| 2008 | 2,185 | 8,397 | 10,582 | 3,447.9 | 9.45 | 13.57 |
| 2009 | 1,912 | 8,382 | 10,294 | 3,354.1 | 9.19 | 13.60 |
| 2010 | 2,455 | 5,997 | 8,452 | 2,753.9 | 7.54 | 11.84 |
| 2011 | 2,713 | 6,179 | 8,892 | 2,897.3 | 7.94 | 12.20 |
| 2012 | 1,798 | 7,399 | 9,197 | 2,996.8 | 8.21 | 12.04 |
| 2013 | 2,317 | 7,436 | 9,753 | 3,177.8 | 8.71 | 12.76 |
| 2014 | 1,470 | 7,767 | 9,237 | 3,009.8 | 8.25 | 12.42 |
| 2015 | 1,758 | 5,917 | 7,675 | 2,500.8 | 6.85 | 10.28 |
| 2016 | 1,844 | 5,300 | 7,144 | 2,327.8 | 6.38 | 10.24 |
| 2017 | 2,320 | 5,159 | 7,479 | 2,436.8 | 6.68 | 10.01 |

## ES 4.2 Historical Water Demands

Historical water demand since is shown 1981 for the Novato Water System in Table E-3. The observed annual demand, annual average day demand, and maximum (max) day demand, along with peaking factors and lost (un-accounted) water percentages for the Novato Water System as a whole are shown in the table.

**Table 4-2**
**Historical Potable Water Demands**

| Fiscal Year | Water Bank Total EDU (EDU) | Annual Production (AF) | Annual Demand (1) (AF) | Average Day Demand (2) (mgd) | Maximum Day Demand (mgd) | Peaking Factor(3) Max Day/Ave Day | Lost Water(4) (%) |
|---|---|---|---|---|---|---|---|
| 1981 | 15,692 | 8,507 | 7,775 | 7.59 | 15.68 | 2.06 | 8.6% |
| 1982 | 15,794 | 8,183 | 7,512 | 7.30 | 13.03 | 1.78 | 8.2% |
| 1983 | 15,955 | 8,116 | 7,467 | 7.25 | 13.32 | 1.84 | 8.0% |
| 1984 | 16,344 | 9,253 | 8,143 | 8.26 | 15.44 | 1.87 | 12.0% |
| 1985 | 16,597 | 9,307 | 8,330 | 8.31 | 15.42 | 1.86 | 10.5% |
| 1986 | 16,832 | 9,352 | 8,688 | 8.35 | 15.60 | 1.87 | 7.1% |
| 1987 | 17,232 | 9,803 | 9,215 | 8.75 | 14.22 | 1.62 | 6.0% |
| 1988 | 17,408 | 9,892 | 9,130 | 8.83 | 15.00 | 1.70 | 7.7% |
| 1989 | 17,712 | 9,549 | 8,814 | 8.52 | 14.97 | 1.76 | 7.7% |
| 1990 | 17,856 | 9,543 | 8,970 | 8.52 | 14.95 | 1.75 | 6.0% |
| 1991 | 18,226 | 10,069 | 9,032 | 8.99 | 14.24 | 1.58 | 10.3% |
| 1992 | 18,390 | 9,446 | 8,445 | 8.43 | 13.79 | 1.64 | 10.6% |
| 1993 | 18,605 | 9,121 | 8,729 | 8.14 | 14.94 | 1.83 | 4.3% |
| 1994 | 18,685 | 9,831 | 9,123 | 8.78 | 16.75 | 1.91 | 7.2% |
| 1995 | 18,785 | 9,779 | 8,860 | 8.73 | 16.09 | 1.84 | 9.4% |
| 1996 | 19,079 | 10,328 | 9,398 | 9.22 | 15.64 | 1.70 | 9.0% |
| 1997 | 19,392 | 10,639 | 9,852 | 9.50 | 17.13 | 1.80 | 7.4% |
| 1998 | 19,885 | 9,211 | 9,128 | 8.22 | 16.43 | 2.00 | 0.9% |
| 1999 | 20,237 | 10,189 | 9,394 | 9.10 | 16.15 | 1.78 | 7.8% |
| 2000 | 20,615 | 10,786 | 10,257 | 9.63 | 17.29 | 1.80 | 4.9% |
| 2001 | 20,673 | 11,306 | 10,673 | 10.09 | 17.78 | 1.76 | 5.6% |
| 2002 | 21,572 | 11,017 | 10,642 | 9.83 | 16.87 | 1.72 | 3.4% |
| 2003 | 21,930 | 10,629 | 9,930 | 9.49 | 18.12 | 1.91 | N/A |
| 2004 | 22,628 | 11,505 | 11,033 | 10.27 | 17.21 | 1.68 | 4.1% |
| 2005 | 22,768 | 10,060 | 9,399 | 8.98 | 17.17 | 1.91 | N/A |
| 2006 | 22,876 | 10,797 | 10,063 | 9.64 | 17.76 | 1.84 | 6.8% |
| 2007 | 22,944 | 11,174 | 10,850 | 9.97 | 17.07 | 1.71 | 2.9% |
| 2008 | 23,091 | 10,582 | 9,989 | 9.45 | 15.77 | 1.67 | 5.6% |
| 2009 | 23,193 | 10,294 | 9,617 | 9.19 | 17.38 | 1.89 | N/A |
| 2010 | 23,299 | 8,452 | 7,896 | 7.54 | 13.41 | 1.78 | N/A |
| 2011 | 23,336 | 8,892 | 8,376 | 7.94 | 14.20 | 1.79 | 5.8% |
| 2012 | 23,384 | 9,197 | 8,397 | 8.21 | 15.40 | 1.88 | 8.7% |
| 2013 | 23,390 | 9,753 | 9,080 | 8.71 | 14.36 | 1.65 | 6.9% |
| 2014 | 23,391 | 9,237 | 8,960 | 8.25 | 14.93 | 1.81 | 3.0% |
| 2015 | 23,426 | 7,675 | 7,622 | 6.85 | 13.71 | 2.00 | 0.7% |
| 2016 | 23,463 | 7,144 | 6,887 | 6.38 | 12.17 | 1.91 | 3.6% |
| 2017 | 23,538 | 7,479 | 7,015 | 6.68 | 15.58 | 2.33 | 6.2% |
| | | | | **37-year average=** | **15.54** | **1.82** | **6.6%** |

## ES 4.3 FY 2013 (Current) Water Demands

The FY 2013 water demand was selected as representative of normal demand conditions (non-drought), and will be utilized in this Master Plan for several tasks including the hydraulic evaluation of the distribution system and the storage and pumping capacity evaluations. FY 2013 demand is also separated by pressure zone. The FY 2013 demand, separated by pressure zone, is shown in Table ES-4.

**Table 4-3**
**FY 2013 Water Demands**

| Pressure Zone | Annual Gross Demand[1] (gallons) | Average Day Demand[2] (gpd) | Average Day Demand (gpm) | Max Day/Ave Day Peaking Factor[3] | Maximum Day Demand (gpd) | Maximum Day Demand (gpm) |
|---|---|---|---|---|---|---|
| No. Novato Subzone | 1,009,804,857 | 2,766,600 | 1,921 | 1.77 | 4,895,500 | 3,400 |
| So. Novato Subzone | 405,217,019 | 1,110,200 | 771 | 1.77 | 1,964,500 | 1,364 |
| **Zone 1 Total** | **1,415,021,876** | **3,876,800** | **2,692** | | **6,860,000** | **4,764** |
| | | | | | | |
| Crest | 53,562,456 | 146,700 | 102 | 1.77 | 259,700 | 180 |
| Black Point | 39,285,127 | 107,600 | 75 | 1.77 | 190,500 | 132 |
| San Mateo/Trumbull Subzone | 761,679,241 | 2,086,800 | 1,449 | 1.77 | 3,692,600 | 2,564 |
| Sunset/Pacheco Subzone | 543,401,535 | 1,488,800 | 1,034 | 1.77 | 2,634,400 | 1,829 |
| Air Base | 96,598,334 | 264,700 | 184 | 1.77 | 468,300 | 325 |
| **Zone 2 Total** | **1,494,526,692** | **4,094,600** | **2,843** | | **7,245,500** | **5,032** |
| | | | | | | |
| Cherry Hill | 44,462,282 | 121,800 | 85 | 1.77 | 215,600 | 150 |
| Half Moon | 7,305,106 | 20,000 | 14 | 1.77 | 35,400 | 25 |
| Wild Horse Valley/Center Rd | 86,840,719 | 237,900 | 165 | 1.77 | 421,000 | 292 |
| Garner | 6,162,487 | 16,900 | 12 | 1.77 | 29,900 | 21 |
| Old Ranch Road | 3,350,462 | 9,200 | 6 | 1.77 | 16,200 | 11 |
| Dickson | 19,222,299 | 52,700 | 37 | 1.77 | 93,200 | 65 |
| Winged Foot | 22,136,686 | 60,600 | 42 | 1.77 | 107,300 | 74 |
| Ponti | 25,110,990 | 68,800 | 48 | 1.77 | 121,700 | 85 |
| San Andreas | 6,175,802 | 16,900 | 12 | 1.77 | 29,900 | 21 |
| Nunes | 3,851,450 | 10,600 | 7 | 1.77 | 18,700 | 13 |
| **Zone 3 Total** | **224,618,283** | **615,400** | **427** | | **1,088,900** | **756** |
| | | | | | | |
| Buck | 6,044,314 | 16,600 | 12 | 1.77 | 29,300 | 20 |
| Upper Wild Horse Valley | 3,454,488 | 9,500 | 7 | 1.77 | 16,700 | 12 |
| Cabro Ct | 1,010,298 | 2,800 | 2 | 1.77 | 4,900 | 3 |
| **Zone 4 Total** | **10,509,100** | **28,900** | **20** | | **50,900** | **36** |
| | | | | | | |
| Windhaven | 1,244,148 | 3,400 | 2 | 1.77 | 6,000 | 4 |
| San Antonio (WCW) | 1,825,028 | 5,000 | 3 | 1.77 | 8,800 | 6 |
| **Misc Zone Total** | **3,069,177** | **8,400** | **6** | | **14,800** | **10** |
| | | | | | | |
| Bahia Hydro | 11,194,006 | 30,700 | 21 | 1.77 | 54,300 | 38 |
| Hayden Hydro | 4,184,333 | 11,500 | 8 | 1.77 | 20,300 | 14 |
| Diablo Hills Hydro | 1,295,745 | 3,500 | 2 | 1.77 | 6,300 | 4 |
| Garner Hydro | 2,003,953 | 5,500 | 4 | 1.77 | 9,700 | 7 |
| Indian Hills Hydro | 2,265,265 | 6,200 | 4 | 1.77 | 11,000 | 8 |
| Rockrose Hydro | 2,896,078 | 7,900 | 5 | 1.77 | 14,000 | 10 |
| Eagle Dr Hydro | 6,415,478 | 17,600 | 12 | 1.77 | 31,100 | 22 |
| **Hydro Zone Total** | **30,254,857** | **82,900** | **58** | | **146,700** | **102** |

[1] Gross Annual Demands represent total production (billed consumption, unmetered consumption, fire hydrants, lost water, etc)

[2] Determined by dividing Gross Annual Demand by 365

[3] Peaking factor is multiplier to obtain maximum day demand from average day demand. Peaking factors obtained using average day demand data from 2004 and Max Day demand data from 2003.

## ES 4.4 Buildout Demand Projections

Previous water demand forecasts for North Marin Water District were prepared in 1992 and based on the 1991 Countywide Plan. The 1996 City of Novato General Plan development forecast was consistent with the 1991 Countywide Plan, so no formal update of the water demand forecast was conducted at that time. Demands and development projections were updated in the 2002, 2007, and 2012 Water System Master Plans. As future years will contain drought years and non-drought years, previous demand projections were scaled based on a historic 37 year average peaking factor of 1.82 (see table ES-4). This is different than the 2003/2004 modeling peaking factor of 1.77 which is more appropriate for the application of non-drought year baseline demand data from FY 2013.

On June 21, 2016, the District's Board of Directors adopted the 2015 NMWD Urban Water Management Plan, (UWMP), which is available to view or download on the District's website at www.nmwd.com. It includes population and water demand forecasts for the Novato service area through buildout in 2040. In this Master Plan, the buildout water demand forecast from the 2015 UWMP, shown in Table ES-5, is used. Actual data from FY 1981 through FY 2017 is provided in the table, along with the forecast from FY 2020 though FY 2035, presented in 5-year increments. At buildout, there is a projected annual demand of 10,155 AF per year, or an average daily demand of 9.07 mgd. The projected maximum day demand is 16.1 mgd.

**Table 4-4**
**Buildout Potable Water Demand Forecast**

| | Fiscal Year | A<br>Annual AF<br>(AF) | B<br>Annual MG<br>(MG) | C<br>Ave Day<br>(mgd) | D<br>ADPM<br>(mgd) | E<br>Max Day<br>(mgd) |
|---|---|---|---|---|---|---|
| Actual | 1981 | 8,507 | 2,771.8 | 7.59 | 12.33 | 15.68 |
| | 1982 | 8,183 | 2,666.3 | 7.30 | 11.58 | 13.03 |
| | 1983 | 8,116 | 2,644.4 | 7.25 | 11.06 | 13.32 |
| | 1984 | 9,253 | 3,014.9 | 8.26 | 12.05 | 15.44 |
| | 1985 | 9,307 | 3,032.5 | 8.31 | 12.75 | 15.42 |
| | 1986 | 9,352 | 3,047.2 | 8.35 | 12.70 | 15.60 |
| | 1987 | 9,803 | 3,194.1 | 8.75 | 12.81 | 14.22 |
| | 1988 | 9,892 | 3,223.1 | 8.83 | 12.57 | 15.00 |
| | 1989 | 9,549 | 3,111.3 | 8.52 | 12.44 | 14.97 |
| | 1990 | 9,543 | 3,109.4 | 8.52 | 13.09 | 14.95 |
| | 1991 | 10,069 | 3,280.8 | 8.99 | 12.92 | 14.24 |
| | 1992 | 9,446 | 3,077.8 | 8.43 | 11.50 | 13.79 |
| | 1993 | 9,121 | 2,971.9 | 8.14 | 12.25 | 14.94 |
| | 1994 | 9,831 | 3,203.2 | 8.78 | 13.18 | 16.75 |
| | 1995 | 9,779 | 3,186.3 | 8.73 | 13.59 | 16.09 |
| | 1996 | 10,328 | 3,365.2 | 9.22 | 13.49 | 15.64 |
| | 1997 | 10,639 | 3,466.5 | 9.50 | 13.92 | 17.13 |
| | 1998 | 9,211 | 3,001.2 | 8.22 | 14.08 | 16.43 |
| | 1999 | 10,189 | 3,319.9 | 9.10 | 13.67 | 16.15 |
| | 2000 | 10,786 | 3,514.4 | 9.63 | 14.05 | 17.29 |
| | 2001 | 11,306 | 3,683.8 | 10.09 | 15.05 | 17.78 |
| | 2002 | 11,017 | 3,589.7 | 9.83 | 15.06 | 16.87 |
| | 2003 | 10,629 | 3,463.2 | 9.49 | 15.72 | 18.12 |
| | 2004 | 11,505 | 3,748.7 | 10.27 | 15.60 | 17.21 |
| | 2005 | 10,060 | 3,277.8 | 8.98 | 14.78 | 17.17 |
| | 2006 | 10,797 | 3,518.0 | 9.64 | 15.58 | 17.76 |
| | 2007 | 11,174 | 3,640.8 | 9.97 | 15.60 | 17.07 |
| | 2008 | 10,582 | 3,447.9 | 9.45 | 13.57 | 15.77 |
| | 2009 | 10,294 | 3,354.1 | 9.19 | 13.60 | 17.40 |
| | 2010 | 8,452 | 2,753.9 | 7.54 | 11.84 | 13.41 |
| | 2011 | 8,892 | 2,897.3 | 7.94 | 12.20 | 14.20 |
| | 2012 | 9,197 | 2,996.8 | 8.21 | 12.04 | 15.40 |
| | 2013 | 9,753 | 3,177.8 | 8.71 | 12.76 | 14.36 |
| | 2014 | 9,237 | 3,009.8 | 8.25 | 12.42 | 14.93 |
| | 2015 | 7,675 | 2,500.8 | 6.85 | 10.28 | 13.71 |
| | 2016 | 7,144 | 2,327.8 | 6.38 | 10.24 | 12.17 |
| | 2017 | 7,479 | 2,436.8 | 6.68 | 10.01 | 15.58 |
| Forecast | 2020 | 10,012 | 3,262.2 | 8.94 | 14.75 | 15.81 |
| | 2025 | 10,058 | 3,277.2 | 8.98 | 14.81 | 15.89 |
| | 2030 | 10,063 | 3,278.8 | 8.98 | 14.82 | 15.90 |
| | 2035 | 10,155 | 3,308.8 | 9.07 | 14.96 | 16.04 |

A: actual per NMWD Annual Reports = SCWA + STP supply
forecast demands per 2015 NWMD UWMP Table 4-2

B: = column A * 43560 * 7.48 / 1000000

C: = column B / 365

D: Historic annual ADPM peaking factor is 1.52, however, a more detailed analysis calculating individual peaking factors for all Novato service area customers resulted in an adjusted ADPM peaking factor of 1.65. See footnote 6 of Table 4-5 for additional details.

E: actual per NMWD Annual Reports
forecast = column C * 1.77
(MaxDay/AveDay peaking factor obtained using average day demand data from 2004 and Max Day demand data from 2003. See section 4.3.1 for detailed explanations)

## ES 5 STORAGE AND PUMPING CAPACITY EVALUATION

The storage and pumping capacity evaluation of the pressure zones and pump stations in the Novato Water System is presented in Section 5. The analysis is based on FY 2013 and projected buildout (FY 2035) water demands presented in Section 4.

### ES 5.1 Storage Capacity Evaluation

The storage capacity evaluation is based on determining three storage volume components as presented in Section 2, and summarized below:

- Operational Storage
  - 25% of Max Day Demand for one day.
- Fire Storage
  - Detailed storage criteria listed in Table 2-2.
  - Generally follows the following residential, non-residential breakdown:
    - 1,500 gpm for two hours for residential areas.
    - 3,500 gpm for three hours in non-residential areas
    - 3,500 gpm for two hours in Buck Zone
- Emergency Storage
  - 100% of Max Day Demand for one day.

The sum of these three components is the total storage capacity goal for the specific pressure zone. This total storage capacity goal is compared to the existing storage capacity to determine if a surplus or deficit of storage capacity exists. The updated results of the storage evaluation are presented in Table ES-6.

### ES 5.2 Pumping Capacity Evaluation

Providing adequate storage capacity is only one distribution system element that beneficially affects system operation. Adequate pumping capacity must be provided to enable the storage capacity to recover depleted volume in a reasonable time period. Undersized pumps may reduce the effectiveness of storage capacity. Therefore, it is necessary to evaluate the pumping capacity requirements at each booster pump station.

The pumping evaluation in this study consists of comparing the pumping requirement (calculated as maximum (max) day demand pumped over 16 hours for a given zone) to the firm capacity of the supplying pump station. Firm capacity is defined as the pump station capacity with the largest pump out of service. All of the District's stations evaluated in this report have at least two pumps, except the San Marin, Lynwood, and Trumbull pump stations, which have three pumps. Note that this analysis uses the rated pump capacity provided by the District. Many pump stations are required to pass water through to a higher zone than the one which the pump station is serving. The total flow that is required to be pumped through the station for both its zone and upper zones is included as appropriate when determining the total pumping capacity requirement. The results of the pumping capacity evaluation are shown in Table ES-7.

## TABLE ES-6

**Additional Storage Capacity Required By Pressure Zone**

| Tank/Pressure Zone | Zone | Total Zone Storage Capacity (gallons) | Additional Storage Capacity Required (Gallons)[2] FY 2013 | FY 2020 | FY 2025 | FY 2030 | FY 2035 |
|---|---|---|---|---|---|---|---|
| No. Novato Subzone | 1 | 6,350,000 | 400,000 | 498,000 | 573,000 | 694,000 | 708,000 |
| So. Novato Subzone | 1 | 7,500,000 | (4,414,000) | (4,333,000) | (4,285,000) | (4,225,000) | (4,216,000) |
| Zone 1 Total | 1 | 13,850,000 | (4,644,000) | (4,465,400) | (4,343,300) | (4,161,600) | (4,139,400) |
| San Mateo/Trumbull Subzone | 2 | 6,500,000 | (1,254,000) | (1,254,000) | (1,226,000) | (1,177,000) | (1,175,000) |
| Sunset/Pacheco Subzone | 2 | 10,000,000 | (6,077,000) | (6,077,000) | (6,071,000) | (6,068,000) | (6,068,000) |
| Primary Zone 2 Total | 2 | 16,500,000 | (7,961,000) | (7,961,200) | (7,928,100) | (7,875,700) | (7,874,400) |
| Crest | 2 | 1,000,000 | (495,000) | (495,000) | (495,000) | (426,000) | (426,000) |
| Black Point | 2 | 324,000 | 95,000 | 95,000 | 95,000 | 157,000 | 157,000 |
| Air Base | 2 | 1,000,000 | 216,000 | 216,000 | 216,000 | 216,000 | 216,000 |
| Cherry Hill | 3 | 450,000 | 0 | 0 | 0 | 1,000 | 1,000 |
| Half Moon | 3 | 100,000 | 125,000 | 125,000 | 125,000 | 126,000 | 126,000 |
| Wild Horse Valley/Center Rd | 3 | 1,000,000 | (293,000) | (293,000) | (293,000) | (291,000) | (291,000) |
| Garner[1] | 3 | 100,000 | 118,000 | 118,000 | 118,000 | 118,000 | 118,000 |
| Old Ranch Road | 3 | 50,000 | 71,000 | 71,000 | 71,000 | 72,000 | 72,000 |
| Dickson | 3 | 250,000 | (46,000) | (46,000) | (46,000) | (46,000) | (46,000) |
| Winged Foot | 3 | 600,000 | (285,000) | (285,000) | (285,000) | (285,000) | (285,000) |
| Ponti | 3 | 500,000 | (167,000) | (167,000) | (167,000) | (167,000) | (167,000) |
| San Andreas | 3 | 250,000 | (32,000) | (32,000) | (32,000) | (32,000) | (32,000) |
| Nunes | 3 | 120,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 |
| Buck | 4 | 500,000 | (43,000) | (43,000) | (43,000) | 19,000 | 19,000 |
| Upper Wild Horse Valley | 4 | 44,000 | (23,000) | (23,000) | (23,000) | (23,000) | (23,000) |

[1] Additional storage capacity will not be constructed in this zone. See Section 5.8.1 for discussion.

[2] Surplus storage capacity listed in parentheses.

## TABLE ES-7

**Additional Pumping Capacity Required**

| Pump Station | Pumps to Pressure Zones[1] | Station Firm Capacity (gpm)[2] | Additional Pumping Capacity Required FY 2013 (gpm) | FY 2020 (gpm) | FY 2025 (gpm) | FY 2030 (gpm) | FY 2035 (gpm) |
|---|---|---|---|---|---|---|---|
| San Marin | **SM/T Sub**, Nunes, **Buck**, Rockrose, San Andreas, Cabro, **Wild Horse/Center, Upper WH, Half Moon**, **Old Ranch** | 3,600 | (411) | (411) | (400) | (361) | (361) |
| Lynwood | **S/P Sub**, Garner, Garner Hydro, Dickson, Indian Hills, Eagle, Winged Foot, Air Base, Ponti | 3,600 | 1,321 | 1,321 | 1,337 | 1,398 | 1,398 |
| Primary Zone 2 Total[3] | | 9,000[3] | (890) | (890) | (863) | (763) | (762) |
| School Road | **Crest**, **Bahia** & **Black Pt** | 400 | 126 | 126 | 126 | 236 | 236 |
| Cherry Hill | **Cherry Hill** | 140 | 85 | 85 | 85 | 85 | 85 |
| Ridge Road | **Half Moon** | 80 | (43) | (43) | (43) | (42) | (42) |
| Trumbull | **Wild Horse/Center, Upper Wild Horse,** Cabro Ct | 680 | (219) | (219) | (219) | (217) | (217) |
| Truman | Garner & Garner Hydro | 75 | (34) | (34) | (34) | (34) | (34) |
| Davies | **Old Ranch Rd** | 50 | (33) | (33) | (33) | (32) | (32) |
| Woodland Heights | Dickson | 110 | (13) | (13) | (13) | (13) | (13) |
| Winged Foot | Winged Foot | 150 | (38) | (38) | (38) | (38) | (38) |
| Ponti | Ponti | 250 | (123) | (123) | (123) | (123) | (123) |
| San Andreas | San Andreas | 110 | (79) | (79) | (79) | (79) | (79) |
| Nunes | Nunes & **Buck** | 110 | (60) | (60) | (60) | (9) | (9) |
| Buck | **Buck** | 100 | (69) | (69) | (69) | (18) | (18) |
| Wild Horse | **Upper Wild Horse** | 50 | (33) | (33) | (33) | (33) | (33) |

(1) Pressure zones with expected demand increase are shown in bold.

(2) Pump station capacity with largest pump out of service.

(3) As San Mateo/Trumbull and Sunset/Pacheco Subzones are hydraulically connected it is relevant to analyze them as a single zone. Firm capacity for Primary Zone 2 Total is 9,000 gpm (5 pumps at 1,800 gpm each).

## ES 6 WATER QUALITY EVALUATION

Section 6 presents information on the current water quality, and provides recommendations for operational modifications and capital improvements related to water quality as well as regulations governing the Novato Water System.

Ensuring water quality is one of the primary goals of the District, and was listed in the District's 2018 Strategic Plan as an ongoing need. Policy supports this goal with Board and management commitment to meeting or exceeding all US Environmental Protection Agency (EPA) and California Water Board Division of Drinking Water (DDW) regulatory requirements. Water quality is monitored by the Water Quality Division whose responsibility is to provide oversight to all District activities as they relate to water quality.

### ES 6.1 Source Water Quality

The two water supply sources for the Novato Water System have different physical quality characteristics. Stafford Lake water is a surface water supply with high levels of naturally-occurring organics that exhibit a high oxidant demand and that has potential to produce high levels of disinfection by-products (DBPs). Stafford Lake water is also subject to taste and odor problems due to algae growth in the lake. In 2015, a study was undertaken to review factors influencing algal growth and to formulate a comprehensive strategy for resulting taste and odor. SCWA water is a ground water supply that originates deep within the aquifer of the Russian River. The SCWA supply is naturally low in organics and requires minimal disinfection to maintain a disinfectant residual. The total DBP formation potential with conventional oxidation using free chlorine is greater in the raw Stafford supply than in SCWA supply.

### ES 6.2 Existing Distribution System Water Quality

Under typical conditions, operation of the STP occurs from approximately May through October on daily 16 to 24 hour shifts. During this time, 3.5 to 5.5 MGD of water is typically delivered to Zone 1. During peak production periods, STP water could account for up to 40 percent of water produced in the system. STP finished water has comparable chlorine demand and a slightly lower DBP formation potential than water from SCWA.

NMWD has a number of distribution system programs to maintain water quality. These programs include the installation of chlorine booster stations, augmenting storage tanks with chlorine on an as needed basis, and implementing a seasonal flushing program. Monitoring of chlorine and heterotrophic plate counts provides feedback to the successful operation of these programs. The District currently has 70 water quality monitoring locations as shown on Figure 6-1. The above-mentioned programs have contributed to significant improvements in maintaining adequate chlorine residual in the distribution system and resulting water quality.

### ES 6.3 Drinking Water Regulations and NMWD Monitoring Programs

The District operates the Novato Water System under an operating permit issued by DDW. DDW is responsible for enforcing both State and Federal (United States Environmental Protection Agency, USEPA) drinking water regulations as a "primacy" State. NMWD's operating permit requires compliance with all State and Federal drinking water regulations and imposes several additional operating and monitoring conditions. The most significant drinking water regulations and permit conditions are listed as follows:

- Surface Water Treatment Rule (SWTR)
- Coliform Rule
- Disinfection By-Product Rules (DBP I and II)
- Long Term Enhanced SWTR and Filter Backwash Rule
- Lead and Copper Rule
- Cross Connection Control
- Other regulations and permit conditions
- Other NMWD programs and emerging issues

## ES 7 HYDRAULIC EVALUATION

The hydraulic evaluation of the Novato Water System is presented in Section 7. The hydraulic network was recreated from the ground up by importing NMWD's GIS of the entire system into a software suite which pulled key hydraulic parameters from the GIS shapefiles. A complete baseline and buildout analysis of all four pressure zones were then evaluated to identify hydraulic adequacy under two demand conditions, including a peak hour and a maximum day plus fire flow evaluation. Additionally, four special operational situations are modeled with baseline maximum day demand. Some portions of the hydraulic evaluation were not performed on the small hydropneumatic zones within the system due to their negligible demands and the complicated modeling parameters associated with pressure vessels. Several projects were identified to address distribution system hydraulic improvements and are described in Section 7.

### ES 7.1 DISTRIBUTION SYSTEM ANALYSIS

The hydraulic network model was utilized to evaluate the performance of the all zones' water distribution systems under baseline (FY 2013) and future buildout (FY 2035) peak hour and fire flow water demands. Additionally, two buildout maximum-day special operational scenarios (Stafford WTP offline and Kastania Reservoir offline) are simulated as well. The hydraulic model output results include flow, velocity and head loss for all pipe segments, hydraulic gradient for all tanks and reservoirs, pressure and hydraulic gradient for all network nodes in the system. This information is compared to specific evaluation criteria to determine hydraulic adequacy. Solutions to correct identified deficiencies are then applied to the model to determine their effectiveness.

### ES 7.2 MODEL SIMULATION APPROACH

All four zones of the distribution system were evaluated under four steady-state demand conditions: 1) baseline and buildout under peak hour demand, with tanks two-thirds full; 2) baseline and buildout under maximum day demand plus fire flow, with tank levels at 10 feet; 3) buildout maximum day demand scenario with SCWA online and Stafford WTP offline; 4) buildout maximum day demand scenario with SCWA offline and Stafford WTP online. The tank levels were set to represent a conservative input, especially to higher zones, as not all zone pumps are modeled as online. The alternation of turning off the two water sources tests the system's reaction to receiving only gravity flows from storage tanks. In reality, over time, the system would experience pressure deficiencies as the tank storages are depleted. These four scenarios intend to stress the distribution system to identify potential bottlenecks, and to test the efficiency of potential improvement projects.

## ES 8 ASSET MANAGEMENT

The District's Asset Management (AM) Program is a staff-driven program, and is updated to promote deeper understand of the following:

- District owned assets, their current physical condition, and the services that they provide;
- The present and future demands on District assets that are critical for delivering a defined level of service to customers and the community;
- Current estimates of the short-term and long-term financial requirements (both capital and operational) necessary to maintain the assets and the services that they provide;
- The current and proposed policies, strategies, and programs that are necessary to meet the long-term provision of services;
- Business risk exposure associated with the potential failure of the assets required to meet the expected service levels;
- Linkages necessary between strategic business objectives and the service that the assets are delivering; and
- The organizational continuity that will span staffing changes and the transfer of asset management knowledge between successive generations of utility managers and staff.

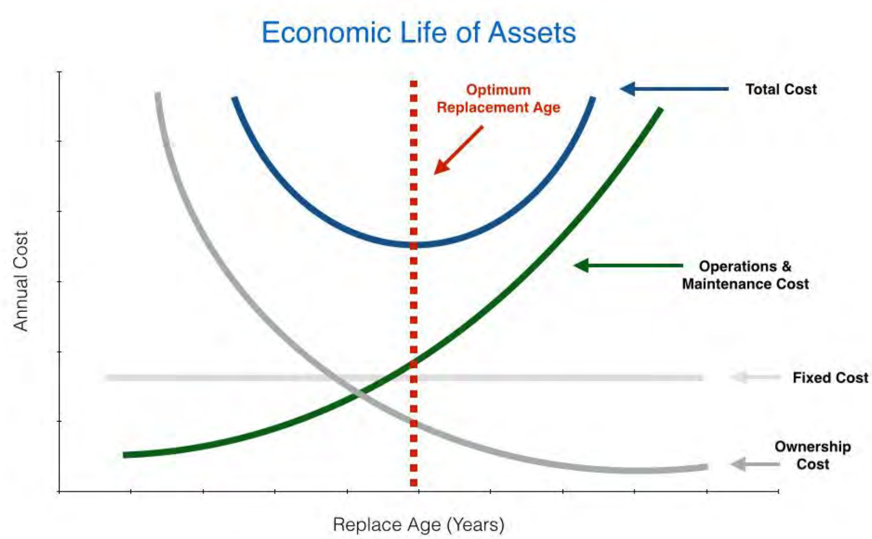
It is intended that the inclusion of a 5-year AM Plan will be incorporated as part of the NMWD ongoing Master Plan process.

### ES 8.1 AM Program Objectives and Goals

The District's mission is to *"meet the expectations of our customers in providing potable and recycled water and sewer services that are reliable, high-quality, environmentally responsible, and reasonably priced".* Accordingly, it is appropriate that the goals of the District's AM Plan are to: (1) improve water system reliability by reducing system failure rates; (2) minimize the time and money spent reacting to problems through proactive implementation of necessary AM maintenance and improvement projects; (3) forecast exhausted asset replacement costs; and (4) develop a practical replacement plan.

Without an effective AM Program, infrastructure reliability cannot be achieved in a cost-effective manner. As an example, consider the graphical illustration in Figure ES-1 depicting total cost as a function of operation and maintenance cost, ownership cost and fixed cost. The graph illustrates there is an optimal point at which replacement costs are lowest.

**Figure ES-1**
**Level of Planned Maintenance**




The Novato service area is substantially built-out, and more of the daily construction and maintenance activities have switched from new construction to repair and replacement (R&R) of aging infrastructure. In addition, a greater percentage of funds for these R&R projects come from District operating revenues and not connection fees associated with new development. The District has contracted with a software firm (NEXGEN) to implement new software and associated procedures, which will be a lengthy and challenging task. Starting in early 2019, the duration is estimated to require 6-12 months.

### ES 8.2 Asset Categories

The Novato water system includes the following major components:

- 31 potable storage tanks
- 3 abandoned tanks and 3 recycled water tanks
- 26 pump stations
- 13 pressure regulating stations
- 7 hydro-pneumatic systems
- 321 miles of pipeline
- 2,659 fire hydrants
- 8,430 valves
- 20,838 service connections (includes active, inactive and closed status for both potable and recycled)

## ES 8.3 Asset Value

Asset values for District infrastructure installed over time are shown in Fig. ES-2. The asset values were derived from original installation costs and are adjusted for inflation (Year n value = $Year_{n-1}$ value x ($CCI_n/CCI_{n-1})$ + current year asset costs). Current infrastructure asset values are in excess of \$330 million. Most of the District's assets are associated with buried facilities (i.e., transmission and distribution pipelines and appurtenances), and comprise the greatest financial obligation for the District. Expansion of the Plan to include above-ground (vertical) infrastructure such as storage tanks, treatment plants and pump stations will occur at a later date after more experience is gained with this step and following implementation of asset management software programming.

## ES 8.4 Focus Area

Whether planned or unplanned, maintenance costs associated with District facilities have been trending higher as the District's assets have expanded and aged over time. Figure ES-3 provides annual and 10-year running average expenditures (FY 2017 dollars). Since the prior 2012 Plan, annual maintenance expenditures have averaged $1.4 million. When compared against the total FY 2017 Operating Budget of $10.88 million (includes only source of supply expense, pumping, operations, water treatment and transmission & distribution), maintenance costs account for about 13% of the budget. Maintenance of water service lines (both copper and PB, polybutylene) consumed approximately 40% of the annual maintenance costs during this period. Note that the identified costs do not include major replacement projects that are typically budgeted as Capital Improvement Projects. Furthermore, some large repair projects are not included in the aforementioned costs since they too are budgeted as a Capital Improvement Project. For example from FY 13 - FY 17, capital costs for PB Service replacements = $494K; and Detector Check Assembly replacements = $358K. For FYs 19 through FY 23, NMWD has planned respective costs of $600K and $460K over this five-year period for more of this same type of aging facility replacement.

**Figure ES-2**
**Asset Value History**

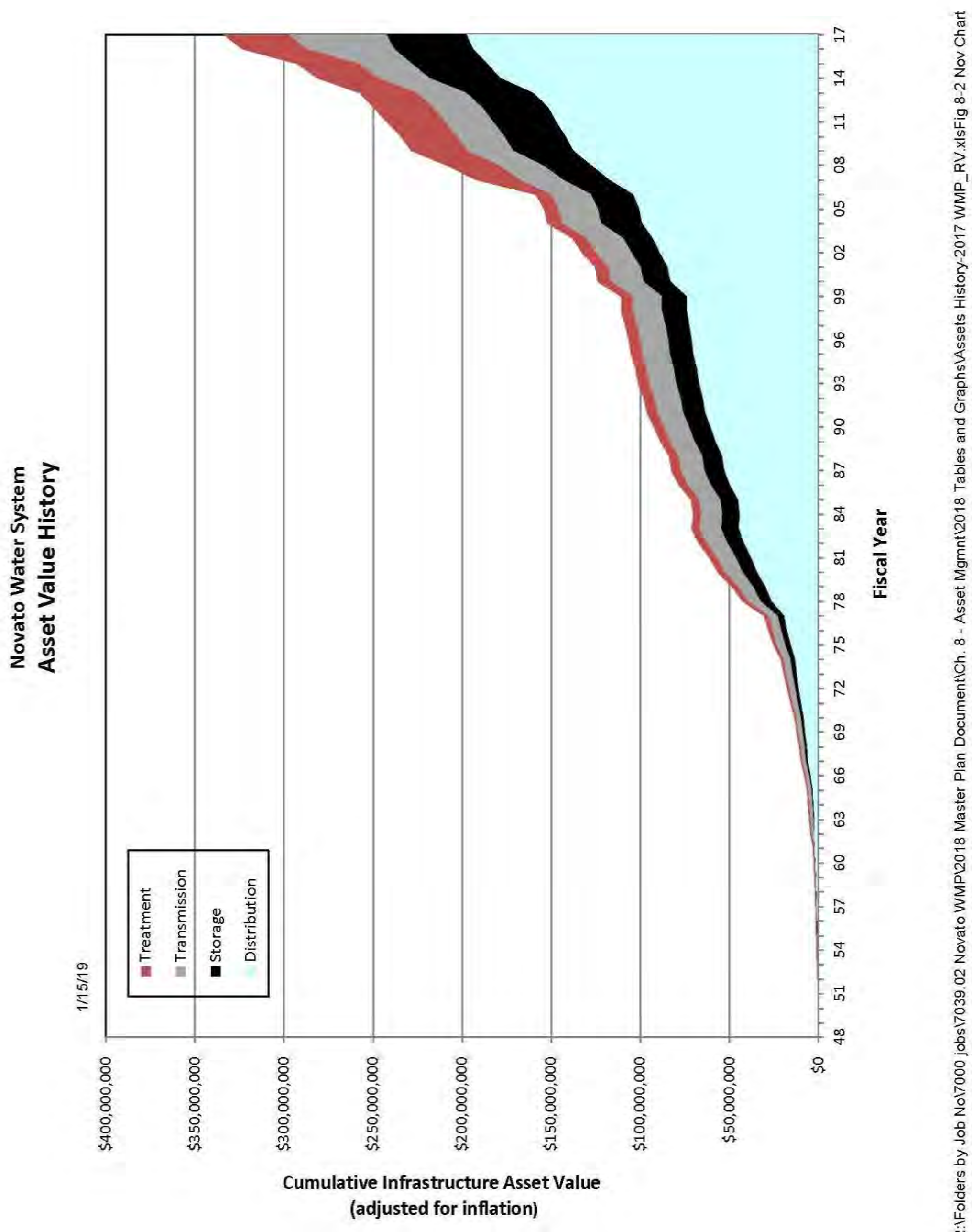
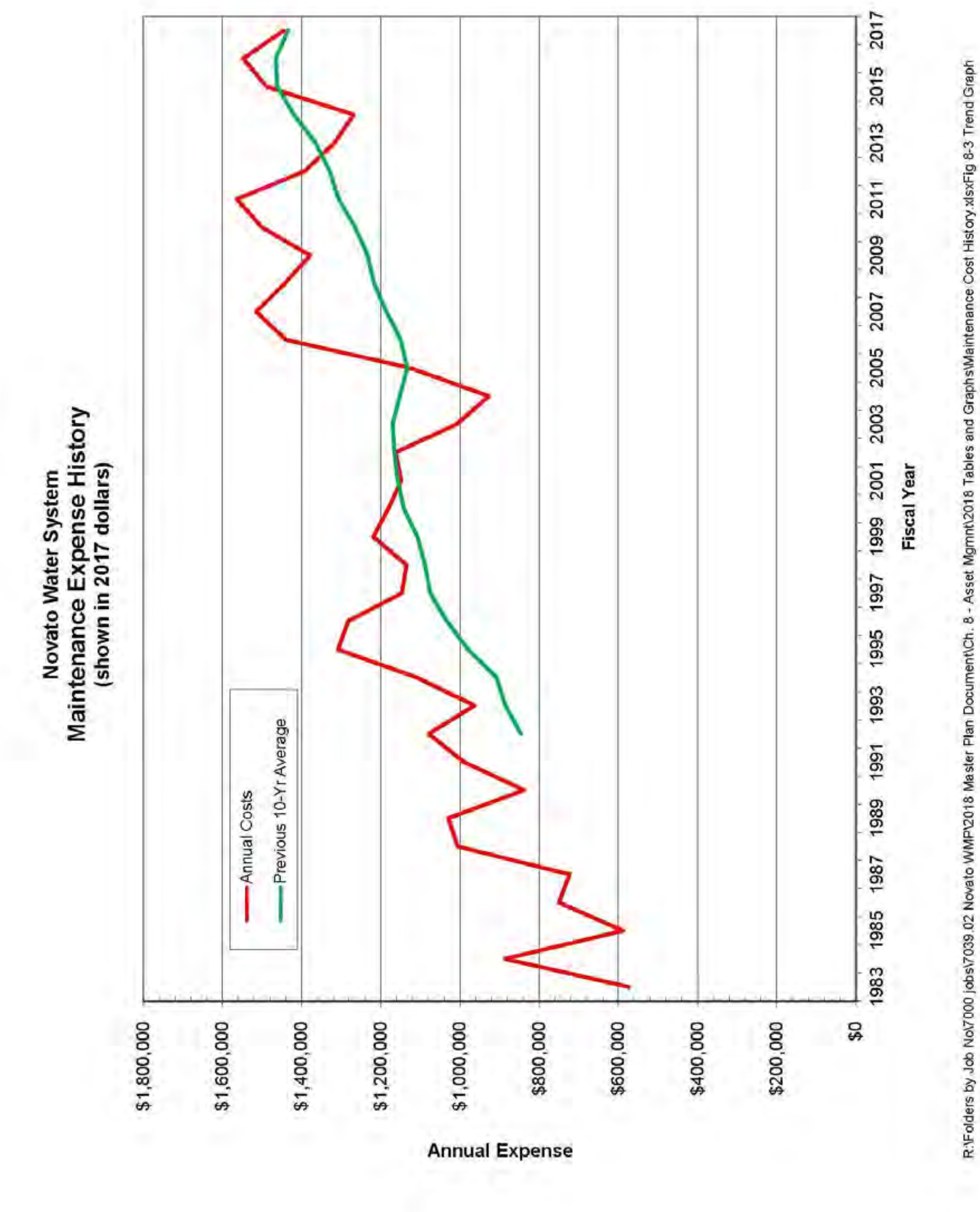


**Figure ES-3**
**Maintenance Expense History**



### ES 8.5 Asset Evaluation

The table below presents the current replacement and depreciated values of NMWD's assets. The replacement value represents the cost in June 2017 dollars to completely rebuild all the assets to a new condition. A formal current condition assessment has not been performed and will be part of the continued development of a full AM program.

| Valuation | Transmission & Distribution | Storage Tanks | Treatment Plants | Total |
|---|---|---|---|---|
| Replacement Value ($M) | $252 | $45 | $36 | $333 |

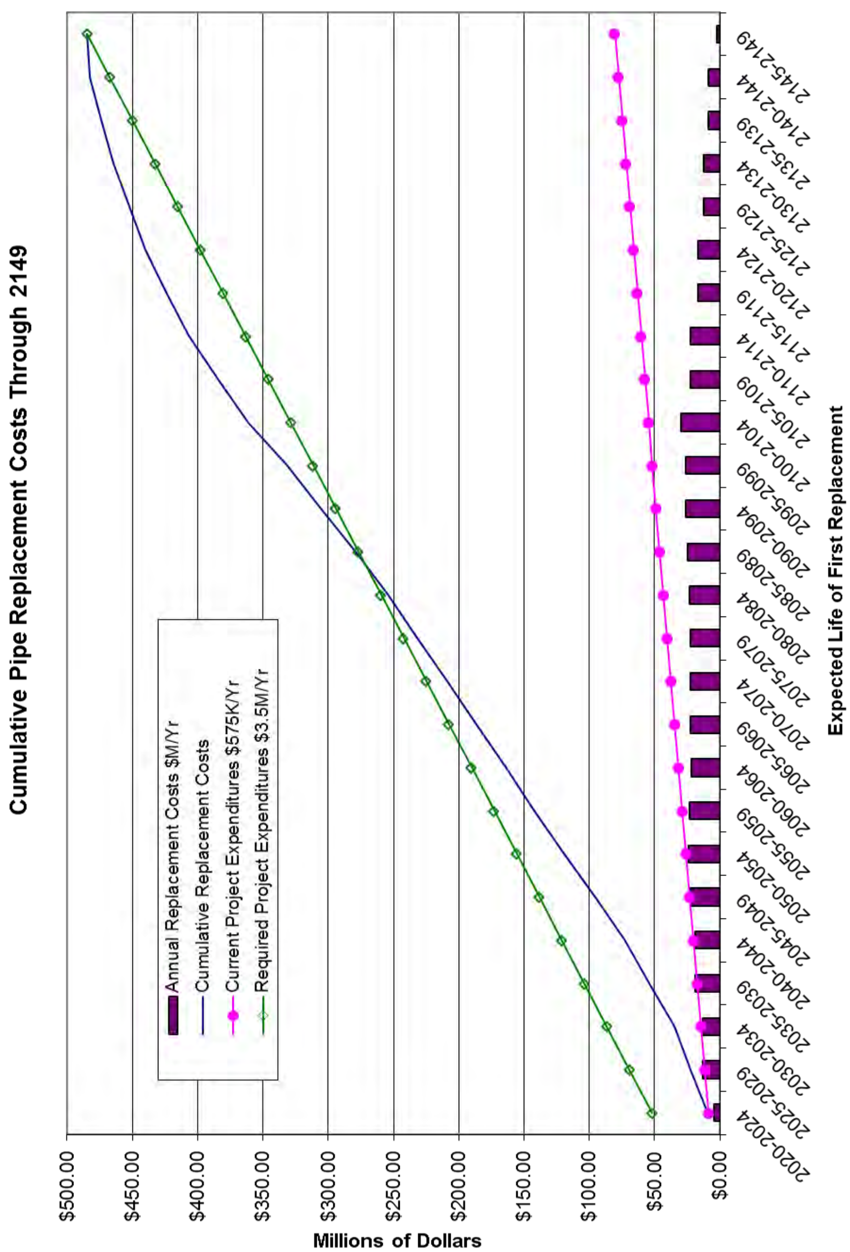
In time, the District AM Program will develop a schedule when these assets are due to be replaced. Currently, complete asset replacement value is estimated at $333M. In the 2007 Master Plan, asset replacement value was assessed at $208M, compared to $238M in the 2012 Plan. The primary reasons for these increases include new assets added to the asset register, and higher replacement costs due constructing in a suburban area like Novato, as opposed to the more rural environment when many of the assets were originally installed.

### ES 8.6 AM Program Summary

The District's AM program consists of four components: monitoring, managing, evaluating infrastructure condition, and replacement planning. Beginning in 2019, EAM system will be used to systematically gather (monitor) information about the current condition of facilities, most of which are below ground. Once collected, the software manages how the information is stored, organized and accessed. District staff then can utilize the EAM program to evaluate the data to identify items in need of rehabilitation or replacement. The following is a description of the EAM plan in place for each of the above-noted assets, broken down into the first three components, with a wrap-up conclusion to address the fourth component.

In conclusion, over the past 5 years efforts have been made to more effectively utilize the various data for this category of maintenance. Pipe section information is documented in the engineering data bases, and various reports are run by sector to track trends in leaks. Future pipeline R&R projects are expected to continue to increase and a long-range forecast is shown in Figure ES-4. The dates for the annual replacement costs are based on a combination of industry expected life and NMWD staff adjustments to smooth out the curve showing anticipated timing for replacing pipe. The current projected level of expenditures falls short of required expenditures. After implementing asset management software, staff will begin a process to refine planned replacements of assets based on incorporating risk of failure and cost of failure metrics.

**Figure ES-4**
**Cumulative Pipe Replacement Costs**



## ES 9 EVALUATION OF IMPROVEMENT PROJECTS

The capital improvement projects and other studies and investigations that have been identified through this study are summarized in Section 9. All projects discussed in Section 9 are included in the Capital Improvement Program presented in Section 10.

### ES 9.1 Project Categories

In order to coordinate with the District annual budgeting process, the projects listed herein are separated by category as shown below:

- *Pipeline Replacements/Additions (CIP budget):*
  Pipeline replacement projects and additional pipelines needed.
- *System Improvements (CIP budget):*
  Improvement projects not specifically related to tanks, pump stations or pipelines.
- *Storage Tanks/Pump Stations (CIP budget):*
  Projects that are related to the storage tanks and pump station facilities.
- *Preliminary Project Engineering and Studies (OPS budget):*
  Engineering studies and investigations that are identified in the Master Plan and may lead to capital improvements at a later date.

Other categories but are not applicable to this Master Plan.

### ES 9.2 Project Timing

Within the CIP list it is necessary to prioritize the projects over the 17-year period until buildout in year 2035. Projects are given a completion goal to identify the urgency with which each project is needed. Each 5-year incremental period (FY 2020, FY 2025, FY 2030, FY 2035) signifies that the project should be included in one or more of the annual budgets for that five-year interval. It is expected that the projects within each interval be evaluated at each annual budgeting cycle to determine which year's budget to assign it. The District regularly updates its 2-year and 5-year CIP budget, and this regular review enables the projects to be developed as funds are more available and priorities change.

## ES 10 CAPITAL IMPROVEMENT PLAN

Section 10 presents the Capital Improvement Plan for distribution system projects that were identified through this Master Plan. Total costs for each project are summarized with detailed breakdowns provided in an appendix. The projects are then scheduled for implementation within each five-year incremental period through buildout in Year 2035.

### ES 10.1 Capital Improvement Projects

Those projects presented in Section 9 were identified by District staff as projects that would provide benefit to the Novato Water System and should be included in the long-range Capital Improvement Plan for the District. Several projects are carried over from the 2012 Master Plan and reprogrammed to reflect current priorities for annual budgeting and severity of need.

### ES 10.2 Project Cost Estimates

Project cost estimates were developed for each capital improvement project described in Section 9. In addition, annual budgets are established for general projects that are not well-defined at the present time.

The following cost estimating criteria serves as the guideline for developing the cost estimates that will be used in the Capital Improvement Plan and as assistance in evaluating developer proposals. Total project cost estimates include the following:

- Baseline construction cost – a conceptual-level estimate of probable construction cost;
- Contingency – added to the construction cost to cover unknowns;
- Design/Construction Management/Administration – non-construction related costs;
- CEQA cost – to cover environmental review (if necessary); and
- Property acquisition – costs to cover easements and property purchases for facilities (if necessary).

Summarized cost estimates for each 5-year period are provided in Tables ES-8 through ES-11, and are segregated by project category. The summarized costs for all project categories combined are included in Table ES-12.

Table ES-8
Pipeline Replacements/Additions Projects
Capital Improvement Plan

| ID # | Project | Improvement Project Cost (2018 $) | | | |
|---|---|---|---|---|---|
| | | FY 2019 to FY2020 | FY 2021 to FY2025 | FY 2026 to FY2030 | FY 2031 to FY2035 |
| 1a-01 | (1) Replace Aging Cast Iron Pipe | $360,000 | $4,429,000 | $4,429,000 | $4,429,000 |
| 1a-02 | Replace 12-Inch CI Pipe in S. Novato Blvd, north of Rowland | | $354,000 | | |
| 1a-03 | Replace All Galvanized Steel Pipe | | $264,000 | | |
| 1a-04 | Replace All < 4-Inch Thin-Walled Pipe | $150,000 | $600,000 | $100,000 | $100,000 |
| 1a-05 | Replace 2-Inch TW Plastic Pipe in Pinto Ln | $32,000 | | | |
| 1a-06 | Replace 2-Inch TW Plastic Pipe in Esquire Ct | $32,000 | | | |
| 1a-07 | Replace 18-Inch Stafford Xmission Line | | | | $9,471,000 |
| 1a-08 | Relocate 8-Inch Pipe in Country Club Dr | | $586,000 | | |
| 1a-09 | Upsize 4-Inch and 6-Inch Mains in East Black Point Subzone | | $1,232,000 | | |
| 1a-10 | Upsize 4-Inch and 6-Inch Mains in East Crest Subzone | | $1,046,000 | | |
| 1b-01 | Loop Southern and Northern Zone 1 at Entrada Dr | | | $2,592,000 | |
| 1b-02 | Loop Bel Marin Keys Residential Area | | | $2,850,000 | |
| 1b-03 | Redwood Blvd-Lamont Looping | | | $505,000 | |
| 1b-04 | Loop Crest Zone at Channel Ave | | | $932,000 | |
| 1b-05 | Loop Zone 2 at Hill Rd | | | $719,000 | |
| 1b-06 | Loop Bel Marin Keys Commercial Area | | $1,238,000 | | |
| 1b-07 | Loop Southern and Northern Zone 2 at Indian Valley Campus | | | $2,730,000 | |
| 1b-08 | Loop Near Grant Ave and Eighth St | | | | $69,000 |
| 1b-09 | Loop Mall Area Near Nave Ct and S Novato Blvd | | | $208,000 | |
| 1b-10 | Connect Dead-ends at George St | | $99,000 | | |
| 1b-11 | Loop Los Robles Rd and Posada del Sol | | $63,000 | | |
| 1c-01 | (2) Replace Polybutylene Service Lines | $300,000 | $750,000 | $750,000 | $750,000 |
| 1d-01 | (3) Relocations to Synchronize with City or County Projects | $200,000 | $500,000 | $500,000 | $500,000 |
| 1e-01 | Replace North Marin Aqueduct (South of Redwood Landfill) (4) | | | | |
| | **Totals** | **$1,074,000** | **$11,161,000** | **$16,315,000** | **$15,319,000** |

Notes:

(1) 2012 Master Plan allocated $500,000 per year for FY2016 to FY2020. Budget $360k for FY2019 and FY2020 per District input. Assume linear yearly progress rate for this on-going/reocurring project for post-2020 years using 10% escalation factor to accelerate costs from 2012 Master Plan.

(2) Per District input, assume $150k per year.

(3) Per District input, assume $100k per year.

(4) Beyond current planning horizon.

Table ES-9
System Improvement Projects
Capital Improvement Plan

| ID # | Project | Improvement Project Cost (2018 $) | | | |
|---|---|---|---|---|---|
| | | **FY 2019 to FY2020** | **FY 2021 to FY2025** | **FY 2026 to FY2030** | **FY 2031 to FY2035** |
| 2-01 | (1) Replace Untestable Detector Checks | $200,000 | $500,000 | | |
| 2-02 | Integrate LIMS into District GIS system | | $44,000 | | |
| 2-03 | (2) Install Anodes on Existing Copper Services | $50,000 | $125,000 | $125,000 | $125,000 |
| 2-04 | Replace Zone Valve with a PRV Station at Park Crest Ct | | $226,000 | | |
| 2-05 | Replace Zone Valve with a PRV Station at Feliz Rd & Ferris Dr | | $234,000 | | |
| 2-06 | Replace Zone Valve with a PRV Station at Fairway Dr | | $223,000 | | |
| 2-07 | Replace Zone Valve with a PRV @ Arthur St &Washington St | | $234,000 | | |
| 2-08 | Add MOV to San Marin PS's 24-inch Feeding Line | | $56,000 | | |
| 2-09 | Replace All Lead Filled Swing Checks | | $30,000 | $30,000 | |
| | **Totals** | **$250,000** | **$1,672,000** | **$155,000** | **$125,000** |

Notes:
(1) Per District input, assume $100k per year.
(2) Per District input, assume $25k per year.

Table ES-10
Storage Tank/Pump Station Projects
Capital Improvement Plan

| ID # | Project | Improvement Project Cost (2018 $) | | | |
|---|---|---|---|---|---|
| | | FY 2019 to FY2020 | FY 2021 to FY2025 | FY 2026 to FY2030 | FY 2031 to FY2035 |
| 4-01 | Add Storage Capacity at Black Point Zone (157,000 Gal) | | | | $1,603,000 |
| 4-02 | Add Storage Capacity at Air Base Zone (216,000 Gal) | | | | $2,090,000 |
| 4-03 | Add Fire Flow Backfeed Valve at Nunes Tank | | $177,000 | | |
| 4-04 | Recoat/Seismic Upgrade Lynwood Tanks | | $2,005,000 | | |
| 4-05 | Recoat/Seismic Upgrade Cherry Hill Tank | $500,000 | | | |
| 4-06 | Recoat Garner Tank | | $354,000 | | |
| 4-07 | Recoating of Other Steel Tanks | | | $1,772,000 | $1,772,000 |
| 4-08 | Tank Seismic Retrofits | | | $709,000 | |
| 4-09 | Demolish Woodland Heights Tank | | $106,000 | | |
| 4-10 | Demolish Loma Verde Tank | | $106,000 | | |
| 4-11 | (1) Relocate and Upsize School Rd Pump Station (Crest PS) | $635,000 | | | |
| 4-12 | Upgrade Davies Pump Station | | $204,000 | | |
| 4-13 | Old Ranch Road Tank No.2 (100,000 Gal) | $150,000 | $481,000 | | |
| | **Totals** | **$1,285,000** | **$3,433,000** | **$2,481,000** | **$5,465,000** |

Notes:

(1) 2012 Master Plan allocated $75,000 for FY2016 to FY2020. Updated based on District input.

Table ES-11
Preliminary Project Engineering and Studies Projects
Capital Improvement Plan

| ID # | Project | Improvement Project Cost (2018 $) | | | |
|---|---|---|---|---|---|
| | | FY 2019 to FY2020 | FY 2021 to FY2025 | FY 2026 to FY2030 | FY 2031 to FY2035 |
| S-01 | Pump Efficiency/Hydraulic Study | | $30,000 | | |
| S-02 | (1)Master Plan Update | $68,000 | $95,000 | $100,000 | $100,000 |
| S-03 | Crest/Black Point Zone Modification Eval | | $27,000 | | |
| S-04 | Hydraulic Model Calibration and Maintenance Updates | $10,000 | $25,000 | $25,000 | $25,000 |
| S-05 | Stafford Dam Seismic Stability Study Update | | | $106,000 | |
| S-06 | (2)Stafford Watershed Master Plan | | $18,000 | $18,000 | $18,000 |
| S-07 | Lynwood and San Marin Zone 2 Pumping Capacity Study | | $28,000 | | |
| S-08 | Water Supply Enhancement Study | $50,000 | $100,000 | | |
| S-09 | Stafford Lake Sediment Survey | | $50,000 | | $50,000 |
| S-10 | Cathodic Protection Master Plan | | $40,000 | | |
| | **Totals** | **$128,000** | **$413,000** | **$249,000** | **$193,000** |

Notes:

(1) 2012 Master Plan allocated $85,000 for FY2016 to FY2020. Updated based on District input.

(2) 2012 Master Plan allocated $10,000 for FY2013 to FY2015. Updated based on District input.

(3) 2012 Master Plan allocated $5,000 for FY2013 to FY2015, this master plan reinjected and escalated this budget to FY2018 to FY2020.

Table ES-12
Capital Improvement Plan Summary

| ID # | Project | Improvement Project Cost (2018 $) | | | |
|---|---|---|---|---|---|
| | | **FY 2019 to FY2020** | **FY 2021 to FY2025** | **FY 2026 to FY2030** | **FY 2031 to FY2035** |
| 1a | Main/Pipeline Replacements | $574,000 | $8,511,000 | $4,529,000 | $14,000,000 |
| 1b | Main/Pipeline Additions | $0 | $1,400,000 | $10,536,000 | $69,000 |
| 1c | PB Service Line Replacements | $300,000 | $750,000 | $750,000 | $750,000 |
| 1d | Relations to Sync w/City CIP | $200,000 | $500,000 | $500,000 | $500,000 |
| 1e | Aqueduct Replacement | $0 | $0 | $0 | $0 |
| | *Category 1 Subtotal* | $1,074,000 | $11,161,000 | $16,315,000 | $15,319,000 |
| 2 | System Improvements | $250,000 | $1,672,000 | $155,000 | $125,000 |
| | | | | | |
| 4 | Storage Tanks/Pump Stations | $1,285,000 | $3,433,000 | $2,481,000 | $5,465,000 |
| | | | | | |
| Study | Preliminary Project Engineering and Studies | $128,000 | $413,000 | $249,000 | $193,000 |
| | **Totals** | **$2,737,000** | **$16,679,000** | **$19,200,000** | **$21,102,000** |

# SECTION 1

# INTRODUCTION

## SECTION 1

## INTRODUCTION

### 1.1 PURPOSE OF STUDY

North Marin Water District (NMWD) has prepared this 2018 update of the Novato Water System Master Plan to guide immediate and planned future system improvements. The previous Master Plan was most recently updated in 2012. This Master Plan Update identifies necessary system improvements for both current operation and as water demands increase in the future, as well as incorporating replacement metrics related to asset age and material. The Master Plan Update includes a proposed Capital Improvement Plan that identifies the improvement projects and required funding throughout the planning period through FY 2035.

Projects contained in the Capital Improvement Plan are separated by budget category utilized in the District budgeting process. Projects are identified for the following categories.

- Pipeline Replacement/Additions (Category No. 1)
- System Improvements (Category No. 2)
- Storage Tanks/Pump Stations (Category No. 4)

Proposed projects related to water conservation and proposed projects falling within Building/Yard/Stafford Water Treatment Plant (Category No. 3) and Recycled Water (Category No. 5) are beyond the scope of the master plan and are not included herein.

### 1.2 MAJOR MODIFICATIONS SINCE PREVIOUS PLANS

The 2002 Novato Water System Master Plan was undertaken by the District in an attempt to develop a long-range strategic plan for identifying and implementing necessary capital improvement projects in the water transmission and distribution system. The Plan included consolidation of various recent planning efforts, development and calibration of hydraulic network models of the most critical pressure zones, development of a procedure and approach for quantifying current water consumption by zone, tracking development of new development within the District boundaries and projecting water demands through buildout. The result of the work was a Capital Improvement Plan that identified a phased plan for implementing recommended improvement projects.

The 2007 Master Plan Update built on the original master plan, with updated historical water production records, updated development and water demand projections, and an updated hydraulic analysis utilizing the hydraulic models incorporating new system facilities that had been constructed since 2002. In addition, an asset management section was added to summarize the District’s efforts to collect data on existing infrastructure and create a reasonable plan to replace aging facilities.

The 2012 Master Plan Update has again built on the original (2002) master plan with updated water production records, updated development and buildout water demand projections, and incorporated a skeletonized hydraulic model using open-platform modeling software (EPANET) for analysis. A more comprehensive asset management section was included to reflect the District’s shift in focus from new development to infrastructure replacement, and provided metrics related to historic maintenance and replacement costs.

Most notably, the 2018 Master Plan Update incorporates a fully developed hydraulic model of the entire Novato Service Area. The model includes the entire pipe and valve network in the Novato

Service Area, and detailed information on the water storage tanks, pump stations, and pressure regulating devices. This was possible since in 2018, NMWD completed (over a multi-year period) the development of a Geographic Information System (GIS) for the Novato Service Area. Previous Master Plan Updates were based on less robust modeling information, but the current Update will provide greater detail granularity necessary for making more informed decisions on how to spend limited capital funds to greatest benefit.

## 1.3 SCOPE OF PROJECT

The scope of work consisted of multiple discrete tasks that covered a particular portion of the study. The following major tasks were performed for this project:

Task 1 – Document Existing System

Task 2 – Establish Planning and Evaluation Criteria

Task 3 Update Water Supply System Planning Discussion

Task 4 – Develop a Comprehensive Hydraulic Model

Task 5 – Update Water Demand Projections

Task 6 – Perform Storage and Pumping Capacity Evaluation

Task 7 – Perform Hydraulic Evaluation

Task 8 – Evaluate Water Quality

Task 9 – Evaluate Facility Replacements

Task 10 – Develop Capital Improvement Program

Task 11 – Prepare Master Plan Report

## 1.4 PROJECT TEAM

The project was performed as a collaborative effort between District staff and Kennedy/Jenks Consultants. Rocky Vogler served as project manager for preparation of the 2018 Master Plan. Susan Dove has been instrumental in coordinating work with Kennedy/Jenks and other agencies. Dave Jackson was primarily responsible for developing the GIS over a multi-year period in collaboration with Open Spatial (consultant). Mr. Rod Houser has been the lead engineer at Kennedy/Jenks, which provided the District with hydraulic modeling services. Staff members have participated in the project through interviews and input in revisions of specific chapters. Each discipline and department within the District has been represented as part of the project team and each section has been updated to reflect current data and information.

## 1.5 LIST OF ABBREVIATIONS

The following abbreviations were utilized in the report and are defined below.

| Abbreviation | Definition |
|---|---|
| AC, ACP | Asbestos Cement Pipe |
| ADPM | Average day peak month |

| Abbreviation | Definition |
|---|---|
| AF | Acre feet |
| AFA | Annual acre feet |
| AM | Asset Management |
| AOC | Assimilable organic carbon |
| APT | Apartment |
| AVE, AVG | Average |
| AWWA | American Water Works Association |
| CC | City/County Coordination |
| CI | Cast iron |
| CIP | Capital Improvement Plan |
| CL2 | Chlorine |
| COP | Copper |
| DBP | Disinfection by-products |
| DBPR | Disinfection By-Product Rule |
| DCMS | Distributed Control and Monitoring System |
| DPH | California Department of Health Services |
| DIP | Ductile Iron Pipe |
| DP | District Planning |
| DU | Dwelling unit |
| EDU | Equivalent dwelling unit |
| fps | Feet per second |
| Ft | Foot, feet |
| FY | Fiscal Year |
| GAC | Granular activated carbon |
| gal | Gallons |
| GHG | Green House Gas |
| GIS | Geographic Information System |
| Gpd | Gallons per day |
| gpm | Gallons per minute |
| HA | Hydraulic Analysis |
| HAA | Haloacetic acids |
| HAFB | Hamilton Air Force Base |
| HDPE | High Density Polyethylene |
| HGL | Hydraulic Grade Line |
| HP | Horsepower |
| In | Inch |
| ISO | Insurance Services Organization |
| kW | Kilowatt |
| LIMS | Laboratory Information Management System |
| LTESWTR | Long-term Enhanced Surface Water Treatment Rule |
| M/DBP | Microbial/Disinfection By-Product |
| MCL | Maximum contaminant level |
| mg | Million gallons |

| Abbreviation | Definition |
|---|---|
| mg/l | Milligrams per liter |
| mgd | Million gallons per day |
| MH | Mobile Home |
| MMWD | Marin Municipal Water District |
| MOU | Memorandum of Understanding |
| ND | Non-detectable |
| NFPD | Novato Fire Protection District |
| NMWD | North Marin Water District |
| PB | Polybutylene |
| PG&E | Pacific Gas and Electric |
| POU | Point-of-use |
| PR | Pressure Regulator |
| PS | Pump Station |
| psi | Pounds per square inch |
| PVC | Poly Vinyl Chloride |
| RAA | Running annual average |
| RCP | Concrete Pressure Pipe |
| SCADA | Supervisory Control and Data Acquisition |
| SCWA | Sonoma County Water Agency (aka Sonoma Water) |
| SF | Single family |
| SP | Storage and Pumping Capacity Analysis |
| SS | Stainless steel, sanitary sewer |
| STL | Steel |
| STP | Stafford Treatment Plant |
| SWTR | Surface Water Treatment Rule |
| TDH | Total Dynamic Head |
| THC | Townhome /condominiums |
| THM | Trihalomethane |
| TOC | Total organic carbon |
| TTHM | Total trihalomethane |
| ug/l | Micrograms per liter |
| USEPA | United States Environmental Protection Agency |
| WQE | Water Quality Evaluation |
| WTP | Water Treatment Plant |
| WUI | Wildland Urban Interface |

# SECTION 2

# PERFORMANCE AND EVALUATION CRITERIA

## SECTION 2

## PERFORMANCE AND EVALUATION CRITERIA

### 2.1 INTRODUCTION

The performance and evaluation criteria used to evaluate the Novato Water System are presented in Section 2.

In order to perform the required hydraulic evaluation of the existing and buildout water system, conduct storage and pumping capacity evaluations and develop the Capital Improvement Plan, evaluation criteria was selected to identify deficiencies and to judge the effectiveness of alternative improvements. Performance and evaluation criteria include:

- Water demand peaking factors for average day peak month (ADPM), maximum day (MDD) and peak hour (PHD) demands for use in developing current and buildout water demands
- Water system operating criteria, including minimum and maximum distribution system pressures and minimum and maximum pipeline velocities and head loss under various demand scenarios
- Storage capacity goals
- Pumping capacity goals
- System reliability goals

The performance and evaluation criteria are summarized in Table 2-1 and further described herein.

**Table 2-1**
**Performance and Evaluation Criteria**

| Item | Criteria |
|---|---|
| Peaking Factors | • Average day peak month (ADPM) demand = annual average day x 1.65<br>• Maximum day demand (MDD) = annual average day x 1.77<br>• Peak hour demand (PHD) = annual average day x 2.8 |
| Minimum pressure | • 40 psi under average day demand<br>• 30 psi under maximum day demand<br>• 20 psi at fire hydrant under fire event |
| Maximum pressure | • 80 psi (services with greater static pressure require a pressure regulator) |
| Maximum pipeline velocity | • 8 fps under average day demand (less than 16-inch diameter)<br>• 5 fps under average day demand (16-inch or greater diameter)<br>• 10 fps under maximum day or fire demand |

| Table 2-1<br>Performance and Evaluation Criteria (cont'd) | |
|---|---|
| Maximum pipeline head loss | • 3 feet per 1,000 feet under average day demand<br>• 10 feet per 1,000 feet under maximum day demand |
| Fire flow/storage goals | • 3,500 gpm for three hours (parcels designated as commercial/industrial/institutional or multi-family within Zone 1, Zone 2, and Airbase, Zones)<br>• 3,500 gpm for two hours (Buck Zone)<br>• 1,500 gpm for two hours (Crest, Black Point, Cherry Hill, Half Moon, Wild Horse Valley, Garner, Old Ranch Rd, Dickson, Winged Foot, Ponti, San Andreas, San Antonio and Nunes Zones) |
| Storage capacity goals | • Storage capacity goal per zone is sum of operational, fire and emergency storage volumes<br>• Operational storage = 25% of maximum day demand<br>• Fire storage = see above<br>• Emergency storage = 100% of maximum day demand |
| Pumping capacity goals | • Station firm capacity is equal to maximum day demand pumped over 16 hour duration<br>• Firm capacity = station capacity with largest pump out of service<br>• Pump stations sized for firm capacity equal to maximum day demand |

## 2.2 WATER DEMAND PEAKING FACTORS

Peaking factors represent the increase above the average annual demand experienced during a specified time period. The various peaking conditions are statistical concepts or numerical values obtained from a review of historical data and, at times, tempered by engineering judgment. The following peaking conditions are of particular significance to hydraulic analysis of the water system.

The peaking factors shown in Table 2-1 are averages obtained from the historical water production data as shown in Table 4-2 in Section 4. The development of the peaking factors shown in Table 2-1 is presented in Section 4.

## 2.3 HYDRAULIC NETWORK MODELING

Hydraulic models of Zone 1 and Zone 2 were previously prepared for the 2002 Novato Water System Master Plan and revised for the 2007 and 2012 Master Plan Updates. These models are a representation of the Novato Water Distribution System, including pipeline facilities, water storage facilities, and pumping facilities. Each successive Update incorporated new data obtained since the prior Update. The hydraulic modeling for the current 2018 Update relies on a fully built-out GIS for the entire Novato Service Area, resulting in a comprehensive model of the entire Novato system in which all pressure zones are analyzed simultaneously and in concert with each other. A more detailed, complete description of the model preparation and proposed use of the model is included in Section 7.

## 2.4 WATER SYSTEM OPERATING CRITERIA

The following operating criteria was used to evaluate system operation and hydraulic analysis.

### 2.4.1 Distribution System Pressure

In accordance with District Regulations 11 and 12, the respective minimum and maximum operating pressure under normal conditions for the Novato Water System is 40 psi and 80 psi, measured at the service meter or building pad. Service connections with less than 40 psi pressure are designated “low-pressure services” and will be furnished only in accordance with Regulation 11.

Service connections greater than 80 psi are designated “high-pressure services” and will be furnished only in accordance with Regulation 12. Services with normal static pressure greater than 80 psi are required to install a pressure regulating device. The maximum design pressure in distribution system pipelines is 150 psi, unless special conditions mandate otherwise.

In evaluating the water system hydraulic operation, the minimum allowable pressure under maximum day demand conditions is 30 psi and the minimum residual pressure at the fire hydrant under fire demand conditions is 20 psi.

### 2.4.2 Pipeline Flow and Velocity

Distribution system pipelines are generally sized to carry the greater of: 1) peak hour demand; or 2) maximum day demand plus fire flow. For most water systems including the Novato Service Area, maximum day demand plus fire flow represents the most challenging condition to meet. Per NMWD Regulation 21, the minimum pipeline diameter is 6 inches. Minimum distribution system pipe sizing in commercial and industrial areas is 12 inches. All pipe segments with a single fire hydrant shall be a minimum of 6 inches diameter; however, larger pipe diameters are preferred.

One other important factor related to the distribution system piping includes maximum velocity, which along with pipe diameter affects friction head losses. Pipeline velocity for distribution pipelines less than 16-inch diameter should be limited to approximately 8 feet per second (fps) under normal operation, while transmission pipelines 16 inches and greater in diameter should limited to 5 fps under normal operating conditions. Velocities could increase to approximately 10 fps without damage if not sustained for long periods.

In most situations, as long as the maximum velocity and pressure criteria are not violated, high head loss by itself is not an important factor. However, a pipe segment with high head loss may serve as a warning that the pipe is nearing the limit of its carrying capacity and may not have excess capacity to perform during peak demand conditions. It is normally good practice to limit head loss to no greater than 10 feet per 1000 feet under maximum day demands or fire flow conditions. Head loss should be limited to approximately 3 feet per 1000 lineal feet of pipe under average day demand conditions.

## 2.5 WATER SUPPLY FACILITIES

Typically, water supply sources must be large enough to meet the various water demand conditions and also be able to meet some demand during emergencies such as power outages and natural disasters. Ideally, water supply sources should meet the maximum day demand. The diurnal fluctuations during the maximum day demand are handled by gravity storage capacity.

## 2.6 STORAGE FACILITIES

The detailed storage capacity evaluation is presented in Section 5. The following criteria serves as a guideline for the analysis.

Storage capacity goals for each zone consists of three components:

- Operational storage volume
- Fire storage volume
- Emergency storage volume

The sum of these three components is the total storage capacity for the specific pressure zone. The total storage capacity goal is compared to the existing storage capacity to determine if a surplus or deficit exists within the zone.

### 2.6.1 Operational Storage Volume

Operational storage volume is the amount of storage capacity required in a system to absorb fluctuations of demand versus supply. Ideally, water supply sources are sized to provide the maximum day demand, with gravity storage capacity delivering the remainder during peak hourly demand periods. With adequate operational storage capacity, system pressures are stabilized and adequate storage can be provided for fire and emergency use. In accordance with AWWA guidelines, operational storage capacity is assumed to be 25 percent of the maximum day demand for each pressure zone.

### 2.6.2 Fire Storage Volume

Fire storage volume is provided for fire-fighting purposes to allow gravity flow in the event the source flow is interrupted. Fire storage volumes vary and are based on the specified fire flow rate for a specified duration as described above.

Fire flow rates are normally based on the requirements of the local Fire Marshal and Insurance Services Office (ISO) requirements. Fire flows are defined as a specified flow rate for a specified duration of time based on the structure size, type of building construction and land use.

The District and the Novato Fire Protection District (NFPD) have cooperatively developed fire flow and fire storage capacity goals throughout the Novato Water System. The most recent correspondence between the NFPD and the District is provided in Appendix A. NFPD has confirmed a maximum fire flow goal of 1,500 gpm (for two hours) for high hazard residential areas, including wildland urban interface (WUI) areas vulnerable to wildfires and areas with poor accessibility for fire-fighting capability, as well as 1,500 gpm (for two hours) for all other residential areas. The fire flow goal for commercial/industrial/institutional areas is 3,500 gpm (for three hours), with the total flow delivered from two to four hydrants.

Based on the representative land use in each of the pressure zones, previous District experience, and in collaboration with NFPD, NMWD has adopted the following fire flow rates and fire storage volume goals for each pressure zone shown in Table 2-2.

For the 2012 Master Plan Update, the Fire Flow Standard was revised from the 2007 Update to meet the 2010 California Fire Code for 10 of the 17 NMWD pressure zones. In Novato, all non-commercial pressure zones have been categorized as WUI/residential areas. While some pressure zones had been assigned this fire flow goal previously, others, such as Nunes and Dickson, were still showing the fire flow goal used during tank design, which is now outdated. All District tanks are designed in cooperation with the NFPD, but for some tanks the fire storage component does not meet the current goal, as the fire code has been updated throughout the years.

Fire flow goals represent flows over a specific duration for the purpose of determining fire storage capacity. It is desirable to provide the fire flow goal everywhere in the distribution system; however, there are many locations within the system that cannot meet the fire flow goals due to small diameter pipelines or the particular piping configuration in that vicinity. It is not always possible to make improvements for all locations that cannot meet the updated fire flow goals.

**Table 2-2**
**Fire Flow and Fire Storage Volume Goals[1]**

| Service Area | Pressure Zone | Area Type[3] | Fire Flow Standard | | Fire Storage Goal[4] (gallons) |
|---|---|---|---|---|---|
| | | | 2018 | Prior | |
| No. Novato Subzone | 1 | Comm | 3500 gpm for 3 hrs | | 630,000 |
| So. Novato Subzone | 1 | Comm | 3500 gpm for 3 hrs | | 630,000 |
| Zone 1 Total[2] | 1 | Comm | 3500 gpm for 3 hrs | | 630,000 |
| San Mateo/Trumbull Subzone | 2 | Comm | 3500 gpm for 3 hrs | | 630,000 |
| Sunset/Pacheco Subzone | 2 | Comm | 3500 gpm for 3 hrs | | 630,000 |
| Primary Zone 2 Total[2] | 2 | Comm | 3500 gpm for 3 hrs | | 630,000 |
| Crest | 2 | WUI | 1500 gpm for 2 hrs | 1750 gpm for 2 hrs | 180,000 |
| Black Point | 2 | WUI | 1500 gpm for 2 hrs | 1750 gpm for 2 hrs | 180,000 |
| Airbase | - | Comm | 3500 gpm for 3 hrs | | 630,000 |
| Cherry Hill | 3 | WUI | 1500 gpm for 2 hrs | 1750 gpm for 2 hrs | 180,000 |
| Half Moon | 3 | WUI | 1500 gpm for 2 hrs | 1750 gpm for 2 hrs | 180,000 |
| Wild Horse Valley/Center Rd | 3 | WUI | 1500 gpm for 2 hrs | 1750 gpm for 2 hrs | 180,000 |
| Garner | 3 | WUI | 1500 gpm for 2 hrs | 1750 gpm for 2 hrs | 180,000 |
| Old Ranch Road | 3 | WUI | 1500 gpm for 2 hrs | 1750 gpm for 2 hrs | 180,000 |
| Dickson | 3 | WUI | 1500 gpm for 2 hrs | 1750 gpm for 2 hrs | 180,000 |
| Winged Foot | 3 | WUI | 1500 gpm for 2 hrs | 1750 gpm for 2 hrs | 180,000 |
| Ponti | 3 | WUI | 1500 gpm for 2 hrs | 1750 gpm for 2 hrs | 180,000 |
| San Andreas | 3 | WUI | 1500 gpm for 2 hrs | 1750 gpm for 2 hrs | 180,000 |
| Nunes | 3 | WUI | 1500 gpm for 2 hrs | 1750 gpm for 2 hrs | 180,000 |
| Buck | 4 | Comm | 3500 gpm for 2 hrs | 3500 gpm for 3 hrs | 420,000 |
| Upper Wild Horse[5] | 4 | n/a | n/a | | 0 |
| Cabro Ct[5] | 4 | n/a | n/a | | 0 |
| San Antonio (WCW) | misc | Res | 1500 gpm for 2 hrs | | 180,000 |
| Windhaven[5] | misc | n/a | n/a | | 0 |

Notes:
(1) Source: Correspondence with Lori Jessell, NFPD, dated 9-20-18 (included in Appendix A-1)
(2) Zone 1 total and Primary Zone 2 total represents hydraulically connected subzones.
(3) Area types: Comm=Commercial, WUI=Wildland Urban Interface, Res=Residential
(4) Indicates a fire flow goal for a specific duration to determine storage capacity volume.

### 2.6.3 Emergency Storage Volume

Emergency storage volume is the storage volume available to meet demand during emergency situations such as pipeline failures, major trunk main failures, pump failures, electrical power outages or other natural disasters. The volume of water allocated for emergency use is determined by historical record of emergencies experienced and by the amount of time which is expected to lapse before the emergency can be mitigated. The amount of emergency storage volume included within a particular water system is District-specified, based on an assessment of risk and the desired degree of system reliability. In California, emergency storage volumes range from 25 percent of average day demand to over 100 percent of maximum day demand. The lower criterion would apply to systems with a single pressure zone, adequate and reliable water supply sources (usually with emergency power), and redundant sources. If some, or all, of these criteria do not apply, it is appropriate to use a higher figure.

The District has adopted a criterion of one maximum day demand for each pressure zone to be reserved as emergency storage capacity.

## 2.7 PUMPING FACILITIES

Providing adequate storage capacity is only one distribution system element that benefits system operation. Adequate pumping capacity must also be provided to enable the storage tank to recover depleted volume within a reasonable timeframe. Undersized pumps may reduce the effectiveness of storage capacity. An analysis of pumping capacity is presented in Section 5.

Booster pump stations feeding the higher pressure zones are normally sized to pump the maximum day demand. In order to account for outages and routine maintenance procedures, the District has adopted a criterion that all booster pump stations must have adequate capacity to pump the maximum day demand over a 16-hour interval. Each station should have enough firm capacity to meet the maximum day demand over the 16-hour interval. This results in a reserve duration of eight (8) hours for unplanned contingencies such as power interruptions, pipeline breaks, etc. Firm capacity is defined as station capacity with one pump out of service. The District's goal is to have at least two pumps at each booster pump station.

The regional pumping capacity is compared to the pumping capacity goals to determine if there is an excess or necessity in the pumping needs for the region.

## 2.8 RELIABILITY CRITERIA

Reliability criteria have been established for the major facilities and operation of the water system to provide a level of reliability for the system.

### 2.8.1 Water Sources

It is preferable to have more than one source of water supply for a water system to provide flexibility should one source be lost. The main supply source, Russian River water supplied via the Sonoma County Water Agency, is augmented by local Stafford Lake storage. Stafford Lake supplies approximately 2,300 AF per year, which is used primarily during warm weather months to offset peak Russian River demands. The minimum pool at Stafford Lake holds 1,400 AF, providing 90 days of STP production.

### 2.8.2 Booster Pump Stations

District standard design practice is to have at least two pumps at each booster pump station. Additional reliability is woven into the design criteria by limiting pumping capacity to a 16-hour window in order to account for outages and mechanical problems. Although standby power is not required at each station, the District has made provisions for emergency standby power at the key Zone 2, 3 and 4 pump stations. Further analysis is presented in Section 9.

### 2.8.3 Storage Tanks

Water storage capacity provides for gravity supply of demands if a pump station is off-line or out of service. The District prefers to have at least two storage tanks for each pressure zone to allow one tank to remain in service while one is taken out of service for maintenance or repairs. All new tanks are designed to meet all seismic codes and requirements. Existing tanks not meeting current seismic requirements have been evaluated and the seismic upgrade recommendations are further discussed in Section 9.

### 2.8.4 Distribution System Pipelines

The distribution system should be adequately looped to minimize dead ends and promote good water circulation. Ideally, there should be at least two paths for water delivery at all locations in the system. Looping is especially important for those areas that do not have storage facilities in the immediate vicinity.

Isolation valves should be located to allow shutdown of pipe segments enabling routine maintenance and emergency repairs which impact the fewest customers.

# SECTION 3

# EXISTING DISTRIBUTION SYSTEM

# SECTION 3

# EXISTING NOVATO WATER SYSTEM

## 3.1 INTRODUCTION

Section 3 describes the existing distribution system facilities of the Novato Water System and presents a general overview of system operation.

## 3.2 NOVATO WATER SYSTEM OVERVIEW

The Novato Water System serves primarily the City of Novato and surrounding unincorporated areas in Marin County, encompassing approximately 75 square miles. The Novato Service Area boundary is shown on Figure 3-1.

As of June 30, 2017, the Novato Service area had approximately 19,645[1] active service connections serving approximately 23,099[1] dwelling units. The estimated service area population is 61,381[1].

## 3.3 WATER SUPPLY SOURCES

The North Marin Water District (NMWD) water supply for the Novato Service area is derived from two sources: 1) surface water stored in Stafford Lake; and 2) Russian River water supplied by Sonoma County Water Agency (SCWA).

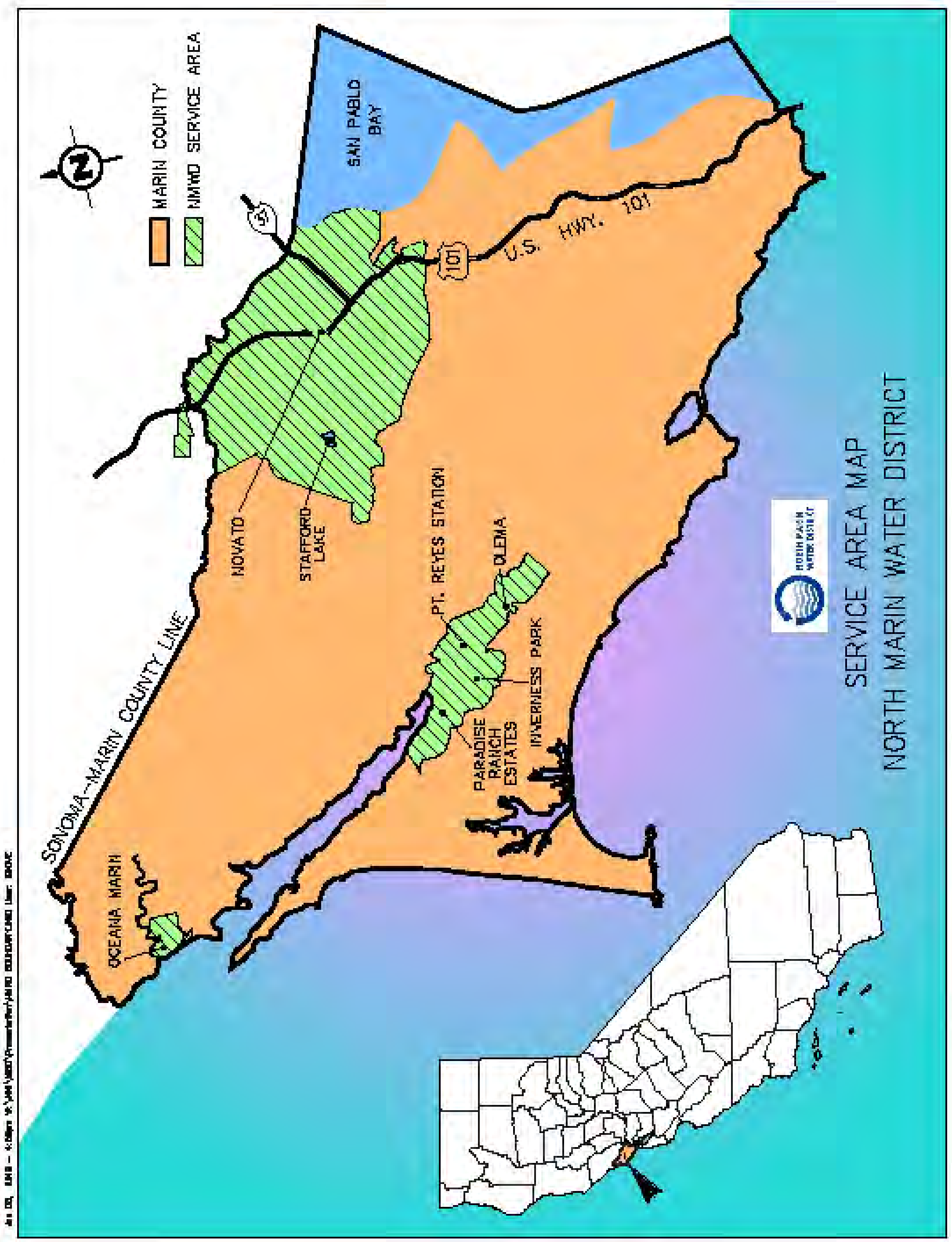
### 3.3.1 Stafford Lake

Stafford Lake lies four miles west of downtown Novato and collects runoff from 8.3 square miles of watershed land adjacent to the upper reaches of Novato Creek. The lake has a surface area of 230 acres and holds 4,400 AF of water at a maximum water surface elevation of 196 feet above sea level. Water from Stafford Lake is drawn by an intake tower and fed by gravity or by pumping (depending on the lake level) into the Stafford Treatment Plant (STP) located just below the Stafford Lake (Novato Creek) dam. Treated water from STP is pumped to the Zone 1 system by the high-lift pump station, which houses two 125 hp and one 75 hp pumps. A 360 kW solar power facility near the Stafford WTP was installed in FY 2012.

NMWD holds two water rights on Novato Creek, tributary to San Pablo Bay in Marin County, California. License 9831, issued by the State Water Resources Control Board in 1970 (Application 13599 filed in February 1950), authorizes 2.9 cubic feet per second (cfs) direct diversion from September 1 to June 30 and 4,000 acre feet (AF) diverted to storage (Stafford Lake) during the same period. The total amount authorized under License 9831 (direct diversion and storage) between the period of October 1 and September 30 of the subsequent year shall not exceed 4,490 AF.

[1] Source: NMWD 2015 Urban Water Management Plan

Figure 3-1


MARIN COUNTY
NMWD SERVICE AREA
SAN PABLO BAY
U.S. HWY. 101
SONOMA-MARIN COUNTY LINE
NOVATO
STAFFORD LAKE
PT. REYES STATION
OLEMA
INVERNESS PARK
PARADISE RANCH ESTATES
OCEANA MARIN
SERVICE AREA MAP
NORTH MARIN WATER DISTRICT

In addition to this license, Water Right Permit 18800, obtained in March 1983, pursuant to an application filed February 1979 with the SWRCB, authorizes 9.75 cfs direct diversion during the period of October 1 through April 30 and 4,400 AF diverted to storage between November 1 and April 1. This permit limits the maximum amount collected to storage under the combined Permit 18800 and License 9831 to 4,400 AF. However, the permit authorizes 8,454 AF to be taken from the Novato Creek source during any water year (October 1 through September 30).

The Stafford Lake source of supply can be operated efficiently to avoid summer drought conditions in dry year periods by "backfeeding" the lake in winter months with Sonoma County Water Agency (SCWA) supply. The "backfeeding" is accomplished by pumping the SCWA supply through San Marin pump station via the transmission main from Stafford Lake Water Treatment Plant, bypassing the treatment plant and discharging into Stafford Lake. Most recently, in February 2009 and March, 2018, Stafford Lake was respectively backfed with 358 AF and 130 AF of Russian River water to offset anticipated dry year conditions. The maximum daily "backfeeding" rate is estimated to be 3 to 5 mgd.

In August 2006, the District put the rehabilitated Stafford Water Treatment Plant on-line, after nearly 10 years of study, environmental review, design, and construction. Located at the base of Stafford Lake Dam, the new facility is designed to treat water to meet current and anticipated future water quality regulatory standards, improve system reliability, and enhance the aesthetic attributes of Novato's local water supply. As part of the project, the old treatment plant, built in 1954, underwent a major upgrade as its filters were retrofitted with granular activated carbon to polish the water, further improving taste and odor. The old treatment plant clarifier was converted to a solids thickener, consolidating the material removed from the lake water. The new water treatment plant is capable of producing 5.4 mgd and is operated seasonally to reduce peak summer demands from the SCWA Russian River transmission system. Stafford Lake provides about 2,300 AF (750 mg per year), or approximately 20% of Novato's annual water demand.

### 3.3.2 Russian River (Sonoma County Water Agency) Supply

The primary water supply source for the Novato Water System is Russian River water delivered by SCWA. Water is delivered to NMWD via the 7.7 mile long North Marin Aqueduct, consisting of 42-inch and 30-inch diameter (I.D.) mortar-lined and tape wrapped steel transmission main extending from the Kastania Pump Station near Petaluma to the connection to the NMWD transmission/distribution system located north of San Marin Dr. The North Marin Aqueduct was originally constructed in 1961 and a substantial portion was most recently relocated in 2016 as part of the Caltrans Marin Sonoma Narrows Highway 101 road widening project, and upsized to transition to a gravity fed system thereby eliminating operation of the Kastania Pump Station. In 1999, SCWA acquired the northernmost portion of the North Marin Aqueduct (from the Kastania Pump Station to the intersection of Petaluma Boulevard South and McNear Avenue) from NMWD, and the Kastania Pump Station from MMWD. The entire Russian River system is shown on Figure 3-2.

Russian River water originates in Mendocino County and is derived from both the Eel River (via Pacific Gas and Electric's Van Arsdale diversion at Cape Horn Dam feeding water through a 1.6 mile tunnel to the Potter Valley Powerhouse on the east fork of the Russian River) and the 1,485 square mile Russian River watershed, which includes most of Sonoma County and extends into Mendocino County to the northeast of the City of Ukiah. Just downstream of the PG&E Potter Valley powerhouse, the Eel River diversions and winter runoff from the local watershed are impounded by Coyote Dam in Lake Mendocino, which is owned and operated by the U.S. Army Corps of Engineers. Releases are made during summer months into the Russian

Figure 3-2
SCWA Russian River Water System

River. At a point about 10 miles upstream of Guerneville on the Russian River, water is collected near the Wohler Pumping Plant by six thirteen-foot diameter collector wells (called Ranney Water Collectors). These deep wells collect river water that has been filtered through 60 to 90 feet of natural sand and gravel through perforated pipes that extend radially at the bottom of each well to a maximum horizontal distance of 175 feet. The thick layer of sand and gravel through which the water must pass before reaching the intake pipes provides a highly-efficient, natural filtration process which, with chlorination treatment, produces a clear, potable, bacteria-free water. This water is then fed directly into the SCWA aqueduct system. Water stored in Lake Mendocino and Lake Sonoma for water supply purposes totals 282,000 AF and is sufficient to meet the needs of the Sonoma and Marin county region.

The Potter Valley Project, owned and operated by Pacific Gas and Electric (PG&E), is a hydroelectric project that provides an interbasin water transfer to the East Fork of the Russian River. Its operations are not coordinated with the operation of Coyote Valley Dam at Lake Mendocino. PG&E releases water from Lake Pillsbury to meet minimum instream flow requirements on the Eel River and to divert water through the Potter Valley Project to generate electricity and maintain minimum instream flow requirements in the East Fork Russian River. The water diverted through the Potter Valley Project flows into the East Fork of the Russian River. The Potter Valley Irrigation District diverts a portion of the released water for irrigation, with the remaining eventually flowing to Lake Mendocino. PG&E's license to operate the hydroelectric facility is issued by the Federal Energy Regulatory Commission, and expires in 2022.

Over many years, PG&E has evaluated various options concerning the future of the Project for the benefit of its electric ratepayers. That effort, and years-long discussions with stakeholders, led to PG&E's May 10, 2018 written and public announcement that it intended to auction the Project but was open to discussions with any local, county or state governmental entity that had an interest in possibly transferring the Project to a local or regional entity as a possible alternative to the auction. Discussions are ongoing, and an Ad Hoc Committee formed by Congressman Jared Huffman has been formed for the purpose of identifying possible areas of agreement among a diverse group of stakeholders. Subsequently in January 2019, PG&E filed for bankruptcy, and in a separate action, withdrew its relicensing application with the Federal Energy Regulatory Commission. A more detailed discussion pertaining to this recent bankruptcy filing is beyond the scope of this document.

Since 1961, NMWD has received water supply from the Russian River under a contractual arrangement with SCWA. The District is a contractual partner (water contractor) with seven other retail water providers (cities of Santa Rosa, Rohnert Park, Cotati, Petaluma, Sonoma, Town of Windsor and Valley of the Moon Water Districts) receiving Russian River water supply from the Sonoma County Water Agency. The current Restructured Agreement for water supply executed by SCWA in June 2006[2] replaces the Eleventh Amended Agreement for Water Supply executed by SCWA in January 2001, and provides for water delivery entitlements to meet demand projections based on current general plans within each water contractor's service area, including NMWD. NMWD's contractual entitlement under the restructured agreement provides for a delivery capacity of 19.9 mgd and total delivery of 14,100 AF during any fiscal year. Neither the Forestville County Water District nor Marin Municipal Water District are designated as water contractors in the Restructured Agreement. The Forestville Water District is however recognized as an "other agency customer" in the agreement and Marin Municipal Water District receives Russian River water under a separate Supplemental Water Supply Agreement with

[2] Restructured Water Supply Agreement expires in 2040

SCWA. MMWD's Russian River supply is "wheeled" through the North Marin Aqueduct when surplus capacity is available in accordance with provision of the Intertie Agreement between the two districts. MMWD water is delivered to the Ignacio Pump Station through the MMWD Novato Bypass pipeline, which connects to the NMWD Aqueduct north of San Marin Drive. NMWD maintains operational control of the water conveyed to MMWD so that service to the NMWD customers is not hydraulically diminished.

Water Supply made available by SCWA for delivery to MMWD is governed by the supplemental water supply agreement between the SCWA and MMWD dated January 25, 1996.

Historically, water was delivered through the North Marin Aqueduct by gravity flow between 8,000 and 9,000 gpm (11.2 mgd), or through the Kastania Pump Station between 12,000 and 13,000 gpm (18 mgd). While the Kastania Pump Station is owned and operated by the SCWA, pump operation was controlled by NMWD and regulated by the water surface level in the District's Lynwood and Atherton tanks. There were no standby power facilities at the Kastania Pump Station.

In 2016, the District completed the Aqueduct Energy Efficiency Project (AEEP) in conjunction with the Caltrans Marin-Sonoma Narrows (MSN) Project to widen and realign Highway 101. The AEEP has eliminated use of the existing Kastania Pump Station and the resulting energy demand, associated greenhouse gas emissions and costs. The AEEP increased the Aqueduct diameter from 30-inch to 42-inch pipeline for the 3.8 miles where the Caltrans MSN project has resulted in Aqueduct relocation; and installed a new 36-inch pipeline parallel to the existing Aqueduct for the 0.8 mile that was not relocated by the Caltrans MSN Project. Additionally, a blind flange was installed at the connection to the Kastania Pump Station permanently disconnecting the Aqueduct from the pump station. The Project was designed such that the Aqueduct's capacity did not increase compared to previous conditions. (i.e., 18 mgd).

## 3.4 RECYCLED WATER SUPPLY

The purpose of this Master Plan is to identify and guide improvements to the Novato potable water system. The following is a summary of the Novato recycled water system, although projects referenced are beyond the scope of this master plan. Further discussion of recycled water projects can be found in the Recycled Water Implementation Plan, May 2006 by Nute Engineering and North Bay Water Reuse Phase 1 Feasibility Study, 2005.

The Recycled Water Implementation Plan identifies potential recycled water customers and phasing of the recycled water expansion program by dividing the Novato Service Area in to North, Central and South service areas. The supply is being expanded incrementally with an ultimate goal of approximately 700 AF for the three service areas (North, Central and South).

In 2007, the North Marin Water District and Novato Sanitary District (NSD) completed construction of the 0.5 mgd Deer Island Recycled Water Facility (RWF) and pipeline for landscape irrigation at the StoneTree Golf Club (STGC) in Novato. This was the first step to incrementally introduce and expand the use of recycled water within the NMWD Novato Service Area. Approximately 260 AF is available annually from the Deer Island RWF for supply to the STGC and added customers. As part of the initial project, this facility also began delivering water to Novato Fire Protection District Station No. #2 property in May 2009. In 2018, 24.6 AF (8 mg) of recycled water was produced at the Deer Island RWF.

In 2010, as part of the North Bay Water Use Authority (NBWRA), NMWD, NSD and Las Gallinas Valley Sanitary District (LGVSD) moved forward with design and construction of expanded recycled water delivery within the Novato North and South Service Areas. Recycled water is produced at either the Deer Island RWF (by NMWD), Davidson St. RWF (by NSD) or LGVSD RWF (by LGVSD). A summary of the three different local RWF's is provided as follows:

- **Deer Island Recycled Water Facility (NMWD)**
  The Deer Island RWF receives treated secondary effluent from NSD and produces 0.5 mgd tertiary treated recycled water that meets the most stringent Title 22 standards.

.

- **Davidson Street Recycled Water Facility (NSD)**
  In 2011, NSD commenced construction of the Davidson Street Recycled Water Facility, including 1.7 mgd of tertiary treatment and disinfection facility to produce recycled water for distribution by NMWD. Construction was completed in September 2012. An additional filtration unit was constructed in 2018, increasing recycled water firm production capacity by 0.85 mgd to 1.7 mgd (total capacity = 2.55 mgd).

- **Las Gallinas Valley Sanitary District Recycled Water Facility**
  Current LGVSD recycled water plant capacity equals 1.4 mgd, provided by a pair of filter trains rated at 0.7 mgd each. Two future filter trains are slated for construction as part of the District's Secondary Treatment Plant Upgrade and Recycled Water Expansion project, at which time recycled water firm capacity will equal 1.87 mgd.

Once produced, NMWD is responsible for the storage and distribution of the recycled water. NMWD splits their recycled water program into two distinct areas based on the source of the recycled water: 1) North and Central Service Area with recycled water from NSD's Davidson Street RWF (with standby capacity from NMWD's Deer Island RWF), and 2) the South Service Area with recycled water from LGVSD.

### 3.4.1 North Service Area

The existing 2.8 miles of North Service Area pipelines completed in 2007 (J-2493.02) convey recycled water from the Deer Island RWF to the StoneTree Golf Course and Novato Fire Department. The additional 4.4 miles of pipelines in the North Service Area, completed in September 2012, include an interconnection between the Deer Island RWF and the Davidson Street RWF to improve the reliability of recycled water supplies. In addition to the pipelines, the North Service Area includes an above ground recycled water storage tank, the Plum Street Tank, with 0.5 mg of operational storage. The Central Service Area proposed pipelines will initiate at the NSD Davidson Street RWF to serve the areas to the south and west.

### 3.4.2 South Service Area

The South Service Area includes pipelines in the south portion of the City of Novato (aka Hamilton Area). Recycled water is conveyed north from the LGVSD RWF to customers in the South Service Area via a main transmission pipeline. The South Service Area includes repurposing and reuse of a concrete water storage tank[3] with a timber roof, the Reservoir Hill Tank, with 0.5 mg of operational storage. The storage tank and approximately 3.8 miles of pipeline was constructed by September, 2012.

[3] Former Hamilton Air Force Base potable water tank

### 3.4.3 Central Service Area

Recycled water distribution system expansion to the Central Service Area was completed in early 2018. The project included 5.7 miles of new pipeline, an undercrossing of Highway 101, repurposing and upgrade of the unused 0.5 MG Norman tank for recycled use, as well the connection of approximately 40 new recycled water users (public and private) including homeowner associations, Marin Country Club, and Vintage Oaks Shopping Center.

## 3.5 CLIMATE PROTECTION MANAGEMENT PLAN

Climate change is a global phenomenon with local implications. Local and regional actions can affect the overall amount of greenhouse gas emitted, and the District pledges its support to reduce greenhouse gases and improve air quality.

The District has embarked on a program to increase awareness of the affects its operation has on greenhouse gas emissions. The GHG Emission Reduction Program continues to include staff training on truck & equipment idling operation, efficient vehicle operation and employee commute options. Operational efficiencies have been implemented at all of our pump stations and new fleet & materials purchases utilizing the most energy-efficient products. The large GHG Emission Reduction Project for the District has been the installation of the 360kW solar panel system in 2012 to supply power to STP.

With these improvements, the District has been able to meet the California Assembly Bill 32 (AB32) 2010 targets for emission reduction for both the fleet and electricity uses. The solar panel system has allowed the District to exceed the AB32 and State/County emission reduction target for 2050. In addition, the District has constructed the AEEP, resulting in decommissioning of the Kastania Pump Station. The District continues to seek opportunities to reduce greenhouse emissions through programs and philosophies, including the following:

- Utilizing high efficiency pumps and motors at pumping plants.
- Investigate opportunities to reduce energy usage at District facilities.
- Install solar power panels to generate power for District-owned facilities.
- Investigate upsizing transmission mains to reduce overall pumping requirements and reducing energy usage.
- Participate in regional Climate Protection Mitigation Management programs, particularly those with Marin County, Sonoma County and other bay area governments.
- Investigate the possibility of 100 percent energy self-sufficiency.
- Investigate the potential impacts to District facilities from a possible three foot sea level rise by 2050 and a 15 foot sea level rise by 2100, particularly in low-lying areas around Bel Marin Keys, Black Point, Deer Island, the airport and the main office.
- Inclusion of flood planning at the Stafford Treatment Plant and Novato Creek in emergency response programs.
- Include climate impacts in all CEQA documents for future projects.

## 3.6 WATER CONSERVATION

NMWD maintains a comprehensive and innovative Water Conservation Program aimed at improving water use efficiency for residential, commercial, and large landscape customers. Each water conservation program element is analyzed to assure that it will efficiently produce long-lasting water savings, mutually worthwhile to the customer and the District. The District’s water conservation programs saved over 1,579 AF in FY 2017 (2015 UWMP DSS Model).

Residential water conservation programs and activities include residential water use surveys (Water Smart Home Survey Program), high efficiency washing machine rebates, high efficiency toilet (HET) rebates, “Cash-for-Grass” and “Lawn be Gone” Programs (turf removal incentives), flapper rebates, weather based irrigation controller rebates, irrigation efficiency upgrade incentives, plumbing retrofit on resale program (toilets, showerheads, and bathroom sink aerators), graywater/rainwater rebates, hot water recirculation rebate and pool cover rebates. Commercial water conservation programs include High Efficiency Toilet (HET) rebates, high efficiency washing machine rebates, and free water audits/surveys. Large landscape programs include a water use audit/survey and landscape water budgeting along with irrigation efficiency upgrade incentives and weather based irrigation controller rebates. On top of the conservation programs, the District has nearly completed the installation of an Advanced Meter Infrastructure (AMI) system which provides hourly water use totals and leak detection alerts for all meters. The AMI project will greatly improve future water conservation opportunities by providing precise and detailed water use data along with the ability for the District to analyze data and effectively communicate with customers.

The public outreach program includes a School Education Program (in cooperation with Sonoma Water), direct mail newsletters, bill text/inserts, newspaper advertisements, social media postings (Facebook, Instagram and Nextdoor), participation in staffing booths at various outreach events in the community, and a variety of other customer outreach activities including participation in the yearly Sonoma Marin Saving Water Partnership Summer Outreach Campaign. The outreach program is designed to increase water use awareness for customers and the District, and help increase customer participation in the various programs offered by the District.

NMWD requires new development to meet stringent water conservation standards, including installation of a high efficiency clothes washing machine, high efficiency toilets, weather based irrigation controllers, a 600 square foot turf limitation for residential development, and no turf for commercial development, drip or other subsurface irrigation for all irrigated non-turf areas and other landscape requirements consistent with or exceeding the current State model Water Efficient Landscape Ordinance (WELO).

## 3.7 DISTRIBUTION SYSTEM CHARACTERISTICS

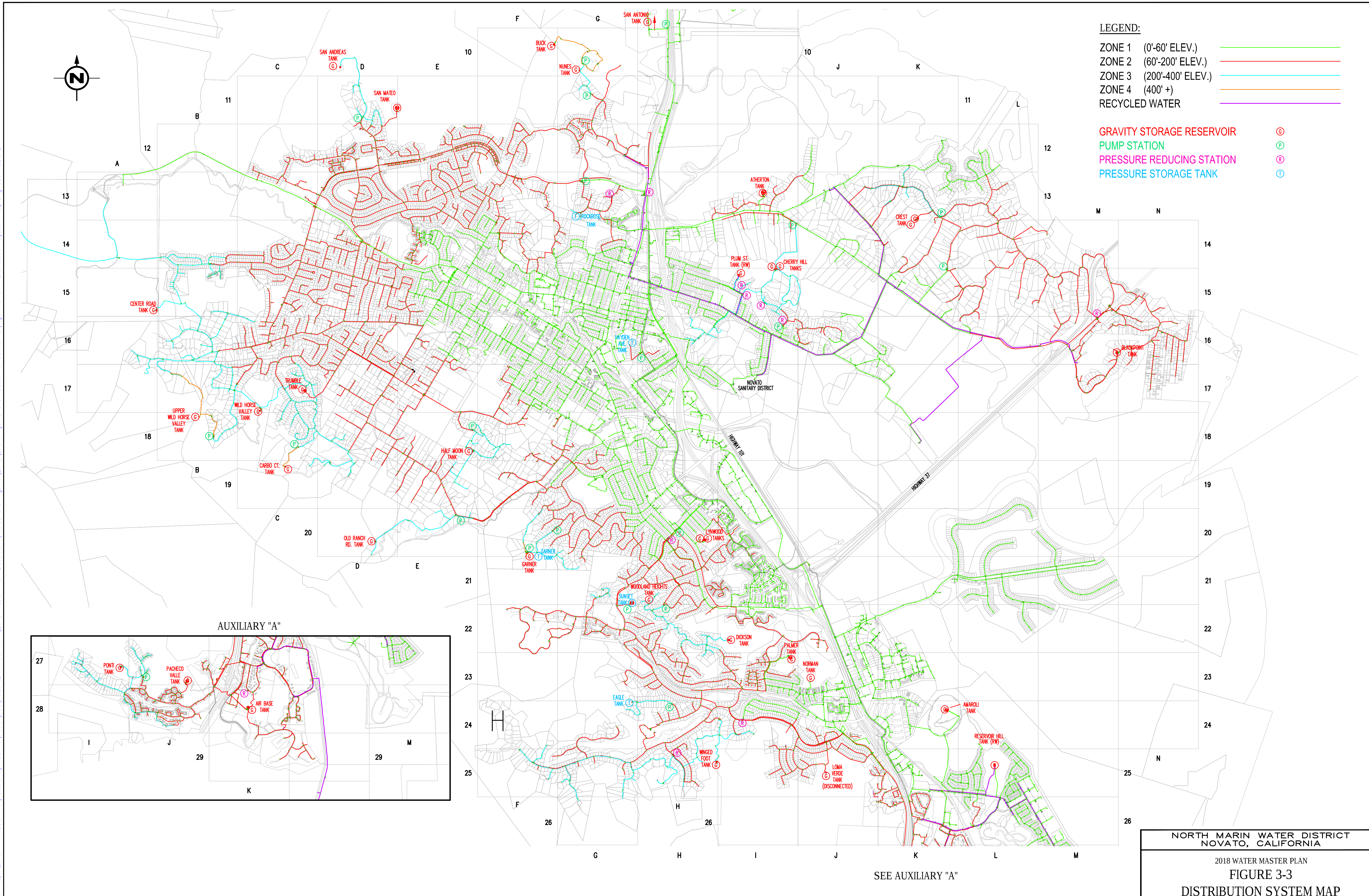
The distribution system facilities for the Novato Water System are described below. The distribution system piping and major facilities are shown on Figure 3-3. A schematic of the water system is shown on Figure 3-4.

### 3.7.1 Pressure Zones

The District has four separate pressure zones based on ground surface elevations. Each pressure zone has one or more water storage tanks that establish the maximum water surface elevation for that zone. The main pressure zone is Zone 1, which comprises the lower elevations (up to approximately 60 feet above sea level). This area covers most of the City of Novato and the area along Highway 101 on both sides of the freeway. Zone 2 serves elevations between 60 and 200 feet. Primary Zone 2 is further divided into the sub-zone identified by the storage tanks that serve it – the San Mateo/Trumbull Zone 2 (north), and the Sunset/Pacheco Zone 2 (south). The dividing line between these two sub-zones is assumed to be along Indian Valley Road at Old Ranch Road for purposes of this master plan. There are also pockets of Zone 2 within Zone 1 - in the Atherton area east of Highway 101 (Crest Zone and Black Point Zone) and in the Hamilton area of south-east Novato (Air Base Zone). Zone 3 serves elevations roughly between 200 and 400 feet and covers mostly the extreme western hills, pockets in the Atherton area, and smaller areas directly east of downtown and U.S. Highway 101. The Zone 3 systems are all separate, isolated systems fed by individual pump stations. Zone 4 serves elevations above 400 feet and includes two small isolated areas. Several hydropneumatic pumping stations are located in areas that cannot be easily served by the normal pressure zones. The range of service elevations for each pressure zone is shown on Figure 3-5.

For FY 2017, approximately 39 percent of the total system demand is in Zone 1 and approximately 51 percent of the total system demand is in Zone 2. Since 2011, Zone 1 potable demand has been decreasing as a result of recycled water use expansion offsetting potable demand for landscape irrigation and commercial car washes. All of the isolated Zone 3 (including Crest zone) and 4 systems account for 9 percent of the total system demand. The hydropneumatic stations account for a mere 1 percent of the total system demand.

Water for each higher pressure zone is delivered by one or more booster pump stations. Each of the pump stations is described below. In many locations, normally-closed zone valves isolate a higher zone from a lower zone. Although not a normal operation, these valves can be opened manually to flow water into the lower zone. Both water sources enter the distribution system in Zone 1.




NORTH MARIN WATER DISTRICT
NOVATO, CALIFORNIA

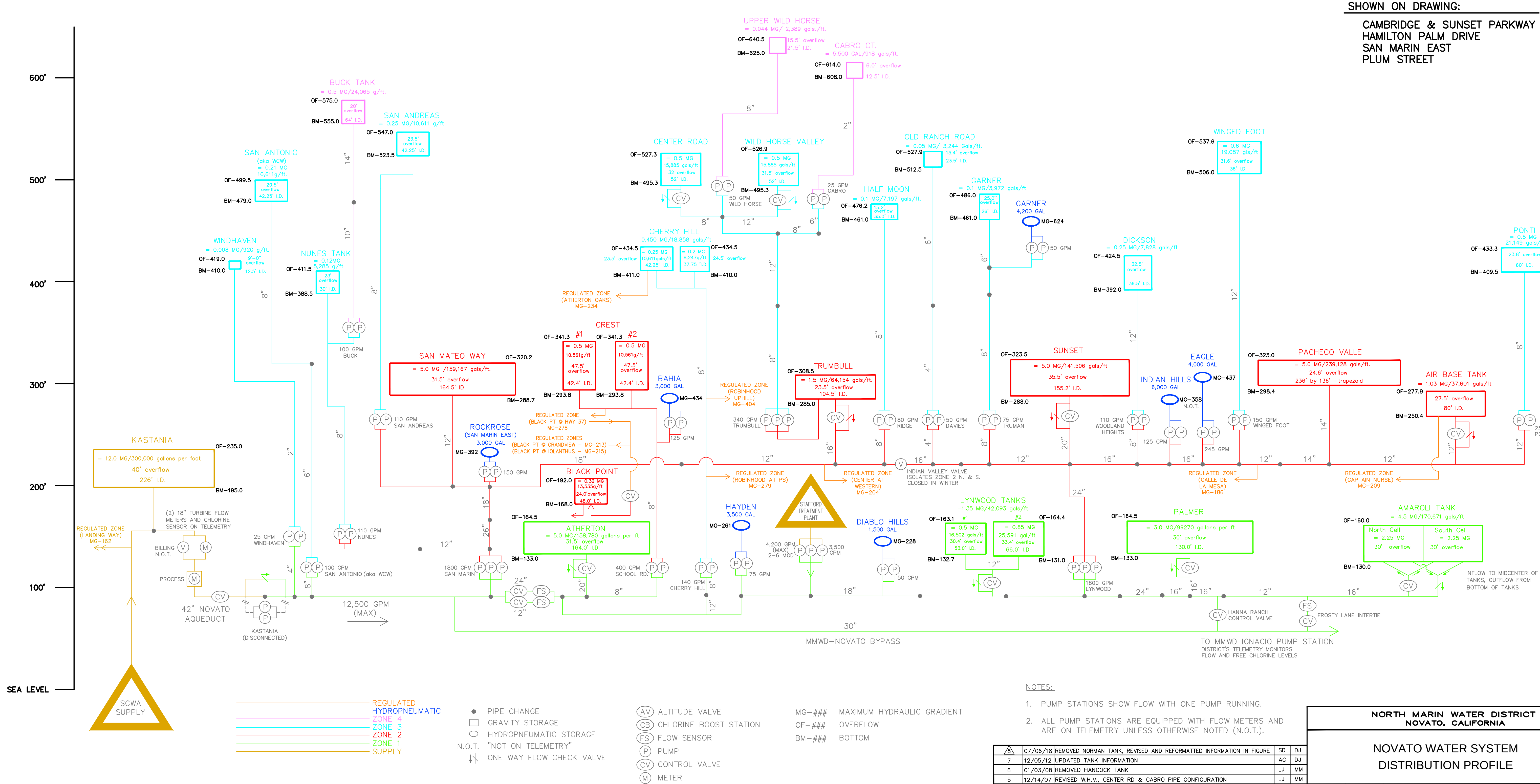
2018 WATER MASTER PLAN

FIGURE 3-3
DISTRIBUTION SYSTEM MAP

# NOVATO WATER SYSTEM
# DISTRIBUTION PROFILE

REGULATING STATIONS NOT SHOWN ON DRAWING:

CAMBRIDGE & SUNSET PARKWAY
HAMILTON PALM DRIVE
SAN MARIN EAST
PLUM STREET




NOTES:

1. PUMP STATIONS SHOW FLOW WITH ONE PUMP RUNNING.
2. ALL PUMP STATIONS ARE EQUIPPED WITH FLOW METERS AND ARE ON TELEMETRY UNLESS OTHERWISE NOTED (N.O.T.).

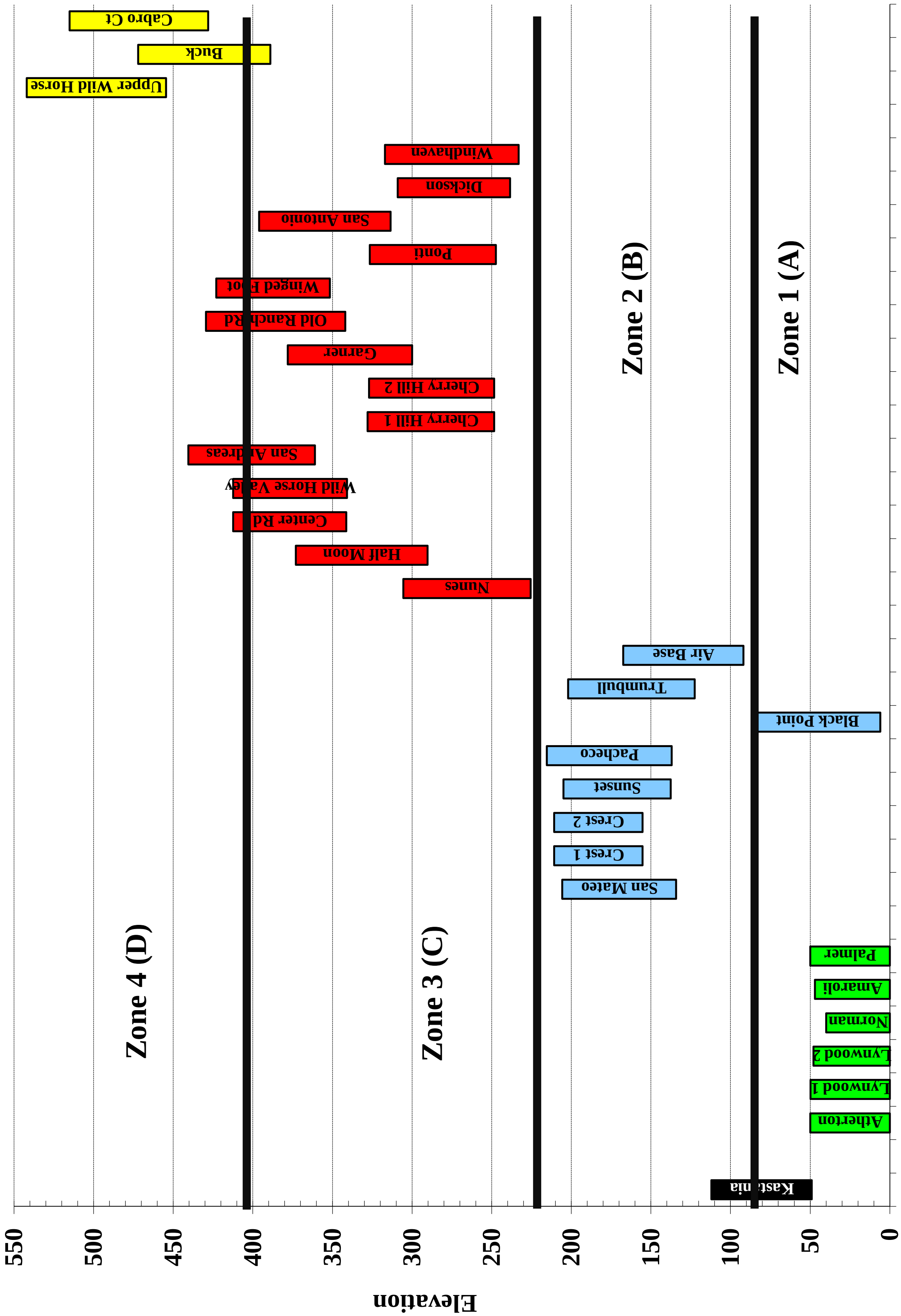
**NORTH MARIN WATER DISTRICT**
**NOVATO, CALIFORNIA**

NOVATO WATER SYSTEM
DISTRIBUTION PROFILE

| NO. | DATE | REVISION | BY | APP |
|---|---|---|---|---|
| 8 | 07/06/18 | REMOVED NORMAN TANK, REVISED AND REFORMATTED INFORMATION IN FIGURE | SD | DJ |
| 7 | 12/05/12 | UPDATED TANK INFORMATION | AC | DJ |
| 6 | 01/03/08 | REMOVED HANCOCK TANK | LJ | MM |
| 5 | 12/14/07 | REVISED W.H.V., CENTER RD & CABRO PIPE CONFIGURATION | LJ | MM |
| 4 | 01/19/07 | ADDED BLACK POINT TANK, UPDATED INFO | LJ | MM |
| 3 | 10/02/02 | ADDED TANK DATA, AMMO HILL AND AIR BASE | MM | MM |
| 2 | 10/19/98 | ADDED WINDHAVEN AND BUCK PUMP STATIONS AND TANKS | PS | PS |
| 1 | 05/07/98 | ADDED TITLE BLOCK TO EXISTING DISTRIBUTION MAP | TM | PS |

| DES | DR | CH | SCALE : NONE |
|---|---|---|---|
| TM, PS | TM | PS | DATE : 05/28/97 |
| APPROVED: CHIEF ENGINEER | | | SHEET NO. 1 OF 1 SHEETS |
| R.E. C75950 | | | SERVICE AREA 1 · ACCT.NO. 52401 · NO. OP13 |

FIGURE 3-5
NOVATO WATER SYSTEM
PRESSURE ZONE SERVICE ELEVATIONS



### 3.7.2 Storage Tanks

Each pressure zone has gravity storage capacity in one or more storage tanks. There are a total of 31 storage tanks throughout the Novato Water System, totaling almost 37.3 MG. Zone 1 has a storage capacity of 14.3 MG. Zone 2 has a total storage capacity of 18.8 MG. Zones 3 and 4 combined have a total storage capacity of 4.1 MG. Tank sizes range from 5,500 gallons to 5 MG. Pertinent information for all storage tanks is shown in Table 3-1.

### 3.7.3 Booster Pump Stations

A total of 26 booster pump stations deliver water from a lower pressure zone to a higher pressure zone. Individual pumps range from 1 hp to 100 hp. Booster pumps are operated based on water surface levels in a storage tank serving the pressure zone. High and low level set points control the priority operation of the pumps within each station. Tank level set points vary by season. None of the booster pump stations has permanent standby power facilities. Portable generators are available to power the pump stations in emergency situations. Three of the large pumps at either the San Marin or Lynwood Pump Stations that serve Zone 2 can be run by emergency generators. Both stations have been retrofitted with manual transfer switches to disconnect from the power grid and to accommodate portable generator hookups.

Water is pumped from Zone 1 to Zone 2 by three main booster pump stations. The San Marin Pump Station feeds the Zone 2 San Mateo/Trumbull area. The Lynwood Pump Station feeds the Zone 2 Sunset/Pacheco area. The School Road Pump Station feeds the separate Crest Zone (including Blackpoint). Several other pump stations deliver water to separate Zone 3 areas served primarily from Zone 2. One booster pump station – Cherry Hill Pump Station – delivers water to the Cherry Hill Zone 3 directly from Zone 1. Two small pump stations pump from the North Marin Aqueduct – Windhaven and San Antonio. Pertinent information for all pump stations is shown in Table 3-2.

### 3.7.4 Hydropneumatic Systems

The Novato Water System includes several hydropneumatic systems serving small demands that cannot be met from the primary pressure zones. There are seven hydropneumatic systems located throughout the Novato Water System – Hayden, Diablo Hills, Eagle Drive, Bahia, Rockrose, Indian Hills and Garner. Pertinent information for all hydropneumatic systems is shown in Table 3-2. The last District approved hydropneumatic system was installed in 1986. Due to the high maintenance and operational complexities of these systems, the District position is that no additional hydropneumatic systems shall be permitted.

### 3.7.5 Pressure Regulator Valves

Services located at elevations that do not match the primary zone elevations are served by intermediate pressure zones. Water is delivered to these intermediate pressure zones from a higher pressure zone through a pressure regulating station, which consists of two or three pressure reducing valves set at an appropriate downstream pressure to serve the zone. Downstream pressure setpoints are based on service elevations and varies for each valve. Pertinent information for all pressure regulator valves is shown in Table 3-3.

**Table 3-1**
**Novato Water Storage Facilities**

**Gravity Storage Tanks**

| Zone | Storage Tanks | Capacity Gallons | Overflow depth (ft) | Elevation | | Inside Dia. (Ft) | Gal Per Ft. | Type of Construction | Year Built |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Bottom | Overflow | | | | |
| 1 | Lynwood 1 | 500,000 | 30.4 | 132.7 | 163.1 | 53.0 | 16,502 | Welded Steel | 1958 |
| 1 | Lynwood 2 | 850,000 | 33.4 | 131.0 | 164.4 | 66.0 | 25,591 | Welded Steel | 1963 |
| 1 | Norman | 500,000 | 33.8 | 123.0 | 156.8 | 50.0 | 14,687 | Welded Steel | 1951 |
| 1 | Atherton | 5,000,000 | 31.5 | 133.0 | 164.5 | 164.0 | 158,780 | Welded Steel | 1973 |
| 1 | Amaroli | 4,500,000 | 30 | 130.0 | 160 | 108x216 | 170,671 | Concrete | 2002 |
| 1 | Palmer Drive | 3,000,000 | 30 | 130.0 | 160 | 130.0 | 99,270 | Welded Steel | 2008 |
| | **Total Zone 1** | **14,350,000** | | | | | | | |
| 2 | Sunset | 5,000,000 | 35.5 | 288.0 | 323.5 | 155.2 | 141,506 | Welded Steel | 1963 |
| 2 | Trumbull | 1,500,000 | 23.5 | 285.0 | 308.5 | 104.5 | 64,154 | Welded Steel | 1963 |
| 2 | San Mateo | 5,000,000 | 31.5 | 288.7 | 320.2 | 164.5 | 159,167 | Welded Steel | 1966 |
| 2 | Crest Tank 1 | 500,000 | 47.5 | 293.8 | 341.3 | 42.4 | 10,561 | Welded Steel | 1966 |
| 2 | Crest Tank 2 | 500,000 | 47.5 | 293.8 | 341.3 | 42.5 | 10,611 | Welded Steel | 2011 |
| 2 | Pacheco (a) | 5,000,000 | 24.6 | 298.4 | 323.0 | 236x136 | 239,128 | Concrete | 1975 |
| 2 | Black Point | 324,000 | 24 | 168.0 | 192.0 | 48.0 | 13,535 | Welded Steel | 2000 |
| 2 | Air Base | 1,000,000 | 27.5 | 250.4 | 277.9 | 80.0 | 37,604 | Welded Steel | 1957 |
| | **Total Zone 2** | **18,824,000** | | | | | | | |
| Note: (a) Depth, 0.9ft. Capacity = 29,400 gal: 0.9 ft to 8.3 ft. refer to Depth/Capacity chart. 8.3 to 24.6 ft capacity = 239,128 gal./ft. | | | | | | | | | |
| 3 | Ponti | 500,000 | 23.8 | 409.5 | 433.3 | 60.0 | 21,149 | Welded Steel | 1976 |
| 3 | Cherry Hill 2 | 200,000 | 25.0 | 410 | 434.5 | 37.75 | 8,247 | Welded Steel | 1997 |
| 3 | Cherry Hill 1 | 250,000 | 23.25 | 411.0 | 434.5 | 42.25 | 10,611 | Welded Steel | 1979 |
| 3 | Garner | 100,000 | 25.0 | 461.0 | 486.0 | 26.0 | 3,972 | Welded Steel | 1986 |
| 3 | Half Moon | 100,000 | 15.2 | 461.0 | 476.2 | 35.0 | 7,197 | Welded Steel | 1969 |
| 3 | Center Road | 500,000 | 32 | 495.3 | 527.3 | 52.0 | 15,885 | Welded Steel | 2007 |
| 3 | Wild Horse Valley | 500,000 | 31.5 | 495.3 | 526.9 | 50.0 | 15,885 | Welded Steel | 1966 |
| 3 | Winged Foot | 600,000 | 31.6 | 506.0 | 537.6 | 57.0 | 19,087 | Welded Steel | 1964 |
| 3 | San Andreas | 250,000 | 23.25 | 523.5 | 546.0 | 42.25 | 10,611 | Welded Steel | 1985 |
| 3 | San Antonio | 200,000 | 20.7 | 479.0 | 500.0 | 42.25 | 10,611 | Welded Steel | 1982 |
| 3 | Dickson | 250,000 | 32.5 | 392.0 | 424.5 | 36.5 | 7,828 | Welded Steel | 1988 |
| 3 | Nunes | 120,000 | 22.0 | 388.5 | 411.5 | 30.0 | 5,285 | Welded Steel | 1994 |
| 3 | Old Ranch Road | 50,000 | 15.4 | 512.5 | 527.9 | 23.5 | 3,244 | Redwood | 1963 |
| 3 | Windhaven | 8,000 | 9 | 410.0 | 419.0 | 12.5 | 920 | Concrete | 1991 |
| | **Total Zone 3** | **3,628,000** | | | | | | | |
| 4 | Upper Wild Horse | 44,000 | 15.5 | 625.0 | 640.5 | 21.5 | 2,389 | Bolted Steel | 1987 |
| 4 | Buck | 500,000 | 20.0 | 555.0 | 575.0 | 64.0 | 24,065 | Weled Steel | 1997 |
| 4 | Cabro Court | 5,500 | 6.0 | 608.0 | 614.0 | 12.5 | 918 | Concrete | 2001 |
| | **Total Zone 4** | **549,500** | | | | | | | |
| | **Novato System Total** | **37,351,500** | | | | | | | |
| Other | Kastania | 12,000,000 | 40.0 | 195.0 | 235.0 | 226.0 | 300000 | Welded Steel | 1985 |

**Hydropneumatic Tank Systems**

| | Hydropneumatic System | Tank Size Gal. | Pump Elev Ft. | Tank Elev Ft. | Pressure On | Pressure Off | Total Head Pump On | Total Head Pump off | Year Built |
|---|---|---|---|---|---|---|---|---|---|
| | Hayden | * 3,500 | 65 | 165 | 75 psi | 90 psi | 220 ft | 275 ft | 1963 |
| | Eagle Drive | * 4,000 | 160 | 315 | 38 psi | 60 psi | 405 ft | 455 ft | 1959 |
| | Bahia | 3,000 | 238 | 290 | 60 psi | 95 psi | 377 ft | 458 ft | 1970 |
| | Rockrose Hydro | 3,000 | 235 | 235 | 50 psi | 68 psi | 350 ft | 392 ft | 1980 |
| | Indian Hills | 6,000 | 215 | 292 | 46 psi | 62 psi | 398 ft | 435 ft | 1982 |
| | Diablo | 1,500 | 25 | 60 | 50 psi | 70 psi | 140 ft | 187 ft | 1985 |
| | Garner | 4,200 | 462 | 462 | 56 psi | 70 psi | 591 ft | 624 ft | 1985 |
| | **Total** | **17,700** | | | | | | | |

*Two Tanks at These Sites

Table 3-2
Pump Stations

| From Zone | To Zone | Location | # of Pumps | HP | Capacity Each Pump gpm | Suction Pressure | Discharge Pressure | Pumps To Tank |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | San Marin | 3 | 100-100-100 | 1800 | 40 psi | 120 psi | San Mateo |
| 1 | 2 | Lynwood | 3 | 100-100-100 | 1800 | 66 psi | 146 psi | Pacheco |
| 1 | 2 | School Road | 2 | 30-30 | 400 | 50 psi | 135 psi | Crest |
| 1 | *2 | Hayden | 2 | 5.0-5.0 | 75 | 33 psi | 80 psi | * |
| 1 | 3 | Cherry Hill | 2 | 15-15 | 140 | 42 psi | 160 psi | Cherry Hill |
| 1 | *2 | Diablo Hills | 2 | 3.0-5.0 | 50 | 50 psi | 65 psi | * |
| 2 | 3 | Davies | 2 | 5.0-5.0 | 50 | 80 psi | 180 psi | Old Ranch Rd. |
| 2 | 3 | Ridge Road | 2 | 5.0-5.0 | 80 | 47 psi | 120 psi | Half Moon |
| 2 | 3 | Truman | 2 | 7.5-7.5 | 75 | 41 psi | 110 psi | Garner |
| 2 | 3 | Winged Foot | 2 | 15-15 | 150 | 50 psi | 139 psi | Winged Foot |
| 2 | 3 | Ponti | 2 | 15-15 | 250 | 50 psi | 100 psi | Ponti |
| 2 | 3 | Trumbull | 3 | 25-25-25 | 340 | 10 psi | 100 psi | Wild Horse / Center Rd |
| 2 | 3 | San Andreas | 2 | 10.0-10.0 | 110 | 40 psi | 135 psi | San Andreas |
| 2 | * 3 | Eagle Drive | 2 | 10.0-10.0 | 245 | 64 psi | 120 psi | * |
| 2 | * 3 | Bahia | 2 | 7.5-7.5 | 125 | 38 psi | 70 psi | * |
| 2 | * 3 | Rockrose | 2 | 5.0-5.0 | 80 | 40 psi | 80 psi | * |
| 2 | * 3 | Indian Hills | 2 | 7.5-7.5 | 125 | 50 psi | 80 psi | * |
| 2 | 3 | Nunes | 2 | 5.0-5.0 | 110 | 50 psi | 90 psi | Nunes |
| 2 | 3 | Woodland Hts | 2 | 7.5-7.5 | 110 | 55 psi | 100 psi | Dickson |
| 3 | * 4 | Garner | 2 | 5.0-5.0 | 50 | 10 psi | 70 psi | * |
| 3 | 4 | Cabro Ct | 2 | 1.5 | 25 | 30 psi | 80 psi | Cabro Ct |
| 3 | 4 | Wild Horse Drive | 2 | 3.0-3.0 | 50 | 70 psi | 125 psi | Upper Wild Horse |
| 3 | 4 | Buck | 2 | 5.0-5.0 | 100 | 25 psi | 95 psi | Buck |
| Aqueduct | 3 | Windhaven | 2 | 1.5-1.5 | 25 | 20 psi | 165 psi | Windhaven |
| Aqueduct | 3 | San Antonio (WCW) | 2 | 10.0-10.0 | 100 | 70 psi | 185 psi | San Antonio |
| Aqueduct | Zone 1 | Kastania | 2 | 250-400 | 11,000-14,000 | 72 psi | 105 psi | NMWD Zone 1 |

* Hydropneumatic Systems

Table 3-3
Regulator Stations and Relief Valves

| Regulator Stations | | | | | |
|---|---|---|---|---|---|
| **Location** | **Elevation** | **Pressure Setting** | **From Zone** | **Upstream Pressure** | **Size** |
| Western Avenue & Center Road | 65 ft. | 60 psi | San Marin 2 | 105 psi | 6" 6" |
| Black Point At Highway 37 | 5 ft. | 118 psi | Crest 2 | 145 psi | 6" 6" 4" 4" |
| Black Point At Grandview (Beattie) | 5 ft. | 90 psi | Crest 2 | 118 psi | 6" 6" 2" |
| Black Point at Iolanthus | 65 ft. | 65 psi | Crest 2 | 85 psi | 6" 6" 2" |
| Calle De La Mesa | 75 ft. | 48 psi | Sunset 2 | 105 psi | 6" 6" 2" |
| Cambridge & Sunset Parkway | 25 ft. | 80 psi | Sunset 2 | 132 psi | 2" 3" |
| San Marin East On Santolina Drive | 35 ft. | 70 psi | San Marin 2 | 118 psi | 6" 6" 4" |
| Robinhood Drive at Pump Station | 55 ft. | 97 psi | Cherry Hill 3 | 165 psi | 8" 8" 4" |
| Robinhood Drive Uphill | 265 ft. | 60 psi | Cherry Hill 3 | 80 psi | 4" 4" |
| Atherton Avenue | 58 ft. | 76 psi | Cherry Hill 3 | 160 psi | 6" 6" 4" |
| Hamilton Palm Drive & Cresent Drive | 48 ft. | 50 psi | Air Base 2 | 115 psi | 8" 8" 6" |
| Plum Street at Summers Avenue | 78 ft. | 115 psi | Cherry Hill 3 | 154 psi | 8" 6" 2" |
| Captain Nurse Circle | 93 ft. | 5 0psi | Air Base 2 | 80 psi | 10" 10" 4" |
| **Relief Valves** | | | | | |
| **Location** | **Elevation** | **Pressure Setting** | **From Zone** | **Upstream Pressure** | **Size** |
| Western & Center Road | 65 ft. | 80 psi | n/a | n/a | 2" |
| Black Point At Highway 37 | 5 ft. | 128 psi | n/a | n/a | 6" |
| Black Point At Grandview (Beattie) | 5 ft. | 100 psi | n/a | n/a | 4" |
| Black Point At Iolanthus | 65 ft. | 74 psi | n/a | na/ | 4" |
| Calle De La Mesa | 75 ft. | 68 psi | n/a | n/a | 3" |
| Cambridge & Sunset Parkway | 25 ft. | 100 psi | n/a | n/a | none |
| San Marin East On Santolina Drive | 35 ft. | 90 psi | n/a | n/a | 6" |
| Robinhood Drive at Pump Station | 55 ft. | 117 psi | n/a | n/a | 6" 6" 6" |
| Robinhood Drive Uphill | 265 ft. | 80 psi | n/a | n/a | 3" |
| Atherton Avenue | 58 ft. | 96 psi | n/a | n/a | 6" |
| Hamilton Palm Drive & Cresent Drive | 48 ft. | 78 psi | n/a | n/a | 8" |
| Plum Street at Summers Avenue | 78 ft. | 125 psi | n/a | n/a | 4" |
| Captain Nurse Circle | 93 ft. | 58 psi | n/a | n/a | 6" |

### 3.7.6 Relief Valves

Pressure relief valves are located at the intermediate zones to open to relieve high pressure that may build up in the distribution system. Pertinent information for all relief valves is also shown in Table 3-3.

### 3.7.7 Pipelines

The transmission system consists of 16- through 30-inch diameter pipelines strategically located to convey water supply to the distribution system. The primary transmission mains include the 30-inch diameter (28.5-inch inside diameter) main connecting the North Marin Aqueduct to Zone 1 and the 18-inch pipeline delivering water from the Stafford Treatment Plant to Zone 1. The transmission mains run primarily north-south across the majority of Zone 1. Larger diameter transmission system piping is generally constructed of steel or reinforced concrete pressure pipe.

The majority of the distribution system is comprised of 6-, 8-, 10- and 12-inch diameter pipelines to distribute water from the transmission mains. Distribution system pipelines are constructed primarily of PVC, asbestos cement, and cast iron. Pipelines in the older sections of town were constructed over 60 years ago, and are constructed of cast iron pipe. Cast iron pipe installation ceased in the early 1950's when the District began to install asbestos cement pipe. Since 1992, distribution system piping was standardized with heavy walled PVC pipe (design ratio 14).

As of June 2018, the distribution system totals approximately 321 miles of pipeline, based on data obtained from the District's GIS. The distribution system pipeline characteristics, including the lengths of each pipe material, pipe diameter, and age of pipe, are shown in Table 3-4.

## 3.8 SYSTEM CONTROL AND OPERATION

The District utilizes a Supervisory Control and Data Acquisition (SCADA) system which allows the system operator to remotely control and monitor pumps, tank levels, pressures and alarm settings for those facilities that are connected to the SCADA system. All of the major facilities are connected to the SCADA system. A few smaller pump stations and tanks, and all but four of the hydropneumatic pump stations, are not connected to the SCADA system and are operated with local control only.

Flow control measurement of the SCWA source is accomplished at the regulating structure located off Redwood Boulevard north of San Marin Drive. The regulating structure contains several appurtenances, including a flow meter, control valves and pressure taps upstream and downstream of the control valve. Flow passes through two valves: 1) a 24-inch motor-operated butterfly valve; and 2) a 12-inch flow control valve on the low flow bypass line. These valves have setpoints tied to the water level in Lynwood Tanks that control their operating position.

**Table 3-4**
**Distribution System Pipeline Characteristics (January 1, 2018)**

| Pipeline Diameter | Pipeline Length (ft) | % of Total |
|---|---|---|
| < 4-inch | 85,782 | 5.1% |
| 4-inch | 112,547 | 6.6% |
| 6-inch | 358,115 | 21.1% |
| 8-inch | 552,229 | 32.5% |
| 10-inch | 18,671 | 1.1% |
| 12-inch | 296,982 | 17.5% |
| 14-inch | 26,378 | 1.6% |
| 16-inch | 99,425 | 5.9% |
| 18-inch | 26,967 | 1.6% |
| 20 to 27-inch | 27,643 | 1.6% |
| 30-inch | 44,913 | 2.6% |
| 36-inch | 24,815 | 1.5% |
| 42-inch | 22,799 | 1.3% |
| **Total** | **1,697,266** | 100.0% |

| Pipe Material | Pipeline Length (ft) | % of Total |
|---|---|---|
| Asbestos Cement | 941,296 | 55.5% |
| Cast Iron (CIP) | 58,140 | 3.4% |
| Copper (COP) | 5,573 | 0.3% |
| Plastic (PVC) | 360,205 | 21.2% |
| Plastic (HDPE) | 4,144 | 0.2% |
| Concrete Pressure Pipe (RCP) | 18,107 | 1.1% |
| Steel (STL) | 220,845 | 13.0% |
| Unknown/Not listed | 88,945 | 5.2% |
| **Total** | **1,697,266** | 100.0% |

| Pipe Age | Pipeline Length (ft) | % of Total |
|---|---|---|
| < 10 years | 55,536 | 3.3% |
| 10-19 years | 169,362 | 10.0% |
| 20-29 years | 155,203 | 9.1% |
| 30-39 years | 232,372 | 13.7% |
| 40-49 years | 314,054 | 18.5% |
| 50-60 years | 467,519 | 27.5% |
| > 60 years | 141,680 | 8.3% |
| Unknown/Not listed | 161,543 | 9.5% |
| **Total** | **1,697,266** | 100.0% |

**Distribution System Pipeline Characteristics (June 30, 2011)**

Because of the proximity of the Lynwood Tanks to the Lynwood Pump Station, the Lynwood Pump Station has overflow and limit setpoints that override normal operating conditions to prevent the overflow or emptying of Lynwood Tanks. In addition to the Lynwood Pump Station controls, a control valve with a remote terminal unit has been installed on the inlet/outlet pipeline to Lynwood tank. This control valve is operated via set points.

All the upper pressure zone booster pump stations are controlled by water levels in their respective storage tanks. The San Marin Pump Station is controlled by San Mateo Tank and the Lynwood Pump Station is controlled by the Pacheco Tank. Level set points vary for each tank and pump station based on staff experience and seasonal adjustments. In summer 2001, the District began time-of-use pumping at the San Marin and Lynwood pump stations to optimize electrical energy costs during the summer months. Typically, these pumps are turned off during the peak time periods (noon to 6 pm weekdays) from May to October. They are then operated to refill the storage tanks prior to the next day peak period.

Several tanks have altitude valves that close when the hydraulic grade line is above the valve set point to prevent overflow of the tank. Altitude valves exist at the Atherton, Norman, Trumbull, Lynwood, Blackpoint, Airbase, Wild Horse, Center Road, and Sunset Tanks. These tanks are located in a location that must fill before another tank in that zone or at elevations well below the other tanks in the zone. At the present time, all of these Altitude valves (except for Sunset Tank) are connected to the SCADA system and can be manipulated from the SCADA system. The water level set points for the altitude valve at the Trumbull Tank can be controlled to open the valve if pressure drops below a set suction pressure at Ridge Road pump station. This altitude valve is set to close at a high water level in Trumbull Tank and remains closed until the lower water level setpoint is reached. During the time the valve is closed, the Trumbull Tank is effectively off-line from Zone 2. When the altitude valve is closed, water from Trumbull Tank can still feed directly into the Wild Horse Valley Pump Station.

Each tank has a high and low level alarm programmed in the SCADA system. Each pump has a low suction and high discharge pressure alarm in the SCADA system. Pumps can be turned on or off manually from the SCADA system. Other system alarms included are power failure, pump failure, low battery, transducer failure, and communication failure alarms.

The MMWD Ignacio Pump Station operates based on the water level in Lynwood Tank with Atherton Tank as back-up. The pump station capacity is reduced in steps as the water level lowers in Lynwood Tank, until all flow is curtailed. Flow to MMWD can be curtailed at any time by NMWD in an emergency.

## 3.9 WATER QUALITY

The District's Water Quality laboratory routinely performs analyses for both regulated and unregulated contaminants. The laboratory staff provides testing services for other District departments for quality control of the water supply as well as testing in response to customer concerns. Monitoring is from source to tap.

The SCWA source meets all primary and secondary standards. Raw water coliform levels in five out of six of the SCWA Ranney Collectors are low enough that the California Department of Public Health has determined they are not subject to the filtration requirements of Chapter 17 of

Title 22. Collector No. 5 is not operated during high raw water turbidity periods to thus avoid the filtration requirement.

The Stafford Lake supply meets all primary drinking water standards for inorganic and organic chemicals. In 20 years of monitoring on record, there have been no detections of organic chemicals and the only inorganic chemicals detected are very low levels of naturally-occurring trace elements. The lake does stratify and is subject to algae blooms and at times can exceed the secondary standard for odor.

Distribution system water quality is presented in greater detail in Section 6.

## 3.10 FUTURE DEVELOPMENT

There are a number of development projects that are planned throughout the service area. Future development projects are presented in Section 4, and are based on consultation with and input from County and City of Novato planning staff.

# SECTION 4

# HISTORICAL WATER DEMANDS AND DEMAND FORECASTS

## SECTION 4

## HISTORICAL WATER DEMANDS AND DEMAND FORECASTS

The historical, current, and forecast buildout water demands for the North Marin Water District's Novato Water System are presented in Section 4.

### 4.1 HISTORICAL WATER PRODUCTION

Historical annual water production since FY 1955 for both water supply sources is shown in Table 4-1. Historically, approximately 10 to 25 percent of the annual water supply was obtained from the Stafford Lake water source through the Stafford Treatment Plant (STP). In 2005, STP was shut down for renovations. The upgraded plant was opened in 2007 and has been producing 15 to 30 percent of the annual water supply since. In recent years, many of the existing accounts that were used primarily for irrigation have been transferred to draw from the recycled water system. This transfer has resulted in a reduction of peak loads on the potable water system.

### 4.2 CONSUMER ACTIVITY

The District maintains four principal residential customer classifications: single family detached unit (SF); single family attached unit, such as townhouse, condominium or duplex unit (THC); apartment unit (APT); and mobile home (MH). The District maintains two other billing classifications that cover non-residential customers: commercial (CM) and government (GVT).

As of June 30, 2017, the approximate water usage, active services and residential dwelling unit mix, per customer classification is summarized as follows:[1]

| Structure Type | Consumption (MG) | | Number of Accounts | | Number of Dwelling Units | |
|---|---|---|---|---|---|---|
| SF | 1,407 | 75% | 14,300 | 79% | 14,765 | 64% |
| THC | 245 | 13% | 3,093 | 17% | 3,711 | 16% |
| APT | 205 | 11% | 687 | 4% | 3,973 | 17% |
| MH | 27 | 1% | 101 | 1% | 650 | 3% |
| Residential Total | 1,884 | 76% | 18,181 | 93% | 23,099 | |
| CM | 464 | 79% | 1,241 | 85% | | |
| GVT | 121 | 21% | 223 | 15% | | |
| Non-residential Total | 586 | 24% | 1,464 | 7% | | |
| **System Total** | **2,469** | | **19,645** | | | |

[1]NMWD Billing Department values indicate all services active as of 7/1/17. Previous master plan documents may have incorporated alternative methods for calculating total number of services.

**Table 4-1**
**Historical Potable Water Supply Production**

| **Fiscal Year** | **Stafford WTP** (AF) | **SCWA** (AF) | **Annual Total** (AF) | **Annual Total** (MG) | **Annual Daily** (mgd) | **ADPM** (mgd) |
|---|---|---|---|---|---|---|
| 1955 | 1,019 | | 1,019 | 332.0 | 0.91 | 1.35 |
| 1956 | 1,355 | | 1,355 | 441.5 | 1.21 | 2.15 |
| 1957 | 1,389 | | 1,389 | 452.6 | 1.24 | 1.98 |
| 1958 | 1,579 | | 1,579 | 514.5 | 1.41 | 2.34 |
| 1959 | 2,162 | | 2,162 | 704.4 | 1.93 | 3.03 |
| 1960 | 2,173 | | 2,173 | 708.0 | 1.94 | 3.30 |
| 1961 | 2,128 | 11 | 2,139 | 696.9 | 1.91 | 3.19 |
| 1962 | 1,830 | 404 | 2,234 | 727.9 | 1.99 | 3.39 |
| 1963 | 1,704 | 916 | 2,620 | 853.7 | 2.34 | 3.86 |
| 1964 | 1,939 | 988 | 2,927 | 953.7 | 2.61 | 4.08 |
| 1965 | 1,994 | 1,499 | 3,493 | 1,138.1 | 3.12 | 4.88 |
| 1966 | 2,111 | 1,940 | 4,051 | 1,319.9 | 3.62 | 5.94 |
| 1967 | 1,992 | 2,034 | 4,026 | 1,311.8 | 3.59 | 5.78 |
| 1968 | 2,223 | 2,625 | 4,848 | 1,579.6 | 4.33 | 6.97 |
| 1969 | 1,929 | 2,888 | 4,817 | 1,569.5 | 4.30 | 7.06 |
| 1970 | 1,955 | 3,650 | 5,605 | 1,826.3 | 5.00 | 7.50 |
| 1971 | 1,953 | 3,668 | 5,621 | 1,831.5 | 5.02 | 8.02 |
| 1972 | 1,870 | 4,539 | 6,409 | 2,088.2 | 5.72 | 8.52 |
| 1973 | 1,792 | 4,553 | 6,345 | 2,067.4 | 5.66 | 9.25 |
| 1974 | 1,253 | 5,284 | 6,537 | 2,129.9 | 5.84 | 9.37 |
| 1975 | 2,080 | 4,830 | 6,910 | 2,251.5 | 6.17 | 9.31 |
| 1976 | 1,690 | 5,946 | 7,636 | 2,488.0 | 6.82 | 10.03 |
| 1977 | 1,020 | 5,306 | 6,326 | 2,061.2 | 5.65 | 10.11 |
| 1978 | 2,022 | 3,324 | 5,346 | 1,741.9 | 4.77 | 8.68 |
| 1979 | 2,118 | 4,883 | 7,001 | 2,281.1 | 6.25 | 10.14 |
| 1980 | 1,414 | 6,135 | 7,549 | 2,459.7 | 6.74 | 10.23 |
| 1981 | 604 | 7,903 | 8,507 | 2,771.8 | 7.59 | 12.33 |
| 1982 | 2,030 | 6,153 | 8,183 | 2,666.3 | 7.30 | 11.58 |
| 1983 | 2,575 | 5,541 | 8,116 | 2,644.4 | 7.25 | 11.06 |
| 1984 | 2,532 | 6,721 | 9,253 | 3,014.9 | 8.26 | 12.05 |
| 1985 | 684 | 8,623 | 9,307 | 3,032.5 | 8.31 | 12.75 |
| 1986 | 1,028 | 8,324 | 9,352 | 3,047.2 | 8.35 | 12.70 |
| 1987 | 1,902 | 7,901 | 9,803 | 3,194.1 | 8.75 | 12.81 |
| 1988 | 974 | 8,918 | 9,892 | 3,223.1 | 8.83 | 12.57 |
| 1989 | 1,188 | 8,361 | 9,549 | 3,111.3 | 8.52 | 12.44 |
| 1990 | 1,157 | 8,386 | 9,543 | 3,109.4 | 8.52 | 13.09 |
| 1991 | 1,217 | 8,852 | 10,069 | 3,280.8 | 8.99 | 12.92 |
| 1992 | 1,438 | 8,008 | 9,446 | 3,077.8 | 8.43 | 11.50 |
| 1993 | 1,952 | 7,169 | 9,121 | 2,971.9 | 8.14 | 12.25 |
| 1994 | 1,917 | 7,914 | 9,831 | 3,203.2 | 8.78 | 13.18 |
| 1995 | 1,065 | 8,714 | 9,779 | 3,186.3 | 8.73 | 13.59 |
| 1996 | 2,039 | 8,289 | 10,328 | 3,365.2 | 9.22 | 13.49 |
| 1997 | 2,136 | 8,503 | 10,639 | 3,466.5 | 9.50 | 13.92 |
| 1998 | 2,323 | 6,888 | 9,211 | 3,001.2 | 8.22 | 14.08 |
| 1999 | 2,502 | 7,687 | 10,189 | 3,319.9 | 9.10 | 13.67 |
| 2000 | 2,029 | 8,757 | 10,786 | 3,514.4 | 9.63 | 14.05 |
| 2001 | 2,241 | 9,065 | 11,306 | 3,683.8 | 10.09 | 15.05 |

**Table 4-1 (Continued)**
**Historical Potable Water Supply Production**

| **Fiscal Year** | **Stafford WTP** (AF) | **SCWA** (AF) | **Annual Total** (AF) | **Annual Total** (MG) | **Annual Daily** (mgd) | **ADPM** (mgd) |
|---|---|---|---|---|---|---|
| 2002 | 1,762 | 9,255 | 11,017 | 3,589.7 | 9.83 | 15.06 |
| 2003 | 2,762 | 7,867 | 10,629 | 3,463.2 | 9.49 | 15.72 |
| 2004 | 2,006 | 9,499 | 11,505 | 3,748.7 | 10.27 | 15.60 |
| 2005 | 734 | 9,326 | 10,060 | 3,277.8 | 8.98 | 14.78 |
| 2006 | 0 | 10,797 | 10,797 | 3,518.0 | 9.64 | 15.58 |
| 2007 | 1,071 | 10,103 | 11,174 | 3,640.8 | 9.97 | 15.60 |
| 2008 | 2,185 | 8,397 | 10,582 | 3,447.9 | 9.45 | 13.57 |
| 2009 | 1,912 | 8,382 | 10,294 | 3,354.1 | 9.19 | 13.60 |
| 2010 | 2,455 | 5,997 | 8,452 | 2,753.9 | 7.54 | 11.84 |
| 2011 | 2,713 | 6,179 | 8,892 | 2,897.3 | 7.94 | 12.20 |
| 2012 | 1,798 | 7,399 | 9,197 | 2,996.8 | 8.21 | 12.04 |
| 2013 | 2,317 | 7,436 | 9,753 | 3,177.8 | 8.71 | 12.76 |
| 2014 | 1,470 | 7,767 | 9,237 | 3,009.8 | 8.25 | 12.42 |
| 2015 | 1,758 | 5,917 | 7,675 | 2,500.8 | 6.85 | 10.28 |
| 2016 | 1,844 | 5,300 | 7,144 | 2,327.8 | 6.38 | 10.24 |
| 2017 | 2,320 | 5,159 | 7,479 | 2,436.8 | 6.68 | 10.01 |

## 4.3 HISTORICAL WATER DEMANDS

As noted in Section 2, water demand peaking factors are utilized to analyze and evaluate the water distribution system. Peaking factors are based on review of historical water demands and production data, operational impacts, and industry standards.

Historical water demand for the Novato Water System is shown in Table 4-2. The observed annual demand, annual average day demand, and maximum (max) day demand, along with peaking factors and lost (un-accounted) water percentages for the Novato Water System as a whole are shown in the table.

Historical annual, average day, and maximum day production records are used to forecast future demand. Over the past 37 years, peaking factors have been highly variable. The method for calculating the peaking factor used to forecast future demand is detailed below.

### 4.3.1 Maximum Day Demand

The maximum day demand represents the highest daily demand for the entire year. A water system is usually evaluated under maximum day demand conditions or maximum day demand plus fire flow conditions. These conditions allow the system to be stressed at a higher demand rate to ascertain if supply sources and pipeline carrying capacities are adequate. Hydraulic evaluation under maximum day plus fire flow demand conditions represents a reasonable "worst case" scenario of system operation.

Since FY 2007, the maximum day to average day demand peaking factor has varied between 1.65 and 2.33. The 37-year average maximum day to average day peaking factor is 1.82. Maximum day to average day demand peaking factors generally range from 1.2 to 2.5 per American Water Works Association guidelines. For this Master Plan, a max day to average day peaking factor of 1.77 was used. This factor was produced by using the max day from 2003 and the average day from 2004. These historic values were used because the baseline data used in the hydraulic model (from 2013) had a relatively high average day value and relatively low max day value compared to historic values. Therefore, a more conservative max day was identified from recent historic records in 2003 and a more "typically" average day was identified in 2004. In addition, both 2003 and 2004 represent non-drought conditions. This calculation produces a max day to average day peaking factor which is conservative but also realistic.

**Table 4-2**
**Historical Potable Water Demands**

| Fiscal Year | Water Bank Total EDU (EDU) | Annual Production (AF) | Annual Demand [(1)] (AF) | Average Day Demand [(2)] (mgd) | Maximum Day Demand (mgd) | Peaking Factor[(3)] Max Day/Ave Day | Lost Water[(4)] (%) |
|---|---|---|---|---|---|---|---|
| 1981 | 15,692 | 8,507 | 7,775 | 7.59 | 15.68 | 2.06 | 8.6% |
| 1982 | 15,794 | 8,183 | 7,512 | 7.30 | 13.03 | 1.78 | 8.2% |
| 1983 | 15,955 | 8,116 | 7,467 | 7.25 | 13.32 | 1.84 | 8.0% |
| 1984 | 16,344 | 9,253 | 8,143 | 8.26 | 15.44 | 1.87 | 12.0% |
| 1985 | 16,597 | 9,307 | 8,330 | 8.31 | 15.42 | 1.86 | 10.5% |
| 1986 | 16,832 | 9,352 | 8,688 | 8.35 | 15.60 | 1.87 | 7.1% |
| 1987 | 17,232 | 9,803 | 9,215 | 8.75 | 14.22 | 1.62 | 6.0% |
| 1988 | 17,408 | 9,892 | 9,130 | 8.83 | 15.00 | 1.70 | 7.7% |
| 1989 | 17,712 | 9,549 | 8,814 | 8.52 | 14.97 | 1.76 | 7.7% |
| 1990 | 17,856 | 9,543 | 8,970 | 8.52 | 14.95 | 1.75 | 6.0% |
| 1991 | 18,226 | 10,069 | 9,032 | 8.99 | 14.24 | 1.58 | 10.3% |
| 1992 | 18,390 | 9,446 | 8,445 | 8.43 | 13.79 | 1.64 | 10.6% |
| 1993 | 18,605 | 9,121 | 8,729 | 8.14 | 14.94 | 1.83 | 4.3% |
| 1994 | 18,685 | 9,831 | 9,123 | 8.78 | 16.75 | 1.91 | 7.2% |
| 1995 | 18,785 | 9,779 | 8,860 | 8.73 | 16.09 | 1.84 | 9.4% |
| 1996 | 19,079 | 10,328 | 9,398 | 9.22 | 15.64 | 1.70 | 9.0% |
| 1997 | 19,392 | 10,639 | 9,852 | 9.50 | 17.13 | 1.80 | 7.4% |
| 1998 | 19,885 | 9,211 | 9,128 | 8.22 | 16.43 | 2.00 | 0.9% |
| 1999 | 20,237 | 10,189 | 9,394 | 9.10 | 16.15 | 1.78 | 7.8% |
| 2000 | 20,615 | 10,786 | 10,257 | 9.63 | 17.29 | 1.80 | 4.9% |
| 2001 | 20,673 | 11,306 | 10,673 | 10.09 | 17.78 | 1.76 | 5.6% |
| 2002 | 21,572 | 11,017 | 10,642 | 9.83 | 16.87 | 1.72 | 3.4% |
| 2003 | 21,930 | 10,629 | 9,930 | 9.49 | 18.12 | 1.91 | N/A |
| 2004 | 22,628 | 11,505 | 11,033 | 10.27 | 17.21 | 1.68 | 4.1% |
| 2005 | 22,768 | 10,060 | 9,399 | 8.98 | 17.17 | 1.91 | N/A |
| 2006 | 22,876 | 10,797 | 10,063 | 9.64 | 17.76 | 1.84 | 6.8% |
| 2007 | 22,944 | 11,174 | 10,850 | 9.97 | 17.07 | 1.71 | 2.9% |
| 2008 | 23,091 | 10,582 | 9,989 | 9.45 | 15.77 | 1.67 | 5.6% |
| 2009 | 23,193 | 10,294 | 9,617 | 9.19 | 17.38 | 1.89 | N/A |
| 2010 | 23,299 | 8,452 | 7,896 | 7.54 | 13.41 | 1.78 | N/A |
| 2011 | 23,336 | 8,892 | 8,376 | 7.94 | 14.20 | 1.79 | 5.8% |
| 2012 | 23,384 | 9,197 | 8,397 | 8.21 | 15.40 | 1.88 | 8.7% |
| 2013 | 23,390 | 9,753 | 9,080 | 8.71 | 14.36 | 1.65 | 6.9% |
| 2014 | 23,391 | 9,237 | 8,960 | 8.25 | 14.93 | 1.81 | 3.0% |
| 2015 | 23,426 | 7,675 | 7,622 | 6.85 | 13.71 | 2.00 | 0.7% |
| 2016 | 23,463 | 7,144 | 6,887 | 6.38 | 12.17 | 1.91 | 3.6% |
| 2017 | 23,538 | 7,479 | 7,015 | 6.68 | 15.58 | 2.33 | 6.2% |
| | | | | **37-year average=** | **15.54** | **1.82** | **6.6%** |

Notes:

(1) Annual demand values listed are calculated from production values minus the lost water percentages reported in this table. For N/A values of lost water the 37-year average value of 6.6% was used.

(2) ADD values listed are based on billing data and do not include lost water.

(3) Peaking Factor (PF) is obtained by dividing the Max Day demand by the Average Day demand

(4) Lost water calculated separately and takes into account known water losses such as flushing flows, hydrant flows, etc.

### 4.3.3 Peak Hour Demand

The peak hour demand represents the highest hourly demand on the entire system and simulates the highest flow rate expected on the hottest day of the year. Peak hour demand usually occurs during the morning or evening peak usage periods. Depending on the data, peak hour demand is sometimes considered the “worst case” scenario instead of maximum day demand plus fire flow. It is not appropriate to evaluate a system against a demand rate of peak hour plus fire flow, as the likelihood of a fire event at the hottest hour demand of the year is extremely low.

Based on review of the peak day and the average day for the selected baseline year of 2013, and assuming that 70% of daily flow occurs collectively between the hours of 6-9 am and 5-8 pm, the peak hour to average day peaking factor is estimated to be 2.80. Peak hour to average day demand peaking factors generally range from 1.6 to 5.0 per American Water Works Association guidelines.

### 4.3.4 Lost (Un-accounted) Water

Lost water is the water that cannot be credited after accounting for flushing flows, hydrant flow tests and other non-billed usage. The amount of un-accounted for water (or lost water) exhibits a decreasing trend over the past 37 years. The forecast assumes that there will be no change in the percent or share of un-accounted for water in the future and is projected to continue at an average of approximately 6.6 percent.

## 4.4 FY 2013 WATER DEMANDS

The FY 2013 water demand will be utilized in this Master Plan for several tasks including the hydraulic evaluation of the distribution system and the storage and pumping capacity evaluations. FY 2013 demand is also separated by pressure zone.

FY 2013 water demand data was obtained from District customer billing data. In FY 2013, the total water produced by the two water sources was 3,178 million gallons. Similarly, the average annual water demand in the Novato Water System was 8.7 mgd. As described in section 4.3.1, the maximum day demand peaking factor was calculated using the 2004 average day demand and the 2003 maximum day demand. The average annual water demand in 2004 was 10.24 mgd and the maximum day demand in 2003 was 18.12 mgd, thus producing a max day to average day peaking factor of 1.77.

The FY 2013 demand, separated by pressure zone, is shown in Table 4-3.

**Table 4-3**
**FY 2013 Water Demands**

| Pressure Zone | Annual Gross Demand[1] (gallons) | Average Day Demand[2] (gpd) | Average Day Demand (gpm) | Max Day/Ave Day Peaking Factor[3] | Maximum Day Demand (gpd) | Maximum Day Demand (gpm) |
|---|---|---|---|---|---|---|
| No. Novato Subzone | 1,009,804,857 | 2,766,600 | 1,921 | 1.77 | 4,895,500 | 3,400 |
| So. Novato Subzone | 405,217,019 | 1,110,200 | 771 | 1.77 | 1,964,500 | 1,364 |
| **Zone 1 Total** | **1,415,021,876** | **3,876,800** | **2,692** | | **6,860,000** | **4,764** |
| | | | | | | |
| Crest | 53,562,456 | 146,700 | 102 | 1.77 | 259,700 | 180 |
| Black Point | 39,285,127 | 107,600 | 75 | 1.77 | 190,500 | 132 |
| San Mateo/Trumbull Subzone | 761,679,241 | 2,086,800 | 1,449 | 1.77 | 3,692,600 | 2,564 |
| Sunset/Pacheco Subzone | 543,401,535 | 1,488,800 | 1,034 | 1.77 | 2,634,400 | 1,829 |
| Air Base | 96,598,334 | 264,700 | 184 | 1.77 | 468,300 | 325 |
| **Zone 2 Total** | **1,494,526,692** | **4,094,600** | **2,843** | | **7,245,500** | **5,032** |
| | | | | | | |
| Cherry Hill | 44,462,282 | 121,800 | 85 | 1.77 | 215,600 | 150 |
| Half Moon | 7,305,106 | 20,000 | 14 | 1.77 | 35,400 | 25 |
| Wild Horse Valley/Center Rd | 86,840,719 | 237,900 | 165 | 1.77 | 421,000 | 292 |
| Garner | 6,162,487 | 16,900 | 12 | 1.77 | 29,900 | 21 |
| Old Ranch Road | 3,350,462 | 9,200 | 6 | 1.77 | 16,200 | 11 |
| Dickson | 19,222,299 | 52,700 | 37 | 1.77 | 93,200 | 65 |
| Winged Foot | 22,136,686 | 60,600 | 42 | 1.77 | 107,300 | 74 |
| Ponti | 25,110,990 | 68,800 | 48 | 1.77 | 121,700 | 85 |
| San Andreas | 6,175,802 | 16,900 | 12 | 1.77 | 29,900 | 21 |
| Nunes | 3,851,450 | 10,600 | 7 | 1.77 | 18,700 | 13 |
| **Zone 3 Total** | **224,618,283** | **615,400** | **427** | | **1,088,900** | **756** |
| | | | | | | |
| Buck | 6,044,314 | 16,600 | 12 | 1.77 | 29,300 | 20 |
| Upper Wild Horse Valley | 3,454,488 | 9,500 | 7 | 1.77 | 16,700 | 12 |
| Cabro Ct | 1,010,298 | 2,800 | 2 | 1.77 | 4,900 | 3 |
| **Zone 4 Total** | **10,509,100** | **28,900** | **20** | | **50,900** | **36** |
| | | | | | | |
| Windhaven | 1,244,148 | 3,400 | 2 | 1.77 | 6,000 | 4 |
| San Antonio (WCW) | 1,825,028 | 5,000 | 3 | 1.77 | 8,800 | 6 |
| **Misc Zone Total** | **3,069,177** | **8,400** | **6** | | **14,800** | **10** |
| | | | | | | |
| Bahia Hydro | 11,194,006 | 30,700 | 21 | 1.77 | 54,300 | 38 |
| Hayden Hydro | 4,184,333 | 11,500 | 8 | 1.77 | 20,300 | 14 |
| Diablo Hills Hydro | 1,295,745 | 3,500 | 2 | 1.77 | 6,300 | 4 |
| Garner Hydro | 2,003,953 | 5,500 | 4 | 1.77 | 9,700 | 7 |
| Indian Hills Hydro | 2,265,265 | 6,200 | 4 | 1.77 | 11,000 | 8 |
| Rockrose Hydro | 2,896,078 | 7,900 | 5 | 1.77 | 14,000 | 10 |
| Eagle Dr Hydro | 6,415,478 | 17,600 | 12 | 1.77 | 31,100 | 22 |
| **Hydro Zone Total** | **30,254,857** | **82,900** | **58** | | **146,700** | **102** |

(1) Gross Annual Demands represent total production (billed consumption, unmetered consumption, fire hydrants, lost water, etc)

(2) Determined by dividing Gross Annual Demand by 365

(3) Peaking factor is multiplier to obtain maximum day demand from average day demand. Peaking factors obtained using average day demand data from 2004 and Max Day demand data from 2003.

For the purposes of this master plan, a break-down of Zone 1 and Zone 2 into geographical subzones was performed. Highway 37 divides Zone 1 demand into the North Novato Subzone and the South Novato Subzone. Zone 2 is divided at the intersection of Indian Valley Rd at Old Ranch Rd and the subzones are identified by the tanks that serve it - SanMateo/Trumbull Subzone to the north, and Sunset/Pacheco Subzone to the southeast. The Airbase Zone is an intermediate zone fed from Zone 2 and the Airbase Zone demands have been subtracted from the Sunset/Pacheco Subzone. The Crest and Black Point Zones are separate from the primary Zone 2 distribution system and are served only by School Rd Pump Station.

### 4.4.1 Zone 1

For FY 2013, Zone 1 accounts for approximately 45 percent of the total system demand. Of this demand, approximately 71 percent is located in the North Novato Subzone. The remaining Zone 1 demand is in the South Novato Subzone. This result varies from previous master plans in part because of the methodologies used to assign demands across the system – this master plan’s hydraulic analysis used geolocated billing data to assign demands whereas previous models typically used an average value assigned to every service connection. See Section 7 for a more in depth description of the different methodologies used for the hydraulic evaluation.

### 4.4.2 Zone 2

Zone 2 accounts for approximately 47 percent of the total system demand. The Crest and Black Point Zones together account for only 7 percent of this Zone 2 total demand. The San Mateo/Trumbull Subzone accounts for approximately 51 percent of the total Zone 2 demand. The Pacheco/Sunset Sub-zone accounts for approximately 36 percent of the total Zone 2 demand. The remaining 6 percent is in the Airbase Zone.

### 4.4.3 Other Zones

All Zone 3 and 4 and Miscellaneous Zone demand accounts for only 7.5 percent of the total system demand. The Wild Horse Valley/Center Road Zone by far makes up the largest demand of these higher-pressure zones (around 3% of the total system demand). The seven hydropneumatic stations combined account for almost 1 percent of the total system demand.

## 4.5 BUILDOUT DEMAND PROJECTIONS

Previous water demand forecasts for North Marin Water District were prepared in 1992 and based on the 1991 Countywide Plan. The 1996 City of Novato General Plan development forecast was consistent with the 1991 Countywide Plan, so no formal update of the water demand forecast was conducted at that time. Demands and development projections were updated in the 2002, 2007, and 2012 Water System Master Plans. As future years will contain drought years and non-drought years, previous demand projections were scaled based on a historic 37 year average peaking factor of 1.82 (see table 4-4). This is different than the 2003/2004 modeling peaking factor which is more appropriate for the application of non-drought year baseline demand data from FY 2013.

**Table 4-4**
**Buildout Potable Water Demand Forecast**

| | Fiscal Year | A Annual AF (AF) | B Annual MG (MG) | C Ave Day (mgd) | D ADPM (mgd) | E Max Day (mgd) |
|---|---|---|---|---|---|---|
| Actual | 1981 | 8,507 | 2,771.8 | 7.59 | 12.33 | 15.68 |
| | 1982 | 8,183 | 2,666.3 | 7.30 | 11.58 | 13.03 |
| | 1983 | 8,116 | 2,644.4 | 7.25 | 11.06 | 13.32 |
| | 1984 | 9,253 | 3,014.9 | 8.26 | 12.05 | 15.44 |
| | 1985 | 9,307 | 3,032.5 | 8.31 | 12.75 | 15.42 |
| | 1986 | 9,352 | 3,047.2 | 8.35 | 12.70 | 15.60 |
| | 1987 | 9,803 | 3,194.1 | 8.75 | 12.81 | 14.22 |
| | 1988 | 9,892 | 3,223.1 | 8.83 | 12.57 | 15.00 |
| | 1989 | 9,549 | 3,111.3 | 8.52 | 12.44 | 14.97 |
| | 1990 | 9,543 | 3,109.4 | 8.52 | 13.09 | 14.95 |
| | 1991 | 10,069 | 3,280.8 | 8.99 | 12.92 | 14.24 |
| | 1992 | 9,446 | 3,077.8 | 8.43 | 11.50 | 13.79 |
| | 1993 | 9,121 | 2,971.9 | 8.14 | 12.25 | 14.94 |
| | 1994 | 9,831 | 3,203.2 | 8.78 | 13.18 | 16.75 |
| | 1995 | 9,779 | 3,186.3 | 8.73 | 13.59 | 16.09 |
| | 1996 | 10,328 | 3,365.2 | 9.22 | 13.49 | 15.64 |
| | 1997 | 10,639 | 3,466.5 | 9.50 | 13.92 | 17.13 |
| | 1998 | 9,211 | 3,001.2 | 8.22 | 14.08 | 16.43 |
| | 1999 | 10,189 | 3,319.9 | 9.10 | 13.67 | 16.15 |
| | 2000 | 10,786 | 3,514.4 | 9.63 | 14.05 | 17.29 |
| | 2001 | 11,306 | 3,683.8 | 10.09 | 15.05 | 17.78 |
| | 2002 | 11,017 | 3,589.7 | 9.83 | 15.06 | 16.87 |
| | 2003 | 10,629 | 3,463.2 | 9.49 | 15.72 | 18.12 |
| | 2004 | 11,505 | 3,748.7 | 10.27 | 15.60 | 17.21 |
| | 2005 | 10,060 | 3,277.8 | 8.98 | 14.78 | 17.17 |
| | 2006 | 10,797 | 3,518.0 | 9.64 | 15.58 | 17.76 |
| | 2007 | 11,174 | 3,640.8 | 9.97 | 15.60 | 17.07 |
| | 2008 | 10,582 | 3,447.9 | 9.45 | 13.57 | 15.77 |
| | 2009 | 10,294 | 3,354.1 | 9.19 | 13.60 | 17.40 |
| | 2010 | 8,452 | 2,753.9 | 7.54 | 11.84 | 13.41 |
| | 2011 | 8,892 | 2,897.3 | 7.94 | 12.20 | 14.20 |
| | 2012 | 9,197 | 2,996.8 | 8.21 | 12.04 | 15.40 |
| | 2013 | 9,753 | 3,177.8 | 8.71 | 12.76 | 14.36 |
| | 2014 | 9,237 | 3,009.8 | 8.25 | 12.42 | 14.93 |
| | 2015 | 7,675 | 2,500.8 | 6.85 | 10.28 | 13.71 |
| | 2016 | 7,144 | 2,327.8 | 6.38 | 10.24 | 12.17 |
| | 2017 | 7,479 | 2,436.8 | 6.68 | 10.01 | 15.58 |
| Forecast | 2020 | 10,012 | 3,262.2 | 8.94 | 14.75 | 15.81 |
| | 2025 | 10,058 | 3,277.2 | 8.98 | 14.81 | 15.89 |
| | 2030 | 10,063 | 3,278.8 | 8.98 | 14.82 | 15.90 |
| | 2035 | 10,155 | 3,308.8 | 9.07 | 14.96 | 16.04 |

A: actual per NMWD Annual Reports = SCWA + STP supply
forecast demands per 2015 NWMD UWMP Table 4-2

B: = column A * 43560 * 7.48 / 1000000

C: = column B / 365

D: Historic annual ADPM peaking factor is 1.52, however, a more detailed analysis calculating individual peaking factors for all Novato service area customers resulted in an adjusted ADPM peaking factor of 1.65. See footnote 6 of Table 4-5 for additional details.

E: actual per NMWD Annual Reports
forecast = column C * 1.77
(MaxDay/AveDay peaking factor obtained using average day demand data from 2004 and Max Day demand data from 2003. See section 4.3.1 for detailed explanations)

### 4.5.1 Water Demand Projection

On June 21, 2016, the District's Board of Directors adopted the 2015 NMWD Urban Water Management Plan, (UWMP), which is available to view or download on the District's website at www.nmwd.com. It includes population and water demand forecasts for the Novato service area through buildout in 2040. In conjunction with the preparation of the 2015 UWMP, the NMWD Final 2015 Urban Water Management Plan Water Demand Analysis and Water Conservation Measures Update, dated July 1, 2015, was published by Maddaus Water Management. This document provides a very comprehensive water demand forecast, utilizing population and employment projections given by the Association of Bay Area Governments (ABAG) as well as District input regarding historical and current water service dwelling unit density (meaning the population residing in single family dwelling units and multi-family dwelling units).

In this Master Plan, the buildout water demand forecast from the 2015 UWMP, shown in Table 4-4, is used. Actual data from FY 1981 through FY 2017 is provided in the table, along with the forecast from FY 2020 though FY 2035, presented in 5-year increments. At buildout, there is a projected annual demand of 10,155 AF per year, or an average daily demand of 9.07 mgd. The projected maximum day demand is 16.1 mgd.

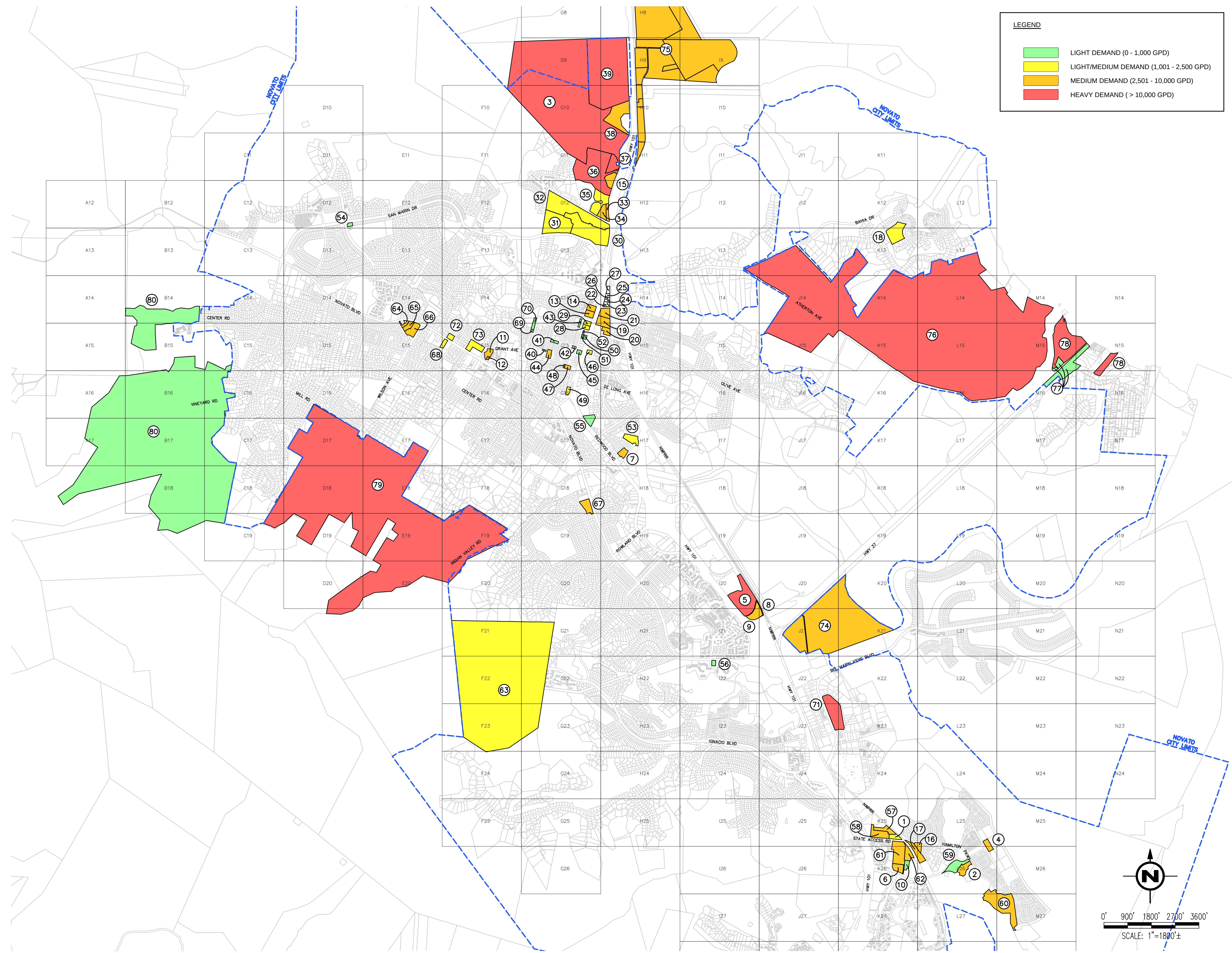
### 4.5.2 Development Projection

Analysis of projected water demands is based on new development slated to be constructed within the District boundaries. The buildout water demand forecast provided herein is updated with the most recent development information obtained from the Marin County Community Development Agency (MCCDA) and confirmed with the City of Novato Planning Department. The MCCDA's current proposed development data, Prop Dev 51, is available on their webpage (www.marincounty.org).

The forecast includes development in the city limits and adjacent county areas. The water demand for each project, separated by pressure zone, includes an estimate of future demand at 5-year increments for use in preparing a comprehensive capital improvement program. The projected buildout development demand is shown in Table 4-5, and known projects total 973 equivalent residential dwelling units (EDU) plus 1,720,711 square feet of potential commercial, institutional (government), and office floor space. The Projected Buildout Development Map in Figure 4-1 shows the locations of all projects listed.

The annual demand for the projected residential units is converted to annual acre-feet (AF) with the District conversion factor of 0.339 AF per EDU, for a total of 330 AF. The commercial, office, and government component is converted using a water duty factor of 0.118 AF per 1000 square feet of space, for a total of 218 AF.

In an effort to correlate future demands between multiple planning documents, the total projected demands have been scaled to match. Specifically, the projected values derived by NMWD from Prop Dev 51 and City of Novato Planning data (totaling 0.49 mgd by FY 2035 and illustrated in Figure 4-1 and delineated in Table 4-5) were scaled to match the demand projection values listed in table 4-2 of the 2015 Urban Water Management Plan (UWMP) which totaled 0.36 mgd by FY 2035. This scaling was done by applying a factor of 0.36/0.49 to each specific area plan's demand. In this manor, spatial allocation and relative amounts were assigned through the specific area plans. Each area plan's demand was then scaled by the factor above so that the summed total matched the overall UWMP demand projection. This scaling is shown in the far-right column of Table 4-5. Novato General Plan zoning data (which includes several County parcels) is shown in Figure 4-2.




| SITE NO. | DEVELOPMENT YEAR | DEVELOPMENT SITE |
|---|---|---|
| 1 | 2020 | State Access Senior Apartments (801 State Access) |
| 2 | 2020 | 516 Hospital Drive (Hamilton Hospital) |
| 3 | 2030 | Buck Institute |
| 4 | 2020 | 700 Hangar Avenue Infill (8 Hamilton Landing) |
| 5 | 2020 | Hanna Ranch |
| 6 | 2020 | Main Gate and "C" (Hamilton Square; 970 C Street ) |
| 7 | 2020 | Landing Court (AHO site #2) |
| 8, 9 | 2020 | 5400 Hanna Ranch Rd. (McPhail's) |
| 10 | 2020 | 933 C Street (Northbay Children's Center) |
| 11, 12 | 2020 | 1787 Grant Ave. (AHO site #1) |
| 13, 14 | 2020 | 7533 and 7537 Redwood Blvd (Atherton Place) |
| 15 | 2025 | 7711 Redwood Bovd., Laurel Ridge Senior Apts (AHO #3) |
| 16, 17 | 2020 | Hamilton Cottages (Senior Housing Triangle) |
| 18 | 2025 | Bahia Heights Subdivision |
| 19, 20 | 2025 | 7506 Redwood Blvd., AHO Site #4 (east of Trader Joe's) |
| 21 | 2020 | 7530 Redwood Blvd. & 7546 Redwood - Dairymen's |
| 22, 23 | 2025 | 7552 Redwood - Shamrock |
| 24 | 2030 | 7576 Redwood - Recycling Center |
| 25, 26 | 2025 | 7586 Redwood - Solar/Fence |
| 27 | 2030 | 7596 Redwood - Landscape Materials |
| 28, 29 | 2030 | Olive/Redwood |
| 30, 31, 32 | 2030 | American Assets (Fireman's Fund Property) |
| 33, 34 | 2025 | Campus Properties - Wood Hollow (Hotel) |
| 35 | 2030 | Oakview Office |
| 36, 37 | 2030 | Campus Properties - Black John & Lands of Wright (Part of 7711 Redwood Blvd) |
| 38 | 2025 | PG&E (Habitat for Humanity) |
| 39 | 2025 | Birkenstock (Chg to business ofc/biotech) |
| 40 | 2030 | 1017 Fourth St. |
| 41 | 2030 | 1053 Third St. |
| 42 | 2030 | Vallejo and First |
| 43 | 2030 | 1110 Olive Ave. |
| 44 | 2030 | 1320 Grant (and Fourth) |
| 45 | 2030 | 7409 Redwood Blvd. (Enterprise Car Rental) |
| 46 | 2030 | 7416 Redwood Blvd. (Chianti Restaurant) |
| 47, 48 | 2025 | 1107 and 1119 Grant (Old Pini Hardware) |
| 49 | 2030 | 935 Front St. (Mission Lodge site) |
| 50, 51, 52 | 2030 | Olive and First |
| 53 | 2035 | 100 Landing Court |
| 54 | 2035 | 200 San Marin Drive |
| 55 | 2035 | Hillside on Redwood/South of DeLong |
| 56 | 2035 | Victoria Commons 999 S. Novato Blvd. |
| 57 | 2025 | Hamilton Commissary Trangle -- HUD Parcel (826 State Access) |
| 58 | 2025 | Hamilton Commissary Triangle (802 State Access) |
| 59 | 2025 | Hamilton Town Center/Theater Parcel |
| 60 | 2030 | Hamilton Visiting Officer's Quarters |
| 61, 62 | 2035 | Hamilton School District Center (930 and 971 C St.) |
| 63 | 2025 | Indian Valley College - Measure B projects |
| 64, 65, 66 | 2030 | Square Shopping Center |
| 67 | 2025 | Oakmont Senior Living 1461 S. Novato Blvd./Quest Church |
| 68 | 2025 | 1905 Novato Blvd (AHO Site 5) |
| 69 | 2025 | Vallejo and Sixth |
| 70 | 2025 | Vallejo and Sixth |
| 71A | 2020 | Bel Marin Keys Industrial Park (BioTech - 2020) |
| 71B | 2025 | Bel Marin Keys Industrial Park (BioTech - 2025 |
| 71C | 2030 | Bel Marin Keys Industrial Park (BioTech - 2030) |
| 72 | 2035 | 1902 Novato Blvd. |
| 73 | 2035 | 1811 Virginia Ave. (Our Lady of Loretto Church) |
| 74 | 2030 | Ronsheimer Parcels (formerly Leveroni) |
| 75 | 2030 | Gnoss Field - Industrial Lands |
| 76 | 2030 | Gnoss Field / Atherton Ave / Greenpoint |
| 77 | 2030 | Blackpoint - Neighborhood Commercial |
| 78 | 2030 | Blackpoint - Residential Lands |
| 79 | 2030 | Indian Valley |
| 80 | 2030 | Vineyard Road |

NORTH MARIN WATER DISTRICT
NOVATO, CALIFORNIA

2018 WATER MASTER PLAN

## FIGURE 4-1
## PROJECTED FUTURE DEVELOPMENT LOCATION AND DEMAND MAP

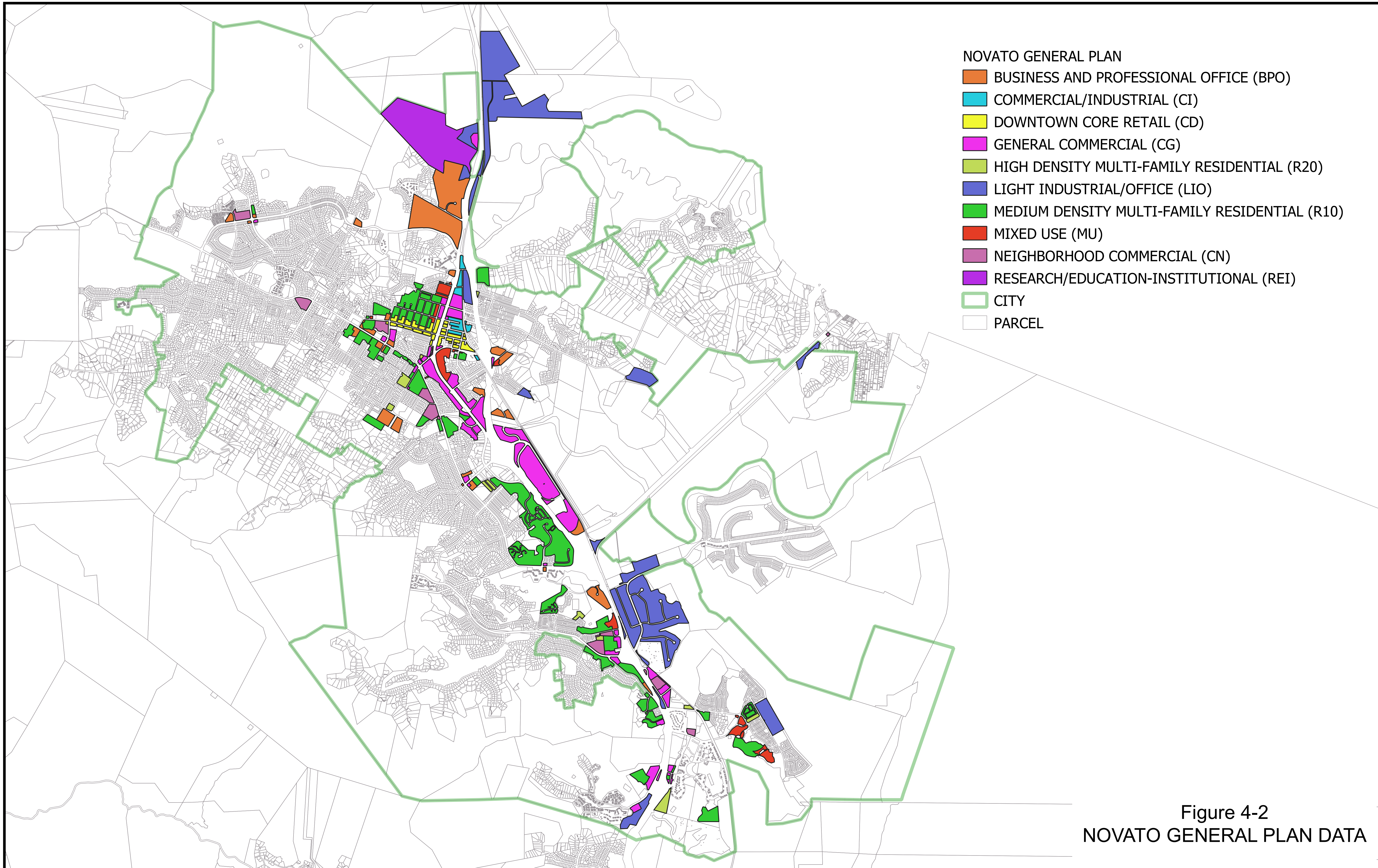



Figure 4-2
NOVATO GENERAL PLAN DATA

# Table 4-5
## Projected Buildout Development Demands

| Site No. | Map Grid | 2020 - 2035 Development Projections | Development Year | APN | NMWD Zone | Residential (units) | Assisted Living (units) | Memory Care[1] (units) | Residential EDUs[3,4] | Residential Demand (AFY) | Commercial (SF)[2] | Industrial (SF) | Office (SF) | Office, Commercial & Industrial Demand (AFY) | Total Annual Demand (AFY)[6] | Average Daily Demand (gal/day) | ADD scaled to match 2015 UWMP (gal/day)[7] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ***Development Projections*** | | | | | | | | | | | | | | | |
| | | *Approved* | | | | | | | | | | | | | | | |
| 1 | K25 | State Access Senior Apartments (801 State Access) | 2020 | 157-970-04 | S Zone 1 | 48 | | | 19 | 6.52 | | | | | 6.52 | 5,820 | 4,264 |
| 2 | L26 | 516 Hospital Drive (Hamilton Hospital) | 2020 | 157-690-52 | Sunset/Pacheco | | 48 | | 19 | 6.52 | 36,064 | | | 4.26 | 10.78 | 9,625 | 7,051 |
| 3 | G9, G10, G11 | Buck Institute | 2030 | 125-180-61 | Buck | 130 | | | 130 | 44.13 | | | 106,000 | 12.53 | 56.66 | 50,577 | 37,052 |
| 4 | L25 | 700 Hangar Avenue Infill (8 Hamilton Landing) | 2020 | 157-690-09 | S Zone 1 | | | | | | | | 56,188 | 6.64 | 6.64 | 5,928 | 4,343 |
| 5 | I20 | Hanna Ranch | 2020 | 153-340-06 | N Zone 1 | 48 | | | 48 | 16.29 | 100,240 | | | 11.85 | 28.14 | 25,117 | 18,400 |
| | | *Applications in Process* | | | | | | | | | | | | | | | |
| 6 | K26 | Hamilton Square Townhomes; 970 C Street | 2020 | 157-980-05 | S Zone 1 | 31 | | | 19 | 6.31 | | | | | 6.31 | 5,633 | 4,126 |
| 7 | H17 | Landing Court Townhomes (AHO site #2) | 2020 | 153-162-70 | N Zone 1 | 34 | | | 20 | 6.92 | | | | | 6.92 | 6,177 | 4,525 |
| 8, 9 | I20, I21 | 5400 Hanna Ranch Rd. (McPhail's) | 2020 | 153-220-16, 19 | N Zone 1 | | | | | | | | 59,600 | 7.04 | 7.04 | 6,288 | 4,606 |
| 10 | K26 | 933 C Street (Northbay Children's Center) | 2020 | 157-980-03 | S Zone 1 | | | | | | 6,769 | | | 0.80 | 0.80 | 714 | 523 |
| 11, 12 | F15 | 1787 Grant Ave. Townhomes (AHO site #1) | 2020 | 141-201-48, 12 | N Zone 1 | 35 | | | 21 | 7.13 | | | | | 7.13 | 6,365 | 4,663 |
| 13, 14 | G14 | Atherton Place Townhomes 7533 and 7537 Redwood Blvd | 2020 | 125-600-51, 52 | N Zone 1 | 50 | | | 30 | 10.18 | 1,340 | | | 0.16 | 10.34 | 9,229 | 6,761 |
| 15 | H11, H12 | Laurel Ridge Senior Apts (AHO #3), 7711 Redwood Blvd | 2025 | 125-580-16 | SM/Trumbull | 100 | | | 40 | 13.58 | | | | | 13.58 | 12,123 | 8,881 |
| 16, 17 | K25, K26, L25, L26 | Hamilton Cottages (Senior Housing Triangle) | 2020 | 157-860-03, 04 | S Zone 1 | 16 | | | 16 | 5.43 | | | | | 5.43 | 4,847 | 3,551 |
| 18 | K13 | Bahia Heights Subdivision | 2025 | 143-272-07 | N Zone 1 | 9 | | | 9 | 3.05 | | | | | 3.05 | 2,723 | 1,995 |
| | | ***Approved and In Process Subtotal*** | | | | ***501*** | ***48*** | | ***371.40*** | ***126.06*** | ***144,413*** | | ***221,788*** | ***43.28*** | ***169.34*** | ***151,165*** | ***110,740*** |
| | | *North Redwood Blvd. Corridor* | | | | | | | | | | | | | | | |
| | | East of Redwood - South | | | | | | | | | | | | | | | |
| 19, 20 | H14, H15 | 7506 Redwood Blvd., AHO Site #4 (east of Trader Joe's) | 2025 | 143-011-05, 08 | N Zone 1 | | | | | | 76,200 | | | 9.01 | 9.01 | 8,039 | 5,889 |
| 21 | H14, H15 | 7530 Redwood Blvd. & 7546 Redwood - Dairymen's | 2020 | 143-011-06 | N Zone 1 | | | | | | 88,500 | -17,948 | | 8.34 | 8.34 | 7,443 | 5,453 |
| | | East of Redwood - North (reallocates demand sites 22-27) | | | | | | | | | 45,000 | | | 3.50 | 3.50 | 3,122 | 2,287 |
| 22, 23 | H14, H15 | 7552 Redwood - Shamrock | 2025 | 143-061-01, 02 | N Zone 1 | | | | | | | -6,227 | | -0.74 | -0.74 | -657 | -481 |
| 24 | H14, H15 | 7576 Redwood - Recycling Center | 2030 | 143-061-06 | N Zone 1 | | | | | | | -3,760 | | -0.44 | -0.44 | -397 | -291 |
| 25, 26 | H14, H15 | 7586 Redwood - Solar/Fence | 2025 | 143-061-10, 11 | N Zone 1 | | | | | | | -4,388 | | -0.52 | -0.52 | -463 | -339 |
| 27 | H14, H15 | 7596 Redwood - Landscape Materials | 2030 | 143-061-08 | N Zone 1 | | | | | | -1,032 | | | -0.12 | -0.12 | -109 | -80 |
| 28, 29 | G14, G15 | Olive/Redwood | 2030 | 141-234-15, 16 | N Zone 1 | 15 | | | 9 | 3.05 | 2,300 | | | 0.27 | 3.32 | 2,965 | 2,172 |
| | | ***North Redwood Blvd. Corridor Subtotal*** | | | | ***15*** | ***0*** | ***0*** | ***9.00*** | ***3.05*** | ***210,968*** | ***-32,323*** | ***0*** | ***19.29*** | ***22.34*** | ***19,944*** | ***14,611*** |
| | | *North, North Redwood Blvd. Area* | | | | | | | | | | | | | | | |
| 30, 31, 32 | G12, G13, H13 | American Assets (Fireman's Fund Property) | 2030 | 125-202-03, 04, 05 | SM/Trumbull | | | | | | 30,000 | | | 3.55 | 3.55 | 3,165 | 2,319 |
| 33, 34 | H12 | Campus Properties - Wood Hollow (Hotel) | 2025 | 125-202-13, 14 | SM/Trumbull | | | | | | 46,865 | | | 5.54 | 5.54 | 4,944 | 3,622 |
| 35 | G12 | Oakview Office | 2030 | 125-202-12 | SM/Trumbull | | | | | | | | 24,000 | 2.84 | 2.84 | 2,532 | 1,855 |
| 36, 37 | G11, H11 | Campus Properties - Black John & Lands of Wright (Part of 7711 Redwood Blvd) | 2030 | 125-580-17, 125-180-38 | SM/Trumbull | | | | | | | | 180,000 | 21.27 | 21.27 | 18,990 | 13,911 |
| 38 | H10 | PG&E (Habitat for Humanity) | 2025 | 125-180-49 | SM/Trumbull | | | | | | | | 40,000 | 4.73 | 4.73 | 4,220 | 3,091 |
| 39 | H9, H10 | Birkenstock (Chg to business ofc/biotech) | 2025 | 125-180-83 | SM/Trumbull | | | | | | | -135,365 | 135,365 | 16.00 | 16.00 | 14,281 | 10,462 |
| | | ***North, North Redwood Blvd. Area Subtotal*** | | | | ***0*** | ***0*** | ***0*** | ***0.00*** | ***0.00*** | ***76,865*** | ***-135,365*** | ***379,365*** | ***53.92*** | ***53.92*** | ***48,132*** | ***35,260*** |

[1] Memory care units are included in Commercial square footage.

[2] Existing Commercial includes all retail, flex and specialty space as defined and identified by CoStar Realty Information, Inc. as of October 2013

[3] Equivalent Dwelling Units per Reg 1: SFR/Duplex=1 EDU; Townhouse/Condo=0.6 EDU; Apartment=0.4 EDU; Mobile Home=0.35 EDU

[4] Non-SFR/Duplex development type assumptions based on lot size and input from City of Novato planning staff

[5] Marin County project development year from the buildout analysis done for the Marin Countywide Plan EIR

[6] Annual demand includes conservation savings and uses the following factors:

| | | | |
|---|---|---|---|
| Residential = | 0.339 | AFY / EDU | =(1EDU)x(500gal/1ADPM)x(1adpm/1.65 ave day)x(365days/1yr)x(1AF/325,850 gal) |
| Comm/Govt = | 0.118 | AFY / 1,000 SF | per "Commercial EDU Factor Data-2017.xls" on 3/23/2018, averaging 31 commercial projects |
| Peaking Factor: ADPM/Avg. Day = | 1.65 | | Calculated in spreadsheet "NMWD FY13 Use by Customer by Billing Period" |

[7] All future demands have been scaled to match the total projected demands listed in the 2015 Urban Water Management Plan. A factor of 0.36 mgd/0.49 mgd was used.

Note: 1 EDU = 500 gallons/day

# Table 4-5 (Continued)
## Projected Buildout Development Demands

| Site No. | Map Grid | 2020 - 2035 Development Projections | Development Year | APN | NMWD Zone | Residential (units) | Assisted Living (units) | Memory Care[1] (units) | Residential EDUs[3,4] | Residential Demand (AFY) | Commercial (SF)[2] | Industrial (SF) | Office (SF) | Office, Commercial & Industrial Demand (AFY) | Total Annual Demand (AFY)[6] | Average Daily Demand (gal/day) | ADD scaled to match 2015 UWMP (gal/day)[7] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Northwest Quad (bounded by Grant and Vallejo Streets and First and Seventh Streets)* | | | | | | | | | | | | | | | |
| 40 | G15 | 1017 Fourth St. | 2030 | 141-253-09 | N Zone 1 | 1 | | | 1 | 0.34 | | | | | 0.34 | 304 | 222 |
| 41 | G15 | 1053 Third St. | 2030 | 141-261-30 | N Zone 1 | 4 | | | 4 | 1.36 | | | | | 1.36 | 1,214 | 889 |
| | | 2 redevelopment sites | 2030 | n/a | N Zone 1 | 3 | | | 3 | 1.02 | | | | | 1.02 | 911 | 667 |
| | | ***Northwest Quad Subtotal*** | | | | ***8*** | ***0*** | ***0*** | ***8.00*** | ***2.72*** | ***0*** | ***0*** | ***0*** | ***0.00*** | ***2.72*** | ***2,428*** | ***1,779*** |
| | | *Downtown* | | | | | | | | | | | | | | | |
| 42 | G15 | Vallejo and First | 2030 | 141-263-30 | N Zone 1 | 6 | | | 4 | 1.22 | 1,000 | | | 0.12 | 1.34 | 1,195 | 875 |
| 43 | G14 | 1110 Olive Ave. | 2030 | 141-234-10 | N Zone 1 | 2 | | | 2 | 0.68 | | | | | 0.68 | 607 | 445 |
| 44 | G5 | 1320 Grant (and Fourth) | 2030 | 141-261-29 | N Zone 1 | 24 | | | 10 | 3.26 | 10,874 | | | 1.29 | 4.55 | 4,057 | 2,972 |
| 45 | G15 | 7409 Redwood Blvd. (Enterprise Car Rental) | 2030 | 141-264-22 | N Zone 1 | 10 | | | 4 | 1.36 | 1,000 | | | 0.12 | 1.48 | 1,320 | 967 |
| 46 | G15 | 7416 Redwood Blvd. (Chianti Restaurant) | 2030 | 153-041-01 | N Zone 1 | 13 | | | 5 | 1.77 | 2,250 | | | 0.27 | 2.04 | 1,817 | 1,331 |
| 47, 48 | G15 | 1107 and 1119 Grant (Old Pini Hardware) | 2025 | 141-282-07, 04 | N Zone 1 | 32 | | | 13 | 4.34 | 13,000 | | | 1.54 | 5.88 | 5,246 | 3,843 |
| 49 | G16 | 935 Front St. (Mission Lodge site) | 2030 | 141-303-06 | N Zone 1 | | | | | | 16,204 | | | 1.92 | 1.92 | 1,710 | 1,252 |
| 50, 51, 52 | G15 | Olive and First | 2030 | 141-244-03, 12 & 17 | N Zone 1 | | | | | | 4,000 | | | 0.47 | 0.47 | 422 | 309 |
| | | ***Downtown Subtotal*** | | | | ***87*** | ***0*** | ***0*** | ***37.20*** | ***12.63*** | ***48,328*** | ***0*** | ***0*** | ***5.71*** | ***18.34*** | ***16,373*** | ***11,995*** |
| | | *Other Vacant/Underutilized* | | | | | | | | | | | | | | | |
| 53 | H17 | 100 Landing Court | 2035 | 153-170-56 | N Zone 1 | | | | | | | | 26,600 | 3.14 | 3.14 | 2,806 | 2,056 |
| 54 | D12 | 200 San Marin Drive | 2035 | 124-282-18 | SM/Trumbull | | | | | | 6,700 | | | 0.79 | 0.79 | 707 | 518 |
| 55 | G17 | Hillside on Redwood/South of DeLong | 2035 | 153-121-03 | N Zone 1 | | | | | | | | 8,600 | 1.02 | 1.02 | 907 | 665 |
| 56 | I22 | Victoria Commons 999 S. Novato Blvd. | 2035 | 160-591-71 | N Zone 1 | | | | | | | | 10,000 | 1.18 | 1.18 | 1,055 | 773 |
| 57 | K25 | Hamilton Commissary Trangle -- HUD Parcel (826 State Access) | 2025 | 157-970-07 | S Zone 1 | | | | | | 40,000 | | | 4.73 | 4.73 | 4,220 | 3,091 |
| 58 | K25 | Hamilton Commissary Triangle (802 State Access) | 2025 | 157-970-03 | S Zone 1 | | | | | | 65,000 | | | 7.68 | 7.68 | 6,857 | 5,024 |
| 59 | L26 | Hamilton Town Center/Theater Parcel | 2025 | 157-690-47 | Sunset/Pacheco | | | | | | 6,000 | | | 0.71 | 0.71 | 633 | 464 |
| 60 | M27 | Hamilton Visiting Officer's Quarters | 2030 | 157-690-53 | Sunset/Pacheco | 25 | | | 25 | 8.49 | 12,000 | | | 1.42 | 9.91 | 8,845 | 6,480 |
| 61, 62 | K26 | Hamilton School District Center (930 and 971 C St.) | 2035 | 157-980-07, 08 | S Zone 1 | | | | | | 50,000 | | | 5.91 | 5.91 | 5,275 | 3,864 |
| 63 | F21, F22, F23 | Indian Valley College - Measure B projects | 2025 | 150-480-12 | Sunset/Pacheco | | | | | | 32,000 | | | 3.78 | 3.78 | 3,376 | 2,473 |
| 64, 65, 66 | E15 | Square Shopping Center | 2030 | 132-183-14, 15, 16 | N Zone 1 | 53 | | | 21 | 7.2 | -24,805 | | | -2.93 | 4.27 | 3,810 | 2,791 |
| 67 | G18 | Oakmont Senior Living 1461 S. Novato Blvd./Quest Church | 2025 | 151-022-09 | N Zone 1 | | 50 | 28 | 20 | 6.79 | 20,288 | | | 2.40 | 9.19 | 8,202 | 6,008 |
| 68 | F15 | 1905 Novato Blvd (AHO Site 5) | 2025 | 140-011-66 | N Zone 1 | 21 | | | 8 | 2.85 | | | | | 2.85 | 2,544 | 1,864 |
| 69 | G15 | Vallejo and Sixth | 2025 | 141-221-74 | N Zone 1 | 1 | | | 1 | 0.2 | | | | | 0.20 | 179 | 131 |
| 70 | G14, G15 | Vallejo and Sixth | 2025 | 141-221-75 | N Zone 1 | 1 | | | 1 | 0.2 | | | | | 0.20 | 179 | 131 |
| | | ***Other Vacant/Underutilized Subtotal*** | | | | ***101*** | ***50*** | ***28*** | ***75.80*** | ***25.73*** | ***207,183*** | ***0*** | ***45,200*** | ***29.83*** | ***55.56*** | ***49,595*** | ***36,332*** |

[1] Memory care units are included in Commercial square footage.

[2] Existing Commercial includes all retail, flex and specialty space as defined and identified by CoStar Realty Information, Inc. as of October 2013

[3] Equivalent Dwelling Units per Reg 1: SFR/Duplex=1 EDU; Townhouse/Condo=0.6 EDU; Apartment=0.4 EDU; Mobile Home=0.35 EDU

[4] Non-SFR/Duplex development type assumptions based on lot size and input from City of Novato planning staff

[5] Marin County project development year from the buildout analysis done for the Marin Countywide Plan EIR

[6] Annual demand includes conservation savings and uses the following factors:

| | | | |
|---|---|---|---|
| Residential = | 0.339 | AFY / EDU | =(1EDU)x(500gal/1ADPM)x(1adpm/1.65 ave day)x(365days/1yr)x(1AF/325,850 gal) |
| Comm/Govt = | 0.118 | AFY / 1,000 SF | per "Commercial EDU Factor Data-2017.xls" on 3/23/2018, averaging 31 commercial projects |
| Peaking Factor: ADPM/Avg. Day = | 1.65 | | Calculated in spreadsheet "NMWD FY13 Use by Customer by Billing Period" |

[7] All future demands have been scaled to match the total projected demands listed in the 2015 Urban Water Management Plan. A factor of 0.36 mgd/0.49 mgd was used.

Note: 1 EDU = 500 gallons/day

# Table 4-5 (Continued)
## Projected Buildout Development Demands

| Site No. | Map Grid | 2020 - 2035 Development Projections | Development Year | APN | NMWD Zone | Residential (units) | Assisted Living (units) | Memory Care[1] (units) | Residential EDUs[3,4] | Residential Demand (AFY) | Commercial (SF)[2] | Industrial (SF) | Office (SF) | Office, Commercial & Industrial Demand (AFY) | Total Annual Demand (AFY)[6] | Average Daily Demand (gal/day) | ADD scaled to match 2015 UWMP (gal/day)[7] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Other Sites from HE Available Land Inventory* | | | | | | | | | | | | | | | |
| 71A | J22, J23 | Bel Marin Keys Industrial Park (BioTech - 2020) | 2020 | | S Zone 1 | | | | | | | 166,667 | | 19.70 | 19.70 | 17,583 | 12,881 |
| 71B | J22, J23 | Bel Marin Keys Industrial Park (BioTech - 2025) | 2025 | | S Zone 1 | | | | | | | 166,667 | | 19.70 | 19.70 | 17,583 | 12,881 |
| 71C | J22, J23 | Bel Marin Keys Industrial Park (BioTech - 2030) | 2030 | | S Zone 1 | | | | | | | 166,667 | | 19.70 | 19.70 | 17,583 | 12,881 |
| 72 | F15 | 1902 Novato Blvd. | 2035 | 141-062-36 | N Zone 1 | 5 | | | 5 | 1.7 | | | | | 1.70 | 1,518 | 1,112 |
| 73 | F15 | 1811 Virginia Ave. (Our Lady of Loretto Church) | 2035 | 141-142-16 | N Zone 1 | 7 | | | 7 | 2.38 | | | | | 2.38 | 2,125 | 1,556 |
| | | Miscellaneous single family | 2030 | various | N Zone 1 | 30 | | | 30 | 10.18 | | | | | 10.18 | 9,087 | 6,657 |
| | | Miscellaneous second units | 2030 | various | S Zone 1 | 60 | | | 21 | 7.13 | | | | | 7.13 | 6,365 | 4,663 |
| | | ***Other sites from HE Available Land Inventory Subtotal*** | | | | ***102*** | ***0*** | ***0*** | ***63.00*** | ***21.39*** | ***0*** | ***500,001*** | ***0*** | ***59.09*** | ***80.48*** | ***71,844*** | ***52,631*** |
| | | *County of Marin[5]* | | | | | | | | | | | | | | | |
| 74 | J21, K21 | Ronsheimer Parcels (formerly Leveroni) | 2030 | 157-171-23, 24 | S Zone 1 | 15 | | | 15 | 5.09 | | | | | 5.09 | 4,544 | 3,329 |
| 75 | H8, H9, H10, H11, I9 | Gnoss Field - Industrial Lands | 2030 | various | SM/Trumbull | | | | | | | 50,000 | | 5.91 | 5.91 | 5,275 | 3,864 |
| 76 | J14, K14, L14, L15, M15 | Gnoss Field/Atherton Ave/Greenpoint | 2030 | various | N Zone 1 and SM/Trumbull | 232 | | | 232 | 78.75 | | | | | 78.75 | 70,299 | 51,499 |
| 77 | M15, M16 | Blackpoint - Neighborhood Commercial | 2030 | various | SM/Trumbull | | | | | | 4,288 | | | 0.51 | 0.51 | 452 | 331 |
| 78 | M15, N15 | Blackpoint - Residential Lands | 2030 | various | SM/Trumbull | 105 | | | 105 | 35.64 | | | | | 35.64 | 31,815 | 23,307 |
| 79 | D17, D18, E18, | Indian Valley | 2030 | various | Sunset/Pacheco | 56 | | | 56 | 19.01 | | | | | 19.01 | 16,970 | 12,432 |
| 80 | B16, B17, B18 | Vineyard Road | 2030 | various | SM/Trumbull | 1 | | | 1 | 0.34 | | | | | 0.34 | 304 | 222 |
| | | ***County of Marin Subtotal*** | | | | ***409*** | ***0*** | ***0*** | ***409.00*** | ***138.83*** | ***4,288*** | ***50,000*** | ***0*** | ***6.42*** | ***145.25*** | ***129,658*** | ***94,985*** |
| | | ***TOTAL DEVELOPMENT THROUGH 2035*** | | | | ***1,223*** | ***98*** | ***28*** | ***973*** | ***330.41*** | ***692,045*** | ***382,313*** | ***646,353*** | ***217.53*** | ***547.94*** | ***489,139*** | ***358,333*** |

[1] Memory care units are included in Commercial square footage.

[2] Existing Commercial includes all retail, flex and specialty space as defined and identified by CoStar Realty Information, Inc. as of October 2013

[3] Equivalent Dwelling Units per Reg 1: SFR/Duplex=1 EDU; Townhouse/Condo=0.6 EDU; Apartment=0.4 EDU; Mobile Home=0.35 EDU

[4] Non-SFR/Duplex development type assumptions based on lot size and input from City of Novato planning staff

[5] Marin County project development year from the buildout analysis done for the Marin Countywide Plan EIR

[6] Annual demand includes conservation savings and uses the following factors:

| | | | |
|---|---|---|---|
| Residential = | 0.339 | AFY / EDU | =(1EDU)x(500gal/1ADPM)x(1adpm/1.65 ave day)x(365days/1yr)x(1AF/325,850 gal) |
| Comm/Govt = | 0.118 | AFY / 1,000 SF | per "Commercial EDU Factor Data-2017.xls" on 3/23/2018, averaging 31 commercial projects |
| Peaking Factor: ADPM/Avg. Day = | 1.65 | | Calculated in spreadsheet "NMWD FY13 Use by Customer by Billing Period" |

[7] All future demands have been scaled to match the total projected demands listed in the 2015 Urban Water Management Plan. A factor of 0.36 mgd/0.49 mgd was used.

Note: 1 EDU = 500 gallons/day

### 4.5.3 Incremental Demand Increase

The projected buildout demand can be divided into phases using implementation schedule estimates for new development projects. Each future development has been assigned an estimated 5-year incremental period that it is expected to be on-line, between 2017 and FY 2035. The incremental average daily demand increase for each period is shown in Table 4-6, divided into each pressure zone. The projected demand increase shows a peak in construction in 2030, followed by a significant decrease in additional demand in 2035.

### 4.5.4 Projected Water Demands

The projected average daily water demand in 5-year increments separated by pressure zone is shown in Table 4-7. Overall, approximately 64% of the new demand will occur in Zone 1, with over 60% of that demand occurring in the North Novato area. Approximately 28% of the new demand will occur in Zone 2, with almost 60% of the Zone 2 demand occurring in the Crest and Black Point areas and 36% occurring in the San Mateo/Trumbull area. Around 9% of the new demand will occur in the higher-pressure zones. However, the growth in the Buck area represents a significant increase in these smaller zones and will likely require improvements to these systems to serve the new customers.

Maximum day demands will be utilized for other tasks in this Master Plan, including the storage and pumping capacity evaluation presented in Section 5. The projected maximum day water demand in 5-year increments separated by pressure zone is shown in Table 4-8. These maximum day demands were obtained by scaling the average day demand form Table 4-7 by the maximum day to average day peaking factor from Table 4-3. As stated in section 4.3.1, this peaking factor was obtained from the 2004 average day demand and the 2003 maximum day demand.

**Table 4-6**
**Incremental Average Day Demand (ADD) Projection (from specific plans)**

| Pressure Zone | FY 2020 ADD Increase (gpd) | FY 2025 Ave Day Demand Increase (gpd) | FY 2030 Ave Day Demand Increase (gpd) | FY 2035 Ave Day Demand Increase (gpd) | Total Ave Day Demand Increase (gpd) |
|---|---|---|---|---|---|
| North Novato Subzone | 44,408 | 33,737 | 54,836 | 6,162 | 139,142 |
| South Novato Subzone | 36,739 | 21,460 | 27,352 | 3,864 | 89,415 |
| **Zone 1 Total** | **81,147** | **55,197** | **82,187** | **10,026** | **228,557** |
| | | | | | |
| San Mateo/Trumbull Subzone | 0 | 12,503 | 22,461 | 518 | 35,481 |
| Sunset/Pacheco Subzone | 0 | 2,473 | 1,276 | 0 | 3,749 |
| **Primary Zone 2 Total** | **0** | **14,976** | **23,737** | **518** | **39,230** |
| | | | | | |
| Crest | 0 | 0 | 31,406 | 0 | 31,406 |
| | | | | | |
| Black Point | 0 | 0 | 28,104 | 0 | 28,104 |
| | | | | | |
| Wild Horse Valley / Center Rd | 0 | 0 | 1,248 | 0 | 1,260 |
| | | | | | |
| Cherry Hill | 0 | 0 | 447 | 0 | 447 |
| | | | | | |
| Buck | 0 | 0 | 27,789 | 0 | 27,789 |
| | | | | | |
| Half Moon | 0 | 0 | 437 | 0 | 437 |
| | | | | | |
| Old Ranch | 0 | 0 | 656 | 0 | 656 |
| | | | | | |
| Bahia | 0 | 0 | 447 | 0 | 447 |
| | | | | | |
| Upper Wild Horse Valley | 0 | 0 | 12 | 0 | 0 |
| | | | | | |
| **Totals** | **81,147** | **70,173** | **196,469** | **10,544** | **358,333** |

(1) Demands from specific plan areas are tabulated in Table 4-5

**Table 4-7**
**Projected Average Day Demand (ADD) [1]**

| Pressure Zone | FY 2013 Total ADD (gpd) [2] | FY 2020 Ave Day Demand (gpd) | FY 2025 Ave Day Demand (gpd) | FY 2030 Ave Day Demand (gpd) | FY 2035 Ave Day Demand (gpd) | Total Ave Day Demand Increase (gpd) |
|---|---|---|---|---|---|---|
| No. Novato Subzone | 2,766,589 | 2,810,997 | 2,844,734 | 2,899,569 | 2,905,731 | 139,142 |
| So. Novato Subzone | 1,110,184 | 1,146,923 | 1,168,383 | 1,195,734 | 1,199,599 | 89,415 |
| **Zone 1 Total** | **3,876,772** | **3,957,920** | **4,013,116** | **4,095,304** | **4,105,330** | **228,557** |
| | | | | | | |
| Crest | 146,746 | 146,746 | 146,746 | 178,152 | 178,152 | 31,406 |
| Black Point | 107,630 | 107,630 | 107,630 | 135,734 | 135,734 | 28,104 |
| San Mateo/Trumbull Subzone | 2,086,792 | 2,086,792 | 2,099,295 | 2,121,756 | 2,122,274 | 35,481 |
| Sunset/Pacheco Subzone | 1,488,771 | 1,488,771 | 1,491,244 | 1,492,520 | 1,492,520 | 3,749 |
| Air Base | 264,653 | 264,653 | 264,653 | 264,653 | 264,653 | 0 |
| **Zone 2 Total** | **4,094,594** | **4,094,594** | **4,109,570** | **4,192,816** | **4,193,334** | **98,740** |
| | | | | | | |
| Cherry Hill | 121,814 | 121,814 | 121,814 | 122,261 | 122,261 | 447 |
| Half Moon | 20,014 | 20,014 | 20,014 | 20,451 | 20,451 | 437 |
| Wild Horse Valley/Center Rd | 237,920 | 237,920 | 237,920 | 239,168 | 239,168 | 1,248 |
| Garner | 16,884 | 16,884 | 16,884 | 16,884 | 16,884 | 0 |
| Old Ranch Road | 9,179 | 9,179 | 9,179 | 9,836 | 9,836 | 656 |
| Dickson | 52,664 | 52,664 | 52,664 | 52,664 | 52,664 | 0 |
| Winged Foot | 60,648 | 60,648 | 60,648 | 60,648 | 60,648 | 0 |
| Ponti | 68,797 | 68,797 | 68,797 | 68,797 | 68,797 | 0 |
| San Andreas | 16,920 | 16,920 | 16,920 | 16,920 | 16,920 | 0 |
| Nunes | 10,552 | 10,552 | 10,552 | 10,552 | 10,552 | 0 |
| **Zone 3 Total** | **615,393** | **615,393** | **615,393** | **618,181** | **618,181** | **2,788** |
| | | | | | | |
| Buck | 16,560 | 16,560 | 16,560 | 44,348 | 44,348 | 27,789 |
| Upper Wild Horse Valley | 9,464 | 9,464 | 9,464 | 9,477 | 9,477 | 12 |
| Cabro Ct | 2,768 | 2,768 | 2,768 | 2,768 | 2,768 | 0 |
| **Zone 4 Total** | **28,792** | **28,792** | **28,792** | **56,593** | **56,593** | **27,801** |
| | | | | | | |
| Windhaven | 3,409 | 3,409 | 3,409 | 3,409 | 3,409 | 0 |
| San Antonio (WCW) | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 | 0 |
| **Misc Zone Total** | **8,409** | **8,409** | **8,409** | **8,409** | **8,409** | **0** |
| | | | | | | |
| Bahia Hydro | 30,669 | 30,669 | 30,669 | 31,115 | 31,115 | 447 |
| Hayden Hydro | 11,464 | 11,464 | 11,464 | 11,464 | 11,464 | 0 |
| Diablo Hills Hydro | 3,550 | 3,550 | 3,550 | 3,550 | 3,550 | 0 |
| Garner Hydro | 5,490 | 5,490 | 5,490 | 5,490 | 5,490 | 0 |
| Indian Hills Hydro | 6,206 | 6,206 | 6,206 | 6,206 | 6,206 | 0 |
| Rockrose Hydro | 7,934 | 7,934 | 7,934 | 7,934 | 7,934 | 0 |
| Eagle Dr Hydro | 17,577 | 17,577 | 17,577 | 17,577 | 17,577 | 0 |
| **Hydro Zone Total** | **82,890** | **82,890** | **82,890** | **83,337** | **83,337** | **447** |
| | | | | | | |
| **Totals** | **8,706,849** | **8,787,997** | **8,858,169** | **9,054,638** | **9,065,182** | **358,333** |

[1] See Table 4-6 for incremental demand increases by 5-year intervals.

[2] FY 2013 is actual day demand.

**Table 4-8**
**Projected Maximum Day Water Demands[1]**

| Pressure Zone | FY 2013 Max Day Demand (gpd) | FY 2020 Max Day Demand (gpd) | FY 2025 Max Day Demand (gpd) | FY 2030 Max Day Demand (gpd) | FY 2035 Max Day Demand (gpd) | Total Max Day Demand Increase (gpd) |
|---|---|---|---|---|---|---|
| No. Novato Subzone | 4,895,500 | 4,974,100 | 5,033,800 | 5,130,800 | 5,141,700 | 246,200 |
| So. Novato Subzone | 1,964,500 | 2,029,500 | 2,067,500 | 2,115,900 | 2,122,700 | 158,200 |
| **Zone 1 Total** | **6,860,000** | **7,003,600** | **7,101,300** | **7,246,700** | **7,264,400** | **404,400** |
| | | | | | | |
| Crest | 259,700 | 259,700 | 259,700 | 315,200 | 315,200 | 55,500 |
| Black Point | 190,500 | 190,500 | 190,500 | 240,200 | 240,200 | 49,700 |
| San Mateo/Trumbull Subzone | 3,692,600 | 3,692,600 | 3,714,700 | 3,754,400 | 3,755,400 | 62,800 |
| Sunset/Pacheco Subzone | 2,634,400 | 2,634,400 | 2,638,800 | 2,641,000 | 2,641,000 | 6,600 |
| Air Base | 468,300 | 468,300 | 468,300 | 468,300 | 468,300 | 0 |
| **Zone 2 Total** | **7,245,500** | **7,245,500** | **7,272,000** | **7,419,100** | **7,420,100** | **174,600** |
| | | | | | | |
| Cherry Hill | 215,600 | 215,600 | 215,600 | 216,300 | 216,300 | 700 |
| Half Moon | 35,400 | 35,400 | 35,400 | 36,200 | 36,200 | 800 |
| Wild Horse Valley/Center Rd | 421,000 | 421,000 | 421,000 | 423,200 | 423,200 | 2,200 |
| Garner | 29,900 | 29,900 | 29,900 | 29,900 | 29,900 | 0 |
| Old Ranch Road | 16,200 | 16,200 | 16,200 | 17,400 | 17,400 | 1,200 |
| Dickson | 93,200 | 93,200 | 93,200 | 93,200 | 93,200 | 0 |
| Winged Foot | 107,300 | 107,300 | 107,300 | 107,300 | 107,300 | 0 |
| Ponti | 121,700 | 121,700 | 121,700 | 121,700 | 121,700 | 0 |
| San Andreas | 29,900 | 29,900 | 29,900 | 29,900 | 29,900 | 0 |
| Nunes | 18,700 | 18,700 | 18,700 | 18,700 | 18,700 | 0 |
| **Zone 3 Total** | **1,088,900** | **1,088,900** | **1,088,900** | **1,093,800** | **1,093,800** | **4,900** |
| | | | | | | |
| Buck | 29,300 | 29,300 | 29,300 | 78,500 | 78,500 | 49,200 |
| Upper Wild Horse Valley | 16,700 | 16,700 | 16,700 | 16,800 | 16,800 | 100 |
| Cabro Ct | 4,900 | 4,900 | 4,900 | 4,900 | 4,900 | 0 |
| **Zone 4 Total** | **50,900** | **50,900** | **50,900** | **100,200** | **100,200** | **49,300** |
| | | | | | | |
| Windhaven | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 | 0 |
| San Antonio (WCW) | 8,800 | 8,800 | 8,800 | 8,800 | 8,800 | 0 |
| **Misc Zone Total** | **14,800** | **14,800** | **14,800** | **14,800** | **14,800** | **0** |
| | | | | | | |
| Bahia Hydro | 54,300 | 54,300 | 54,300 | 55,100 | 55,100 | 800 |
| Hayden Hydro | 20,300 | 20,300 | 20,300 | 20,300 | 20,300 | 0 |
| Diablo Hills Hydro | 6,300 | 6,300 | 6,300 | 6,300 | 6,300 | 0 |
| Garner Hydro | 9,700 | 9,700 | 9,700 | 9,700 | 9,700 | 0 |
| Indian Hills Hydro | 11,000 | 11,000 | 11,000 | 11,000 | 11,000 | 0 |
| Rockrose Hydro | 14,000 | 14,000 | 14,000 | 14,000 | 14,000 | 0 |
| Eagle Dr Hydro | 31,100 | 31,100 | 31,100 | 31,100 | 31,100 | 0 |
| **Hydro Zone Total** | **146,700** | **146,700** | **146,700** | **147,500** | **147,500** | **800** |
| | | | | | | |
| **Totals** | **15,406,800** | **15,550,400** | **15,674,600** | **16,022,100** | **16,040,800** | **634,000** |

[1] Maximum day demands obtained by scaling ADD from Table 4-7 by pressure zone specific Max Day/Ave Day peaking factor from Table 4-3.

# SECTION 5

# STORAGE AND PUMPING CAPACITY EVALUATION

## SECTION 5

## STORAGE AND PUMPING CAPACITY EVALUATION

### 5.1 INTRODUCTION

The storage and pumping capacity evaluation of the pressure zones and pump stations in the Novato Water System is presented in Section 5. The analysis is based on FY 2013 and projected buildout (FY 2035) water demands presented in Section 4. The existing storage capacity is compared to storage capacity requirements based on District storage criteria for each pressure zone, to determine storage capacity adequacy. Similarly, the existing firm pumping capacity is compared to pumping capacity requirements based on District pumping criteria for the major booster pump stations serving Zones 2, 3 and 4, to determine pumping capacity adequacy.

### 5.2 BACKGROUND/PREVIOUS STUDIES

The District has performed several storage and pumping capacity evaluations in recent years. In 1991, the District conducted an evaluation of storage capacity for Zones 1 and 2 (James M. Montgomery, Evaluation of Zone 1 Storage Requirements, 1991). That study concluded that Zone 2 had ample storage capacity to meet current and buildout demands, but that Zone 1 was deficient approximately 3 million gallons. Specific storage capacity criteria were established during that study and adopted system-wide.

In 1996, storage capacity was reviewed again for Zones 1 and 2 due to demand growth since 1991 and the long-term land use changes contained in the 1996 City of Novato General Plan (Soldati Engineering Services, Storage Evaluation and Siting Study, January 1997). This study concluded that Zone 1 was deficient approximately 2.8 million gallons based on FY 1996 demands and would be deficient approximately 8.8 million gallons by buildout (FY 2015). Zone 2 continued to have a surplus of storage capacity. The Crest Zone was deficient approximately 430,000 gallons based on FY 1996 demands and would be deficient approximately 750,000 gallons by buildout. The many separate isolated Zone 3 and 4 systems were not addressed in the study.

In 1998, a storage and pumping capacity study was prepared for the major Zone 3 and 4 service areas (Soldati Engineering Services, Zones 3 and 4 Storage Capacity Evaluation, April 20, 1999). Service areas found to be deficient in storage and pumping capacity under both current (FY 1997) and buildout demand conditions were identified.

A storage and pumping capacity evaluation was performed in the 2002 Water System Master Plan utilizing FY 2001 demand and demand projections based on planned development at that time. The evaluation was updated in the 2007 Water System Master Plan utilizing FY 2006 demand and current demand projections at that time. Both studies recommended additional storage capacity immediately for the Crest and Wild Horse Valley Zones, and additional storage capacity was recommended for Zone 1 to meet buildout demands. Additional pumping capacity was recommended immediately for the School Road and Trumbull Pump Stations, and additional pumping capacity was required for the Nunes and Buck Pump Stations to meet buildout demands.

A storage and capacity evaluation was performed again for the 2012 Water System Master Plan Update utilizing FY 2011 demand and demand projects based on planned development at that time. The study recommended additional storage capacity for Zone 1 and the Half Moon and Old Ranch Road Zones to meet buildout and fire flow storage demands. The study also recommended the installation of a new tank in the Buck Zone to be constructed when buildout development occurs. No immediate additional pumping capacity was required, although the Lynwood and Cherry Hill pump stations were recommended for further study, while the Nunes and Buck pump station capacities were recommended to be increased after final approval of buildout development.

The following projects have been constructed (or are ongoing) since the last iteration of the Water Master Plan was prepared in 2012:

- Replace aging cast iron pipe (ongoing)
- Replace 12-inch CI pipe in S. Novato Blvd, south of Rowland
- Replace 6-inch CI pipe in Shields Lane
- Replace 1-inch pipe at Grant Ave & 4$^{th}$ Ave
- Replace 2-inch TW plastic pipe in Ashley Ct
- San Mateo Tank inlet/outlet pipeline (in process)
- Upgrade NMWD-MMWD BMK intertie
- Replace Polybutylene service lines (ongoing)
- Loop in Bel Marin Keys commercial area
- North Marin Aqueduct Energy Efficiency project
- Replace untestable detector checks (ongoing)
- Install flushing taps at dead ends (ongoing)
- Install permanent water quality sampling stations
- Install tank hatch access alarms
- Install anodes on existing copper services (ongoing)
- Install chlorine boosters at Sunset Tank
- Recoat/Structurally repair Atherton Tank
- Recoat San Mateo tank
- Relocate School Rd pump station (in process)
- Prepare Emergency Action Plan for Stafford Dam
- Prepare Inundation Map for Stafford Dam (update in process)

With the updated water demand projections now presented in Section 4, storage and pumping capacity evaluations are similarly updated for all pressure zones within the Novato Water System. All pressure zones are included, except for the small hydropneumatic pumping stations, the Cabro Court Zone, and the two small pressure zones off the aqueduct north of Novato – San Antonio and Windhaven.

## 5.3 EVALUATION METHODOLOGY

As described in section 7, previous models (2012) assumed that nearly all potable water demands were distributed uniformly across each zone, except for a few locations that were known to have very high demands. In contrast, this 2018 analysis relies on geolocated customer billing data to precisely allocate demands. When comparing the results of this current analysis to the results of previous analysis much of the differences are likely due to this change in flow allocation methodology.

The pertinent storage capacity evaluation criteria and pumping capacity evaluation criteria are presented in Section 2. Other major elements of the approach are summarized herein.

### 5.3.1 Storage Capacity Evaluation

The storage capacity evaluation is based on determining three storage volume components as presented in Section 2, and summarized below:

- Operational Storage
  - 25% of Max Day Demand for one day.
- Fire Storage
  - Detailed storage criteria listed in Table 2-2.
  - Generally follows the following residential, non-residential breakdown:
    - 1,500 gpm for two hours for residential areas.
    - 3,500 gpm for three hours in non-residential areas
    - 3,500 gpm for two hours in Buck Zone
- Emergency Storage
  - 100% of Max Day Demand for one day.

The sum of these three components is the total storage capacity goal for the specific pressure zone. This total storage capacity goal is compared to the existing storage capacity to determine if a surplus or deficit of storage capacity exists. A detailed discussion of this storage evaluation is presented in article 5.5 of this section.

### 5.3.2 Pumping Capacity Evaluation

Providing adequate storage capacity is only one distribution system element that beneficially affects system operation. Adequate pumping capacity must be provided to enable the storage capacity to recover depleted volume in a reasonable time period. Undersized pumps may reduce the effectiveness of storage capacity. Therefore, it is necessary to evaluate the pumping capacity requirements at each booster pump station.

The pumping evaluation in this study consists of comparing the pumping requirement (calculated as maximum (max) day demand pumped over 16 hours for a given zone) to the firm capacity of the supplying pump station. Firm capacity is defined as the pump station capacity with the largest pump out of service. All of the District's stations evaluated in this report have at least two pumps, except the San Marin, Lynwood, and Trumbull pump stations, which have three pumps. Note that this analysis uses the rated pump capacity provided by the District. Many pump stations are required to pass water through to a higher zone than the one which the pump station is serving. The total flow that is required to be pumped through the station for both its zone and upper zones is included as appropriate when determining the total pumping capacity requirement.

### 5.3.3 Evaluation of Pump Station Energy Usage

Each pump station was evaluated in terms of specific energy, and unit-cost of pumping, based on operational data during the period between 2014 – 2017. The term 'specific energy' in this context is defined as the energy required to pump one million gallons. Similarly, the unit cost of pumping is the combined costs of energy and demand charges divided by gallons pumped. These two metrics are useful for identifying and tracking changes in pump station performance over time. For example, simple changes in pump station control logic (i.e. off-peak pumping) can have a significant effect on specific energy and unit cost of pumping. Similarly, pump replacement or rebuilds can also have an effect on these metrics.

Additionally, the District engages outside firms to perform tests of individual pump efficiency under the auspices of PG&E's energy efficiency incentive program. Under this program the District is eligible for free testing at some of their facilities. Test results provide measurements of overall pump efficiency (OPE) that considers the combined effects of motor and hydraulic efficiency.

## 5.4 PRESSURE ZONE WATER DEMANDS

The storage and pumping evaluation utilizes FY 2013 water demand and projected buildout (FY 2035) water demand. Specifically, operational and emergency storage criteria, as well as the pumping capacity criteria, are based on maximum day demand for each pressure zone, as shown in Table 4-8. Pumping demands were obtained from FY 2013 billing data for the zones the pumps serve. In the case of Primary Zone 2, where multiple pump stations (Lynwood and San Marin) serve a single zone, the demands were split in the same ratio as was done in the 2012 water master plan based on pump station totalizer data (see Note 6 on Table 5-8).

Water pumped into the pressure zone ideally should equal the consumption for each zone plus a percentage for lost (unaccounted) water. Discrepancies in the production versus consumption data can indicate: (1) lost (un-accounted) water; (2) a problem in the method of determining consumption data; (3) a problem in the obtaining and recording of production data; or (4) an issue in the actual performance of the pumps.

## 5.5 STORAGE CAPACITY EVALUATION

The storage capacity requirements for each pressure zone for FY 2013 and buildout (FY 2035) water demands are described below. A comparison to prior evaluations and specific recommendations to address storage needs are presented later in this section.

### 5.5.1 FY 2013 Water Demands

Storage capacity requirements by pressure zone for FY 2013 water demand are shown in Table 5-1. Around half of the pressure zones have surplus storage capacity based on 2013 demand, while the other half show a storage capacity deficit. All of the major pressure zones were analyzed. In contrast, storage requirements for hydropneumatic systems, Cabro Ct, San Antonio & Windhaven pressure zones are not included.

#### 5.5.1.1 Zone 1 Storage Capacity Summary

The Zone 1 North Novato Subzone has a small storage deficit of 400,000 gallons while the Zone 1 South Novato Subzone has a much larger storage surplus of approximately 4.4 million gallons. Since both subzones are connected hydraulically, storage capacity from each subzone is available to the other. Therefore, Zone 1 has sufficient storage capacity under the 2013 demand scenario.

#### 5.5.1.2 Zone 2 Storage Capacity Summary

The two main subzones within Zone 2 San Mateo/Trumbull and Sunset/Pacheco Subzones each have a surplus of approximately 1.25 million gallons and 6.1 million gallons respectively. These subzones can also be connected hydraulically, so storage capacity from each subzone is available to the other, although the hydraulic grade line tends to be higher in the Sunset/Pacheco Subzone. This hydraulic connectivity is interrupted approximately November through April when a zone valve located at Slowdown Court is closed when demands are lower. This is done to increase water turnover in the San Mateo tank in an effort to avoid water quality issues.

There are three other pressures zones within Zone 2. The Crest Zone has a surplus of approximately 495,000 gallons, while the Black Point and Air Base Zones have a deficit of 95,000 and 216,000 gallons respectively.

#### 5.5.1.3 Zone 3 Storage Capacity Summary

The Wild Horse Valley/Center Road, Winged Foot, Ponti, and San Andreas Zones all have surplus storage capacity currently. Dickson Zone is considered to have a surplus as the emergency storage component is combined with the fire storage component for this small system.

Fire storage requirements for Black Point and Cherry Hill zones are based on residential fire flow criteria, even though there is a small amount of commercial development in these areas.

Half Moon and Garner Zones each have significant storage capacity deficiencies, primarily due to the high fire storage component which is itself greater than the existing storage capacity for these zones. Each of these pressure zones have at least 2.8 days of maximum day demand in storage capacity, so there is adequate capacity to withstand a limited loss of pumping. It was considered to combine the emergency storage component with the fire storage component for these small systems, as was done in the Dickson Zone. However, the Blackpoint, Half Moon, Garner, and Old Ranch Road Zones have deficiencies despite the combination, so the components have been kept separate for future project planning.

The Nunes Zone has a deficiency equivalent to 70% of existing storage capacity. However, there are over 6 days of maximum-day demand in storage capacity, so there is adequate capacity to withstand a limited loss of pumping.

#### 5.5.1.4 Zone 4 Storage Capacity Summary

Upper Wild Horse Valley Zone is considered to have a surplus as there is no fire storage volume provided by the tank.

The Buck Zone has surplus capacity since the required fire storage volume has been reduced from 3,500 gpm for three hours to 3,500 for two hours.

### 5.5.2 Buildout Water Demands

Storage capacity requirements by pressure zone for each 5-year incremental milestone until buildout in FY 2035 are shown in Tables 5-2 through 5-5. The additional storage capacity requirements by pressure zone for each incremental 5-year period are summarized in Table 5-6. Additional significant demand is expected in the North Novato Subzone, the Black Point Zone, and the Buck Zone.

The North Novato Subzone is approximately 708,000 gallons deficient at buildout, while the South Novato Subzone has a surplus of approximately 4.2 million gallons. Since both areas of Zone 1 are combined hydraulically, the surplus in the Southern portion negates the deficit in the

Northern portion. Therefore, no additional storage is needed because a surplus of 4.1 million gallons is available at buildout when Zone 1 is analyzed in its entirety.

The San Mateo/Trumbull and Sunset/Pacheco Subzones will have a slight increase in demand until buildout in 2035. At buildout, Sunset/Pacheco Subzone will continue to have a significant surplus of over 6 million gallons, and the San Mateo/Trumbull Subzone will have approximately 1.2 million gallons of surplus at buildout.

The Air Base Zone will have a significant deficit at buildout of around 216,000 gallons.

The Buck Zone will have a slight deficit at buildout that is too small to necessitate any action. Crest, Wild Horse Valley/Center Road, Dickson, Winged Foot, Ponti, San Andreas, and Upper Wild Horse Valley Zones will continue to exhibit surplus storage capacity even at buildout.

The Cherry Hill, Blackpoint, Half Moon, Garner, Old Ranch Road and Nunes Zones all have significant storage deficits now and at buildout. These deficits are close to or exceed the total current tank capacity and are primarily due to fire storage requirements.

### 5.5.3 Historical Comparison

A comparison of the storage capacity deficit from FY 2006, FY 2011, current (FY 2013), and at buildout (FY 2035) is shown in Table 5-7. Four zones show a decrease in storage capacity deficit, while three tanks show an increase.

The Black Point storage deficit has increased from FY 2011 to FY2013 largely due to high fire flow areas identified during this analysis. This deficit is expected to increase further through buildout due to development at sites number 76, 77 & 78 as listed in Table 4-5. The Black Point Zone has no FY 2006 data to compare to as it was not analyzed in the 2006 Master Plan.

While the Airbase Zone storage capacity deficit dropped substantially after FY 2006, the storage capacity analysis from FY 2013 shows a return of the deficit to 216,000 gallons. However, since 2013 the District has made efforts to switch irrigation requirements to recycled water. This is expected to buffer the need for additional storage in this zone.

There continues to be a storage deficit at Half Moon Zone though it has decreased to 126,000 gallons at FY 2035. This decrease is due to a decrease in max day demand from the previous analysis.

The Dickson Zone continues to show no storage deficit as the zone's emergency storage was combined with the fire storage for this small system.

The change in the deficit occurring in the Garner, Old Ranch Road, and Nunes Zones is due to post-FY 2011 updated fire storage requirements and continues through buildout.

**Table 5-1**
**Storage Capacity Goals**
**FY 2013 Demand**

| Pressure Zone[1] | Zone | Tanks | Total Zone Storage Capacity (gal) | Estimated Max Day Demand[2] (gpd) | No. Days of Max Day Demand in Storage[3] | Operational Storage (gal) [4] [7] | Fire Storage (gal) [4] [8] [11] | Emergency Storage (gal) [4] [9] | Total Storage Required (gal) | Additional Storage Required (gal) [10] |
|---|---|---|---|---|---|---|---|---|---|---|
| No. Novato Subzone | 1 | Atherton (5 mg), Lynwood (0.5 mg & 0.85 mg tanks). | 6,350,000 | 4,895,500 | 1.3 | 1,223,900 | 630,000 | 4,895,500 | 6,750,000 | 400,000 |
| So. Novato Subzone | 1 | Palmer (3 mg), Amaroli (4.5 mg) | 7,500,000 | 1,964,500 | 3.8 | 491,200 | 630,000 | 1,964,500 | 3,086,000 | (4,414,000) |
| Zone 1 Total[5] | 1 | | 13,850,000 | 6,860,000 | 2.0 | 1,715,100 | 630,000 | 6,860,000 | 9,206,000 | (4,644,000) |
| San Mateo/Trumbull Subzone | 2 | San Mateo (5 mg), Trumbull (1.5 mg). | 6,500,000 | 3,692,600 | 1.8 | 923,200 | 630,000 | 3,692,600 | 5,246,000 | (1,254,000) |
| Sunset/Pacheco Subzone | 2 | Sunset (5 mg), Pacheco (5 mg). | 10,000,000 | 2,634,400 | 3.8 | 658,600 | 630,000 | 2,634,400 | 3,923,000 | (6,077,000) |
| Primary Zone 2 Total[6] | 2 | | 16,500,000 | 6,327,000 | 2.6 | 1,581,800 | 630,000 | 6,327,000 | 8,539,000 | (7,961,000) |
| Crest | 2 | Crest (two 0.5 mg tanks) | 1,000,000 | 259,700 | 3.9 | 65,000 | 180,000 | 259,700 | 505,000 | (495,000) |
| Black Point | 2 | Black Point (0.324 mg) | 324,000 | 190,500 | 1.7 | 47,700 | 180,000 | 190,500 | 419,000 | 95,000 |
| Air Base | 2 | Air Base (1 mg) | 1,000,000 | 468,300 | 2.1 | 117,100 | 630,000 | 468,300 | 1,216,000 | 216,000 |
| Cherry Hill | 3 | Cherry Hill (0.2 mg & 0.25 mg) | 450,000 | 215,600 | 2.1 | 53,900 | 180,000 | 215,600 | 450,000 | 0 |
| Half Moon | 3 | Half Moon (0.1 mg) | 100,000 | 35,400 | 2.8 | 8,900 | 180,000 | 35,400 | 225,000 | 125,000 |
| Wild Horse Valley/Center Rd | 3 | Wild Horse Valley (0.5 mg), Center Rd (0.5 mg). | 1,000,000 | 421,000 | 2.4 | 105,300 | 180,000 | 421,000 | 707,000 | (293,000) |
| Garner | 3 | Garner (0.1 mg) | 100,000 | 29,900 | 3.3 | 7,500 | 180,000 | 29,900 | 218,000 | 118,000 |
| Old Ranch Road | 3 | Old Ranch Road (0.05 mg) | 50,000 | 16,200 | 3.1 | 4,100 | 100,000 | 16,200 | 121,000 | 71,000 |
| Dickson | 3 | Dickson (0.25 mg) | 250,000 | 93,200 | 2.7 | 23,300 | 180,000 | 0 | 204,000 | (46,000) |
| Winged Foot | 3 | Winged Foot (0.6 mg) | 600,000 | 107,300 | 5.6 | 26,900 | 180,000 | 107,300 | 315,000 | (285,000) |
| Ponti | 3 | Ponti (0.5 mg) | 500,000 | 121,700 | 4.1 | 30,500 | 180,000 | 121,700 | 333,000 | (167,000) |
| San Andreas | 3 | San Andreas (0.25 mg) | 250,000 | 29,900 | 8.4 | 7,500 | 180,000 | 29,900 | 218,000 | (32,000) |
| Nunes | 3 | Nunes (0.12 mg) | 120,000 | 18,700 | 6.4 | 4,700 | 180,000 | 18,700 | 204,000 | 84,000 |
| Buck | 4 | Buck (0.5 mg) | 500,000 | 29,300 | 17.1 | 7,400 | 420,000 | 29,300 | 457,000 | (43,000) |
| Upper Wild Horse Valley | 4 | Upper Wild Horse Valley (0.044 mg) | 44,000 | 16,700 | 2.6 | 4,200 | 0 | 16,700 | 21,000 | (23,000) |

(1) Only major pressure zones shown. Hydropneumatic systems and Cabro Ct, San Antonio and Windhaven pressure zones are not included
(2) Demands presented in Section 4
(3) This is the number of days of demand that could be met at the highest demand if all demand is served from the tank capacity only
(4) Storage criteria presented in Section 2
(5) North Novato and South Novato Subzone are hydraulicly connected so analysis has been performed on the entirety of Zone 1 to decrease redundant fire flow requirement
(6) San Mateo/Trumbull and Sunset/Pacheco Subzone are hydraulicly connected so analysis has been performed on the entirety of Zone 1 to decrease redundant fire flow requirement
(7) Operational Storage = 25% of Max Day Demand
(8) Fire Storage = 3,500 gpm for 3 hours for non-residential areas or 1,500 gpm for 2 hours for residential areas. Buck Zone requries 2 hour duration. 100,000 gal for Old Ranch Rd (see footnote 11)
(9) Emergency Storage = 100% of Max Day Demand
(10) Values shown in parentheses indicates a surplus
(11) Storage requirement developed in consultation with Novato Fire on 09/12/2018

**Table 5-2**
**Storage Capacity Goals**
**FY 2020 Demand**

| Pressure Zone[1] | Zone | Tanks | Total Zone Storage Capacity (gal) | Estimated Max Day Demand[2] (gpd) | No. Days of Max Day Demand in Storage[3] | Operational Storage (gal) [4] [7] | Fire Storage (gal) [4] [8] [11] | Emergency Storage (gal) [4] [9] | Total Storage Required (gal) | Additional Storage Required (gal) [10] |
|---|---|---|---|---|---|---|---|---|---|---|
| No. Novato Subzone | 1 | Atherton (5 mg), Lynwood (0.5 mg & 0.85 mg tanks). | 6,350,000 | 4,974,100 | 1.3 | 1,243,600 | 630,000 | 4,974,100 | 6,848,000 | 498,000 |
| So. Novato Subzone | 1 | Palmer (3 mg), Amaroli (4.5 mg) | 7,500,000 | 2,029,500 | 3.7 | 507,400 | 630,000 | 2,029,500 | 3,167,000 | (4,333,000) |
| Zone 1 Total[5] | 1 | | 13,850,000 | 7,003,600 | 5.0 | 1,751,000 | 630,000 | 7,003,600 | 9,384,600 | (4,465,400) |
| San Mateo/Trumbull Subzone | 2 | San Mateo (5 mg), Trumbull (1.5 mg). | 6,500,000 | 3,692,600 | 1.8 | 923,200 | 630,000 | 3,692,600 | 5,246,000 | (1,254,000) |
| Sunset/Pacheco Subzone | 2 | Sunset (5 mg), Pacheco (5 mg). | 10,000,000 | 2,634,400 | 3.8 | 658,600 | 630,000 | 2,634,400 | 3,923,000 | (6,077,000) |
| Primary Zone 2 Total[6] | 2 | | 16,500,000 | 6,327,000 | 5.6 | 1,581,800 | 630,000 | 6,327,000 | 8,538,800 | (7,961,200) |
| Crest | 2 | Crest (two 0.5 mg tanks) | 1,000,000 | 259,700 | 3.9 | 65,000 | 180,000 | 259,700 | 505,000 | (495,000) |
| Black Point | 2 | Black Point (0.324 mg) | 324,000 | 190,500 | 1.7 | 47,700 | 180,000 | 190,500 | 419,000 | 95,000 |
| Air Base | 2 | Air Base (1 mg) | 1,000,000 | 468,300 | 2.1 | 117,100 | 630,000 | 468,300 | 1,216,000 | 216,000 |
| Cherry Hill | 3 | Cherry Hill (0.2 mg & 0.25 mg) | 450,000 | 215,600 | 2.1 | 53,900 | 180,000 | 215,600 | 450,000 | 0 |
| Half Moon | 3 | Half Moon (0.1 mg) | 100,000 | 35,400 | 2.8 | 8,900 | 180,000 | 35,400 | 225,000 | 125,000 |
| Wild Horse Valley/Center Rd | 3 | Wild Horse Valley (0.5 mg), Center Rd (0.5 mg). | 1,000,000 | 421,000 | 2.4 | 105,300 | 180,000 | 421,000 | 707,000 | (293,000) |
| Garner | 3 | Garner (0.1 mg) | 100,000 | 29,900 | 3.3 | 7,500 | 180,000 | 29,900 | 218,000 | 118,000 |
| Old Ranch Road | 3 | Old Ranch Road (0.05 mg) | 50,000 | 16,200 | 3.1 | 4,100 | 100,000 | 16,200 | 121,000 | 71,000 |
| Dickson | 3 | Dickson (0.25 mg) | 250,000 | 93,200 | 2.7 | 23,300 | 180,000 | 0 | 204,000 | (46,000) |
| Winged Foot | 3 | Winged Foot (0.6 mg) | 600,000 | 107,300 | 5.6 | 26,900 | 180,000 | 107,300 | 315,000 | (285,000) |
| Ponti | 3 | Ponti (0.5 mg) | 500,000 | 121,700 | 4.1 | 30,500 | 180,000 | 121,700 | 333,000 | (167,000) |
| San Andreas | 3 | San Andreas (0.25 mg) | 250,000 | 29,900 | 8.4 | 7,500 | 180,000 | 29,900 | 218,000 | (32,000) |
| Nunes | 3 | Nunes (0.12 mg) | 120,000 | 18,700 | 6.4 | 4,700 | 180,000 | 18,700 | 204,000 | 84,000 |
| Buck | 4 | Buck (0.5 mg) | 500,000 | 29,300 | 17.1 | 7,400 | 420,000 | 29,300 | 457,000 | (43,000) |
| Upper Wild Horse Valley | 4 | Upper Wild Horse Valley (0.044 mg) | 44,000 | 16,700 | 2.6 | 4,200 | 0 | 16,700 | 21,000 | (23,000) |

(1) Only major pressure zones shown. Hydropneumatic systems and Cabro Ct, San Antonio and Windhaven pressure zones are not included.
(2) Demands presented in Section 4
(3) This is the number of days of demand that could be met at the highest demand if all demand is served from the tank capacity only.
(4) Storage criteria presented in Section 2
(5) North Novato and South Novato Subzone are hydraulicly connected so analysis has been performed on the entirety of Zone 1 to decrease redundant fire flow requirement
(6) San Mateo/Trumbull and Sunset/Pacheco Subzone are hydraulicly connected so analysis has been performed on the entirety of Zone 1 to decrease redundant fire flow requirement.
(7) Operational Storage = 25% of Max Day Demand
(8) Fire Storage = 3,500 gpm for 3 hours for non-residential areas or 1,500 gpm for 2 hours for residential areas. Buck Zone requries 2 hour duration. 100,000 gal for Old Ranch Rd (see footnote 11).
(9) Emergency Storage = 100% of Max Day Demand
(10) Values shown in parentheses indicates a surplus
(11) Storage requirement developed in consultation with Novato Fire on 09/12/2018

**Table 5-3**
**Storage Capacity Goals**
**FY 2025 Demand**

| Pressure Zone[1] | Zone | Tanks | Total Zone Storage Capacity (gal) | Estimated Max Day Demand[2] (gpd) | No. Days of Max Day Demand in Storage[3] | Operational Storage (gal) [4] [7] | Fire Storage (gal) [4] [8] [11] | Emergency Storage (gal) [4] [9] | Total Storage Required (gal) | Additional Storage Required (gal) [10] |
|---|---|---|---|---|---|---|---|---|---|---|
| No. Novato Subzone | 1 | Atherton (5 mg), Lynwood (0.5 mg & 0.85 mg tanks). | 6,350,000 | 5,033,800 | 1.3 | 1,258,500 | 630,000 | 5,033,800 | 6,923,000 | 573,000 |
| So. Novato Subzone | 1 | Palmer (3 mg), Amaroli (4.5 mg) | 7,500,000 | 2,067,500 | 3.6 | 516,900 | 630,000 | 2,067,500 | 3,215,000 | (4,285,000) |
| Zone 1 Total[5] | 1 | | 13,850,000 | 7,101,300 | 4.9 | 1,775,400 | 630,000 | 7,101,300 | 9,506,700 | (4,343,300) |
| San Mateo/Trumbull Subzone | 2 | San Mateo (5 mg), Trumbull (1.5 mg). | 6,500,000 | 3,714,700 | 1.7 | 928,700 | 630,000 | 3,714,700 | 5,274,000 | (1,226,000) |
| Sunset/Pacheco Subzone | 2 | Sunset (5 mg), Pacheco (5 mg). | 10,000,000 | 2,638,800 | 3.8 | 659,700 | 630,000 | 2,638,800 | 3,929,000 | (6,071,000) |
| Primary Zone 2 Total[6] | 2 | | 16,500,000 | 6,353,500 | 5.5 | 1,588,400 | 630,000 | 6,353,500 | 8,571,900 | (7,928,100) |
| Crest | 2 | Crest (two 0.5 mg tanks) | 1,000,000 | 259,700 | 3.9 | 65,000 | 180,000 | 259,700 | 505,000 | (495,000) |
| Black Point | 2 | Black Point (0.324 mg) | 324,000 | 190,500 | 1.7 | 47,700 | 180,000 | 190,500 | 419,000 | 95,000 |
| Air Base | 2 | Air Base (1 mg) | 1,000,000 | 468,300 | 2.1 | 117,100 | 630,000 | 468,300 | 1,216,000 | 216,000 |
| Cherry Hill | 3 | Cherry Hill (0.2 mg & 0.25 mg) | 450,000 | 215,600 | 2.1 | 53,900 | 180,000 | 215,600 | 450,000 | 0 |
| Half Moon | 3 | Half Moon (0.1 mg) | 100,000 | 35,400 | 2.8 | 8,900 | 180,000 | 35,400 | 225,000 | 125,000 |
| Wild Horse Valley/Center Rd | 3 | Wild Horse Valley (0.5 mg), Center Rd (0.5 mg). | 1,000,000 | 421,000 | 2.4 | 105,300 | 180,000 | 421,000 | 707,000 | (293,000) |
| Garner | 3 | Garner (0.1 mg) | 100,000 | 29,900 | 3.3 | 7,500 | 180,000 | 29,900 | 218,000 | 118,000 |
| Old Ranch Road | 3 | Old Ranch Road (0.05 mg) | 50,000 | 16,200 | 3.1 | 4,100 | 100,000 | 16,200 | 121,000 | 71,000 |
| Dickson | 3 | Dickson (0.25 mg) | 250,000 | 93,200 | 2.7 | 23,300 | 180,000 | 0 | 204,000 | (46,000) |
| Winged Foot | 3 | Winged Foot (0.6 mg) | 600,000 | 107,300 | 5.6 | 26,900 | 180,000 | 107,300 | 315,000 | (285,000) |
| Ponti | 3 | Ponti (0.5 mg) | 500,000 | 121,700 | 4.1 | 30,500 | 180,000 | 121,700 | 333,000 | (167,000) |
| San Andreas | 3 | San Andreas (0.25 mg) | 250,000 | 29,900 | 8.4 | 7,500 | 180,000 | 29,900 | 218,000 | (32,000) |
| Nunes | 3 | Nunes (0.12 mg) | 120,000 | 18,700 | 6.4 | 4,700 | 180,000 | 18,700 | 204,000 | 84,000 |
| Buck | 4 | Buck (0.5 mg) | 500,000 | 29,300 | 17.1 | 7,400 | 420,000 | 29,300 | 457,000 | (43,000) |
| Upper Wild Horse Valley | 4 | Upper Wild Horse Valley (0.044 mg) | 44,000 | 16,700 | 2.6 | 4,200 | 0 | 16,700 | 21,000 | (23,000) |

(1) Only major pressure zones shown. Hydropneumatic systems and Cabro Ct. San Antonio and Windhaven pressure zones are not included.
(2) Demands presented in Section 4.
(3) This is the number of days of demand that could be met at the highest demand if all demand is served from the tank capacity only.
(4) Storage criteria presented in Section 2.
(5) North Novato and South Novato Subzone are hydraulicly connected so analysis has been performed on the entirety of Zone 1 to decrease redundant fire flow requirement.
(6) San Mateo/Trumbull and Sunset/Pacheco Subzone are hydraulicly connected so analysis has been performed on the entirety of Zone 1 to decrease redundant fire flow requirement.
(7) Operational Storage = 25% of Max Day Demand
(8) Fire Storage = 3,500 gpm for 3 hours for non-residential areas or 1,500 gpm for 2 hours for residential areas. Buck Zone requries 2 hour duration. 100,000 gal for Old Ranch Rd (see footnote 11).
(9) Emergency Storage = 100% of Max Day Demand
(10) Values shown in parentheses indicates a surplus
(11) Storage requirement developed in consultation with Novato Fire on 09/12/2018.

**Table 5-4**
**Storage Capacity Goals**
**FY 2030 Demand**

| Pressure Zone[1] | Zone | Tanks | Total Zone Storage Capacity (gal) | Estimated Max Day Demand[2] (gpd) | No. Days of Max Day Demand in Storage[3] | Operational Storage (gal) [4] [7] | Fire Storage (gal) [4] [8] [11] | Emergency Storage (gal) [4] [9] | Total Storage Required (gal) | Additional Storage Required (gal) [10] |
|---|---|---|---|---|---|---|---|---|---|---|
| No. Novato Subzone | 1 | Atherton (5 mg), Lynwood (0.5 mg & 0.85 mg tanks). | 6,350,000 | 5,130,800 | 1.2 | 1,282,700 | 630,000 | 5,130,800 | 7,044,000 | 694,000 |
| So. Novato Subzone | 1 | Palmer (3 mg), Amaroli (4.5 mg) | 7,500,000 | 2,115,900 | 3.5 | 529,000 | 630,000 | 2,115,900 | 3,275,000 | (4,225,000) |
| Zone 1 Total[5] | 1 | | 13,850,000 | 7,246,700 | 4.8 | 1,811,700 | 630,000 | 7,246,700 | 9,688,400 | (4,161,600) |
| San Mateo/Trumbull Subzone | 2 | San Mateo (5 mg), Trumbull (1.5 mg). | 6,500,000 | 3,754,400 | 1.7 | 938,600 | 630,000 | 3,754,400 | 5,323,000 | (1,177,000) |
| Sunset/Pacheco Subzone | 2 | Sunset (5 mg), Pacheco (5 mg). | 10,000,000 | 2,641,000 | 3.8 | 660,300 | 630,000 | 2,641,000 | 3,932,000 | (6,068,000) |
| Primary Zone 2 Total[6] | 2 | | 16,500,000 | 6,395,400 | 5.5 | 1,598,900 | 630,000 | 6,395,400 | 8,624,300 | (7,875,700) |
| Crest | 2 | Crest (two 0.5 mg tanks) | 1,000,000 | 315,200 | 3.2 | 78,800 | 180,000 | 315,200 | 574,000 | (426,000) |
| Black Point | 2 | Black Point (0.324 mg) | 324,000 | 240,200 | 1.3 | 60,100 | 180,000 | 240,200 | 481,000 | 157,000 |
| Air Base | 2 | Air Base (1 mg) | 1,000,000 | 468,300 | 2.1 | 117,100 | 630,000 | 468,300 | 1,216,000 | 216,000 |
| Cherry Hill | 3 | Cherry Hill (0.2 mg & 0.25 mg) | 450,000 | 216,300 | 2.1 | 54,100 | 180,000 | 216,300 | 451,000 | 1,000 |
| Half Moon | 3 | Half Moon (0.1 mg) | 100,000 | 36,200 | 2.8 | 9,100 | 180,000 | 36,200 | 226,000 | 126,000 |
| Wild Horse Valley/Center Rd | 3 | Wild Horse Valley (0.5 mg), Center Rd (0.5 mg). | 1,000,000 | 423,200 | 2.4 | 105,800 | 180,000 | 423,200 | 709,000 | (291,000) |
| Garner | 3 | Garner (0.1 mg) | 100,000 | 29,900 | 3.3 | 7,500 | 180,000 | 29,900 | 218,000 | 118,000 |
| Old Ranch Road | 3 | Old Ranch Road (0.05 mg) | 50,000 | 17,400 | 2.9 | 4,400 | 100,000 | 17,400 | 122,000 | 72,000 |
| Dickson | 3 | Dickson (0.25 mg) | 250,000 | 93,200 | 2.7 | 23,300 | 180,000 | 0 | 204,000 | (46,000) |
| Winged Foot | 3 | Winged Foot (0.6 mg) | 600,000 | 107,300 | 5.6 | 26,900 | 180,000 | 107,300 | 315,000 | (285,000) |
| Ponti | 3 | Ponti (0.5 mg) | 500,000 | 121,700 | 4.1 | 30,500 | 180,000 | 121,700 | 333,000 | (167,000) |
| San Andreas | 3 | San Andreas (0.25 mg) | 250,000 | 29,900 | 8.4 | 7,500 | 180,000 | 29,900 | 218,000 | (32,000) |
| Nunes | 3 | Nunes (0.12 mg) | 120,000 | 18,700 | 6.4 | 4,700 | 180,000 | 18,700 | 204,000 | 84,000 |
| Buck | 4 | Buck (0.5 mg) | 500,000 | 78,500 | 6.4 | 19,700 | 420,000 | 78,500 | 519,000 | 19,000 |
| Upper Wild Horse Valley | 4 | Upper Wild Horse Valley (0.044 mg) | 44,000 | 16,800 | 2.6 | 4,200 | 0 | 16,800 | 21,000 | (23,000) |

(1) Only major pressure zones shown. Hydropneumatic systems and Cabro Ct, San Antonio and Windhaven pressure zones are not included.
(2) Demands presented in Section 4.
(3) This is the number of days of demand that could be met at the highest demand if all demand is served from the tank capacity only.
(4) Storage criteria presented in Section 2.
(5) North Novato and South Novato Subzone are hydraulicly connected so analysis has been performed on the entirety of Zone 1 to decrease redundant fire flow requirement.
(6) San Mateo/Trumbull and Sunset/Pacheco Subzone are hydraulicly connected so analysis has been performed on the entirety of Zone 1 to decrease redundant fire flow requirement.
(7) Operational Storage = 25% of Max Day Demand
(8) Fire Storage = 3,500 gpm for 3 hours for non-residential areas or 1,500 gpm for 2 hours for residential areas. Buck Zone requries 2 hour duration. 100,000 gal for Old Ranch Rd (see footnote 11)
(9) Emergency Storage = 100% of Max Day Demand
(10) Values shown in parentheses indicates a surplus
(11) Storage requirement developed in consultation with Novato Fire on 09/12/2018.

**Table 5-5**
**Storage Capacity Goals**
**FY 2035 Demand**

| Pressure Zone[1] | Zone | Tanks | Total Zone Storage Capacity (gal) | Estimated Max Day Demand[2] (gpd) | No. Days of Max Day Demand in Storage[3] | Operational Storage (gal) [4] [7] | Fire Storage (gal) [4] [8] [11] | Emergency Storage (gal) [4] [9] | Total Storage Required (gal) | Additional Storage Required (gal) [10] |
|---|---|---|---|---|---|---|---|---|---|---|
| No. Novato Subzone | 1 | Atherton (5 mg), Lynwood (0.5 mg & 0.85 mg tanks). | 6,350,000 | 5,141,700 | 1.2 | 1,285,500 | 630,000 | 5,141,700 | 7,058,000 | 708,000 |
| So. Novato Subzone | 1 | Palmer (3 mg), Amaroli (4.5 mg) | 7,500,000 | 2,122,700 | 3.5 | 530,700 | 630,000 | 2,122,700 | 3,284,000 | (4,216,000) |
| Zone 1 Total[5] | 1 | | 13,850,000 | 7,264,400 | 4.8 | 1,816,200 | 630,000 | 7,264,400 | 9,710,600 | (4,139,400) |
| San Mateo/Trumbull Subzone | 2 | San Mateo (5 mg), Trumbull (1.5 mg). | 6,500,000 | 3,755,400 | 1.7 | 938,900 | 630,000 | 3,755,400 | 5,325,000 | (1,175,000) |
| Sunset/Pacheco Subzone | 2 | Sunset (5 mg), Pacheco (5 mg). | 10,000,000 | 2,641,000 | 3.8 | 660,300 | 630,000 | 2,641,000 | 3,932,000 | (6,068,000) |
| Primary Zone 2 Total[6] | 2 | | 16,500,000 | 6,396,400 | 5.5 | 1,599,200 | 630,000 | 6,396,400 | 8,625,600 | (7,874,400) |
| Crest | 2 | Crest (two 0.5 mg tanks) | 1,000,000 | 315,200 | 3.2 | 78,800 | 180,000 | 315,200 | 574,000 | (426,000) |
| Black Point | 2 | Black Point (0.324 mg) | 324,000 | 240,200 | 1.3 | 60,100 | 180,000 | 240,200 | 481,000 | 157,000 |
| Air Base | 2 | Air Base (1 mg) | 1,000,000 | 468,300 | 2.1 | 117,100 | 630,000 | 468,300 | 1,216,000 | 216,000 |
| Cherry Hill | 3 | Cherry Hill (0.2 mg & 0.25 mg) | 450,000 | 216,300 | 2.1 | 54,100 | 180,000 | 216,300 | 451,000 | 1,000 |
| Half Moon | 3 | Half Moon (0.1 mg) | 100,000 | 36,200 | 2.8 | 9,100 | 180,000 | 36,200 | 226,000 | 126,000 |
| Wild Horse Valley/Center Rd | 3 | Wild Horse Valley (0.5 mg), Center Rd (0.5 mg). | 1,000,000 | 423,200 | 2.4 | 105,800 | 180,000 | 423,200 | 709,000 | (291,000) |
| Gamer | 3 | Gamer (0.1 mg) | 100,000 | 29,900 | 3.3 | 7,500 | 180,000 | 29,900 | 218,000 | 118,000 |
| Old Ranch Road | 3 | Old Ranch Road (0.05 mg) | 50,000 | 17,400 | 2.9 | 4,400 | 100,000 | 17,400 | 122,000 | 72,000 |
| Dickson | 3 | Dickson (0.25 mg) | 250,000 | 93,200 | 2.7 | 23,300 | 180,000 | 0 | 204,000 | (46,000) |
| Winged Foot | 3 | Winged Foot (0.6 mg) | 600,000 | 107,300 | 5.6 | 26,900 | 180,000 | 107,300 | 315,000 | (285,000) |
| Ponti | 3 | Ponti (0.5 mg) | 500,000 | 121,700 | 4.1 | 30,500 | 180,000 | 121,700 | 333,000 | (167,000) |
| San Andreas | 3 | San Andreas (0.25 mg) | 250,000 | 29,900 | 8.4 | 7,500 | 180,000 | 29,900 | 218,000 | (32,000) |
| Nunes | 3 | Nunes (0.12 mg) | 120,000 | 18,700 | 6.4 | 4,700 | 180,000 | 18,700 | 204,000 | 84,000 |
| Buck | 4 | Buck (0.5 mg) | 500,000 | 78,500 | 6.4 | 19,700 | 420,000 | 78,500 | 519,000 | 19,000 |
| Upper Wild Horse Valley | 4 | Upper Wild Horse Valley (0.044 mg) | 44,000 | 16,800 | 2.6 | 4,200 | 0 | 16,800 | 21,000 | (23,000) |

(1) Only major pressure zones shown. Hydropneumatic systems and Cabro Ct, San Antonio and Windhaven pressure zones are not included.
(2) Demands presented in Section 4.
(3) This is the number of days of demand that could be met at the highest demand if all demand is served from the tank capacity only.
(4) Storage criteria presented in Section 2.
(5) North Novato and South Novato Subzone are hydraulicly connected so analysis has been performed on the entirety of Zone 1 to decrease redundant fire flow requirement.
(6) San Mateo/Trumbull and Sunset/Pacheco Subzone are hydraulicly connected so analysis has been performed on the entirety of Zone 1 to decrease redundant fire flow requirement.
(7) Operational Storage = 25% of Max Day Demand
(8) Fire Storage = 3,500 gpm for 3 hours for non-residential areas or 1,500 gpm for 2 hours for residential areas. Buck Zone requries 2 hour duration. 100,000 gal for Old Ranch Rd (see footnote 11).
(9) Emergency Storage = 100% of Max Day Demand
(10) Values shown in parentheses indicates a surplus
(11) Storage requirement developed in consultation with Novato Fire on 09/12/2018

**Table 5-6**
**Additional Storage Capacity Required By Pressure Zone**

| Tank/Pressure Zone | Zone | Total Zone Storage Capacity (gallons) | Additional Storage Capacity Required (Gallons)[2] | | | | |
|---|---|---|---|---|---|---|---|
| | | | FY 2013 | FY 2020 | FY 2025 | FY 2030 | FY 2035 |
| No. Novato Subzone | 1 | 6,350,000 | 400,000 | 498,000 | 573,000 | 694,000 | 708,000 |
| So. Novato Subzone | 1 | 7,500,000 | (4,414,000) | (4,333,000) | (4,285,000) | (4,225,000) | (4,216,000) |
| Zone 1 Total | 1 | 13,850,000 | (4,644,000) | (4,465,400) | (4,343,300) | (4,161,600) | (4,139,400) |
| San Mateo/Trumbull Subzone | 2 | 6,500,000 | (1,254,000) | (1,254,000) | (1,226,000) | (1,177,000) | (1,175,000) |
| Sunset/Pacheco Subzone | 2 | 10,000,000 | (6,077,000) | (6,077,000) | (6,071,000) | (6,068,000) | (6,068,000) |
| Primary Zone 2 Total | 2 | 16,500,000 | (7,961,000) | (7,961,200) | (7,928,100) | (7,875,700) | (7,874,400) |
| Crest | 2 | 1,000,000 | (495,000) | (495,000) | (495,000) | (426,000) | (426,000) |
| Black Point | 2 | 324,000 | 95,000 | 95,000 | 95,000 | 157,000 | 157,000 |
| Air Base | 2 | 1,000,000 | 216,000 | 216,000 | 216,000 | 216,000 | 216,000 |
| Cherry Hill | 3 | 450,000 | 0 | 0 | 0 | 1,000 | 1,000 |
| Half Moon | 3 | 100,000 | 125,000 | 125,000 | 125,000 | 126,000 | 126,000 |
| Wild Horse Valley/Center Rd | 3 | 1,000,000 | (293,000) | (293,000) | (293,000) | (291,000) | (291,000) |
| Garner[1] | 3 | 100,000 | 118,000 | 118,000 | 118,000 | 118,000 | 118,000 |
| Old Ranch Road | 3 | 50,000 | 71,000 | 71,000 | 71,000 | 72,000 | 72,000 |
| Dickson | 3 | 250,000 | (46,000) | (46,000) | (46,000) | (46,000) | (46,000) |
| Winged Foot | 3 | 600,000 | (285,000) | (285,000) | (285,000) | (285,000) | (285,000) |
| Ponti | 3 | 500,000 | (167,000) | (167,000) | (167,000) | (167,000) | (167,000) |
| San Andreas | 3 | 250,000 | (32,000) | (32,000) | (32,000) | (32,000) | (32,000) |
| Nunes | 3 | 120,000 | 84,000 | 84,000 | 84,000 | 84,000 | 84,000 |
| Buck | 4 | 500,000 | (43,000) | (43,000) | (43,000) | 19,000 | 19,000 |
| Upper Wild Horse Valley | 4 | 44,000 | (23,000) | (23,000) | (23,000) | (23,000) | (23,000) |

(1) Additional storage capacity will not be constructed in this zone. See Section 5.8.1 for discussion.
(2) Surplus storage capacity listed in parentheses.

**Table 5-7**
**Historical Comparison of Additional Storage Capacity Required**

| Tank/Pressure Zone | Zone | Total Zone Storage Capacity (gallons) | Storage Deficit (Gallons)[2] | | | |
|---|---|---|---|---|---|---|
| | | | FY 2006 | FY 2011 | FY 2013 | FY 2035 |
| Zone 1 Total | 1 | 13,850,000 | 0 | (4,742,000) | (4,644,000) | (4,139,400) |
| Primary Zone 2 Total | 2 | 16,500,000 | 0 | (9,057,000) | (7,961,000) | (7,874,400) |
| Crest | 2 | 1,000,000 | 299,000 | (404,000) | (495,000) | (426,000) |
| Black Point | 2 | 324,000 | n/a | 28,000 | 95,000 | 157,000 |
| Air Base | 2 | 1,000,000 | 406,000 | (70,000) | 216,000 | 216,000 |
| Cherry Hill | 3 | 450,000 | 0 | (2,000) | 0 | 1,000 |
| Half Moon | 3 | 100,000 | 197,000 | 150,000 | 125,000 | 126,000 |
| Wild Horse Valley/Center Rd | 3 | 1,000,000 | 0 | 313,000 | (293,000) | (291,000) |
| Garner[1] | 3 | 100,000 | 126,000 | 141,000 | 118,000 | 118,000 |
| Old Ranch Road | 3 | 50,000 | 64,000 | 188,000 | 71,000 | 72,000 |
| Dickson | 3 | 250,000 | 2,000 | (12,000) | (46,000) | (46,000) |
| Winged Foot | 3 | 600,000 | 0 | (264,000) | (285,000) | (285,000) |
| Ponti | 3 | 500,000 | 0 | (134,000) | (167,000) | (167,000) |
| San Andreas | 3 | 250,000 | 0 | 13,000 | (32,000) | (32,000) |
| Nunes | 3 | 120,000 | 0 | 107,000 | 84,000 | 84,000 |
| Buck | 4 | 500,000 | 160,000 | 159,000 | (43,000) | 19,000 |
| Upper Wild Horse Valley | 4 | 44,000 | 0 | (27,000) | (23,000) | (23,000) |
| **Total (Deficit)[3]** | | **36,638,000** | **1,254,000** | **1,099,000** | **666,000** | **793,000** |

(1) Additional storage capacity will not be constructed in this zone. See Section 5 for discussion.

(2) Surplus storage capacity listed in parentheses. No surplus data available for 2006 so those are shown as zero.

(3) These total storage deficit values for the system have not been offset by the individual zone surplus' listed. In other words, a surplus in one zone does not offset the deficit in another zone.

## 5.6 PUMPING CAPACITY EVALUATION

The pumping capacity requirements for each pressure zone for FY 2013 and buildout (FY 2035) water demands are shown below. Specific recommendations to address pumping capacity needs are presented later in this section.

### 5.6.1 FY 2013 Water Demands

Pumping capacity requirements for each pump station were assessed using geolocated billing data – this is different from the 2012 water master plan that used pump totalizer data based on the max day demands presented in Section 4 and a summation of the total demands for each subzone that the pump station serves. The maximum day pumping requirement represents the gallons per minute pumping capacity needed by each pump station to pump the maximum day demand over 16 hours, per District criterion.

### 5.6.2 Buildout Water Demands

Pumping capacity requirements by pump station are shown in Table 5-8 for each 5-year increment until buildout in FY 2035.

Significant demand increases are expected in the Crest, Bahia, and Black Point pressure zones, and the Nunes and Buck pressure zones. The pump stations affected by these demand increases are School Road, Nunes, and Buck. Other future demand is expected in the Cherry Hill, Half Moon, Wild Horse/Upper Wild Horse/Cabro Court, and Old Ranch Road pressure zones, but the total expected increases are minor in comparison.

The additional pumping capacity requirements by pressure zone for each incremental 5-year period are shown in Table 5-9.

Under current demand, only three pump stations have a pumping capacity deficiency, Lynwood, School Road, and Cherry Hill. Lynwood pump station has a deficiency of 1,321 gpm, School Road pump station has a deficiency of 126 gpm, and Cherry Hill pump station has a deficiency of 85 gpm. Recommendations to address these deficiencies are discussed later in the section.

When the two pump stations that service Primary Zone 2 are analyzed individually a deficiency is calculated at the Lynwood pump station. However, the San Marin/Trumbull and Sunset/Pacheco Subzones that make up Primary Zone 2 are hydraulically connected, and the entire pressure zone can be fed by either the San Marin or Lynwood pump stations (each of which have three 1800 gpm pumps). Therefore, the firm capacity for the combined Primary Zone 2 is five pumps at 1800 gpm each, or 9000 gpm. Analyzed in this manner, the Primary Zone 2 deficit is negated and instead shows a surplus of 762 gpm at buildout. Thus, additional pumping capacity is not required at Lynwood or San Marin pump stations.

The School Road and Cherry Hill pump stations will each have a slight increase in the pumping capacity required to meet expected demand at buildout and will be deficient at that time by approximately 236 gpm and 85 gpm, respectively.

Due to the large increase in demand in the Buck Zone anticipated after FY 2025, the Buck pump station will decrease from a pumping capacity surplus of 69 gpm under current demand to 18 gpm at buildout. The Nunes Pump Station (which passes water from Zone 2 to the Buck Pump Station) will also experience a similar decrease from a surplus of 60 gpm to 9 gpm between 2025 and 2030. The pumping capacities for these two zones should be reviewed again when specific water use data in the Buck and Nunes Zones becomes available, to ensure a deficit does not occur.

### 5.6.3 Historical Comparison

A comparison of the pumping capacity deficit from FY 2006, FY 2011, current (FY 2013), and at buildout (FY 2035) is shown in Table 5-10. It should be noted that water use demands in FY 2013 were approximately 10% greater system-wide than in FY 2011. An increase in annual demand results in greater max day pumping demands at any given pump station.

The Trumbull Pump Station no longer has a pump capacity deficit of 177 gpm as the pumps were upgraded in 2008. The station’s firm capacity was increased from 360 gpm to 680 gpm.

The School Road pumping deficit increased between FY 2011 and FY 2013 as the combined maximum day demand for the Crest, Bahia, and Black Point pressure zone increased by 32,600 gpd (approximately 7%). The Cherry Hill pumping deficit increased between FY 2011 and FY 2013 as the maximum day demand for the Cherry Hill pressure zone increased by 25,700 gpd (approximately 14%).

**Table 5-8**
**Projected Maximum Day Pump Station Demands[(1)]**

| Pump Station | Pumps to Pressure Zones[(2)] | Station Firm Capacity (gpm)[(3)] | FY 2013 Max Day Demand (gpd) | FY 2013 Max Day Demand (gpm)[(4)] | FY 2020 Max Day Demand (gpd) | FY 2020 Max Day Demand (gpm)[(4)] | FY 2025 Max Day Demand (gpd) | FY 2025 Max Day Demand (gpm)[(4)] | FY 2030 Max Day Demand (gpd) | FY 2030 Max Day Demand (gpm)[(4)] | FY 2035 Max Day Demand (gpd) | FY 2035 Max Day Demand (gpm)[(4)] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| San Marin | **SM/T Sub**, Nunes, **Buck**, Rockrose, San Andreas, Cabro, **Wild Horse/Center, Upper WH, Half Moon, Old Ranch**. | 3,600 | 3,061,536 | 3,189 | 3,061,536 | 3,189 | 3,071,957 | 3,200 | 3,109,472 | 3,239 | 3,109,865 | 3,239 |
| Lynwood | **S/P Sub**, Garner, Garner Hydro, Dickson, Indian Hills, Eagle, Winged Foot, Air Base, Ponti. | 3,600 | 4,723,764 | 4,921 | 4,723,764 | 4,921 | 4,739,843 | 4,937 | 4,797,728 | 4,998 | 4,798,335 | 4,998 |
| **Primary Zone 2 Total[(5)]** | | **9,000[(6)]** | **7,785,300** | **8,110** | **7,785,300** | **8,110** | **7,811,800** | **8,137** | **7,907,200** | **8,237** | **7,908,200** | **8,238** |
| School Road | **Crest, Bahia & Black Pt** | 400 | 504,500 | 526 | 504,500 | 526 | 504,500 | 526 | 610,500 | 636 | 610,500 | 636 |
| Cherry Hill | **Cherry Hill** | 140 | 215,600 | 225 | 215,600 | 225 | 215,600 | 225 | 216,300 | 225 | 216,300 | 225 |
| Ridge Road | **Half Moon** | 80 | 35,400 | 37 | 35,400 | 37 | 35,400 | 37 | 36,200 | 38 | 36,200 | 38 |
| Trumbull | **Wild Horse/Center, Upper Wild Horse,** Cabro Ct | 680 | 442,600 | 461 | 442,600 | 461 | 442,600 | 461 | 444,900 | 463 | 444,900 | 463 |
| Truman | Garner & Garner Hydro | 75 | 39,600 | 41 | 39,600 | 41 | 39,600 | 41 | 39,600 | 41 | 39,600 | 41 |
| Davies | **Old Ranch Rd** | 50 | 16,200 | 17 | 16,200 | 17 | 16,200 | 17 | 17,400 | 18 | 17,400 | 18 |
| Woodland Heights | Dickson | 110 | 93,200 | 97 | 93,200 | 97 | 93,200 | 97 | 93,200 | 97 | 93,200 | 97 |
| Winged Foot | Winged Foot | 150 | 107,300 | 112 | 107,300 | 112 | 107,300 | 112 | 107,300 | 112 | 107,300 | 112 |
| Ponti | Ponti | 250 | 121,700 | 127 | 121,700 | 127 | 121,700 | 127 | 121,700 | 127 | 121,700 | 127 |
| San Andreas | San Andreas | 110 | 29,900 | 31 | 29,900 | 31 | 29,900 | 31 | 29,900 | 31 | 29,900 | 31 |
| Nunes | Nunes & **Buck** | 110 | 48,000 | 50 | 48,000 | 50 | 48,000 | 50 | 97,200 | 101 | 97,200 | 101 |
| Buck | **Buck** | 100 | 29,300 | 31 | 29,300 | 31 | 29,300 | 31 | 78,500 | 82 | 78,500 | 82 |
| Wild Horse | **Upper Wild Horse** | 50 | 16,700 | 17 | 16,700 | 17 | 16,700 | 17 | 16,800 | 18 | 16,800 | 18 |

(1) Demand increase per pressure zone presented in Section 4.
(2) Pressure zones with expected demand increase are shown in bold.
(3) Pump station capacity with largest pump out of service.
(4) Calculated as maximum day demand pumped over 16 hours per day per District criterion.
(5) As San Mateo/Trumbull and Sunset/Pacheco Subzones are hydraulically connected and it is relevant to analyze them as a single zone. Firm capacity for Primary Zone 2 Total is 9,000 gpm (5 pumps at 1,800 gpm each).
(6) The primary zone 2 totals were from metered data listed in section 4. The split between San Marin & Lynwood PS is per the ratio of San Marin & Lynwood pumping data listed in table 5-9 of the 2012 WMP.

**Table 5-9**
**Additional Pumping Capacity Required**

| Pump Station | Pumps to Pressure Zones[1] | Station Firm Capacity (gpm)[2] | Additional Pumping Capacity Required [4] FY 2013 (gpm) | FY 2020 (gpm) | FY 2025 (gpm) | FY 2030 (gpm) | FY 2035 (gpm) |
|---|---|---|---|---|---|---|---|
| San Marin | **SM/T Sub**, Nunes, **Buck**, Rockrose, San Andreas, Cabro, **Wild Horse/Center, Upper WH, Half Moon**, **Old Ranch** | 3,600 | (411) | (411) | (400) | (361) | (361) |
| Lynwood | **S/P Sub**, Garner, Garner Hydro, Dickson, Indian Hills, Eagle, Winged Foot, Air Base, Ponti | 3,600 | 1,321 | 1,321 | 1,337 | 1,398 | 1,398 |
| Primary Zone 2 Total[3] | | 9,000[3] | (890) | (890) | (863) | (763) | (762) |
| School Road | **Crest, Bahia & Black Pt** | 400 | 126 | 126 | 126 | 236 | 236 |
| Cherry Hill | **Cherry Hill** | 140 | 85 | 85 | 85 | 85 | 85 |
| Ridge Road | **Half Moon** | 80 | (43) | (43) | (43) | (42) | (42) |
| Trumbull | **Wild Horse/Center, Upper Wild Horse,** Cabro Ct | 680 | (219) | (219) | (219) | (217) | (217) |
| Truman | Garner & Garner Hydro | 75 | (34) | (34) | (34) | (34) | (34) |
| Davies | **Old Ranch Rd** | 50 | (33) | (33) | (33) | (32) | (32) |
| Woodland Heights | Dickson | 110 | (13) | (13) | (13) | (13) | (13) |
| Winged Foot | Winged Foot | 150 | (38) | (38) | (38) | (38) | (38) |
| Ponti | Ponti | 250 | (123) | (123) | (123) | (123) | (123) |
| San Andreas | San Andreas | 110 | (79) | (79) | (79) | (79) | (79) |
| Nunes | Nunes & **Buck** | 110 | (60) | (60) | (60) | (9) | (9) |
| Buck | **Buck** | 100 | (69) | (69) | (69) | (18) | (18) |
| Wild Horse | **Upper Wild Horse** | 50 | (33) | (33) | (33) | (33) | (33) |

[1] Pressure zones with expected demand increase are shown in bold.
[2] Pump station capacity with largest pump out of service.
[3] As San Mateo/Trumbull and Sunset/Pacheco Subzones are hydraulically connected it is relevant to analyze them as a single zone. Firm capacity for Primary Zone 2 Total is 9,000 gpm (5 pumps at 1,800 gpm each).
[4] Surplus pumping capacity listed in parentheses.

**Table 5-10**
**Historical Comparison of Additional Pumping Capacity Required**

| Pump Station | Pumps Directly to Pressure Zone | Station Firm Capacity (gpm)[1] | Pump Station Deficit [4] | | | |
|---|---|---|---|---|---|---|
| | | | FY 2006 (gpm) | FY 2011 (gpm) | FY 2013 (gpm) | FY 2035 (gpm) |
| San Marin & Lynwood | Primary Zone 2 [2] | 9,000 | 221 | (1802) | (890) | (762) |
| School Road | Crest | 400 | 180 | 86 | 126 | 236 |
| Cherry Hill | Cherry Hill | 140 | 70 | 58 | 85 | 85 |
| Ridge Road | Half Moon | 80 | 0 | (47) | (43) | (42) |
| Trumbull | Wild Horse Valley / Center Rd. | 680 | 177 | (184) | (219) | (217) |
| Truman | Garner | 75 | 0 | (38) | (34) | (34) |
| Davies | Old Ranch Rd | 50 | 0 | (117) | (33) | (32) |
| Woodland Heights | Dickson | 110 | 0 | 5 | (13) | (13) |
| Winged Foot | Winged Foot | 150 | 0 | (45) | (38) | (38) |
| Ponti | Ponti | 250 | 0 | (121) | (123) | (123) |
| San Andreas | San Andreas | 110 | 0 | (66) | (79) | (79) |
| Nunes | Nunes & Buck | 110 | 0 | (72) | (60) | (9) |
| Buck | Buck | 100 | 0 | (76) | (69) | (18) |
| Wild Horse | Upper Wild Horse | 50 | 0 | (36) | (33) | (33) |
| | **Totals [3]** | **11,305** | **648** | **149** | **210** | **321** |

[1] Pump station capacity with largest pump out of service.
[2] Firm capacity for hydraulically connected Zone 2 is 5 pumps at 1800 gpm each.
[3] These total storage deficit values for the system have not been offset by the individual zone surplus' listed. In other words, a surplus in one zone does not offset the deficit in another zone.
[4] Surplus pumping capacity listed in parentheses.

## 5.7 PUMPING EFFICIENCY EVALUATION

The pumping efficiency evaluation is summarized below.

### 5.7.1 Specific Energy and Unit Cost

By using pump totalizer and PG&E billing data from FY 2014 through FY 2017, an average specific energy and unit cost has been calculated for each pump station. These results are presented in Table 5-11.

### 5.7.2 Overall Pumping Efficiency

In May of 2018 the District had "Pump Efficiency Testing Services, PETS" test the pumps in four pump stations. The overall pumping efficiency that PETS found for each pump is presented in Table 5-12.

**Table 5-11**
**Pumping Specific Energy & Unit Cost**

| Pump Station | Specific Energy (gal/kWh) | Unit Cost[1] ($/MG) |
|---|---|---|
| San Marin | 1,413 | $124.67 |
| Lynwood | 1,220 | $144.51 |
| School Road | 1,896 | $95.78 |
| Cherry Hill | 613 | $293.42 |
| Ridge Road | 897 | $268.35 |
| Trumbull | 835 | $218.04 |
| Truman | 1,305 | $188.04 |
| Woodland Heights | 1,612 | $142.76 |
| Winged Foot | 840 | $382.98 |
| Ponti | 1,171 | $161.61 |
| San Andreas | 812 | $287.37 |
| Nunes | 1,332 | $185.15 |
| Buck | 754 | $327.76 |
| Wild Horse | 1,156 | $266.11 |
| Eagle | 1,350 | $204.12 |
| Bahia | 1,200 | $188.63 |
| Rock Rose | 1,578 | $218.65 |

[1]Average values from 2014 through 2017 pump totalizer and PG&E billing data.

**Table 5-12**
**Tested Pumping Efficiency**

| Pump Station | Nominal HP of each pump | Overall Pump Efficiency [1] | | |
|---|---|---|---|---|
| | | P1 | P2 | P3 |
| Lynwood | 100 | 59% | 62% | 64% |
| San Marin | 100 | 70% | 70% | 71% |
| Trumbull | 25 | 55% | 58% | 54% |
| School Rd | 30 | 45% | 45% | N/A |

[1] Pumps tested 5-30-2018 by "Pumping Efficiency Testing Services, PETS"

## 5.8 CONCLUSIONS AND RECOMMENDATIONS

The recommended improvements to address current and future storage and pumping capacity deficiencies and are summarized below. Conclusions and recommendations related to pump efficiency follow. Specific project recommendations are listed in Sections 9 and 10.

### 5.8.1 Storage Capacity Improvements

Specific improvements to address pressure zones with inadequate storage capacity are presented below. Other pressure zones not specifically listed require no improvements.

**Zone 1**

Zone 1 currently has a substantial surplus of storage capacity. Although the analysis indicates that the North Novato Subzone is deficient in storage capacity, the combined total Zone 1 storage capacity yields a surplus through 2035. If demands increase as projected, the combined Zone 1 zones will be in surplus at buildout and no additional storage is needed in Zone 1.

**Air Base Zone**

In the Air Base Zone, the current storage capacity deficiency is primarily due to the fire flow storage requirement of 630,000 gallons. Although development is not expected to increase storage capacity required at buildout, the construction of additional storage capacity may be required.

**Half Moon Zone**

In the Half Moon Zone, the current storage capacity deficiency is primarily due to the fire flow goal of 1500 gpm for 2 hours and the resulting storage requirement of 180,000 gallons. The District has confirmed fire flows in the system to be approximately 1,300 gpm. The NFPD is conducting its own fire fuels management program with homeowners in the area. The 1999 Zones 3 and 4 Storage Capacity Evaluation recommended construction of a new 300,000 gallon tank to replace the existing 100,000 gallon tank on the same site. These recommendations presented in the 1999 evaluation have proved challenging to implement due to a constrained site and no vacant land available for sale in the area. Therefore, the addition of storage capacity in this zone may not be feasible.

**Garner Zone**

In the Garner Zone, the storage capacity deficiency is primarily due to the fire flow goal of 1500 gpm for 2 hours and the resulting storage requirement of 180,000 gallons. The District has confirmed flows between 775 and 1,000 gpm within the zone in limited testing. Although fire storage capacity cannot be maintained in the existing tank, the zone does have over three days of maximum day demand in storage capacity. This site has a relatively small tank with limited access and space for additional facilities. There are no other feasible sites, and the Garner Zone serves only small demands. Previous discussions with NFPD concluded that most homes within this zone are sprinkled and they have indicated that funds for storage construction would be better spent on older facilities requiring upgrades. Construction of additional storage capacity cannot be accomplished cost-effectively in this zone, therefore no additional action is recommended.

**Old Ranch Road Zone**

The Old Ranch Road Zone serves only thirteen homes in a remote forested area. The existing storage tank is an old redwood tank built in the early 1960's. Based on September 2018 discussion with the NFPD chief and fire marshal, it was agreed that the standard 1,500 gpm at 2-hour duration was not feasible given the limited existing development, and the fire storage requirement was set at 100,000 gallons. The existing 50,000 gallon redwood tank is scheduled for replacement by FY 2025. New future development may warrant additional storage requirement beyond the planned 100,000 gallons.

The District has confirmed fire flow of approximately 850 gpm in the area in limited testing. The fire hydrant at the highest elevation on the main line has a lower fire flow. As with the Half Moon Zone, NFPD conducts its own fire fuel management program with the homeowners in the immediate vicinity of this fire hydrant.

**Nunes Zone**

The Nunes Zone fire flow has been updated to the standard WUI fire flow goal of 1500 gpm for 2 hours with a resultant 180,000 gallons of required fire storage. In this small system with little operational demands, the fire storage is now 83% of the total storage requirement. It is recommended that instead of additional storage capacity construction, a fire flow backfeed valve, or control valve be installed at the tank site so higher pressure Buck System water can be utilized for fire protection purposes. A solenoid operated control system similar to the ones installed at the Paradise Ranch Estates Pump Stations in the District's West Marin water system is advised.

### 5.8.2 Pumping Capacity Improvements

Specific improvements to address pump station capacity deficits are presented below. Other pump stations not specifically listed require no improvements.

**Lynwood and San Marin Zone 2 Pump Stations**

Although the Lynwood pump station shows a deficiency at buildout, the combined Primary Zone 2 has a surplus pumping capacity.

Since approximately 55 percent of the total Novato Water System demand passes through these two Zone 2 pump stations, it is imperative that these stations operate efficiently and cost-effectively. For the FY 2013 baseline scenario evaluated, 55 percent of the total Primary Zone 2 demand is in the northerly San Mateo/Trumbull Subzone. Yet, when reviewing pump totalizer data for FY 2017 the southerly Lynwood pump station pumps 61 percent more water annually than the San Marin pump station (850 mg compared to 550 mg) due to the demands in the higher zones for which water passes through from Zone 2. The District may want to study this issue in more depth to determine if more pumping capacity is needed at the Lynwood pump station.

In 2001, the District initiated time-of-use pumping at both pump stations. The program has resulted in over 5% energy savings annually. The district will continue to work with PG&E and Marin Clean Energy to further optimize the program to reduce energy consumption and pumping cost. Should the time-of-use operation continue to be standard operation, the District may desire to add pumping capacity at the two stations to increase firm capacity.

### School Road Pump Station

The School Road Pump Station has a pumping capacity deficit of approximately 125 gpm, which is over one-quarter of the pump station's firm capacity. At buildout, the deficiency increases to 236 gpm. The alternative to increasing pumping capacity at the School Road Pump Station is the District's plan to construct a new pump station on Bahia Drive, now that construction of the new Crest Tank has been completed. This new station will be sized to meet buildout demands and will eliminate the need for the existing station.

### Cherry Hill Pump Station

The Cherry Hill Pump Station has a pumping capacity deficit of approximately 85 gpm at buildout. There is adequate storage capacity in this zone, and it may not be necessary to construct additional pumping capacity. The District should monitor future demand in the Cherry Hill zone and reevaluate the pumping capacity analysis.

### Nunes and Buck Pump Stations

Although both Nunes and Buck Pump Stations currently have sizable pumping capacity surpluses, both pump stations will experience decreases in this surplus due to the projected demand increase in the Buck Zone after FY 2025. The anticipated demand increase results in only a small pumping capacity surplus at buildout for these pump stations, 9 gpm at Nunes pump station and 18 gpm at Buck pump station. As with the storage capacity, the final pumping capacity needed should be determined after final approval of the development and any needed pump station improvements should be constructed with the new development.

## 5.8.3 Pumping Efficiency Conclusions & Recommendations

Results from individual pump tests can help the District reduce cost of operations by optimizing pump sequencing logic at a particular pump station. This is accomplished by designating the most efficient pump to always serve as the lead duty pump, rather than rotating all pumps in an attempt to balance runtime across all pumps. Optimizing pump sequencing in this manner is preferred over balancing runtime for three reasons:

- There is a direct relationship between OPE and the recurring cost of operations
- The present value cost of operations (e.g. monthly energy usage) is usually much greater than the capital costs required for rebuilds and replacements
- Measurements of OPE are also a good indicator of overall pump condition, so selecting the most efficient pump as the lead unit in the pump sequencing logic also enhances pump station reliability

Similarly, measurements of actual OPE can be compared against published values to assess the physical condition of the pump/motor system and timing of replacements or rebuilds. This information can be used together with the pump station’s other performance metrics i.e. specific energy and unit cost of pumping, to evaluate the potential cost savings that could be realized with an upgrade project. Also, monitoring of specific energy at a pump station before and after a change allows the District to measure and predict the energy and cost benefits of optimizing pump sequencing logic or a pump upgrade. This information provides the District with the tools needed to identify facilities that would yield the greatest benefit from capital investments.

More recently, specialized process controllers have been developed to optimize pump station energy usage. This is accomplished by continuously monitoring pump performance and evaluating optimal speed settings and sequencing logic for individual pumps in real time. This device and the algorithms that run it are the pump-station equivalent to the engine-control unit on automobile engines.

As a result of the Tubbs and Nunes fires in October of 2017, several operational changes have been implemented that will impact NMWD Operations as it relates to pumping and storage, in the following two ways: first, when “red flag” warnings are issued by state and local fire protection agencies NMWD will switch from the normal “Time Of Use” mode of operations (which limits pumping during peak energy rate times) to a mode which ignores the time of day and cost of energy to instead maximize tank storages. Secondly, in an effort to limit fire risk PG&E is planning on de-energizing their systems during high fire potential events – it is unclear how exactly this will impact pumping operations but NMWD will coordinate with PG&E to manage District tank levels during these outage events.

# SECTION 6

# WATER QUALITY EVALUATION

# SECTION 6

# WATER QUALITY EVALUATION

## 6.1 INTRODUCTION

Ensuring water quality is one of the primary goals of the District, and was listed in the District's 2018 Strategic Plan as an ongoing need. Policy supports this goal with Board and management commitment to meeting or exceeding all US Environmental Protection Agency (EPA) and California Water Board Division of Drinking Water (DDW) regulatory requirements. Water quality is monitored by the Water Quality Division whose responsibility is to provide oversight to all District activities as they relate to water quality.

Section 6 presents information on the current water quality, and provides recommendations for operational modifications and capital improvements related to water quality in the Novato Water System.

## 6.2 CURRENT WATER QUALITY

### 6.2.1 Source Water Quality

The two water supply sources for the Novato Water System have different physical quality characteristics. Stafford Lake water is a surface water supply with high levels of naturally-occurring organics that exhibit a high oxidant demand and that has potential to produce high levels of disinfection by-products (DBPs). Stafford Lake water is also subject to taste and odor problems due to algae growth in the lake. In 2015, NMWD contracted SRT Consultants to undertake a review of factors influencing algal growth and to formulate a comprehensive strategy for addressing taste and odor. SCWA water is a ground water supply that originates deep within the aquifer of the Russian River. Well supplies adjacent to and which augment the Russian River supply contain iron and manganese, hydrogen sulfide, and other aesthetically problematic constituents. The SCWA supply is naturally low in organics and requires minimal disinfection to maintain a disinfectant residual. The total DBP formation potential with conventional oxidation using free chlorine is greater in the raw Stafford supply than in SCWA supply.

Comparison of the major constituents of the Stafford and SCWA treated water supplies is shown in Table 6-1.

**Table 6-1**
**Source Water Quality Comparison**

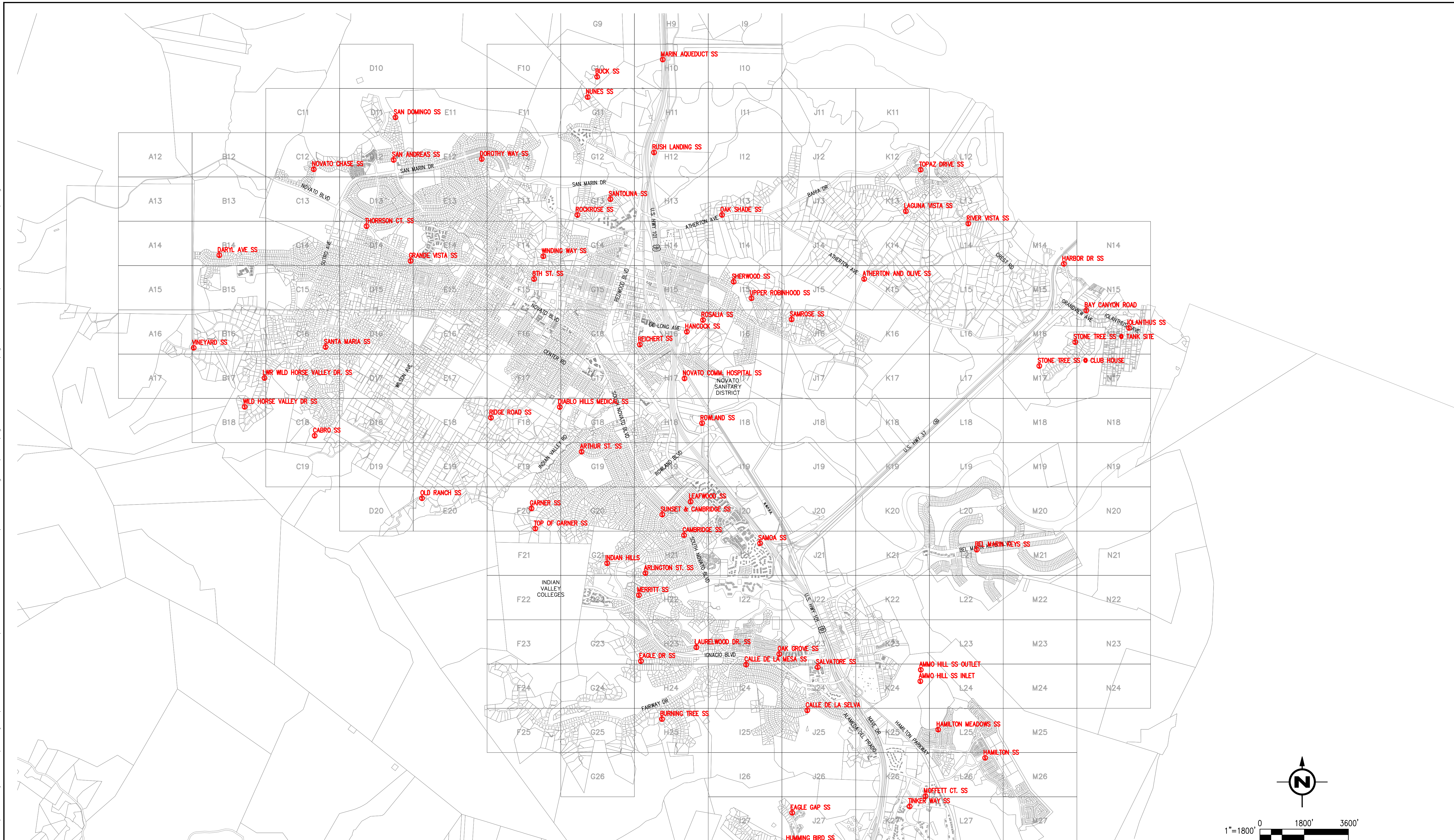
| Constituent | SCWA Russian River Supply | Stafford Treatment Plant |
|---|---|---|
| Trihalomethanes | 10-50 | 10-45 |
| Haloacetic Acids | 5-20 | 5-25 |
| Total Organic Carbon (TOC) | <1-2 | 2-3.5 |
| Assimilable Organic Carbon (AOC) | Low | Low-Med |
| Chlorine Demand | Low | Low |
| T&O problems | Rare/slight | Infrequent/ moderate |
| Turbidity | 0.10 avg | 0.09 avg |
| pH | 8.2 – 8.4 | 8.0-8.9 |
| Hardness | 100 - 130 | 100 - 120 |
| Conductivity | 240-303 | 278-315 |
| Corrosion Potential | Non-corrosive | Non-corrosive |

ND = Non-detectable

### 6.2.2 Existing Distribution System Water Quality

Under typical conditions, operation of the STP occurs from approximately May through October on daily 16 to 24 hour shifts. During this time, 3.5 to 5.5 MGD of water is typically delivered to Zone 1. During peak production periods, STP water could account for up to 40 percent of water produced in the system. STP finished water has comparable chlorine demand and a slightly lower DBP formation potential than water from SCWA.

NMWD has a number of distribution system programs to maintain water quality. These programs include the installation of chlorine booster stations, augmenting storage tanks with chlorine on an as needed basis, and implementing a seasonal flushing program. Monitoring of chlorine and heterotrophic plate counts provides feedback to the successful operation of these programs. The District currently has 70 water quality monitoring locations as shown on Figure 6-1. The above-mentioned programs have contributed to significant improvements in maintaining adequate chlorine residual in the distribution system and resulting water quality.




NORTH MARIN WATER DISTRICT
NOVATO, CALIFORNIA

2018 WATER MASTER PLAN

FIGURE 6-1
SAMPLE STATION LOCATION MAP

The formation of DBPs is a critical issue that is a current focus of public health regulations. The Novato Water System has never had a violation of regulatory limits for DBPs and is in compliance with the 2009 Disinfection byproduct Rule, Stage 2 standard for THMs of 80 ug/L reported as running annual averages at each location sampled. STP water has a slightly lower DBP formation potential than SCWA water. DBPs are monitored at the entrance to the Novato distribution system and at eight distribution sample sites shown on Figure 6-1. The regulations have focused on DBPs in areas of the distribution system with higher water age because DBPs increase with contact time and chlorine concentration. Additional tabular information on sample stations across the Novato service area can be found in Appendix B.

Water age can also aggravate problems associated with high chlorine demand. Storage reservoirs hold large quantities of water for emergency and fire suppression requirements for long periods. Dead-end mains with low-water usage can also increase the age of water held in the pipe. Efforts to lower water elevations in tanks on a frequent basis are limited by the storage requirements. Looping mains to minimize dead-end pipes is practiced where possible. In many cases, looping is not possible.

### 6.2.3 Water Quality Impacts Related to System Dynamics

Water quality in the Novato Water System is related to the distribution system operation dynamics, i.e., how water is delivered to customers. A discussion of water quality dynamics of each zone is presented below.

### 6.2.4 Zone 1

Zone 1 is served with both Stafford and SCWA supplies. Stafford water enters from the west via a transmission pipeline that runs along Novato Boulevard. The SCWA water is fed to Zone 1 via the North Marin Aqueduct that enters at the north end of the system at Redwood Boulevard and San Marin Drive as well as the Frosty Lane intertie. The Stafford and SCWA supplies have an opportunity to blend in Zone 1 based on Stafford output and customer demand. On days of high Stafford production and low demand, Stafford water can be delivered to the southern part of Zone 1 and will be pumped to Zone 2 via the Lynwood Pump Station. Stafford water has been similarly observed in the Crest and Cherry Hill pressure zones.

### 6.2.5 Zone 2

In Novato, five pump stations pump from Zone 1 to three separate Zone 2 areas and two hydropneumatic systems. The two main Zone 2 areas are served by Lynwood and San Marin Pump Stations and the independent Crest pressure zone is served by the School Road Pump Station. Hayden and Diablo Hills Pump Stations feed their independent hydropneumatic systems.

The Lynwood and San Marin Pump Stations pump to the largest of the three Zone 2 systems. The water in the San Mateo/Trumbull Zone is primarily SCWA water as the San Marin Pump Station pumps directly from the aqueduct. The water in the Sunset/Pacheco Zone is a mix of SCWA and Stafford water, depending on the flow from SCWA and the status of the Stafford WTP. Because of system hydraulics, Stafford water does migrate into the southern portion of San Mateo/Trumbull Zone.

The School Road pump station pumps water from the eastern side of Zone 1 to the Crest pressure zone. Water can be either completely SCWA supply or a blend of SCWA and Stafford water, depending on the status of the treatment plant.

The Air Base Tank distribution system in South Novato takes water from the Pacheco/Sunset area of Zone 2. Water quality conditions in this area are similar to the southern area of Zone 2.

Hayden and Diablo Hills are both small, intermediate zone pressure tank systems, located in central Novato. Both hydropneumatic systems can be filled with either SCWA water or a blend of SCWA and Stafford water, depending on the status of the treatment plant.

Additionally, two small second zone areas exist north of Novato. San Antonio pump station pumps to San Antonio tank, serving the Institute of Noetic Sciences. Windhaven Pump Station and tank serve several houses on Windhaven Road. Both of these isolated zone 2 areas are served from the North Marin Aqueduct.

### 6.2.6 Zone 3

Thirteen independent Zone 3 systems receive water from Zone 2, including four hydropneumatic systems. The Cherry Hill Zone obtains water directly from Zone 1, and can be a blend of both SCWA and Stafford water, depending on the status of the treatment plant. Several lower elevation areas are served from the Cherry Hill system by pressure reducing stations. In addition, two other Zone 3 systems, Windhaven and San Antonio, are served directly from the North Marin Aqueduct, north of Novato.

All Zone 3 pressure zones are currently subject to low chlorine residuals. This is due entirely to water age. Low chlorine residuals are a concern because an active residual provides protection from bacterial growth or a contamination event.

The Cherry Hill Zone had been problematic due to low chlorine residuals which lead to high heterotrophic plate counts (See the discussion under the Surface Water Treatment Rule section herein). The installation of a chlorine booster pump at the Cherry Hill Pump Station was moderately successful in controlling the problem. Due to high maintenance requirements use of the chlorinator was discontinued in 2001, though the tanks are still monitored for CL2 residual and Cl2 is added as needed. Additional development in the area along with the extension of the Cherry Hill pipeline to Rosalia Drive increased demand, lowered water age and increased chlorine residual. These changes to the plumbing of this system have greatly improved water quality. Other contributing factors to improved water quality include adjusting set points for greater turnover in the tanks.

### 6.2.7 Zone 4

Four pump stations pump from Zone 3 to three independent Zone 4 systems and one hydropneumatic system. The Zone 4 systems in the Novato water system are all subject to degradation of water quality due to water age resulting from extreme distance from water sources and the associated loss of chlorine residual. Bacterial growth can be a problem during periods of higher temperature and low demand. Water in all Novato Zone 4 storage tanks is routinely monitored for chlorine concentration by operators and often tab-chlorinated if required.

## 6.3 DRINKING WATER REGULATIONS AND NMWD MONITORING PROGRAMS

The District operates the Novato Water System under an operating permit issued by DDW. DDW is responsible for enforcing both State and Federal (United States Environmental Protection Agency, USEPA) drinking water regulations as a “primacy” State. NMWD’s operating permit requires compliance with all State and Federal drinking water regulations and imposes several additional operating and monitoring conditions.

Discussion follows on the drinking water regulations and permit conditions that are most significant in regards to distribution system water quality. The purpose of the regulation, NMWD’s response and review of issues for the Novato community is addressed for each:

- Surface Water Treatment Rule (SWTR)
- Coliform Rule
- Disinfection By-Product Rules (DBP I and II)
- Long Term Enhanced SWTR and Filter Backwash Rule
- Lead and Copper Rule
- Cross Connection Control
- Other regulations and permit conditions
- Other NMWD programs and emerging issues

### 6.3.1 Surface Water Treatment Rule (SWTR)

- *Purpose of rule*:
  Assure surface water treatment (STP) disinfection and microbial removal process is effective.

- *Monitoring requirement*:
  Each routine sampling collected under the total coliform rule must include a test for disinfectant residual. If no residual is detected, a heterotrophic plate count (HPC) for bacterial growth may be substituted. If less than 500 colony forming units per milliliter are found, it is considered equivalent to a measurable residual.

- *NMWD response*:
  Prior to 1991, NMWD used the presence of chlorine in water as it entered the distribution system as the evidence of disinfection. After the promulgation of the SWTR, NMWD initiated chlorine monitoring at each routine coliform sample site. Monitoring is conducted as described above including the substitution for HPC as appropriate.

- *Issues*:
  Currently, NMWD uses detection of total combined chlorine as a trigger for regulatory HPC testing rather than free chlorine. This change was initiated after a discussion of SWTR requirements with the DDW District Engineer. HPC testing is still performed when free chlorine drops to non-detectable levels but the information is used as an operational control factor and is not reported as a regulatory requirement.

  NMWD’s goal is that all tanks in the system are monitored for chlorine residual weekly. Manual addition of chlorine to tanks occurs as needed, to maintain acceptable levels of residual throughout the system.

### 6.3.2 Coliform Rule

- *Purpose of rule:*
  Assure pathogenic microbial growth is not present in water supply.

- *Monitoring requirement:*
  Every separate hydraulic zone of water, as represented by a tank or pressure system, must be monitored monthly. DDW requires a minimum of 18 samples to be collected per week based on our population served.

- *NMWD response:*
  Currently, 56 samples sites are identified in the NMWD Coliform Sampling Plan. NMWD has structured a sampling program that provides for sampling 18-19 sites on three separate routes, each sampled every three weeks.

- *Issues:*
  Historically the District relied on customer taps for sample sites. Finding suitable representative sample sites among residential and business taps was difficult. A standard sampling station design was developed and now 70 permanent, District-owned, sample stations are situated throughout the hydraulic zones and distributed in accordance with representing the zone's population density.

### 6.3.3 Disinfection By-Product Rules

- *Purpose of rules*:
  Minimize health effects related to chemicals formed during the disinfection process.

- *Monitoring requirement:*
  Distribution sampling is required on a quarterly basis at eight locations for total trihalomethanes and haloacetic acids. Compliance is based on locational running annual average. Locations were determined by conducting an Initial Distribution System Evaluation (IDSE) using a number of factors including results from increased system wide monitoring for one year, residence time, and population distribution.

  Daily monitoring is required at the entrance of the distribution system for chlorite and chlorate and monthly monitoring at an additional 3 locations in the distribution system. Any sample at the entrance of the distribution system with a chlorite concentration above 1.0 mg/L triggers sampling at the 3 locations in the distribution system within 24 hours.

- *NMWD response*:
  NMWD has monitored for THMs since 1978 and Haloacetic Acids (HAAs) since 1999. Both SCWA supply and STP (post rehab) have low DBP levels. Due to high total organic carbon (TOC)in Stafford Lake, prior to rehabilitation of the Stafford Treatment Plant, finished water had high levels of TTHMs which occasionally exceeded 100ug/l. Due to blending with SCWA water and seasonal operation of STP, the District never exceeded the Stage I EPA standard. In addition, the Stafford Treatment Plant was operated to minimize DBP formation by minimizing the chlorine pre-oxidant dose. New processes in place after the Stafford rehabilitation project have drastically reduced DBP formation. DBP concentrations are now similar to SCWA supply as a result.

The rule also requires a minimum reduction of TOC in treatment based on the TOC concentration in raw water and alkalinity. NMWD routinely exceeds the removal requirement.

The MCL for chlorite is 1.0 mg/L; compliance is based on an average of the 3 distribution system samples. There is no MCL for chlorate but it has been included for several years as a candidate for regulation by the EPA.

- *Issues*:
  Use of chlorine dioxide as a replacement for chlorine as a pre-oxidant is a primary factor for the reduction of formation potential at STP, as well as improved coagulation and removal of DBP precursors prior to chlorine addition. The use of chlorine dioxide requires additional monitoring of chlorite and chlorate as DBPs.

  There is a conflict in simultaneous compliance with maintaining an adequate chlorine residual and keeping DBPs as low as possible. Other water utilities have converted to chloramines to lower DBPs while maintaining a disinfectant residual in the distribution system. Conversion to chloramines by NMWD would require both water supply sources to be treated, and is not necessary under current standards.

  The process used in chlorine dioxide generation at STP requires chlorine gas. Chlorine gas is difficult to work with and caries additional permit requirements and procedures for safety. Alternative pre-oxidants exist (such as ozone) that would not require the use of chlorine gas and may have other positive characteristics; the district may consider studying modifications at STP to use these alternatives.

### 6.3.4 Long Term Enhanced Surface Water Treatment Rule Stage II (LT2) and Filter Backwash Rule

- *Purpose of rule*:
  LT2 enhances water quality by tightening treatment standards to provide removal of *Cryptosporidium*, a small parasite that resists standard disinfection methods. The Filter Backwash Rule identifies plant operational performance measures to assure *Cryptosporidium* cysts are removed in any recycle returned to the plant process.

- *Monitoring requirement:*
  Based on results of monitoring for cryptosporidium and E. Coli required by LT2 the district has been placed in “Bin 2” for compliance. Bin 2 water providers are required to achieve an additional 1 log removal of cryptosporidium in treatment.

- *NMWD response:*
  The STP rehabilitation project specifically addressed compliance with these new rules by being able to meet filter performance standards which target the removal of *Cryptosporidium* oocysts and separates waste streams to exclude unpermitted recycling.

  Watershed source controls have been identified to augment the overall program by reducing the potential for *Cryptosporidium* to enter the lake. This is accomplished by working with local agricultural interests to reduce impacts of agricultural run-off on lake water quality.

- *Issues:*
  A component in the reduction of *Cryptosporidium* that should not be overlooked is watershed controls. This is one of the elements in the “tool box” proposed by the LT2 guidance. Implementing watershed controls and maintaining *Cryptosporidium* below certain levels is a protective measure that can take the place of increased levels of treatment. Monitoring of the Stafford Lake supply has resulted in finding few *Cryptosporidium* cysts over the past several years. Existing controls, including riparian fencing, erosion control and dairy waste management, may be credited for this performance. Future water quality could be impacted by modification of practices and land use by watershed landowners. The District maintains a hands-on approach and provides incentives for watershed landowners or lessees to implement best management practices.

  The watershed controls that have been identified for reducing microbial contaminants also reduce TOCs and nutrients that specifically trigger algal growth. Reduction in lake TOC will reduce both DBPs and chlorine demand in the finished water. If TOC is allowed to increase, more frequent replacement cycles for the GAC adsorption filters at Stafford Treatment Plant will continue to add to the cost of purification. TOC and nutrients can be used to measure effectiveness of watershed controls as a surrogate for *Cryptosporidium* monitoring.

### 6.3.5 Lead & Copper Rule

- *Purpose of rule:*
  Reduce corrosion of lead and copper in consumer plumbing.

- *Monitoring requirement:*
  Sixty residences have been identified to test for lead and copper. Currently, NMWD is under a reduced monitoring program of 30 residences every three years. Biweekly pH monitoring is required for water entering the distribution system. Compliance is established by maintaining a pH greater than or equal to 8.0 in the Novato distribution system.

- *Issues:*
  Stafford water has always been pH-controlled. SCWA initiated pH control in 1995 after distribution monitoring by water contractors indicated copper concentrations above action levels. Sodium hydroxide is used to control pH at both Stafford and SCWA. Alternative corrosion control treatments have been evaluated by SCWA. No pH control is currently used by SCWA for their auxiliary well supplies.

  Customer calls related to green staining and metallic copper after-taste have essentially disappeared with SCWA’s pH control practice.

  Changes in water pH and the presence of bromide can impact types of DBP formed. Studies are being conducted at the national level to compare risk factors of different DBP species that make up the THM and HAA standards. Future regulations may use a risk-based approach. The impact of pH on risk factors could cause a reevaluation of copper control by pH adjustment.

Some of the older valves in the distribution system, such as those associated with older fire service assemblies, have lead weights. These valves are being removed from the system as repairs are identified. The Novato distribution system has no lead service lines.

### 6.3.6 Cross-Connection Control

- *Relationship to Water Quality:*
  Contamination of a treated water supply within the distribution system due to cross-connection/backflow conditions is a primary concern. California regulations require that all water suppliers maintain a cross-connection control program with specific required elements including identifying those customers for which backflow control devices are indicated based on their on-site use, annual testing of devices and certification of personnel.

  North Marin has experienced cross-connection events in the distribution system. There have been several cases where soda-dispensing systems (soft drinks) have allowed carbonated water to backflow, causing copper leaching. The most serious cross-connection case was during a 1995 District test of a fire relay system involving use of a Novato Fire Protection District pumper truck to supply water to a higher pressure system zone. A surfactant in the fire pumper truck tank contaminated the zone.

  Other cross-connection events may not have been recognized and reported. Close compliance with the District program remains the strongest protection.

- *The North Marin Water District Program:*
  The current NMWD cross-connection program is the responsibility of the Maintenance Division. The responsibility includes identification of hazards within the system, and assuring compliance with NMWD regulation 6 and Title 17, California Code of Regulations.

  The NMWD program differs from other local water agencies in that District staff test backflow prevention devices. This has the advantage of assuring that tests have been properly performed and costs are reduced for the rate payers because employees trained and supervised by the District's certified cross-connection control technician are used. Management provides the staff resources and oversight to assure that the program is carried out and minimal delays occur between a test failure and repairs.

- *Issues:*
  There have been several revisions to the California Code of Regulations, Title 17 governing selection and location of backflow preventers. A survey of the Novato cross-connection control program has revealed under-utilization of backflow devices throughout the system. The largest number of devices needed to bring the program current with state law are for commercial customers and multi-unit housing. The District has planned for the capital and maintenance costs for upgrading services and updated District regulations and fee schedules to cover these required costs.

### 6.3.7 Other Regulations and Permit Conditions

In addition to the regulations discussed above, DDW has regulations that focus on assuring that water systems are designed, constructed and operated in a manner compatible with public health goals. Cross connection control, State Waterworks Standards and Operator Certification stand out as regulations focused on maintaining water quality. In addition, the Novato Water System Permit issued by DDW cites specific operating conditions.

- Fluoridation Mandate
- State Waterworks Standards
- Operator Certification
- Novato Permit Provisions

### 6.3.7.1 Fluoridation Mandate

- *Purpose of California Legislative mandate:*
  Prevent dental health problems, thereby reducing State costs for dental services.

- *Requirement:*
  All water utilities with greater than 10,000 connections are required to submit and periodically update a cost estimate to fluoridate their supplies. State regulations rank NMWD in the top quartile of agencies (32/167) to receive funding for implementation of fluoridation. The funding source has not yet been identified. Funding for implementation must come from a source other than the ratepayers.

- *NMWD response:*
  The NMWD Board of Directors has long held the position that fluoridation of District water supplies would only be initiated at the request of the voters. Little action has occurred at the State level regarding this legislative initiative to fluoridate water supplies.

- *Issues:*
  Fluoridation of supplies from both Stafford and the North Marin Aqueduct should occur simultaneously due to blending dynamics. Other SCWA contractors are ranked lower on the State ranking list which, if necessary, would cause NMWD to request that the State re-evaluate their listing. The State would be asked to consider providing sufficient funds for the entire SCWA supply to be fluoridated as well as any supplemental sources of SCWA contractors.

  Should the State require NMWD to fluoridate, planning should include provisions to provide space and controls to install fluoridation at STP and at a location off the North Marin Aqueduct or at Kastania PS. Since MMWD already fluoridates, site selection may be subject to negotiation if a combined system is desired.

  Hydrofluosilicic acid is considered an extremely hazardous chemical, and special provisions will have to be made for any installation of fluoridation facilities on the aqueduct and at Stafford Treatment Plant and to comply with local hazardous materials code

### 6.3.7.2 State Waterworks Standards

- *Relationship to Water Quality*:
  DDW sets regulations including design and construction standards to be used by water suppliers. These standards were recently revised. Specific design and construction criteria are identified to provide protection of public health.

- *Highlights of the Waterworks Standards as related to Novato:*
    - Requires an amendment to the water permit if volume of water delivered increases by more than 10 percent.
    - A source capacity report is required of all systems.
    - All coatings, linings, gaskets or sealing materials, joint compounds or tank materials must be certified to meet ANSI/NSF Standard 61.
    - Water Main separation between wastewater or recycled water lines are restricted (4-ft. horizontal, 1 ft. above.)
    - Details on standards for flushing valves and blow-offs, air release valves and isolation valves are identified.
    - Reservoirs are required to have separate inlet and outlet and sampling taps.
    - A Distribution System Operation Plan is required with updates every five years.
    - Mapping Standards are identified.

- *Issues:*
  The most significant issue is the requirement for NSF Standard 61 certification for materials. Standard 61 addresses water quality contamination issues but does not address longevity or strength. Care must be taken in selecting appropriate materials.

  Both District and contract work will be required to be in compliance with these standards.

#### 6.3.7.3 Operator Certification

- *Relationship to Water Quality*:
  All states are required to develop operator certification programs to comply with regulations. California water treatment operators have been certified for many years. As more focus has recently arisen related to distribution system operation, a California program has been underway since 2004 to certify distribution operators. Certification is also required for cross-connection control device testers.

- *The North Marin Water District Program*:
  The District is required to have distribution operator certification for all employees with duties that involve decisions in operation, maintenance or repair of distribution system facilities. All District treatment operators are certified. The District's cross connection control technician is certified by AWWA as a tester and assumes the role of certifying other District personnel hired to test NMWD devices.

- *Issues:*
  The most significant impact of the new California certification rules is the requirement for continuing education units and the successful testing of all employees to receive certification.

### 6.3.8 OTHER NMWD PROGRAMS AND EMERGING ISSUES

Distribution water quality is maintained if policies and procedures are in place to assure that good planning, construction and maintenance practices are followed. These programs developed by NMWD staff can be considered quasi-regulated because they are cited in the

Novato Distribution Operations Plan that is reviewed and approved by DDW. Following is a review of:

- Tank inspections, operations and maintenance
- Valve Turning
- Flushing
- New construction approval process
- Water Quality Laboratory
- Source Controls and Treatment
- Emerging Issues

### 6.3.8.1 Tank Inspections, Operations and Maintenance

- *Relationship to Water Quality*:
  Storage tanks are a location of high vulnerability. Storage of water, while providing fire protection and emergency supply, can cause the water to age and lose chlorine residual. Screens on vents and overflows must be properly maintained to prevent intrusion by birds and animals.

- *The North Marin Water District program:*
  The current NMWD tank inspection program is carried out by the Operations division with occasional assistance from the Maintenance division. The Maintenance division conducts annual inspections, typically performed by the Electrical/Mechanical staff. The Operations division inspects tanks weekly for chlorine residuals and tank security issues. A water quality-focused inspection of all tanks typically occurs once a year during the winter. Samples are collected by the distribution system operator for lab analysis, including coliform growth and heterotrophic bacteria. Tank inspection observations are recorded in the database "Tank Cleaning Sch.xls" which is maintained by the Maintenance department. Tank Inspection forms, typically filled out during tank cleanings, are included in the individual tank binders located in the Engineering department.

  Reduced chlorine residuals have caused a tank chlorine augmentation program to be developed. Chlorine dispersion tubes have been installed in 22 tanks. A regular program is conducted by the distribution operator to monitor all of the tanks and add chlorine tablets as necessary with exception of the largest tanks which are dosed by spraying CL2 solution over the surface of the water of the tank. Records are maintained on this activity and correlation with lab sampling within the zone is reviewed by the Water Quality division. Significant improvement in maintaining adequate chlorine residual and a marked decrease in the number of coliform positive samples in the distribution system has been observed as a result of these actions

  The pump operational set points at the storage tanks and system dynamics have a great influence on water age.

- *Issues:*
  Tank inspections must be scheduled and maintenance prioritized so water quality problems are quickly remedied.

Some overflows are protected by a weighted flapper valve, though their effectiveness has not been fully demonstrated. All flapper installations are inspected annually and improvements are made as needed.

Overflow drains may not be located on facility drawings.

Augmentation of tanks with chlorine tablets is time-consuming. If it is determined that ongoing chlorine augmentation is advantageous, alternatives to the program will be investigated.

A system to chlorinate the larger tanks under emergency conditions is needed.

Separate tank inlet and outlet pipelines have been designed for some NMWD tanks. Their performance has been positive in de-stratifying tank water and maintaining adequate chlorine residuals throughout the water column. Proposed Water Works Standards will require separate inlet and outlet pipelines.

#### 6.3.8.2 Valve Turning Program

- *Relation to Water Quality:*
  Turning all valves provides assurance that valves are functioning and can be used to valve off main breaks or contamination events in a timely manner. It also provides an opportunity for staff to gain knowledge of valve locations and assure they haven't been buried by new paving and are fully operational.
- *The North Marin Water District program*:
  NMWD has a good program that provides for turning all distribution and transmission system valves each year by the Maintenance Division.

- *Issues*:
  A valve replacement program with identified goals should be considered.

#### 6.3.8.3 Flushing

- *Relation to Water Quality:*
  Flushing has long been identified as one of the most effective maintenance practices for improving water quality by removing sediments, corrosion by-product biofilms and introducing higher chlorine residual to stagnant dead ends.

- *The North Marin Water District program:*
  North Marin initiated an annual, system-wide flushing program over 30 years ago. Budget constraints caused the program to be abbreviated in the '90s. Currently, flushing is carried out by Maintenance, Construction, and Operations department personnel, coordinated by the Distribution/Maintenance Foreman with flushing routes assigned to several flushing teams. Flushing is conducted annually.

- *Issues:*
  Flushing of dead ends and between pressure zones is complicated by the lack of flushing blow-offs at zone valves. A program to install zone valve blow-offs has been underway for several years. Flushing zone-valve dead-ends without blow-offs requires that stagnant water from the higher zone be flushed to the lower zone which can

jeopardize customer water quality, as well as the risks associated with introducing a higher pressure to an area.

The STP rehabilitation has increased removal of iron and manganese from lake water. This has resulted in a smaller accumulation of fine sediment in the distribution system. Although the flushing program has been normally performed annually, cutting the program back due to water supply concerns has not resulted in an increase of colored water complaints.

Stormwater protection rules require dechlorinating of all discharges of flushed water. The District has adopted a policy of dechlorinating at all flushing points; previously dechlorination took place only adjacent to locations that were perceived as being environmentally sensitive.

#### 6.3.8.4 New Construction Approval Process

- *Relationship to Water Quality:*
  New facilities are approved for service by procedures that allow for their disinfection and subsequent testing to show no contamination. The final approval depends on more than the disinfection process but starts with good design and construction practices.

- *The North Marin Water District Program*:
  Design review procedures include review for water quality concerns. District procedure EP-4-Disinfection documents construction, disinfection, and approval procedures. The Maintenance division has drafted procedures for liquid chlorine disinfection of mains. Protection of the sanitary condition of pipe in storage has been identified as a goal and is now practiced.

- *Issues:*
  The electrical/mechanical crew has developed a procedure for the disinfection of pressure reducing stations and their bypass valves. This procedure should be documented and periodically reviewed.

  Engineering should include a representative from the Water Quality division at pre-construction meetings on larger projects to review the approval process and discuss BMPs as relating to assuring water quality. Distribution of the appropriate standards related to disinfection and main approval to the project construction superintendent could be included on the job check list.

  Flushing velocities have been less than sufficient in many cases to clear lines. Tie-in to existing mains has been required in several cases prior to main approval in order to achieve flushing velocities. NMWD should consider providing temporary connection with backflow protection to mains.

  Covered storage has been suggested to provide contamination protection for pipe and appurtenances in yard. In lieu of covered storage, end caps are used on stored pipe. End cap effectiveness requires prompt capping and contractor attention at job sites.

  District experience with pipeline disinfection using liquid hypochlorite is positive. Training District personnel on main disinfection procedures has been done to enhance the ability to respond to emergencies. However, the District utilizes outside contractors for pipeline disinfection on large, planned projects.

### 6.3.8.5 Water Quality Laboratory

- *Relationship to Water Quality*:
  The ability to consistently control and improve water quality is determined by the ability to quickly obtain data and detect trends. The ability to provide quantitative data that can be used to guide process control decisions allows for a higher quality product. It is the role of the laboratory to provide this data. An on-site laboratory equipped to perform tests on demand provides the timely detection that is crucial to good water quality control.

- *The North Marin Water District Program:*
  The NMWD Water Quality laboratory is staffed and equipped to perform common regulatory tests and those tests that are routinely requested by staff or customers. The laboratory is certified under the California Environmental Laboratory Accreditation Program and staff are certified as Water Quality Analysts by the California-Nevada Section of the American Water Works Association. It has been the policy to equip the lab with the ability to perform those tests essential to monitoring constituents of concern, i.e., those that can be controlled by adjustment to either plant operations or distribution practices. Use of commercial laboratory services is limited to those tests of constituents that are required for regulatory purposes, primarily to show their absence, or to those tests which are not cost effective for the District to perform.

- *Issues:*
  The use of an Ion Chromatograph has been implemented to monitor chlorite and chlorate as DBPs of chlorine dioxide. This instrument has the added benefit of increasing the ability to monitor nutrients such as nitrate and phosphate which are of critical interest in evaluating watershed controls.

  There is no commercial laboratory in Marin County that is certified to perform bacteriological tests on water. The NMWD laboratory has been asked by County Environmental Health if NMWD would be capable of accepting private well bacteriological tests of Non-District County residents. The NMWD laboratory routinely analyzes samples from Novato Sanitary District as part of the two district's mutual aid agreement. Then NMWD lab also occasionally accepts samples from other regional public agencies. The lab should continue to market lab services to neighboring water and wastewater utilities to add revenue and reduce operational costs.

  A Laboratory Information Management System (LIMS) was implemented in June 2007 and has been put into daily operation. This system allows for automated reporting from instruments and a streamlined, multistep process for validating results. All bench sheets and reports (including electronic reports to the state database) are generated from the LIMS.

  Results of all testing are compiled and summarized in an Annual Water Quality Report. This report (identified as a Consumer Confidence Report as required by the US Safe Drinking Water Act) lists any detected contaminant or constituent with a primary standard as well as several constituents with secondary standards that may be of interest to consumers. The Annual Water Quality Report is sent to each customer in a special mailer and is posted on the District's website.

### 6.3.8.6 Source Controls and Treatment

- *Relationship to Water Quality*:
  Good source water quality is typically directly related to treated water quality. Improving source water quality can improve treated water quality.

- *The North Marin Water District Program:*
  NMWD has developed a Stafford Watershed Protection Plan. This plan is focused on implementing controls to improve lake water quality by reducing nutrients, pesticides, erosion and pathogens from entering Stafford Lake.

  Treatment controls implemented include mixing of the lake with solar powered circulating pumps (SolarBees), and adjustment of Lake Intake levels. The District's practice of treating the lake with copper sulfate to kill algal blooms has been discontinued since the addition of the SolarBees.

  Watershed Controls for Cryptosporidium have been proposed. See discussion under the Section titled "Microbial/Disinfection By-Product Rule, Long Term Enhanced SWTR and Filter Backwash Rule".

- *Issues*
  Lake aeration is an important control mechanism. When aeration was initiated in 1968, months of active algae production dropped from 7 to 6. After dairy controls were required in 1974, an additional month reduction was achieved due to lower nutrient levels. The effectiveness of the aeration system was reduced as the air release lines are located on the lake bottom became covered in bottom sediments, thus allowing nutrients to be disturbed. In 2006 solar powered mixers were installed in the lake to further reduce the occurrence of algae blooms, particularly blue green algae.

  As years pass sediments build in the lake. The sediment buildup at the intake tower has the potential to restrict the scour-gate. A barrier was constructed to minimize buildup and to provide a localized area for sediment removal. A formal lake sediment survey conducted in FY11 found that the accumulation of sediment in the lake is not very significant; therefore no formal sediment removal strategy has been developed.

### 6.3.8.7 Emerging Issues

- *Security of Facilities:*
  Terrorist attacks on the U.S. have raised concern about security measures and potential biological/chemical contamination. Security measures taken over the past three years include upgrades to access controls at the main office, corp yard, storage facilities and STP. On-line monitoring, increased surveillance, barriers etc., may be considered as new facilities are designed and older facilities are upgraded.

- *Point of Use Treatment:*
  Customers are increasingly turning to Point of Use (POU) treatment devices. The District may want to consider their role in providing customer service in this regard.

- *Contaminants of Emerging Concern (CECs):*
  Public concern with health effects from manmade chemicals found in pesticides and pharmaceuticals has increased over the past years. Scientific studies have revealed a number of environmental impacts from CECs that are released into waterways from wastewater treatment plants throughout the world. The US EPA has included a number of these contaminants of drinking water testing as part of the Unregulated Contaminant Monitoring program (UCMR III). NMWD monitoring results in UCMR III did not show the presence of any of these. The results of UCMR III testing may result in future regulation for chemicals which are found to have wide occurrence at toxicologically relevant concentrations.

  Other monitoring for certain CECs has been conducted on Russian River water as well as treated water in MMWD's system with no detection. The District stays abreast of issues as they are identified.

## 6.4 WATER QUALITY GOALS

Based on the issues discussed and experienced the following goals are identified as appropriate to assure water quality in the Novato Water System:

1. A minimum 0.20 chlorine residual maintained at all points in the distribution system.
2. Heterotrophic plate counts not exceeding 500/ml bacteria at all points in the distribution system.
3. No taste and odor complaints or detection.
4. Total Trihalomethanes below 60 ug/L at all DBP sample sites; total haloacetic acids below 40 ug/L at all sample sites.
5. Annual inspection and testing of all reservoirs for bacterial quality and sediments that would warrant disinfection and/or cleaning.
6. All reservoirs cleaned (or bypassed for cleaning based on data) every five years.
7. Annually, flush all mains and turn all valves.
8. Expand the Cross Connection Control program and update supporting regulations to have consistent use of backflow preventers at any service for which the requirement is indicated consistent with California regulations
9. Test backflow prevention devices annually and repair within 45 days of failure identification date.
10. Maintain lead and copper below action level at all consumer taps.
11. Respond to customer complaints within the workday.
12. Reduce nutrients in Stafford source water to eliminate need for algae control with copper sulfate and to reduce TOC.

## 6.5 RECOMMENDATIONS

The following are recommended actions towards achieving water quality goals.

### 6.5.1 Source Quality

1. Develop and implement nutrient control strategies on Stafford watershed to reduce TOC, chlorine demand and AOC.
2. Install continuous turbidity monitoring of SCWA water supply.

3. Encourage SCWA to treat well sources that have potential to exceed secondary standards and maintain > 0.5 mg/l CL2.
4. Intake tower - Incorporate sediment removal components to Stafford intake structure to permit cleaning every 5 – 10 years.
5. Water quality data can be analyzed to assess quality as a function of depth (strata), which can inform future decisions regarding intake tower modifications to provide additional operational flexibility related to intake elevations.

### 6.5.2 Treatment

Due to ongoing upgrading changes at the STP, no recommendations are included in this master plan other than reinforcement of treatment goals to reduce DBP formation, chlorine demand and TOC/AOC.

### 6.5.3 Distribution

1. Install continuous chlorine monitoring equipment at entry points to major zones.
2. Continue to identify low chlorine residual or excessive water age areas that can be mitigated by system looping or installation of chlorine boosters.
3. Develop emergency disinfection procedures that can provide disinfectant mixing in large storage reservoirs. Incorporate emergency disinfection taps in all pump stations and identify other strategic locations.
4. Improve flushing by including Engineering in annual update of flushing routes adding new mains.
5. Continue to install flushing blow-offs at dead-end valves.
6. A valve replacement program with identified goals should be considered.
7. Review security issues and address vulnerabilities as appropriate. Consider SCADA-based security alarms and general SCADA security.
8. Increase level of attention to cross connection control measures as recycled water is made available.
9. Consider electronic collection of cross connection control test results in the field that can be downloaded upon return to base.
10. Continue to replace the older NMWD-design fire service double check detector assembly and rely on fire systems with approved single detector checks and rely on the alarm check in the fire system to provide redundancy. The older checks should be removed to eliminate head loss, lead components and liability.
11. Consider use of a temporary intertie with backflow protection in new construction where flushing velocities are an issue.

### 6.5.4 Other Issues

1. Maintain laboratory service ability to meet customer priorities and provide feedback to operational issues. Utilize contract laboratory services to monitor regulated contaminants that are not a concern and testing and/or maintaining laboratory certification is not cost effective.
2. Integrate all District Information management systems including the development of a Laboratory Information Management System (LIMS). Information is critical to effective application of resources.
3. Provide laboratory services to County and other agencies.

# SECTION 7

# HYDRAULIC EVALUATION

## SECTION 7

## HYDRAULIC EVALUATION

### 7.1 INTRODUCTION

The hydraulic evaluation of the Novato Water System is presented in Section 7. The hydraulic network was recreated from the ground up by importing NMWD's GIS of the entire system into a software suite which pulled key hydraulic parameters from the GIS shapefiles. A complete baseline and buildout analysis of all four pressure zones were then evaluated to identify hydraulic adequacy under two demand conditions, including a peak hour and a maximum day plus fire flow evaluation. Additionally, four special operational situations are modeled with baseline maximum day demand. Some portions of the hydraulic evaluation, as described below, were not performed on the small hydropneumatic zones within the system due to their negligible demands and the complicated modeling parameters associated with pressure vessels. However, some recommendations that were identified in previous studies or have been noted by staff may be discussed as appropriate. Several projects were identified to address distribution system hydraulic improvements and are described in this section.

### 7.2 HYDRAULIC MODEL UPDATE

Although prior hydraulic models exist which have been used to prepare previous water master plans, an entirely new model was created using NMWD's GIS data. A GIS based software suite was used to build the hydraulic model after importing key hydraulic parameters from the GIS shapefiles. There are several advantages with this approach. First, the entire Novato water system was able to be comprehensively modeled as opposed to previous efforts which relied on skeletonized individual zone models. Second, all of the facilities are geolocated and have an elevation associated with them which is advantageous when tracking demands and facility management. Third, the latest facilities were automatically included as NMWD's GIS data is routinely updated when improvements to their system are made. In addition to the modeling and GIS data, current operational procedures used by NMWD were also noted and utilized as appropriate.

For this 2018 Master Plan Update, the modeling software used is called Infowater, a hydraulic network modeling software program created and supported by Innovyze. It is run as an add-on to the ArcGIS platform by ESRI thus enabling spatial referencing in the GIS environment. Because of this, Infowater has many more features and graphical interface capabilities than the previously used EPANET, and provides a much more potent analysis tool for hydraulic analyses. The District does not currently own an Infowater software license. However, model files created in Infowater can be saved as EPANET files, and thus, the District can still utilize files created for this 2018 Master Plan Update.

Water demands were updated in the model by importing the georeferenced locations of the District's water meters through GIS so demands were able to be allocated to the system spatially. Demands were modified throughout the system to reflect the current water use patterns and water consumption data obtained from District billing records and as presented in other sections of this Master Plan document.

One significant enhancement over the 2012 modeling effort is the addition of all of the pipelines included in the District's GIS. The only pipes that were not modeled were the service connection laterals. Previous models included only pipes from Zone 1 & 2 equal to 4 inches and greater. The 2018 model has added more pipes and nodes which provides greater detail in the model and enables more specific evaluation in areas not previously analyzed.

After all the pipes and nodes were imported, the tanks, pumps and pressure regulating stations were constructed in the model. The tanks and pressure regulating stations were modeled using the data from system tables presented in Section 3. The pump stations were all modeled by utilizing pump curves provided by the District.

### 7.2.1 Modeling Criteria

Establishing hydraulic modeling criteria is important for development, calibration and use of the hydraulic network model, as well as interpreting the results. Key criteria utilized in development and use of the District's hydraulic model is as follows:

- All pipes that are not service connection laterals are included in the model.
- Pipe lengths, nominal inside diameters, and pipe roughness coefficient (Hazen-Williams "C" value) were obtained from the District's GIS database maintained by the Engineering Department.
- Water entering the model comes from two sources – the Kastania Tank (SCWA connection) which is modeled as a constant head reservoir and Stafford Lake which is modeled by utilizing pump curves provided by the District.
- Supply to meet demands in the small hydropneumatic zones is met by modeling the pumps for those zones as running at full capacity but omitting the pressure vessel. However, hydropneumatic zones are not evaluated in this plan.
- Tank dimensions and elevations were input as they are listed in the system tables in Section 3.
- Ground surface elevations for typical nodes throughout the system were obtained from the District's GIS database. These elevations in the GIS database are based on Marin County topographic mapping using NGVD 29.
- Water demands and flow rates in the model are expressed in gallons per minute (gpm).

### 7.2.2 Water Demands

The model demands are based on FY 2013 average annual daily demands as presented in Section 4. For model runs under conditions other than average day demands, a multiplier was used to determine those demands. Multipliers for maximum day and peak hour demands are presented in Section 4.

The associated demand from each meter is allocated to the closest node in the model. Previous models relied on an assumed demand for the typical service connection and only assigned actual billed data to the largest water consumers. As a result of using actual data that was spatially allocated to facilities, 2018 hydraulic modeling efforts have produced results that are more refined than models constructed previously.

### 7.2.3 Model Verification

The District has performed flow and pressure tests on fire hydrants throughout their system. This data was used to verify and calibrate the model results. Figure 7-1 and Table 7-1 present the results of this verification at twenty-eight hydrant locations throughout the system.

The model run used to verify hydrant pressures incorporated average day demands assuming all tanks full and all pumps off (except the hydropneumatic pumps). Kennedy/Jenks selected one hydrant from each subzone and two hydrants each from Zones 1 and Primary Zone 2 for model calibration purposes.

Minor adjustments were made to the model files as part of the verification process. These adjustments included modifications to some piping configurations, node elevations, boundary conditions, and other input data such as the closing of zone valves, conformance of PRV station node elevations, etc. Additionally, raw water and recycled water meters were identified and removed during the verification process.

In general, the model is considered calibrated if the modeled pressure at a given node is within 5 psig of the measured static pressure. Large deviations are often due to discrepancies in the estimated elevations used for a node in the model. While modeling calibration results are not all within an accuracy standard of +/- 5 psi of the hydrant test data, the majority are. The two hydrants with modeled results lower than a -5 psi delta were in Primary Zone 2 (hydrants 2259 and 353). The one hydrant with modeled results higher than a 5 psi delta was in Zone 1 (hydrant 218). Further analysis and/or more recent hydrant test data may be needed at these three locations.

Because of possible inaccuracies in hydrant elevation measurements and unknown operational conditions during the hydrant pressure testing, a full calibration of the model to exactly match the modeled pressures to the tested pressures was not deemed necessary. Future model updates could incorporate enhanced calibration efforts including but not limited to simulation of hydrant flow tests.

The results of model verification suggest that the demand distribution and other input data is significantly accurate. With the possible exception to the limited areas surrounding the three hydrants listed above and highlighted on Table 7-1 and Figure 7-1, the model is judged to be ready for use in the updated hydraulic analysis performed in this master plan effort.

**Table 7-1**
**Tested vs Modeled Fire Hydrant Pressures**

| FH ID from District records | Subzone Hydrant is in | Date of FH static pressure test | Measured FH Static Pressure (PSI) | Modeled FH Static Pressure (PSI) | Delta (PSI) | Delta (%) |
|---|---|---|---|---|---|---|
| 362 | 1RB | 6/27/2008 | 55.3 | 58.8 | 3.5 | 6.4% |
| 218 | 1TA-N | 3/20/2011 | 46.8 | 54.5 | 7.7 | 16.4% |
| 1652 | 1TA-S | 7/8/2009 | 68.5 | 65.3 | -3.2 | -4.7% |
| 2259 | 2TA-SM/T | 10/20/2008 | 78.3 | 68.8 | -9.5 | -12.1% |
| 353 | 2TA-SS/P | 7/8/2009 | 111.5 | 104.9 | -6.6 | -6.0% |
| 899 | 2RD | 3/20/2011 | 79.2 | 77.5 | -1.7 | -2.2% |
| 182 | 2RF | 6/23/2008 | 58.1 | 55.0 | -3.1 | -5.3% |
| 1989 | 2RG | 7/8/2009 | 93.5 | 94.5 | 1.0 | 1.1% |
| 1980 | 2RK | 6/15/2009 | 75.3 | 74.8 | -0.5 | -0.6% |
| 411 | 2RM | 3/20/2011 | 84 | 83.3 | -0.7 | -0.9% |
| 900 | 2RN | 3/20/2011 | 73.9 | 75.0 | 1.1 | 1.5% |
| 2293 | 2RP | 10/20/2008 | 67 | 65.8 | -1.2 | -1.8% |
| 700 | 2TE | 3/20/2011 | 123.5 | 121.2 | -2.3 | -1.9% |
| 2178 | 2TL | 3/20/2011 | 81.3 | 79.3 | -2.0 | -2.5% |
| 2097 | 2TO | 7/7/2009 | 81.1 | 79.0 | -2.1 | -2.6% |
| 1645 | 3RR | 10/20/2008 | 119.1 | 123.1 | 4.0 | 3.4% |
| 163 | 3TB | 3/20/2011 | 73.3 | 71.3 | -2.0 | -2.7% |
| 573 | 3TC | 7/29/2008 | 138.2 | 136.1 | -2.1 | -1.5% |
| 2326 | 3TD | 3/20/2011 | 91.8 | 89.5 | -2.3 | -2.5% |
| 593 | 3TE | 7/29/2008 | 41.4 | 39.4 | -2.0 | -4.7% |
| 1331 | 3TG | 10/20/2008 | 95.5 | 93.4 | -2.1 | -2.2% |
| 1450 | 3TH | 8/3/2018 | 105 | 104.6 | -0.4 | -0.4% |
| 1507 | 3TM | 3/20/2011 | 156.6 | 154.9 | -1.7 | -1.1% |
| 1795 | 3TN | 10/20/2008 | 64.8 | 62.8 | -2.0 | -3.0% |
| 1771 | 3TO | 10/20/2008 | 78.4 | 76.4 | -2.0 | -2.5% |
| 1939 | 3TQ | 3/20/2011 | 64.8 | 62.8 | -2.0 | -3.1% |
| 2265 | 4TC | 3/20/2011 | 65.8 | 63.8 | -2.0 | -3.1% |
| 1995 | 4TD | 10/20/2008 | 103.1 | 101.1 | -2.0 | -1.9% |

Note:
1) Vertical datum: NGVD29.
2) Shaded cells indicate that pressure discrepencies between actual and modeled results are greater than 5 PSI.

## 7.3 DISTRIBUTION SYSTEM ANALYSIS

The hydraulic network model was utilized to evaluate the performance of the all zones' water distribution systems under baseline (FY 2013) and future buildout (FY 2035) peak hour and fire flow water demands. Additionally, two buildout maximum-day special operational scenarios (Stafford WTP offline and Kastania Reservoir offline) are simulated as well. The hydraulic model output results include flow, velocity and head loss for all pipe segments, hydraulic gradient for all tanks and reservoirs, pressure and hydraulic gradient for all network nodes in the system. This information is compared to specific evaluation criteria to determine hydraulic adequacy. Solutions to correct identified deficiencies are then applied to the model to determine their effectiveness.

Modelling was completed using steady-state analysis, which represents specific snapshots in time. The status of zone pumps, outflows from the zone, peaking factors, and pipelines and tanks that are in service or out of service are all input into the model as boundary conditions.

Extended-period simulations are typically reserved for modelling water quality, which was outside the scope of this master planning effort.

### 7.3.1 Evaluation Criteria

In order to effectively evaluate the model runs, the model output results were compared against established evaluation criteria. These criteria include minimum and maximum pressure, maximum velocity, maximum head loss, residual pressure at fire nodes, and fire flow requirements. In addition, other system reliability criteria also govern the analysis. A detailed discussion of the development of these criteria is presented in Section 2, and the pertinent criteria are summarized below:

- Minimum normal pressure = 40 psi
- Maximum normal pressure = 80 psi
- Minimum pressure under max day demand = 35 psi
- Minimum pressure under peak hour demand = 30 psi
- Maximum pipeline head loss = 10 feet per 1000 feet
- Maximum pipeline velocity = 10 fps; does not apply to fire-flow scenarios
- Minimum fire flow requirement = 3,500 gpm for commercial, industrial and institutional zones, and 1,500 gpm for all other zones
- Minimum residual pressure under fire flow = 20 psi

### 7.3.2 Operation Parameters

Operations parameters for the modeling are summarized in Table 7-2.

**Table 7-2**
**Model Operation Parameters**

| Equipment/Instruments | Status |
|---|---|
| Reservoirs | On; except for operational scenarios |
| Tanks | On; with different initial depths under different scenarios |
| Non-hydropneumatic Pumps | Various[1] |
| Hydropneumatic Pumps | On |
| Zone Valves | Closed |
| PRV Stations | Active with pre-existing settings |

## 7.4 MODEL SIMULATION APPROACH

All four zones of the distribution system were evaluated under four steady-state demand conditions: 1) baseline and buildout under peak hour demand, with tanks two-thirds full; 2) baseline and buildout under maximum day demand plus fire flow, with tank levels at 10 feet; 3) buildout maximum day demand scenario with SCWA online and Stafford WTP offline; 4) buildout maximum day demand scenario with SCWA offline and Stafford WTP online. The tank levels were set to represent a conservative input, especially to higher zones, as not all zone pumps are modeled as online. The alternation of turning off the two water sources tests the system's reaction to receiving only gravity flows from storage tanks. In reality, over time, the system would experience pressure deficiencies as the tank storages are depleted. This can be modeled in extended-period state whereas this evaluation focuses on steady-state analysis. These four scenarios intend to stress the distribution system to identify potential bottlenecks, and to test the efficiency of potential improvement projects. The modeled pressure, pipe head loss and velocity were compared against the evaluation criteria noted above.

One of the capabilities of InfoWater (as compared to EPANET) is that a fire flow scenario can be simulated for essentially all nodes within the model in an iterative manner instead of at individual nodes. For purpose of this analysis fire demands were located at nodes where there are at least three connecting pipes that are 6 inches or larger. With this approach, it is possible to evaluate significantly more locations within the system. Analysis of fire-flow availability will be further detailed later in this section.

### 7.4.1 Assumptions

The main difference between the current modelling effort and previous studies is that all four zones are included and modelled simultaneously as a complete integrated system. A separate model run was prepared for each demand/operation scenario, and the results for each zone are discussed separately. The following general simulation assumptions were used:

- For fire flow analysis, the storage tanks are operated at an initial water level of 10 feet that represents an estimated typical minimum level during maximum day demand in the summer, except for Cabro Court Tank and Windhaven Tank[2] .
- For peak hour scenarios, the storage tanks are operated at a 2/3 of maximum water level.
- For other scenarios, the storage tanks are modelled as full.

[1] Pump station operation status and capacities are listed in the model parameter tables under each zone analysis.
[2] Cabro Court Tank and Windhaven Tank's maximum levels are less than 10 feet.

- For FY 2035, the average day demand is 6,300 gpm; maximum day demand is 10,700 gpm; and peak hour demand is 17,640 gpm. FY 2035 demands are anticipated to increase by approximately 4% compared to those of FY 2013[1].
- Kastania tank and Stafford WTP are online except for scenarios testing operational emergencies.

The fire flow analysis consisted of applying the fire demands at the nodes under the boundary conditions described in Table 7-2 and determining if the 20-psi residual pressure criterion is met. Fire flows exceeding 1,500 gpm are typically drafted from multiple hydrants near the actual fire. However, the model is limited to simulating all the flow from a single hydrant. This simplification artificially inflates velocities for fire events, so the maximum velocity criterion was disregarded for fire flow availability evaluations. Note also that the 3,500 gpm fire flow requirement is for larger commercial and industrial land uses, and the fire flow requirement for predominantly residential areas is 1,500 gpm, including Wildland Urban Interface (WUI) areas.

In general, model results from peak-hour simulations did not reveal any significant hydraulic bottlenecks. In contrast, fire-flow scenarios revealed areas of the distribution system that could not satisfy the specified criterion. Therefore, all subsequent pipeline and operation improvement concepts were modeled for the purpose of meeting fire flow demands, and the simulation results presenting the impacts of these new projects are listed in Attachment 1. Discussions of the model results and recommendations are summarized in the following sections.

## 7.5 ZONE 1 HYDRAULIC ANALYSIS

Table 7-3 summarizes the model input of Zone 1 water sources, tank levels, pump flows and MMWD aqueduct status under each evaluated scenario. Only certain pump stations identified by the District are turned on with their respective firm capacities. Although only certain pump stations are identified for pumping operation in this analysis, it is conservative to assume that water withdrawn/pumped from Zone 1 to Zone 2 is underestimated.

**Table 7-3**
**Zone 1 Model Parameters**

| Model Run Scenario<br>Model Input Parameter | Peak Hour | Maximum Day+ Fire Flow | Stafford WTP Offline under Maximum Day | Kastania Reservoir Offline under Maximum Day |
|---|---|---|---|---|
| Peaking Factor (multiple of average-day demands) | 2.80 | 1.77[2] | 1.77 | 1.77 |
| Atherton Tank Initial Water Elevation (ft) | 155 | 143 | 164 | 164 |
| Lynwood Tanks Initial Water Elevation (ft) | 153 | 142 | 162 | 162 |
| Amaroli Tank Initial Water Elevation (ft) | 150 | 143 | 159 | 159 |

[1] Refer to Section 4 for detailed demand projection calculations.
[2] Peaking factors are applied to domestic demands only. There is no peaking factor applied to the fire flows.

**Table 7-3 (continued)**

| **<u>Model Run Scenario</u>** **Model Input Parameter** | **Peak Hour** | **Maximum Day+ Fire Flow** | **Stafford WTP Offline under Maximum Day** | **Kastania Reservoir Offline under Maximum Day** |
|---|---|---|---|---|
| Palmer Tank Initial Water Elevation (ft) | 150 | 140 | 159 | 159 |
| Lynwood PS Flow (gpm) | 3600 | 3600 | 3600 | 3600 |
| San Marin PS Flow (gpm) | 3600 | 3600 | 3600 | 3600 |
| School Road PS Flow (gpm) | 0 | 0 | 0 | 0 |
| Cherry Hill PS Flow (gpm) | 0 | 0 | 0 | 0 |
| MMWD Demand (gpm) | 4,375 | 4,375 | 4,375 | 4,375[1] |
| Hayden Hydro PS Flow (gpm) | 80 | 80 | 80 | 80 |
| Diablo Hills Hydro PS Flow (gpm) | 80 | 80 | 80 | 80 |
| Kastania Reservoir[2] | On | On | On | Off |
| Stafford WTP | On | On | Off | On |
| MMWD Hanna Ranch Intertie | Closed | Closed | Closed | Closed |
| MMWD Frosty Acres Intertie | Closed | Closed | Closed | Closed |

### 7.5.1 Peak Hour Demand Scenario

The peak hour demand scenario was run with buildout (FY 2035) demand data. The simulation shows that both the North Novato Subzone and the South Novato Subzone nodes meet the minimum pressure criterion (30 psi) other than nodes in vicinity of water tanks and around dead ends at high elevations. All pipes meet the maximum velocity criterion (10fps). Almost all pipes meet the maximum head loss criterion (10ft/1000ft) except for the following locations:

- the intersection of a 6-inch line and 12-inch line at Wilson Ave and Novato Blvd
- the 6-inch line segment along Simons Ln from Novato Blvd to Virginia Ave
- a segment of the 12-inch line along Novato Blvd at the intersection of Novato Blvd and Eucalyptus Ave
- the 1-inch line connecting a 2-inch line along Nugent Ln to the 8-inch along Machin Ave
- a 4-inch lateral branching off of the main at the end of Boulevard Terrace
- the 12-inch segment along Center Road at the intersection of Tamalpais Ave and Center Rd
- the 8-inch lateral of the main on Entrada Drive in between Lilac Place and Poppy Place
- the 24-inch line exiting Kastania Tank

These exceptions are not deemed significant enough to warrant a capital improvement project solely on the basis of high head loss gradient, if adequate pressure is otherwise available at nearby service connections.

[1] When Kastania Tank is offline, it is likely that the District will decrease output to MMWD.
[2] Kastania Tank is modeled with a constant head of 235 feet. The tank is assumed to be always full or can be topped off quickly, which approximates realistic operation.

### 7.5.2 Maximum Day Demand + Fire Flow Scenario

The model was run under maximum-day demand conditions, plus a 3,500 gpm or 1,500 gpm fire flow located discretely at junctions where at least three pipes connected, and pipe diameters are no smaller than 6 inches.

The deficit in residual pressure under this scenario is primarily caused by the incremental fire flow demands, as the magnitude of fire flow demand is much greater than that of the maximum day demand. Therefore, only the buildout maximum day plus fire flow scenario is analyzed and the results are assumed to be similar under the baseline scenario.

Zone 1 is split between the North and South Subzones, although both are hydraulically interconnected and operate at roughly the same hydraulic grade elevation. Both subzones are east of Sunset-Pacheco Subzone (Zone 2), and the approximate border between them is Highway 37 and its imaginary extension west of Highway 101. Storage for North Subzone 1 is via the Atherton and Lynwood tanks, while South Subzone 1 storage is via Palmer and Amaroli tanks.

Model results indicate fire flow and pressure criterion cannot be met in some areas within Zone 1. In general, these areas share some common characteristics:

- isolated areas served by a single pipeline;
- areas on the extremities of the system far away from the main system;
- areas of predominantly smaller pipelines;
- higher elevations within Zone 1, where static pressures are lower.

Specific areas that do not meet the specified fire-flow requirements are listed below:

No. Novato Subzone

- Nodes around Novato High School with fire flows of 3,500 gpm. The loop around Novato High School narrows to 6-inch pipeline from the 8-inch pipeline on Arthur St.
- Nodes on Marion Ave between Eighth Street and Seventh Street with a fire flow demand of 3,500 gpm. This area is served primarily by 6-inch pipelines.
- Nodes on Marion Ave between Benton Ln and Paradise Court with a fire flow of 1,500 gpm. This 6-inch pipeline induces high head losses under fire flows and pressures are reduced at the higher elevations.
- Nodes at De long Ave between Reichert Ave and SMART Train tracks with a fire flow demand of 3,500 gpm. This area is served by one single 8-inch pipeline.
- Nodes near the commercial buildings southeast to the intersection of South Novato Blvd and Diablo Ave and northeast to the intersection of S. Novato Blvd and Nave Court, with a fire flow of 3,500 gpm. This area is served with a single 8-inch pipeline.
- Several isolated nodes at higher elevations, primarily at the end of short dead-end pipelines with a fire flow of 1,500 gpm. These locations generally occur at the interface between Zone 1 and Zone 2.
- Nodes along Driftwood Ave and Surf Way with 1,500 gpm of fire flow demands. These nodes are served by 6-inch lines and are not inter-looped.
- Nodes along the east run of Lark Court with 3,500 gpm of fire flow demands. These nodes are at the dead ends of an unlooped pipe.

- Nodes around the commercial (storage facilities) area south to the intersection of Airport Road and Binford Road. These nodes require 3,500 gpm of fire flows and the area is not well looped.
- Nodes at the east dead ends of 8-inch lines east to Airport Rd. This area is served by a single 8-inch line and not well looped, therefore struggles to satisfy the 1,500 gpm of fire flow demands.
- Nodes along School Road northeast to Atherton Ave with fire flows of 1,500 gm. This line is not looped and is isolated from Zone 2 by a zone valve.
- Nodes along McClay Road between Dow Ln and Pleasant View Road with fire flows of 1,500 gpm. This area is served by a single 8-inch line that branches off to a 6-inch line with dead-ends.
- Nodes in downtown DMV office area (north to the intersection of Novato Blvd and Seventh St) with 3,500 gpm of fire flow demands. Although this area is looped by 8-inch and 6-inch lines and is served by a 12-inch line along Grant Ave, it is not connected to the 12-inch line along Novato Blvd.
- Nodes along Court Road from George Street to First Street with fire flow demands of 3,500 gpm. The nodes are close to meeting the criterion with the most insufficient node receiving 2,504 gpm available fire flow.
- Nodes around the commercial areas north to Deer Island Ln with fire flow demands of 3,500 gpm. The available fire flows at these nodes are close to meeting the criterion, with the most deficiency in available fire flow at 2,695 gpm.
- Nodes at the extremities of small un-looped pipelines.

<u>So. Novato Subzone</u>

- The east nodes at the end of the Bel Marin Keys commercial area with a fire flow demand of 3,500 gpm. The problematic area, nodes along and north to Digital Drive and east to Galli Drive, is served by a single 8-inch pipeline, which feeds several dead-end pipelines smaller than 12-inch. This piping configuration results in high head losses under high flows in the 8-inch pipelines. Available fire flows are as low as 1,836 gpm at the end of the network.

- Nodes along Montego Key (Bel Marin Keys residential area) that requires 1,500 gpm is served by a single 8-inch pipeline and poorly looped. Not much development is anticipated at this area.

- Nodes at the extremities of small un-looped lines.

In the Bel Marin Keys residential area, it is not practical or cost-effective to loop pipelines due to constraints including the adjacent waterways and the configuration of the streets.

Fire flow availability was examined near the following public schools:

- Lu Sutton Elementary (Junction 20763)
- Olive Elementary (Junction 16866, 25283 and 24405)
- Lynwood Elementary (Junction 23467, 25347 and 25350)
- Novato Charter School (Junction 21680, 21682 and 20244)
- Novato High School (Junction 16780, 22297, 16819, 16779 and 16818)
- Rancho Elementary (Junction 18707 and 24449)
- Hamilton Elementary (Junction 22168 and 20860)
- Hill Middle School (Junction 18173).

The results show that residual pressures are well above 20 psi for all school locations in Zone 1, except for nodes around Novato High School. Model fire flow availability in the pipeline on school grounds around Novato High School registers less than 2,900 gpm. However, this pipeline appears to be intended for domestic or irrigation purposes, which is not suitable to deliver fire flows. Existing utility mapping in this area also displays a separate service for school believed to be a dedicated fire service for sprinkling.

The fire flow analysis only identified two deficient areas in the downtown area – shopping space northwest of the Grant Ave and Seventh Street intersection and the DMV office area southwest to the intersection of Grant Ave and Seventh Street. The required fire flows of 3,500 gpm cannot be met, since these areas are primarily served by 6-inch pipelines. However, both areas are not far from meeting the fire flow demands, with the most insufficient node receiving 2,036 gpm in available fire flow.

It should be noted that areas where it is not economically feasible to upgrade parts of the distribution system, it may be possible to install fire sprinklers. The presence of automatic fire sprinklers can significantly reduce the fire flow requirement at a given location, per International Code Council's (ICC) Fire-flow Requirements for Buildings[1].This concept is not included in the CIP projects as the District does not regulate nor has responsibilities for fire sprinkler installations.

### 7.5.3 Stafford WTP Offline Under Maximum Day Demand

This scenario is modeled with Stafford Water Treatment Plant offline and with buildout (FY 2035) maximum day demand assumptions. The simulations show that both the No. Novato Subzone and the So. Novato Subzone nodes generally meet the minimum pressure criterion (35 psi), except at dead ends or in vicinity of water tanks. All pipes meet the maximum velocity criterion. Almost all pipes meet the maximum head loss criterion except for a few isolated locations. Pipe segments that experience excessive head losses are:

- the 24-inch pipe coming exiting Kastania Tank
- the last run of the 12-inch pipe leading to Lynwood Tank 2
- the 4-inch looping pipeline at the east end of Lynwood Drive, east to the intersection of Lynwood Drive and Sunset Parkway
- the 8-inch connection pipe bridging the two 12-inch pipelines on the east side of Sunset Parkway, between S. Novato Blvd and Monte Maria Ave.

### 7.5.4 Kastania Tank Offline Under Maximum Day Demand

This scenario is modeled with Kastania Tank offline and with buildout (FY 2035) maximum day demand data. The simulation shows that more nodes fall under the 35-psi pressure criterion in this scenario compared to losing the Stafford source connection. Similar to the previous scenario, nodes at dead ends and near water tanks often cannot meet the criterion. Additionally, the following areas see concentrated nodes failing the pressure criterion:

- nodes along Redwood Hwy, from Kastania tank until around Buck Center Drive.
- nodes along the north and west boundaries between No. Novato Subzone and San Mateo/Trumbull Subzone also fall under the criterion.
- nodes along De Long Ave between Redwood Blvd and Davidson Street.

[1] ICC Fire-flow Requirements for Buildings link
https://codes.iccsafe.org/content/IFC2018/APPENDIX-B-FIRE-FLOW-REQUIREMENTS-FOR-BUILDINGS

- nodes around Olive Elementary School, enclosed by Cherry Street, Chase Street, Willow Court and Rita Court.
- nodes along Atherton Ave between Bay Tree Hollow and Equestrian Court.
- nodes on the north side of Novato High School.
- nodes in the area enclosed by Margarita Terrace, Redwood Blvd and Royal Oak Terrace
- nodes in the area enclosed by Redwood Blvd and Rosewood Drive, northeast to the intersection of Redwood Blvd and Cricklewood Drive.

All pipes meet the maximum velocity criterion. Pipe segments that experience considerable (greater than 10ft/1000ft) head losses are:

- the 4-inch segment at the end of Lynwood Drive and the initial segment of the 12-inch pipe coming out of Lynwood Tank 2.
- the 6-inch pipe on Sierra Vista connecting mains on Grande Vista and Novato Blvd.
- the 12-inch main on Novato Blvd between Wilson Ave and Simmons Ln.
- the 6-inch Simmons Ln between Novato Blvd and Virginia Ave.
- the 6-inch line on Marion Ave between Winding Way and Valencia Court.
- a segment of the 12-inch line along Novato Blvd at the intersection of Novato Blvd and Eucalyptus Ave.
- the 12-inch segment along Center Road at the intersection of Tamalpais Ave and Center Rd.
- the 4-inch lateral branching out of the main at the end of Boulevard Terrace.
- the 6-inch line on Hill Road between Canyon Road and Paxton Villa Court.
- the 8-inch line on S. Novato Blvd between Pine Ave and Diablo Ave.
- the 8-inch connection pipe along Grant Ave from Railroad Ave to Reichert Ave.
- the 6-inch line connecting two 8-inch lines at the intersection of Yukon Way and Ford Way.
- the pipes along streets that start at the intersection of Redwood Blvd and Rowland Blvd and travels south along Rowland Blvd, east onto Leafwood Drive, then south along Sunset Pkwy and ends at the end of Lynwood Drive.
- the pipes along streets that start at the intersection of Cambridge Street and Sunset Pkwy and north along Sunset Pkwy then east to Lynwood Drive ending at Lynwood Tank 2.
- the 12-inch intertie between the two Zone 1 subzones, south to the intersection of Highway 101 and Highway 37.

### 7.5.5 Improvement Concepts and Simulated Results

The Zone 1 distribution system is very well looped north of Highway 37. The weakest area in regard to looping is the South Novato area south of Highway 37. Not all areas mentioned in Section 7.5.2 are suitable for cost-effective improvements. The following recommendations considered the District's input regarding buildability and cost-effectiveness of potential projects. Priority of improvements firstly applies to operation changes of existing facilities then to infrastructure upgrades or additions.

- The operational improvement that the model tested was opening Frosty Lane Intertie to the MMWD aqueduct to serve Bel Marin Keys commercial area, especially east to Galli Drive. Additions to available fire flows range from 30 gpm to 230 gpm. The District has also considered upgrading the existing intertie valve to be remotely opened to augment fire flows when needed, and remain closed at other times when water quality in Zone 1 tanks is diminished due to lack of tank turnover.

- New looping pipe near the intersection of Grant Ave. and Eighth Street – A new pipe (8-inch) connects the inner area northeast to Grant Ave. and Eighth Street to the 12-inch pipe on Grant Ave. With this new pipe, most deficient nodes can meet the pressure requirements under fire flow other than the ones on Marion Ave. Although this area requires fire flow of 3,500 gpm, it is likely that the buildings are equipped with sprinklers, potentially resulting in a smaller fire flow requirement, which may render the new looping pipe unnecessary.
- New looping pipes for shopping mall area northwest to the intersection of S. Novato Blvd and Nave Court – The worst location showed an available fire flow of 2,038 gpm. However, with one new pipe (8 inch) connecting the mall's 8-inch pipe to the 12-inch pipe on Redwood Blvd and another pipe (8 inch) closing the loop for all buildings within the area, all junctions are able to meet the pressure requirements under fire flow condition. Although this area requires fire flow of 3,500 gpm, it is likely that the buildings are equipped with sprinklers, potentially resulting in a smaller fire flow requirement, which may render the new looping pipe unnecessary.
- Replacing zone valve at Park Crest Court with PRV station – Junctions around Park Crest Court belong to two pressure zones, No. Novato Subzone (Zone 1) and Sunset Pacheco Subzone (Zone 2). Moreover, the fire demands are different as well, with northeast Zone 1 and Zone 2 nodes on Park Crest Court requiring 3,500 gpm and the southwest Zone 1 nodes 1,500 gpm. The "worst" node is a Zone 2 node on Park Crest Court, adjacent to the existing zone valve: only 1,758 gpm fire flow is available while the demand is 3,500 gpm. The focus of the improvement plan is to improve available fire flows at No. Novato Subzone nodes northeast to Park Crest Court. By replacing the zone valve at the end of Park Crest Court with a PRV to regulate downstream (No. Novato Subzone) pressure at 34 psi (elevation 62ft, HGL 140ft), almost all zone 1 nodes of concern with 3,500 gpm fire flow demand meet the residual pressure criterion.
- Upsizing main and connecting dead ends at George Street – Although the nodes are not severely under fire flow demand criterion, upsizing the main on George Street to an 8-inch line and connecting the two dead ends by an 8-inch line can improve water quality by moving stagnant water and creating operational redundancy, and at least, increasing available fire flows at junctions.
- Replacing zone valve at intersection of Arthur Street and Washington Street with PRV station – Parts of Novato High School's buildings are equipped with sprinklers which reduces the fire flow demands at those structures. Available fire flows north of the school on Arthur Street are as low as 1,902 gpm. Independent of the fire sprinklers, setting the PRV at 40 psi (elevation 46ft, HGL 138ft) increases available fire flows on Arthur Street in front of Novato High School by more than 1,000 gpm.
- Replacing zone valve with PRV station at the intersection of Feliz Road and Ferris Drive – the nodes in this area are close to meeting the 1,500 gpm fire flow demand criterion with the most insufficient node receiving 1,052 gpm available fire flow. Setting the PRV at 30 psi (elevation 62ft, HGL 131ft) drastically increases available fire flows along Feliz Road but moderately boosts the nodes along Driftwood Ave and Surf Way to about 1,400 gpm.

## 7.6 ZONE 2 HYDRAULIC ANALYSIS

Zone 2 serves elevations between elevation 60 feet and 200 feet. The zone generally has sufficient hydraulic capacity to satisfy buildout requirements, except for the Black Point and Air Base subzones. While some additional pumping capacity is required at buildout to increase firm pumping capacity, the two large pump stations with three pumps (San Marin PS and Lynwood PS) each provide operational flexibility and overall system reliability. Pressures fluctuate widely throughout the zone due to the widely varying elevations.

Table 7-4 summarizes the model input of Zone 2's water sources, tank levels, pump flows and intertie status under each evaluated scenario. Only certain pump stations identified by the District are turned on with their respective firm capacities. Although only certain pump stations are identified for pumping operation in this analysis, it is conservative to assume that water withdrawn/pumped from a lower zone to a higher zone is underestimated.

**Table 7-4**
**Zone 2 Model Parameters**

| **Model Run Scenario**<br>**Model Input Parameter** | **Peak Hour** | **Maximum Day + Fire Flow** | **Stafford WTP Offline under Maximum Day** | **Kastania Reservoir Offline under Maximum Day** |
|---|---|---|---|---|
| Multiplier | 2.80 | 1.77[1] | 1.77 | 1.77 |
| San Mateo Tank Water Elevation (ft) | 309 | 299 | 320 | 320 |
| Trumbull Tank Water Elevation (ft) | 307 | 295 | 308 | 308 |
| Sunset Tank Water Elevation (ft) | 312 | 298 | 323 | 323 |
| Pacheco Valle Tank Water Elevation (ft) | 314 | 308 | 322 | 322 |
| San Andreas PS Flow (gpm) | 0 | 0 | 0 | 0 |
| Trumbull PS Flow (gpm) | 680 | 680 | 680 | 680 |
| Ridge Road PS Flow (gpm) | 0 | 0 | 0 | 0 |
| Davies PS Flow (gpm) | 0 | 0 | 0 | 0 |
| Truman PS Flow (gpm) | 0 | 0 | 0 | 0 |
| Woodland Hts PS Flow (gpm) | 0 | 0 | 0 | 0 |
| Ponti PS Flow (gpm) | 250 | 250 | 250 | 250 |
| Winged Foot PS Flow (gpm) | 150 | 150 | 150 | 150 |
| Nunes PS Flow (gpm) | 0 | 0 | 0 | 0 |
| Indian Hills Hydro PS Flow (gpm) | 125 | 125 | 125 | 125 |
| Eagle Hydro PS Flow (gpm) | 228 | 228 | 228 | 228 |
| San Marin PS | 0 | 0 | 0 | 0 |
| Lynwood PS | 0 | 0 | 0 | 0 |

[1] Peaking factors are applied to domestic demands only. There is no peaking factor applied to the fire flows.

### 7.6.1 Peak Hour Demand Scenario

The peak hour demand scenario was simulated with buildout (FY 2035) demand data. Model results show that the majority of Zone 2 nodes meet the minimum pressure criterion with the exception of those in the immediate vicinity of water tanks and reservoirs. All pipes meet the maximum velocity criterion (10 fps). Almost all pipes meet the maximum head loss criterion (10ft/1000ft) with the following exceptions:

- a 2-inch looping pipe at Sinaloa Middle School
- the 4-inch looping pipe at the end of a 12-inch main near San Marion Drive and Santolina Drive
- the 2-inch lateral at the end of Los Robles Road
- the isolated 1-inch laterals along Pelican Lane
- the 10-inch pipeline connecting an 18-inch and 10-inch pipe southwest to intersection of Marin Valley Drive and Green Oak Drive
- the 12-inch pipe segment at the intersection of Sunset Pkwy and Shon Drive
- the 12-inch segment on Shevelin Road between Balra Drive and Sunset Pkwy

These are relatively minor exceptions that do not have a significant impact on day to day operations, so these areas were not explored further.

### 7.6.2 Maximum Day Demand + Fire Flow Demand Scenario

Based on the results, fire flow and pressure criterion cannot be met at several areas within Zone 2, primarily limited to isolated areas served by a single pipeline, higher elevations within the zone, and scattered locations at the extremities of the zone furthest away from the storage tank sites.

Areas that do not have enough fire-flow availability are summarized below:

<u>San Mateo/Trumbull Subzone</u>

- Nodes around the Sinaloa Middle School south to Vineyard Road with fire flow of 3,500 gpm. This area is surrounded by 6-inch pipelines. Available fire flow in this area is approximately 3,000 gpm, with the most deficient node receiving 2,630 gpm under fire flow conditions. If the school buildings are sprinkled, the fire flow requirement would be less than 3,500 gpm.

<u>Sunset/Pacheco Subzone</u>

- nodes at the west ends of Elmview Way and the end of Owens Drive, both with fire flow requirement of 3,500 gpm. These areas are served with one single 8-inch pipeline and one 6-inch pipeline.
- nodes at west extremities of Posada Del Sol (including at west end of Cielo Lane) with fire flow requirement of 3,500 gpm. This area is served with one-single 8-inch pipeline.
- nodes at southside of College of Marin Indian Valley Campus/Ignacio Blvd with fire flow requirement of 3,500 gpm. The nodes are served with two single 12-inch pipelines from two directions. There is a strong possibility that the campus is sprinkled, resulting in a lower fire flow requirement.

- nodes on Prestwick Court, Capilano Drive and along Fairway Drive with fire flow requirement of 1,500 gpm. These areas are served with one single 8-inch pipeline.
- nodes along Cheda Knolls Drive and within intersecting roads with fire flow requirement of 3,500 gpm. These areas are fed by a single 12-inch pipeline that narrows to 8-inch and eventually 4-inch.
- nodes along Birchwood Drive with fire flow requirement of 3,500 gpm. These nodes are served with a single 9-inch pipeline diverted to two directions.
- nodes along Park Crest Court with fire flow requirement of 3,500 gpm. Half of the nodes on Park Crest Court are served by the same 8-inch line on Birchwood Circle and the other half by a 6-inch pipeline. Neither pipeline is well looped at Park Crest Court.
- nodes in the southern areas of the College of Marin Indian Valley Campus. The campus is served by a single 16-inch pipeline with a 12-inch looping pipe. More than half of the fire nodes around and inside the campus meet the 3,500 gpm fire flow demands, except for the ones in the Southern half of the campus, with lowest available fire flow of 2,122 gpm.

<u>Crest Subzone</u>

- nodes south to Sunset Trail, mostly along north-south crossing lines to Crest Road with 1,500 gpm fire flow requirement. This area is mostly fed by a single 8-inch pipeline that cannot meet the residual pressure criterion due to high elevations in this area.

<u>Black Point Subzone</u>

- more than half of Black Point nodes do not meet the fire flow criterion, of both 3,500 gpm and 1,500 gpm. Areas requiring 3,500 gpm are mostly industrial establishments northeast to the intersection of Harbor Drive and Renaissance Road. The entire Black Point Subzone is poorly looped and is fed primarily by the Crest Tanks. Additionally, and more importantly, many of these areas are served from 4-inch and 6-inch mains that do not have adequate capacity to satisfy fire flow criteria.

Analysis of fire flows to the schools in Zone 2 was also conducted. Schools located in Zone 2 include San Marin High (Node 2329), Pleasant Valley Elementary (Node 2467), Sinaloa Middle School (Node 2453), Indian Valley College (Node 2713), San Jose Middle School (Node 2703), Loma Verde Elementary (Node 2775) and San Ramon Elementary (Nodes 12-127 and 12-128). At most school locations (other than Sinaloa Middle School) the residual pressures are well above 20 psi.

### 7.6.3 Stafford WTP Offline Under Maximum Day Demand

This scenario is modeled with Stafford Water Treatment Plant offline and with buildout (FY 2035) maximum day demand assumptions. The simulations show that almost all Zone 2 nodes meet the minimum pressure criterion (35 psi under maximum day demand scenarios), except at dead ends or in vicinity of water tanks. All pipes in Zone 3 meet the maximum velocity criterion (10 fps). Almost all pipes meet the maximum head loss criterion except for a few isolated locations. Pipe segments that experience excessive head losses are:

- the 8-inch segment connecting 12-inch lines at the intersection of Center Road and Sutro Ave.
- the 2-inch looping pipe of the 6-inch pipe on the west side of Sinaloa Middle School.
- the 12-inch segment at the intersection of Sunset Pkwy and Shon Drive.
- the 10-inch connection segment connecting a 12-inch and an 18-inch pipelines just north to the end of Green Oak Drive.
- the first run of the 12-inch pipeline connected to the Airbase Tank.

### 7.6.4 Kastania Reservoir Offline Under Maximum Day Demand

This scenario is modeled with Kastania Reservoir offline and with buildout (FY 2035) maximum day demand data. Similar to the previous scenario, nodes that fall under the 35-psi pressure criterion are generally adjacent to dead ends and near water tanks.
All pipes meet the maximum velocity criterion and the pipe segments that fall under the head loss criterion are as the following:

- the 2-inch looping pipe of the 6-inch pipe on the west side of Sinaloa Middle School;
- the 10-inch connection segment connecting a 12-inch and an 18-inch pipelines just north to the end of Green Oak Drive;
- the first run of the 12-inch pipeline connected to the Airbase Tank;

### 7.6.5 Improvement Concepts and Simulated Results

Not all areas mentioned in Section 7.6.2 are suitable for cost-effective improvements. The following recommendations considered the District's input regarding buildability and cost-effectiveness of potential projects.

- [1]San Mateo Tank connection pipeline – In any fire flow event during maximum day demand, the San Mateo Tank inlet/outlet line exhibits high head loss. This high head loss lowers the hydraulic grade line in the northern portion of the zone. The 2012 Master Plan identified a new 24-inch pipeline that connects the 12-inch pipeline on San Mateo Way to San Mateo Way Tank, and construction is planned to be occur by 2020. This new pipeline will be able to alleviate the pressure deficiency under fire flows for the north and west junctions around Sinaloa Middle School but not the east junctions. Although this institutional area requires fire flow of 3,500 gpm, it is likely that the buildings are equipped with sprinklers, potentially resulting in a smaller fire flow requirement.
- [2]New 16-inch pipeline along Indian Valley Fire Road – The 2012 Master Plan recommended that the District install a 16-inch pipeline with College of Marin to connect to Davies Pump Station. This new pipeline helps alleviate the deficit of residual pressures of junctions south of College of Marin Indian Valley Campus by approximately 400 gpm, yet most of the insufficient junctions will remain below the fire flow pressure criterion. Therefore, this project is not recommended for the sole purpose of increasing fire flow availability.

[1] This previously proposed project is currently on-going and will not be added in Section 9 nor Section 10 as a new CIP project, nor presented in Attachment 1.
[2] This previously identified project is remodeled and re-estimated in Section 9 and 10. Davies Pump Station is not online in the overall model but turned on with firm capacity (30 gpm) to test the impact of this project, presented in Attachment 1.

- New pipe connecting Los Robles Road and Posada Del Sol – Installing a new pipe (8-inch) to connect the two 8-inch pipes on Los Robles Road and Posada Del Sol resolves the deficit in residual pressure near the dead ends of Cielo Lane.
- Construct a PRV intertie station on Fairway Drive – Nodes on the north side of Fairway Drive belong to Sunset-Pacheco (Zone 2) while those on the south side are connected to Winged Foot (Zone 3). The nodes of concern are those along Fairway Drive and along Capilano Drive. Adding a PRV at the intersection of Fairway Drive and Thornhill Court with a setting of 74 psi (HGL 271ft, elevation 100ft) helps mitigate the residual pressure deficit for most of the junctions on Fairway Drive and Capilano Drive, other than the last node at the end of Prestwick Court. Additionally, simulation of adding a new looping pipe (8 inch) that connects the dead ends of Capilano Way and Olympia Way, with the Eagle Hydropneumatic pumps on and off, results in very similar residual pressure results for all nodes in this area, which could allow the District to remove the Eagle Hydropneumatic zone.
- Upsizing small water mains in East Crest Subzone and Black Point Subzone – These areas are all within Zone 2 but regulated by gate valves and PRV stations. Usually, the gate valves are closed and PRV stations are on. Various combinations of valve and PRV operations were tested, however to little avail. Replacing the existing 4-inch and 6-inch water mains with 8-inch pipes, especially for roads east of Grandview Ave., will allow the system to deliver closer to the required 1,500 gpm fire flows.

## 7.7 ZONE 3 HYDRAULIC ANALYSIS

Table 7-5 summarizes the model input of Zone 3's water sources, tank levels, pump flows and intertie status under each evaluated scenario. Although not every pump station is turned on, it is remote the water withdrawn from Zone 3 to Zone 4 is underestimated.

**Table 7-5**
**Zone 3 Model Parameters**

| **Model Run Scenario**<br>**Model Input Parameter** | **Peak Hour** | **Maximum Day + Fire Flow** | **Stafford WTP Offline under Maximum Day** | **Kastania Reservoir Offline under Maximum Day** |
|---|---|---|---|---|
| Multiplier | 2.80 | 1.77[1] | 1.77 | 1.77 |
| Center Road Tank Water Elevation (ft) | 515 | 505 | 526 | 526 |
| Cherry Hill Tanks Water Elevation (ft) | 426 | 421 | 434 | 434 |
| Dickson Tank Water Elevation (ft) | 414 | 402 | 424 | 424 |
| Garner Tank Water Elevation (ft) | 477 | 471 | 485 | 485 |
| Half Moon Tank Water Elevation (ft) | 471 | 471 | 475 | 475 |
| Nunes Tank Water Elevation (ft) | 404 | 399 | 411 | 411 |
| Old Ranch Road Tank Water Elevation (ft) | 523 | 523 | 527 | 527 |

[1] Peaking factors are applied to domestic demands only. There is no peaking factor applied to the fire flows.

| | | | | |
|---|---|---|---|---|
| Ponti Tank Water Elevation (ft) | 426 | 420 | 433 | 433 |
| San Andreas Tank Water Elevation (ft) | 540 | 534 | 546 | 546 |
| San Antonio Tank Water Elevation (ft) | 493 | 489 | 499 | 499 |
| Wild Horse Valley Tank Water Elevation (ft) | 515 | 505 | 526 | 526 |
| Windhaven Tank Water Elevation (ft) | 416 | 414 | 418 | 418 |
| Winged Foot Tank Water Elevation (ft) | 527 | 516 | 537 | 537 |
| Cherry Hill PS Flow (gpm) | 0 | 0 | 0 | 0 |
| Buck PS Flow (gpm) | 100 | 100 | 100 | 100 |
| Upper Wild Horse PS Flow (gpm) | 0 | 0 | 0 | 0 |
| Cabro Court PS Flow (gpm) | 0 | 0 | 0 | 0 |

### 7.7.1 Peak Hour Demand Scenario

The peak hour demand scenario is run with buildout (FY 2035) demand data. The simulation shows that most Zone 3 nodes meet the minimum pressure criterion (30 psi) other than those in vicinity of water tanks and reservoirs. All pipes meet the maximum velocity criterion (10 fps). Almost all pipelines meet the maximum head loss criterion (10ft/1000ft) except for the initial 4-inch segment of the 8-inch pipeline connected to Nunes Tank.

### 7.7.2 Maximum Day Demand + Fire Flow Demand Scenario

The model was run under FY 2035 maximum day demand plus a fire flow located individually at each of the model nodes. Zone 3's fire flow demand is primarily 1,500 gpm. A small business park east of Highway 101 should be capable of 3,500 gpm fire flow; however, this is a very small portion of the zone near Delong Ave. and Reservoir Drive.

In Zone 3, the areas that are most vulnerable consist of the following:

<u>Cherry Hill Subzone</u>

- nodes at north Robinhood Drive and Cherry Ridge Fire Road with fire flows of 1,500 gpm. These nodes are served with a single 8-inch pipeline connected to Cherry Hill Tank 1. These nodes cannot meet the minimum residual criterion due to high elevations being served.
- nodes along Reservoir Drive and east end of De Long Ave with fire flow demands of 3,500 gpm. Although the pipes in this area are not well-looped and nodes are at relatively high elevations, the available fire flows in this area are close to the demand criterion, with the most insufficient node receiving 2,316 gpm of fire flow.

Half Moon Subzone

- nodes along Half Moon Road with fire flows of 1,500 gpm. The nodes are served with one single 8-inch pipeline directly connected to Half Moon Tank. Available fire flows on Half Moon Road are below 340 gpm. Looping Forrest Road to Half Moon Road did not improve fire flows on Half Moon Road. Modeled nodes on Ridge Road typically show flows in excess of 1,500 gpm.

Garner Subzone

- nodes along Garner Drive with fire flows of 1,500 gpm. These nodes are at high elevations and close to the Garner Pump Station. Available fire flows are generally above 1,100 gpm.

Dickson Subzone

- nodes along Arlington Circle and Woodland Court with fire flows of 1,500 gpm. They are served with two single 8-inch pipelines. These nodes are at high elevations relative to the rest of the zone. Available fire flows can exceed 1,020 gpm for nodes at elevation below 240 ft, but they drop below 450 gpm as the elevation increases above elevation 240 ft.

Wild Horse Valley/Center Road Subzone

- nodes at the end of Wilson Ave. (past Tanglewood Lane) with 1,500 gpm of fire flow demands. This location is the dead ends of an 8-inch line.

### 7.7.3 Stafford WTP Offline Under Maximum Day Demand

This scenario is modeled with Stafford Water Treatment Plant offline and with buildout (FY 2035) maximum day demand assumptions. The simulations show that all pipes in Zone 3 meet the maximum velocity criterion (10 fps). Almost all Zone 3 nodes generally meet the minimum pressure criterion (35 psi under maximum day demand scenarios), except at dead ends or in vicinity of water tanks. Almost all pipes meet the maximum head loss criterion except for a few isolated locations. Pipe segments that experience excessive head losses are:

- the southern half of the 8-inch main along Woodland Court

### 7.7.4 Kastania Reservoir Offline Under Maximum Day Demand

Similar to the previous scenario, nodes that fall under the 35-psi pressure criterion are generally adjacent to dead ends and near water tanks. All pipes meet the maximum velocity criterion, Pipe segment that experience excessive head losses are:

- the southern half of the 8-inch main along Woodland Court

### 7.7.5 Improvement Concepts and Simulated Results

There are no viable improvement projects identified for Zone 3 given that the deficiencies relate to the static head available at some of the nodes with high elevations (relative to the tank serving those nodes).

## 7.8 ZONE 4 HYDRAULIC ANALYSIS

**Table 7-6**
**Zone 4 Model Parameters**

| Model Run Scenario<br>Model Input Parameter | Peak Hour | Maximum Day + Fire Flow | Stafford WTP Offline under Maximum Day | Kastania Reservoir Offline under Maximum Day |
|---|---|---|---|---|
| Multiplier | 2.80 | 1.77[1] | 1.77 | 1.77 |
| Buck Tank Water Elevation (ft) | 569 | 565 | 574 | 574 |
| Cabro Court Water Elevation (ft) | 612 | 611 | 613 | 613 |
| Upper Wild Horse Valley Tank Water Elevation (ft) | 635 | 635 | 640 | 640 |

### 7.8.1 Peak Hour Demand Scenario

The peak hour demand scenario is run with buildout (FY 2035) demand data. The simulation shows that the majority of Buck Zone and Upper Wild Horse Valley Zone nodes meet the minimum pressure (30 psi) criterion other than those in vicinity of water tanks and reservoirs. All pipes meet the maximum pipe velocity criterion (10fps) and head loss criterion (10ft/1000ft).

### 7.8.2 Maximum Day Demand + Fire Flow Demand Scenario

There are no significant areas of nodes with insufficient residual pressure under buildout maximum day plus fire flow scenario.

### 7.8.3 Improvement Concepts and Simulated Results

There are no viable improvement projects identified for Zone 4.

[1] Peaking factors are applied to domestic demands only. There is no peaking factor applied to the fire flows.

# SECTION 8

# ASSET MANAGEMENT

## SECTION 8

## ASSET MANAGEMENT

### 8.1 BACKGROUND

The District's Asset Management (AM) Program is a staff-driven program. In December 2007, the NMWD Board accepted their first Infrastructure Repair/Replacement Plan as part of the 2007 Master Plan Update. From this effort, staff recommended defining AM for NMWD as a long-range planning document that can be used to promote a deeper understanding of the following:

- District owned assets, their current physical condition, and the services that they provide;
- The present and future demands on District assets that are critical for delivering a defined level of service to customers and the community;
- Current estimates of the short-term and long-term financial requirements (both capital and operational) necessary to maintain the assets and the services that they provide;
- The current and proposed policies, strategies, and programs that are necessary to meet the long-term provision of services;
- Business risk exposure associated with the potential failure of the assets required to meet the expected service levels;
- Linkages necessary between strategic business objectives and the service that the assets are delivering; and
- The organizational continuity that will span staffing changes and the transfer of asset management knowledge between successive generations of utility managers and staff.

It is intended that the inclusion of a 5-year AM Plan will be incorporated as part of the NMWD ongoing Master Plan process.

The District's AM Plan has a short-term focus (five years) within the AM Program of the longer-term period (100 years) covering a full length life cycle encompassing all assets. It is based on a set of systematic planning activities to assess asset performance and demands, improve reliability of asset performance, improve forecasts for both capital and operational budgets based on asset performance and reliability needs, identify and quantify business risks and trends, formulate and evaluate both capital and operational options for meeting service levels, and plan continuous improvements related to delivering the lowest life cycle cost service solutions.

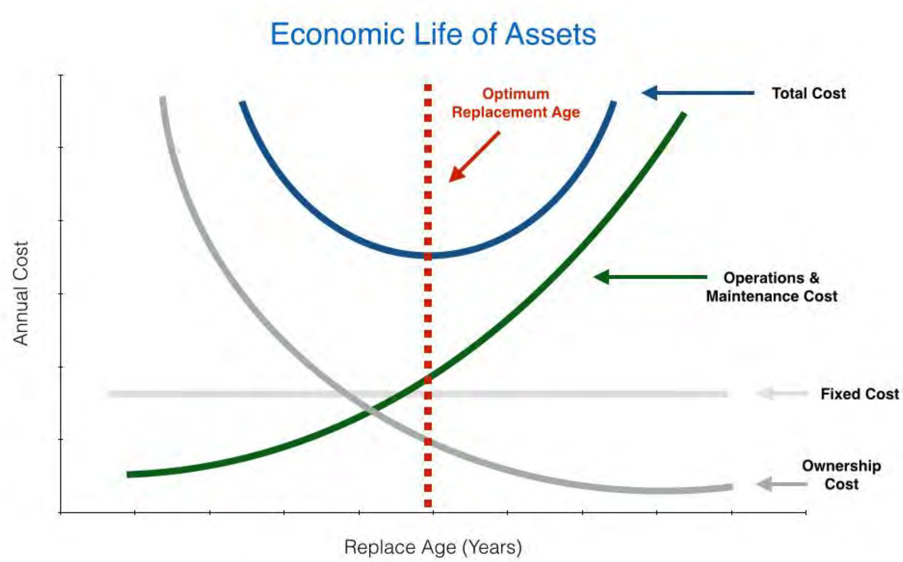
AM Program Development & Planning is related to the assets that are currently owned and will be owned in the future, and how the business decisions related to these assets will affect the District's ability to sustain asset performance and consequently sustain provision of economical services to its customers. NMWD has traditionally performed many of these tasks across the organization; however, the results of this work have not been collated into a single, concise document to allow the organization to clearly understand the overall business planning ramifications.

## 8.2 AM PROGRAM OBJECTIVES AND GOALS

The District's mission is to *"meet the expectations of our customers in providing potable and recycled water and sewer services that are reliable, high-quality, environmentally responsible, and reasonably priced".* Accordingly, it is appropriate that the goals of the District's AM Plan are to: (1) improve water system reliability by reducing system failure rates; (2) minimize the time and money spent reacting to problems through proactive implementation of necessary AM maintenance and improvement projects; (3) forecast exhausted asset replacement costs; and (4) develop a practical replacement plan.

Without an effective AM Program, infrastructure reliability cannot be achieved in a cost-effective manner. As an example, consider the graphical illustration in Figure 8-1 depicting total cost as a function of operation and maintenance cost, ownership cost and fixed cost. The graph illustrates there is an optimal point at which replacement costs are lowest.

**Figure 8-1**
**Level of Planned Maintenance**




The Novato service area is substantially built-out, and more of the daily construction and maintenance activities have switched from new construction to repair and replacement (R&R) of aging infrastructure. In addition, a greater percentage of funds for these R&R projects come from District operating revenues and not connection fees associated with new development.

Managing water facility infrastructure R&R projects has always been a part of the District's annual Capital Improvement Project budgeting process. However, in the past, many of the R&R projects have been developed based primarily on an intuitive process utilizing the knowledge of senior construction and maintenance staff. Since the District has been losing much of this historical and institutional knowledge due to retirements, it is important that the program moves forward with a fact-based or Enterprise Asset Management (EAM) plan rather than one that is intuitive-driven.

In 2017, District staff developed a plan to further its AM objectives. A consultant (Soft Resources) was hired to assist the District by providing AM software selection consulting services. The last 5-10 years have seen a proliferation of new AM software services and products being offered by numerous companies, including technology and understanding that was not part of the District skill set. Soft resources provided the following services for the District over a 9-month period from September 2017 – June 2018 including:

- Conduct requirements analysis and develop NMWD Key Requirements document for an AM solution.
- Conduct vendor analysis for AM software (limited to a long list of 6-8 vendors based on SoftResources recent experience conducting AM software evaluation for other organizations) and recommend a short list of approximately three software solutions that could meet NMWD's Key Requirements.
- Develop a Software Demo Script and facilitate software demos with short listed vendors.
- Provide support to assist NMWD with their final decision.

The process to develop key requirements for the District was informative. Currently, the District relies on multiple software programs and databases to perform specific discrete tasks which have some relationship to AM. Staff had to evaluate their interrelationships, and determine which programs should be would be best suited for migration into new AM software. Ultimately, after working through the tasks listed above, the District has determined that one company in particular (NEXGEN) offers the best AM software solution for the District.

The process of implementing new software and associated procedures will be a lengthy and challenging task. Starting in early 2019, the duration is estimated to require 6-12 months, and will included the following tasks:

- Identify and document user requirements based on user needs. Identify business processes required to support functional requirements. Develop a data conversion plan.
- Migrate all vertical assets and horizontal assets not included in GIS into the EAM software.
- Configure EAM to support user requirements and business processes. Configure resources and create Work Order Type, Tasks, Cause and Resolution by department. Configure Backflow Program processes.
- Integrate District GIS containing all horizontal assets.
- Test the system, resolve issues and optimize configurations.
- Provide on-site training and support both pre- and post-deployment.

## 8.3 CURRENT ASSETS

### 8.3.1 Asset Categories

The Novato water system includes the following major components:

- 31 potable storage tanks
- 3 abandoned tanks and 3 recycled water tanks
- 26 pump stations
- 13 pressure regulating stations
- 7 hydro-pneumatic systems

- 321 miles of pipeline
- 2,659 fire hydrants
- 8,430 valves
- 20,838 service connections (includes active, inactive and closed status for both potable and recycled)

### 8.3.2 Asset Value

Asset values for District infrastructure installed over time are shown in Fig. 8-2. The asset values were derived from original installation costs and are adjusted for inflation (Year n value = $Year_{n-1}$ value x ($CCI_n/CCI_{n-1)}$ + current year asset costs). Current infrastructure asset values are in excess of $330 million. Most of the District's assets are associated with buried facilities (i.e., transmission and distribution pipelines and appurtenances). Accordingly, the following discussion will focus on NMWD's buried assets (horizontal) so that the AM Plan is focused on the greatest financial obligation for the District. Expansion of the Plan to include above-ground (vertical) infrastructure such as storage tanks, treatment plants and pump stations will occur at a later date after more experience is gained with this step and following implementation of asset management software programming.

### 8.3.3 Recent Improvements

As part of ongoing AM and business planning processes with NMWD, the following efforts continue:

- Best appropriate practices for AM, as well as current implementation of asset management software (NEXGEN); and
- Development of tools for decision analysis and implementation of asset management practices. This includes a cost tool and a risk analysis tool that helps to compare NMWD AM practices to those of other utilities. These tools will allow NMWD to benchmark against other utilities.

### 8.3.4 Levels of Service

Work in this area of the AM Program has not been updated since the previous Plan update in 2012. NMWD will develop a summary of its present and future Levels of Service requirements and incorporate into the current implementation of asset management software, and will be described more fully in the next Plan period.

### 8.3.5 Focus Area

Whether planned or unplanned, maintenance costs associated with District facilities have been trending higher as the District's assets have expanded and aged over time. Figure 8-3 provides annual and 10-year running average expenditures (FY 2017 dollars). Since the prior 2012 Plan, annual maintenance expenditures have averaged $1.4 million. When compared against the total FY 2017 Operating Budget of $10.88 million (includes only source of supply expense, pumping, operations, water treatment and transmission & distribution), maintenance costs account for about 13% of the budget. A tabulation of total maintenance costs for the District's nine categories (from FY 84 to FY 17) is provided in Table 8-1. This tabulation shows that maintenance of water service lines (both copper and PB, polybutylene) consumed approximately 40% of the annual maintenance costs during this period. Note that the identified costs do not include major replacement projects that are typically budgeted as Capital Improvement Projects. Furthermore, some large repair projects are not included in the aforementioned costs since they too are budgeted as a Capital Improvement Project. For example from FY 13 - FY 17, capital costs for PB Service replacements = $494K; and Detector Check Assembly replacements = $358K. For FYs 19 through FY 23, NMWD has planned respective costs of $600K and $460K over this five-year period for more of this same type of aging facility replacement.

# Figure 8-2
# Asset Value History

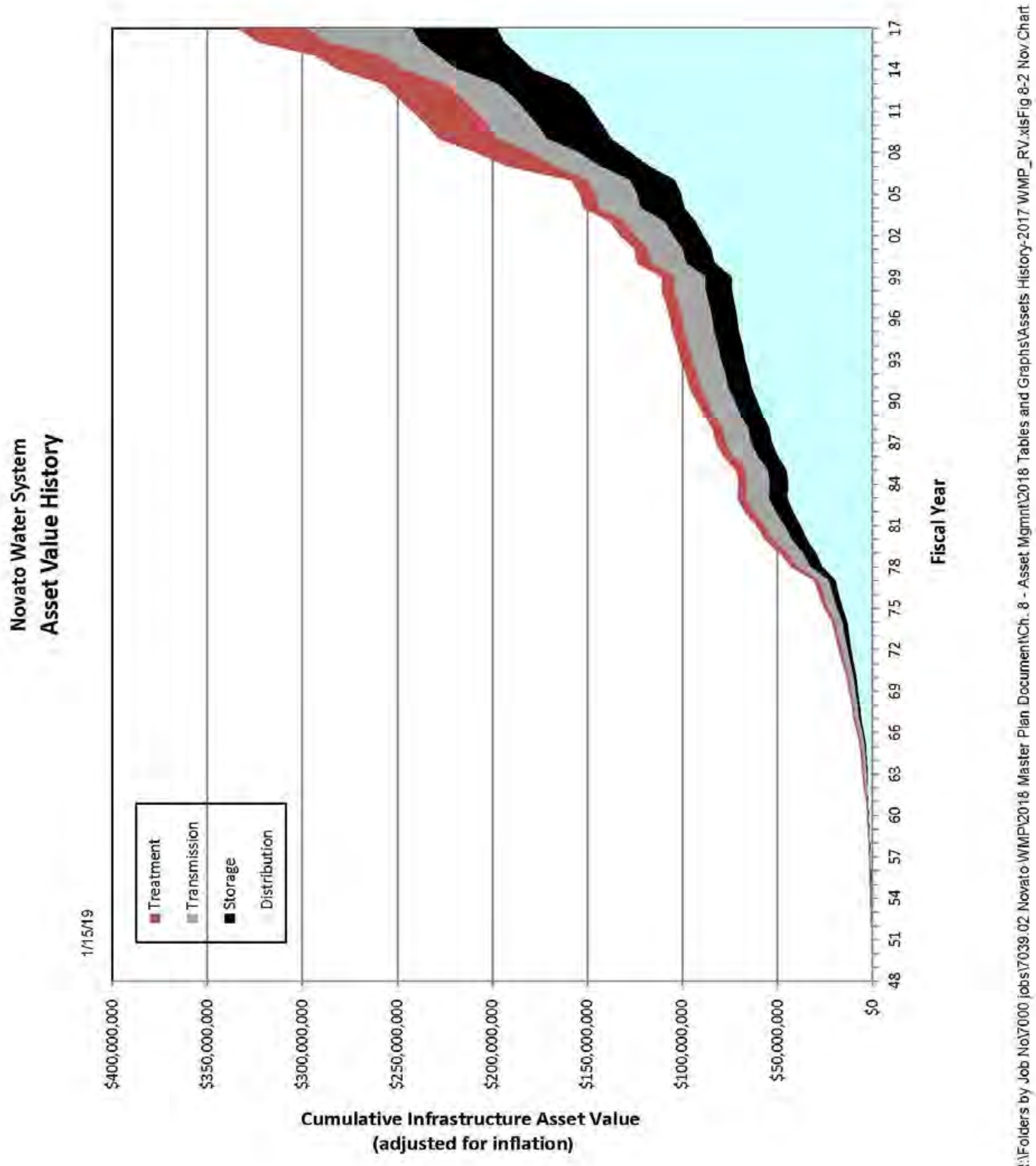
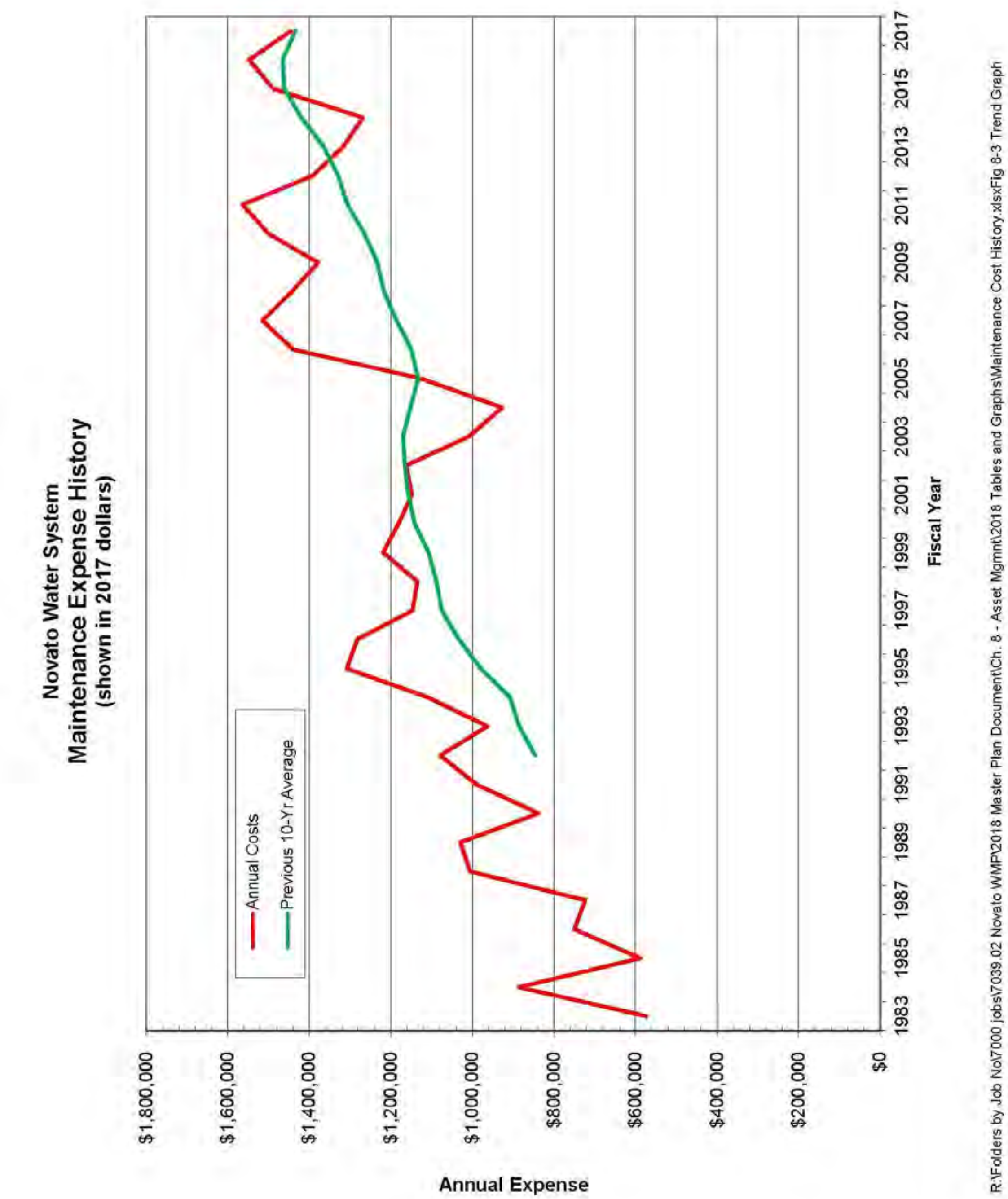


**Figure 8-3**
**Maintenance Expense History**



## Table 8-1
## Total Annual Maintenance Costs (shown in 2017 dollars)
## Novato Service Area

Table 8-1
Total Annual Maintenance Costs (shown in 2017 dollars)
Novato Service Area

| | Detector Check Assembly Maint | Maintenance of Hydrants | Backflow Prevention Program | Maintenance of Mains | Maintenance of Storage Facilities | Maintenance of Valves & Reliefs | Maintenance of Meters | Maintenance of PB Service Lines | Maintenance of Copper Services | Annual Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **FY 2017** | $72,208 | $51,020 | $155,536 | $149,584 | $141,046 | $196,162 | $66,356 | $473,695 | $138,832 | **$1,444,439** |
| **FY 2016** | $55,389 | $34,816 | $152,509 | $204,767 | $133,164 | $192,158 | $101,879 | $540,269 | $132,788 | **$1,547,740** |
| **FY 2015** | $69,109 | $26,966 | $164,591 | $140,280 | $168,969 | $159,442 | $105,531 | $454,936 | $199,185 | **$1,489,010** |
| **FY 2014** | $56,348 | $23,838 | $159,114 | $77,660 | $127,489 | $98,677 | $101,592 | $442,614 | $180,768 | **$1,268,101** |
| **FY 2013** | $8,554 | $32,194 | $115,476 | $98,063 | $84,025 | $132,358 | $105,346 | $545,014 | $195,676 | **$1,316,706** |
| **FY 2012** | $43,327 | $38,379 | $95,682 | $56,385 | $140,671 | $149,360 | $153,495 | $500,929 | $213,186 | **$1,391,413** |
| **FY 2011** | $42,058 | $58,008 | $142,987 | $169,129 | $170,302 | $219,877 | $168,387 | $400,666 | $192,286 | **$1,563,699** |
| **FY 2010** | $49,183 | $91,175 | $110,958 | $121,467 | $185,775 | $225,168 | $170,059 | $312,107 | $233,615 | **$1,499,508** |
| **FY 2009** | $36,769 | $75,731 | $104,478 | $131,158 | $171,416 | $158,103 | $178,627 | $301,536 | $220,623 | **$1,378,442** |
| **FY 2008** | $33,439 | $94,320 | $137,421 | $181,222 | $151,305 | $135,551 | $170,925 | $363,408 | $174,600 | **$1,442,191** |
| **FY 2007** | $44,186 | $54,913 | $98,483 | $154,773 | $149,270 | $214,411 | $162,044 | $334,578 | $301,697 | **$1,514,356** |
| **FY 2006** | $23,289 | $59,528 | $89,071 | $219,122 | $169,240 | $182,689 | $157,901 | $228,663 | $309,904 | **$1,439,406** |
| **FY 2005** | $20,401 | $48,797 | $69,696 | $145,947 | $169,160 | $125,439 | $151,322 | $137,111 | $257,427 | **$1,125,299** |
| **FY 2004** | $24,804 | $35,138 | $63,798 | $93,804 | $134,786 | $112,730 | $146,309 | $149,363 | $166,126 | **$926,858** |
| **FY 2003** | $18,933 | $76,573 | $74,049 | $97,363 | $111,868 | $88,527 | $193,227 | $163,232 | $184,806 | **$1,008,577** |
| **FY 2002** | $13,190 | $48,425 | $87,614 | $86,520 | $204,778 | $173,148 | $225,818 | $168,600 | $154,764 | **$1,162,856** |
| **FY 2001** | $38,829 | $49,719 | $68,927 | $113,060 | $165,727 | $135,209 | $208,196 | $147,213 | $220,859 | **$1,147,739** |
| **FY 2000** | $14,064 | $69,503 | $64,155 | $173,514 | $179,922 | $151,630 | $222,884 | $131,566 | $173,714 | **$1,180,952** |
| **FY 1999** | $15,997 | $22,721 | $85,666 | $131,362 | $178,890 | $208,095 | $233,170 | $166,168 | $176,668 | **$1,218,738** |
| **FY 1998** | $4,027 | $45,975 | $87,708 | $127,838 | $160,557 | $78,557 | $239,230 | $243,180 | $147,580 | **$1,134,652** |
| **FY 1997** | $22,372 | $81,812 | $58,202 | $101,928 | $163,920 | $167,036 | $273,662 | $213,856 | $64,096 | **$1,146,885** |
| **FY 1996** | $9,949 | $28,167 | $77,967 | $108,829 | $129,769 | $151,159 | $302,717 | $400,578 | $73,172 | **$1,282,306** |
| **FY 1995** | $105,512 | $35,166 | $89,227 | $123,349 | $132,277 | $166,203 | $147,260 | $195,372 | $313,630 | **$1,307,995** |
| **FY 1994** | $0 | $49,285 | $96,511 | $75,922 | $153,890 | $163,714 | $91,550 | $122,211 | $356,506 | **$1,109,589** |
| **FY 1993** | $15,025 | $74,529 | $79,874 | $64,482 | $102,102 | $166,012 | $62,303 | $118,687 | $279,945 | **$962,960** |
| **FY 1992** | $283 | $22,005 | $58,929 | $115,812 | $89,512 | $152,742 | $130,903 | $168,015 | $340,502 | **$1,078,702** |
| **FY 1991** | $0 | $19,555 | $73,069 | $65,437 | $84,687 | $143,040 | $82,686 | $199,250 | $322,722 | **$990,446** |
| **FY 1990** | $22,373 | $48,465 | $95,444 | $78,938 | $59,595 | $119,432 | $46,656 | $102,555 | $264,270 | **$837,728** |
| **FY 1989** | $25,867 | $30,747 | $123,960 | $51,632 | $120,903 | $119,186 | $95,869 | $195,647 | $265,622 | **$1,029,434** |
| **FY 1988** | $73,838 | $55,447 | $12,520 | $78,899 | $101,589 | $97,483 | $78,836 | $267,555 | $239,563 | **$1,005,731** |
| **FY 1987** | $27,453 | $35,905 | $20,457 | $40,931 | $65,201 | $76,217 | $66,879 | $204,257 | $185,166 | **$722,466** |
| **FY 1986** | $21,472 | $68,332 | $20,142 | $65,186 | $59,813 | $76,668 | $60,647 | $172,426 | $205,428 | **$750,115** |
| **FY 1985** | $0 | $17,872 | $37,638 | $73,092 | $51,892 | $62,278 | $61,408 | $89,149 | $194,238 | **$587,567** |
| **FY 1984** | $0 | $55,608 | $1,684 | $130,083 | $239,672 | $161,322 | $81,323 | $0 | $216,275 | **$885,966** |
| **Category Total** | **$1,008,251** | **$1,660,633** | **$2,973,544** | **$3,847,536** | **$4,653,182** | **$4,959,783** | **$4,844,998** | **$8,654,405** | **$7,296,241** | **$39,898,574** |

R:\Folders by Job No\7000 jobs\7039.02 Novato WMP\2018 Master Plan Document\Ch. 8 - Asset Mgmnt\2018 Tables and Graphs\Maintenance Cost History.xlsxTable 8-1

## 8.4 ASSET CONDITION AND PERFORMANCE ASSESSMENT

Since the focus of this Plan is buried infrastructure, there are limited methods readily available to assess overall condition, performance and remaining useful life for water facilities installed below grade. Although the District collects a significant amount of information regarding maintenance costs and line breaks, the planning of repair and replacement projects has primarily been based on the institutional knowledge base of senior staff. While this approach has its merits, it should not serve as the sole source of asset management planning. Historically, the District has been "data rich" but "knowledge poor" when it comes to reporting and analyzing much of this data. Efforts have been made and/or are in progress to help move the District from an intuitive based R&R decision process to a data-based R&R decision process. These improvements include:

- Implementation of (EAM) software which includes work orders
- Improved tagging, filing, and diagnosis of worn facilities taken out of the ground when performing repairs
- Improved proactive subsurface investigation program to better quantify areas of poor infrastructure condition
- Refinement of the District's GIS system that will ultimately allow expansion of the existing facility map database to serve as a key database repository for infrastructure information (in progress)
- Development of asset condition & evaluation matrices which will be incorporated in the new asset management software
- Better characterization of existing asset inventory
- Better exchange of information between NMWD departments as it relates to condition assessment/repair

### 8.4.1 Condition/Performance

Historically, service lines have been the highest costs for maintenance activities, most of which have been unplanned due to the randomness of both plastic and copper failures. Since the early 2000's, staff has focused effort to better understand the modes of these failures and have identified key aspects to help plan replacements and extend service life. All new copper service installations require cathodic protection anodes as well as adding anodes to existing copper service installations. Moving forward, specific testing methods will be further refined to aid in condition assessments.

### 8.4.2 Inventory of Assets

The average age and replacement cost of NMWD assets is increasing steadily over time. As a consequence, NMWD must anticipate that a larger portion of capital expenditures will be dedicated to repair and replacement type projects, and that overall annual capital improvement costs will rise. More focus will be required to ensure that appropriate operation and maintenance strategies are being applied in consideration of the varying ages and conditions of the assets being maintained in order to extend service life where financially prudent to do so.

As previously mentioned under the Current Assets section, NMWD's assets can generally be categorized into two simple groups: those assets which are below ground (horizontal) and those which are above ground (vertical). Below-ground assets include transmission and distribution (T&D) pipelines and appurtenances (valves and regulators). Above-ground assets include storage and hydropneumatic tanks, pump stations, regulating stations, fire hydrants, administrative and treatment facilities, service connections (meters), and backflow prevention assemblies (BFPAs).

Figure 8-4 represents the history and age profile by material type for pipelines (horizontal assets). Figure 8-5 provides similar data for hydrants (vertical assets). Additional information for vertical assets including storage tanks, hydropneumatic systems and pump stations can be found in Section 3 of this Plan. The monitoring (testing) of BFPAs is done on an annual basis, and depending on the type of device, maintenance and/or repairs are the responsibility of both NMWD and the customer being served.

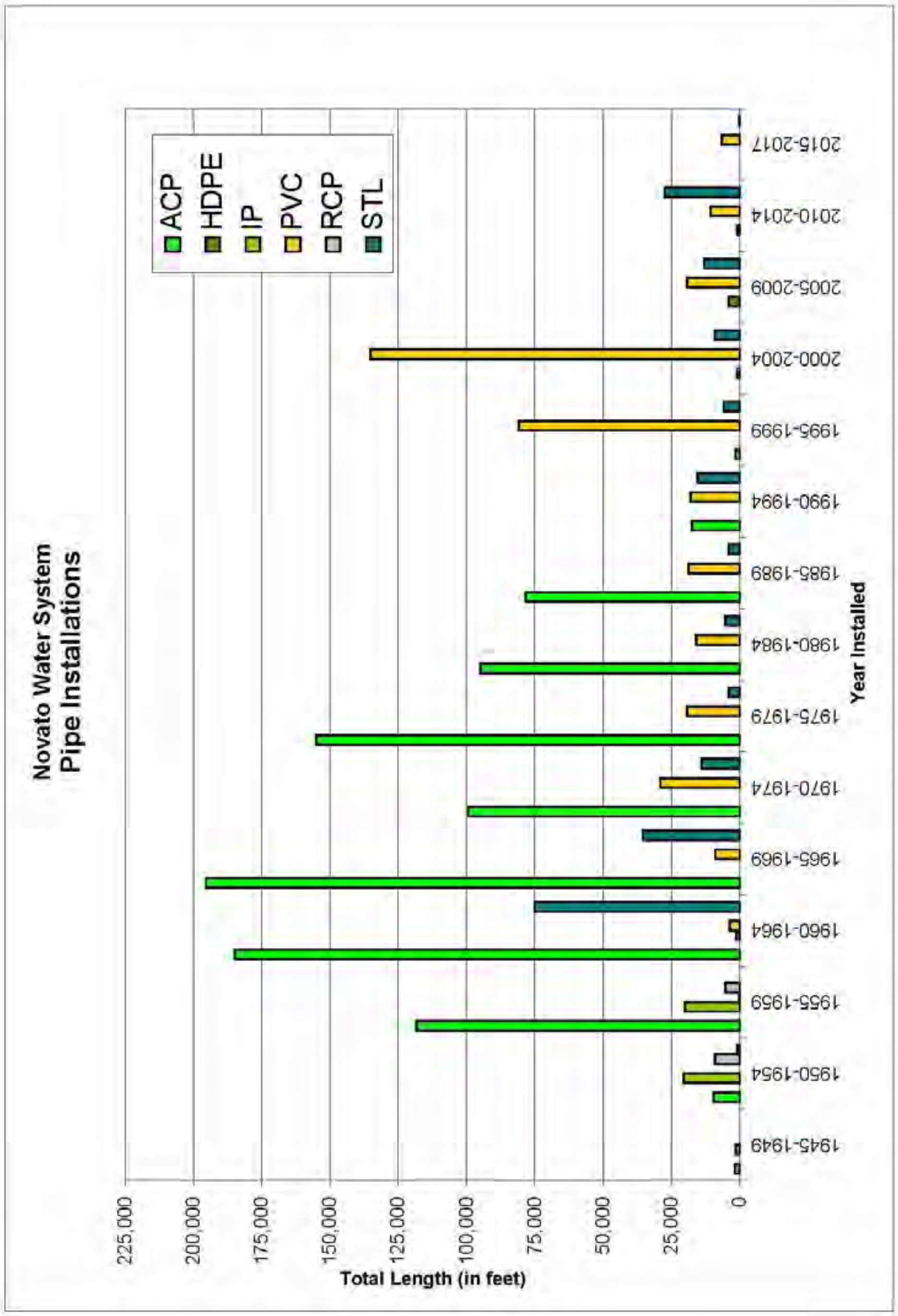
### 8.4.3 Asset Evaluation

The table below presents the current replacement and depreciated values of NMWD's assets. The replacement value represents the cost in June 2017 dollars to completely rebuild all the assets to a new condition. A formal current condition assessment has not been performed and will be part of the continued development of a full AM program.

| Valuation | Transmission & Distribution | Storage Tanks | Treatment Plants | Total |
|---|---|---|---|---|
| Replacement Value ($M) | $252 | $45 | $36 | $333 |

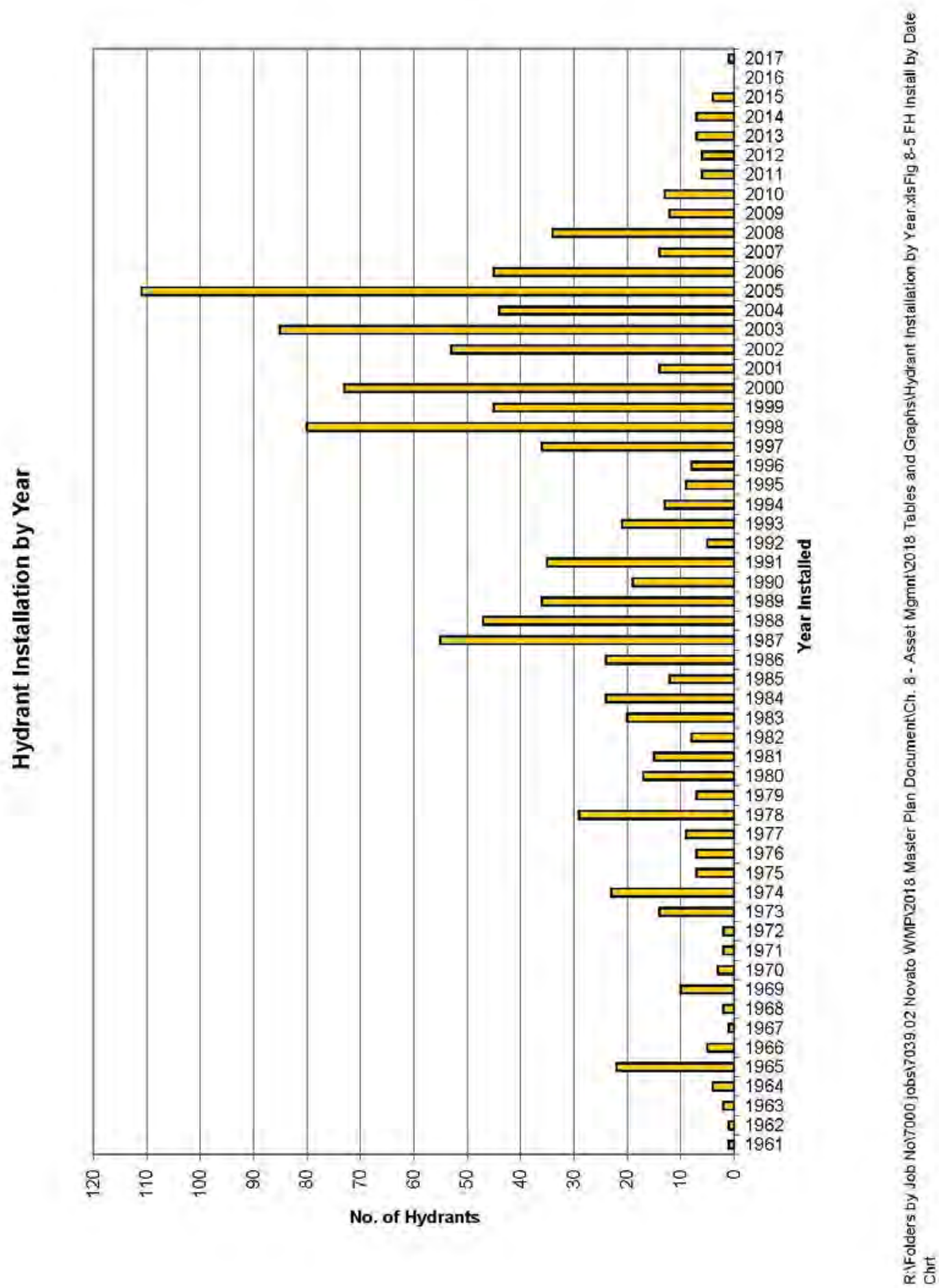
In time, the District AM Program will develop a schedule when these assets are due to be replaced. Currently, complete asset replacement value is estimated at $333M. In the 2007 Master Plan, asset replacement value was assessed at $208M, compared to $238M in the 2012 Plan. The primary reasons for these increases include new assets added to the asset register, and higher replacement costs due constructing in a suburban area like Novato, as opposed to the more rural environment when many of the assets were originally installed.

**Figure 8-4**
**Pipe Installations**




R:\Folders by Job No\7000 jobs\7039.02 Novato WMP\2018 Master Plan Document\Ch. 8 - Asset Mgmnt\2018 Tables and Graphs\C Inventory (Pipe)_updated 1-17-19.xlsxFig 8-4 Pipe Install by Type

**Figure 8-5**
**Hydrant Installation by Date**



## 8.5 AM PROGRAM SUMMARY

Note: For the purposes of this plan, the remainder of the discussion will focus on the top five buried infrastructure maintenance categories:

- Maintenance of Polybutylene (PB) Services
- Maintenance of Copper (CU) Services
- Maintenance of Meters
- Maintenance of Valves/Air Relief Valves
- Maintenance of Mains

The District's AM program consists of four components: monitoring, managing, evaluating infrastructure condition, and replacement planning. Beginning in 2019, EAM system will be used to systematically gather (monitor) information about the current condition of facilities, most of which are below ground. Once collected, the software manages how the information is stored, organized and accessed. District staff then can utilize the EAM program to evaluate the data to identify items in need of rehabilitation or replacement. The following is a description of the EAM plan in place for each of the above-noted assets, broken down into the first three components, with a wrap-up conclusion to address the fourth component.

### 8.5.1 Service Lateral Pipes

- *Monitoring:*
  Service laterals are inspected in coordination with City of Novato and Marin County street rehabilitation projects, and during replacement activities, exposing laterals and evaluating their condition. Future testing may include specific field tests that could be more intensive and specific for type and location.

- *Data Management:*
  For every service line leak, a "Service Line Maintenance Order" form is filled out by the Construction Foreman making the repair. These forms are collected by the Engineering Secretary and divided into three categories: Polybutylene laterals installed before 1978; Polybutylene laterals installed in or after 1978; and copper laterals. The data will be entered and stored in the EAM program. The information tracked includes the location, the old lateral type and installation date, the new lateral type and installation date, the type of failure, and the repair job number. All leaks and line breaks will be identifiable in the EAM GIS database.

- *Evaluation:*
  A graph of service lateral leaks for both PB and CU services is shown in Figure 8-6. This graph includes both annual leak rates and running average failure rates for PB and CU services. Results show that PB service leaks have averaged almost three times the leak rate of CU services. This is particularly significant considering that PB services represent only 10% of the total District-wide services. It is important to note that there continues to be an increasing trend in PB service line leaks. During the past 5 years, the frequency of PB service failures appears to have stabilized somewhat, averaging 115 per year. Importantly, the District has reduced the total number of PB services from a high of 6,100 in 1985 to approximately 651 in 2018 resulting in just 10% of the original PB services remaining to be replaced. The trend of increasing CU service leaks may be attributed to corrosion of the aging CU service laterals in the District's system. When

comparing respective total PB and CU service lateral maintenance costs (Figures 8-7 and 8-8), the annual PB costs from FY13 to FY17 were almost three times as much as the CU costs. However, actual per service maintenance costs during this five-year period were approximately $3,500 for PB services and $8,850 for CU services. Part of the disparity in per unit replacement costs for CU vs. PB may include Construction Department accounting practices which for CU services, includes other work whether or not the entire CU service was replaced (e.g., when an angle valve needs replacing at the meter). As a result, the number of CU services replaced is only counted when the entire service is replaced, and is not "counted" when repairs are made that don't include full replacement. By contrast, PB per unit costs only include full replacement of the service. When looking at number of failures since the mid-1990's, the CU failure rate has remained relatively consistent while PB rates began to increase in the mid-2000's. Labor costs for both PB & CU replacements have remained fairly steady over the last five years.

- *Conclusions:*
  Improvements have been made in the area of condition assessment for leaking services and the new EAM program will be a much better method for keeping track of these services. In addition, future R&R projects should include anode installations for corrosion protection at existing CU service areas which have had excessive premature failure rates due to pitting, etc. CU service anode installations have already been implemented in some instances, but more are needed.

**Figure 8-6**
**Service Lateral Leak and Replacement History**

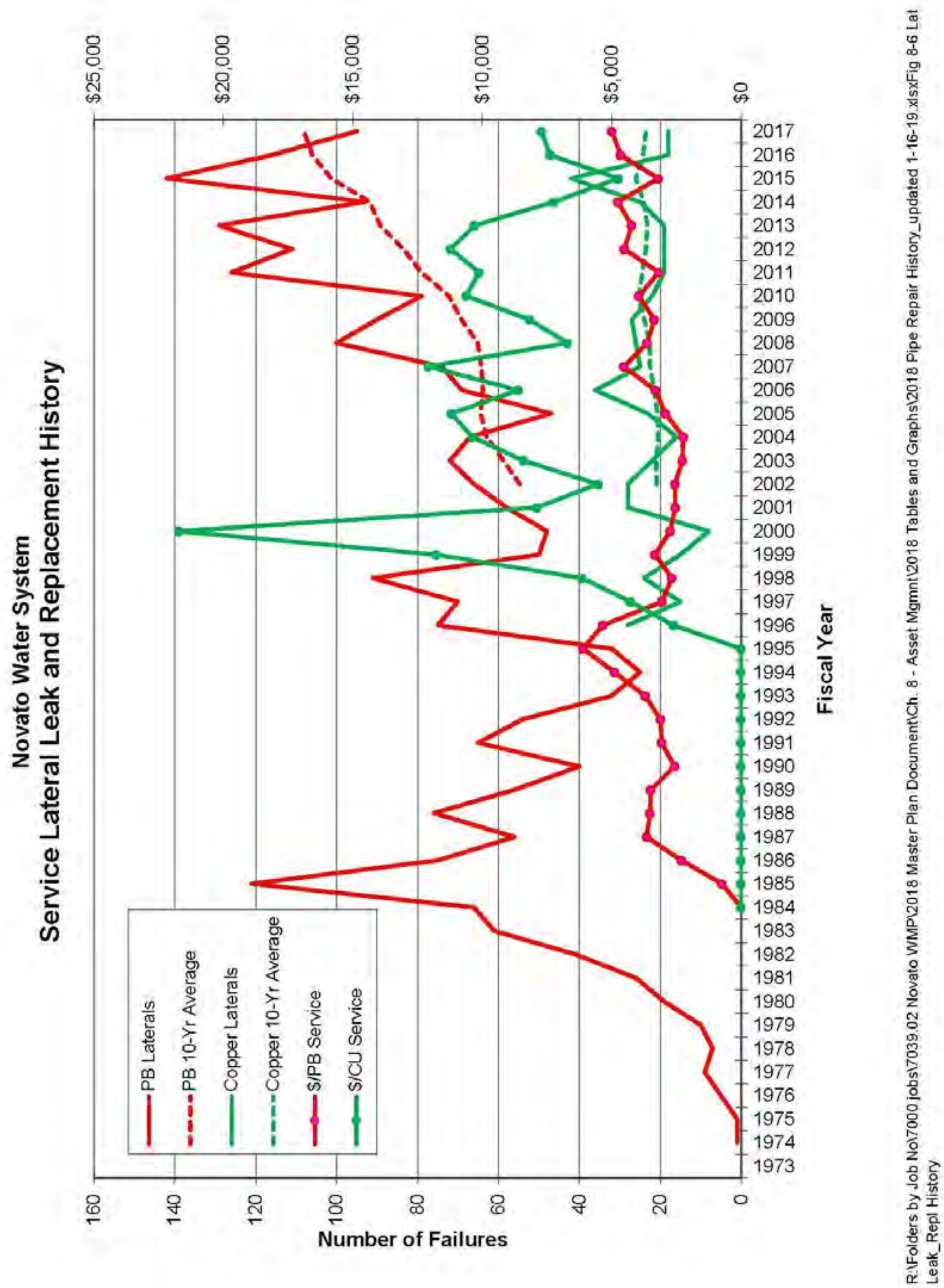


**Figure 8-7**
**Annual Maintenance of Polybutylene Service Lines Cost History**

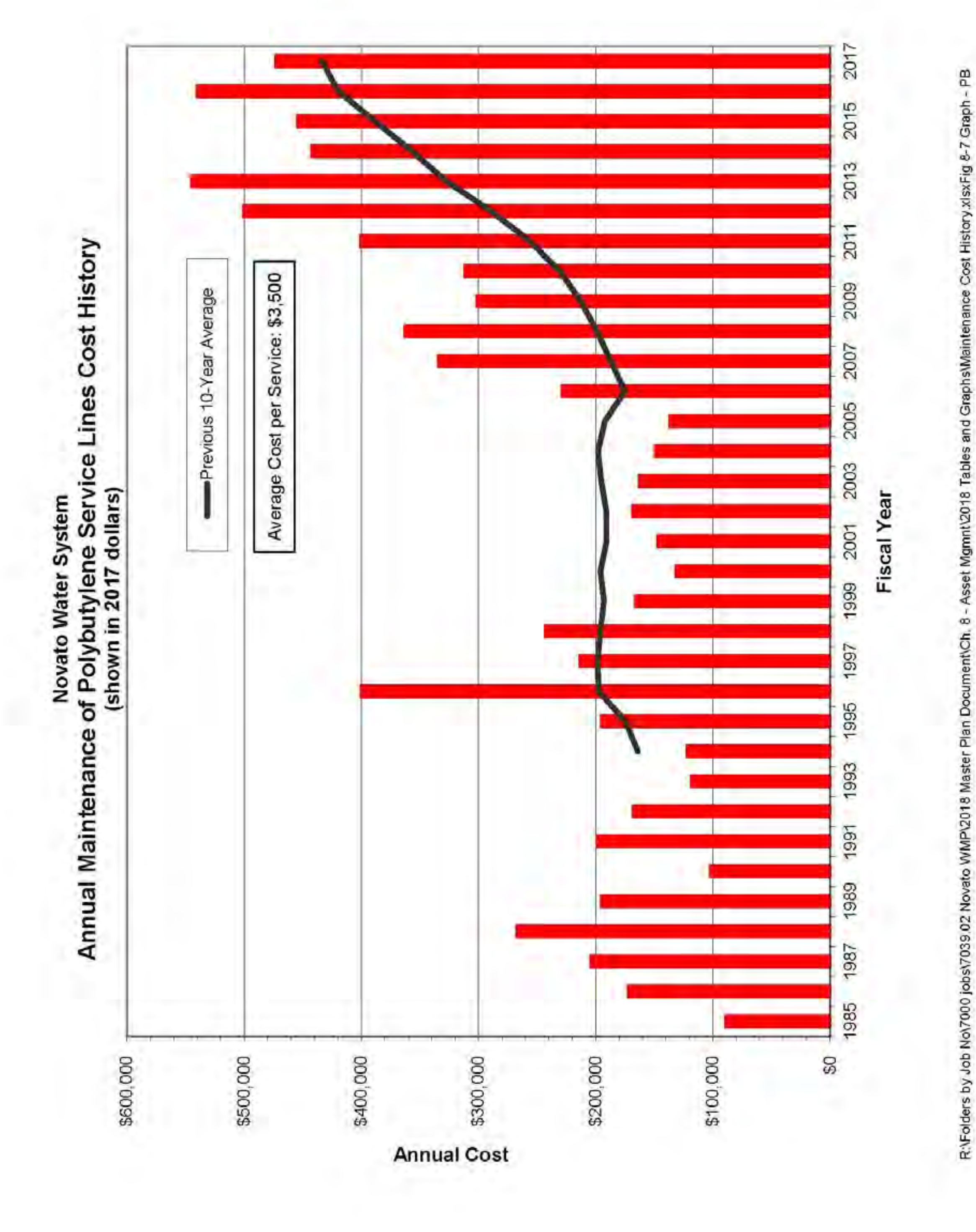
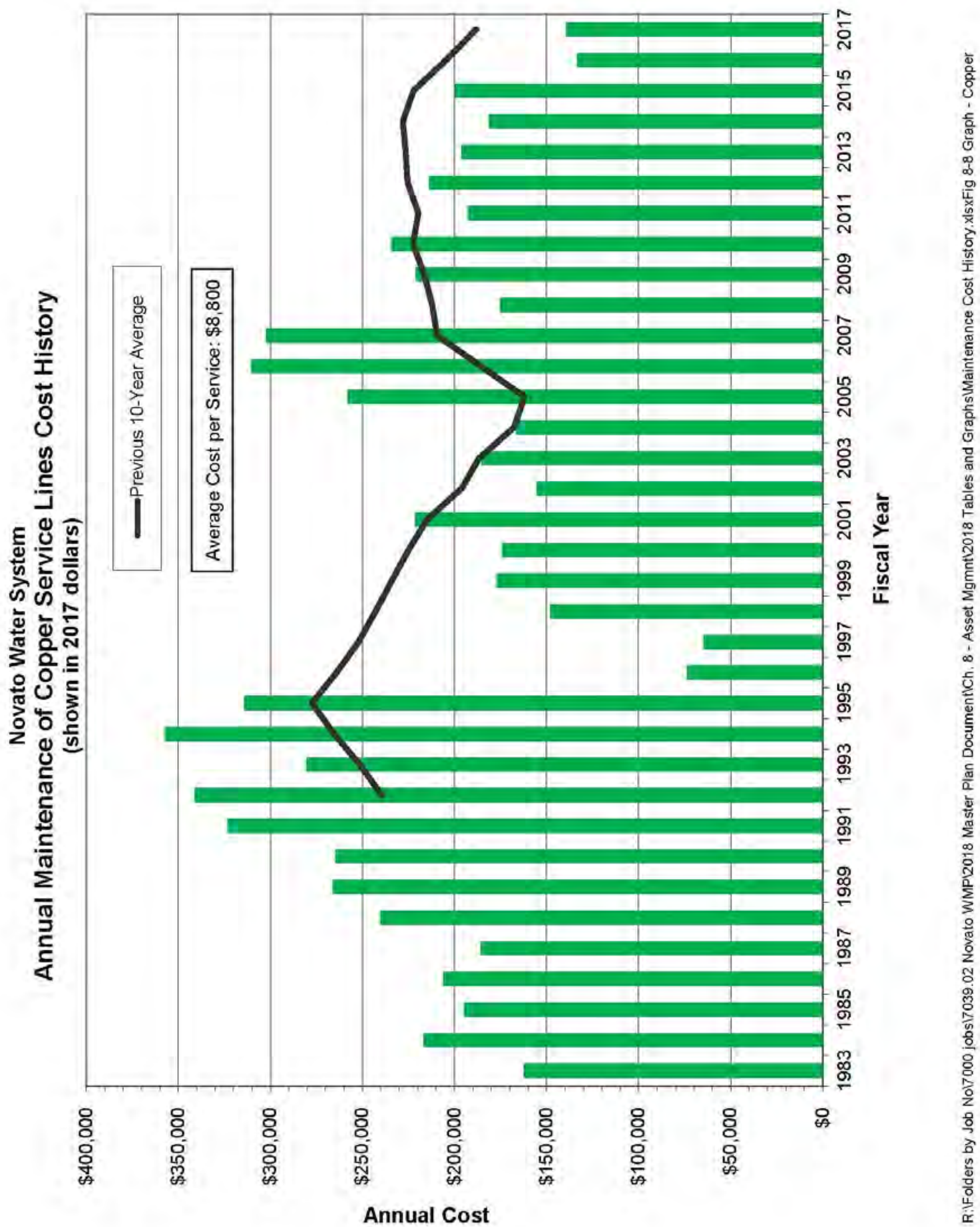


**Figure 8-8**
**Annual Maintenance of Copper Service Lines Cost History**



### 8.5.2 Maintenance of Meters

- *Monitoring:*
  The Novato Service area is being upgraded with advanced metering infrastructure (AMI) in 2018-19. All meters with more than 10 MG of use or greater than 25 years old and were unable to be retrofitted with a new register were replaced. Meter maintenance will continue to be overseen by the Administration Department. The meter maintenance program consists of an observation, access and operational replacement in their entirety as needed and not repaired.

- *Data Management:*
  With the new AMI, detailed information collected regarding operation of meters will be used to forecast all future replacement requirements. Meters requiring repair will be evaluated based on the life of the register and may be replaced with a new meter while keeping the register, or a full meter and register will be replaced based on potential lower overall meter cost versus repair cost.

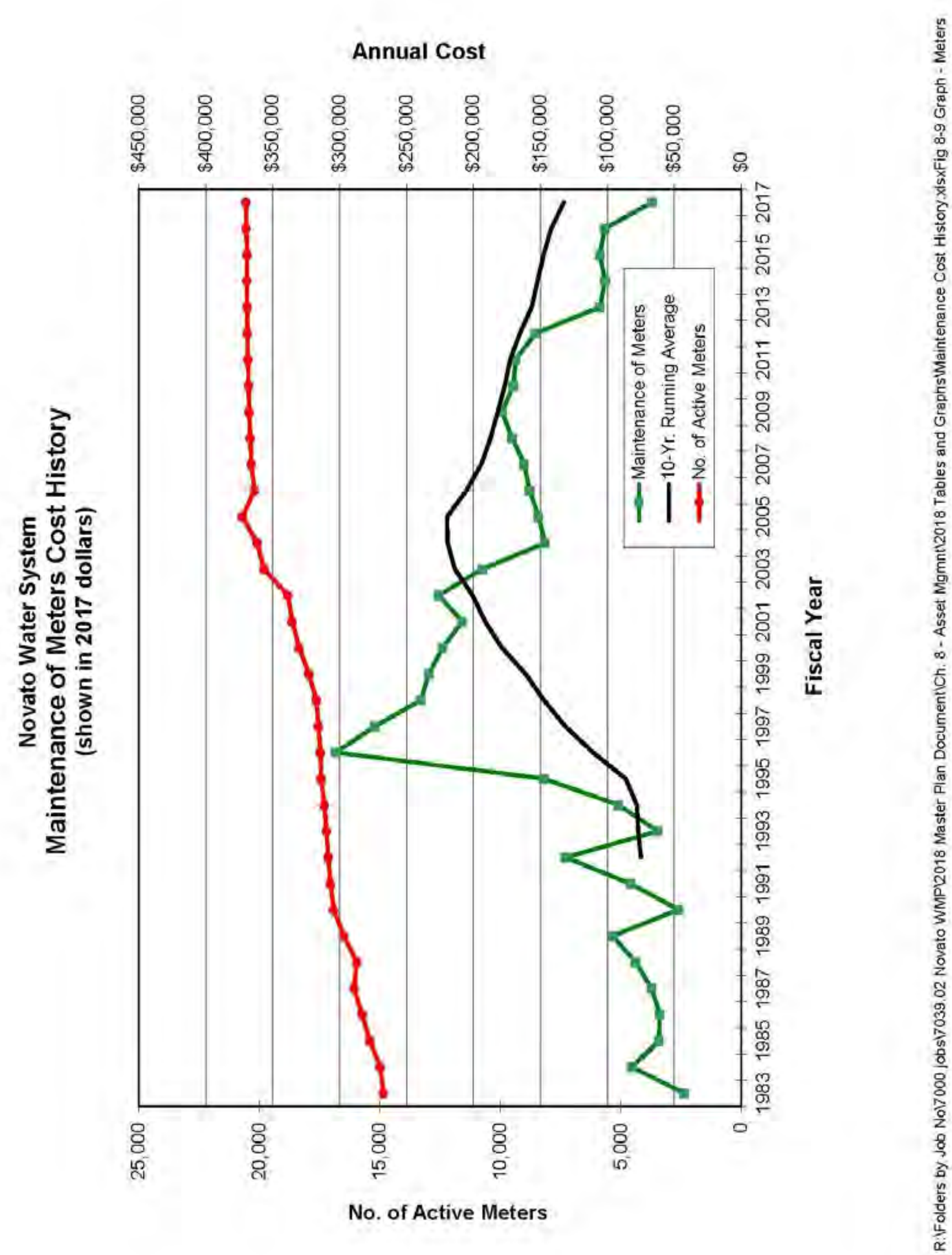
- *Evaluation:*
  A graph of annual meter maintenance costs over the last 34 years (shown in 2017 $) is shown in Figure 8-9. This graph also includes a plot of 10-year running average expenditures. Results show that overall meter maintenance costs increased significantly in FY 95/96 due to financial tracking changes, followed by a subsequent decreasing trend. Also, annual meter maintenance costs have exhibited a slight decreasing trend since FY 2012.

- *Conclusions:*
  Consideration should be given to tracking the actual number of meters changed per year in an effort to obtain a maintenance cost per meter changed. Random meter accuracy testing will continue in FY19 to further assess meter accuracy.

### 8.5.3 Valves

- *Monitoring:*
  There are approximately 8,005 valves in the Novato distribution system: 3,934 main-line valves; 2,785 fire hydrant valves; 346 fire service valves; 825 blow-off valves, 38 stub valves and 77 zone valves. The Valve Operation Program, run by the Construction/Maintenance Department, is typically conducted year-round. This is an ongoing program under which all valves are exercised over a period of approximately 18-24 months. However, the goal is to cycle all valves on an annual basis.

## Figure 8-9
## Maintenance of Meters Cost History

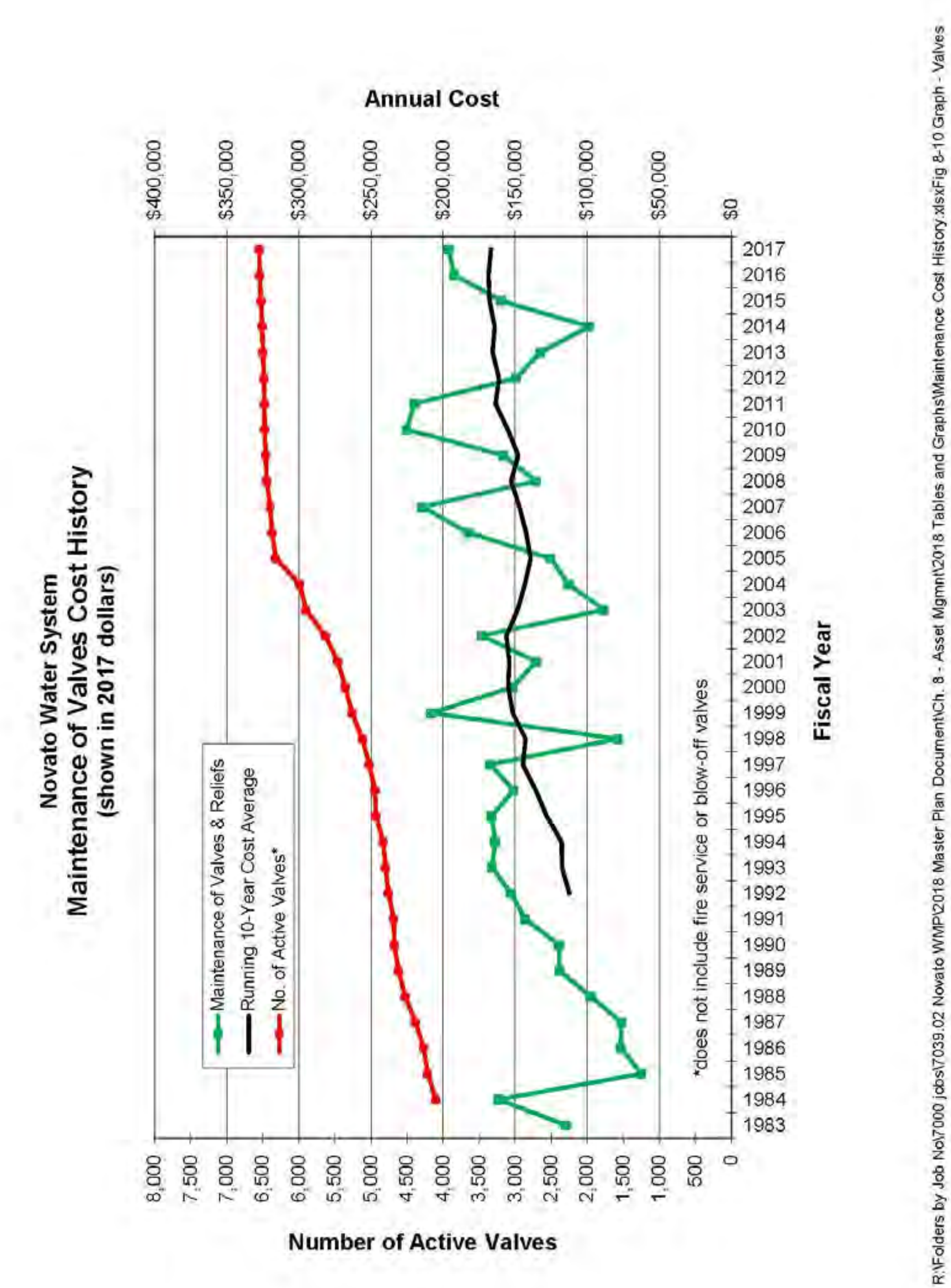


- *Data Management:*
  Valve maintenance information collected during the Valve Operation Program will be logged into EAM program to track minor repairs performed during the annual program. Valves found to need total replacement will now be integrated into the EAM program. If the replacements are not urgent, then they are scheduled in conjunction with other work performed in the area. For every valve break, a “Main & Valve Repair Report” form will be filled out within the EAM program by the Construction Foreman. These reports, along with Leak Reports and the Damage Report form, will be stored in the EAM program and will also be filled out by the Construction Foreman. This data will be used to prioritize repairs and replacement as well as track hours and costs.

- *Evaluation:*
  During the Valve Operation Program, any valve found to be inoperable will be noted in the EAM program, a maintenance work order produced, and the valve replaced. At the end of each year, a summary of the valves operated is listed in an annual report. Each year, problem valves listed in the previous year’s report are examined more closely and a decision as to the action to be taken is made by the Construction/Maintenance Superintendent. A graph of annual valve maintenance costs over the last 24 years (shown in 2017 $) is displayed in Figure 8-10. This graph also includes a plot of 10-year running average expenditures. Results show that overall valve maintenance costs are variable primarily due to the Construction/ Maintenance crew(s) prioritizing other tasks over valve work. Annual expenses over the last five years have averaged $156K per year.

- *Conclusion:*
  The EAM program will be an effective tool to manage the valve operation and maintenance program. Adjusted average valve maintenance costs have increased nearly 13% over the past 10 years, ranging from a high of $196K to a low of $91K. However, with the majority of valves nearing 50 years of life, industry studies suggest this will increase. More time is needed to effectively evaluate long-range cost benefits of a well-planned preventive valve maintenance program. Staff will focus on the development of an Asset Evaluation matrix and implement over the next five years.

**Figure 8-10**
**Maintenance of Valves Cost History**



### 8.5.4 Water Main Pipe Sections

- *Monitoring:*
  Pipe sections are monitored every time a main is exposed for a leak or break repair, or when a tap for a new service or main extension is made. “Coupon” samples (small sections of pipe removed during hot tap operations) are now being stored in the Engineering Department according to Facility Map location. Also, often in coordination with City/County street rehabilitation projects, pipe sections may be exposed for the sole purpose of observing and gathering data.

- *Data Management:*
  Existing water main pipe will be tracked in the EAM program The existing Novato pipe counts include the percentages by type (Table 3-4) for a total of 321 miles of pipe. For every water main break, a “Main & Valve Repair Report” form is filled out by the Construction Foreman and routed to the appropriate Engineer for review. Data from these forms will be consolidated within the EAM program with Leak Reports.. Also, items collected in the field, such as failed cast iron pipe sections and coupons from hot-tapped mains, are tagged and stored as noted above. Asbestos cement pipe coupons are die-tested to assess remaining life and results are tabulated on the AC Pipe Assessment forms.

- *Evaluation:*
  The District’s leak average (combined mainline and valve leaks) is up slightly over the past 5 years to 6.0 leaks per 100 miles of pipe vs. an average of 4.8 leaks per 100 miles for the previous 15 years. A graph of pipeline leaks for the past 20 years in shown in Figure 8-11. This graph includes both annual pipeline failure rates and a 10-year running average failure rate. The graph of annual water main maintenance costs over the last 34 years (2017 $) is shown in Figure 8-12. This graph also includes a plot of running 10-year average expenditures. Results show that overall water main maintenance costs have remained fairly consistent over the last 10 years. Pipe life expectancy is defined for each pipe category. This was based on information obtained from AWWA – Buried No Longer and input was provided by the Chief Engineer and the General Manager. See Table 8-2 for the pipe categories and their assumed optimistic and pessimistic life expectancies. The 100% in the table signifies that all pipe is expected to survive the number of years as shown. For each pipe type, the average life expectancies of half of the pipe (50%) and the longest surviving 10% are shown.

**Table 8-2**
**Pipe Life Expectancy**

**Optimistic and Pessimistic Estimates**

| Pipe Material | Pipe Category | Life Expectancy (years) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Pessimistic | Optimistic | Pessimistic | Optimistic | Pessimistic | Optimistic |
| | | 100% | 100% | 50% | 50% | 10% | 10% |
| ACP | TYPE 1 | 35 | 75 | 75 | 105 | 105 | 150 |
| COP | TYPE 2 | | | | | | |
| HDPE | TYPE 3 | 75 | 100 | 100 | 120 | 120 | 150 |
| IP | TYPE 4 | 40 | 60 | 60 | 90 | 90 | 100 |
| PVC | TYPE 5 | 75 | 100 | 100 | 120 | 120 | 150 |
| RCP | TYPE 6 | 50 | 80 | 80 | 120 | 120 | 150 |
| STL | TYPE 7 | 60 | 100 | 100 | 150 | 150 | 200 |

**Average Optimistic and Pessimistic Estimates**

| Pipe Material | Pipe Category | Life Expectancy (years) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Average | | Average | | Average | |
| | | 100% | | 50% | | 10% | |
| ACP | TYPE 1 | 55 | | 90 | | 135 | |
| COP | TYPE 2 | | | | | | |
| HDPE | TYPE 3 | 87.5 | | 110 | | 135 | |
| IP | TYPE 4 | 50 | | 75 | | 95 | |
| PVC | TYPE 5 | 87.5 | | 110 | | 135 | |
| RCP | TYPE 6 | 65 | | 100 | | 135 | |
| STL | TYPE 7 | 80 | | 125 | | 175 | |

- *Conclusions:*
  Over the past 5 years efforts have been made to more effectively utilize the various data for this category of maintenance. Pipe section information is documented in the engineering databases, and various reports are run by sector to track trends in leaks. Future pipeline R&R projects are expected to continue to increase and a long-range forecast is shown in Figure 8-13. The dates for the annual replacement costs are based on a combination of industry expected life and NMWD staff adjustments to smooth out the curve showing anticipated timing for replacing pipe. The current projected level of expenditures falls short of required expenditures. After implementing asset management software, staff will begin a process to refine planned replacements of assets based on incorporating risk of failure and cost of failure metrics.

**Figure 8-11**
**Pipe Line Leaks Per 100 Miles of Pipe**

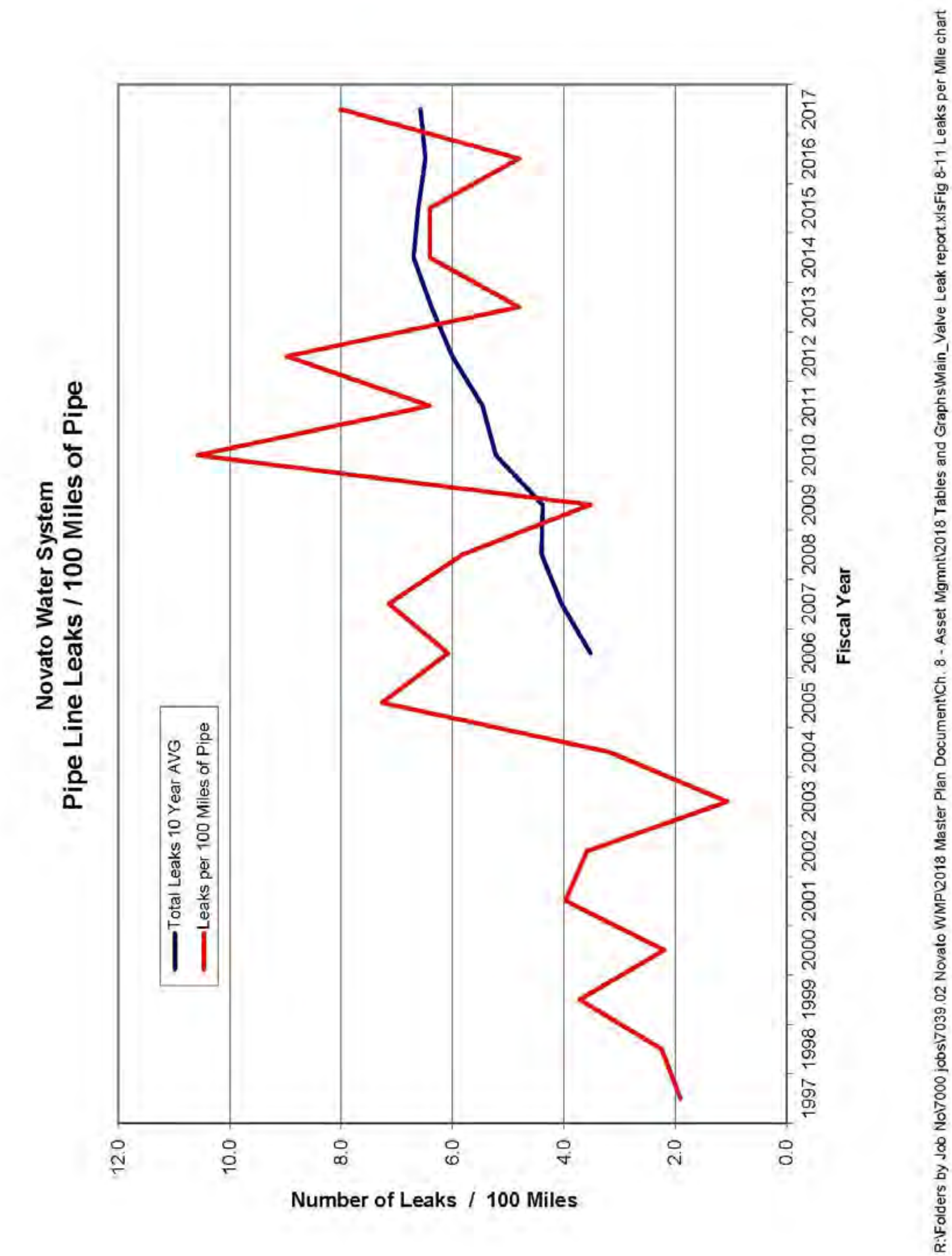


**Figure 8-12**
**Maintenance of Mains Cost History**

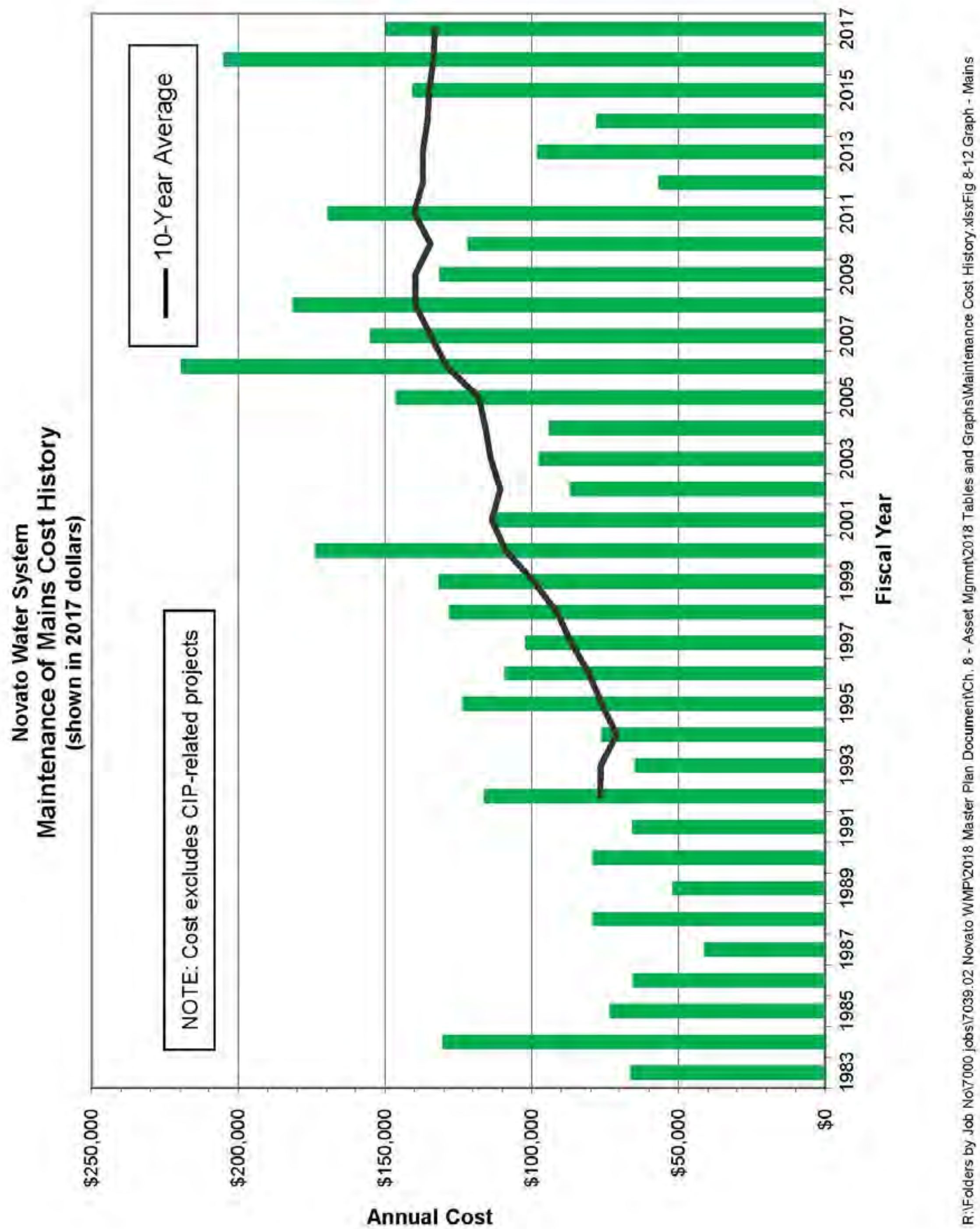
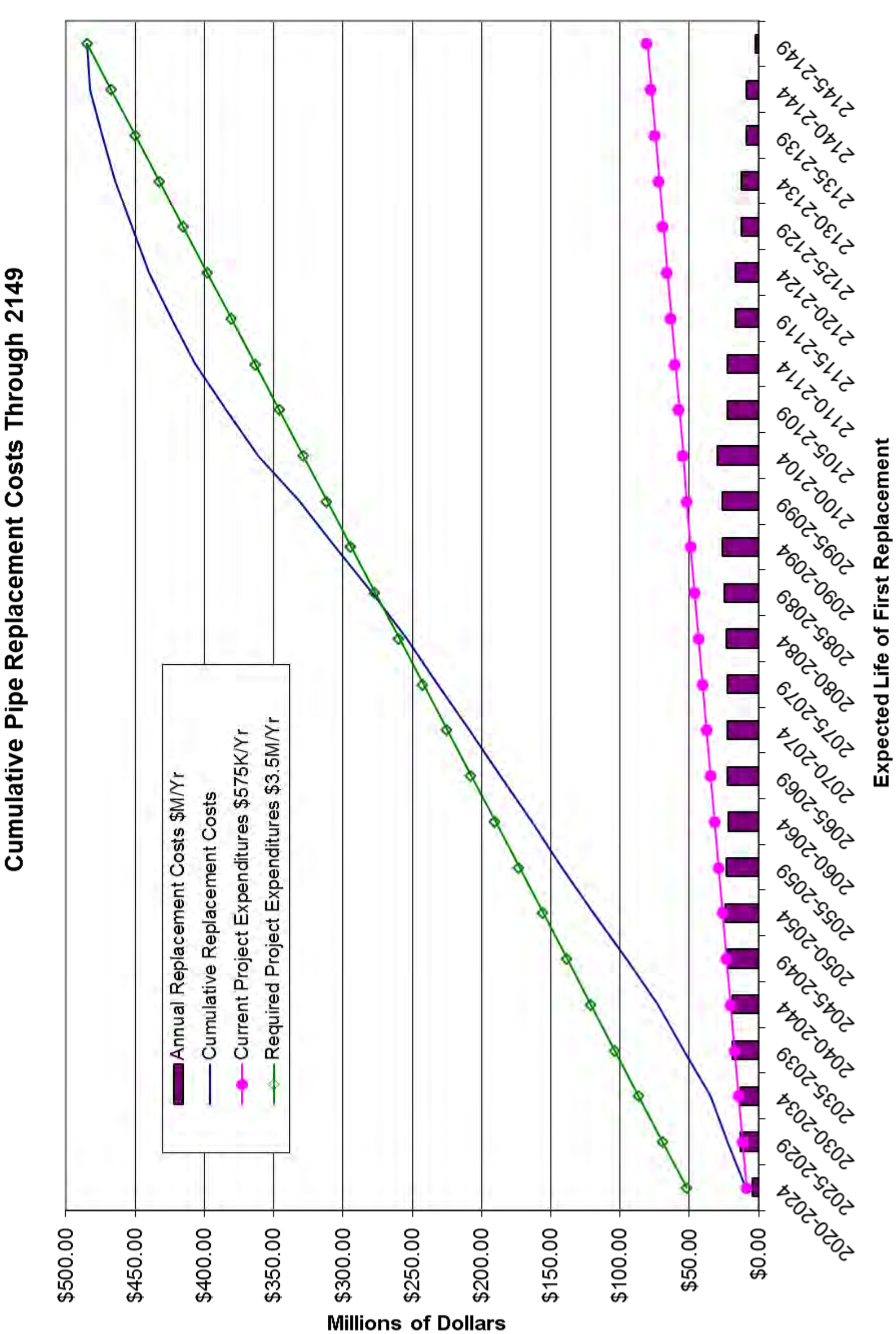


**Figure 8-13**
**Cumulative Pipe Replacement Costs**



## 8.6 OTHER INFRASTRUCTURE MANAGEMENT ACTIVITIES

### 8.6.1 Cathodic Protection

- *Monitoring:*
  Cathodic Protection (CP) systems for all steel tanks are inspected quarterly. CP for the North Marin aqueduct is maintained following the rolling 5-Year Maintenance Master Plan. CP has been installed on most steel water mains in various city locations, and is being routinely monitored at the present time. In addition, CP is being installed with all new steel pipes and copper laterals, and is being inspected every five years.

  Periodically (every 3-6 years), a close interval study of the entire aqueduct and distribution system is conducted. Previously in 2014, CorrPro performed a study in concert with the District's Aqueduct Energy Efficiency Project.

- *Data Management:*
  The data collected during the quarterly inspections of the steel tank and pipe CP is logged in the table "CP Quarterly Inspections.xls", and includes the tester, test date, test results, any rectifier problems noted, and possible repairs to be made. This database is updated by the Electrical/Mechanical Supervisor every quarter. Staff will develop a database in concert with EAM for tracking and managing the sacrificial anodes for the distribution system and service laterals.

- *Evaluation:*
  The current CP system information in the quarterly inspection, along with the close interval surveys, is used to track the effectiveness of CP. Information from these reports and studies are used to create the CP plan and help focus on any individual deficiencies.

  The current 5-Year CP Maintenance Master Plan has identified the need for upgraded CP in the next few years at the Lynwood/Sunset main, the Marin County Airport (Gnoss Field) main, and a close interval survey of the central and southern Marin aqueduct.

- *Conclusions:*
  Completion of the CP database is critical for ensuring proper maintenance of the sacrificial anodes. Over all, CP continues to protect District assets. Over the next five years, staff will update the CP Master Plan.

# SECTION 9

# EVALUATION OF IMPROVEMENT PROJECTS

# SECTION 9

# EVALUATION OF IMPROVEMENT PROJECTS

## 9.1 INTRODUCTION

The capital improvement projects and other studies and investigations that have been identified through this study are summarized in Section 9. All projects discussed in this section are included in the Capital Improvement Program presented in Section 10. Cost estimates and project phasing are presented in Section 10.

## 9.2 PROJECT SUMMARIES

### 9.2.1 Project Categories

In order to coordinate with the District annual budgeting process, the projects listed herein are separated by category as shown below:

- *Pipeline Replacements/Additions (CIP budget):*
  Pipeline replacement projects and additional pipelines needed.
- *System Improvements (CIP budget):*
  Improvement projects not specifically related to tanks, pump stations or pipelines.
- *Storage Tanks/Pump Stations (CIP budget):*
  Projects that are related to the storage tanks and pump station facilities.
- *Preliminary Project Engineering and Studies (OPS budget):*
  Engineering studies and investigations that are identified in the Master Plan and may lead to capital improvements at a later date.

Other categories also exist for which specific projects have been identified elsewhere and are not included in this Master Plan. These categories include:

- Building, Yard, STP Improvements
- Water Conservation
- Liability/Safety Modifications
- Recycled Water System

Projects have been identified through several processes, many of which are presented in this Master Plan. Each listed project references the process by which it was found, and the Master Plan section where it is discussed, using the following codes:

SP - Storage and Pumping Capacity Analysis (Section 5)
WQ - Water Quality Evaluation (Section 6)
HE - Hydraulic Evaluation (Section 7)
AM - Asset Management (Section 8)
DP - District Planning
CC - City/County Coordination

### 9.2.2 Project Timing

Within the CIP list it is necessary to prioritize the projects over the 17-year period until buildout in year 2035. Projects are given a completion goal to identify the urgency with which each project is needed. Each 5-year incremental period (FY 2020, FY 2025, FY 2030, FY 2035) signifies that the project should be included in one or more of the annual budgets for that five-year interval. It is expected that the projects within each interval be evaluated at each annual budgeting cycle to determine which year's budget to assign it. The District regularly updates its 2-year and 5-year CIP budget, and this regular review enables the projects to be developed as funds are more available and priorities change. Approval of this Master Plan does not constitute adoption or approval of individual projects. Each project will be considered for inclusion in specific annual budgets. Note that the FY 2020 interval includes only two years (FY 2019, and FY 2020).

## 9.3 PIPELINE REPLACEMENTS/ADDITIONS

Projects within this category fall into two main areas: 1) replacement of existing pipelines; or 2) installation of new pipelines required to improve system operation. Pipeline replacement and pipeline addition improvement projects are shown below:

**Table 9-1**
**Pipeline Replacement and Addition Projects**

**Pipeline Replacement Projects**

| ID # | Project Name & Description | When | Category |
|---|---|---|---|
| **1a-01** | **Replace Aging Cast Iron Pipe**<br>Replace 77,300 feet of cast iron (CI) pipe, with priority given to the oldest pipe. Replace 2,000 feet each year until the program is completed. Locations tracked in the database “NovatoPipeCount.xls” which is maintained by the Engr Dept and shown in Appendix D-1. | *ongoing* | *AM* |
| **1a-02** | **Replace 12-Inch CI Pipe - S. Novato Blvd, north of Rowland**<br>Replace 700 feet of 12-inch CI pipe in South Novato Blvd, north of previous pipe replacement at Rowland, due to age and City project coordination. | *2020* | *CC/AM* |
| **1a-03** | **Replace All Galvanized Steel Pipe**<br>Replace 880 feet of galvanized steel (GS) pipe, with priority given to the oldest pipe. Replace 200 feet each year until the program is completed. Locations tracked in the database “Galvanized and TW Pipe Location DB.xls” which is maintained by the Engr Dept and shown in Appendix D-2. | *2025* | *AM* |
| **1a-04** | **Replace All Thin-Walled Pipe < 4-inches**<br>Replace and upsize 66,200 feet of less than 4-inch thin-walled (TW) plastic pipe, with priority given to the oldest pipe, historical leak records and pipe experiencing higher pressures. Locations tracked in the database “Galvanized and TW Pipe Location DB.xls” which is maintained by the Engr Dept and shown in Appendix D-3. | *ongoing* | *AM* |
| **1a-05** | **Replace 2-Inch TW Plastic Pipe - Pinto Ln**<br>Replace and upsize 100 feet of 2-inch TW plastic pipe in Pinto Ln due to poor pipe condition and to bring main into compliance with Reg 21. | *2020* | *AM* |

**Pipeline Addition Projects**

| | Project Name & Description | When | Category |
|---|---|---|---|
| **1a-06** | **Replace 2-Inch TW Plastic Pipe - Esquire Ct**<br>Replace and upsize 100 feet of 2-inch TW plastic pipe in Esquire Ct due to poor pipe condition and to bring main into compliance with Reg 21. | *2020* | *AM* |
| **1a-07** | **Replace 18-Inch Stafford Transmission Line**<br>Replace 14,000 feet of 18-inch supply pipe from the Stafford Treatment Plant to the distribution system. Recent spot investigations indicate the pipe coating integrity is still sound, the 50-year old pipeline is constructed of thin-walled concrete cylinder pipe and is difficult to repair or install appurtenances. Given the critical function of this pipeline, future replacement should be planned before problems increase and reliability is compromised. | *2035* | *DP* |
| **1a-08** | **Relocate 8-Inch Pipe - Country Club Dr**<br>Relocate 1,700 feet of 8-inch ACP pipe located 8 feet behind the sidewalk on Country Club Dr from Country Club to Birdie Dr to increase accessibility, when pipe is at the end of useful life. | *2025* | *DP* |
| **1a-09** | **Upsize 4-Inch and 6-Inch Mains - E. Black Pt. Subzone**<br>Upsize existing mains smaller than 6-inch to 8-inch, 600 feet along Holly Ave, 795 feet along Oak Ave, 1,405 feet along Laurel Ave and 780 feet along Norton Ave. | *2025* | *HE* |
| **1a-10** | **Upsize 4-Inch and 6-Inch Mains - E. Crest Subzone**<br>Upsize existing mains smaller than 6'' to 8''. 1,240 feet along Hampton Ln and 1801 feet along Green Point Ln. | *2025* | *HE* |

**Pipeline Addition Projects**

| ID # | Project Name & Description | When | Category |
|---|---|---|---|
| **1b-01** | **Loop Southern and Northern Zone 1 - Entrada Dr**<br>Install 4,500 feet of 16-inch pipe on the west side of Highway 101 between South Novato Blvd near the freeway on-ramp to Entrada Dr to increase flows to the South Zone 1 area and to provide a redundant pipeline to the single pipeline that currently feeds South Novato in the Hanna Ranch area east of Highway 101. Hydraulic modelling should be conducted since the Frosty Lane Intertie may impact this project's necessity. | *2030* | *HE* |
| **1b-02** | **Loop Bel Marin Keys Residential Area**<br>Install 5,500 feet of 16-inch pipe from Bel Marin Keys Blvd 1500 feet west of Montego Key, along the levees to the Amaroli Tank wye to loop the system at the Bel Marin Keys residential area to reduce vulnerability to loss of supply. (project subject to effects of climate change) | *2030* | *HE* |
| **1b-03** | **Redwood Blvd - Lamont Looping**<br>Install 1,000 feet of 12-inch pipe in Redwood Blvd between Lamont and the 12-inch stub just south of DeLong Blvd near the Woodside development to increase fire flows to the downtown area and connect a long dead-end pipe segment closing a gap in the distribution system piping in the area. | *2030* | *HE* |

**Pipeline Addition Projects**

| ID # | Project Name & Description | When | Category |
|---|---|---|---|
| **1b-04** | **Loop Crest Zone - Channel Ave**<br>Install 2,700 feet of 8-inch pipe in Channel Road from the west end to Crest Drive to connect to the 8-inch pipe in Crest Drive and provide partial looping of the Crest Zone system to the Black Point area to increase fire flows and reduce vulnerability to loss of supply. | *2030* | *HE* |
| **1b-05** | **Loop Zone 2 - Hill Rd**<br>Install 2,500 feet of 8-inch pipe along Hill Rd from Canyon Rd to Indian Valley Rd to connect two dead end branches of Zone 2 piping to reduce head losses and provide another route for water transfer between the northern and southern portion of Zone 2. If this pipeline is installed, the District could consider eliminating the Diablo Hills hydropneumatic system and providing service from Zone 2. | *2030* | *HE* |
| **1b-06** | **Loop Bel Marin Keys Commercial Area**<br>Upsize 1,250 feet of 8-inch pipe in Digital Ave between Highway 101 and Galli Drive to 16-inch pipe, and upsize 750 feet of 8-inch pipe in Bel Marin Keys Blvd between Hamilton Drive and Galli Drive to 16-inch pipe, to increase flow into the commercial area and achieve fire flow requirements. | *2025* | *HE* |
| **1b-07** | **Loop Southern and Northern Zone 2 at Indian Valley Campus**<br>Install 5,280 feet of 16-inch pipe between Indian Valley Campus of the College of Marin and Indian Valley Road east of Old Ranch Road to provide another transmission main for water flow between the northern and southern portions of Zone 2, also relieving high head loss under certain fire flow conditions in the northern portion with Trumbull Tank off-line. | *2030* | *HE* |
| **1b-08** | **Loop Near Grant Ave and Eighth St**<br>Install 245 feet of 8-inch pipe through Marion Recreation Area northeast of Grant Ave and Eighth St to increase fire flow to the inner area northeast to Grant and Eighth. | *2035* | *HE* |
| **1b-09** | **Loop the Mall Area Near Nave Ct and S Novato Blvd**<br>Install 265 feet of 8-inch pipe connecting the mall's 8-inch main to the 12-inch pipe on Redwood Blvd, and another 340 feet of 8-inch pipe closing the loop for all buildings within the mall area. These additional pipes help increase fire flows to the shopping mall area, if the buildings are not equipped with sprinklers. | *2030* | *HE* |
| **1b-10** | **Connect Dead-ends at George St**<br>Upsize the laterals to 8 inches and connect the dead ends at George St by a 288 feet of 8-inch pipe will improve available fire flows as well as water quality. | *2025* | *HE* |
| **1b-11** | **Loop Los Robles Rd and Posada del Sol**<br>Install a new 230-feet of 8-inch pipe to connect pipes along Los Robles Rd and Posada Del Sol to provide extra fire flows for the dead ends near Cielo Ln. | *2025* | *HE* |

**Pipeline Addition Projects**

| ID # | Project Name & Description | When | Category |
|---|---|---|---|
| 1c-01 | **Replace Polybutylene Service Lines**<br>Replace 120 PB services per year with copper until complete. Approximately 625 PB service lines remain (December 2018). PB service lines are tracked in the database “pbleaks.xls” which is maintained by the Accounting Dept and shown in Appendix D-4. | *ongoing* | *AM* |

**Pipeline Addition Projects**

| ID # | Project Name & Description | When | Category |
|---|---|---|---|
| 1d-01 | **Relocations to Synchronize with City or County Projects**<br>Relocation of existing District pipes required by City of Novato and County of Marin street improvement projects. Specific projects to be included in each annual CIP as appropriate. Upcoming projects include: Rush Creek Drainage, Sherman Ave/Cain Ln improvements, Novato Blvd improvements from Diablo Ave to Grant Ave, Redwood Blvd at Olive Ave traffic signal, Olive Ave improvements east of railroad, and Grant Ave Bridge rehabilitation. | *ongoing* | *CC* |

**Pipeline Addition Projects**

| ID # | Project Name & Description | When | Category |
|---|---|---|---|
| 1e-01 | **Replace North Marin Aqueduct (South of Redwood Landfill)** (BCPH = Beyond Current Planning Horizon)<br>Replace 2.6 miles of aging 30-inch pipe from Redwood Landfill intersection south to San Marin Regulating Station (excludes ~2,000-feet near Birkenstock’s replaced by previous Aqueduct Energy Efficiency Project). | *BCPH* | *DP* |

## 9.4 SYSTEM IMPROVEMENTS

System improvements include valving projects, installation, repair or replacement of appurtenances, and other non-pipeline, tank or pump station facilities, or those projects related to improving water quality. System improvement projects are shown in Table 9-2.

**Table 9-2**
**System Improvement Projects**

| ID # | Project Name & Description | When | Category |
|---|---|---|---|
| 2-01 | **Replace Untestable Detector Checks**<br>Replace 5-10 assemblies per year with District-standard assemblies. 111 untestable assemblies remain (Dec. 2018) and are listed in the database “DCDA DB.xls” which is maintained by Maintenance Dept and is shown in Appendix D-5. This project should be completed as soon as possible in order to minimize District risk associated with potentially inoperable DCDAs. | *Ongoing* | *WQ/AM* |
| 2-02 | **Integrate LIMS into District Asset Management System**<br>Integrate Laboratory Information Management System (LIMS) into District Asset Management system. | *2025* | *WQ* |

| ID # | Project Name & Description | When | Category |
|---|---|---|---|
| 2-03 | **Install Anodes on Existing Copper Services**<br>Install 150 anodes per year on ex copper services. Number of copper services w/out anodes is unknown. | *ongoing* | *AM* |
| 2-04 | **Replace Zone Valve with a PRV Station at Park Crest**<br>Replace the zone valve separating Zone 1 and Zone 2 near the end of Park Crest Ct with a PRV station with a setting of 140 ft (valve elevation at 62 ft regulating Zone 1 pressure at 34 psi). This will improve the residual pressures of the Zone 1 nodes along Royal Oak Ter and Valley Oak Ct under fire flow condition. | *2025* | *HE* |
| 2-05 | **Replace Zone Valve with a PRV Station at Feliz Rd & Ferris Dr**<br>Replace the existing zone valve at the intersection of Feliz Rd and Ferris Dr with a PRV station. The existing zone valve separates Zone 1 and Zone 2. Available fire flows will increase by setting the PRV station at 131 ft (valve elevation at 62 ft regulating Zone 1 pressure at 30 psi). | *2025* | *HE* |
| 2-06 | **Install PRV Station Intertie at Fairway Dr & Capilano Dr**<br>Install PRV station intertie on Fairway Dr west to Capilano Dr. There is no existing zone valve separating Zone 2 and Zone 3 in that vicinity. Most of the nodes can meet the fire flow residual pressure requirement by setting the PRV station at 326 ft (valve elevation at 155 ft regulating Zone 2 pressure at 74 psi). | *2025* | *HE* |
| 2-07 | **Replace Zone Valve with a PRV at Arthur St &Washington St**<br>Replace the existing zone valve at the intersection of Arthur St and Washington St with a PRV station. The existing zone valve separates Zone 1 and Zone 2. Most of the nodes can meet the fire flow residual pressure requirement by setting the PRV station at 138 ft (valve elevation at 46 ft regulating Zone 1 pressure at 40 psi). | *2025* | *HE* |
| 2-08 | **Add MOV to San Marin PS's 24-inch Feeding Line**<br>Install a new MOV to allow Operations to choose the source of water for San Marin PS and to immediately react to water quality problems coming from SCWA by closing the aqueduct valves at the valve pit without hindering flow into the San Marin area. | *2025* | *HE* |
| 2-09 | **Replace All Lead Filled Swing Checks**<br>One compound service with a leaded swing check at the Novato Coast Guard Housing site will be replaced in the AMI project. The number of small leaded swing checks within residential services is unknown and would require a system-wide audit. | *ongoing* | *WQ* |

## 9.5 STORAGE TANKS AND PUMP STATIONS

Storage tank and pump station projects include storage or pumping capacity additions, tank modifications and pump station modifications, based on the results of the storage and pumping capacity analysis summarized in Section 5, and asset management projects related to tanks and pump stations discussed in Section 8. Capital improvement projects at storage tanks and pump stations are shown in Table 9-3.

**Table 9-3**
**Storage Tank & Pump Station Projects**

| ID # | Project Name & Description | When | Category |
|---|---|---|---|
| 4-01 | **Add Storage Capacity at Black Point Zone**<br>Construct 157,000 gallon tank and piping modification (to address zone deficiency of 157,000 gallons at buildout) | *2035* | *SP* |

| ID # | Project Name & Description | When | Category |
|---|---|---|---|
| **4-02** | **Add Storage Capacity at Air Base Zone**<br>Construct 216,000 gallon tank and piping modification (to address zone deficiency of 216,000 gallons at buildout) | *2035* | *SP* |
| **4-03** | **Add Fire Flow Backfeed Valve at Nunes Tank**<br>Add solenoid operated control system at Nunes Tank (similar to PRE pump stations) to allow backfeeding into Nunes System from Buck System for fire protection. | *2025* | *SP* |
| **4-04** | **Recoat/Seismic Upgrade Lynwood Tanks**<br>Recoat Lynwood Tanks #1 & #2 (steel) and seismically retrofit Lynwood Tank #2. | *2025* | *AM* |
| **4-05** | **Recoat/Seismic Upgrade Cherry Hill Tank**<br>Recoat Cherry Hill #2 Tank (steel) and seismically retrofit. | *2020* | *AM* |
| **4-06** | **Recoat Garner Tank**<br>Recoat Garner Tank (steel). | *2025* | *AM* |
| **4-07** | **Recoating of Other Steel Tanks**<br>Recoating of other steel tanks per recoating database found at "Tank Coating DB.xls" which is maintained by the Engr Dept and shown in Appendix D-6. | *ongoing* | *AM* |
| **4-08** | **Tank Seismic Retrofits**<br>Seismic retrofitting of remaining 7 tanks per (updated Feb. 2019) database "Tank Seismic Table.xls" which is maintained by the Engineering Dept and shown in Appendix D-7. | *2030* | *AM* |
| **4-09** | **Demolish Woodland Heights Tank**<br>Clear/grub and demolish Woodland Heights Tank site. | *2025* | *DP* |
| **4-10** | **Demolish Loma Verde Tank**<br>Clear/grub and demolish Loma Verde tank site. | *2025* | *DP* |
| **4-11** | **Relocate and Upsize School Rd Pump Station**<br>New, larger pump station 636 gpm firm capacity (to address zone deficiency of 126 gpm now and 236 gpm at buildout). | *2020* | *SP* |
| **4-12** | **Upgrade Davies Pump Station**<br>Upgrade existing Davis PS controls and building. | *2025* | *DP* |
| **4-13** | **Old Ranch Road Tank No. 2 (100,000 Gal)**<br>Replace existing 50,000 gallon redwood tank with new 100,000 gallon steel tank. Carryover project from 2012 WMP is in process. | *2025* | *DP* |

## 9.6 PRELIMINARY PROJECT ENGINEERING AND STUDIES

As a result of initial investigations and evaluations conducted in this Master Plan, several additional engineering studies are recommended to be included in the Studies budget (which were historically CIP projects, but are now funded by an OPS budget). These studies are beyond the scope of the master plan or cannot be completed within the time frame of the master plan. These studies may identify additional capital improvement projects that will need to be included in subsequent CIPs. These studies are identified in Table 9-4.

**Table 9-4**
**Preliminary Project Engineering and Study Projects**

| ID # | Project Name & Description | When | Category |
|---|---|---|---|
| **S-01** | **Pump Efficiency/Hydraulic Study**<br>Evaluation of pump and hydraulic efficiency at all booster pump stations (except Lynwood and San Marin PS). | *2025* | *DP* |
| **S-02** | **Master Plan Update**<br>Update of 2017 Master Plan (every five years) | *ongoing* | *DP* |
| **S-03** | **Crest/Black Point Zone Modification Evaluation**<br>Evaluation of Black Point PRV system and Crest Zone to improve reliability and fire protection. | *2025* | *DP* |
| **S-04** | **Hydraulic Model Calibration and Maintenance Updates**<br>Periodically (e.g. semi-annually) check results from newly completed hydrant tests vs. model predictions under similar conditions. Troubleshoot areas of the model and distribution system where model results fail to adequately match hydrant test results. Update model data set to reflect improvements made to the distribution system, including but not limited to new pipelines, pumping stations, pressure regulating valves and storage. | *2025* | *DP* |
| **S-05** | **Stafford Dam Seismic Stability Study Update**<br>Update of 2007 Study (every 15-20 years). | *2030* | *DP* |
| **S-06** | **Stafford Watershed Master Plan**<br>Master Plan update (every 5 years) of nutrient control strategies on Stafford watershed to reduce TOC, chlorine demand and AOC. | *ongoing* | *WQ* |
| **S-07** | **Lynwood and San Marin Zone 2 Pumping Capacity Study**<br>Investigate if more pumping capacity is needed at Lynwood Pump Station as Lynwood Pump Station pumps 61% more water annually than San Marion Pump Station. Also evaluate pumping capacity needed to deliver maximum-day demands over off-peak periods. | *2025* | *SP* |
| **S-08** | **Water Supply Enhancement Study**<br>Conduct a Local Water Supply Enhancement Study to identify new sources of local water supply. The timing of this Study is impacted by initial work on the SCWA Regional Water Supply Resiliency Project. This project is part of Goal 1 in the District's 2018 Strategic Plan. | *2025* | *DP* |
| **S-09** | **Stafford Lake Sediment Survey**<br>Conduct bathymetric survey of Stafford Lake to determine remaining storage availability and develop trending analysis to predict precipitation/sedimentation impacts on storage (every 10-15 years). | *2025* | *DP* |
| **S-10** | **Cathodic Protection Master Plan**<br>Develop plan to add/replace cathodic protection for pipelines/services (every 10-15 years). | *2025* | *DP* |

## 9.7 SONOMA COUNTY WATER AGENCY

The Sonoma County Water Agency is currently planning improvements in the water supply system that delivers water to its customers, including North Marin Water District. The District is responsible for a portion of the cost of the new facilities in accordance with the 2006 Restructure Agreement for Water Supply. However, several potential projects have been identified through this master plan that would be in addition to the work planned by SCWA. There has been no attempt to incorporate SCWA's improvements into the modelling performed under this version of the Master Plan.

## 9.8 STAFFORD WATER TREATMENT PLANT IMPROVEMENTS

In August 2006, the District put the new Stafford Water Treatment Plant on-line, after nearly 10 years of study, environmental review, design, and construction. Located at the base of Stafford Lake Dam, the facility is designed to treat water to meet current and anticipated future water quality regulatory standards, improve system reliability, and to enhance the aesthetic attributes of Novato's local water supply.

The water treatment plant facilities were not evaluated in this master plan, which focused exclusively on the distribution system facilities. Improvements to the treatment plant and related facilities have been identified separately and included in the 2-year and 5-year District Capital Improvement Plans.

## 9.9 LIABILITY/SAFETY MODIFICATIONS

All of the District facilities (pumps, tanks, regulating stations, etc.) are designed to provide security against unlawful entry and/or operation. In recent years, District staff has increased security awareness and made improvements as necessary at its facilities. Security at tanks has been identified as a risk and a project to alarm access hatches to the SCADA System is in progress.

## 9.10 FUTURE DEVELOPMENT

As discussed in Section 4, the average annual demand in the Novato Water System is projected to increase by approximately 4% at buildout in Year 2035, based on comparison of total projected year 2035 demand versus baseline year 2013 demand. All the projected new development known at this time will occur within the current existing pressure zones and service areas. Therefore, it is not expected that new pressure zones will be required or that facilities will require extension beyond the current boundaries.

Each of the development projects that come up for review and approval in the future will be evaluated on a case-by-case basis for impacts to the existing water system. The District requires specific projects or system upgrades for domestic water service and fire protection to serve the new development and to bolster the distribution system in the vicinity of the new development. All new construction of water facilities will be governed by District Regulations.

# SECTION 10

# CAPITAL IMPROVEMENT PLAN

# SECTION 10

# CAPITAL IMPROVEMENT PLAN

## 10.1 INTRODUCTION

Section 10 presents the Capital Improvement Plan for distribution system projects that were identified through this master plan and described in Section 9. Total costs for each project are summarized with detailed breakdowns provided in an appendix. The projects are then scheduled for implementation within each five-year incremental period through buildout in Year 2035.

## 10.2 CAPITAL IMPROVEMENT PROJECTS

The capital improvement projects developed through this master plan are presented in Section 9 and separated by classifications which are consistent with the District budget:

- Pipeline Replacement/Additions
- System Improvement Projects
- Storage Tank/Pump Station Projects
- Preliminary Project Engineering and Study

Those projects presented in Section 9 were identified by District staff as projects that would provide benefit to the Novato Water System and should be included in the long-range Capital Improvement Plan for the District. Several projects are carried over from the 2012 Master Plan and reprogrammed to reflect current priorities for annual budgeting and severity of need.

## 10.3 PROJECT COST ESTIMATES

Project cost estimates were developed for each capital improvement project described in Section 9. In addition, annual budgets are established for general projects that are not well-defined at the present time.

The following cost estimating criteria serves as the guideline for developing the cost estimates that will be used in the Capital Improvement Plan and as assistance in evaluating developer proposals. Total project cost estimates include the following:

- Baseline construction cost – a conceptual-level estimate of probable construction cost;
- Contingency – added to the construction cost to cover unknowns;
- Design/Construction Management/Administration – non-construction related costs;
- CEQA cost – to cover environmental review (if necessary); and
- Property acquisition – costs to cover easements and property purchases for facilities (if necessary).

Project cost estimates for all capital improvement projects identified in Section 9 are provided in Appendix E-1 to E-5. Distribution pipeline projects are typically designed in-house by District staff, while storage tank and pump station designs are often outsourced to engineering consultants.

### 10.3.1 Baseline Construction Costs

Construction costs for new facilities are based on cost curves, engineering judgment, recent bid prices, historical trends and recent District experience, and are not based on detailed engineering design and analysis. Therefore, in accordance with American Association of Cost Engineers (AACE) Class 5 estimates, this Opinion of Probably Construction Cost (OPCC) has a range of accuracy of +50%/-30%.

The line items and unit construction costs are based on projects of the same categories. Costs are based on normal construction. Unusual construction must be addressed individually on a project-by-project basis. Contractor overhead and profit costs are included in the baseline construction costs.

### 10.3.2 Pipelines.

A majority of the projects are pipeline installation and replacement projects. Therefore, it is appropriate to develop unit prices for various pipe diameters constructed in pavement and in non-paved areas. Table 10-1 lists unit construction costs adjusted with an average annual inflation rate of 10% based on the established unit costs from the 2012 Master Plan. While the annual cost escalation factor of 10% may seem high (applied from 2013 to 2018), recent project construction costs have supported the proposed increase. The estimated unit cost of pipelines includes pipe material, trenching (at minimum cover), installation of the pipe, fittings, appurtenances, service connections, backfill, pavement restoration (as applicable), traffic control and testing. Pipeline costs are for PVC C-900 (Class DR14) pipe up to 12 inches in diameter; PVC C-905 (DR14) for 14- and 16-inch pipelines; and steel for pipelines 18-inch and greater. Pipeline unit prices are shown in Table 10-1.

**Table 10-1**
**Pipeline Unit Prices (shown in 2018 dollars)**

| Pipe Diameter | PVC Pipe Unit Cost ($/lf) | | Steel Pipe Unit Cost ($/lf) | |
|---|---|---|---|---|
| | In Paved[1] Road | In Unpaved Road | Paved Road | Unpaved Road |
| 6 | 185 | 160 | - | - |
| 8 | 213 | 175 | - | - |
| 12 | 285 | 240 | - | - |
| 16 | 354 | 320 | - | - |
| 18 | - | - | 415 | 370 |
| 24 | - | - | 525 | 485 |
| 30 | - | - | 600 | 560 |

(1) Note: Unit cost for paved roads can increase by $15 to $20 per foot due to increased paving requirements by the City of Novato and Marin County instituted in 2018. Application is on a case-by-case basis.

It should be noted that the unit pipeline costs in the 2018 Master Plan include all ancillary items, including line valves, air relief valves, and tie-ins.

### 10.3.3 Storage Tanks.

Based on the District's experience with steel water storage tank construction, tank construction costs cannot be easily developed with cost curves and unit prices. It is possible to determine the tank structure cost with unit prices. However, site limitations, excavation cost, access road cost and other site-specific conditions vary greatly between sites. Therefore, storage tank construction cost estimates will be determined on a project-by-project basis utilizing recent bid prices and conceptual level site-specific estimates of non-structure costs.

### 10.3.4 Pump Stations.

Pump stations and pumping capacity modifications are unique in nature and conceptual-level cost estimates will be provided on a project-by-project basis.

### 10.3.5 Construction Contingency

Since site-specific conditions are unknown for projects in the early planning stages in a master plan, a 30 percent construction contingency will be added to each project baseline construction cost to account for unforeseen events and unknown conditions.

### 10.3.6 Non-construction Costs

At this preliminary stage of development, the final costs for administration, engineering, construction management are not known. Therefore, a cost equal to 25% or 35% of the sum of the baseline construction cost, excluding the construction contingency, is applied to the cost estimate for in-house and contracted design projects, respectively.

Some projects will require environmental review to comply with the California Environmental Quality Act (CEQA). For those projects that will likely require environmental review, a cost to cover this work is included. Some projects may require purchase of easements or right-of-way. If known during development of the master plan, additional costs are included for those projects.

## 10.4 CAPITAL IMPROVEMENT PLAN

Placement of projects within the CIP is based on a number of factors, including relative cost in relation to other required projects, timing of new demand, physical need for the project, and equitable distribution of funds for each interval. Cost estimations for 2012 Master Plan projects were adjusted with an averaged annual inflation rate of 10% through 2018. Ongoing or reoccurring projects' costs were assumed to be on track for FY 2013 and FY 2015; and linearly distributed during FY2016 and FY 2020.

In addition, the projects identified in this Master Plan are those associated with the distribution and transmission system. Other projects in the categories listed herein and in other categories as well may be identified by other means and included in the annual budgets as they are developed.

The Capital Improvement Plan is presented in Tables 10-2 through 10-5 in accordance with the appropriate budget categories. The Capital Improvement Plan summary separated by 5-year increments is shown in Table 10-6. An overview of the CIP project locations is shown in Figure 10-1, included both in the report, and attached as a full-size drawing.

Table 10-2
Pipeline Replacements/Additions Projects
Capital Improvement Plan

| ID # | Project | Improvement Project Cost (2018 $) | | | |
|---|---|---|---|---|---|
| | | FY 2019 to FY2020 | FY 2021 to FY2025 | FY 2026 to FY2030 | FY 2031 to FY2035 |
| 1a-01 | (1) Replace Aging Cast Iron Pipe | $360,000 | $4,429,000 | $4,429,000 | $4,429,000 |
| 1a-02 | Replace 12-Inch CI Pipe in S. Novato Blvd, north of Rowland | | $354,000 | | |
| 1a-03 | Replace All Galvanized Steel Pipe | | $264,000 | | |
| 1a-04 | Replace All < 4-Inch Thin-Walled Pipe | $150,000 | $600,000 | $100,000 | $100,000 |
| 1a-05 | Replace 2-Inch TW Plastic Pipe in Pinto Ln | $32,000 | | | |
| 1a-06 | Replace 2-Inch TW Plastic Pipe in Esquire Ct | $32,000 | | | |
| 1a-07 | Replace 18-Inch Stafford Xmission Line | | | | $9,471,000 |
| 1a-08 | Relocate 8-Inch Pipe in Country Club Dr | | $586,000 | | |
| 1a-09 | Upsize 4-Inch and 6-Inch Mains in East Black Point Subzone | | $1,232,000 | | |
| 1a-10 | Upsize 4-Inch and 6-Inch Mains in East Crest Subzone | | $1,046,000 | | |
| 1b-01 | Loop Southern and Northern Zone 1 at Entrada Dr | | | $2,592,000 | |
| 1b-02 | Loop Bel Marin Keys Residential Area | | | $2,850,000 | |
| 1b-03 | Redwood Blvd-Lamont Looping | | | $505,000 | |
| 1b-04 | Loop Crest Zone at Channel Ave | | | $932,000 | |
| 1b-05 | Loop Zone 2 at Hill Rd | | | $719,000 | |
| 1b-06 | Loop Bel Marin Keys Commercial Area | | $1,238,000 | | |
| 1b-07 | Loop Southern and Northern Zone 2 at Indian Valley Campus | | | $2,730,000 | |
| 1b-08 | Loop Near Grant Ave and Eighth St | | | | $69,000 |
| 1b-09 | Loop Mall Area Near Nave Ct and S Novato Blvd | | | $208,000 | |
| 1b-10 | Connect Dead-ends at George St | | $99,000 | | |
| 1b-11 | Loop Los Robles Rd and Posada del Sol | | $63,000 | | |
| 1c-01 | (2) Replace Polybutylene Service Lines | $300,000 | $750,000 | $750,000 | $750,000 |
| 1d-01 | (3) Relocations to Synchronize with City or County Projects | $200,000 | $500,000 | $500,000 | $500,000 |
| 1e-01 | Replace North Marin Aqueduct (South of Redwood Landfill) (4) | | | | |
| | **Totals** | **$1,074,000** | **$11,161,000** | **$16,315,000** | **$15,319,000** |

Notes:

(1) 2012 Master Plan allocated $500,000 per year for FY2016 to FY2020. Budget $360k for FY2019 and FY2020 per District input. Assume linear yearly progress rate for this on-going/reocurring project for post-2020 years using 10% escalation factor to accelerate costs from 2012 Master Plan.

(2) Per District input, assume $150k per year.

(3) Per District input, assume $100k per year.

(4) Beyond current planning horizon.

Table 10-3
System Improvement Projects
Capital Improvement Plan

| ID # | Project | Improvement Project Cost (2018 $) | | | |
|---|---|---|---|---|---|
| | | FY 2019 to FY2020 | FY 2021 to FY2025 | FY 2026 to FY2030 | FY 2031 to FY2035 |
| 2-01 | (1) Replace Untestable Detector Checks | $200,000 | $500,000 | | |
| 2-02 | Integrate LIMS into District GIS system | | $44,000 | | |
| 2-03 | (2) Install Anodes on Existing Copper Services | $50,000 | $125,000 | $125,000 | $125,000 |
| 2-04 | Replace Zone Valve with a PRV Station at Park Crest Ct | | $226,000 | | |
| 2-05 | Replace Zone Valve with a PRV Station at Feliz Rd & Ferris Dr | | $234,000 | | |
| 2-06 | Replace Zone Valve with a PRV Station at Fairway Dr | | $223,000 | | |
| 2-07 | Replace Zone Valve with a PRV @ Arthur St &Washington St | | $234,000 | | |
| 2-08 | Add MOV to San Marin PS's 24-inch Feeding Line | | $56,000 | | |
| 2-09 | Replace All Lead Filled Swing Checks | | $30,000 | $30,000 | |
| | **Totals** | **$250,000** | **$1,672,000** | **$155,000** | **$125,000** |

Notes:

(1) Per District input, assume $100k per year.

(2) Per District input, assume $25k per year.

Table 10-4
Storage Tank/Pump Station Projects
Capital Improvement Plan

| ID # | Project | Improvement Project Cost (2018 $) | | | |
|---|---|---|---|---|---|
| | | FY 2019 to FY2020 | FY 2021 to FY2025 | FY 2026 to FY2030 | FY 2031 to FY2035 |
| 4-01 | Add Storage Capacity at Black Point Zone (157,000 Gal) | | | | $1,603,000 |
| 4-02 | Add Storage Capacity at Air Base Zone (216,000 Gal) | | | | $2,090,000 |
| 4-03 | Add Fire Flow Backfeed Valve at Nunes Tank | | $177,000 | | |
| 4-04 | Recoat/Seismic Upgrade Lynwood Tanks | | $2,005,000 | | |
| 4-05 | Recoat/Seismic Upgrade Cherry Hill Tank | $500,000 | | | |
| 4-06 | Recoat Garner Tank | | $354,000 | | |
| 4-07 | Recoating of Other Steel Tanks | | | $1,772,000 | $1,772,000 |
| 4-08 | Tank Seismic Retrofits | | | $709,000 | |
| 4-09 | Demolish Woodland Heights Tank | | $106,000 | | |
| 4-10 | Demolish Loma Verde Tank | | $106,000 | | |
| 4-11 | (1) Relocate and Upsize School Rd Pump Station (Crest PS) | $635,000 | | | |
| 4-12 | Upgrade Davies Pump Station | | $204,000 | | |
| 4-13 | Old Ranch Road Tank No.2 (100,000 Gal) | $150,000 | $481,000 | | |
| | **Totals** | **$1,285,000** | **$3,433,000** | **$2,481,000** | **$5,465,000** |

Notes:
(1) 2012 Master Plan allocated $75,000 for FY2016 to FY2020. Updated based on District input.

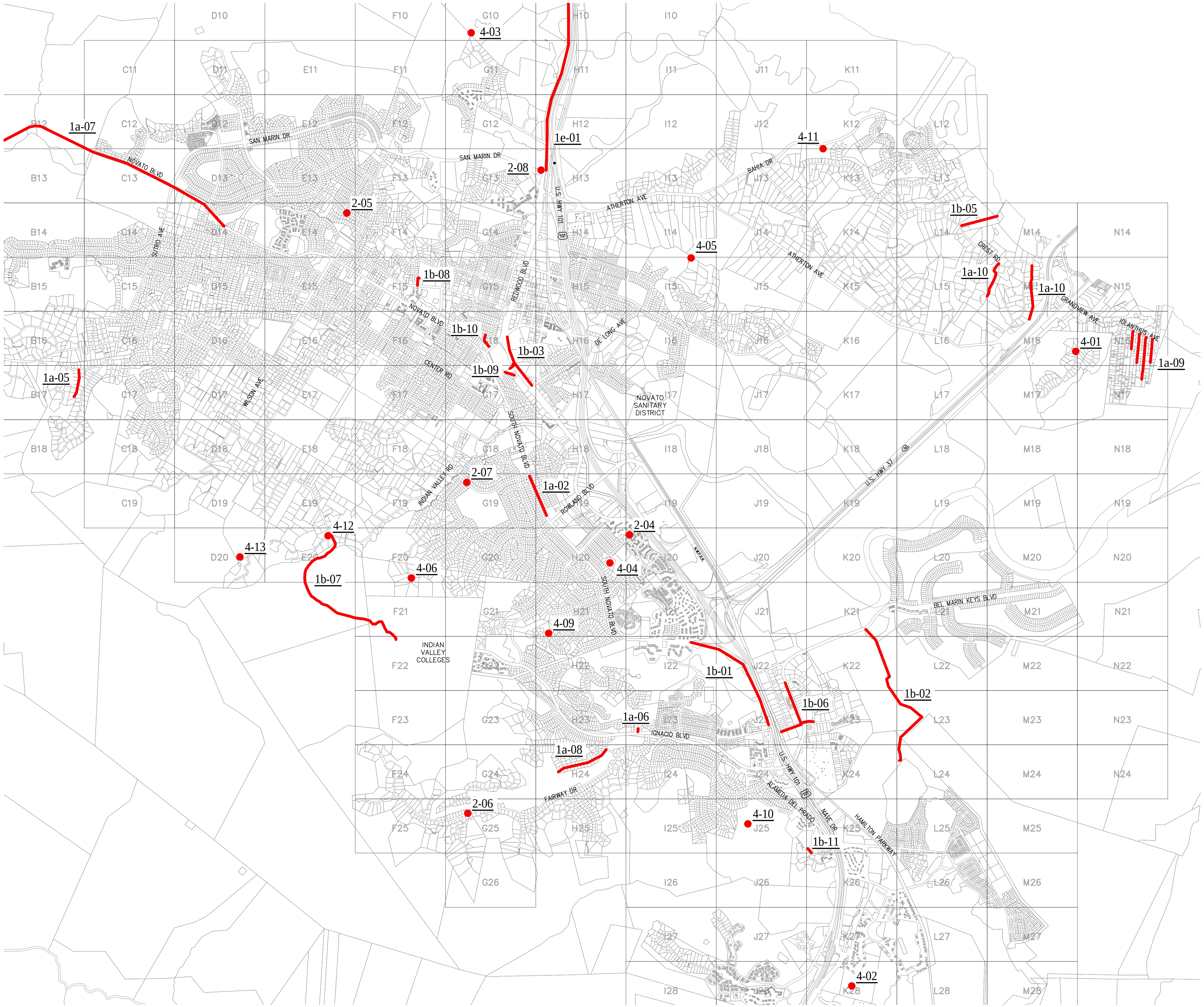
Table 10-5
Preliminary Project Engineering and Studies Projects
Capital Improvement Plan

| ID # | Project | Improvement Project Cost (2018 $) | | | |
|---|---|---|---|---|---|
| | | **FY 2019 to FY2020** | **FY 2021 to FY2025** | **FY 2026 to FY2030** | **FY 2031 to FY2035** |
| S-01 | Pump Efficiency/Hydraulic Study | | $30,000 | | |
| S-02 | [(1)]Master Plan Update | $68,000 | $95,000 | $100,000 | $100,000 |
| S-03 | Crest/Black Point Zone Modification Eval | | $27,000 | | |
| S-04 | Hydraulic Model Calibration and Maintenance Updates | $10,000 | $25,000 | $25,000 | $25,000 |
| S-05 | Stafford Dam Seismic Stability Study Update | | | $106,000 | |
| S-06 | [(2)]Stafford Watershed Master Plan | | $18,000 | $18,000 | $18,000 |
| S-07 | Lynwood and San Marin Zone 2 Pumping Capacity Study | | $28,000 | | |
| S-08 | Water Supply Enhancement Study | $50,000 | $100,000 | | |
| S-09 | Stafford Lake Sediment Survey | | $50,000 | | $50,000 |
| S-10 | Cathodic Protection Master Plan | | $40,000 | | |
| | **Totals** | **$128,000** | **$413,000** | **$249,000** | **$193,000** |

Notes:
(1) 2012 Master Plan allocated $85,000 for FY2016 to FY2020. Updated based on District input.
(2) 2012 Master Plan allocated $10,000 for FY2013 to FY2015. Updated based on District input.
(3) 2012 Master Plan allocated $5,000 for FY2013 to FY2015, this master plan reinjected and escalated this budget to FY2018 to FY2020.

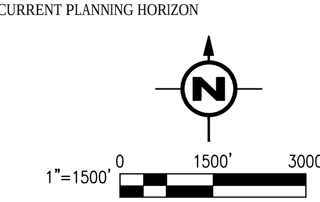
Table 10-6
Capital Improvement Plan Summary

| ID # | Project | Improvement Project Cost (2018 $) | | | |
|---|---|---|---|---|---|
| | | **FY 2019 to FY2020** | **FY 2021 to FY2025** | **FY 2026 to FY2030** | **FY 2031 to FY2035** |
| 1a | Main/Pipeline Replacements | $574,000 | $8,511,000 | $4,529,000 | $14,000,000 |
| 1b | Main/Pipeline Additions | $0 | $1,400,000 | $10,536,000 | $69,000 |
| 1c | PB Service Line Replacements | $300,000 | $750,000 | $750,000 | $750,000 |
| 1d | Relations to Sync w/City CIP | $200,000 | $500,000 | $500,000 | $500,000 |
| 1e | Aqueduct Replacement | $0 | $0 | $0 | $0 |
| | *Category 1 Subtotal* | $1,074,000 | $11,161,000 | $16,315,000 | $15,319,000 |
| 2 | System Improvements | $250,000 | $1,672,000 | $155,000 | $125,000 |
| | | | | | |
| 4 | Storage Tanks/Pump Stations | $1,285,000 | $3,433,000 | $2,481,000 | $5,465,000 |
| | | | | | |
| Study | Preliminary Project Engineering and Studies | $128,000 | $413,000 | $249,000 | $193,000 |
| | **Totals** | **$2,737,000** | **$16,679,000** | **$19,200,000** | **$21,102,000** |




| CAPITAL IMPROVEMENT PROJECTS | | | |
|---|---|---|---|
| PROJECT ID NUMBER | PROJECT NAME | PROJECT TYPE | CIP YEAR |
| 1a-02 | REPLACE 12" CI PIPE IN S. NOVATO BLVD, NORTH OF ROWLAND | CC | 2020 |
| 1a-05 | REPLACE 2" THIN-WALLED PLASTIC PIPE IN PINTO LANE | AM | 2020 |
| 1a-06 | REPLACE 2" THIN-WALLED PLASTIC PIPE IN ESQUIRE COURT | AM | 2020 |
| 1a-07 | REPLACE 18" STAFFORD TRANSMISSION LINE | DP | 2035 |
| 1a-08 | RELOCATE 8" PIPE IN COUNTRY CLUB DRIVE | DP | 2025 |
| 1a-09 | UPSIZE 4" AND 6" MAINS IN EAST BLACK POINT SUBZONE | HE | 2025 |
| 1a-10 | UPSIZE 4" AND 6" MAINS IN EAST CREST SUBZONE | HE | 2025 |
| 1b-01 | LOOP SOUTHERN AND NORTHERN ZONE 2 AT ENTRADA DRIVE | HE | 2030 |
| 1b-02 | LOOP BEL MARIN KEYS RESIDENTIAL AREA | HE | 2030 |
| 1b-03 | REDWOOD BLVD AND LAMONT AVE LOOPING | HE | 2030 |
| 1b-04 | LOOP CREST ZONE AT CHANNEL AVE | HE | 2030 |
| 1b-05 | LOOP ZONE 2 AT HILL ROAD | HE | 2030 |
| 1b-06 | LOOP BEL MARIN KEYS COMMERCIAL AREA | HE | ONGOING |
| 1b-07 | LOOP SOUTHERN AND NORTHERN ZONE 2 AT INDIAN VALLEY CAMPUS | HE | 2030 |
| 1b-08 | LOOP NEAR GRANT AVENUE AND EIGHTH STREET | HE | 2035 |
| 1b-09 | LOOP THE MALL AREA NEAR NAVE COURT AND SOUTH NOVATO BOULEVARD | HE | 2030 |
| 1b-10 | CONNECT DEAD-ENDS AT GEORGE ST | HE | 2020 |
| 1b-11 | LOOP LOS ROBLES ROAD AND POSADA DEL SOL | HE | 2025 |
| 1e-01 | REPLACE NORTH MARIN AQUEDUCT (SOUTH OF REDWOOD LANDFILL) | HE | BCPH |
| 2-04 | REPLACE ZONE VALVE WITH A PRV STATION AT PARK CREST COURT | HE | 2025 |
| 2-05 | REPLACE ZONE VALVE WITH A PRV STATION AT FELIZ ROAD AND FERRIS DR | HE | 2025 |
| 2-06 | INSTALL PRV STATION AT FAIRWAY DRIVE/ CAPILANO DRIVE | HE | 2025 |
| 2-07 | REPLACE ZONE VALVE WITH A PRV AT ARTHUR ST AND WASHINGTON ST | HE | 2025 |
| 2-08 | ADD MOTOR OPERATED VALVE TO SAN MARIN PUMP STATION 24" FEEDING LINE | HE | 2025 |
| 4-01 | ADD STORAGE CAPACITY (157,000 GALLONS) AT BLACK POINT ZONE | SP | 2035 |
| 4-02 | ADD STORAGE CAPACITY (216,000 GALLONS) AT AIR BASE ZONE | SP | 2035 |
| 4-03 | ADD FIRE FLOW BACKFEED VALVE AT NUNES TANK | SP | 2020 |
| 4-04 | RECOAT/SEISMIC UPGRADE LYNWOOD TANKS | AM | 2020 |
| 4-05 | RECOAT/SEISMIC UPGRADE CHERRY HILL TANK | AM | 2020 |
| 4-06 | RECOAT GARNER TANK | AM | 2025 |
| 4-09 | DEMOLISH WOODLAND HEIGHTS TANK | DP | 2025 |
| 4-10 | DEMOLISH LOMA VERDE TANK | DP | 2025 |
| 4-11 | RELOCATE AND UPSIZE SCHOOL ROAD PUMP STATION (CREST PS) | SP | 2020 |
| 4-12 | UPGRADE DAVIES PUMP STATION | DP | 2025 |
| 4-13 | OLD RANCH ROAD TANK NO. 2 | SP | 2025 |

BCPH = BEYOND CURRENT PLANNING HORIZON




NORTH MARIN WATER DISTRICT
NOVATO, CALIFORNIA

2018 WATER MASTER PLAN

FIGURE 10-1

CAPITAL IMPROVEMENT PROJECT LOCATION MAP