Section 6

Supply Facilities Analysis

The supply category consists of groundwater wells and other water supply projects. Well site destruction is also included. This section describes the analysis of the District's water supply facilities including asset management R/R activities and the need for new facilities.

Strategic Plan Alignment

Facilities and Operations – 2.A. - The District will utilize appropriate planning tools, identify financial resources necessary, and prioritize system requirements to protect and maintain District assets and attain water resource objectives incorporating resource sustainability and lifecycle cost analysis into the framework.

- **Identifies well replacement and rehabilitation activities.**

Facilities and Operations – 2.B. - Monitor and improve the system efficiencies in operating and maintaining system infrastructure.

- **Business case evaluation of reducing the number of wells.**

Facilities and Operations – 2.C. Develop cost-effective strategies utilizing technology and available resources to optimize delivery of water and enhance service.

- **Under-performing wells procedures.**
- **Well investment decision process tool.**

Facilities and Operations – 2.D. Manage assets by implementing, preventive and predictive maintenance and analysis programs on District assets to extend their life and reduce service interruptions.

- **Recommends phased downhole well rehabilitation and pump repair.**

Policy Implications

- **Phased downhole well rehabilitation and pump repair recommendations.**
- **Well replacement program to replace wells at end of useful life.**
- **Reduction in overall number of well sites from existing system.**
- **Recommends increased expenditures on well replacement compared to current implementation.**

6.1 Groundwater Well Facility Asset Management

As summarized in Section 5, the components that should be added to the Groundwater Well Facility AMP are identified in Table 5-2. Some of the key items that could add more value to the AMP if added are as follows:

- Update the Groundwater Well Facility AMP document to incorporate the components of the Long Term Well Plan (LTWP), described in Section 6.2.
- Define and document AMP roles and responsibilities for plan development, maintenance and implementation.
- Develop risk management strategies to focus resources on the greatest risk to the District. Identify the critical (high likelihood and high consequence of failure) wells to help focus District resources on the greatest risk assets.
- Develop and document a plan to manage condition information. One tool that could be developed is a well field management database. The database is a useful organization tool to store well data. This type of database could position the District to be able to more efficiently manage the well field and long term replacement and rehabilitation plan and schedule.

- The AMP document should lay out a plan for asset commissioning and decommissioning so that adjustments to the O&M practices can be made based on asset changes.

6.2 Long Term Well Plan

The LTWP is a schedule for the replacement and rehabilitation of the District's existing groundwater wells so that water demands can be supplied by groundwater in the most efficient manner. This LTWP builds off of the Groundwater Well Facility AMP and the District's 2009 WSMP.

6.2.1 Background and Objectives

As part of the District's 2009 WSMP, a LTWP and schedule was developed providing a plan for when to replace and rehabilitate the District's groundwater wells. In 2009 the District also developed the Groundwater Well Facility AMP which created a scoring system to rank the District's existing wells based on condition assessment, well performance, water quality, and future value. In 2015, six wells were removed from operation due to high hexavalent chromium concentrations, and three wells were removed from operation due to positive bacteria samples. The District updated the Groundwater Well Facility AMP in August 2015. The goals of this updated LTWP is to incorporate the updated condition ranking developed in the District's Groundwater Well Facility AMP to provide an updated LTWP rehabilitation and replacement schedule that:

- Maintains groundwater well assets by developing a long-term rehabilitation and replacement plan.
- Results in the District's groundwater supply wells, in combination with storage booster pumping capacity, meeting a desired goal of 115 percent of peak hour water demand.
- Increases reliability and value of the groundwater supply system.

6.2.2 Methodology

The methodology in this analysis has been updated from the methodology used in the 2009 WSMP. The 2009 WSMP assumed that wells in good condition per the Groundwater Well Facility AMP could be expected to have a longer useful life than those with a poorer Groundwater Well Facility AMP ranking. In the 2009 WSMP a longer useful life was assumed for non-key wells.

For this analysis, a risk evaluation is developed to estimate the useful life of each well based on the condition and importance of the well to the system, as discussed in Section 6.2.3.

Current well capacity for 2016 is based on current well capacity as provided by the District as of October 1, 2015. The capacity of new wells is assumed to be 1,500 gpm. Because the District has multiple wells with current capacity below 1,500 gpm, as wells are being replaced, it is assumed that the District will be able to reduce the quantity of well facilities overall.

The reliable pumping capacity of the District's three ground level reservoirs is used in this analysis as available pumping capacity to help meet the 115 percent of peak hour demand criteria.

6.2.3 Risk Analysis

The risk of failure of each well is determined based on the consequence of failure multiplied by the likelihood of failure. The useful life of each well is estimated based on the calculated risk of each well. Wells not meeting level of service goals are under-performing (UP). For UP wells there are recommended procedures (See Section 6.2.6) that incorporate a well investment decision tool (see Section 6.2.7) to use as a guideline to assist District staff in making cost effective decisions. Figure 6-1 provides a summary of this LTWP process. See Appendix F for a more detailed flow chart of this LTWP.

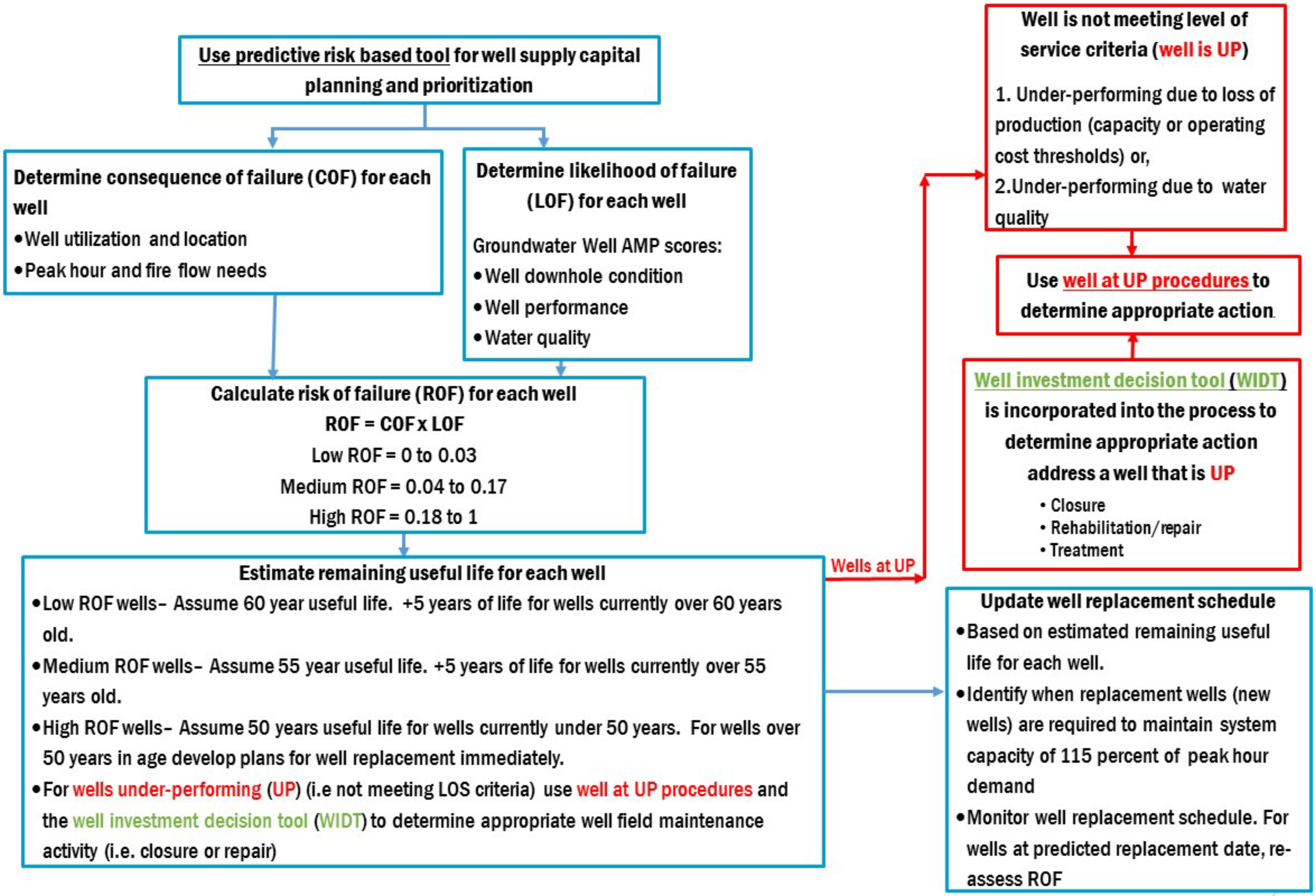


Figure 6-1. Long Term Well Plan Process

6.2.3.1 Likelihood of Well Failure

The likelihood rating is a function of well downhole condition, well performance, and water quality. These factors are assumed to have the greatest influence of the likelihood of failure (LOF) of a well. The District's Groundwater Well Facility AMP provides detailed analysis and scoring of each well. Table 6-1 lists the factors and weighting for which each well is scored in the Groundwater Well Facility AMP.

Table 6-1. Well Likelihood of Failure Factors and Weighting

Factor	Points Available Range [a]	Overall Weight
Downhole condition		
Age	0 - 10	
Construction method	0 - 10	
Depth of annular seal	0 - 10	
Casing diameter	0 - 10	
Casing thickness	0 – 5	
Sand production	0 - 5	
Downhole condition subtotal	50	31%
Performance		
Loss of production performance	0 - 10	
Loss of pumping efficiency	0 – 20	
Loss of specific capacity	0 – 20	
Performance subtotal	50	31%
Water quality	60	38%
Total	160	100%

[a] *Points range and actual points score by well are from the Groundwater Well Facility AMP (SSWD, 2015)*

The LOF rating is a measure of the likelihood or probability of a well to fail. The LOF rating can vary from 0 to 1. The lower the LOF rating (closer to or equal to zero), the lower the probability of failure, and the higher the LOF rating (closer to or equal to 1) means failure is eminent. The LOF rating is grouped into low, medium, and high based on the total points a well scores for each of the factors listed in Table 6-1 from the Groundwater Well Facility AMP, divided by the total points possible (160 points). The formula used to calculate the LOF score is presented in Equation 6-1. Table 6-2 lists the minimum and maximum LOF ratings for each of the LOF groups (low, medium, and high).

Equation 6-1. Likelihood of Failure Factor for Each Well

LOF factor for each well = (downhole condition points + performance points + water quality points) / total points (160)

Table 6-2. Likelihood of Failure Factor Ranges

Likelihood of Failure (LOF) Group	Minimum LOF Score	Maximum LOF Score
Low	0	0.31
Medium	0.36	0.68
High	0.74	1.00

6.2.3.2 Consequence of Well Failure

The consequence rating is a function of well location and production capacity as well as peak hour and fire flow needs for each well. These factors are assumed to have the greatest influence on the consequence of failure (COF) of each well. The COF rating is a measure of the consequence of failure for each well. The COF rating can vary from 0 to 1. The lower the COF (closer to or equal to 0), the lower impact on decreasing the level of service in the system. The higher the COF (closer to or equal to 1) the higher potential impact of decreasing the level of service in the system. The COF is grouped into low, medium, and high based on the well capacity percent of subarea production capacity combined with the need for the well to meet localized fire flow and/or peak hour demands. A well that is required to meet peak hour and/or fire flow demands will have an additional COF rating of 0.5, not to exceed a COF score of 1 for any well.

Below are considerations regarding this factor. Table 6-3 lists the minimum and maximum COF ratings for each of the COF groups (low, medium, and high). The formula used to calculate the COF score is presented in Equation 6-2.

- A well with higher production capacity will have a higher COF than a well with lower production capacity in the same subarea.
- A well in a subarea with fewer wells will likely have a higher COF than a well in a subarea with many wells.

Equation 6-2. Consequence of Failure Factor for Each Well

COF factor for each well (not to exceed a score of 1) = (well production capacity/total subarea production capacity) + fire flow well factor(0.5 if applicable) + peaking well factor (0.5 if applicable)

Table 6-3. Consequence of Failure Factor Ranges

Consequence of Failure (COF) Group	Minimum COF Score	Maximum COF Score
Low	0	0.10
Medium	0.11	0.25
High	0.26	1.00

6.2.3.3 Risk of Well Failure

Based on the condition driven LOF factor and the importance driven COF factor the risk of failure (ROF) of each well is calculated. The generally accepted risk equation is shown in Equation 6-3.

Equation 6-3. Risk of Failure Factor for Each Well

ROF factor for each well = LOF factor x COF factor

The risk scoring range matrix is shown on Figure 6-2. This figure illustrates the risk score as it is related to the LOF and COF factor ranges. Below are considerations regarding the risk factor.

- A well that has a high LOF factor may have a low risk of failure if the consequence of failure is low.
- A well that has a high COF factor may have a high risk of failure even if the likelihood of failure is low.

COF		Low (min)	Low (max)	Med (low)	Med (max)	High (min)	High (max)
	High (max)	-	0.31	0.36	0.68	0.74	1.00
	High (min)	-	0.08	0.09	0.18	0.19	0.26
	Med (max)	-	0.08	0.09	0.17	0.18	0.25
	Med (low)	-	0.03	0.04	0.07	0.08	0.11
	Low (max)	-	0.03	0.04	0.07	0.07	0.10
	Low (min)	-	-	-	-	-	-

LOF

Figure 6-2. Risk of Failure Possible Scoring Ranges for Low, Medium, and High Groups

A risk assessment matrix of the District wells is plotted on Figure 6-3, with the highest risk well show in the red shaded area in the upper right corner of the matrix. The boundaries between high, medium, and low risk are based on the boundaries of the possible scores shown on Figure 6-2. Appendix F contains the data tables used to develop these risk results. Below are some observations regarding the risk results

- One well, Capehart MC-3C, is considered at high risk of failure. This is primarily due to the low number of wells in the AASA, indicating a high COF for this well. This well is currently inactive due to the presence of Cr+6 in this well.
- Most of the wells in the system are considered to have a low ROF. It should be noted that a well at low ROF does not indicate the well does not have a high LOF. Many of the District's wells with a low ROF have a relatively high LOF.

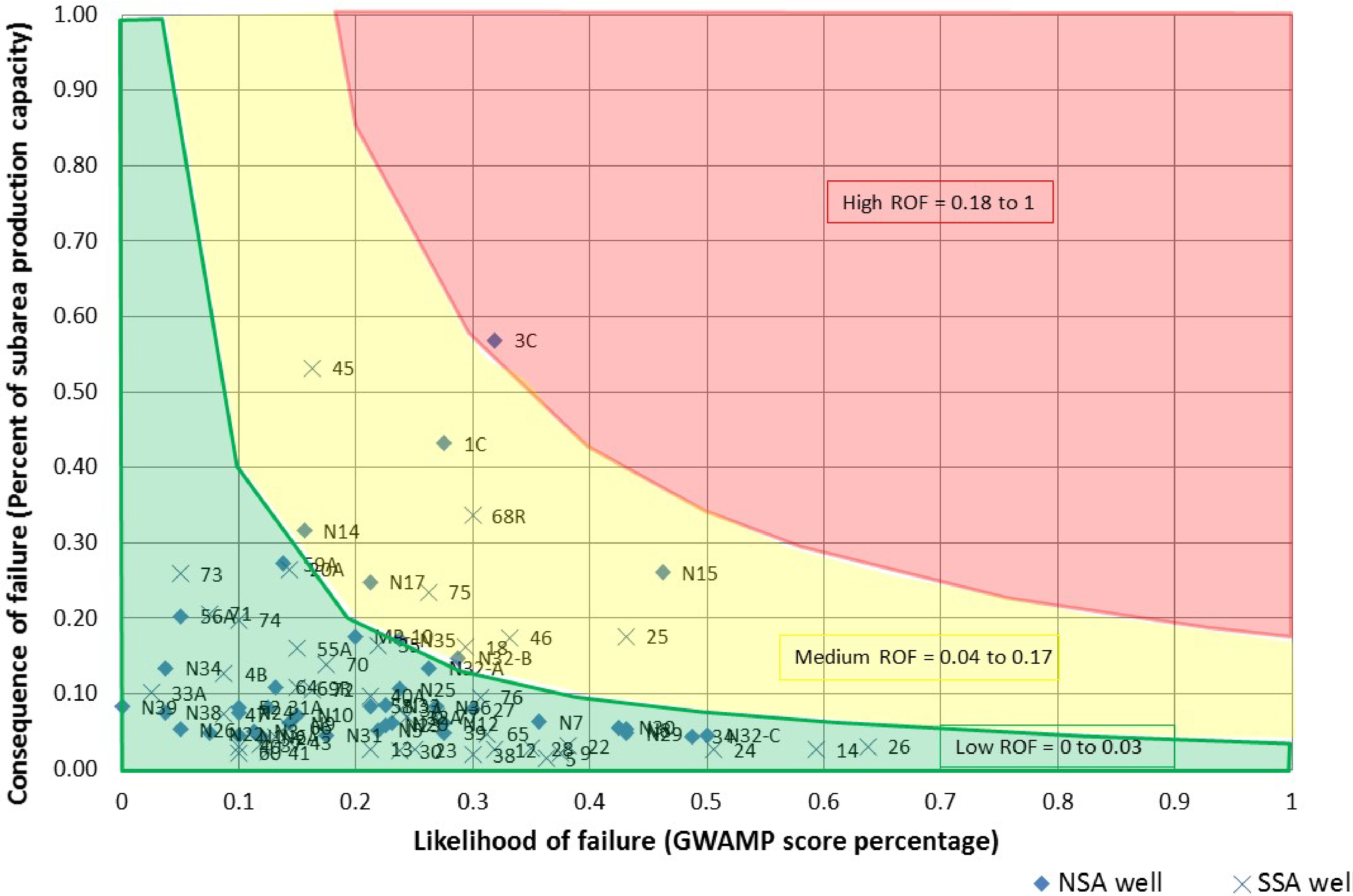


Figure 6-3. Consequence and Likelihood of Failure Risk Matrix

6.2.4 Estimated Well Useful life

The remaining useful life of a well is estimated in order to estimate the year the well capacity will be lost for that well. The commonly accepted industry standard assumes a 50-year life span for a municipal water well. Estimates for a municipal well life span and reference sources are shown in Table 6-4. The age of a well is directly related to useful life remaining for the well. The useful life of a well is often less than its physical life.

Table 6-4. Municipal Groundwater Well Life Span

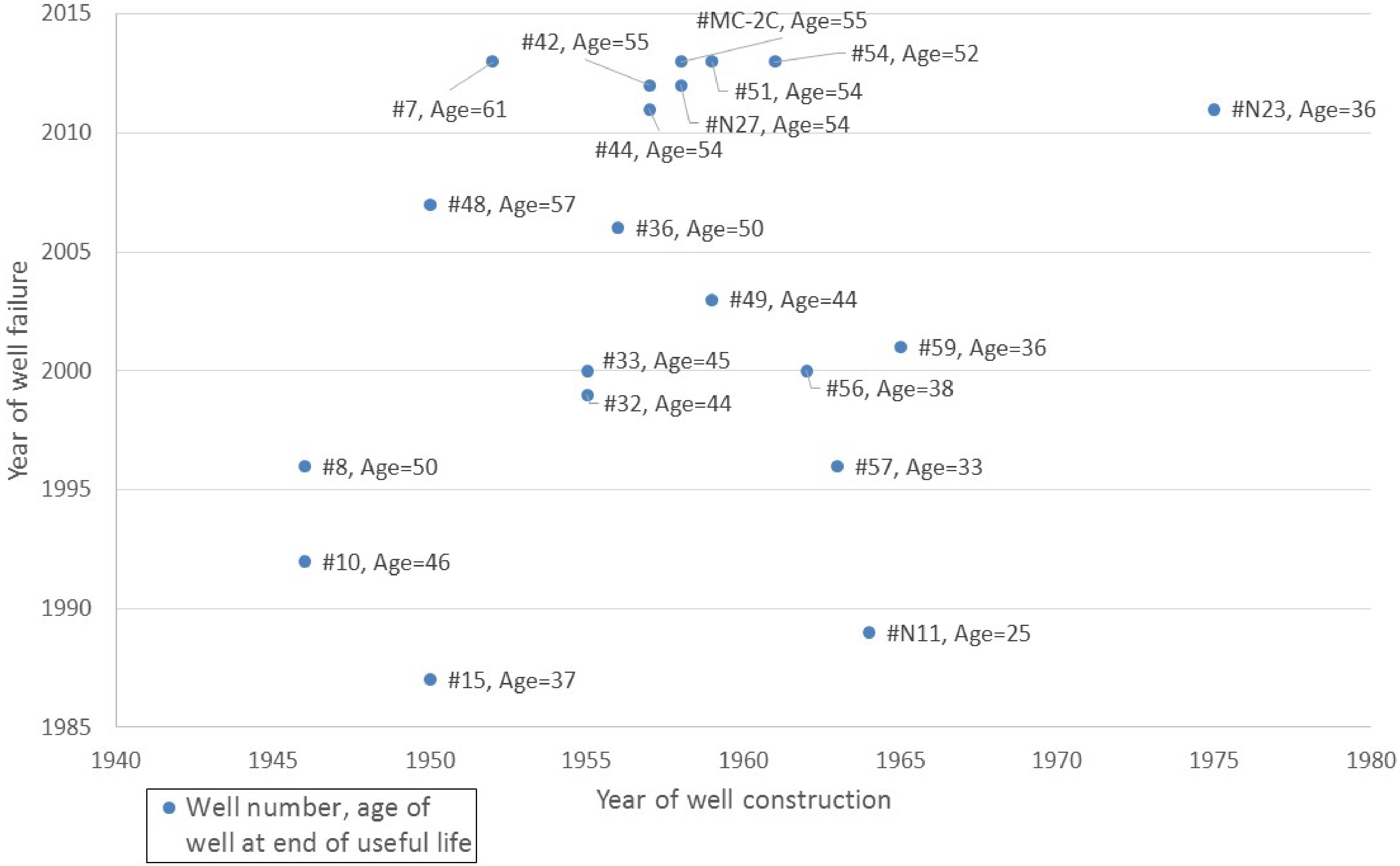
Life Span Estimate, Years	Notes	Source
50	Neighboring water agency	Personal communication, Deanna Donohure, PE, Vice President – Engineering, California American Water
50	From the City of Waterford 2016 Water Master Plan	Shoreline Environmental Engineering, 2016
40	City of Davis Water Distribution System Optimization Plan	Brown and Caldwell et al, 2011
40 - 50	Carmichael Water District Master Plan, Business Plan and Water Rate Study 2015-2065	Carmichael Water District, 2015
30 - 50	Infrastructure life expectance	County of Santa Barbara, EPA, 2012 (from Roscoe Moss Case Study)
30 -50	UC Cooperative Extension, Tehama County	Fulton, 2003
15 - 20	Depreciation recovery period	IRS
25 - 35	Typical Equipment Life Expectancy	EPA, 2003
30	Suggested useful lives of fixed assets	California State Controller's Office

The average and median well age for the current system is shown in Table 6-5. Figure 6-4 illustrates historical District well failures occurring of the last 30 years. Eight wells have failed and been removed from service since 2010. These do not include the wells that are currently off-line due to the presence of Cr+6 in the well.

Table 6-5. Current System Well Age Characteristics

	Number of Wells	Average Age of Well, Years	Median Age of Well, Years
NSA	42	42	48
SSA	41	48	58
Total system	83	46	53

Notes wells in system currently range from 2 to 75 years old.



Note: Average age at end of useful life is 46.3 years.

Figure 6-4. Historical District Well Failure

For this analysis, the useful life of a District well is based on the ROF score for each well.

- Low ROF wells– Assume 60-year useful life. Add an additional 5 years of life for wells currently over 60 years old.
- Medium ROF wells– Assume 55-year useful life. Add an additional 5 years of life for wells currently over 55 years old.
- High ROF wells– Assume 50 years useful life for wells currently under 50 years. For wells over 50 years in age develop plans for well replacement immediately.

Figures 6-5 and 6-6 illustrate the estimated useful life versus the current well age for each of the wells in the NSA and SSA, respectively. Also, shown on these figures are the historical well failure ages for actual District wells. Observations related to these figures are listed below.

- Most wells are estimated to reach replacement year at 60 years or greater.
- Wells that are currently at UP, not meeting level of service criteria for production or water quality requirements, as further defined 6.2.5, are shown to be replaced at their current age. It is recommended that District staff evaluate these wells to identify the appropriate and cost effective action based on the procedures for wells at UP and the well investment decision tool described later in this section.

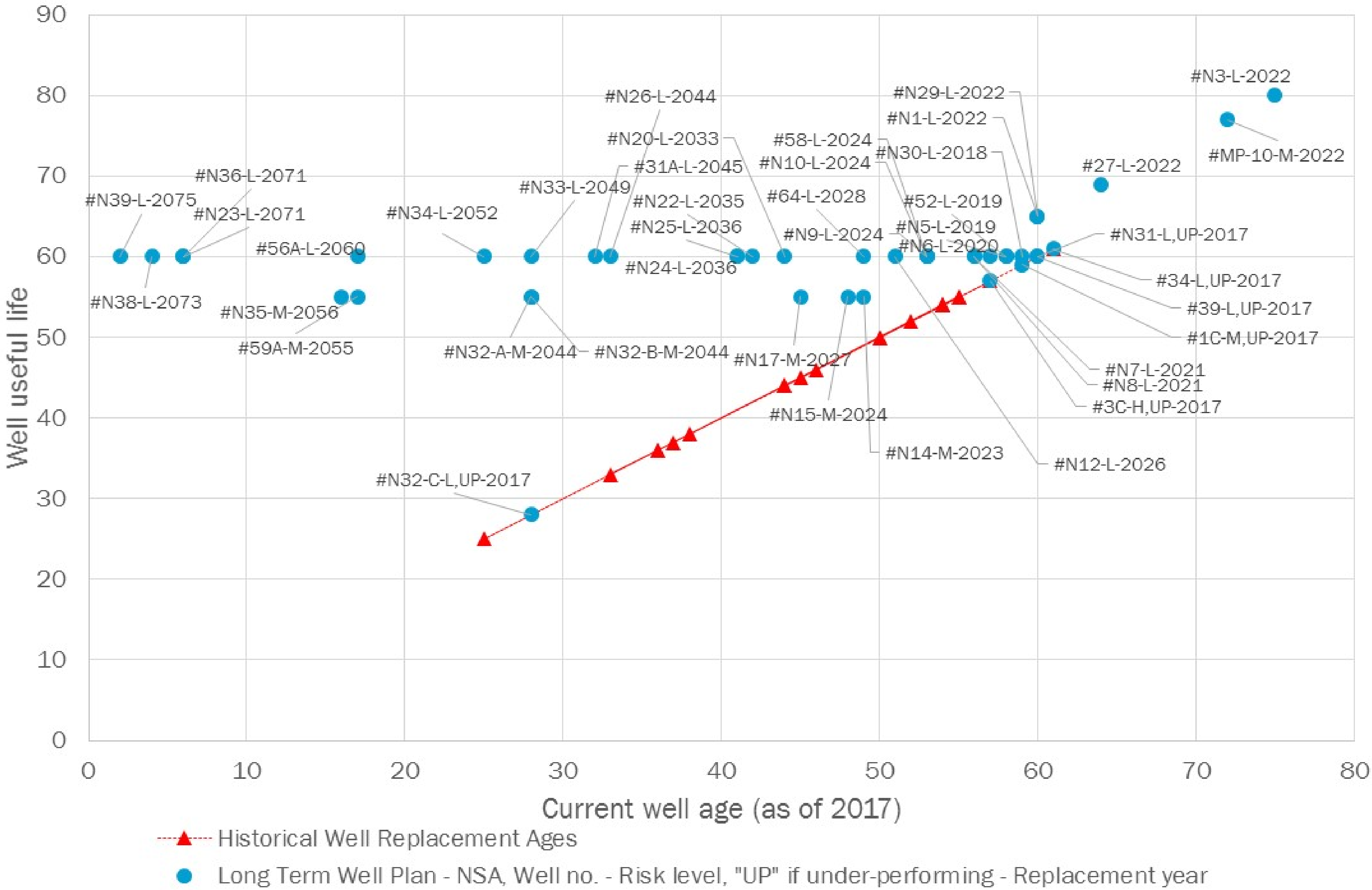


Figure 6-5. Well Age vs. Estimated Useful Life, North Service Area

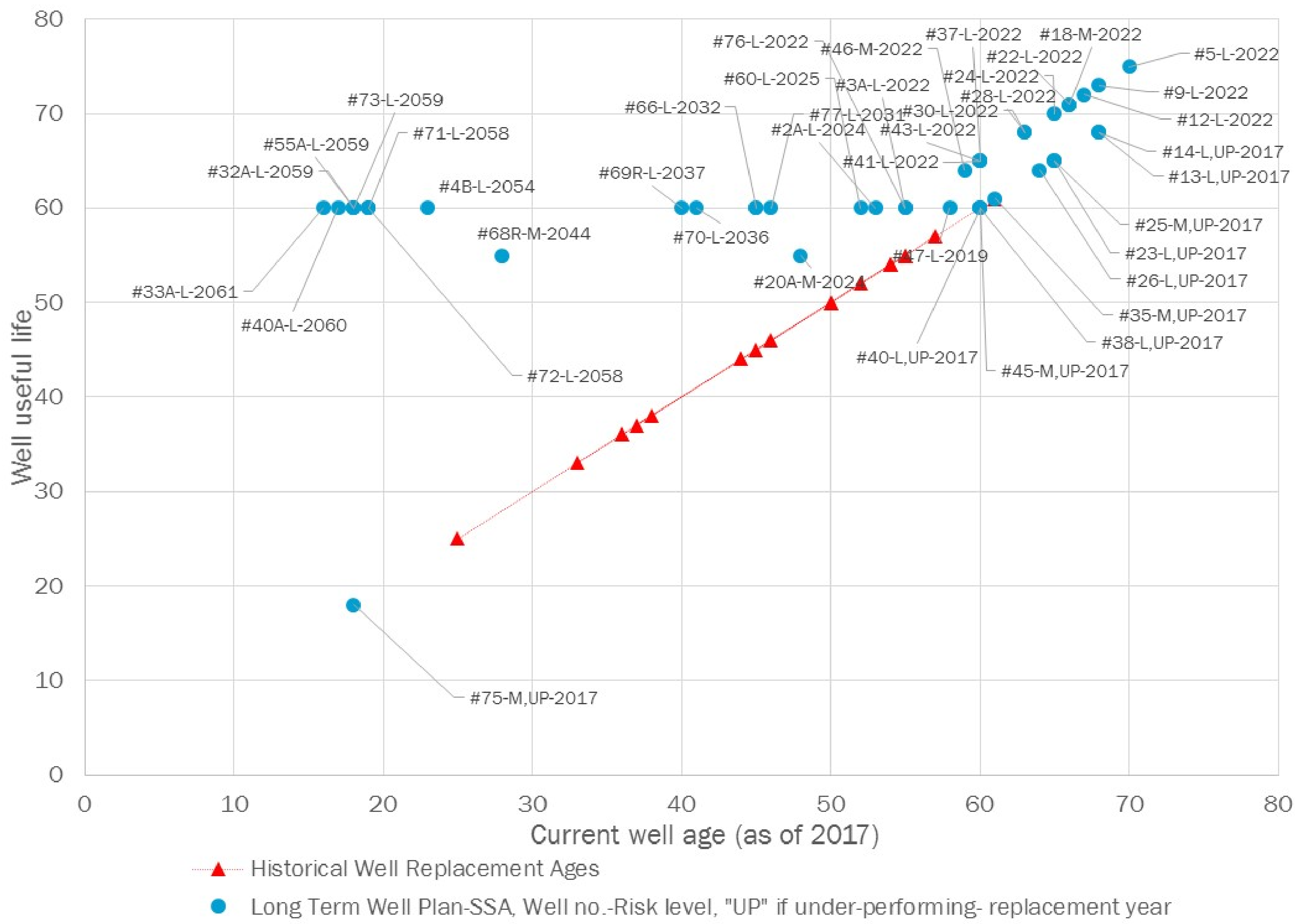


Figure 6-6. Well Age vs. Estimated Useful Life, South Service Area

6.2.5 Level of Service Related to Well Failure and Under Performance

A well reaches the end of its useful life when it can no longer meet the level of service (LOS) for which it was designed and cannot be repaired. This is considered the point at which the well fails. A well not be meeting the LOS criteria does not necessarily indicate the well is at failure. Repairs and rehabilitation could potentially be performed to improve performance. There are two overall LOS criteria used to determine if a well is approaching failure or under performing (1) meeting production goal and (2) meeting water quality requirements. These LOS criteria are described below.

1. Meeting production goal – Each well is designed to produce the water supply necessary to meet demands in the service area. Over time, water moves less efficiently through a well screen due to plugging and deterioration. Deposits accumulate; the casing corrodes; and sand blocks the openings. The casing and well screen can be cleaned or parched, but these repairs take their toll on productivity.

   When a well's production capacity drops below what is required from a well to meet demands and the well is not meeting its level of service for production, the well is under performing. Another indicator that a well is not meeting its production LOS is when the net operating cost of an existing well exceeds the annual cost for rehabilitation, a new well, or an alternative water supply source, the well has failed. It is recommended that the District develop quantifiable criteria to track performance indicators and determine when a well is not meeting it's LOS goals for production.

2. Meeting water quality requirements. Over time wells can begin pumping constituents that cause it to exceed water quality standards or it is producing at water quality levels that cannot be mitigated by existing treatment facilities at the site or downhole modifications. There are multiple water contaminants that the District encounters. When a well's production water quality does not meet requirements for primary maximum contaminant levels (MCLs), secondary MCLs, or has taste/odor issues or bacteriological presence (raw water) the well is under performing.

Well under performance and failure can occur in many ways and modes. Table 6-6 summarizes the typical failure modes that that commonly occur within the District causing a well to not meet the level of service criteria.

Table 6-6. Typical Failure Modes Leaking to Well Failure or Under Performance

Loss of Production	Loss of Water Quality
Well issues: Well screen plugged (i.e. bacterial growth, Mineral encrustation) Casing failure (break, holes) Casing failure can cause well to fill with formation material/gravel pack Physical plugging of gravel pack (due to poor design) Sand production (from plugged well screen, casing failure, enlarged perforations due to previous rehabs) Well patches placed in screened section Casing liner installation will cause loss of production and specific capacity Declining water table Aquifer/formation damage Well construction: formation collapse in cable tool wells Pumping interference from nearby wells Pump issues: Pump is wearing out Pump failure	Presence or elevated levels: Manganese Iron PCE TCE Nitrate Methane Bacteriological fouling Cr+6

6.2.6 Well Under Performance Decision Procedures

Under performance from any mode requires a decision to be made regarding immediate closure of the facility or repair or rehabilitation of the facility. Figure 6-7 illustrates a recommended decision process for how to proceed if a well is under performing due to loss of production. Figure 6-8 illustrates a recommended decision process for how to proceed if a well is under performing due to loss of water quality. Both processes incorporate the use of the well investment decision tool (WIDT) (described in Section 6.2.7). The intent of these recommended processes are to provide a series of steps for staff to proceed for analyzing potential repair options and ultimately selecting an action that is cost effective.

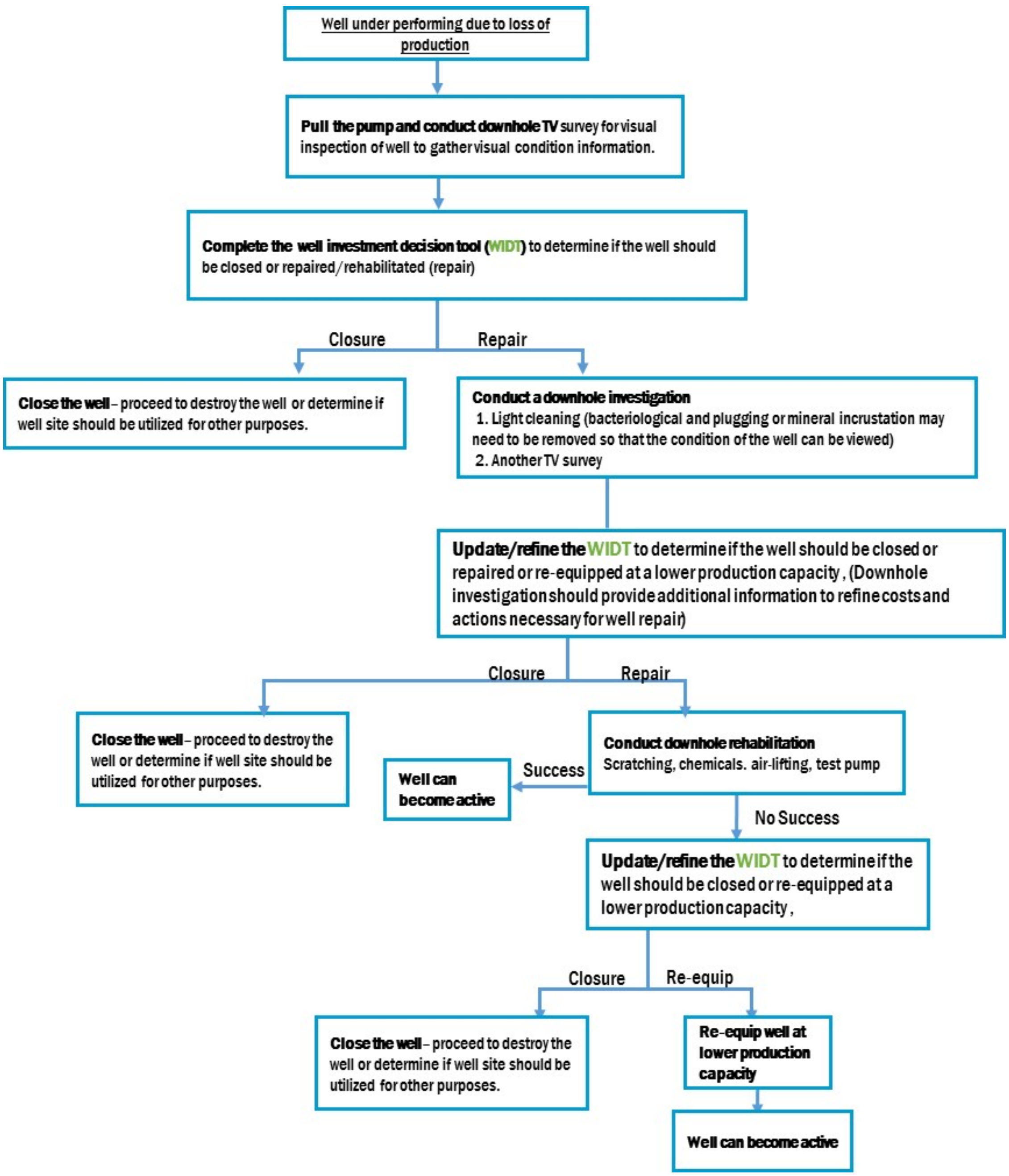


Figure 6-7. Recommended Decision Process for Under Performing Wells Due to Loss of Production

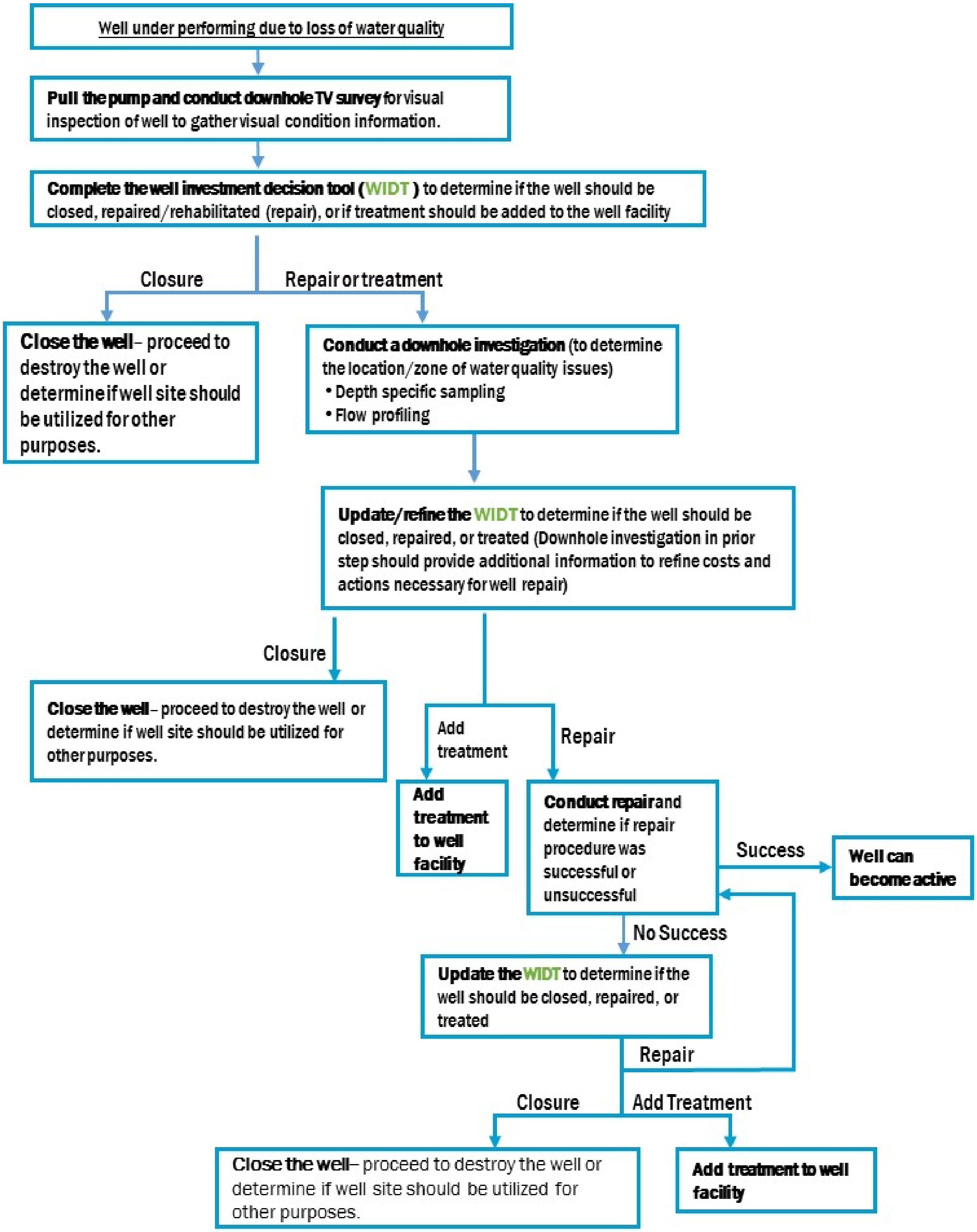


Figure 6-8. Recommended Decision Process for Under Performing Wells Due to Loss of Water Quality

6.2.7 Well Investment Decision Tool

The purpose of the WIDT is to create a discriminatory process to work towards an operationally and fiscally efficient well field. This decision tool allows for District staff to document and analyze investment decisions relative to the value of the well asset. The investment decision tool is cost driven based on the value of the well and utilizes the District's well ranking scores developed as part of the District Groundwater Well Facility AMP as a major differentiator between investment priorities. The following three steps describe how to use the tool:

1. Step 1. Identify Decision to be Made (investment activity): This could be a reactive activity such as a well repair or a proactive activity such as planned system maintenance for light or heavy rehabilitation.
2. Step 2. List Facility Facts: Document the well characteristics, potential investment activities, and costs to identify the potential range of costs of the investment activity. Table 6-7 lists the facility facts required to complete Step 2. Other well characteristics to consider are the value of the well hydraulically to the system. For example, a well that is required to meeting fire flow demands in a particular area will have an increased hydraulic value.

Table 6-7. Well Investment Decision Tool - Step 2. List Facility Facts

A. Well Characteristics:	
Year well was constructed	
Well age	Estimated well useful life
Current monetary value of well facility (=age/estimated useful life*$3mil*current capacity/1,500) *Notes:* • Estimated useful life as estimated in the well risk of failure analysis • $3mil assumed to be value of new well with 1,500 gpm production capacity	
Current well capacity, gpm	
Current well specific capacity, gpm/ft	
Production cost per ac-ft (over last one to three years), $/ac-ft	
Well risk of failure: Low, medium, or high Well likelihood of failure: Low, medium, or high Well consequence of failure (note if well needed for peak demands or fire flow): Low, medium, or high	
Water System Master Plan - schedule for replacement: CIP Phase 1, CIP Phase 2, CIP Phase 3, or Post CIP	
B. Potential Investment Activities and Costs:	
List historical repairs occurring over the last 5-years	
Sum of repair costs over last 5-years, $	
List all known and potential new repairs required at this facility	Select those that apply: Pump repairs • Pull pump and TV = $5,000 • Repair pump = $40,000 • Replace pump = $75,000 • Other site improvements $______ Well (downhole) repairs • Liner installation = $50,000 • Casing patch = $15,000 • Other site improvements $______

Table 6-7. Well Investment Decision Tool - Step 2. List Facility Facts

	Well rehab • Light rehab (Phase 1), $25,000 • Heavy rehab (Phase 2), $75,000 Pump rehab • Light rehab (Phase 1), $50,000 • Heavy rehab (Phase 2), $90,000
Sum of new repair/potential repair cost, $	
Investment activity, percent of well value • Sum of new repair costs/current value of well facility	
C. Projected Operational Impacts of Well Investment	
Well capacity following well investment activity, gpm, *(or state "no change" if no anticipated change) Note: Rehab involving a well liner is assumed to reduce capacity by 50 percent.*	
Specific capacity following well investment activity, gpm/ft, *(or state "no change" if no anticipated change)*	
Well investment activity increase in useful life of well, years*, or state "no change" if no anticipated change)*	

3. Step 3. Analyze Investment Decision: Follow a decision flow chart, shown on Figure 6-9, based on the well condition and usefulness to the system, the allowable investment activity cost for each well priority category. The flow chart will lead to a decision on the most cost effective investment activity.

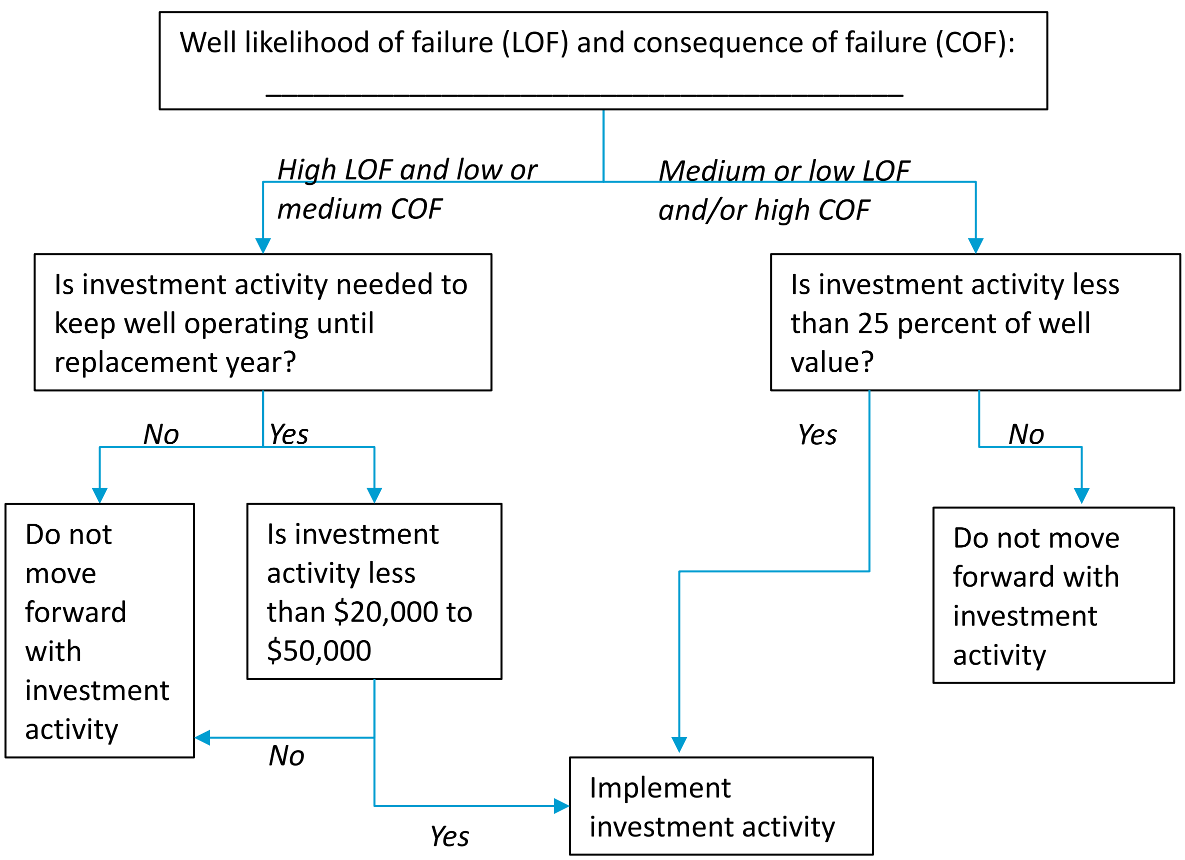


Figure 6-9. Well Investment Decision Tool - Step 3. Analyze Investment Decision

6.2.8 Downhole Well Rehabilitation and Pump Rehabilitation/Replacement Activities and Cost

Downhole well rehabilitation and pump rehabilitation and repair are recommended to occur in two coordinated phases. For downhole well rehabilitation, Phase 1 is light rehabilitation and Phase 2 is heavy rehabilitation. Well rehabilitation phases are recommended to coincide with the timing of well pump rehabilitation and pump replacement phases. For well pump repair and replacement, Phase 1 is repairing/rebuilding the well pump and Phase 2 is a complete well pump replacement. Phase 1 and Phase 2 well R/R activities are assumed to follow a 7-14 year cycle. Available pump repair data for twenty of the District's wells over the previous ten years was incorporated in the pump rehabilitation schedule.

Pump tests may also be used to determine the need for more frequent well rehabilitation activities. These pump tests will be useful to indicate if issues are associated with the pump or well. When well production declines and specific capacity decreases, it indicates a problem with the well. When well production declines and specific capacity increases, it indicates a problem with the pump.

The costs for Phase 1 and Phase 2 well rehabilitation are estimated at $25,000 and $75,000, respectively. The costs for Phase 1 and Phase 2 well pump rebuild and replacement are estimated at $50,000 and $90,000, respectively.

Based on experience, typical Phase 1 and Phase 2 downhole well rehabilitation and pump repair and replacement would consist of the actives listed in Table 6-8.

Table 6-8. Well Rehabilitation and Pump Repair/Replacement Phasing

Downhole Well Rehabilitation Activities	Pump Rehabilitation and Replacement Activities
Phase 1 (Light Rehabilitation)	
1. Remove pump lubricating oil. 2. Downhole TV survey. 3. Remove materials such as residual pump lubricating oil and well fill at bottom of well, if applicable. 4. Inject appropriate well rehabilitation chemicals. 5. Perform mechanical well development – line swabbing, scratching, etc. 6. Neutralize chemicals and pump off fluids – air lifting. 7. Second downhole TV survey.	1. Remove and inspect well pump. 2. Rebuild pump bowls, straighten pump shafts, replace line shaft bearings and some column pipe, etc. 3. Reinstall repaired pump. 4. Startup and testing (includes water quality sampling and laboratory analysis).
Phase 2 (Heavy Rehabilitation)	
1. Remove pump lubricating oil. 2. Downhole TV survey. 3. Remove materials such as fill (sediment) at bottom of well, if applicable. 4. Inject initial well rehabilitation chemicals. 5. Perform mechanical well development – line swabbing, scratching, etc. 6. Inject additional rehabilitation chemicals and agitate well water. 7. Neutralize chemicals and pump off fluids – air lifting swabbing. 8. Test pump for development – surging, over pumping, etc. 9. Second downhole TV survey.	1. Remove well pump. 2. Install new well pump. 3. Startup and testing (includes water quality sampling and laboratory analysis).

6.2.8.1 New Well Cost

For new well construction, it is assumed that Year 1 costs include property selection and land acquisition, Year 2 costs include environmental review, pilot hole drilling and engineering, well design, and well construction. Year 3 costs include pump station construction and other well equipping activities. For the addition of a treatment system to an existing well system, it is assumed that costs are incurred within one year.

The new well capacity will be attained in the third year of the three-year duration. The replacement well cost assumptions are provided in Table 6-9. These costs are based on industry experience and similar District projects.

Table 6-9. New Well Construction and Equipping Costs

Item	Year 1 costs (Land acquisition)	Year 2 costs (Design, drill well)	Year 3 costs (Construct pump station, equip well)	Total Costs
New well w Fe/Mn treatment	$500,000	$1,000,000	$3,000,000	$4,500,000
New well w/o treatment	$500,000	$1,000,000	$2,000,000	$3,500,000
2 new wells w/ treatment (at same site)	$500,000	$1,500,000	$4,000,000	$6,000,000
1,000 gpm Cr6 treatment (to existing well)	--	$1,700,000	--	$1,700,000
1,500 gpm Cr6 treatment (to existing well)	--	$2,500,000	--	$2,500,000

6.2.8.2 Well Site Destruction Costs

Wells are projected to be removed from operations based on their projected useful life. Wells scheduled to be removed from operations during the 15-year CIP period are grouped into three phases:

Phase 1 – 2017-2021, near term removal of well site from system.

Phase 2 – 2022 – 2026, removal of well site from system at midpoint of the 15-year CIP

Phase 3 – 2027 - 2031, removal of well site from system towards the end of the 15-year CIP.

Well site destruction is assumed to cost $100,000 per well.

6.2.9 Long Term Well Plan Schedule

A spreadsheet tool was developed to present the rehabilitation and replacement schedule for each well. It should be noted that because new well capacities are typically larger than the capacity of some of the wells being replaced in many instances some wells will not be replaced one-for-one.

For each year, the well capacity assumed to be lost (wells removed from production) or gained (new wells) and the costs for new well construction are shown in the spreadsheet tool. For each year, the available water supply capacity is the sum of the existing well capacities plus the well capacity added as a result of new well construction minus the well capacity from retired wells.

The total amount of well replacements by subarea for each set of years from 2016 to 2030 is summarized in Table 6-10. Table 6-11 provides a comparison of the current (2016) and buildout (2031) water demands for each of the subarea versus the available supply pumping capacity in each subarea.

The years for those wells to be replaced within the 15-year CIP planning detail are shown well by well for the NSA in Table 6-12 and for the SSA in Table 6-13. The replacement wells and wells to be removed from service are illustrated on Figure 6-10 for the NSA and Figure 6-11 for the SSA.

Table 6-10. Summary of Recommended Well Activities

Activity	Phase 1 (2017-2021)		Phase 2 (2022-2026)		Phase 3 (2027-2031)		Total 15-year CIP period
	NSA	SSA	NSA	SSA	NSA	SSA	
Replacement wells							
Replacement well -no treatment added	2	0	6	3	2	1	14
Replacement well - with Mn treatment	2[a]	0	0	0	0	0	2
Add Cr 6 treatment to existing well	1[b]	0	0	0	0	0	1
Total	5	0	6	3	2	1	17

(a) *Includes expansion and additional of Mn treatment at N36 Verner Well and at new well in the AASA.*

(b) *Add Cr 6 treatment to existing N33 Walerga Well.*

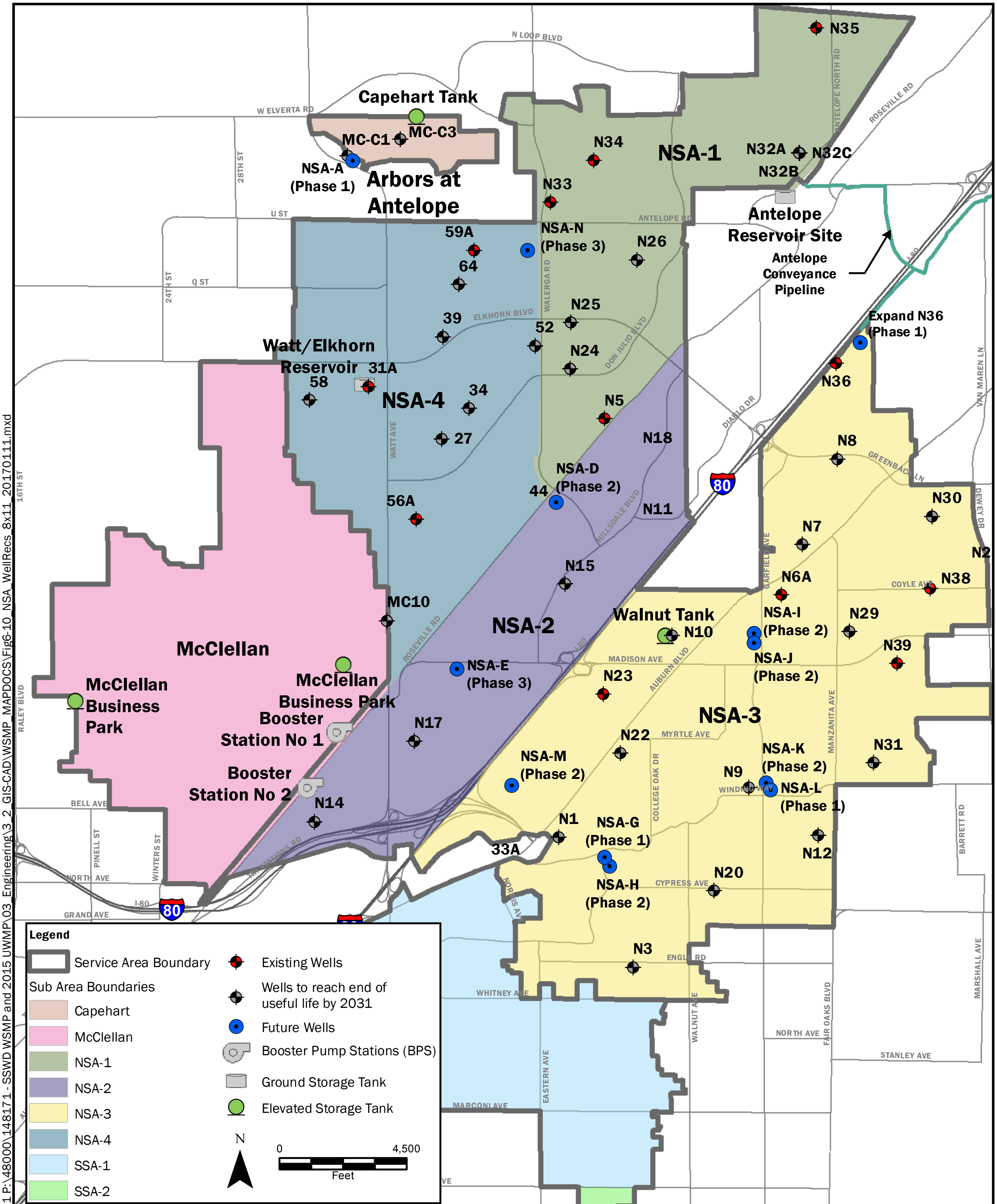
Table 6-11. Supply vs. Demand by Subarea														
	Existing (2016)[a]							Buildout (2031)						
	Demand[b]			Production Capacity				Demand			Production Capacity			
Subarea	Annual Demand, ac-ft/yr	MDD, gpm	PHD, gpm	Well, gpm	Reliable Storage Pumping, gpm	Total, gpm	Capacity vs Demand, % of phd	Annual Demand, ac-ft/yr	MDD, gpm	PHD, gpm	Well [d], gpm	Reliable Storage Pumping, gpm	Total, gpm	Capacity vs Demand, % of phd
NSA[c]														
1	4,403	5,443	9,253	14,305	8,000	22,305	241%	5,495	6,473	11,003	13,530	8,000	21,530	196%
2	3,205	3,962	6,736	3,390	0	3,390	50%	3,158	3,720	6,325	3,000	0	3,000	47%
3	7,970	9,852	16,748	15,000	0	15,000	90%	7,711	9,083	15,442	20,860	0	20,860	135%
AASA	1,106	1,367	2,323	0	0	-	0%	1,156	1,362	2,316	1,500	0	1,500	65%
MBP	912	1,128	1,917	723	0	723	38%	1,561	1,839	3,126	0	0	0	0%
Subtotal - NSA 1,2,3, Capehart, and MBP	**17,596**	**21,752**	**36,977**	**34,418**	**8,000**	**41,418**	**124%**	**19,081**	**22,477**	**38,212**	**38,890**	**8,000**	**46,890**	**122%**
4 (North Highlands)	4,100	5,068	8,616	10,025	8,000	18,025	209%	4,312	5,079	8,635	7,630	8,000	15,630	181%
NSA total	**21,696**	**26,820**	**45,593**	**44,443**	**16,000**	**59,443**	**136%**	**23,393**	**27,556**	**46,847**	**46,520**	**16,000**	**62,520**	**133%**
SSA														
1	9,049	11,185	16,778	23,762	0	23,762	142%	9,207	10,845	16,268	14,742	0	14,742	91%
2	648	801	1,202	1,771	0	1,771	147%	667	785	1,178	1,500	0	1,500	127%
3	4,078	5,041	7,562	13,130	0	13,130	174%	3,884	4,575	6,863	12,180	0	12,180	177%
4	1,961	2,424	3,637	4,315	4,500	8,815	242%	2,440	2,873	4,311	4,015	4,500	8,515	198%
SSA total	**15,736**	**19,451**	**29,179**	**42,978**	**4,500**	**47,478**	**163%**	**16,198**	**19,078**	**28,620**	**32,437**	**4,500**	**36,937**	**129%**
Total	**37,432**	**46,271**	**74,772**	**86,421**	**20,500**	**106,921**	**143%**	**39,591**	**46,634**	**75,467**	**78,957**	**20,500**	**99,457**	**132%**

[a] *For planning purposes existing 2016 demand is based on a partial rebound back to pre-drought demand conditions as described in Section 3. Actual 2016 demands were significantly less than what is assumed in this analysis, at 29,312 ac-ft.*

[b] *Demand does not include sales to others.*

[c] *Subarea NSA 4 (North Highlands) is a separate pressure zone from the rest of the NSA and the supply capacity versus demand in this area is analyzed separately from the rest of the NSA area.*

[d] *Well capacity based on the existing and buildout well capacity listed in Table 6-7 for the NSA and Table 6-8 for the SSA.*



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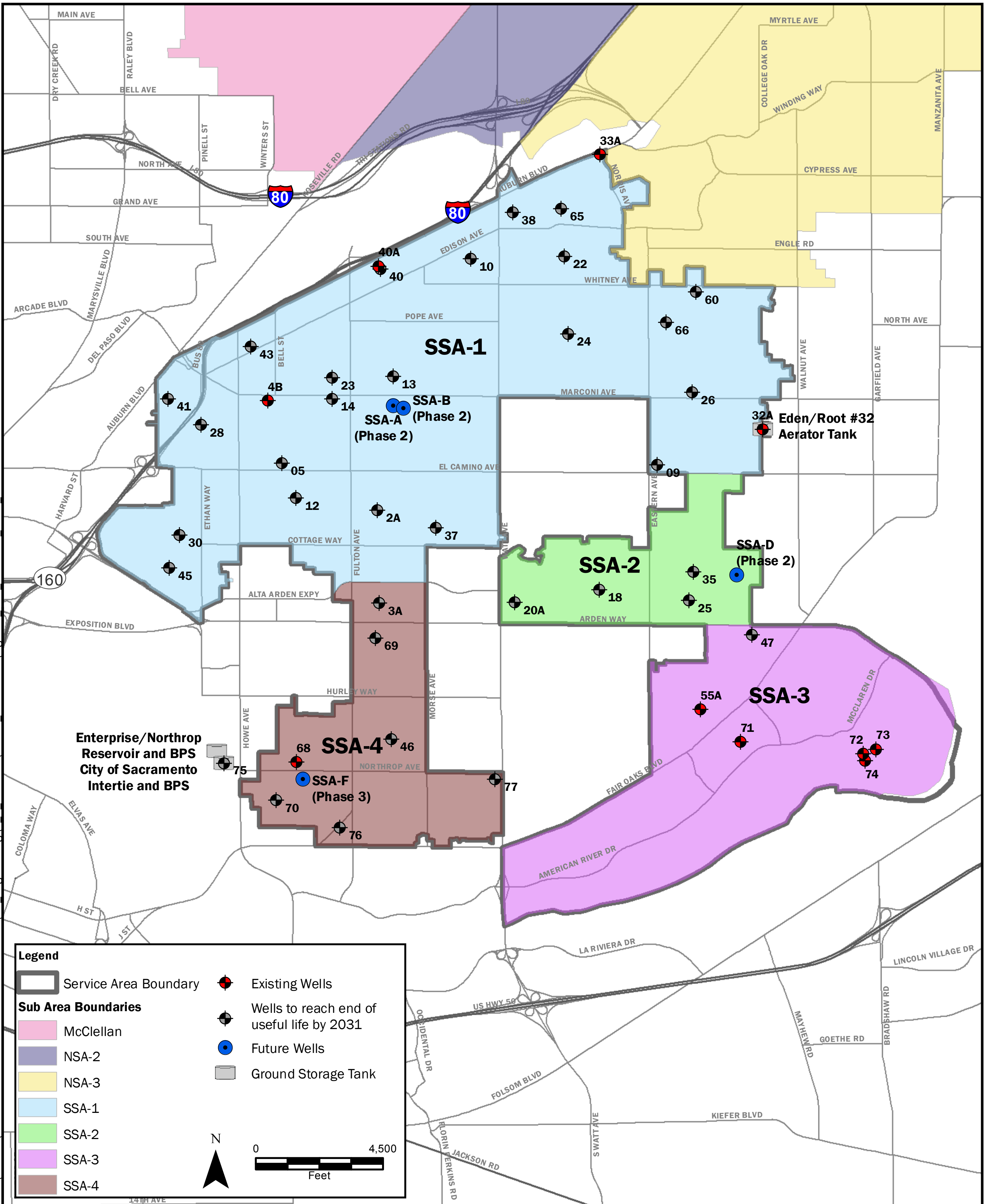
DATE	PROJECT	SITE	
3/21/17	148171	**Water System Master Plan** **Sacramento Suburban Water District**	**Figure 6-10**
Brown AND Caldwell		TITLE **Recommended Well Activities in the NSA**	



Document Path: bcsac01 P:\48000\148171 - SSWD WSMP and 2015 UWMP\03_Engineering\3_2_GIS-CAD\WSMP_MAPDOCS\Fig6-11_SSA_WellRecs_8x11_20170111.mxd

DATE	PROJECT	SITE	
3/21/17	148171	**Water System Master Plan** **Sacramento Suburban Water District**	**Figure 6-11**
Brown AND Caldwell		TITLE **Recommended Well Activities in the SSA**	

Table 6-12. Summary of Well Schedule – NSA

Subarea/Well Name	Year Existing Well Constructed	2015 Capacity, gpm	Risk analysis				Estimated Useful Life, Years	Year Capacity Lost Assumption	Year New Well Constructed	Notes	2017 Capacity, gpm	2031 Capacity, gpm
			COF (score)	LOF (score)	ROF (score)	ROF (low, medium, high)						
AASA												
Capehart 1C	1958	550	0.43	0.28	0.12	M	59	2017	--	Well is under performing (UP), Cr+6, remove from service	0	0
Capehart 3C	1960	725	0.57	0.32	0.18	H	57	2017	--	Well is under performing (UP), Cr+6, remove from service	0	0
New Well NSA-A	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2018**	**New well, Mn Treatment**	**0**	**1,500**
McClellan Business Park												
McClellan Park #10	1945	723	0.18	0.20	0.04	M	77	2022	--	-- [a]	723	0
Subarea NSA 1												
Antelope #N35	2001	2,570	0.17	0.24	0.04	M	55	2056	--	-- [a]	2,570	2,570
Cottage #N34	1992	2,000	0.13	0.04	0.01	L	60	2052	--	-- [a]	2,000	2,000
Don Julio #N24	1976	1,130	0.08	0.10	0.01	L	60	2036	--	-- [a]	1,130	1,130
Hillsdale #N5	1959	775	0.05	0.22	0.01	L	60	2019	--	-- [a]	775	0
Monument #N26	1984	780	0.05	0.05	0.00	L	60	2044	--	-- [a]	780	780
Poker #N32-A	1989	2,000	0.13	0.26	0.04	M	55	2044	--	-- [a]	2,000	2,000
Poker #N32-B	1989	2,200	0.15	0.29	0.04	M	55	2044	--	-- [a]	2,200	2,200
Poker #N32-C	1989	670	0.04	0.50	0.02	L	28	2017	--	Well is under performing (UP), Cr+6, remove from service, other use	0	0
Sutter #N25	1976	1,590	0.11	0.24	0.03	L	60	2036	--	-- [a]	1,590	1,590
Walerga #N33	1989	1,260	0.08	0.23	0.02	L	60	2049	2017	Add Cr+6 treatment	1,260	1,260

Table 6-12. Summary of Well Schedule – NSA

Subarea/Well Name	Year Existing Well Constructed	2015 Capacity, gpm	Risk analysis				Estimated Useful Life, Years	Year Capacity Lost Assumption	Year New Well Constructed	Notes	2017 Capacity, gpm	2031 Capacity, gpm
			COF (score)	LOF (score)	ROF (score)	ROF (low, medium, high)						
Subarea NSA 2												
Cabana #N15	1969	1,070	0.26	0.46	0.12	M	55	2024	--	-- [a]	1,070	0
Oakdale #N17	1972	1,020	0.25	0.21	0.05	M	55	2027	--	-- [a]	1,020	0
Orange Grove #N14	1968	1,300	0.32	0.16	0.05	M	55	2023	--	-- [a]	1,300	0
New Well NSA-D	--	--					--	--	**2024**	**New well**	**0**	**1,500**
New Well NSA-E	--	--					--	--	**2027**	**New well**	**0**	**1,500**
Subarea NSA 3												
Barrett Meadows #N31	1957	820	0.05	0.18	0.01	L	60	2017	--	Destroyed		0
Verner #N36 and #N36a (same site)	2011	1,500	0.08	0.27	0.02	L	60	2071	2017	Expand capacity, Mn treatment	0	3,000
Rutland #N39	2015	1,500	0.08	-- [b]	-- [b]	L	60	2075	--	Maintain	1,500	1,500
Cameron #N9	1964	1,100	0.06	0.14	0.01	L	60	2024	--	-- [a]	1,100	0
Cypress #N20	1973	1,100	0.06	0.23	0.01	L	60	2033	--	-- [a]	1,100	1,100
Engle #N3	1942	900	0.05	0.11	0.01	L	80	2022	--	-- [a]	900	0
Evergreen #N1	1957	800	0.04	0.10	0.00	L	65	2022	--	-- [a]	800	0
Field #N8	1961	950	0.05	0.43	0.02	L	60	2021	--	-- [a]	950	0
Freeway #N23	2011	1,050	0.06	0.23	0.01	L	60	2071	--	-- [a]	1,050	1,050
Merrihill #N29	1957	860	0.05	0.43	0.02	L	65	2022	--	-- [a]	860	0
Palm #N6	1960	800	0.04	0.12	0.01	L	60	2020	--	Other use, new well on site (#N6a, assumed to be New Well NSA-G)	0	0
Parkoaks #N30	1958	1,000	0.06	0.43	0.02	L	60	2018	--	-- [a]	1,000	0
River College #N22	1975	860	0.05	0.08	0.00	L	60	2035	--	-- [a]	860	860
Rosebud #N7	1961	1,130	0.06	0.36	0.02	L	60	2021	--	-- [a]	1,130	0
St. John #N12	1966	1,100	0.06	0.28	0.02	L	60	2026	--	-- [a]	1,100	0

Table 6-12. Summary of Well Schedule – NSA												
			Risk analysis									
Subarea/Well Name	Year Existing Well Constructed	2015 Capacity, gpm	COF (score)	LOF (score)	ROF (score)	ROF (low, medium, high)	Estimated Useful Life, Years	Year Capacity Lost Assumption	Year New Well Constructed	Notes	2017 Capacity, gpm	2031 Capacity, gpm
Coyle #N38	2013	1,350	0.07	0.04	0.00	L	60	2073	--	-- [a]	1,350	1,350
Walnut #N10	1964	1,300	0.07	0.15	0.01	L	60	2024	--	-- [a]	1,300	0
New Well NSA-G	--	--	--	--	--	--	--	--	**2018**	**New well (Palm N6a)**	**0**	**1,500**
New Well NSA-H	--	--	--	--	--	--	--	--	**2024**	**New well**	**0**	**1,500**
New Well NSA-I	--	--	--	--	--	--	--	--	**2024**	**New well**	**0**	**1,500**
New Well NSA-J	--	--	--	--	--	--	--	--	**2022**	**New well**	**0**	**1,500**
New Well NSA-K	--	--	--	--	--	--	--	--	**2022**	**New well**	**0**	**1,500**
New Well NSA-L	--	--	--	--	--	--	--	--	**2021**	**New well**	**0**	**1,500**
New Well NSA-M	--	--	--	--	--	--	--	--	**2023**	**New well**	**0**	**1,500**
NSA 1,2,3,AASA, McClellan subtotal	--	--	--	--	--	--	--	--	--	--	**33,418**	**38,890**
Subarea NSA 4 (North Highlands)											0	
Bainbridge/Holmes #59A	2000	3,000	0.27	0.14	0.04	M	55	2055	--	Assume repaired	3,000	3,000
Fairbairn/Karl #56A	2000	2,230	0.20	0.05	0.01	L	60	2060	--	- [a]	2,230	2,230
Galbrath/Antelope Woods #64	1968	1,200	0.11	0.13	0.01	L	60	2028	--	- [a]	1,200	0
La Cienga/Melrose #34	1956	475	0.04	0.49	0.02	L	61	2017	--	Remove from service	0	0
Melrose/Channing #27	1953	875	0.08	0.30	0.02	L	69	2022	--	- [a](Old open bottom, but rehabbed in 2010/2011 and yield is good.)	875	0
Thirty Second/Elkhorn #58	1964	920	0.08	0.21	0.02	L	60	2024	--	- [a]	920	0
Thomas/Elkhorn #39	1957	530	0.05	0.28	0.01	L	60	2017	--	Remove from service	0	0

Table 6-12. Summary of Well Schedule – NSA												
Subarea/Well Name	Year Existing Well Constructed	2015 Capacity, gpm	Risk analysis				Estimated Useful Life, Years	Year Capacity Lost Assumption	Year New Well Constructed	Notes	2017 Capacity, gpm	2031 Capacity, gpm
			COF (score)	LOF (score)	ROF (score)	ROF (low, medium, high)						
Watt/Elkhorn #31A	1985	900	0.08	0.13	0.01	L	60	2045	--	Assume repaired. Could drill multiple wells on this site.	900	900
Weddigen/Gothberg #52	1959	900	0.08	0.10	0.01	L	60	2019	--	- [a]	900	0
New Well NSA-M	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**2028**	**New well**	**0**	**1,500**
NSA 4 (North Highlands) subtotal	**--**	**--**					**--**	**--**	**--**	**--**	**10,025**	**7,630**
Total North Service Area Capacity	**--**	**--**					**--**	**--**	**--**	**--**	**43,443**	**45,020**

[a] *Well risk of failure shall be re-evaluated when estimated useful life is reached. Useful life shall be updated dependent upon the re-evaluated risk of failure.*

[b] *Well condition not evaluated in GWAMP.*

Table 6-13. Summary of Well Schedule – SSA

Subarea/Well Name	Year Existing Well Constructed	2015 Capacity, gpm	Risk analysis				Estimated Useful Life, Years	Year Capacity Lost Assumption	Year new well constructed	Notes	2017 Capacity, gpm	2031 Capacity, gpm
			COF (score)	LOF (score)	ROF (score)	ROF (low, medium, high)						
Subarea SSA 1												
Albatross/Iris #41	1957	530	0.02	0.13	0.00	L	65	2022	--	- [a]	530	0
Auburn/Norris #33A	2001	2,400	0.10	0.03	0.00	L	60	2061	--	Maintain	2,400	2,400
Auburn/Yard #40	1957	700	0.03	0.10	0.00	L	60	2017	--	Remove from service	700	0
Auburn/Yard #40A	2000	2,297	0.10	0.21	0.02	L	60	2060	--	Maintain	2,297	2,297
Becerra/Woodcrest #24	1952	600	0.03	0.51	0.01	L	70	2022	--	- [a]	600	0
Bell/El Camino #5	1947	325	0.01	0.36	0.00	L	75	2022	--	- [a]	325	0
Bell/Marconi #4B	1994	3,000	0.13	0.09	0.01	L	60	2054	--	Maintain	3,000	3,000
Calderwood/Marconi #13	1949	625	0.03	0.21	0.01	L	68	2017	--	Well is under performing (UP)	625	0
Eastern/Woodside Church #66	1972	1,300	0.05	0.14	0.01	L	60	2032	--	- [a]	1,300	1,300
Eden/Root #32A	1999	1,645	0.07	0.24	0.02	L	60	2059	--	Maintain	1,645	1,645
Edison/Traux #43	1957	850	0.04	0.14	0.01	L	65	2022	--	- [a]	850	0
El Prado/Park Estates #2A	1964	1,000	0.04	0.13	0.01	L	60	2024	--	- [a]	1,000	0
Greenwood/Marconi #26	1953	700	0.03	0.64	0.02	L	64	2017	--	Well is under performing (UP), remove from service	700	0
Hernando/Santa Anita #12	1950	600	0.03	0.32	0.01	L	72	2022	--	- [a]	600	0
Jamestown/Middleberry #45	1957	750	0.53	0.16	0.09	M	60	2017	--	Well is under performing (UP), remove from service	750	0
Marconi North/Fulton #23	1952	600	0.03	0.25	0.01	L	65	2017	--	Well is under performing (UP), remove from	600	0

Table 6-13. Summary of Well Schedule – SSA												
			Risk analysis									
Subarea/Well Name	Year Existing Well Constructed	2015 Capacity, gpm	COF (score)	LOF (score)	ROF (score)	ROF (low, medium, high)	Estimated Useful Life, Years	Year Capacity Lost Assumption	Year new well constructed	Notes	2017 Capacity, gpm	2031 Capacity, gpm
										service		
Marconi South/Fulton #14	1949	600	0.03	0.59	0.01	L	68	2017	--	Well is under performing (UP), remove from service	600	0
Merrily/Annadale #65	1972	1,100	0.05	0.31	0.01	L	60	2032	--	- [a]	1,100	1,100
Morse/Cottage Park #37	1957	760	0.03	0.12	0.00	L	65	2022	--	- [a]	760	0
Ravenwood/Eastern #9	1949	495	0.02	0.38	0.01	L	73	2022	--	Recently rebuilt. - [a]	495	0
Red Robin/Darwin #28	1954	650	0.03	0.35	0.01	L	68	2022	--	- [a]	650	0
Rockbridge/Keith #30	1954	560	0.02	0.24	0.01	L	68	2022	--	- [a]	560	0
Watt/Auburn #38	1957	450	0.02	0.30	0.01	L	60	2017	--	Well is under performing (UP), remove from service	450	0
West/Becerra #22	1951	725	0.03	0.38	0.01	L	71	2022	--	- [a]	725	0
Whitney/Concetta #60	1965	500	0.02	0.10	0.00	L	60	2025	--	- [a]	500	0
New Well SSA-A	--	--	--	--	--	--	--	--	**2022**	**New well**	**0**	**1,500**
New Well SSA-B	--	--	--	--	--	--	--	--	**2022**	**New well**	**0**	**1,500**
Subarea SSA 2												
Enterprise/Northrop#75	1999	975	0.23	0.26	0.06	M	18	2017		Well is under performing (UP), remove from service	0	0
Riding Club/Ladino #18	1951	671	0.16	0.29	0.05	M	71	2022		- [a]	671	0
Thor/Mercury #25	1952	730	0.18	0.43	0.08	M	65	2017		Well is under performing (UP), remove from service	0	0
Ulysses/Mercury #35	1956	681	0.16	0.22	0.04	M	61	2017		Well is under performing (UP), remove from	0	0

Table 6-13. Summary of Well Schedule – SSA													
			Risk analysis										
Subarea/Well Name	Year Existing Well Constructed	2015 Capacity, gpm	COF (score)	LOF (score)	ROF (score)	ROF (low, medium, high)	Estimated Useful Life, Years	Year Capacity Lost Assumption	Year new well constructed	Notes	2017 Capacity, gpm	2031 Capacity, gpm
										service		
Watt/Arden #20A	1969	1,100	0.26	0.14	0.04	M	55	2024		- [a]	1,100	0
New Well SSA-D	**--**	**--**					**--**	**--**	**2025**	**New well**	**0**	**1,500**
Subarea SSA 3												
Copenhagen/Arden #47	1959	950	0.07	0.09	0.01	L	60	2019	--	- [a]	950	0
River Walk/NETP #72	1998	1,380	0.11	0.16	0.02	L	60	2058	--	- [a]	1,380	1,380
River Walk/NETP East #73	1999	3,400	0.26	0.05	0.01	L	60	2059	--	- [a]	3,400	3,400
River Walk/NETP South #74	1998	2,600	0.20	0.10	0.02	L	60	2058	--	- [a]	2,600	2,600
River Drive/Jacob #71	1998	2,700	0.21	0.08	0.02	L	60	2058	--	- [a]	2,700	2,700
Stewart/Lyndale #55A	1999	2,100	0.16	0.15	0.02	L	60	2059	--	- [a]	2,100	2,100
Subarea SSA 4												
Fulton/Fair Oaks #76	1962	410	0.10	0.31	0.03	L	60	2022	--	- [a]	410	0
Hillsdale/Cooper #69R	1977	465	0.11	0.15	0.02	L	60	2037	--	- [a]	465	465
Jonas/Sierra Mills #46	1958	750	0.17	0.33	0.06	M	64	2022	--	Other use	750	0
Kubel/Armstrong 3A	1962	340	0.08	0.24	0.02	L	60	2022	--	Currently being rehabbed, assume another 5 years, Other use	340	0
Larch/Northrop #77	1971	300	0.07	0.27	0.02	L	60	2031	--	- [a]	300	0
Northrop/Dornajo #68R	1989	1,450	0.34	0.30	0.10	M	55	2044	--	Connect to Well 75 treatment plant	1,450	1,450
Sierra/Blackmer #70	1976	600	0.14	0.18	0.02	L	60	2036	--	- [a]	600	600

Table 6-13. Summary of Well Schedule – SSA												
			Risk analysis									
Subarea/Well Name	Year Existing Well Constructed	2015 Capacity, gpm	COF (score)	LOF (score)	ROF (score)	ROF (low, medium, high)	Estimated Useful Life, Years	Year Capacity Lost Assumption	Year new well constructed	Notes	2017 Capacity, gpm	2031 Capacity, gpm
New Well SSA-F	--	--					--	--	**2031**	New well on Hillsdale/cooper site	0	2031
Total South Service Area capacity	--	--					--	--	--	--	**42,978**	**32,437**

[a] *Well risk of failure shall be re-evaluated when estimated useful life is reached. Useful life shall be updated dependent upon the re-evaluated risk of failure.*

The recommended well replacement plan will reduce the average age and number of wells in the system as shown on Figure 6-12.

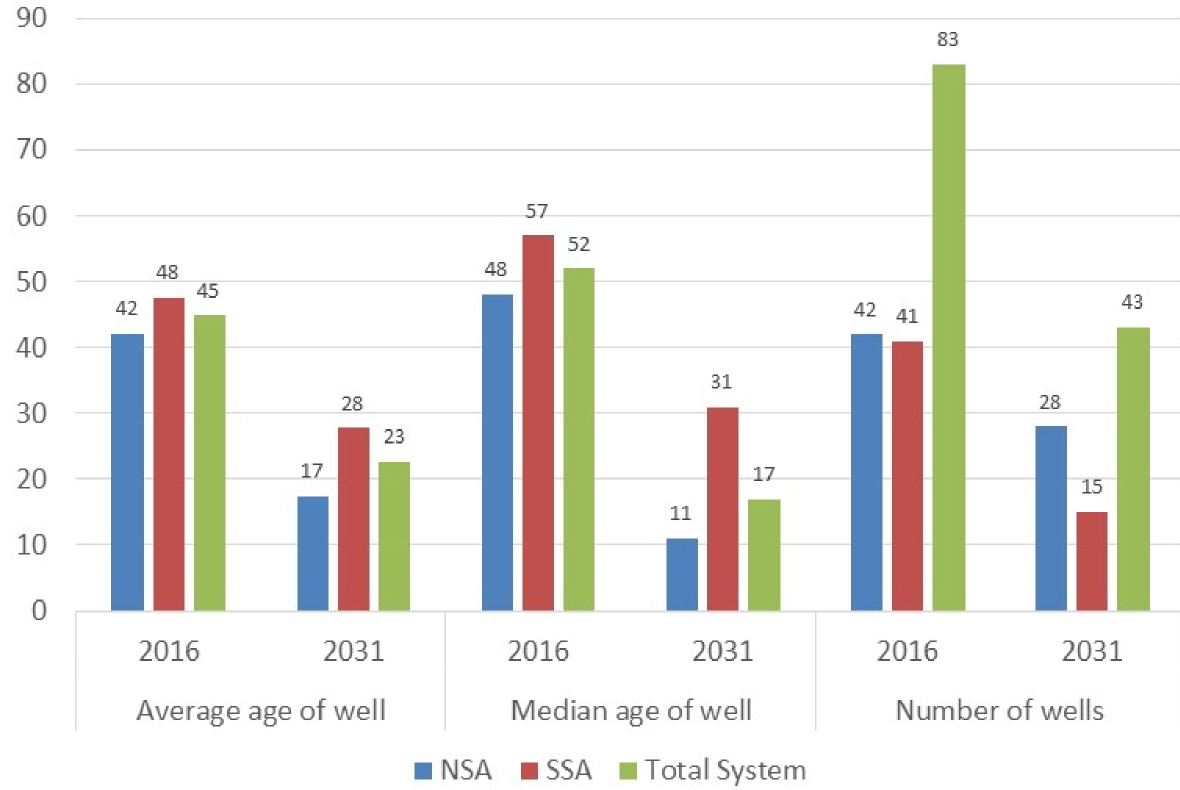


Figure 6-12. Well Age and Number of Wells Currently and at Buildout

6.2.10 Wellfield Business Case Evaluation

The purpose of this section is to present the business case evaluation of having a well field with less wells compared to the current wellfield. The number of wells would be reduced from a total of 73 active wells to 43 wells over a fifteen-year period while still maintaining a production capacity adequate to meet the District's demands. This section evaluates the cost of the operation and maintenance and the CIP of the existing wellfield configuration or the status quo wellfield scenario compared to the ultimate wellfield configuration. It is reasonable to expect that some of the costs associated with operating, maintaining, rehabilitating, and replacing the wellfield would be reduced by having a smaller total number of wells. Similarly, one would expect that some of the costs would increase if the number of wells were increased.

The operation and maintenance of the existing wellfield is a large part of the District's production department's budget. The costs of well rehabilitation, well destruction, and new wells are a part of the CIP budget. The District's budget was reviewed to identify the select budget items that are associated with the operation and maintenance of the existing wellfield. These include items such as labor, supplies, utilities, repairs, outside services, permits and fees, and testing. Since the production department is responsible for the pump stations and storage reservoirs in addition to the wells, it is assumed that 80 percent of the production costs are associated with the wells. The total costs of the budget items that would vary with the number of wells were divided by the number of wells to arrive at a unit cost per well. Budget items that would not change in total cost due to a change in the number of wells, such as power, chemicals, and some miscellaneous costs were identified. The well operation and maintenance costs of another water district, Carmichael Water District, were reviewed as an additional cross check on the costs (Carmichael Water District, 2016). Carmichael Water District was selected as a comparison primarily because it tracks costs such that the labor and material costs of maintaining its wells could be easily identified.

Table 6-14 presents the variable labor and non-labor operation and maintenance costs and some miscellaneous fixed costs per well for the two Districts. The chemical and power costs are not included in Table 6-14. As can be seen in Table 6-14, the labor cost is a significant portion of the total operation and maintenance cost per well. The labor cost per well is much higher for Carmichael Water District, which is likely due to the lack of economy of scale due to a much smaller number of wells. The labor cost per well for Carmichael Water District likely reflects an upper cap for the labor cost per well item. The non-labor costs per well are similar for the two Districts, which increases the confidence in the accuracy of the cost estimate for those items.

Table 6-14. Well O&M Cost Comparison

Category	SSWD	CWD
Labor cost per well	$15,436	$28,621
All other costs per well	$5,478	$5,030
Misc fixed costs	$2,299	$1,075
Total cost per well	$23,213	$34,726

Note:

Excludes power and chemical costs.

Table 6-15 presents a comparison of the annual operation and maintenance and CIP costs of the existing wellfield configuration (Scenario 1. Status Quo) to the ultimate wellfield vision scenario (Scenario 2. Ultimate Vision Wellfield). As shown in Table 6-15 a shift to the ultimate well field vision would reduce the District’s well field operation and maintenance and CIP costs from $8.3 million per year to $6.8 million per year for an annual cost savings of $1.5 million per year. The majority of the cost reduction is due to the smaller number of wells that would need to be rehabilitated.

The total operation and maintenance costs are reduced for the ultimate vision wellfield primarily due to the reduction in labor and other costs needed to operate and maintain the lesser number of wells. The labor cost per well is estimated to be higher for the ultimate vision scenario due to the reduction in the economy of scale. The costs for chemical and power are based on the 2016 production budget for these items and is assumed to be the same for the two scenarios. The power cost is slightly reduced for the ultimate vision wellfield since the fixed meter charge would be reduced with a fewer number of wells. Figure 6-13 presents the breakdown of the wellfield O&M and CIP annual costs for 2016.

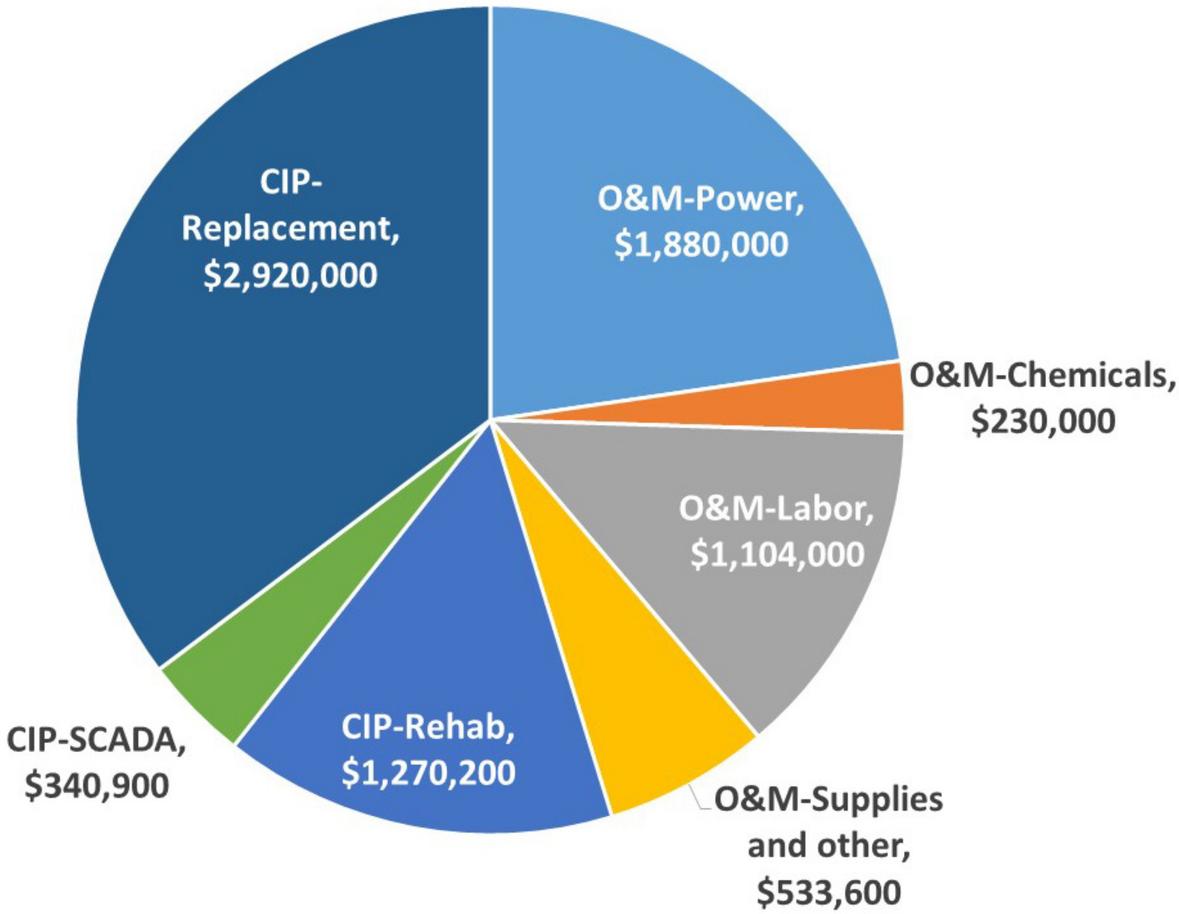


Figure 6-13. 2016 Wellfield O&M and CIP Annual Cost, $8.3 million/yr

The CIP items that apply to the wellfield are included in Table 6-15 and consist of well rehabilitation, SCADA repair and replacement, and replacement well construction. As shown in Table 6-15 and illustrated on Figure 6-14, there is a significant reduction in CIP costs with the ultimate vision scenario due to the lesser number of wells that would need to be rehabilitated and replaced. The CIP items are based on the recommendations and costs presented elsewhere in this document and may not be in the District's current budget. While most of the CIP items would occur intermittently every few years for a specific well, they are expressed as a uniform annual cost value for simplification. The costs for well replacement is also included as an annual value with the assumption that status quo replacement wells would cost less due to their smaller average well capacity. It is assumed that the District would perform the recommended well rehabilitation and SCADA projects as well as the well replacements on all of its wells for the status quo scenario, although it is possible that the District may defer some of these projects on the more infrequently used wells.

Table 6-15. Well O&M Cost Comparison					
		Cost/Yr			
Category	Cost/Well/Yr	Scenario 1. Existing Well Field Or Status Quo (73 Active Wells)	Scenario 2. Ultimate Vision Wellfield (43 Wells)	Cost Change	Remarks
O&M Costs, Production budget					
Labor	$15,100	$1,104,000	$817,000	$(287,000)	From 2016 budget for status quo. Assume $19k/well for ultimate vision.
Other costs	$5,000	$368,000	$172,000	$(196,000)	From 2016 budget for status quo.
Misc fixed costs	$2,300	$165,600	$165,600	--	From 2016 budget for status quo.
Chemicals	--	$230,000	$230,000	--	From 2016 budget for status quo.
Power	--	$1,880,000	$1,837,000	$(43,000)	From 2016 budget for status quo. Assume meter charge reduction of $1,000 per well for ultimate vision.
subtotal	$22,400	$3,747,600	$3,221,600	$(526,000)	--
CIP budget					
Minor rehab	$5,400	$394,200	$232,200	$(162,000)	Based on $75,000/well every 14 years.
Major rehab	$12,000	$876,000	$516,000	$(360,000)	Based on $165,000/well every 14 years.
SCADA repair and adjustments	$1,000	$73,000	$43,000	$(30,000)	--
SCADA onsite replacement	$3,300	$240,900	$141,900	$(99,000)	Based on $50,000/well every 15 years.
SCADA server replacement	--	$27,000	$27,000	--	Based on $500,000 times 80% every 15 years.
Well replacement	$40,000	$2,920,000	$2,580,000	$(340,000)	Based on $2 million/well for status quo and $3 million/well for ultimate vision every 50 years.
subtotal	$61,700	$4,531,100	$3,540,100	$(991,000)	--
Total	$79,500	$8,278,700	$6,761,700	$(1,517,000)	--

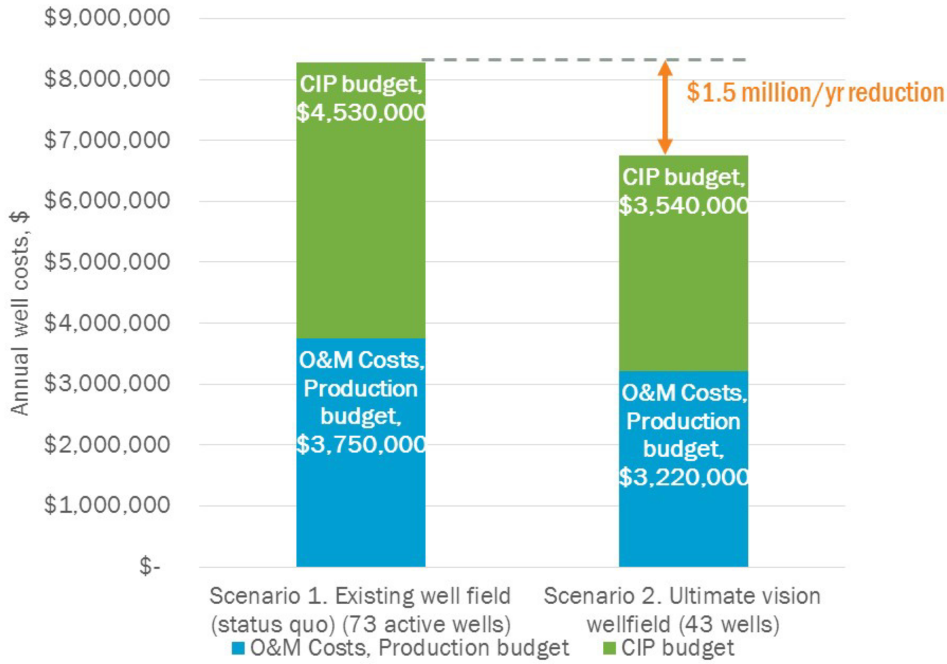


Figure 6-14. Comparison of Scenario 1 and Scenario 2 Annual Well Costs

The development of these wellfield costs allows for the derivation of unit cost factors to compare to the factors that are commonly used by water supply planners when developing conceptual cost estimates of water supply alternatives. Table 6-16 presents the wellfield operation and maintenance and CIP costs expressed as a percentage of the cost to construct the wellfield and as a cost per ac-ft of water supplied. The annual operation and maintenance and well and SCADA rehabilitation costs for the wells is approximately two percent of the construction cost. This is low compared to the typical value of 5.0 percent of construction cost that is used for pumping stations and wells that is intended to include all costs for routine operating functions and routine servicing and repair of plant and equipment and excludes power costs. The total operation and maintenance cost of $107 per ac-ft is typical for groundwater supplies in the Sacramento area. The total cost of the District's groundwater supply including the costs to construct the wellfield of $225 per ac-ft is competitive with the $500 per ac-ft that is occasionally mentioned in the region as the unit cost of new water supplies.

Table 6-16. Ultimate Vision Wellfield Cost Factors

Item	Value
Wellfield cost	$129,000,000
2015 production, ac-ft/yr	30,000
O&M and CIP, % of wellfield cost [(a)] [(b)]	1.6%
O&M, $/ac-ft	$107
O&M and CIP, $/ac-ft [(b)]	$139
O&M and CIP, $/ac-ft	$225

[(a)] *Excluding power and chemicals*

[(b)] *Excluding well replacement*

6.3 Recommended Supply Facility Improvements

Supply facility improvements related to groundwater well R/R is the dominating component of the supply category in the recommended CIP described in Section 12. The recommended improvements are described below.

1. Well R/R projects – New well projects are recommended to replace existing wells as they reach the end of their useful life. Rehabilitation efforts are included for maintaining existing wells.
2. Well site destruction – Retirement of wells that reach the end of their useful life within the 15-year CIP period is recommended.
3. New infrastructure - New land acquisition is required for the replacement wells. The size of the majority of the existing well sites are not adequate for replacement well construction, access, and potential water treatment needs. The intent of the new land acquisition is to provide for minimum 1-acre lots that will allow multiple wells on site and treatment facility as necessary. New well sites must also be located near the backbone transmission system.

The annual costs over the next 100 years for the Supply category for R/R projects, and 15-year new infrastructure projects are shown on Figure 6-15. The annual discrete costs are shown as well as the 15-year average annual cost and the post 15-year CIP long term average annual costs. A graph of the long term cumulative costs is shown in Appendix B.

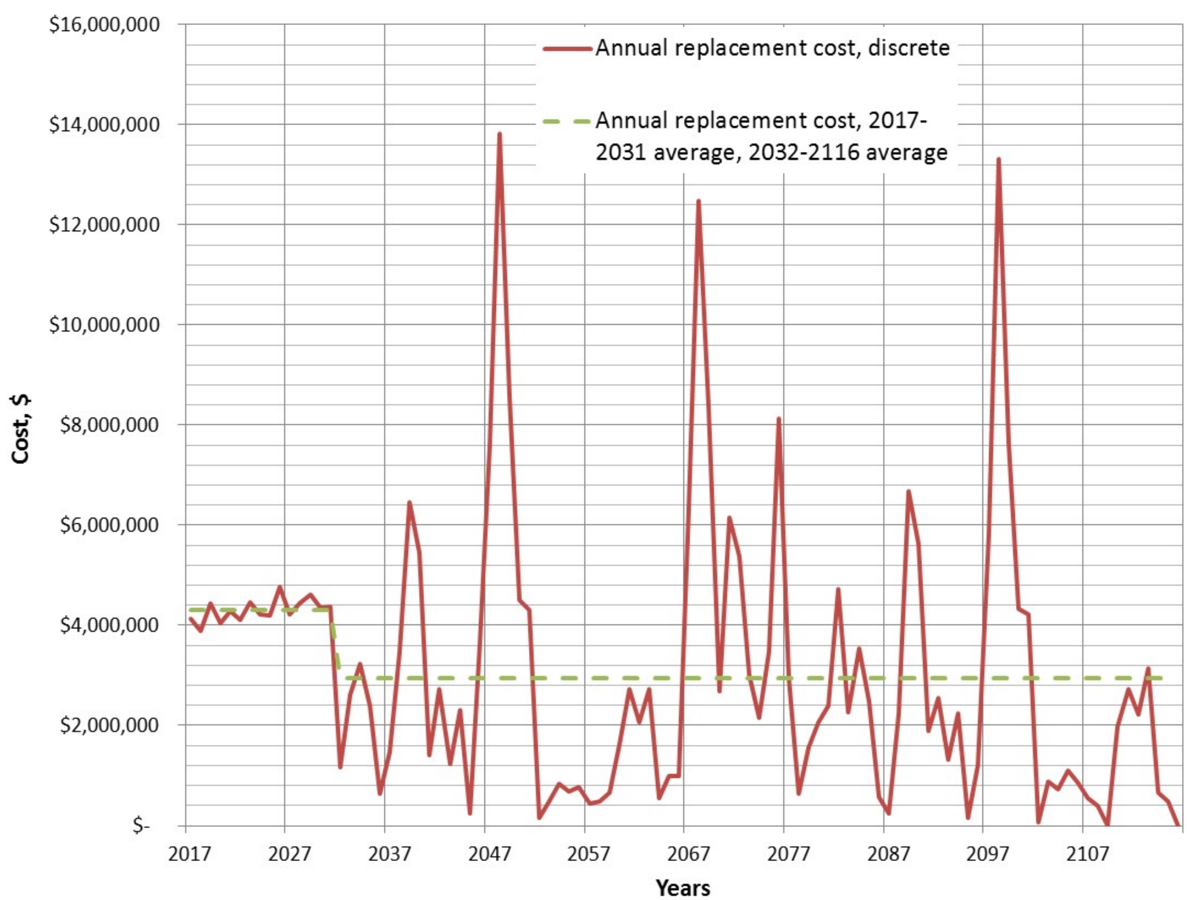


Figure 6-15. Annual Supply Costs

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Section 7

Transmission Facilities Analysis

The transmission category consists of transmission pipelines typically greater than or equal to 16-in diameter. This section describes the analysis of the District's transmission facilities including asset management R/R activities and the need for new facilities.

Strategic Plan Alignment

Facilities and Operations – 2.A. - The District will utilize appropriate planning tools, identify financial resources necessary, and prioritize system requirements to protect and maintain District assets and attain water resource objectives incorporating resource sustainability and lifecycle cost analysis into the framework.

- **Projected long term annual and cumulative replacement needs.**

Facilities and Operations – 2.C. Develop cost-effective strategies utilizing technology and available resources to optimize delivery of water and enhance service.

- **Completion of transmission main backbone.**
- **Improved ability to have wells supply water beyond localized area.**
- **Reduced potential for water quality contamination/regulatory impacts.**

Policy Implications

- **Prioritizes long term costs and schedule for transmission main replacement activities.**
- **New transmission mains recommended to complete the system transmission main backbone.**

7.1 Transmission Main Asset Management

The plan components that should be added to the Water Transmission Main AMP are identified in Table 5-2. Some of the key items that could add more value to the Transmission Main AMP if added are as follows:

- Establish performance measures to evaluate and communicate performance of the transmission mains.
- Identify the critical (high likelihood and high consequence of failure) transmission mains to help focus and District resources on the greatest risk assets.
- Condition monitoring and consistent documentation.

The District has established some key assumptions for use in estimating long-term rehabilitation and replacement planning needs for transmission mains. The useful life estimates used by the District are consistent with industry standard assumptions. R/R frequency assumptions are shown in Table 7-1.

Table 7-1. Transmission Mains Rehabilitation and Replacement Assumptions	
Asset Class Name	**Asset Useful Life, Years**
Transmission mains (Installed prior to 1985)	70
Transmission mains (Installed 1985 or later)	90

The District's Water Transmission Main AMP provides estimated unit costs for rehabilitation and replacement, as shown in Table 7-2. These increased costs assumptions are used for this WSMP analysis. It is recommended that the District use these increased cost assumptions to incorporate planning level project contingencies.

Table 7-2. Transmission Mains Cost Assumptions

Pipe Diameter	AMP Replacement Cost Assumptions		Recommended Replacement Cost Assumptions [a]	
	$/in-dia/LF	$/LF	$/in-dia/LF	$/LF
16	$15	$234	26	412
18	$15	$262	26	464
20	$15	$290	26	515
24	$15	$351	23	544
30	$17	$524	23	680
36	$17	$625	23	816
48	$17	$837	23	1,088

[a] *Includes 25 percent construction contingency, 25 percent engineering, and 10 percent construction management. In addition, a 3 percent markup is included to account for the future increase in paving costs as a result of the new Sacramento County paving rules.*

7.2 Recommended Transmission Facility Improvements

Transmission facility improvements related to completing the transmission backbone in the NSA is the dominating component of the transmission category in the recommended CIP described in Section 11. The recommended improvements are described below.

1. Transmission R/R Projects - Replacement of transmission pipelines at the end of their useful life. Based on the long term cumulative replacement needs, shown in Appendix B, the 15-year recommended replacement rate is at an average rate of 0.3 percent per year in terms of LF per year, or 900 LF per year. Recommended replacement rates past the 15-year CIP period will on average be much higher, approximately 4 percent per year which is an average of 11,000 LF per year. The annual discrete CIP costs over the next 100 years for the Transmission category include short term and long term R/R projects, and 15-year new infrastructure projects and are shown on Figure 7-1.
2. New Transmission Pipelines – New Transmission mains are recommended to complete the system transmission main backbone. The specific transmission main projects are illustrated on Figure 7-2 for the NSA and Figure 7-3 for the SSA. The timing of the new backbone pipelines

would be related to the replacement well construction and well destruction schedule. At this time, the timing of each project is not assigned. It is recommended that the District conduct further analysis to prioritize and optimize the new transmission pipelines. An average annual cost for the new transmission pipelines is shown in the CIP in Section 12 as well as on Figure 7-1. Table 7-3 lists the new backbone transmission main projects, as labeled on Figures 7-2 and 7-3.

It should be noted that although new transmission main projects are shown for the McClellan backbone system, these projects are speculative based on the uncertainty of type and water demand of future development within the McClellan service area. In addition, due to the fire flow demand requirements based on industrial land use zoning, 16-in diameter is the minimum pipe size recommended in this area and as a result the 16-in diameter pipelines in the McClellan area are not always considered transmission mains and could be distribution lines.

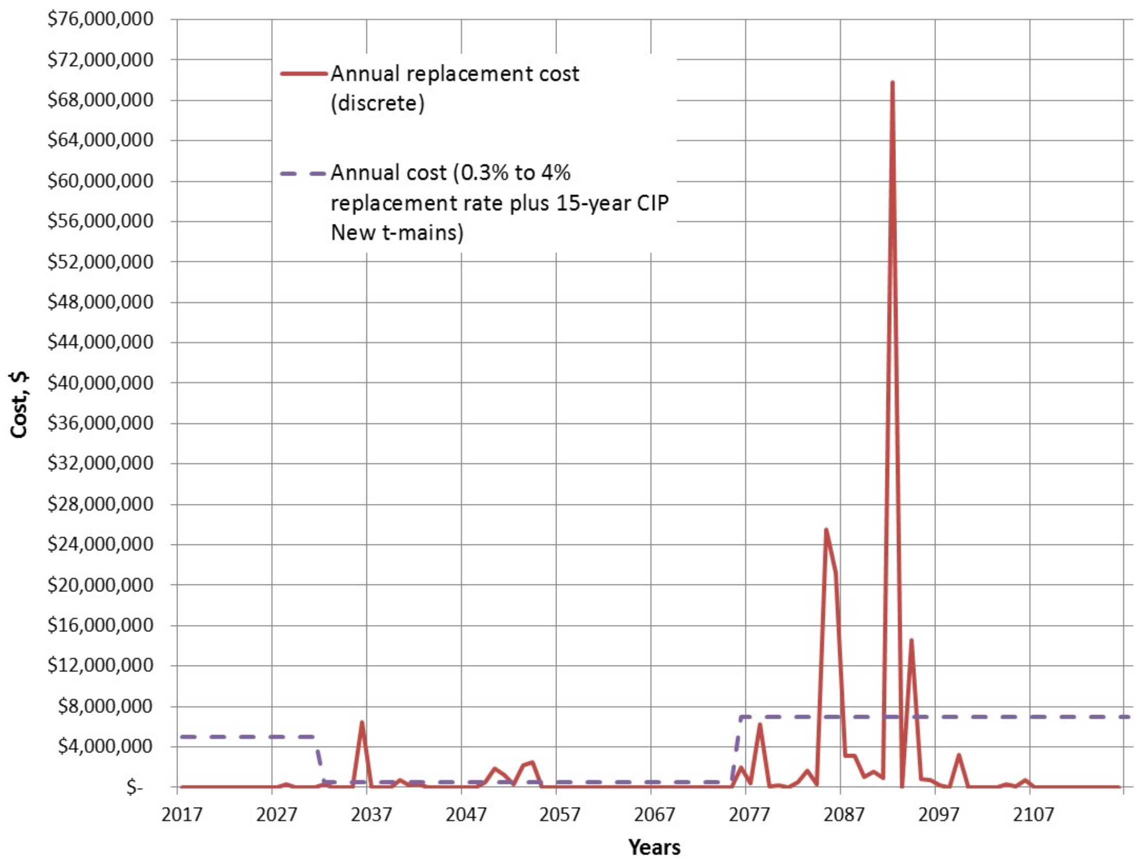
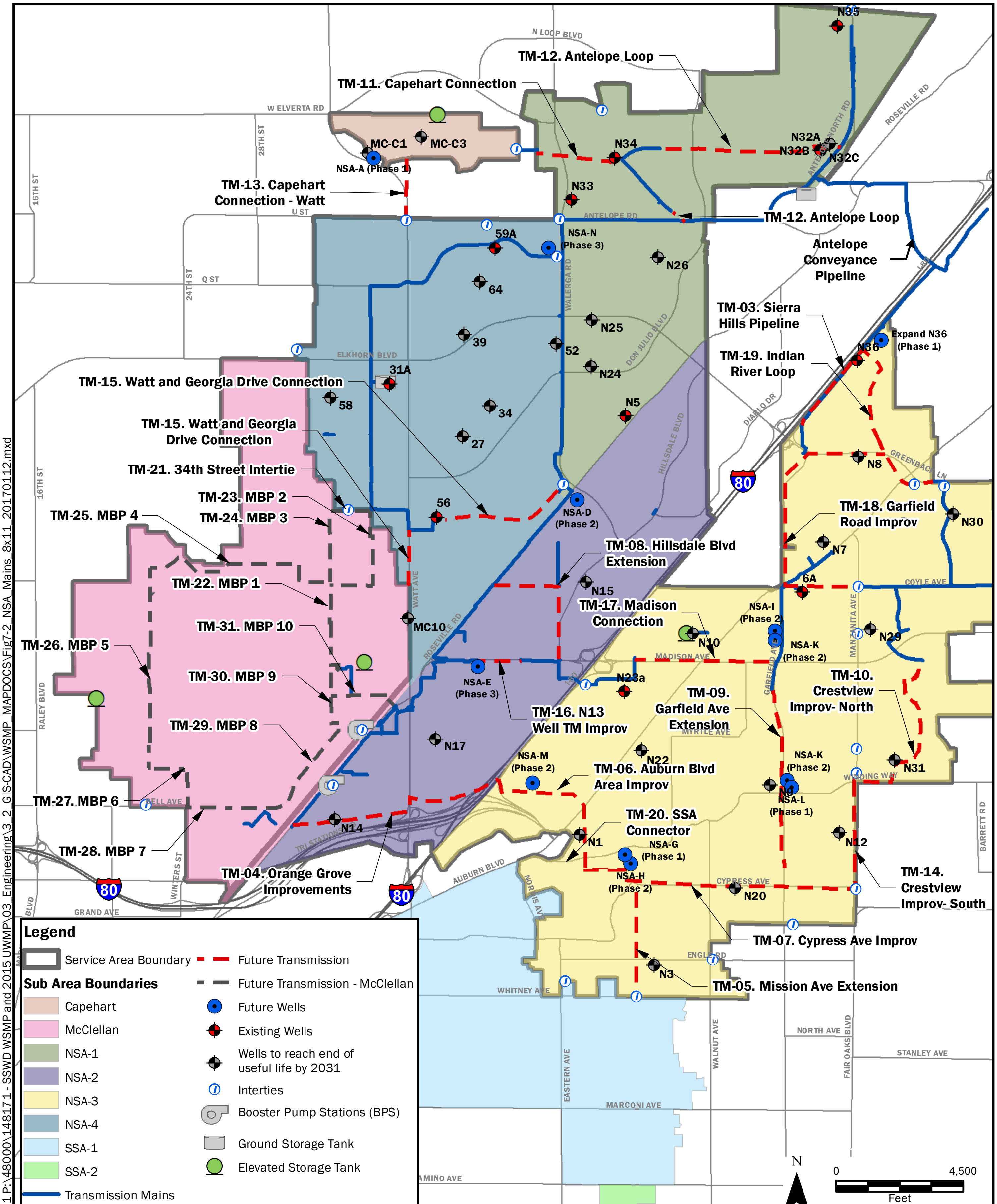


Figure 7-1. Annual R/R Transmission Costs

Table 7-3. New Backbone Transmission Main Projects				
Project Name	Subarea(s) Location	Diameter, in	Length, LF	Planning Level Cost Estimate, $
TM-01. Marconi TM Extension	SSA	16	1,300	$524,200
TM-02. El Camino Ave Extension	SSA	16	600	$252,700
TM-03. Sierra Hills Pipeline	NSA	30	5,500	$3,629,700
TM-04. Orange Grove Improvements	NSA	30	8,000	$5,278,000
TM-05. Mission Ave Extension	NSA	30	4,000	$2,640,700
TM-06. Auburn Blvd Area Improv	NSA	30	7,300	$4,816,500
TM-07. Cypress Ave Improv	NSA	30	6,100	$4,073,600
TM-08. Hillsdale Blvd Extension	NSA	24	4,900	$2,516,100
TM-09. Garfield Ave Extension	NSA	24	6,400	$3,285,200
TM-10. Crestview Improv- North	NSA	16	5,500	$2,163,400
TM-11. Capehart Connection	NSA	16	3,000	$1,181,600
TM-12. Antelope Loop	NSA	16	7,000	$2,752,500
TM-13. Capehart Connection - Watt	NSA	16	2,200	$855,900
TM-14. Crestview Improv- South	NSA	16	7,800	$3,001,100
TM-15. Watt and Georgia Drive Connection	NSA	16	6,700	$2,634,700
TM-16. N13 Well TM Improv	NSA	16	1,600	$635,700
TM-17. Madison Connection	NSA	16	600	$243,000
TM-18. Garfield Ave- North Improv	NSA	16	10,300	$3,958,800
TM-19. Indian River Loop	NSA	16	4,500	$1,737,000
TM-20. SSA Connector	NSA	16	2,600	$1,009,200
TM-21. 34th St Intertie	McClellan	24	500	$287,300
TM-22. MBP 1	McClellan	16 24	3,300 200	$1,448,500
TM- 23. MBP 2	McClellan	24	4,300	$2,234,700
TM- 24. MBP 3	McClellan	24	4,000	$2,064,700
TM- 25. MBP 4	McClellan	16	7,500	$2,977,300
TM- 26. MBP 5	McClellan	16	7,300	$2,900,700
TM- 27. MBP 6	McClellan	16	2,700	$1,073,500
TM- 28 MBP 7	McClellan	16	3,700	$1,469,500
TM- 29 MBP 8	McClellan	16	3,500	$1,392,900
TM- 30 MBP 9	McClellan	16	2,700	$1,073,500
TM- 31 MBP 10	McClellan	16	1,900	$754,000
Total	--	--	137,500	$64,866,200



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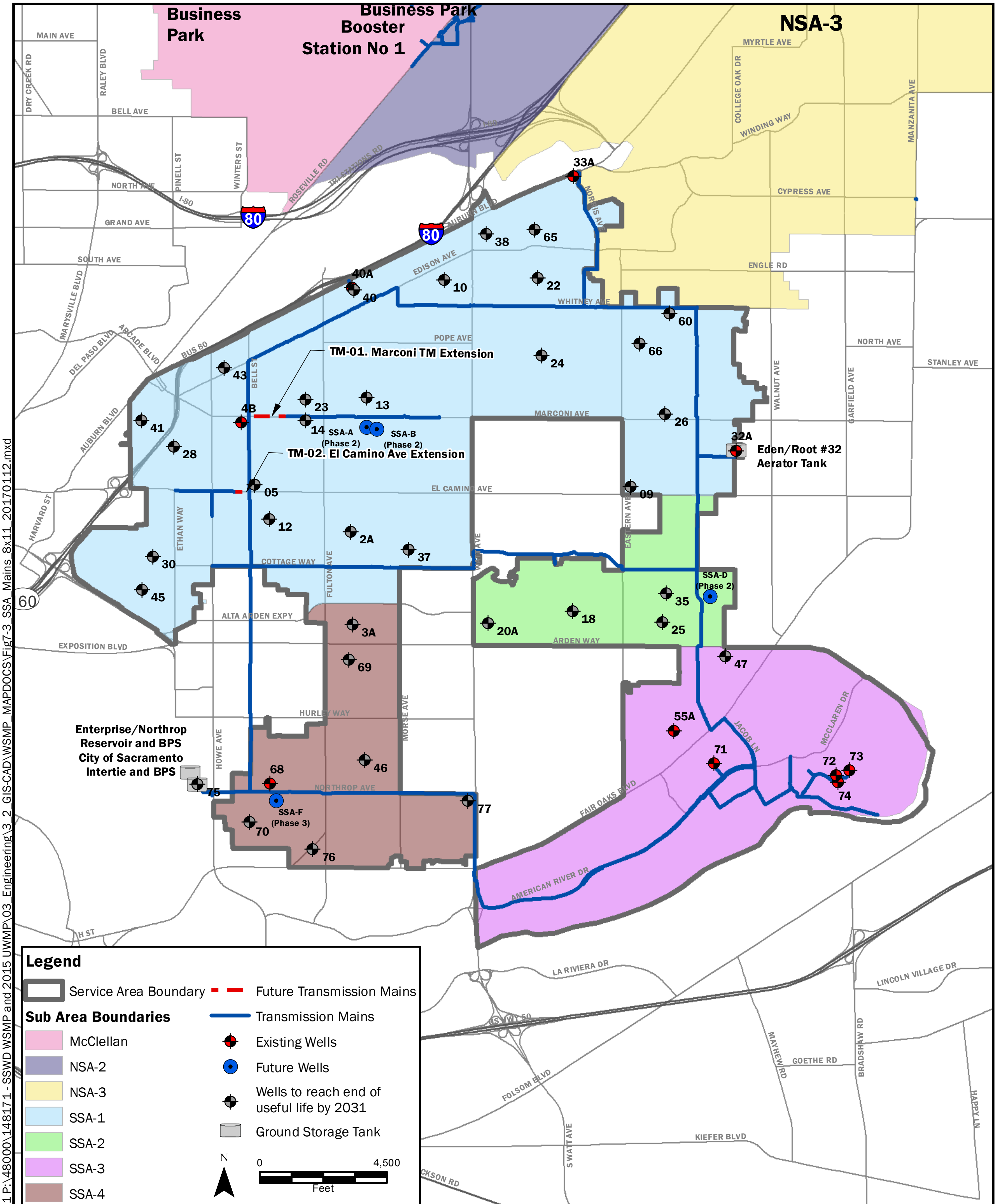
DATE	PROJECT	SITE
3/21/17	148171	Water System Master Plan Sacramento Suburban Water District

Brown AND Caldwell

TITLE

Recommended New Transmission Mains in the NSA

Figure 7-2



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DATE	PROJECT	SITE
3/21/17	148171	**Water System Master Plan** **Sacramento Suburban Water District**

Brown AND Caldwell

TITLE

Recommended New Transmission Mains in the SSA

Figure 7-3

Section 8

Distribution Facilities Analysis

The distribution category consists of pipelines that are typically less than 16-in diameter. This section describes the analysis of the District's distribution pipeline facilities including asset management R/R activities and the need for new facilities.

Strategic Plan Alignment

Facilities and Operations – 2.A. - The District will utilize appropriate planning tools, identify financial resources necessary, and prioritize system requirements to protect and maintain District assets and attain water resource objectives incorporating resource sustainability and lifecycle cost analysis into the framework.

- **Projected long term annual and cumulative replacement needs.**

Policy Implications

- **Recommended reduction in annual replacement activities and expenditures from current implementation levels.**

8.1 Distribution Mains Asset Management

The plan components that should be added to the Distribution Main AMP are identified in Table 5-2. Some of the key items that could provide more value to the AMP if added are as follows:

- Establish performance measures to evaluate and communicate performance of the distribution mains.
- Monitor and consistently document the condition of critical pipelines to help support repair and replacement prioritization.

8.1.1 Distribution Main Risk Analysis

The AMP conducts a detailed likelihood of failure and consequence of failure analysis of the distribution mains as grouped by replacement areas. Figure 8-1 provides a summary of the likelihood of failure considerations. These likelihood considerations are related to the intrinsic pipe characteristics for main age, break history, and pipe material. Figure 8-2 provides a summary of the consequence of failure considerations consisting of main location, pipe size, and fire protection. These consequence considerations are related to the impact the failure of the pipe would have on the system and surroundings. The sum of the scores related to the likelihood of failure and consequence of failure considerations were then used to prioritize the replacement areas for distribution main replacement as shown on Figure 8-3. It is recommended for future updates of this risk analysis District staff consider the following modifications:

- Develop scoring factors that range from zero to 1.
- Utilize actual scores from each factor analysis and avoid ranking the results until the risk scores are developed.
- Assign an importance weight factor to each of the likelihood and consequence factors.
- Develop an overall likelihood factor and an overall consequence factor.
- Calculate the replacement area risk by multiplying the likelihood factor times the consequence factor.

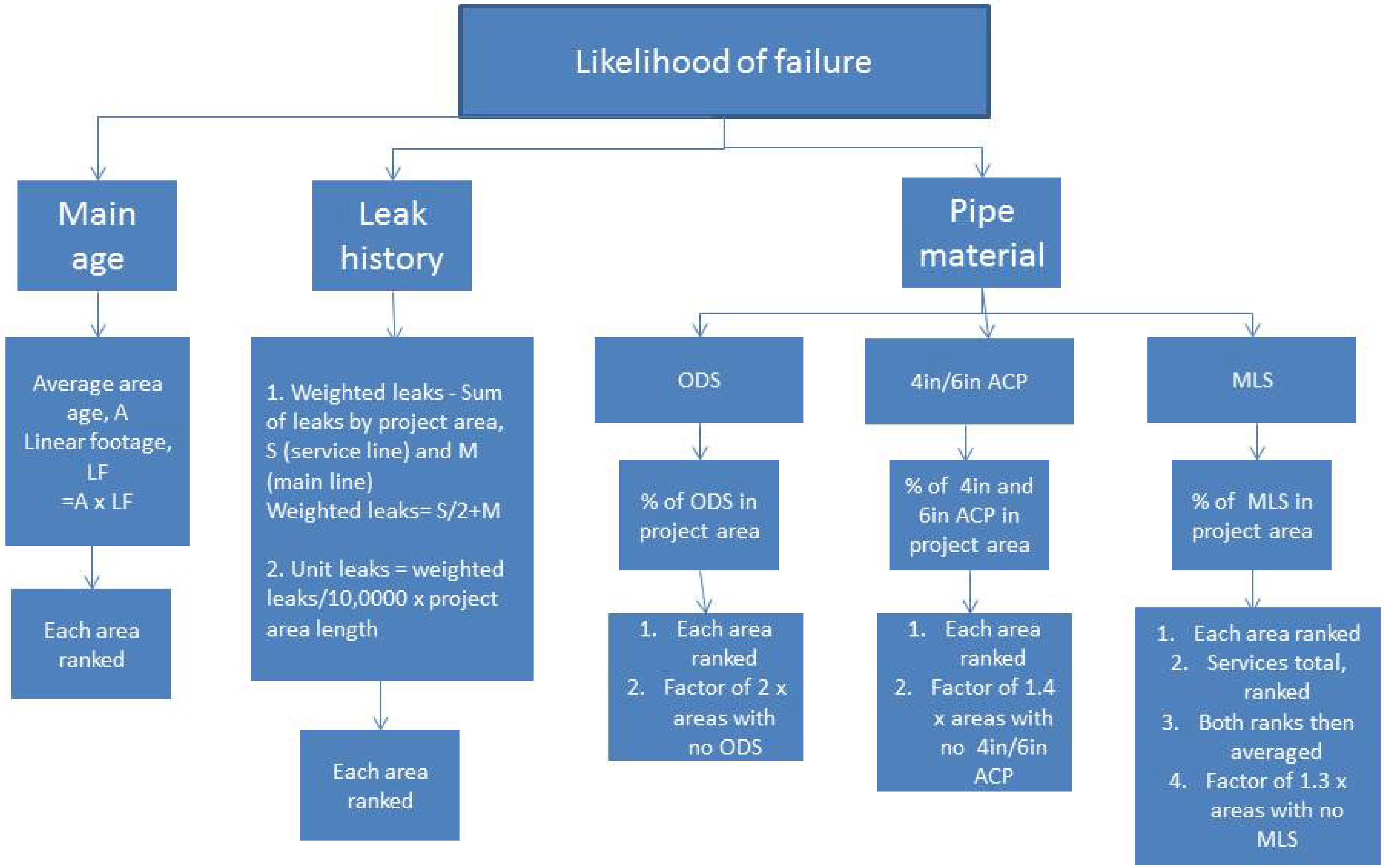

Figure 8-1. Likelihood of Failure Analysis – Distribution Mains AMP

Note: The order of likelihood of failure factors on this figure does not indicate the weight or relative importance of these factors in the analysis.

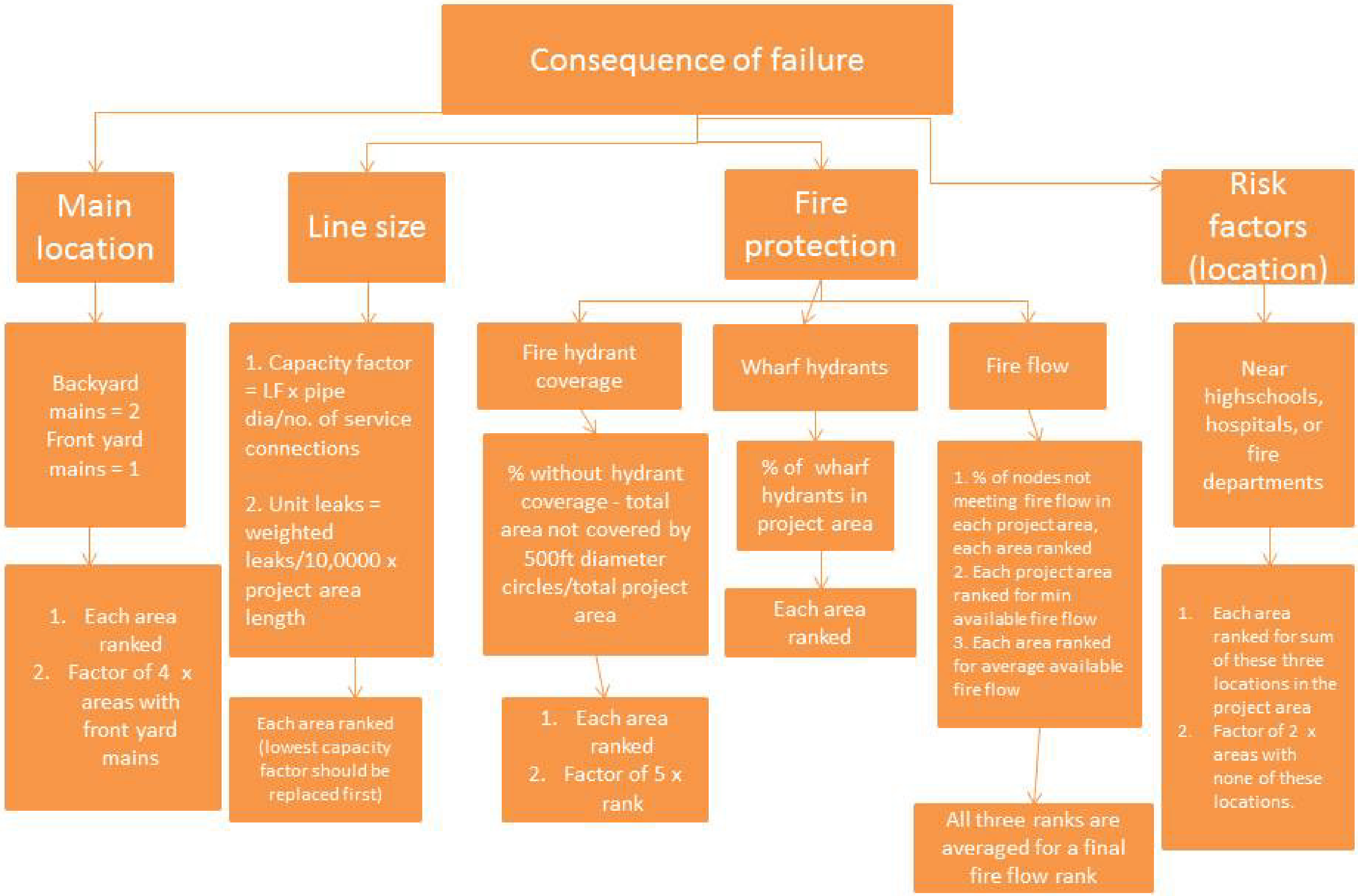

Figure 8-2. Consequence of Failure Analysis – Distribution Mains AMP

Note: The order of consequence of failure factors does not indicate the weight or relative importance of these factors in the analysis.

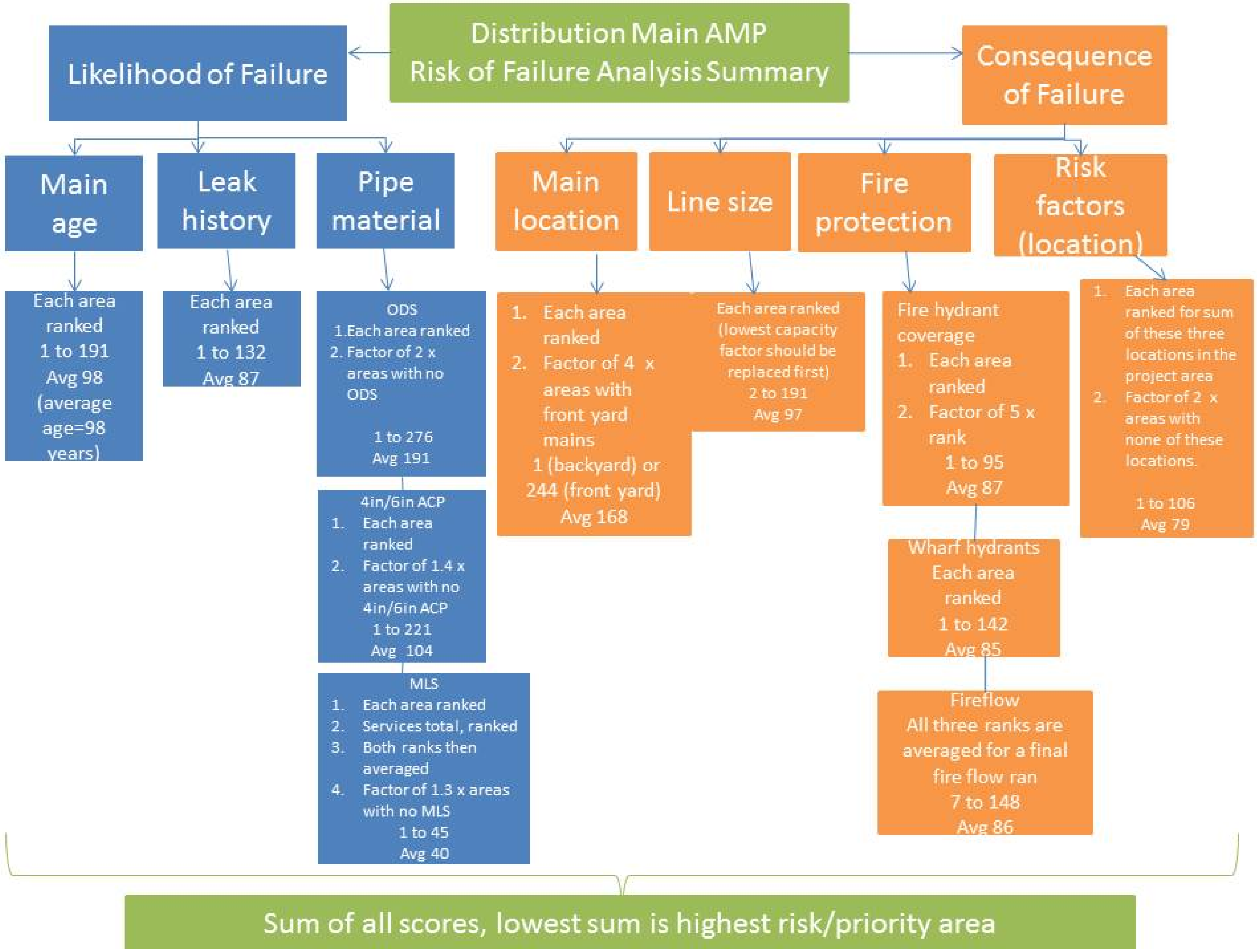

Figure 8-3. Risk of Failure Analysis Summary – Distribution Mains AMP

8.1.2 Distribution Main Rehabilitation and Replacement Assumptions

The Distribution Main AMP assumes an average 100-year useful life for pipelines less than 16-in diameter. For the replacement rate analysis useful life assumptions based on pipe material were assigned. The resulting overall average useful life assumed for the distribution system is 80 years. The assumed asset useful life assumptions by material are shown in Table 8-1.

Table 8-1. Distribution Mains Rehabilitation and Replacement Assumptions

Material	Asset Useful Life, Years
Asbestos cement	80
Cast iron	115
Ductile iron	100
Outside diameter steel[a]	60
Mortar lined steel[a]	40
Polyvinyl chloride	70
Other	70

Source: AWWA. Buried No Longer: Confronting America's Water Infrastructure Challenge

[a] Useful life is assumed to be less than industry standard due to installation issues specific to the District's water system.

The Distribution Main AMP does not provide estimated unit costs for replacement. Based on recent conversations with the District staff (August 2016), distribution main replacements have cost approximately $1.6 million per mile. This is for mostly 8-in diameter pipes. This is approximately $250/LF for 8-in diameter main replacements, or $38/LF/-in dia. The portion of the unit costs related to pavement are increased by 30 percent to account for the new Sacramento County paving requirements. The assumed main replacement unit cost is shown in Table 8-2.

Table 8-2. Distribution Mains Cost Assumptions

Pipe Diameter, in	Replacement Cost Assumptions [a]	
	$/in-dia/LF	$/LF
1	39	39
1.5	39	59
2	39	78
3	39	117
4	39	157
5	39	196
6	39	235
8	39	313
10	39	391
12	39	470
14	39	548

[a] A 3 percent markup is included to account for the future increasing paving costs as a result of the new Sacramento County paving rules.

8.2 Recommended Distribution Main Improvements

The recommended distribution main improvements are described below. The annual costs over the next 100 years for the distribution category are shown on Figure 8-4.

1. Rehabilitation and Replacement - Replacement of distribution pipelines at useful life. The distribution main replacement should be focused on priority replacement areas as identified in the Distribution Main AMP. The District is currently replacing distribution pipelines at a rate of 1 percent per year. Based on the long term cumulative replacement needs, shown in Appendix B, the 15-year recommended replacement rate is at a rate of 1.3 percent per year (46,000 LF per year).
2. New Infrastructure – No new distribution pipelines have been identified.

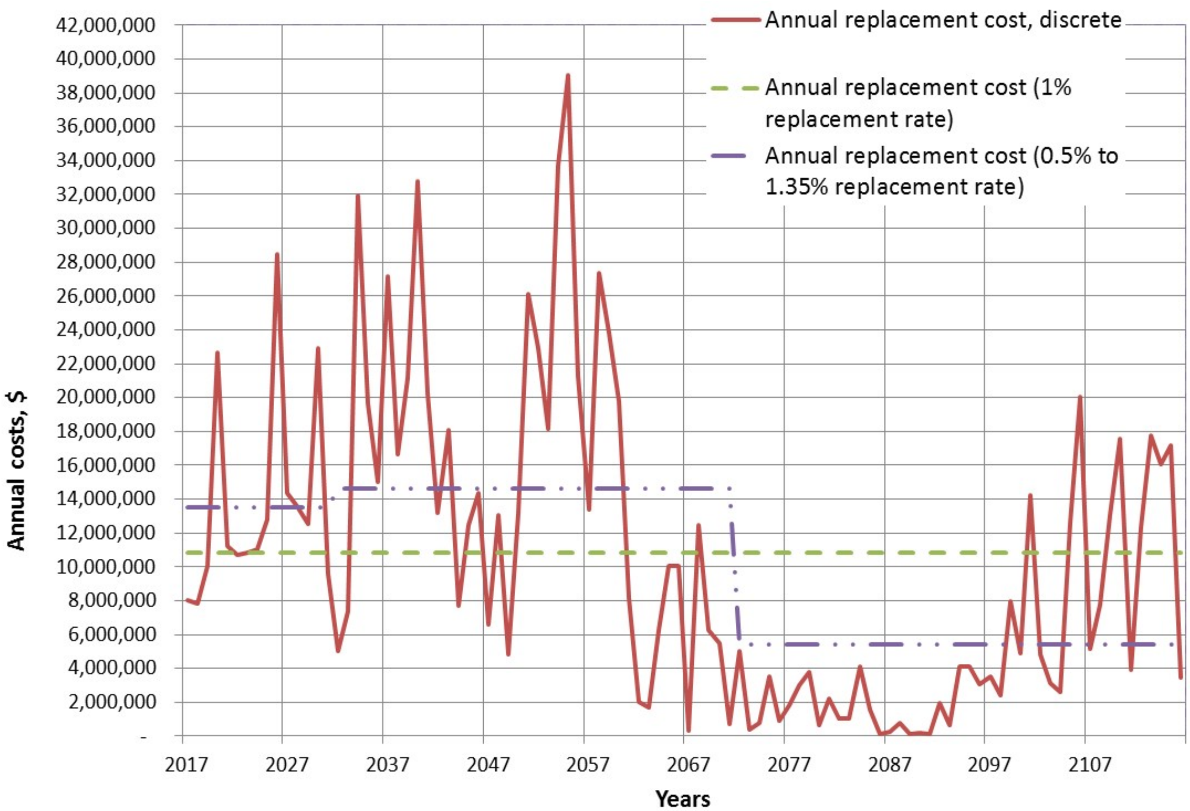

Figure 8-4. Annual Distribution Costs

Section 9

Storage Facilities Analysis

The storage category consists of pipelines and booster pump stations. This section describes the analysis of the District's storage facilities including asset management R/R activities and the need for new facilities.

Strategic Plan Alignment

Water Supply – 1.A. - Protect public health and the environment through compliance with all applicable federal, state and local regulations.

- **Adequacy of system water storage capacity for emergency, operational, and fire flow volume is analyzed for each pressures zone.**

Facilities and Operations – 2.A. - The District will utilize appropriate planning tools, identify financial resources necessary, and prioritize system requirements to protect and maintain District assets and attain water resource objectives incorporating resource sustainability and lifecycle cost analysis into the framework.

- **Analysis of projected long term annual and cumulative storage tank rehabilitation and replacement needs.**

Facilities and Operations – 2.D. Manage assets by implementing, preventive and predictive maintenance and analysis programs on District assets to extend their life and reduce service interruptions.

- **Storage tank rehabilitation and cleaning activities.**

Policy Implications

- **No new storage facilities recommended.**

9.1 Reservoir and Booster Pump Station Asset Management

The plan components that should be added to the Reservoirs and Booster Pump Station AMP are identified in Table 5-2. Some of the key items that could add more value to the AMP if added are as follows:

- Establish performance measures to evaluate and communicate performance of the storage tanks and booster pump stations.
- Identify the critical (high likelihood and high consequence of failure) storage tanks and booster pumps to help focus and resources on the greatest risk assets. A good description of each tank and booster pump including capacity, location, extent of use, and maintenance practices are provided for each facility. This information should be used to help develop asset criticality.
- Conduct condition monitoring and develop consistent documentation.

The District has established some key assumptions for use in estimating long-term rehabilitation and replacement planning needs as part of the AMPs. The useful life estimates used by the District are consistent with industry standard assumptions. R/R frequency assumptions are shown in Table 9-1.

Table 9-1. Reservoir and Booster Pump Station Rehabilitation and Replacement Assumptions				
Asset Class Name	Rehab Interval, years	Inspections/Cleaning, years	Re-Coating, years	Asset Useful Life, years
Elevated steel tank	--	5	15	100
Ground level reservoir	15	2	15	100
Pump/motor	7	--	--	20

In addition to the useful life and rehabilitation frequency assumptions, the Reservoir and Booster Pump Station AMP provides estimated unit costs for rehabilitation and replacement, as shown in Table 9-2. The cost estimates have been developed based on historical costs for previous District projects in most cases, which is the preferred method for obtaining costs for planning level estimates.

Table 9-2. Reservoirs and Booster Pump Stations Cost Assumptions					
Asset Class Name	Rehab (floor/roof)	Maintenance Inspections	Re-coating	Replacement	Remove from Service
Elevated steel tank	--		$300,000	$6/gallon capacity	$200,000
Ground level reservoir	$500,000 to $600,000		$550,000	$1/gallon capacity	$100,000
Pump/motor	$90,000				

9.2 Storage Capacity Analysis

The District's storage capacity is analyzed in Table 9-3. The adequacy of the storage is analyzed for each pressure zone. Two storage requirement methods are used for the analysis. Method 1 is peak hour supply from all above ground storage and Method 2 is peak hour supply from a mix of above ground storage and aquifer storage. Method 2 is how the District currently operates the system. Below is a description of each method.

Method 1. Peak hour supply from all above ground storage – using this method, about 3 MG of storage is required in the NSA, 1.7 MG in McClellan, and 3 MG of storage is required in the SSA. This storage requirement method is not recommended because it overlooks the peak hour supply that is provided by groundwater wells.

Method 2. Peak hour supply from mix of above ground storage and aquifer storage - this is how the District currently operates. Using this method, 1 MG of storage is required in the MBPSA. This is less than what is currently in place in both service areas. Method 2 storage requirement method is recommended.

Conclusions and recommendations as a result of this storage capacity evaluation are provided below.

1. There is sufficient storage and well pumping capacity to meet peak hour demands and fire flow requirements in all areas except for the MBPSA. The District cannot meet its peak hour demand with its well pumping capacity alone.
2. Additional storage of 1 MG may be needed in the MBPSA to meet fire flow demands, dependent upon future development in this area. System reliability could be improved by installing an intratie(s) at the interconnection with the North Highlands Pressure Zone (NSA 4). This would allow the MBPSA to utilize the available storage and pumping capacity in the North Highlands

pressure zone. It is recommended that the District further analyze through hydraulic modeling the location and benefit of the intratie(s).

Table 9-3. Buildout (2031) Storage and Pumping Capacity Evaluation by Pressure Zone

	NSA 1, 2, 3, and AASA	NSA 4 - North Highlands Pressure Zone	McClellan	SSA	Total	Comments
Supply Capacity						
Wells, gpm	35,001	6,867	0	29,193	71,061	This is the buildout reliable well capacity (total well capacity from Table 6-11 reduced by 10%).
Storage, gpm	8,000	8,000	0	4,500	20,500	This is the reliable booster pumping capacity, from Table 2-3.
Booster pump capacity into pressure zone	-4,000		4,000			This is reliable booster pumping capacity, which is booster pumping capacity with largest pump out of service.
Total, gpm	39,001	14,867	4,000	33,693	91,561	--
Storage volume, MG	5.275	5.0	0	5.0	15.0	From Table 2-3.
Buildout Demand						
Maximum day, gpm	20,639	5,079	1,839	19,064	46,621	NSA is sum of NSA, AASA, and McClellan from Table 3-21. SSA is from Table 3-21.
Peak hour, gpm	35,086	8,635	3,126	28,596	75,443	NSA is sum of NSA, AASA, and McClellan from Table 3-21. SSA is from Table 3-21.
Peak hour minus maximum day, gpm	14,447	3,556	1,287	9,541	28,831	Increment of demand greater than maximum day.
Maximum day plus fire flow, gpm	24,639	9,079	5,839	23,064	50,621	
Excess Supply Capacity						--
Maximum day, gpm	10,362	1,788	2,161	10,129	24,440	Sufficient supply (well supply plus booster pump capacity minus maximum day demand).
Peak hour, gpm	3,915	6,232	874	5,097	16,118	Sufficient supply (total supply minus peak hour demand).
Maximum day plus fire flow, gpm	14,362	5,788	-1,839	10,629	40,940	Sufficient supply except for McClellan (total supply minus maximum day plus fire flow demand).
Method 1. Peak Hour Supply-All Above Ground Storage						This method is typical for surface water systems and over sizes storage for groundwater supply systems.
Required supply from wells, gpm	20,639	5,079	1,839	19,064	46,621	Wells used to meet maximum day demand. Sufficient supply.
Required supply from storage, gpm	14,447	3,556	1,287	9,532	28,822	Supply from storage required to meet peak hour demand. (PHD minus MDD). Insufficient supply for NSA 1, 2, 3, and AASA, and McClellan and adequate supply for NSA 4 and SSA.
Required operational volume, MG	7.4	1.8	0.7	6.9	16.8	Based on 25% of maximum day demand.
Required fire storage, MG	1.0	1.0	1.0	1.0	4.0	Based on 4,000 gpm for 4-hour period, per Table 11-1.

Table 9-3. Buildout (2031) Storage and Pumping Capacity Evaluation by Pressure Zone						
	NSA 1, 2, 3, and AASA	NSA 4 - North Highlands Pressure Zone	McClellan	SSA	Total	Comments
Method 1 total required storage	8.4	2.8	1.7	7.9	20.8	Sum of required operational and fire storage.
Sufficiency of available storage vs required storage for Method 1	-3.1	+2.3	-1.7	-2.9	-5.8	Method 1 required storage minus available storage. Negative value indicates additional storage is required. Positive value indicates there is a storage surplus. Only NSA 4 has adequate storage volume under this method.
Method 2. Peak Hour and Maximum Day plus Fire Supply-Above Ground and Aquifer Storage Mix						This is how the District typically operates. The District uses a combination of aquifer storage and above ground storage to meet peak hour and fire flow demands.
Supply from storage, gpm	8,000	8,000	0	4,500	20,500	Use storage pumping capacity. Note adequate storage pumping capacity for fire flow in the NSA and SSA.
Required peak hour supply from wells (or intratie booster pump station), gpm	27,086	635	3,126	24,096	54,943	Calculated as peak hour demand less storage pumping capacity and then compared to well capacity (or intratie booster pump station). Adequate capacity.
Required maximum day plus fire supply from wells (or intratie booster pump station), gpm	16,639	1,079	-1,839	18,564	34,443	Calculated as maximum day plus fire demand less storage pumping capacity and then compared to well capacity (or intratie booster pump station. Adequate capacity except for McClellan.
Required operational storage volume, MG	1.4	1.4	-- [a]	0.8	3.6	Storage pumping capacity for three hours based on diurnal curve analysis in previous master plan.
Required fire storage, MG	1.0	1.0	1.0	1.0	4.0	Based on 4,000 gpm for 4-hour period, per Table 11-1.
Method 2 total required storage	2.4	2.4	1.0	1.8	7.6	Sum of required operational and fire storage.
Sufficiency of available storage vs what is required for Method 2	+2.9	+2.6	-1.0	+3.2	+7.4	Method 2 required storage minus available storage. Negative value indicates additional storage is required. Positive value indicates there is a storage surplus. Adequate storage except for McClellan. Some of the surplus storage in NSA 4 could be used to help supply McClellan assuming adequate infrastructure capacity is available.

[a] BPS from the NSA to MBPSA can meet peak hour demands in MBPSA.

9.3 Recommended Storage Facility Improvements

The recommended storage facility improvements are described below. The annual costs over the next 100 years for the storage category are shown on Figure 9-1. The annual discrete costs are shown as well as the 15-year average annual cost and the long-term average annual costs. The long-term cumulative replacement needs are shown in Appendix B.

1. Tank Re-coating – recoating tanks per the frequency and cost described in Table 9-1.

2. Tanking Cleaning – cleaning and inspecting tanks per the frequency and cost described in Table 9-1.
3. Tank Replacement – replacing tanks per the useful life described in Section 6. It is assumed that McClellan Business Park elevated tanks No. 769 and No. 216 will be removed from service around 2020.
4. New Storage Facilities - No new storage facilities are recommended in the 15-year CIP.

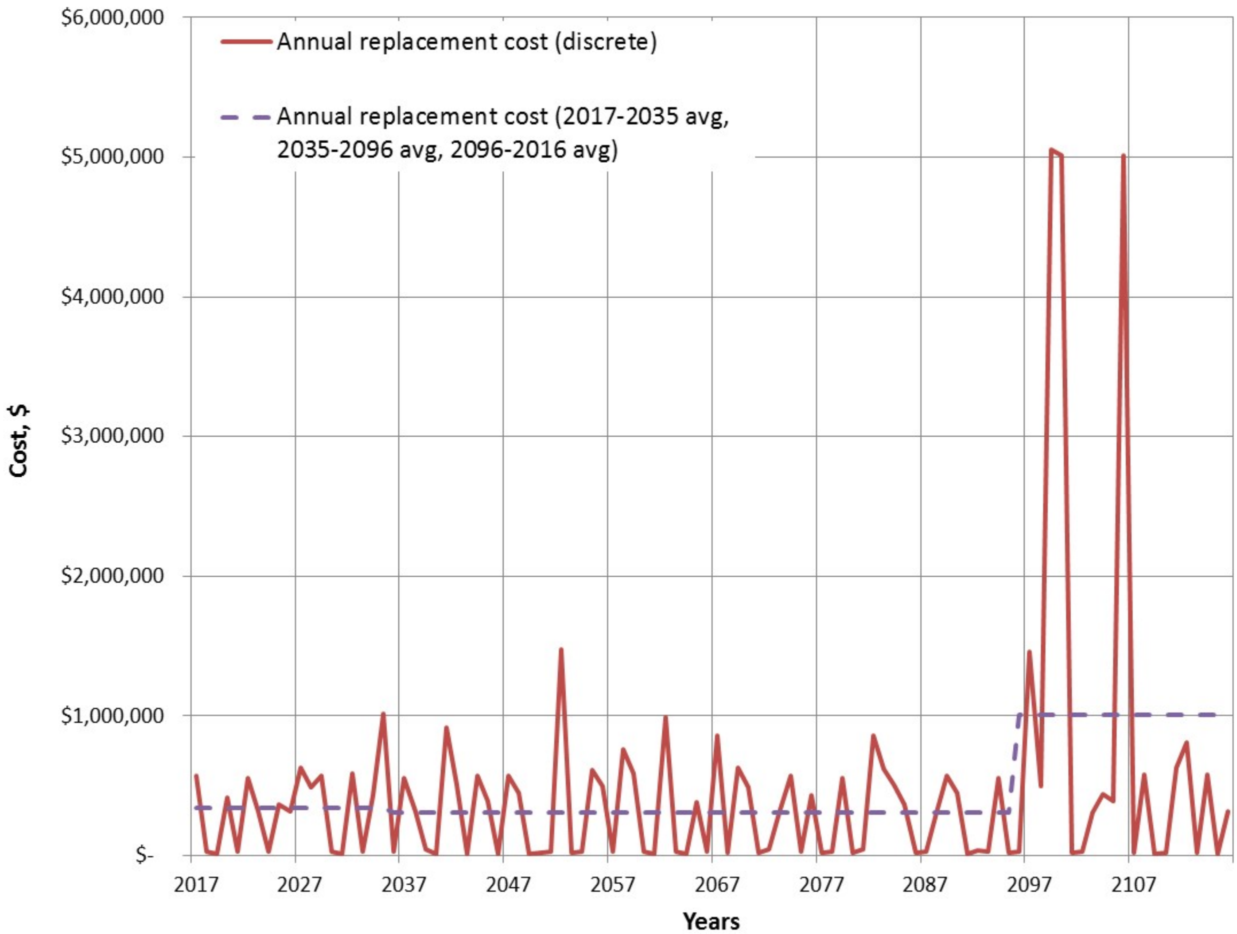

Figure 9-1. Annual Storage Costs

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Section 10

Special Projects Analysis

The special projects category consists of buildings and structures, water meters, and SCADA. This section describes the analysis of the District's special projects including asset management R/R activities and the need for new facilities.

Strategic Plan Alignment

Facilities and Operations – 2.A. - The District will utilize appropriate planning tools, identify financial resources necessary, and prioritize system requirements to protect and maintain District assets and attain water resource objectives incorporating resource sustainability and lifecycle cost analysis into the framework.

- **Analysis of projected long term annual and cumulative buildings and structures, SCADA, and water meters rehabilitation and replacement needs.**

Facilities and Operations – 2.D. Manage assets by implementing, preventive and predictive maintenance and analysis programs on District assets to extend their life and reduce service interruptions.

- **Buildings and structures painting and roof replacement activities, SCADA repair and software adjustments/upgrades and major central and per site replacements, and meter testing and replacement activities included.**

Facilities and Operations – 2.E. - Continue with information technology systems that will provide the availability of timely and accurate information allowing a provision of superior service to our customers.

- **Recommendations for improvements to SCADA Alarm Management, Use of SCADA Data, Standardization of SCADA System, Optimization/Integration of SCADA system.**

Policy Implications

- **Increased expenditures on developing and maintaining SCADA system than currently implemented.**
- **Meter installation completion by 2022.**

10.1 Buildings and Structure Analysis

This section presents the building and structures asset management and recommended improvements.

10.1.1Buildings and Structures Asset Management

The components that should be added to the Buildings and Structures AMP are identified in Table 10-1. Some of the key items that could add more value to the AMP if added are as follows:

- Establish performance measures to evaluate and communicate performance and condition of the buildings and structures.
- Identify the critical (high likelihood and high consequence of failure) buildings and structures to help focus and resources on the greatest risk assets. A good description of each the District's largest and most expensive buildings are described in the Buildings and Structures AMP. The descriptions typically include building or structure size, purpose, construction date, building material, and location.

- Condition monitoring and consistent documentation of this monitoring should be provided in the Buildings and Structures AMP. This information could be used to identify likelihood of failure factors when evaluating when to replace critical structures.

The District has established some key assumptions for use in estimating long-term rehabilitation and replacement planning needs as part of the AMPs. R/R frequency assumptions are shown in Table 10-1.

Table 10-1. Buildings and Structures Rehabilitation and Replacement Assumptions

Asset Class Name	Painting Frequency, years	Roof Replacement, years	Asset Useful Life, years
Buildings	15	20 to 30	100

In addition to the useful life and rehabilitation frequency assumptions, unit costs for painting and roof replacement are shown in Table 10-2. The Buildings and Structures AMP effectively explains and provides the background and basis for how the useful life and cost assumptions were derived and how they are used to develop the long-term R/R plans. The useful life estimates used by the District are consistent with industry standard assumptions. The cost estimates have been developed based on historical costs for previous District projects in most cases or recent estimates from roof contractors, which is the preferred method for obtaining costs for planning level estimates.

Table 10-2. Buildings and Structures Cost Assumptions

Task	Cost Assumption, $
Painting	$5 to $10 per sq ft
Roof replacement	Varies, $5,000 to $270,000
Replace administrative and operations building, combined location	$10,000,000

10.1.2 Recommended Buildings and Structures Improvements

The annual CIP costs over the next 100 years for the buildings and structure category are shown on Figure 10-1. The buildings and structure long term cumulative replacement costs are illustrated in Appendix B. R/R of existing buildings and structures include painting and roof replacement as described in Section 10.1.1. The future administrative/operations facility building is assumed to cost $10 million and be constructed in 2030 and 2031.

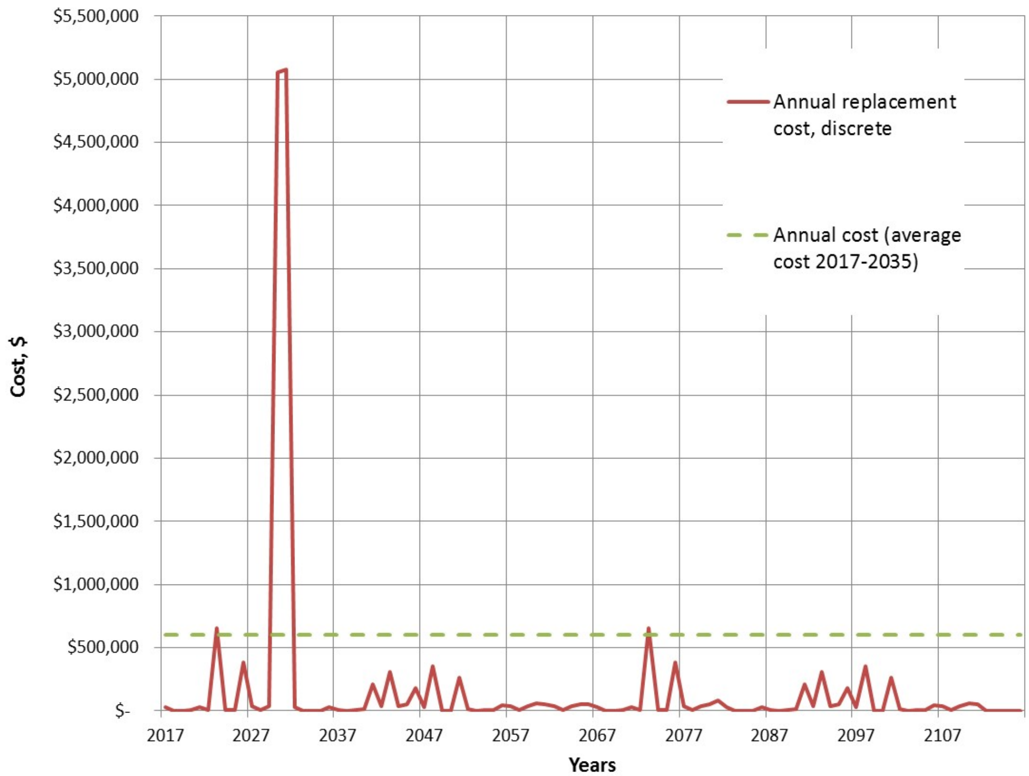

Figure 10-1. Annual Buildings and Structures Costs

10.2 SCADA Analysis

The District does not currently have a SCADA AMP. The District does have a 2012 SCADA Master Plan (Westin, 2012) which serves as a guide for decisions on the purchase of future SCADA hardware and software components. BC met with District staff on September 21, 2015 and reviewed available documents to identify and prioritize tasks for the District to improve its SCADA system and discuss current issues and challenges that the District faces with their SCADA system.

The water system is monitored and operated automatically using a Wonderware/Tesco Controls Supervisory Control and Data Acquisition (SCADA) system. Most of the system active wells are connected to the SCADA system, as well as most of the reservoirs and booster pump stations. The District's SCADA system consists of three major components: remote site controls, radio communications, and the SCADA master station.

The typical AMP plan components listed in Section 5 should be added to the SCADA Master Plan to develop it into an AMP. Based on conversations with District staff, the areas where the SCADA system may be improved are classified into the following broad categories:

1. SCADA Alarm Management
2. Use of SCADA Data
3. Standardization of SCADA System
4. Optimization/Integration of SCADA System

A key approach to developing solutions to these and other issues is to establish a framework for sustainable, long-term SCADA system asset management. The key components of this framework include plans and guidance documents such as the existing SCADA Master Plan, development of SCADA Standards, establishing Information Technology Governance (describing work processes and responsibilities between IT and Operations for supporting SCADA), and development of an Organizational Assessment to align the workforce to best support Operation's SCADA needs. While some of these components may be long-term efforts, they can be partially developed in phases to address the current needs. The recommended framework for addressing the District's SCADA system issues is illustrated on Figure 10-2.

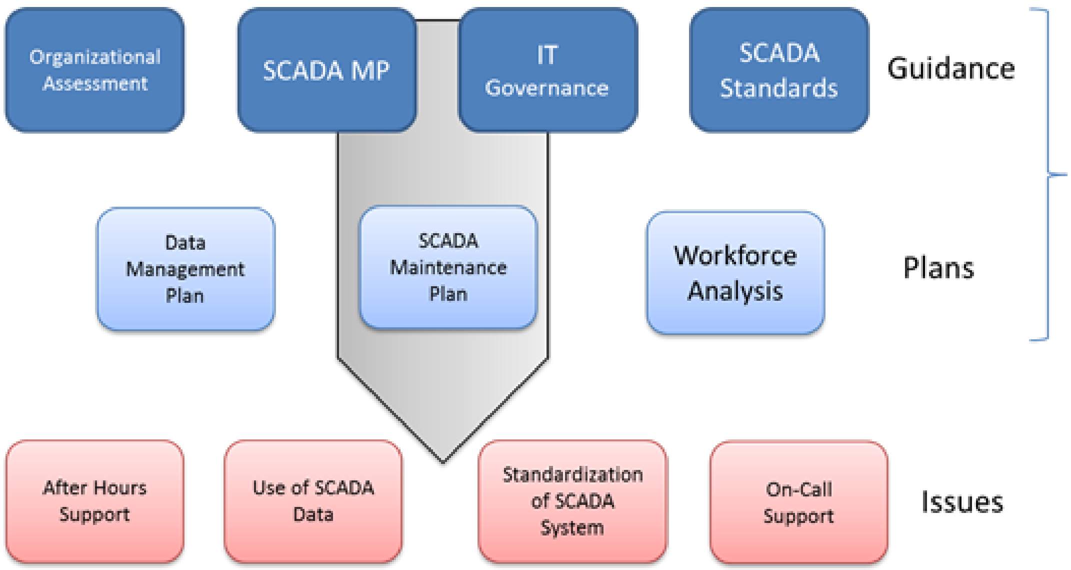

Figure 10-2. Framework for Sustainable, Long-term SCADA System Management

10.2.1SCADA Improvement Areas

As described above, there are specific areas identified by District staff that have issues and could be improved. This section discussed these issues and recommendations to address these issues. Many of the recommendations are from the District's SCADA Master Plan, (Westin, 2012).

10.2.1.1 SCADA Alarm Management

From discussion with District staff, the District's current alarm management process has the following deficiencies:

1. There is typically only one point of contact for after-hours alarm response, which reduces reliability and may result in delayed response to an after-hours alarm.
2. There is a significant responsibility on a single District staff member.
3. Equipment currently used by operators may not be most efficient or reliable for after-hours alarm response.
4. The use of personal internet services may pose a security risk.

It is recommended that the District implement the following actions to improve SCADA alarm management, particularly after-hours alarm response:

1. Prepare Alarm Management Plan, described S-7 (Alarm Management Plan) in the SCADA Master Plan. The District's Information Technology (IT) Department should be engaged early and should be an active participant throughout the preparation of the Alarm Management Plan. This will

allow the IT and Operations Departments to understand the needs, limitations, and consequences of procedures described in the Alarm Management Plan.

2. Upgrade Staff Communication Equipment. District staff members currently receive after-hours SCADA alarms as text messages on analog mobile phones and respond by logging into District server using work laptops through personal Wi-Fi service. This method limits the staff members who can respond to after-hours SCADA alarms to those who have access to Wi-Fi internet service at home. The response to after-hours SCADA alarms may also be delayed if the after-hours operator is at a location without immediate internet access or if there is an internet outage at the operator's home.

   Other water agencies in the Sacramento area provide mobile devices that are able to be used to receive alarms and access the agency's SCADA system to respond to alarms, such as smart mobile phones or tablets. The District could maintain a certain number of on-call devices that would be checked out by on-call operators. Another alternative would be to provide cellular network cards for use with District laptop computers. Cellular network cards would enable on-call operator to connect to the Internet and log into District system mobility, for example, if the on-call operator were at a restaurant. Cellular network cards would also allow on-call operator to respond to after-hours alarms if home internet service was not available.

   The District's Operations and IT Departments should work closely to ensure that new devices are compatible with the District's SCADA system and will not pose a security threat, while being able to meet the needs of after-hours operations staff.

10.2.1.2 Use of SCADA Data

The District currently collects and stores a large amount of data from components of the District's water system. District operators currently cannot access data stored by the SCADA system. This data should be used proactively to understand the condition of the water system and its components, schedule preventative maintenance, develop early warning system for railing components, and allow the District to plan for those failures proactively, as opposed to responding to system failures on a reactive, emergency basis. Tasks that will improve the District's use of SCADA Data include:

1. Data Management Plan. As a first step, the District should prepare a Data Management Plan, to understand what data is being collected and stored by the SCADA system, what data is most useful to District staff, and appropriate monitoring frequency. For example, pumping rate and water level data can be used to calculate the specific capacity of a well, which is an important performance parameter, and can be used to diagnose problems with the well. A decrease in pumping rate and specific capacity is an indication of plugging in a well that may trigger rehabilitation of the well. A decrease in pumping rate without a decrease in specific capacity is an indication of a pump issue. While these trends are important, they should be monitored on a monthly or quarterly basis, as opposed to an hourly or daily basis.
2. Operations Data Management System (ODMS). The District should consider integration of the SCADA system with Computerized Maintenance Management System (CMMS), finance, and asset management systems as a long-term goal. This task is described in items S-3 (ODMS Readiness Assessment), and L-5 (ODSM Implementation) of the SCADA Master Plan. This integration would result in an ODMS, which would provide the District with a consolidated enterprise historian and user-friendly reporting tools.

10.2.1.3 Standardization of SCADA System

The District's SCADA system is currently composed of equipment and programming supplied by TESCO, and is not currently standardized. For example, different SCADA screens are available at different facilities. District staff noted that the integration of new facilities is difficult and new SCADA systems currently are sole-sourced to TESCO as opposed to being competitively bid. The current lack of standardization causes the District to store a larger number of spare parts, and maintenance and repair activities are more difficult than if the SCADA system was standardized. The standardization of the District's SCADA system is discussed in items S-6 (Documentation Analysis and Upgrade), S-9 (SCADA Governance Plan), and L-4 (Expansion of SCADA Standards) of the SCADA Master Plan.

10.2.1.4 Optimization of the SCADA System

Optimization of the SCADA system will allow the District to realize the maximum benefit of the system. As part of this task, the District should evaluate opportunities to optimize SCADA processes, determine which concepts have the highest potential payback, and develop technical requirements and estimated costs for implementation. Optimization of the SCADA system is described in items S-5 (Optimization Feasibility Analysis) of the SCADA Master Plan.

10.2.1.5 Summary of Recommended SCADA Projects

A summary of the recommended SCADA projects discussed in the preceding sections are provided in Table 10-3.

Table 10-3. Summary of Recommended SCADA Projects

Project Number	Project Name	Recommendation Source Document
System completion/upgrades		
SCADA-S2	Radio Replacement Pilot Study	from SCADA Master Plan [a]
SCADA-S4	HMI Evaluation	from SCADA Master Plan [a]
SCADA-L1	SCADA System completion	From SCADA Master Plan [a,b]
SCADA-L2	RTU Upgrade Program	from SCADA Master Plan [a]
SCADA-L3	HMI Upgrade	from SCADA Master Plan
SCADA Alarm Management		
SCADA-1	Communication Equipment	2016 WSMP
SCADA-S7	Alarm Management Plan	from SCADA Master Plan [a]
Use of SCADA Date		
SCADA-2	Data Management Plan	2016 WSMP
SCADA-S3	ODMS Readiness Assessment	from SCADA Master Plan [a]
SCADA-L5	ODMS Implementation	from SCADA Master Plan [a]
Standardization of SCADA system		
SCADA-S6	SCADA System Documentation Upgrade	from SCADA Master Plan [a]
SCADA-S9	SCADA Governance Implementation	from SCADA Master Plan [a]
SCADA-L4	Standards Expansion	from SCADA Master Plan [a]
Optimization of SCADA system		
SCADA-S5	Optimization Feasibility Analysis	from SCADA Master Plan [a]

[a] *Westin Engineering, 2012*

[b] *Updated in this 2016 WSMP for the two remaining facilities - N20 and 12.*

10.2.2 SCADA Rehabilitation and Replacement Assumptions

Key assumptions that are recommended for estimating long-term SCADA rehabilitation and replacement planning needs are shown in Table 10-4. The recommended unit costs for SCADA rehabilitation and replacement are shown in Table 10-5. These assumptions are used to estimate future R/R expenditures related to the SCADA system.

Table 10-4. SCADA Rehabilitation and Replacement Assumptions

Asset Class Name	Repair and Software Adjustments/Upgrades, years	Major Replacement, years	Asset Useful Life, years
SCADA equipment	1	15	15

Table 10-5. SCADA Cost Assumptions

Asset Class Name	Repair and Software Adjustments/Upgrades	Major Replacement	
		Per Site [a]	Central Resources [b]
SCADA equipment	$200,000	$50,000	$500,000

[a] Assumed to be 50 sites.

[b] Central resources include servers, control room, networking, remote access.

10.2.3 Recommended SCADA Improvements

As described in Section 10.2.1 there are projects remaining to complete the SCADA system as well as projects to improve the utilization of the SCADA system. Annual O&M projects for SCADA consist of equipment repair and software adjustments and upgrades. Major replacement costs are also included as described in Section 10.2.2.

The annual CIP costs over the next 100 years are shown on Figure 10-3. The SCADA long term cumulative replacement costs are illustrated in Appendix B.

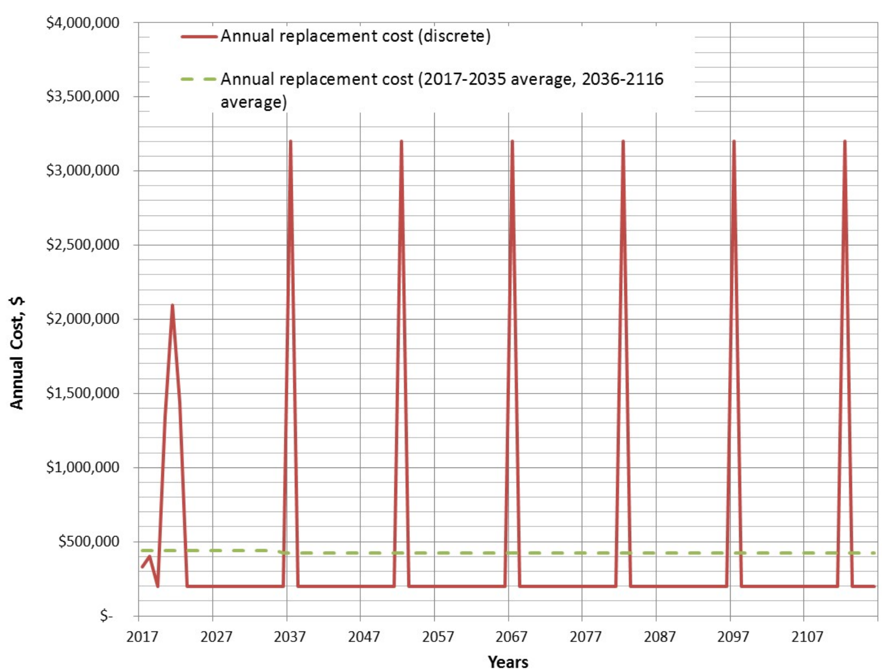

Figure 10-3. Annual SCADA Costs

10.3 Water Meters Analysis

Water meters include meters in the distribution system.

10.3.1Completion of Water Meter Retrofit Program

There are approximately 10,000 services remaining to be metered at a cost of $1,750 per service. Based on the analysis in the Water Meter AMP this is assumed to cost $2.1 million per year through 2022.

10.3.2Water Meter Asset Management

The plan components that should be added to the Water Meter AMP are identified in Table 5-2. Some of the key items that could add more value to the AMP if added are as follows:

- Performance measures and levels of service – Identifying and documenting the performance measures and level of service requirements for water meters, allows the District to evaluate meter performance as well as justify meter replacements.
- Condition Assessment - Consistent documentation of meter asset condition supports decisions about when to repair, rehabilitate and replace assets and also informs asset managers on how best to operate and maintain an asset.

The District has established assumptions for use in estimating long-term rehabilitation and replacement planning needs as part of the AMPs. Water meter R/R frequency assumptions are shown in Table 10-6

Table 10-6. Water Meter Rehabilitation and Replacement Assumptions

Meter Size	Testing Interval, years	Replacement Interval, years	Asset Useful Life, years	Notes
5/8-in, ¾-in, 1-in	--	20	20	Typically, useful life through 4 to 5 MG
1.5-in, 2-in	--	10 (rebuilt)	10	100 meters per year
3-in, 4-in	5	As necessary	--	Rebuilt as necessary
6-in or larger	Annual	As necessary	--	Rebuilt as necessary

In addition to the useful life and rehabilitation frequency assumptions, the Water Meter AMP provides estimated unit costs for rehabilitation and replacement. The unit costs used in the Water Meter AMP for the District's small meter replacement and large meter rehabilitation cost projections are summarized in Table 10-7.

Table 10-7 Water Meter Cost Assumptions	
Meter size	Unit R/R cost, $/meter
Small meter replacement (every 20 years)	
5/8-in	$168
¾-in	$191
1-in	$253
Large meter rehabilitation (every 10 years)	
1.5-in	$352
2-in	$365
3-in	$984
4-in	$1,003
6-in	$3,740
8-in	$3,740
10-in	$4,658

The annual CIP costs over the next 100 years for the meter category are shown on Figure 10-4. The water meter long term cumulative replacement costs are illustrated in Appendix B. R/R of existing water meters include replacement of smaller meters (5/8-in to 2-in) and testing and rebuilding of larger meters (3-in and greater).

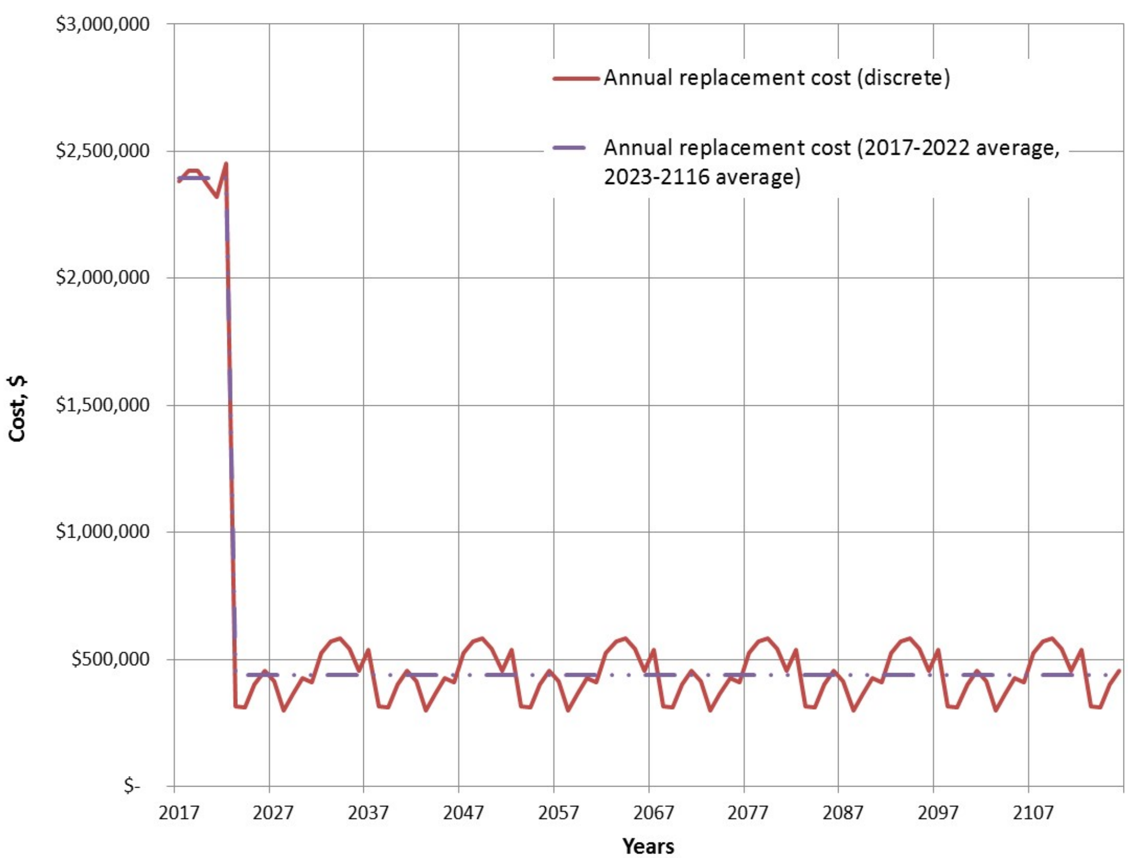

Figure 10-4. Annual Water Meter Costs

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Section 11

Hydraulic Modeling

The District's Infowater hydraulic model is utilized as a tool to help identify system deficiencies in the existing system and confirm the system will meet operational and performance criteria at buildout. The hydraulic model was updated in July 2014 (Brown and Caldwell, 2014). The model update included updated piping from GIS, updated diurnal demand curves based on diurnal flow patterns from summer 2013, and allocated metered and non-metered water demand from summer 2013. An operational calibration was also performed utilizing District 2013 SCADA production data. District Staff updated the hydraulic model in Spring 2016 with the current GIS piping.

Strategic Plan Alignment

Water Supply – 1.B. - Provide for the long-term water supply needs of the customers through prudent planning that will ensure capacity to serve system demands.

- **Utilize District's hydraulic model tool to validate demands can be met in distribution system.**

Facilities and Operations – 2.A. - The District will utilize appropriate planning tools, identify financial resources necessary, and prioritize system requirements to protect and maintain District assets and attain water resource objectives incorporating resource sustainability and lifecycle cost analysis into the framework.

- **Utilize District hydraulic model tool to optimize recommended infrastructure layout.**

Policy Implications

- **Recommended new facilities meet the District's performance criteria.**
- **Verified that District's water system provides required fire flows.**

11.1 Evaluation Criteria

Typically, the District maintains minimum service pressures of 35 psi with allowable minimum pressures down to 20 psi during maximum day plus fire flow demand conditions. The standard operational and performance criteria used for this analysis are summarized in Table 11-1.

Table 11-1. Operational and Performance Criteria for Planning and Design

Component	Criteria
Fire Flow Requirements (flow [gpm] @ duration [hours]) [a]	
Single-Family Residential	1,500 gpm @ 2 hrs.
Multi-Family Residential	2,500 gpm @ 2 hrs.
Commercial	3,000 gpm @ 3 hrs. (with approved automatic sprinkler system)
Institutional (schools, hospitals, etc.)	4,000 gpm @ 4 hrs. (with approved automatic sprinkler system)
Industrial/Business Park	4,000 gpm @ 4 hrs. (with approved automatic sprinkler system)

Table 11-1. Operational and Performance Criteria for Planning and Design	
Component	**Criteria**
Water Transmission Line Sizing (16-in in diameter or greater)	
Max day plus Fire Flow or Peak Hour Demand Condition	
Minimum Pressure, psi	35 psi (20 psi for fire flow)
Maximum Head Loss, ft per 1000 ft of pipe (ft/kft)	7 ft/kft
Maximum Velocity, ft per second (fps)	7 fps
Water Distribution Line Sizing (Less than 16-in in diameter)	
Max day plus Fire Flow or Peak Hour Demand Condition	
Minimum Pressure, psi	35 psi (20 psi for fire flow)
Maximum Head Loss, ft/k ft	10 ft/kft
Maximum Velocity, ft/sec	5 fps

[a] *Typical minimum flow will be verified by Sacramento Metropolitan Fire District on a case by case basis.*

11.2 Scenarios

The water system is analyzed under existing (2016) and buildout (2031) demand conditions and two supply scenarios: all groundwater and maximize surface water use. The modeling scenarios are summarized in Table 11-2. The hydraulic model runs as an extended period analysis over a 24-hour period. The MDD demand conditions includes the peak hour demands because the District's diurnal demand curves over a 24-hour period are used to model the demand peaks that occur within the system.

Table 11-2. Modeling Scenarios		
Scenario	**Demand Condition**	**Supply Condition**
1. All Groundwater – Existing MDD	2016 maximum day/peak hour demand	Existing wells
1a. All Groundwater – Existing MDD plus Fire Flow	2016 maximum day demand plus fire flow	Existing wells
2. All Groundwater – Buildout MDD	Buildout maximum day demand/peak hour demand	Ultimate vision wells
2a. All Groundwater- Buildout MDD plus Fire Flow	Buildout maximum day demand plus fire flow	Ultimate vision wells
3. Maximize surface water – Buildout MDD	Buildout maximum day demand/peak hour demand	Ultimate vision wells Surface water NSA (PCWA) = 9 MGD (6,250 gpm) SSA (City of Sacramento) – 20 MGD (13,900 gpm)

11.3 Existing System Evaluation

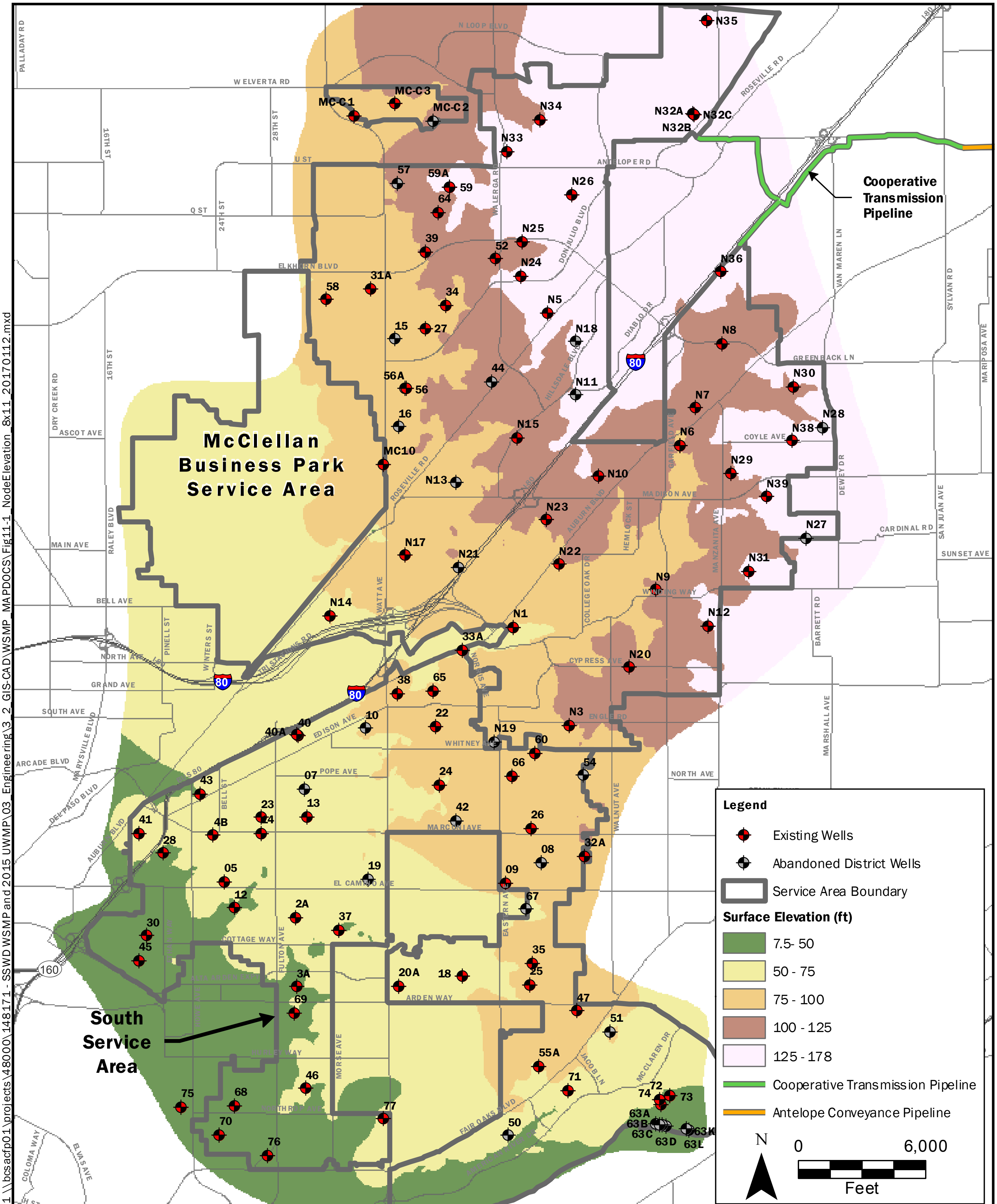
The existing system is evaluated to identify any low pressure or high velocity areas as well as fire flow capacity within the distribution system with an all groundwater supply. The ground elevations in the system are shown on Figure 11-1. As shown on Figures 11-2, 11-3, and 11-4, minimum pressures, maximum velocities, and maximum unit headlosses are maintained in most areas. Below are some observations of this existing system evaluation.

1. Service pressures – Figures 11-2a and 11-2b for the NSA and SSA, respectively, illustrate the minimum nodal pressure ranges.
   a. Service pressures remained above 35 psi in all areas of the system under maximum day demand and peak hour demand conditions
2. Pipeline velocities – Figures 11-3a and 11-3b for the NSA and SSA, respectively, illustrate maximum pipeline velocity ranges.
   a. For most of the system pipeline velocities are predominantly under 2 fps under both maximum day and peak hour demand conditions.
   b. Maximum velocities in the AASA exceed 8 fps in the 6-in diameter pipelines along Ottawa Way (1,500 LF) and Pima Way (1,200 LF). These two 6-in diameter pipelines connect to the 16-in diameter transmission main pipeline near Golden Rink Way which conveys water from the rest of the NSA to the AASA. These high velocities occur because in this existing scenario, Scenario 1, there are no AASA wells operating due to high Cr+6 levels. In this Scenario 1 all supply to the AASA is provided from the NSA through the 16-in diameter Golden Rink Way pipeline.

      In Section 6 of this document a replacement well (NSA-A) is recommended for the AASA by 2018. The velocities in the 6-in diameter pipelines on Ottawa Way and Pima Way are reduced when some of the peak hour demands in the Capehart area are met with the new well NSA-A. These improvements will reduce the flow through the 6-in diameter pipes conveying water from the rest of the NSA into the AASA.
3. Pipeline unit headlosses – Figures 11-4a and 11-4b for the NSA and SSA, respectively, illustrate maximum pipeline unit headlosses (feet of headloss per 1,000 LF of pipe) ranges. Most system pipelines are less than 3 ft/1,000ft. In the AASA there are pipelines in the west area that have unit headlosses greater than 7ft/1,000ft.
4. The available fire flow in the existing system is evaluated. The hydraulic model is utilized to evaluate the available fire flow at each model junction. This available fire flow is compared to the required fire flow by parcel land use type, described in Table 11-1. As shown on Figure 11-5a and 11-5b for the NSA and SSA, respectively, there are areas of the water system where model junctions could not provide the required fire flow. In some locations there is sufficient fire flow capacity from a nearby model junction. In other locations such as the AASA and MBPSA there the model indicates there may be fire flow supply deficiencies. It should be noted that the hydraulic model analysis runs one model junction at a time. In some areas it is possible that two hydrants could be operated simultaneously to meet fire flow requires. Two hydrants operating simultaneously is not reflected in the modeling results.

   For the MBPSA, additional fire flow can be provided by increasing the size of the transmission pipelines and distribution system, as recommended for the buildout scenario. Fire flow requirements have been met in this area by operating two hydrants simultaneously in the field.

For the AASA, additional fire flow is provided with the addition of New Well NSA A that is recommended for completion by 2018. In addition, a new booster pump was added to the Capehart storage tank in 2016, and is included in the modeling analysis. Due to small distribution pipe (6-in diameter) in the AASA, there are high velocities and unit headlosses, reducing the fire flow capacity in the western portion of the AASA even the NSA A replacement well and the Capehart storage tank booster pump. This information should be verified by field testing. Potential distribution piping improvements should be further evaluated in this area.



DATE	PROJECT	SITE
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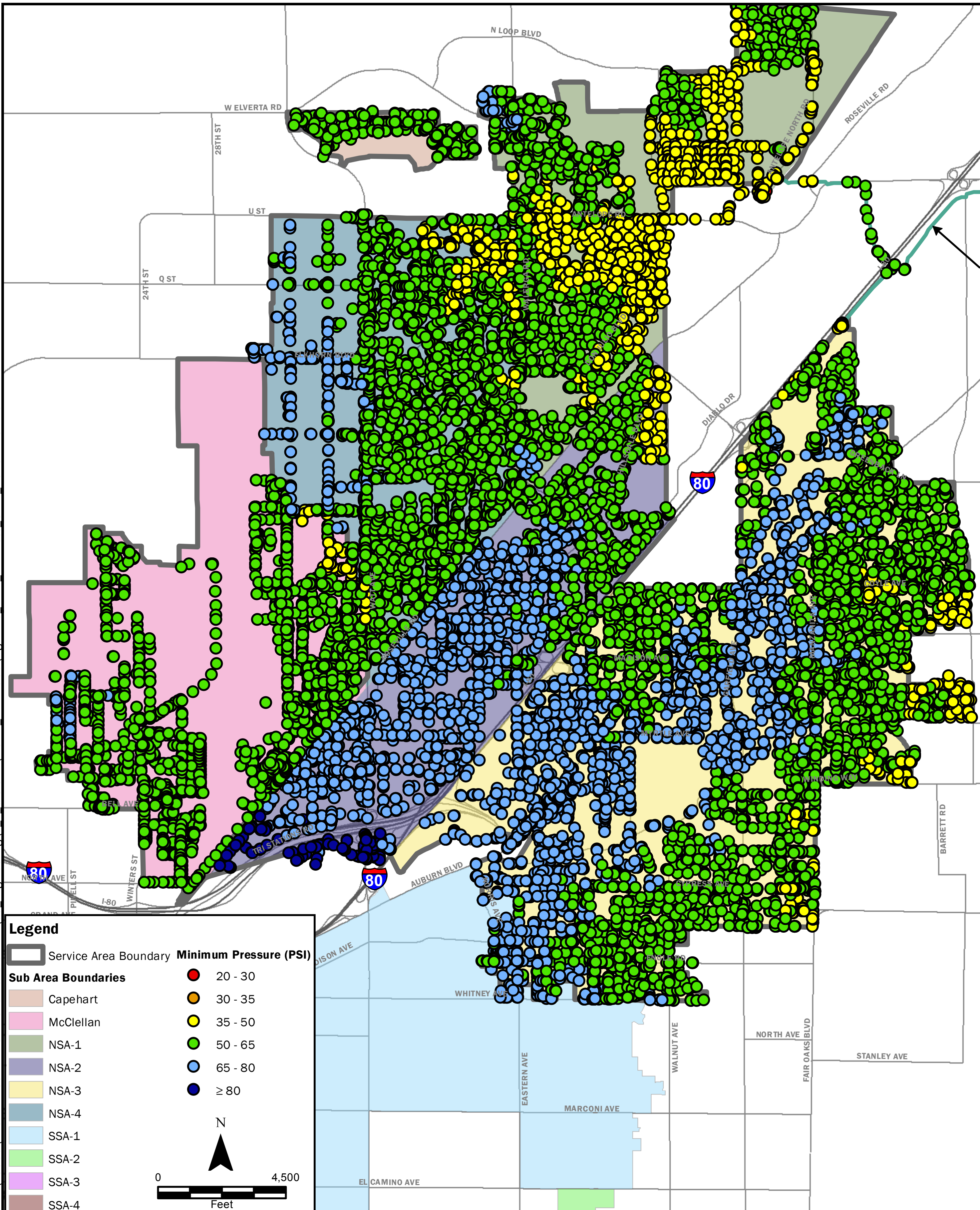
Brown AND Caldwell

TITLE

System Ground Elevation at Model Nodes

Figure 11-1

Document Path: bcsac01\\bcsacfp01\projects\48000\148171 - SSWD WSMP and 2015 UWMP\03_Engineering\3_2_GIS-CAD\WSMP_MAPDOCS\Fig11-1_NodeElevation_8x11_20170112.mxd



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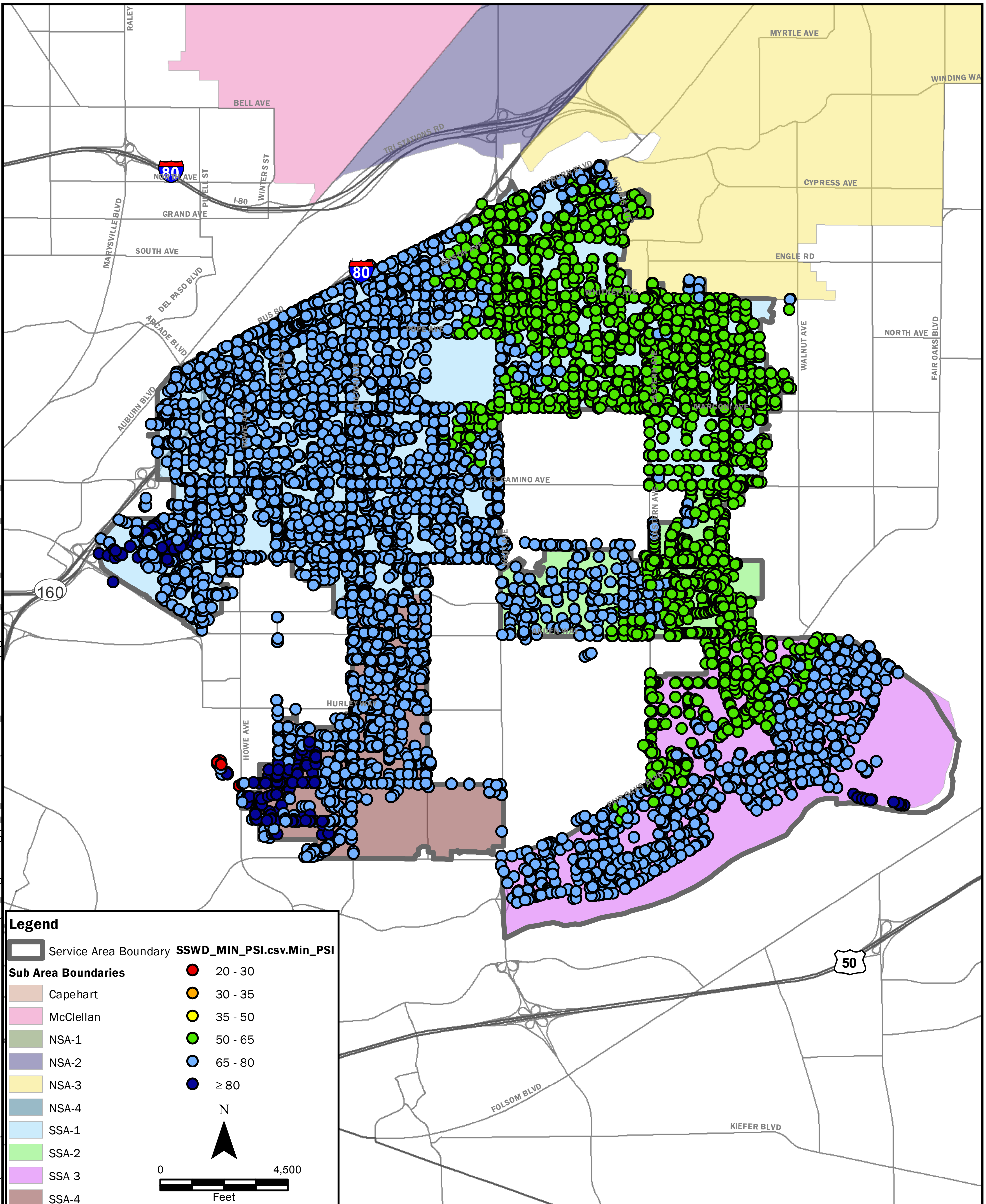
DATE	PROJECT	SITE	
3/22/17	148171	**Water System Master Plan** **Sacramento Suburban Water District**	**Figure 11-2a**
Brown AND Caldwell		TITLE **Scenario 1, All Groundwater, Existing MDD - Minimum Pressures (NSA)**	



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DATE	PROJECT
3/22/17	148171

Brown AND Caldwell

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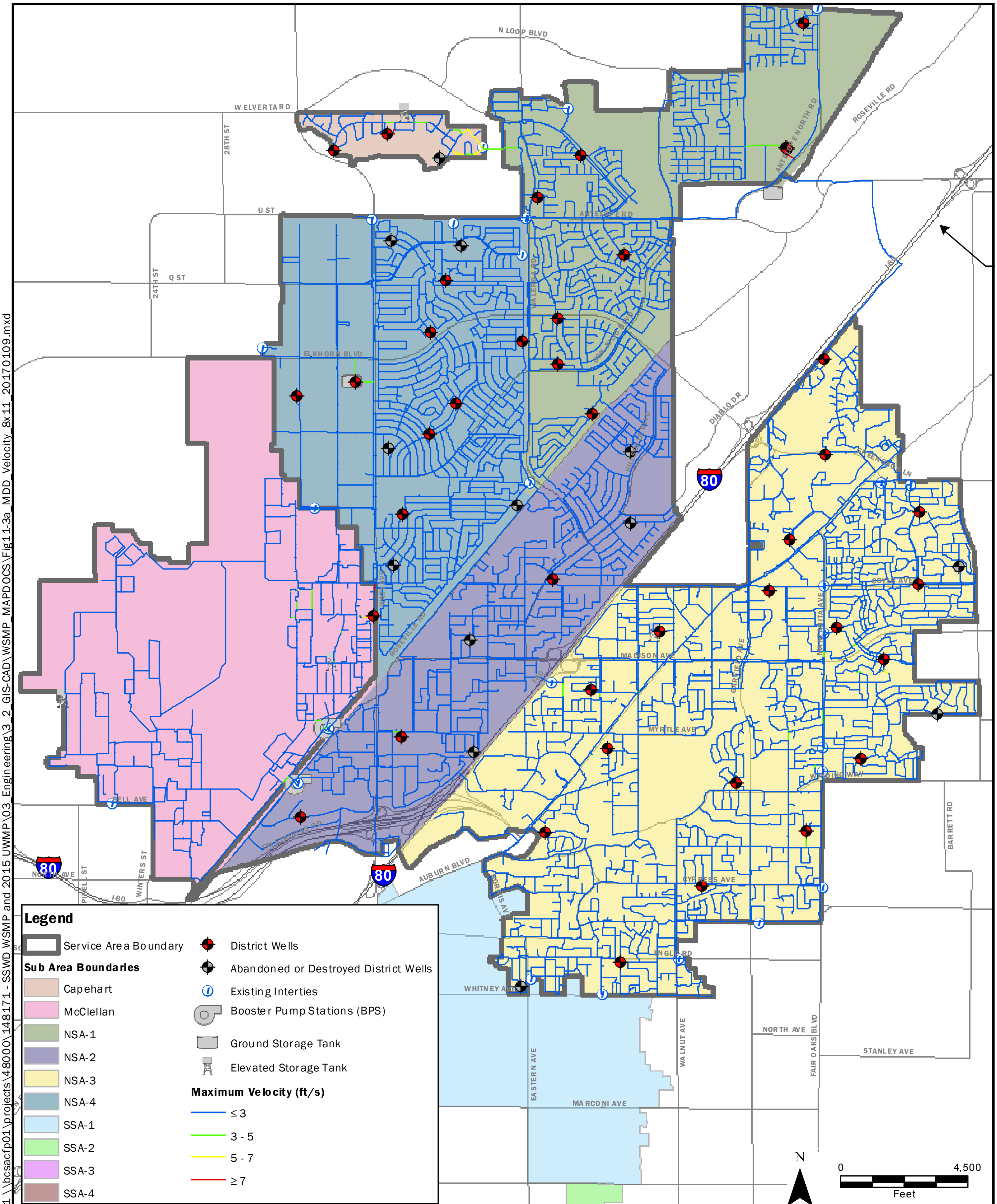
Water System Master Plan
Sacramento Suburban Water District

TITLE

Scenario 1, All Groundwater, Existing MDD - Minimum Pressures (SSA)

Figure 11-2b



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DATE	PROJECT	SITE
1/9/2017	148171	**Water System Master Plan** **Sacramento Suburban Water District**

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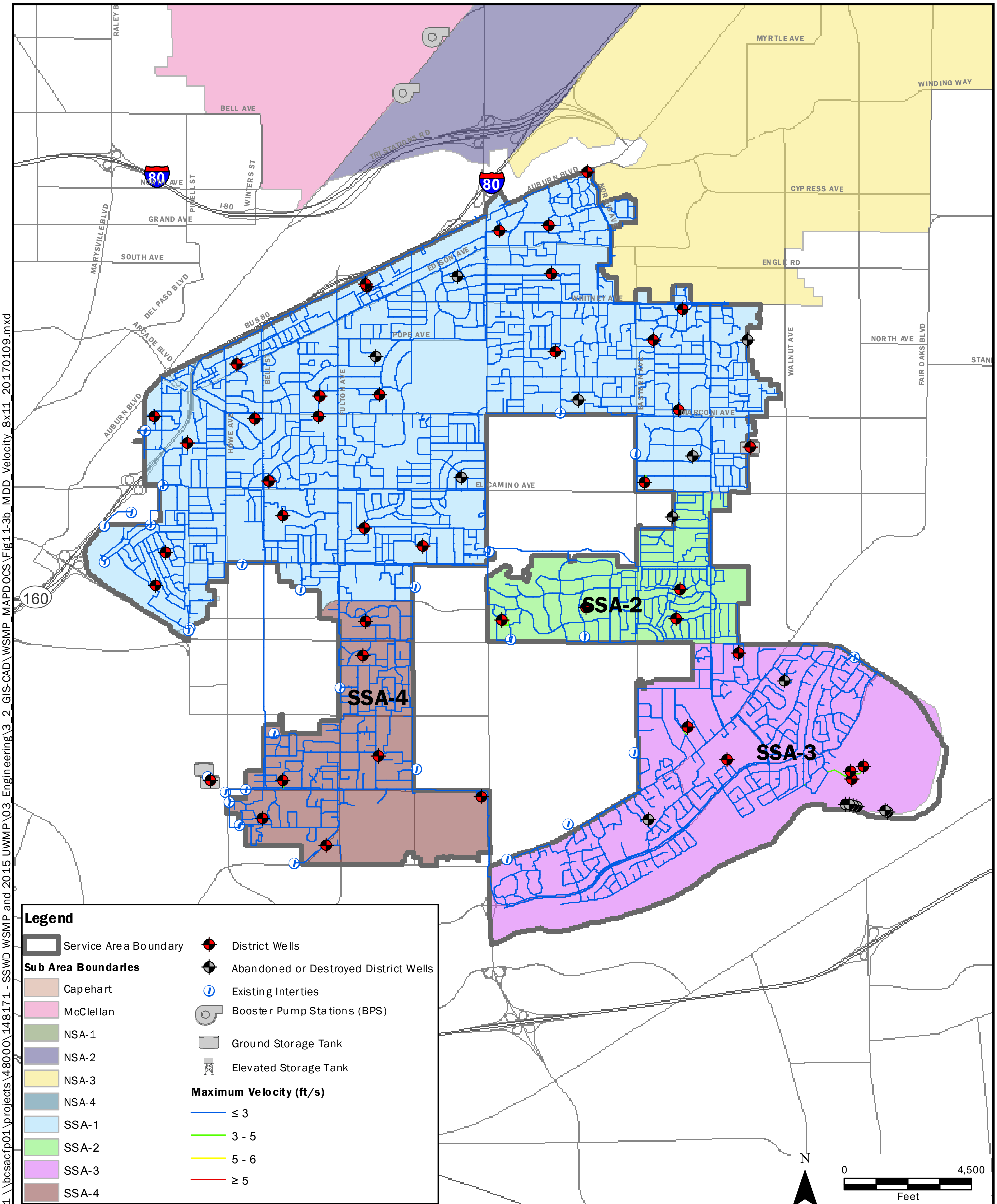
TITLE

Scenario 1, All Groundwater, Existing MDD - Maximum Velocity (NSA)

Figure 11-3a



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DATE	PROJECT
1/9/2017	148171

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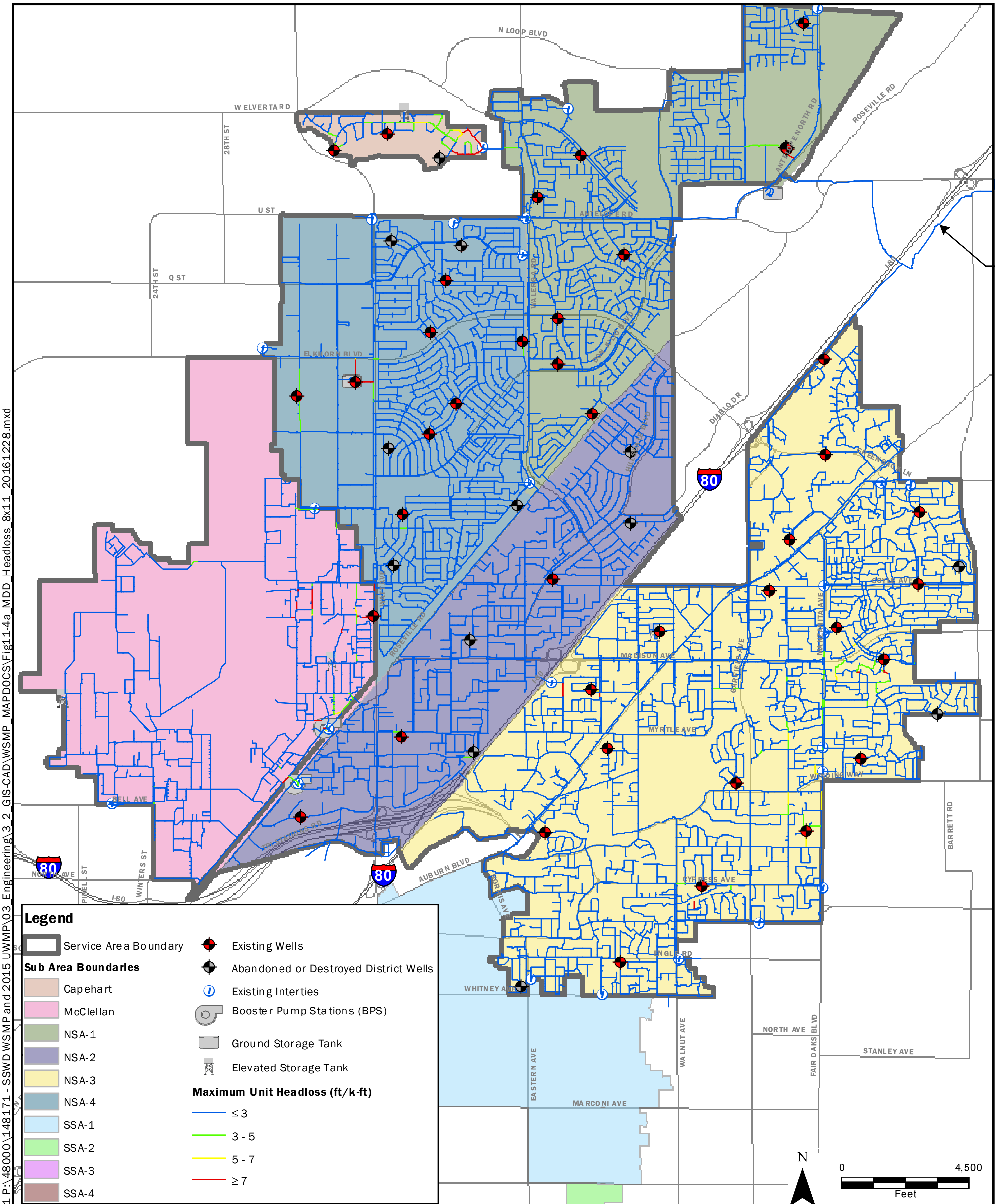
Sacramento Suburban Water District

TITLE

Scenario 1, All Groundwater, Existing MDD - Maximum Velocity (NSA)

Figure 11-3b



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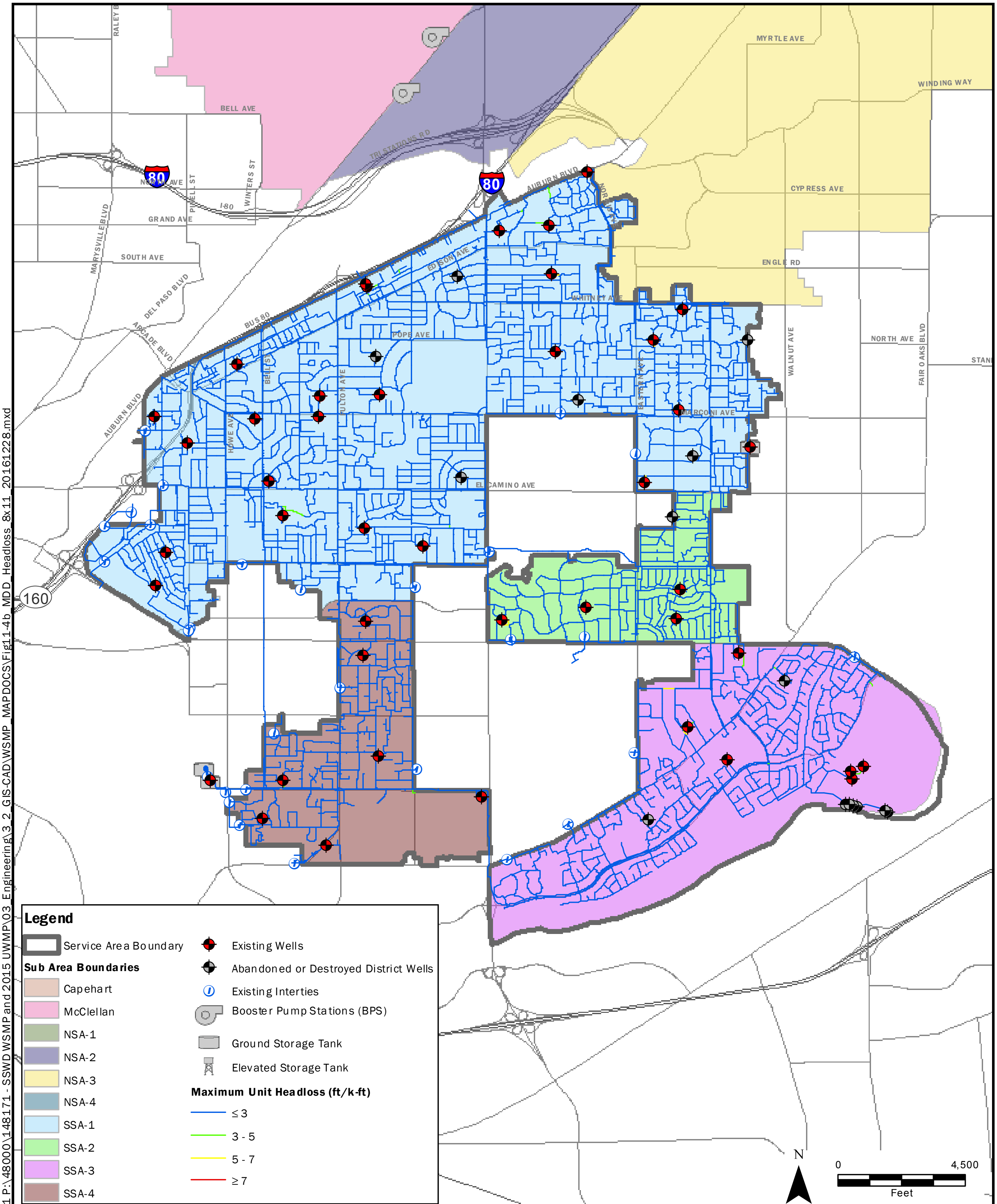
DATE	PROJECT	SITE	
1/9/2017	148171	**Water System Master Plan** **Sacramento Suburban Water District**	**Figure 11-4a**
Brown AND Caldwell		TITLE **Scenario 1, All Groundwater, Existing MDD - Maximum Unit Headloss (NSA)**	



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1/9/2017	148171

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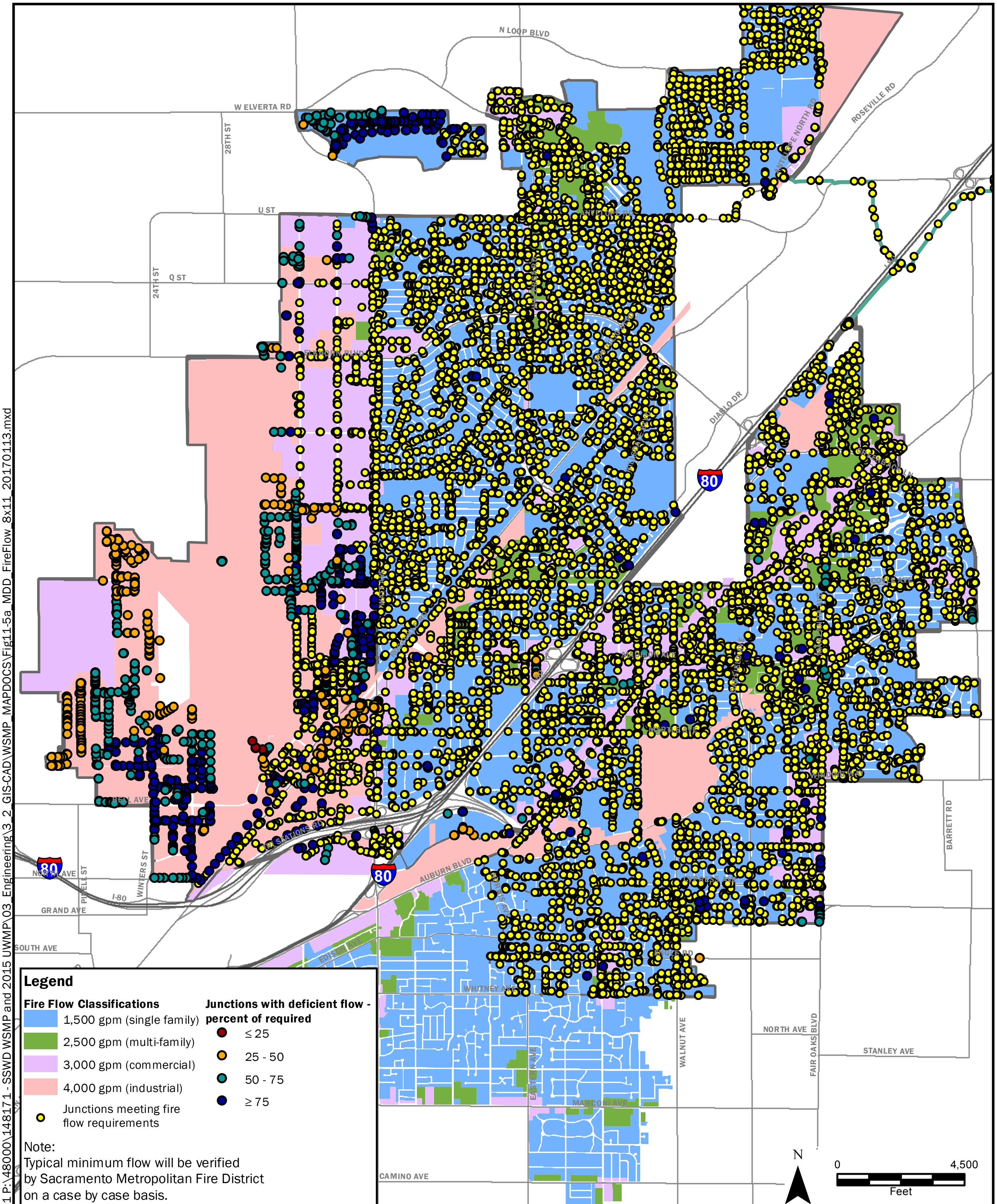
SITE

Water System Master Plan
Sacramento Suburban Water District

TITLE

Scenario 1, All Groundwater, Existing MDD - Maximum Unit Headloss (SSA)

Figure 11-4b



Document Path: bcsac01 P:\48000\148171 - SSWD WSMP and 2015 UWMP\03_Engineering\3_2_GIS-CAD\WSMP_MAPDOCS\Fig11-5a_MDD_FireFlow_8x11_20170113.mxd

DATE	PROJECT	SITE
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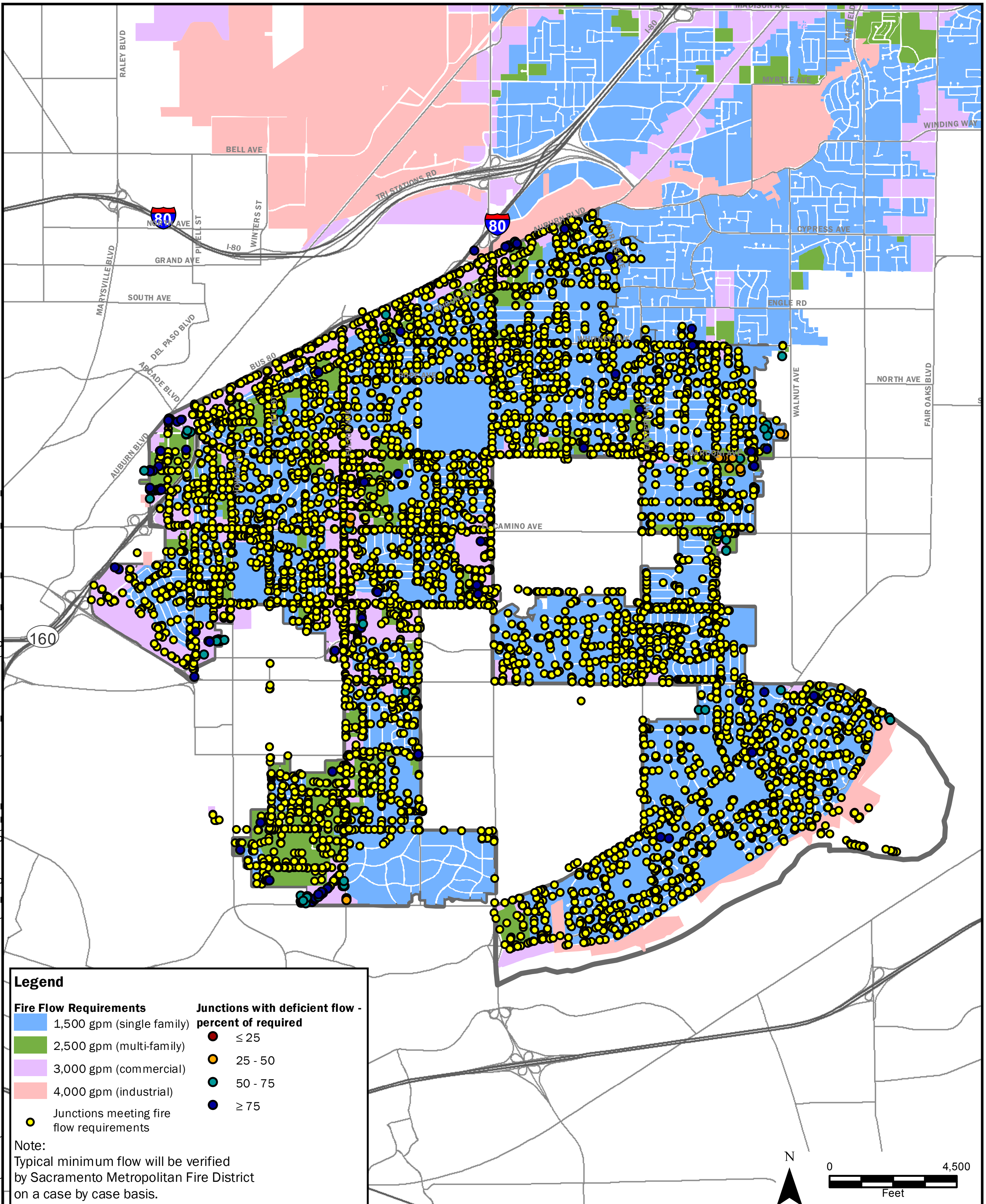
Scenario 1, All Groundwater, Existing MDD - Fire Flow (NSA)

Figure 11-5a



Legend

Fire Flow Requirements
- 1,500 gpm (single family)
- 2,500 gpm (multi-family)
- 3,000 gpm (commercial)
- 4,000 gpm (industrial)
- Junctions meeting fire flow requirements

Junctions with deficient flow - percent of required
- ≤ 25
- 25 - 50
- 50 - 75
- ≥ 75

Note:
Typical minimum flow will be verified by Sacramento Metropolitan Fire District on a case by case basis.

N

0 4,500
Feet

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DATE	PROJECT	SITE	
3/22/17	148171	**Water System Master Plan** **Sacramento Suburban Water District**	**Figure 11-5b**
Brown AND Caldwell		TITLE **Scenario 1, All Groundwater, Existing MDD - Fire Flow (SSA)**	

11.4 Buildout System Evaluation

The evaluation results by buildout scenario are described in this section. Appendix E contains the pump range information for each scenario. The pump range information documents minimum, maximum, and average flow for each the wells and pumps that are active during each of the hydraulic model scenarios.

11.4.1All Groundwater – Buildout

The buildout system, which includes the ultimate vision wells and completed backbone transmission mains as the supply source, is evaluated to identify any low pressure or high velocity areas as well as fire flow capacity within the distribution system with an all groundwater supply. As shown on Figures 11-6, 11-7, and 11-8, minimum pressures, maximum velocities, and maximum unit headlosses are maintained in most areas. Below are some observations of this existing system evaluation.

1. Service pressures – Figures 11-6a and 11-6b for the NSA and SSA, respectively, illustrate the minimum nodal pressure ranges. Service pressures remained above 35 psi in all areas of the system under maximum day demand and peak hour demand conditions.
2. Pipeline velocities – Figures 11-7a and 11-7b for the NSA and SSA, respectively, illustrate maximum pipeline velocity ranges. System pipeline velocities are predominantly under 3 fps under both maximum day and peak hour demand conditions.
3. Pipeline unit headlosses – Figures 11-8a and 11-8b for the NSA and SSA, respectively, illustrate maximum pipeline unit headlosses (feet of headloss per 1,000 LF of pipe) ranges. Most system pipelines are less than 3 ft/1,000ft. In the AASA there are pipelines in the west area that have unit headlosses greater than 7ft/1,000ft.
4. The available fire flow in the buildout system is evaluated. The hydraulic model is utilized to evaluate the available fire flow at each model junction. This available fire flow is compared to the required fire flow by parcel land use type, described in Table 11-1. As shown on Figure 11-9a and 11-9b for the NSA and SSA, respectively, there are areas of the water system where model junctions could not provide the required fire flow. In some locations there is sufficient fire flow capacity from a nearby model junction. In other locations such as the Island area in the SSA, located to the west of Highway 80, there are areas where fire flow supply may be deficient and additional supply or transmission main may be required in this location.

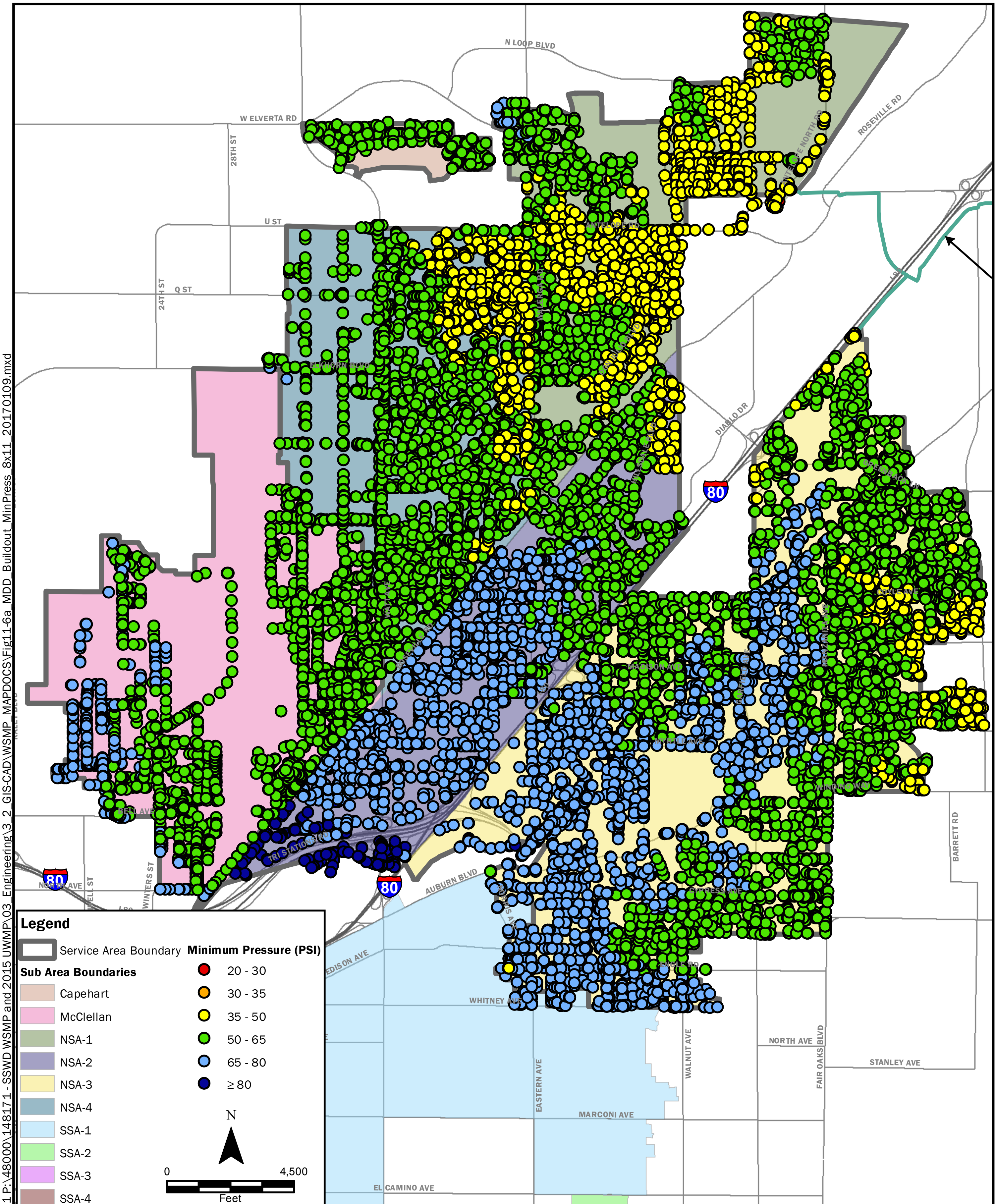
   The MBPSA in the NSA has improved fire flow capabilities compared to the existing system scenario. There are some areas that still show fire flow deficiencies. As the MBPSA master plan information becomes available the required transmission main and distribution system improvements should be refined beyond what is identified in this WSMP to address these potential fire flow deficiencies.

   For the AASA, additional fire flow is provided with the addition of New Well NSA A that is recommended for completion by 2018. Due to small distribution pipe (6-in diameter) in the AASA, there are high velocities and unit headlosses, reducing the fire flow capacity in the western portion of the AASA even the NSA A replacement well and the Capehart storage tank booster pump. This information should be verified by field testing. Potential distribution piping improvements should be further evaluated in this area.

11.4.2Maximize Surface Water – Buildout

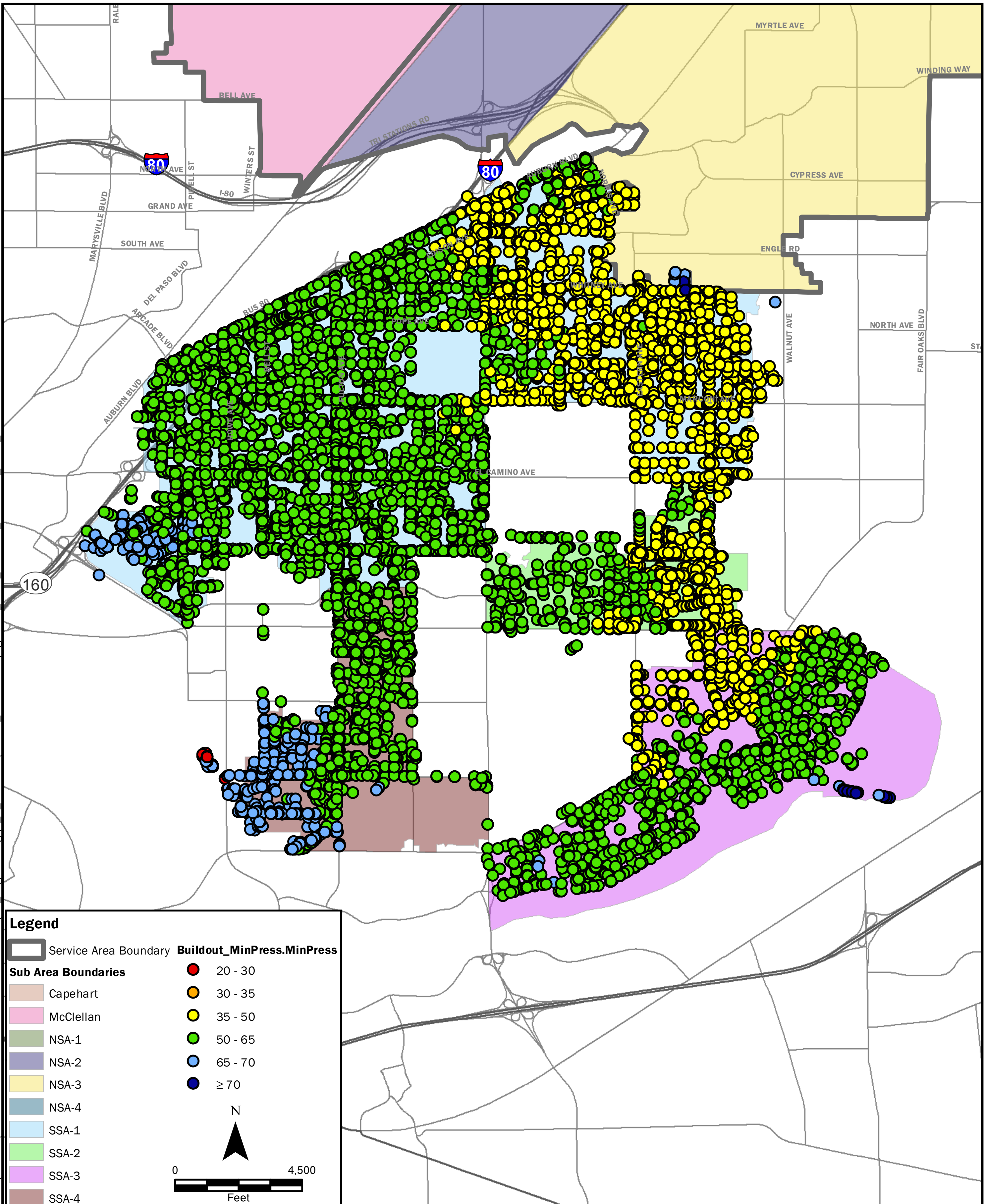
The purpose of this scenario is to evaluate the capacity of the buildout system to utilize surface water supply from others. For this Scenario 3 it is assumed surface water is supplied to the SSA from the City of Sacramento conveyed to the District near the Enterprise/Northrop pump station and to the NSA from PCWA conveyed to the District through the Cooperative Transmission Pipeline. The surface water supply available from the City of Sacramento is assumed to be limited to the instantaneous maximum flow rate of 20 MGD (13,900 gpm) as described in Section 4. The surface water supply available from PCWA is assumed to be limited to 9 MGD (6,250 gpm). Below are some observations of this scenario.

1. The District can utilize approximately 10,000 gpm of supply from the City of Sacramento in the SSA. The limiting factor are maintaining minimum pressures of 35 psi on the east side of the SSA. To maintain minimum 35 psi pressures throughout the SSA, some groundwater supply must be operated. This limits the ability to maximize surface water use in the SSA.
2. The District can utilize the full 6,250 gpm surface water supply from PCWA in the NSA.



Document Path: bcsac01 P:\48000\148171 - SSWD WSMP and 2015 UWMP\03_Engineering\3_2_GIS-CAD\WSMP_MAPDOCS\Fig11-6a_MDD_Buildout_MinPress_8x11_20170109.mxd

DATE	PROJECT	SITE	
3/22/17	148171	**Water System Master Plan** **Sacramento Suburban Water District**	**Figure 11-6a**
Brown AND Caldwell		TITLE **Scenario 2, All Groundwater, Buildout MDD - Minimum Pressure (NSA)**	



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1/9/2017	148171	Water System Master Plan Sacramento Suburban Water District

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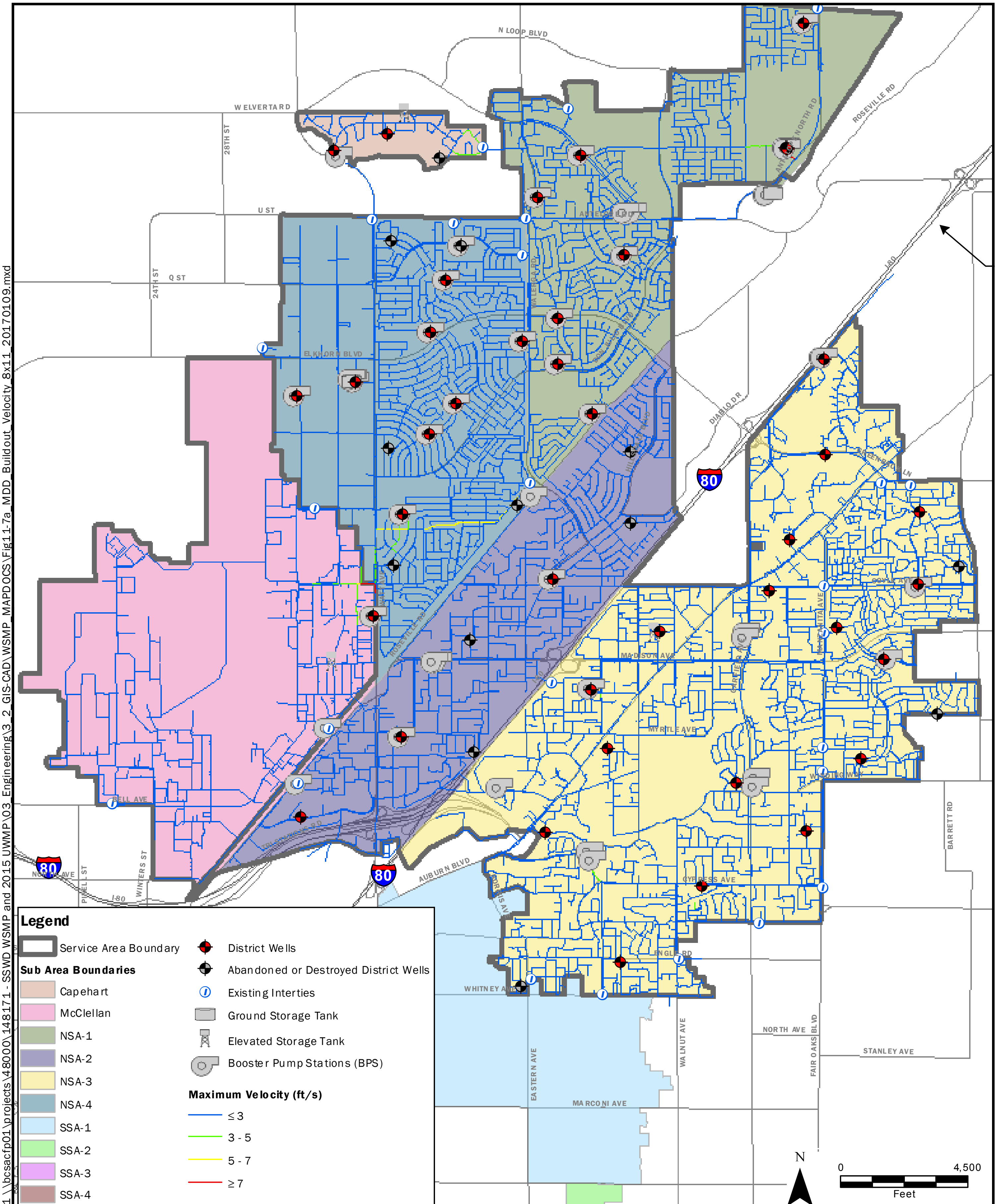
TITLE

Scenario 2, All Groundwater, Buildout MDD - Minimum Pressure(SSA)

Figure 11-6b



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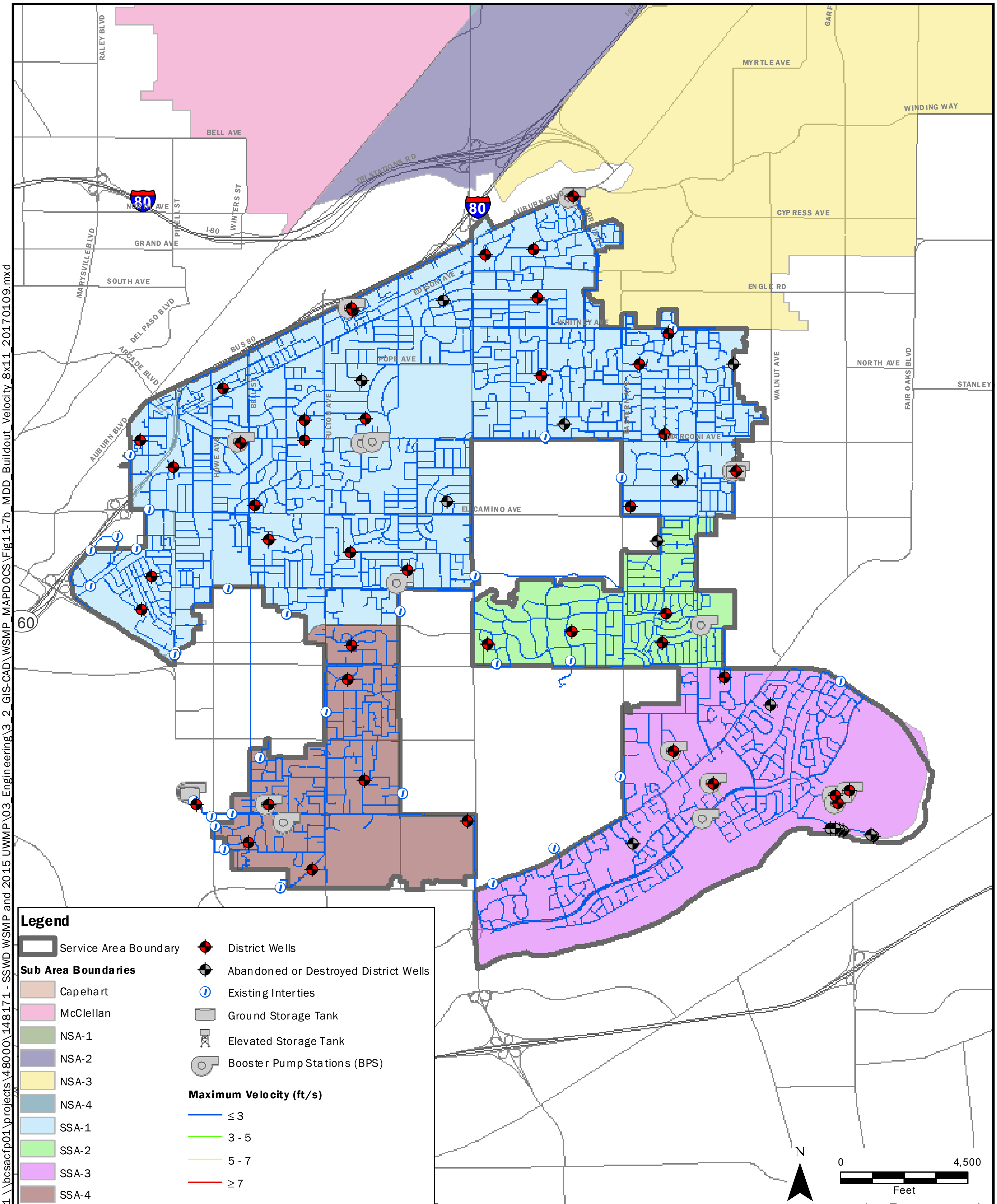
DATE	PROJECT	SITE	
1/9/2017	148171	**Water System Master Plan** **Sacramento Suburban Water District**	**Figure 11-7a**
Brown AND Caldwell		TITLE **Scenario 2, All Groundwater, Buildout MDD - Maximum Velocity (NSA)**	



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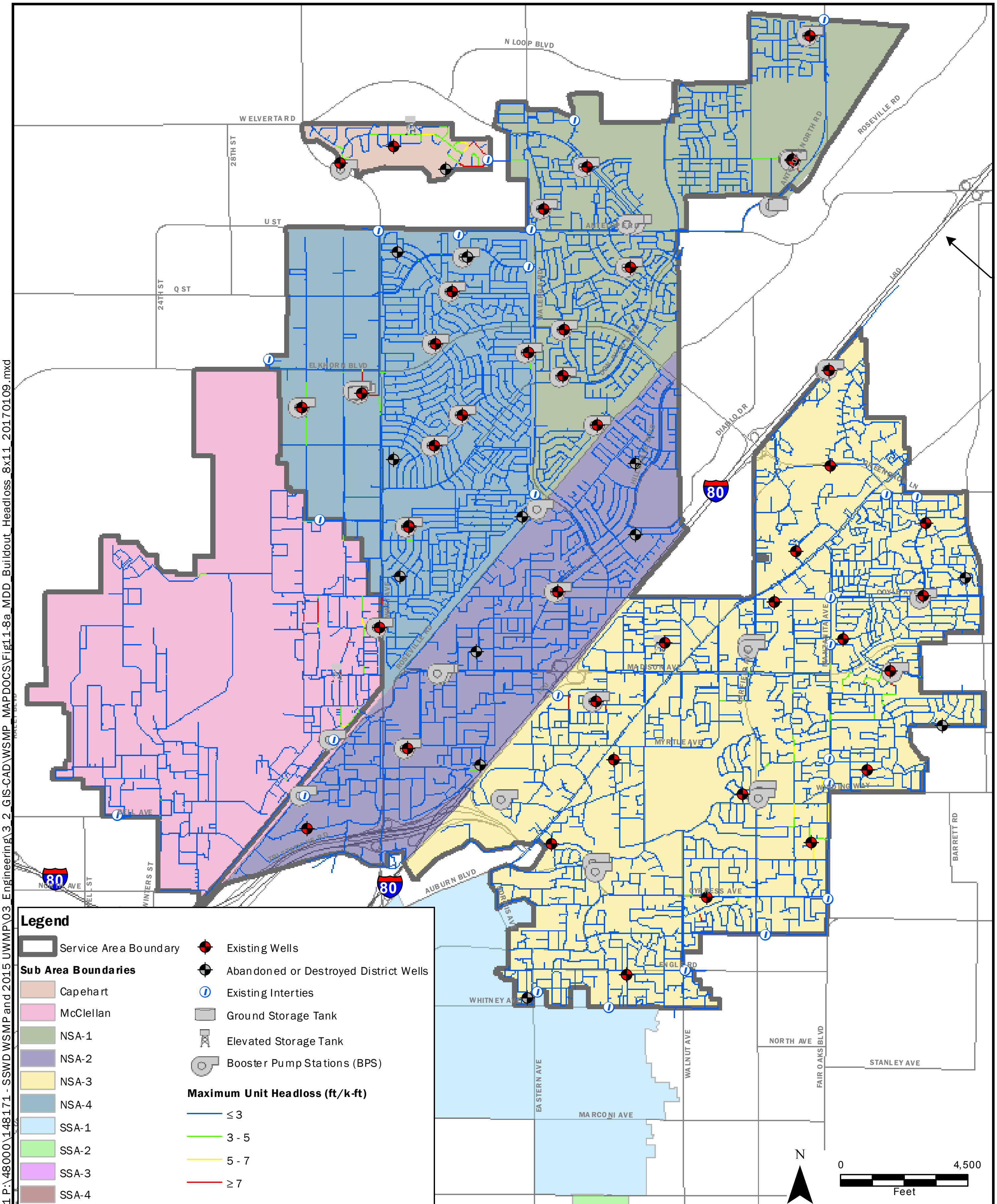
TITLE

Scenario 2, All Groundwater, Buildout MDD - Maximum Velocity (SSA)

Figure 11-7b

Document Path: bcsac01\bcsacfp01\projects\48000\148171 - SSWD WSMP and 2015 UWMP\03 Engineering\3.2 GIS-CAD\WSMP_MAPDOCS\Fig11-7b_MDD_Buildout_Velocity_8x11_20170109.mxd



Document Path: bcsac01 P:\48000\148171 - SSWD WSMP and 2015 UWMP\03 Engineering\3.2 GIS-CAD\WSMP MAPDOCS\Fig11-8a MDD Buildout Headloss 8x11 20170109.mxd

DATE	PROJECT	SITE
1/9/2017	148171	Water System Master Plan Sacramento Suburban Water District

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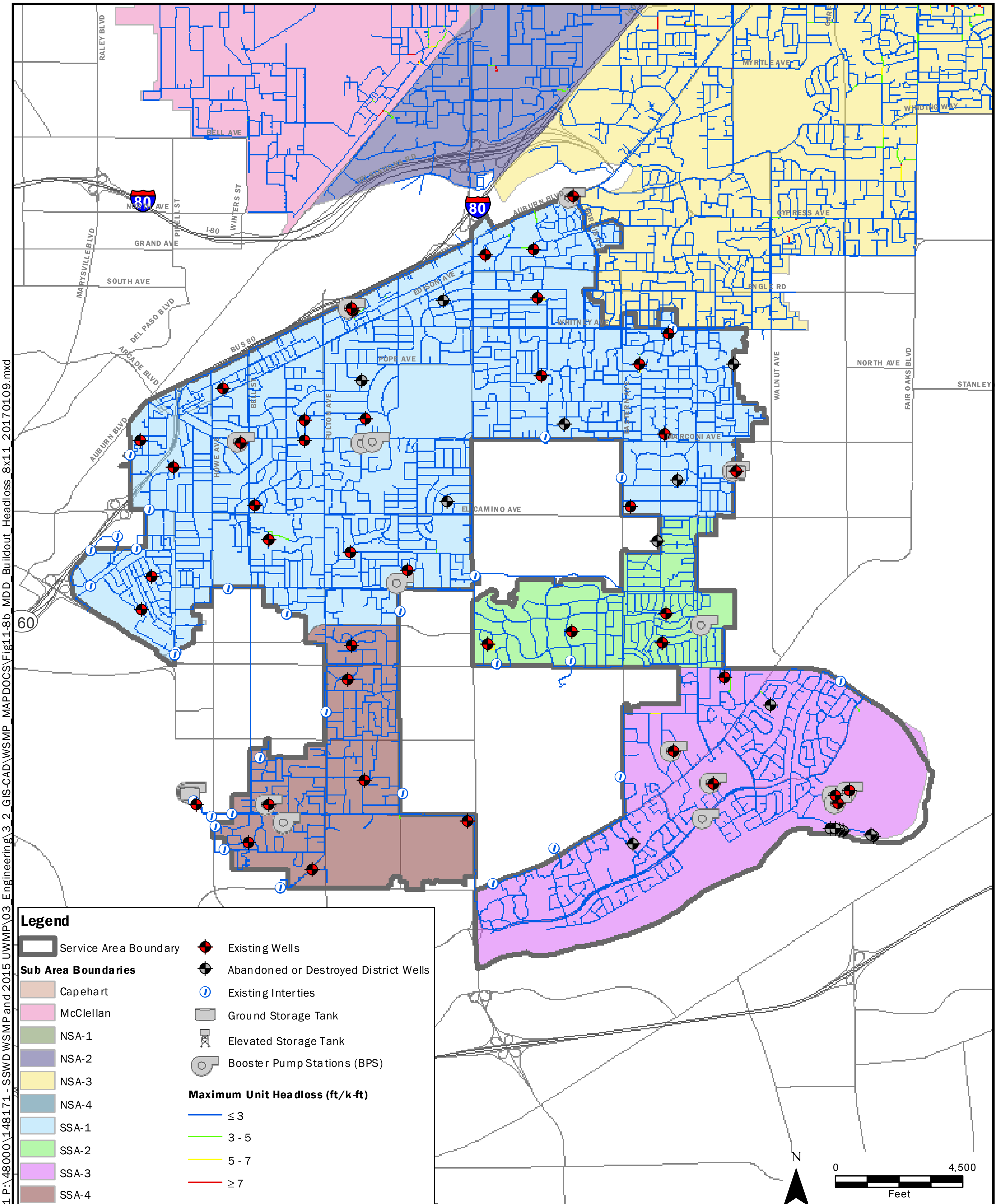
TITLE

Scenario 2, All Groundwater, Buildout MDD - Maximum Headloss (NSA)

Figure 11-8a



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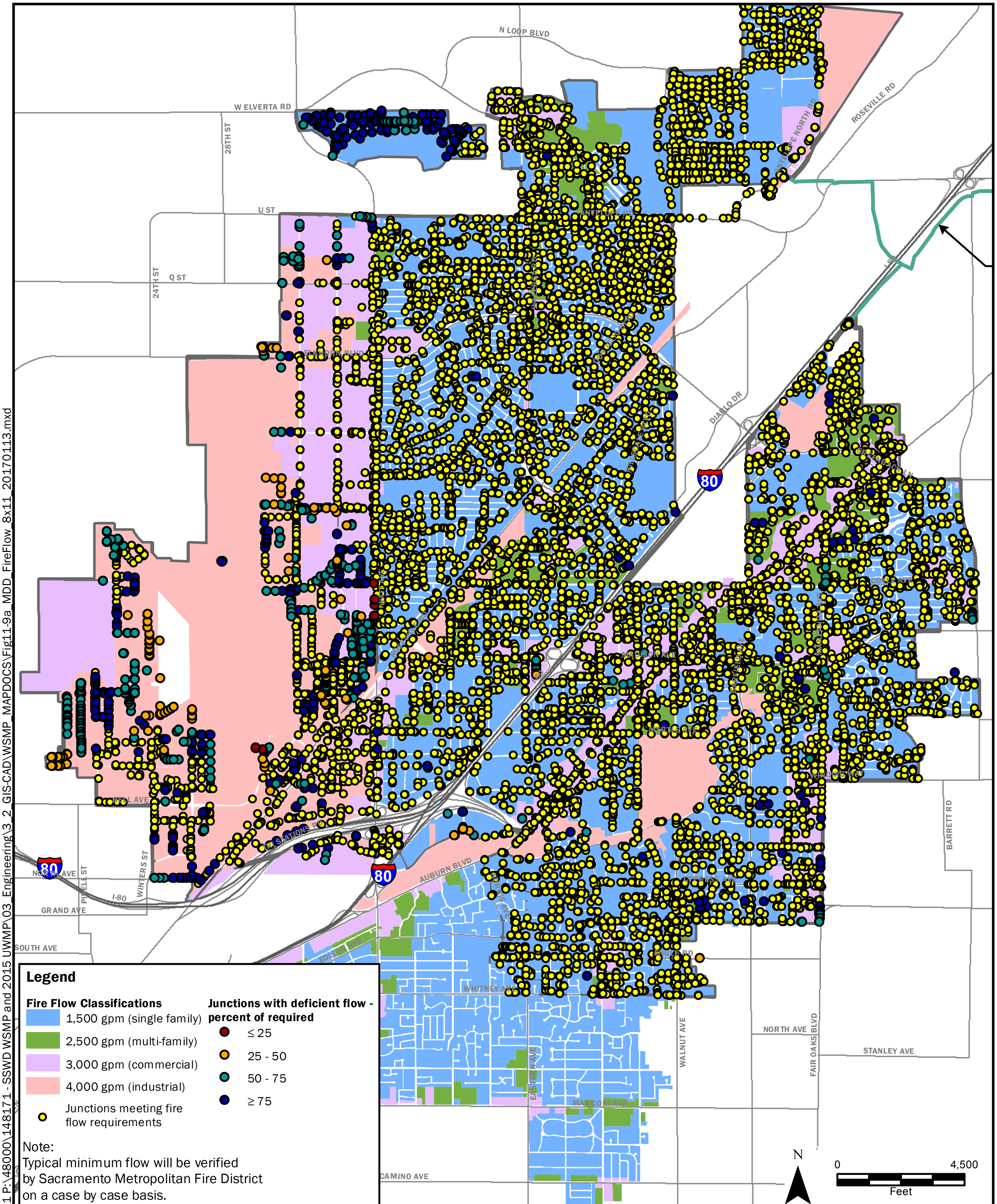
Scenario 2, All Groundwater, Buildout MDD - Maximum Headloss (SSA)

Figure 11-8b

Document Path: bcsac01 P:\48000\148171 - SSWD WSMP and 2015 UWMP\03_Engineering\3_2_GIS-CAD\WSMP_MAPDOCS\Fig11-8b_MDD_Buildout_Headloss_8x11_20170109.mxd



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DATE	PROJECT	SITE
3/22/17	148171	**Water System Master Plan** **Sacramento Suburban Water District**

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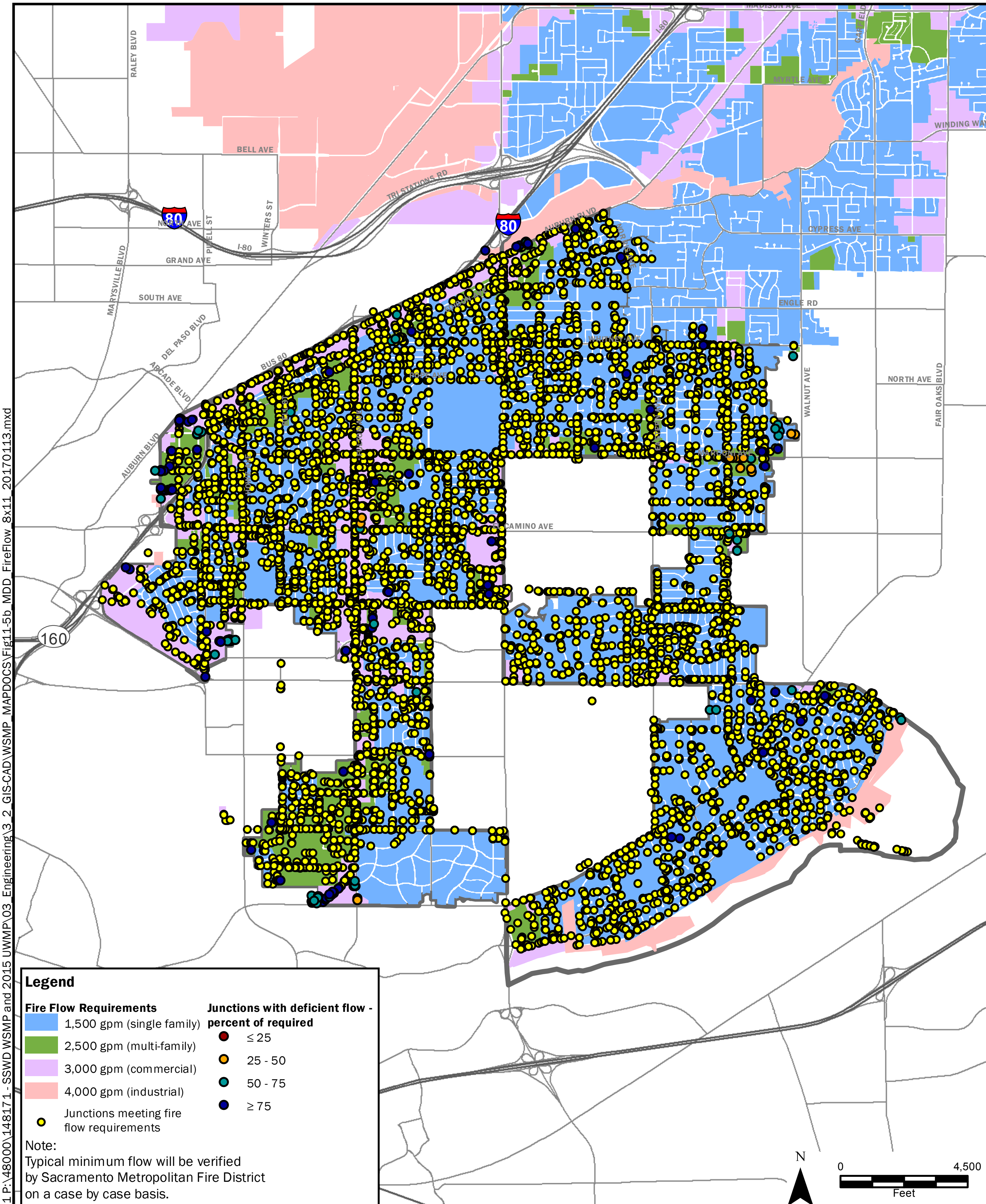
TITLE

Scenario 2, All Groundwater, Buildout MDD - Fire Flow (NSA)

Figure 11-9a



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DATE	PROJECT	SITE	
3/22/17	148171	**Water System Master Plan** **Sacramento Suburban Water District**	**Figure 11-9b**
Brown AND Caldwell		TITLE **Scenario 2, All Groundwater, Buildout MDD - Fire Flow (SSA)**	

Section 12

Capital Improvement Plan

This section presents a capital needs analysis for a 15-year period from 2017 through 2031. It is intended to be used as a planning tool for the development of the District's capital improvement plan (CIP).

Strategic Plan Alignment

Facilities and Operations – 2.A.-The District will utilize appropriate planning tools, identify financial resources necessary, and prioritize system requirements to protect and maintain District assets and attain water resource objectives incorporating resource sustainability and lifecycle cost analysis into the framework.

- **CIP developed to include budget for maintaining District assets**

Finance – 4.H. -Produce and monitor an annual budget for system operations, maintenance and replacements.

- **CIP provides budget for system maintenance and replacements.**

Policy Implications

- **Recommended 15-year CIP.**
- **CIP developed to optimize the maintenance and replacement of the District's key water system assets.**
- **Shift of budget from replacing pipelines to replacing wells.**

12.1 Ultimate System Configuration

The ultimate system vision in shown on Figure 12-1. The District has three major actions to complete to implement the ultimate system vision:

1. Complete the Meter Installation Program – to be completed by 2022 to meet Water Forum and State Law requirements.
2. Complete the transmission main backbone – to enable the District to meet demands throughout the system with a more centralized supply system and less supply facilities.
3. Continue to consolidate the number of well sites – to reduce O&M costs and enable cost efficient centralized treatment in the future, as necessary.

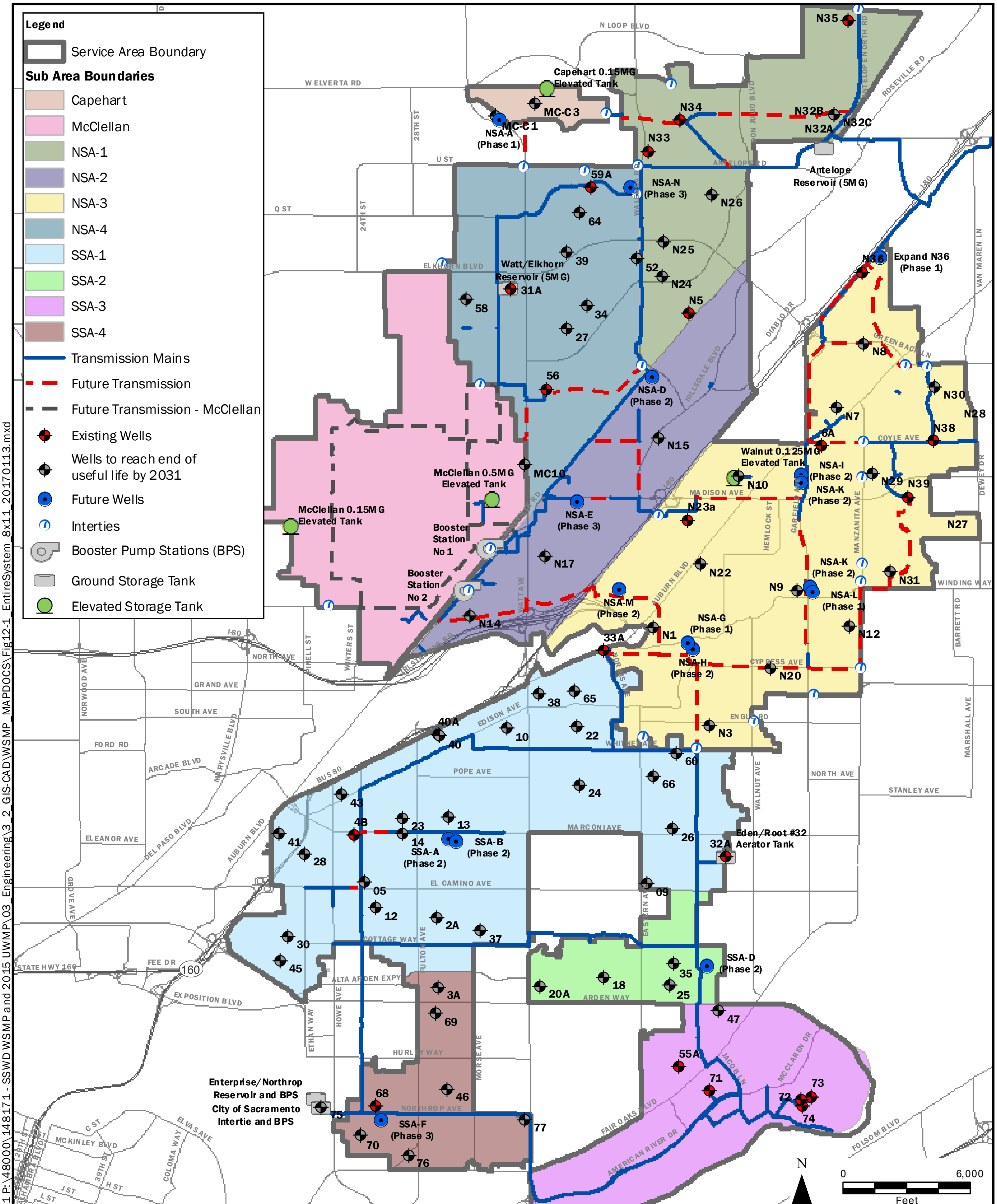
Table 12-1 compares the 2016 length of backbone transmission pipe (greater than or equal to 16-in diameter) and the recommended ultimate length of backbone transmission pipe. New backbone transmission pipeline will result in a 40 percent increase in the amount of transmission pipeline in the overall system. There is a dual purpose for the transmission main backbone system to connect the subareas within the District service area to enable the District to meet demands in all part of the system with increased localized reliability as well as to provide an opportunity for interagency cooperation and regional reliability.

Table 12-1. Increase in Backbone Transmission Pipeline			
	Length of Backbone Pipe, LF		% Increase
	2016	Ultimate	
NSA	113,000	204,000	80%
SSA	117,000	118,000	2%
Total	230,000	322,000	40%

The District will continue to consolidate the number of well sites with the majority of the wells being larger production wells. Additional land acquisition for the replacement wells with space for treatment is required. The well locations will be near the transmission main or clustered near treatment locations, dependent upon land acquisition opportunities.

12.2 15–Year Project List

The District’s capital needs for a 15-year period from 2017 through 2031 is based on the recommendations in this WSMP. Figure 12-2 illustrates the annual costs of projected capital projects (in 2016 dollars). On this figure the annual costs are illustrated, broken down by the five CIP categories: supply, transmission, distribution, storage, and special projects. Also shown are the District’ debt service costs. Table 12-2 provides the annual costs by project in 2016 dollars. Also shown is the District’s past CIP spending for 2014, 2015, and 2016 as well as future CIP budget for 2017 and 2018. A table showing the annual costs by project and escalated at 3 percent per year is provided in Appendix D.



DATE	PROJECT	SITE
3/21/17	148171	

Water System Master Plan
Sacramento Suburban Water District

TITLE

Ultimate System Vision

Figure 12-1

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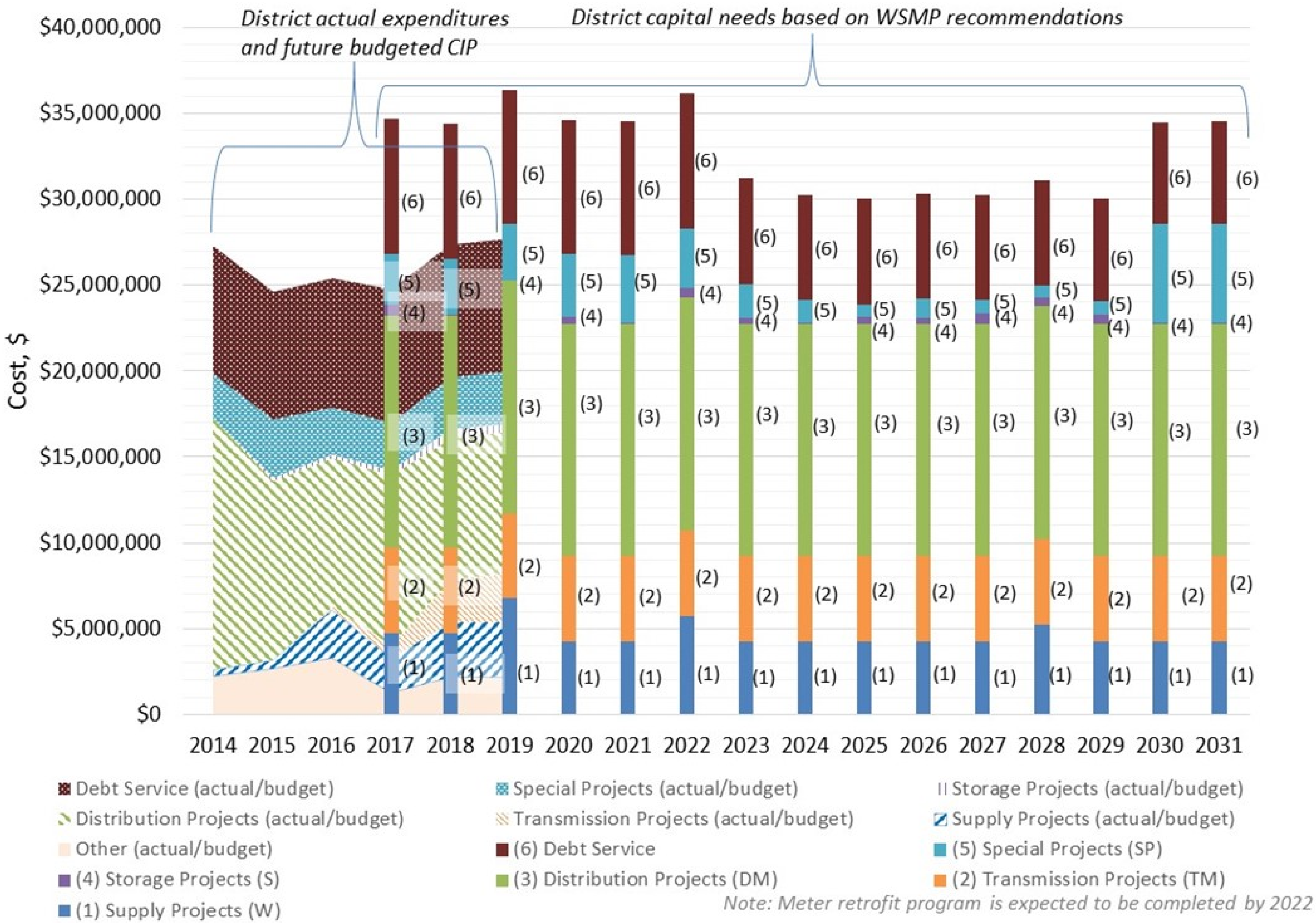

Figure 12-2. Capital Needs Assessment Total Annual Costs (Non-Escalated)

Table 12-2. Capital Needs Assessment Annual Cost (Non-Escalated)																
Project number	Project name	Project total ($)	2017 ($)	2018 ($)	2019 ($)	2020 ($)	2021 ($)	2022 ($)	2023 ($)	2024 ($)	2025 ($)	2026 ($)	2027 ($)	2028 ($)	2029 ($)	2030 ($)	2031 ($)
Supply Projects																	
W-Replace-01	Replacement Wells	52,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000	3,500,000
W-Land-01	Replacement Well Land Acquisition	6,000,000	500,000	500,000	2,500,000	-	-	1,500,000	-	-	-	-	-	1,000,000	-	-	-
W-Destroy-01	Well Site Destruction	5,205,000	347,000	347,000	347,000	347,000	347,000	347,000	347,000	347,000	347,000	347,000	347,000	347,000	347,000	347,000	347,000
W-Rehab-01	Well Light and Heavy Rehab	6,060,000	404,000	404,000	404,000	404,000	404,000	404,000	404,000	404,000	404,000	404,000	404,000	404,000	404,000	404,000	404,000
	Supply Projects Subtotal	69,765,000	4,751,000	4,751,000	6,751,000	4,251,000	4,251,000	5,751,000	4,251,000	4,251,000	4,251,000	4,251,000	4,251,000	5,251,000	4,251,000	4,251,000	4,251,000
	Supply Projects Cumulative Subtotal		4,751,000	9,502,000	16,253,000	20,504,000	24,755,000	30,506,000	34,757,000	39,008,000	43,259,000	47,510,000	51,761,000	57,012,000	61,263,000	65,514,000	69,765,000
Transmission Projects																	
TM-New-01	New Transmission Mains	66,960,000	4,464,000	4,464,000	4,464,000	4,464,000	4,464,000	4,464,000	4,464,000	4,464,000	4,464,000	4,464,000	4,464,000	4,464,000	4,464,000	4,464,000	4,464,000
TM-Replace-01	Transmission Mains Replacement	7,665,000	511,000	511,000	511,000	511,000	511,000	511,000	511,000	511,000	511,000	511,000	511,000	511,000	511,000	511,000	511,000
	Transmission Projects Subtotal	74,625,000	4,975,000	4,975,000	4,975,000	4,975,000	4,975,000	4,975,000	4,975,000	4,975,000	4,975,000	4,975,000	4,975,000	4,975,000	4,975,000	4,975,000	4,975,000
	Transmission Projects Cumulative Subtotal		4,975,000	9,950,000	14,925,000	19,900,000	24,875,000	29,850,000	34,825,000	39,800,000	44,775,000	49,750,000	54,725,000	59,700,000	64,675,000	69,650,000	74,625,000
Distribution Projects																	
DM-Replace-01	Distribution Mains Replacement	202,890,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000
	Distribution Projects Subtotal	202,890,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000	13,526,000
	Distribution Projects Cumulative Subtotal		13,526,000	27,052,000	40,578,000	54,104,000	67,630,000	81,156,000	94,682,000	108,208,000	121,734,000	135,260,000	148,786,000	162,312,000	175,838,000	189,364,000	202,890,000
Storage Projects																	
S-Destroy-01	Remove MBP Elevated Tank#216	200,000	-	-	-	200,000	-	-	-	-	-	-	-	-	-	-	-
S-Destroy-02	Remove MBP Elevated Tank#769	200,000	-	-	-	200,000	-	-	-	-	-	-	-	-	-	-	-
S-RR-01	Antelope Ground Reservoir - BPS	1,150,000	-	-	-	-	-	-	-	-	-	-	600,000	-	550,000	-	-
S-RR-02	Capehart Elevated Tank	300,000	-	-	-	-	-	-	300,000	-	-	-	-	-	-	-	-
S-RR-03	Enterprise/Northrop Ground Reservoir - BPS	550,000	-	-	-	-	-	550,000	-	-	-	-	-	-	-	-	-
S-RR-06	Walnut Yard Elevated Tank	300,000	-	-	-	-	-	-	-	-	-	300,000	-	-	-	-	-
S-RR-07	Watt/Elkhorn Ground Reservoir - BPS	1,030,000	550,000	-	-	-	-	-	-	-	-	-	-	480,000	-	-	-
S-RR-08	McClellan BPS #1	240,000	-	-	-	-	-	-	-	-	240,000	-	-	-	-	-	-
S-RR-09	McClellan BPS #2	120,000	-	-	-	-	-	-	-	-	120,000	-	-	-	-	-	-
S-RR-10	Inspections and Cleaning	300,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
Storage Projects (continued)																	
	Storage Projects Subtotal	4,390,000	570,000	20,000	20,000	420,000	20,000	570,000	320,000	20,000	380,000	320,000	620,000	500,000	570,000	20,000	20,000
	Storage Projects Cumulative Subtotal		570,000	590,000	610,000	1,030,000	1,050,000	1,620,000	1,940,000	1,960,000	2,340,000	2,660,000	3,280,000	3,780,000	4,350,000	4,370,000	4,390,000

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Table 12-2. Capital Needs Assessment Annual Cost (Non-Escalated)																	
Project number	Project name	Project total ($)	2017 ($)	2018 ($)	2019 ($)	2020 ($)	2021 ($)	2022 ($)	2023 ($)	2024 ($)	2025 ($)	2026 ($)	2027 ($)	2028 ($)	2029 ($)	2030 ($)	2031 ($)
Special Projects																	
SCADA																	
SP-SCADA-S2	Radio Replacement Pilot Study	135,000	-	-	-	121,000	14,000	-	-	-	-	-	-	-	-	-	-
SP-SCADA-S3	ODMS Readiness Assessment	31,000	31,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SP-SCADA-S4	HMI Evaluation	47,000	-	47,000	-	-	-	-	-	-	-	-	-	-	-	-	-
SP-SCADA-S5	Optimization Feasibility Analysis	25,000	2,000	23,000	-	-	-	-	-	-	-	-	-	-	-	-	-
SP-SCADA-S6	SCADA System Documentation Upgrade	43,000	-	43,000	-	-	-	-	-	-	-	-	-	-	-	-	-
SP-SCADA-S7	Alarm Management Plan	45,000	-	45,000	-	-	-	-	-	-	-	-	-	-	-	-	-
SP-SCADA-S9	SCADA Governance Implementation	46,000	-	46,000	-	-	-	-	-	-	-	-	-	-	-	-	-
SP-SCADA-L1	SCADA System completion	100,000	100,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SP-SCADA-L2	RTU Upgrade Program	3,000,000	-	-	-	600,000	600,000	600,000	600,000	600,000	-	-	-	-	-	-	-
SP-SCADA-L3	HMI Upgrade	494,000	-	-	-	-	494,000	-	-	-	-	-	-	-	-	-	-
SP-SCADA-L4	Standards Expansion	28,000	-	-	28,000	-	-	-	-	-	-	-	-	-	-	-	-
SP-SCADA-L5	ODMS Implementation	212,000	-	-	212,000	-	-	-	-	-	-	-	-	-	-	-	-
SP-SCADA-01	Communication Equipment	500,000	-	250,000	250,000	-	-	-	-	-	-	-	-	-	-	-	-
SP-SCADA-02	Data Management Plan	100,000	-	-	-	100,000	-	-	-	-	-	-	-	-	-	-	-
SP-SCADA RR-01	Ongoing SCADA R/R	3,000,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000
	SCADA Subtotal	7,806,000	333,000	654,000	690,000	1,021,000	1,308,000	800,000	800,000	800,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000
Buildings and Structures																	
SP-Buildings RR-01	Buildings and Structures R/R	1,306,000	47,000	-	-	5,000	29,000	7,000	634,000	5,000	7,000	384,000	11,000	13,000	38,000	53,000	73,000
SP-Buildings RR-02	Admin/Opps Facility Bldg. Replacement	10,000,000	-	-	-	-	-	-	-	-	-	-	-	-	-	5,000,000	5,000,000
	Buildings and Structures Subtotal	11,306,000	47,000	-	-	5,000	29,000	7,000	634,000	5,000	7,000	384,000	11,000	13,000	38,000	5,053,000	5,073,000
Meters																	
SP-Meter Retrofit-01	Water Meters Retrofits	12,552,000	2,092,000	2,092,000	2,092,000	2,092,000	2,092,000	2,092,000	-	-	-	-	-	-	-	-	-
SP-Meter RR-01	Water Meters Replacements	7,950,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000
	Meters Subtotal	20,502,000	2,622,000	2,622,000	2,622,000	2,622,000	2,622,000	2,622,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000	530,000
	Special Projects subtotal	39,614,000	3,002,000	3,276,000	3,312,000	3,648,000	3,959,000	3,429,000	1,964,000	1,335,000	737,000	1,114,000	741,000	743,000	768,000	5,783,000	5,803,000
	Special Project Cumulative Subtotal		3,002,000	6,278,000	9,590,000	13,238,000	17,197,000	20,626,000	22,590,000	23,925,000	24,662,000	25,776,000	26,517,000	27,260,000	28,028,000	33,811,000	39,614,000
Debt Service																	
Debt-1	Debt payments	101,673,000	7,825,000	7,824,000	7,783,000	7,818,000	7,823,000	7,899,000	6,173,000	6,154,000	6,158,000	6,136,000	6,163,000	6,126,000	5,923,000	5,942,000	5,926,000
All projects (non-escalated)																	
	Total	391,284,000	34,649,000	34,372,000	36,367,000	34,638,000	34,554,000	36,150,000	31,209,000	30,261,000	30,027,000	30,322,000	30,276,000	31,121,000	30,013,000	34,497,000	34,501,000
	Cumulative total		34,649,000	69,021,000	105,388,000	140,026,000	174,580,000	210,730,000	241,939,000	272,200,000	302,227,000	332,549,000	362,825,000	393,946,000	423,959,000	458,456,000	492,957,000

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12.3 15-year Recommended Projects by CIP Category

Most of the District's capital improvement expenditures are a result of R/R of existing assets with some projects for new infrastructure recommendations. All recommended expenditures are based on the assumptions described in Sections 6, 7, 8, 9, and 10 of this WSMP. The projects within each of the five CIP categories as well as the key assumptions for each project are summarized in this section.

12.3.1Supply Projects

Projects in this category are related to the District's water supply infrastructure for groundwater wells. A graph of the annual costs in 2016 dollars is shown on Figure 12-3. Table 12-3 provides a list of the supply projects along with the key assumptions used to develop planning level costs for these projects.

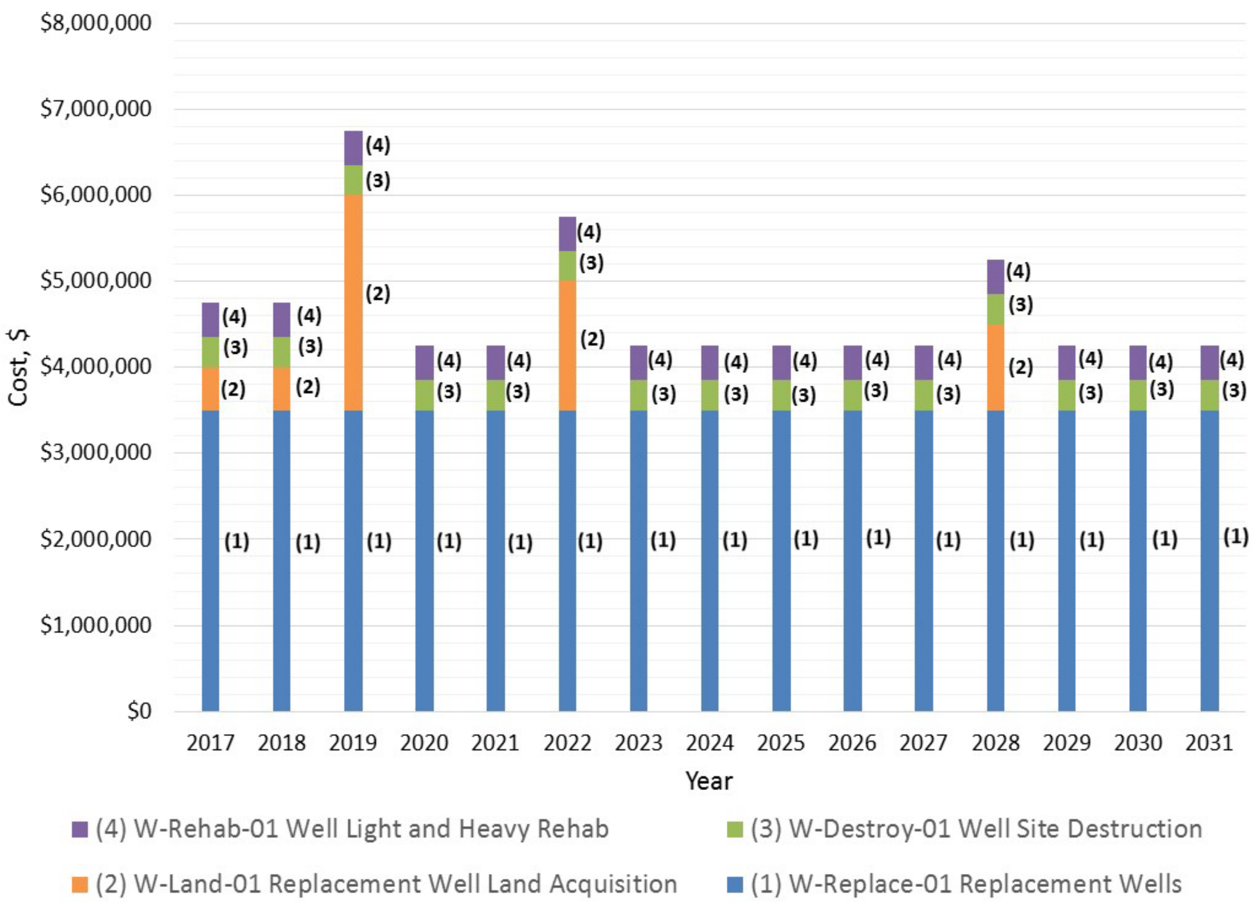

Figure 12-3. Capital Needs Analysis Supply Projects Annual Cost

Table 12-3. Supply Projects and Assumptions		
Project No.	**Project Name**	**Assumptions**
W-replacement-01	Replacement wells	• Replacement useful life 50 to 70 years. • Design, drill well = $1 mil (Year 1). • Build pump station, equip well, treatment as necessary, $2million to $4million (Year 2). • Refer to Section 6 for analysis.
W-land-01	Replacement well land acquisition	• $500,000 per well site. • Land acquisition will occur in three phases.
W-destroy-01	Well site destruction	• $100,000 per well site. • CIP shows average annual cost of well site destruction over 15-year CIP period.
W-rehab-01	Well light and heavy rehabilitation	• Light rehab (every 14 years) • Downhole - $25,000 • Well pump - $50,000 • Heavy rehab (every 14 years) • Downhole - $75,000 • Well pump - $90,000 • CIP shows average annual cost of well light and heavy rehab recommended activities over the 15-year CIP period.

12.3.2Transmission Projects

Projects in this category are related to the District's transmission pipe infrastructure. A graph of the annual costs in 2016 dollars is shown on Figure 12-4. Table 12-4 provides a list of the supply projects along with the key assumptions used to develop planning level costs for these projects.

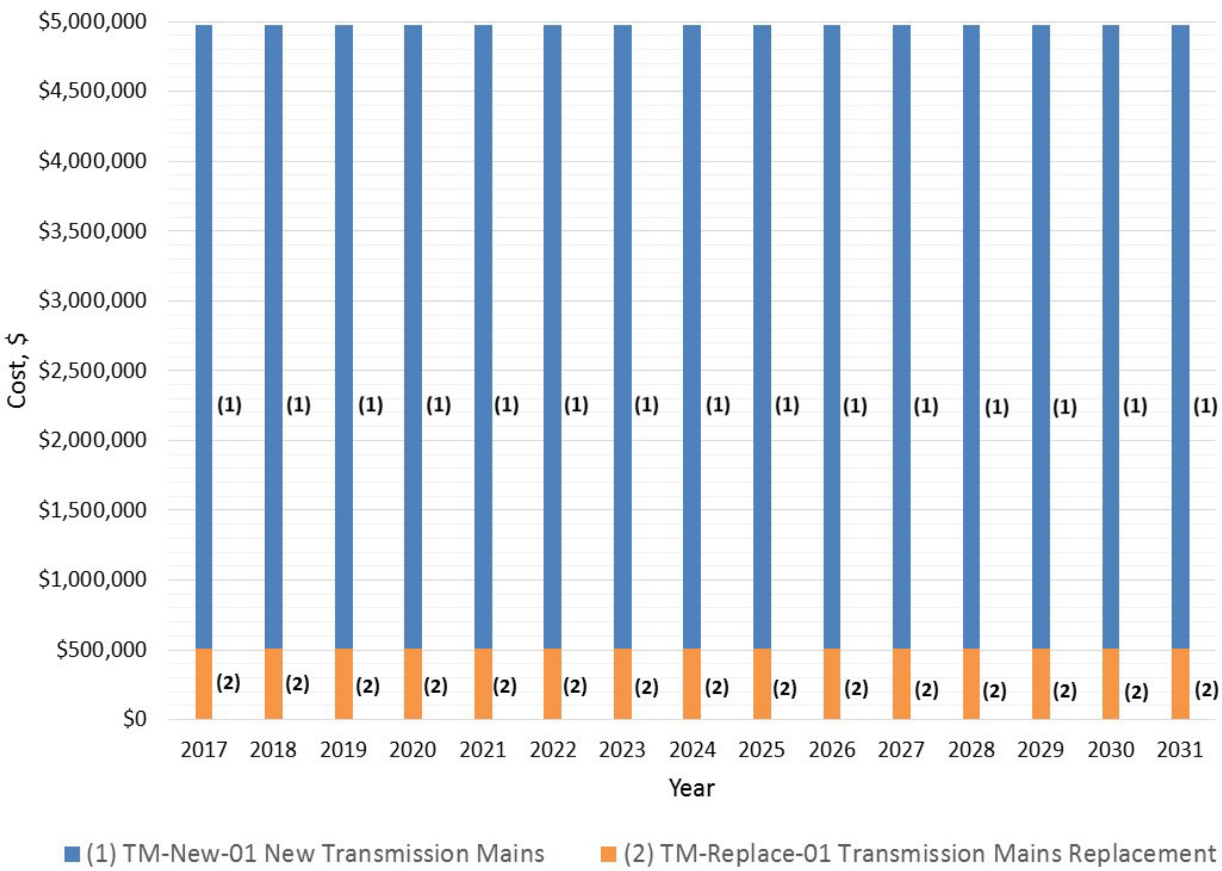

Figure 12-4. Capital Needs Analysis Transmission Projects Annual Cost

Table 12-4. Transmission Projects and Assumptions		
Project No.	**Project Name**	**Assumptions**
TM-New-01	New Transmission Mains	• $23 to $26/in-dia/LF. • Includes 30% increase in paving costs for new County requirements, 25% contingency, 25% engineering, 10% construction management/inspection. • Average replacement rate of 0.3 percent per year which is 900 LF per year. • CIP shows average annual cost over 15-year CIP period.
TM-Replace-01	Transmission Mains Replacement	• $23 to $26/in-dia/LF. • Includes 30% increase in paving costs for new County requirements, 25% contingency, 25% engineering, 10% construction management/inspection. • CIP shows average annual cost over 15-year CIP period.

12.3.3 Distribution Projects

Projects in this category are related to the District's distribution infrastructure. A graph of the annual costs in 2016 dollars is shown on Figure 12-5. Table 12-5 provides a list of the distribution projects along with the key assumptions used to develop planning level costs for these projects.

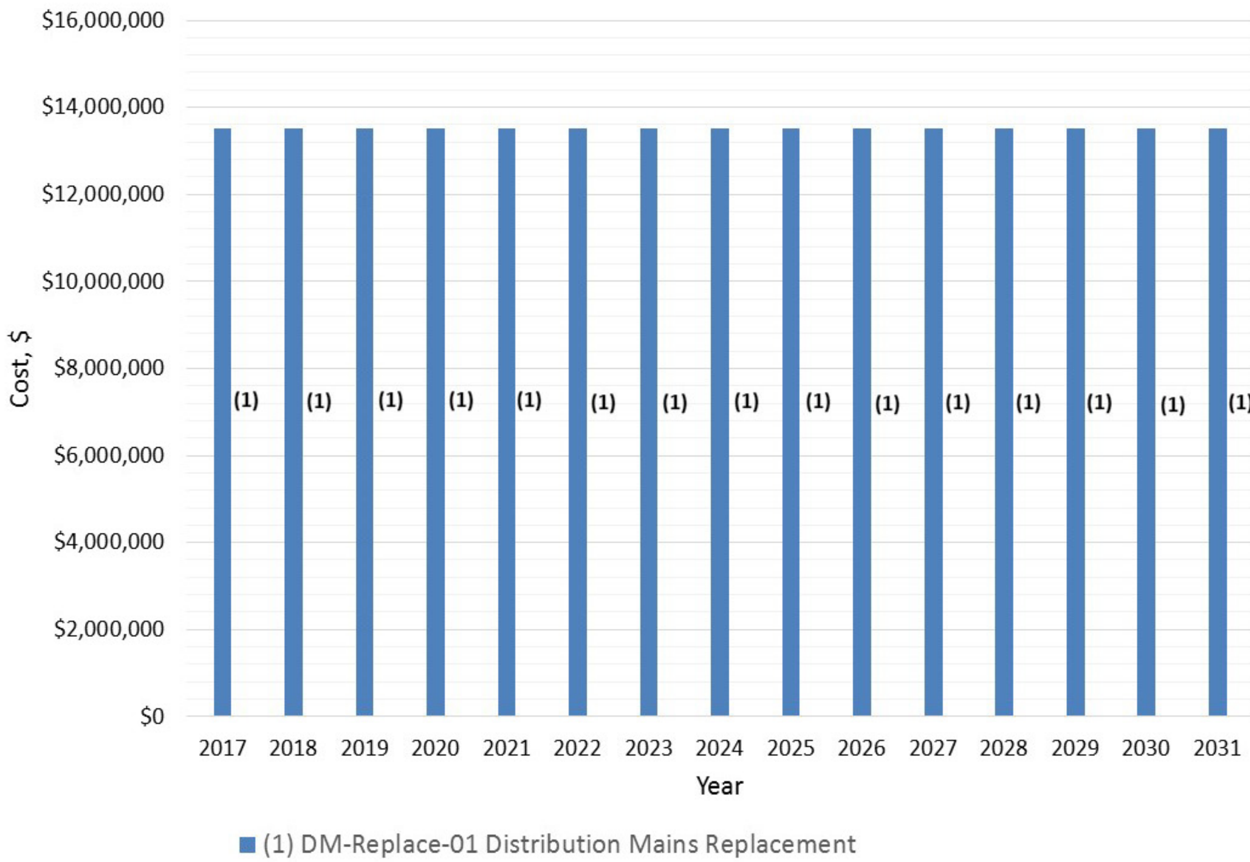

Figure 12-5. Capital Needs Analysis Distribution Projects Annual Cost

Table 12-5. Distribution Projects and Assumptions		
Project No.	Project Name	Assumptions
DM-Replace-01	Distribution Mains Replacement	• $39/in-dia/LF • Includes 30% increase in paving costs for new County requirements, 25% contingency, 25% engineering, 10% construction management/inspection • Average replacement rate of 1.3 percent per year which is 46,000 LF per year • CIP shows average annual cost over 15-year CIP period

12.3.4 Storage Projects

Projects in this category are related to the District's storage infrastructure. A graph of the annual costs in 2016 dollars is shown on Figure 12-6. Table 12-6 provides a list of the distribution projects along with the key assumptions used to develop planning level costs for these projects.

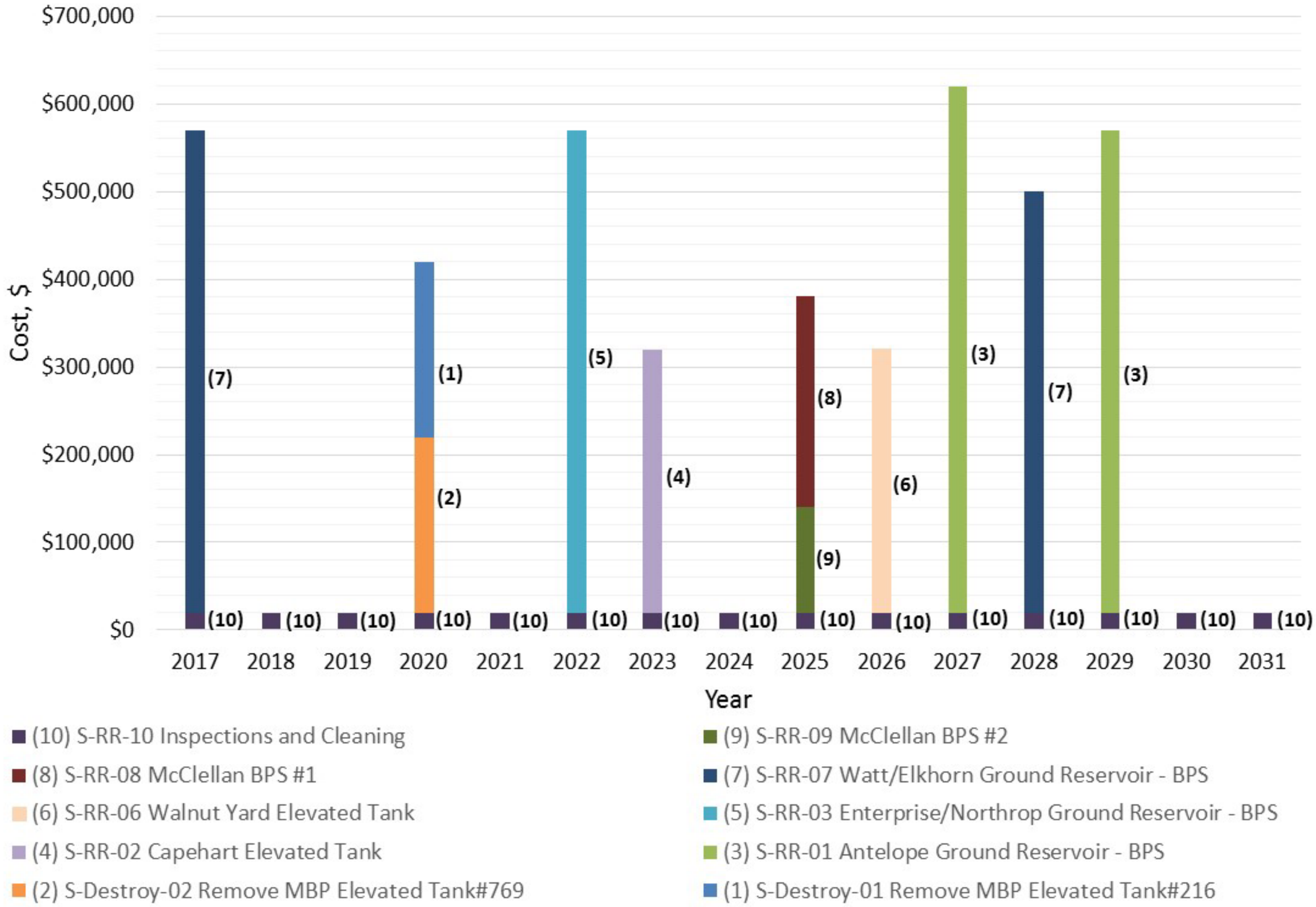

Figure 12-6. Capital Needs Analysis Storage Projects Annual Cost

Table 12-6. Storage Projects and Assumptions

Project No.	Project Name	Assumptions
S-Destroy-01	Remove McClellan Business Park Elevated Tank#216	• Remove from service and destroy
S-Destroy-02	Remove McClellan Business Park Elevated Tank#769	• Remove from service and destroy
S-RR-01	Antelope Ground Reservoir - BPS	• Tank recoating and BPS replacement
S-RR-02	Capehart Elevated Tank	• Tank recoating
S-RR-03	Enterprise/Northrop Ground Reservoir - BPS	• Tank recoating
S-RR-06	Walnut Yard Elevated Tank	• Tank recoating
S-RR-07	Watt/Elkhorn Ground Reservoir - BPS	• Tank recoating and BPS replacement
S-RR-08	McClellan BPS #1	• BPS rebuild and replacement
S-RR-09	McClellan BPS #2	• Rehabilitation
S-RR-10	Inspections and Cleaning	• Tank inspections and cleaning

12.3.5 Special Projects

Projects in this category are related to the District's meter program, buildings and structures, and SCADA. A graph of the annual costs in 2016 dollars is shown on Figure 12-7. Table 12-7 provides a list of the projects along with the key assumptions used to develop planning level costs for these projects.

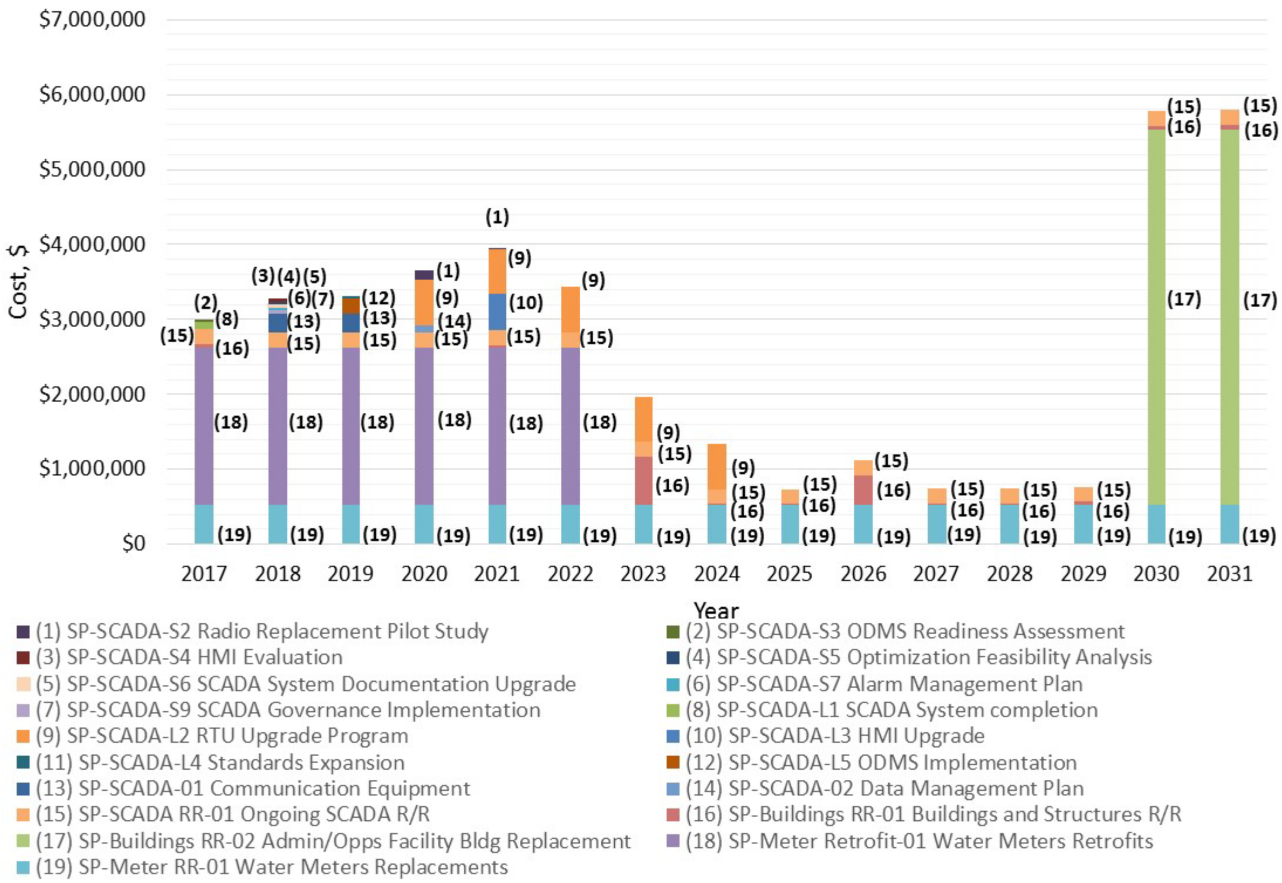

Figure 12-7 Capital Needs Analysis Special Projects Annual Cost

Table 12-7. Special Projects and Assumptions		
Project No.	**Project Name**	**Assumptions**
SCADA		
SP-SCADA-S2	Radio Replacement Pilot Study	• Better quantify the bandwidth requirements necessary to support RTU data and video. Review several new radio technologies.
SP-SCADA-S3	ODMS Readiness Assessment	• Evaluate existing business applications such as CMMS, Finance, or Asset Management to determine operation data integration requirements to support optimized operation and business decision support and guide design and configuration of an ODMS.
SP-SCADA-S4	HMI Evaluation	• Evaluate the long-term plans for the HMI Software.
SP-SCADA-S5	Optimization Feasibility Analysis	• Identify and document optimization opportunities, define pressure spike control strategy.
SP-SCADA-S6	SCADA System Documentation Upgrade	• Formally define the SCADA System design and maintenance documentation requirements.
SP-SCADA-S7	Alarm Management Plan	• Application of the alarm purposes, priorities, and presentation defined in the SCADA HMI Standard. • Does not include any ongoing additional alarm remediation or training. • Could be completed within 2 to 3 months.
SP-SCADA-S9	SCADA Governance Implementation	• Review and document the District's organization structure that supports SCADA planning, design, implementation, and maintenance. • Could be completed within 2 to 3 months.
SP-SCADA-L1	SCADA System completion	• Two sites remaining to be added to the SCADA system with RTU installation. • $50,000 per site.
SP-SCADA-L2	RTU Upgrade Program	• Upgrade program to occur over five years. • $600,000 per year.
SP-SCADA-L3	HMI Upgrade	• Follows completion of HMI Evaluation (SP-SCADA-S4).
SP-SCADA-L4	Standards Expansion	• Develop RTU Design Standards. • Develop Process Control Standards. • Focus on facility operations and on electrical and instrumentation components that connect the SCADA to facilities and equipment. • To occur prior to the RTU Upgrade Program (SP-SCADA-L2).
SP-SCADA-L5	ODMS Implementation	• Will be based on recommendations in the ODMS Readiness Assessment (SP-SCADA-S3).
SP-SCADA-01	Communication Equipment	• Evaluation, Purchase, Integration of alternative remote monitoring/communication devices to improve current methods. • Planning level cost estimate of $500,000 for this project is recommended for further evaluation. • Assumed to occur over a two-year period.
SP-SCADA-02	Data Management Plan	• Data management Plan for data stored and collected by SCADA system. • Planning level cost estimate of $100,000 for this project is recommended for further evaluation.

Table 12-7. Special Projects and Assumptions		
Project No.	**Project Name**	**Assumptions**
SP-SCADA RR-01	Ongoing SCADA R/R	• Annual O&M costs - $200,000/yr for equipment repair and software adjustment/upgrades. • Major replacement costs - $3 million, every 15 years. • $50,000 per site (assume 50 sites) and • $500,000 for central resources (servers, control room, networking, remote access).
Buildings and Structures		
SP-Buildings RR-01	Facility Buildings and Structures R/R	• Roof replacement and painting of facility buildings Roof replacement, varies as estimated by contractor and documented in Buildings and Structures AMP. • Painting, $5 to $10/sq-ft, cost per facility documented in Buildings and Structures AMP.
SP-Buildings RR-02	Admin/Opps Facility Bldg Replacement	• Replacement of current administrative and operational facility corp yard with one combined facility. • Assumed cost is $10,000,000 to occur over two years.
Meters		
RR-Meter-01	Water Meters Retrofits	• $1,750 per service. • $2.1 million/yr through 2022 based on approximately 10,000 services remaining to be metered.
RR-Meter-02	Water Meters Replacements	• Small meter replacements and large meter rehabilitation (rebuild) per the costs provided in the District's Water Meter AMP

12.4 Summary of Long Term Rehabilitation and Replacement Analysis

A compilation of the projected long term rehabilitation and replacement costs developed for each of the District's asset categories described in Section 6 through Section 10 is illustrated on Figure 12-8. This does not include the District's debt service which will be completed in 2032.

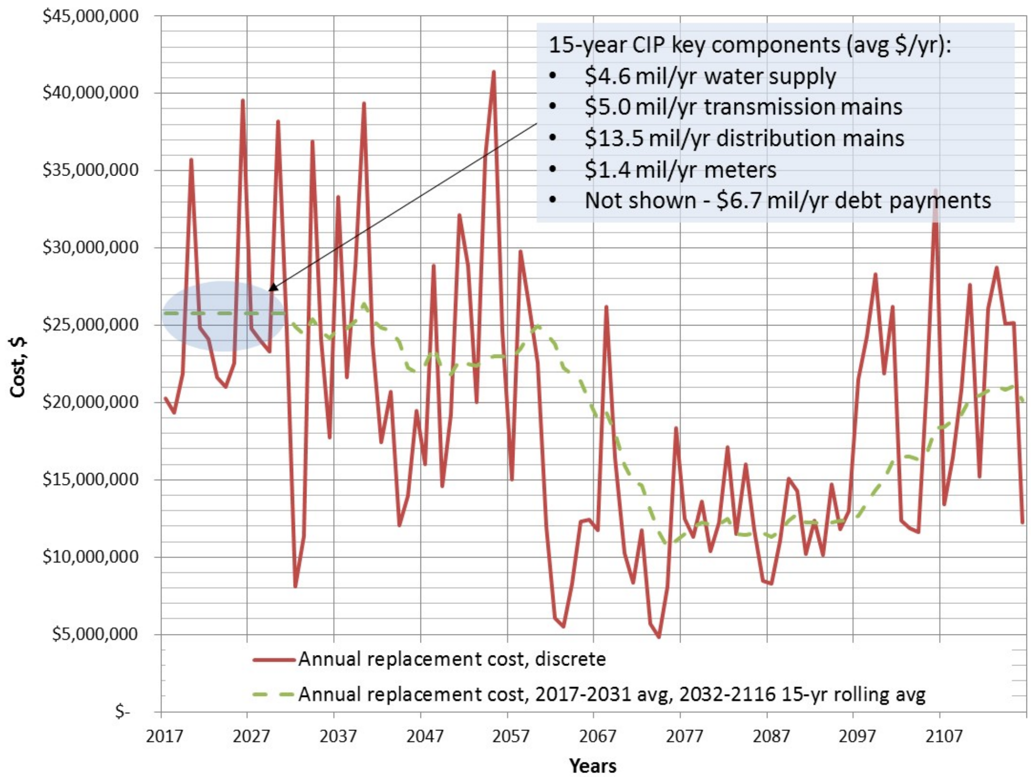

Figure 12-8. Total Projected Long Term Rehabilitation and Replacement Costs

12.5 Next Steps

This section presents recommendations for items to develop to better inform the preparation of the next WSMP update as well as move forward in the implementation of this WSMP:

1. Existing water system:
   a. Maintain GIS system with up-to-date facility data.
2. Water demands:
   a. Regularly update number of connections, annual water demands, and the maximum day demands for each of the service areas, including wholesale deliveries to Cal Am.
   b. Track the plans for the development of the MBPSA and obtain the development plan.
   c. Quantify the number of dwelling units that have converted to low flow plumbing fixtures, known as the saturation level, to better understand future water conservation potential.
   d. Conduct annual water system audits that would better characterize and quantify water system losses and other non-revenue water use.
3. Water supply:
   a. Track the water quality of the District's groundwater supply and the movement and status of groundwater contamination plumes that are within or near the District's service area. Consider the development of groundwater quality models.
   b. Develop improved estimates of the facilities needed to export water to other agencies and the anticipated water transfer amounts and revenue per ac-ft for the different climate year types.

   c. Quantify the spare capacity in District pipelines and facilities that could be made available to the RiverArc project and for other water transfer approaches.
   d. Participate in regional efforts related to regional reliability and conjunctive use planning because these efforts provide the potential for the District to be able to access firmer surface water supplies for conjunctive use and potentially for firm year-round supply, improvements to the health of the groundwater basin, as well as increased revenue opportunities.
4. Asset Management:
   a. Update the District's asset management plans to incorporate the recommended improvements identified for each of the asset management plans in order to standardize, consistently present, and analyze the District's approach to sustainable infrastructure R/R practices.
5. Water Supply Facilities:
   a. Develop and document a plan to manage asset condition information. One tool that could be developed is a well field management database.
   b. Continue gathering well condition data including forensic analysis and documentation of wells that fail.
   c. Update the groundwater well facility AMP condition assessment data and scoring.
   d. Track and update the well long term replacement plan at regular intervals.
   e. Develop quantifiable criteria to track performance indicators and determine when a well is not meeting its LOS goals for production.
   f. Run well under performing procedures analysis and well investment decision tool for wells currently not meeting level of service.
   g. Replace AASA well that is under performing due to the presence of Cr+6 with recommended new well NSA-A to improve reliability and fire flow supply capacity in the AASA.
6. Water Distribution and Transmission Facilities:
   a. Conduct a condition assessment of the District's transmission and distribution pipelines.
   b. Update the risk analysis for the rehabilitation and replacement prioritization of the distribution system.
   c. Prioritize and optimize the implementation of new transmission facilities.
   d. Further analyze through hydraulic modeling the installation of intratie(s) to allow emergency water supply transmission from the North Highlands pressure zone (NSA 4) to the McClellan pressure zone.
   e. Conduct field testing and further analysis of small diameter pipelines within the AASA to determine improvements to increase fire flow supply capacity.
7. SCADA:
   a. Develop a SCADA asset management plan.
   b. Implement recommendations related to SCADA alarm management, Use of SCADA data, and standardization and optimization of the SCADA system.
8. Capital Improvement Program:
   a. Regularly update the CIP project timing to reflect the actual and updated projected water demands.
   b. Track which WSMP recommendations and CIP projects are being implemented and provide explanation for projects that are not implemented.