APPLE VALLEY HEIGHTS
COUNTY WATER DISTRICT
760-247-7330

REPORT

OF

LONG-TERM DEVELOPMENT PLAN

OF

SYSTEM UPGRADES

2016

Prepared by:
Engineering Resources of Southern California, Inc.

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REPORT PURPOSE AND DISTRICT INFORMATION

This report of a long-term development plan of system upgrades was authorized by the Board of Directors of Apple Valley Heights County Water District (District) at its meeting of November 2015. In general, purpose of the effort is to conduct a review and prepare a plan for repair, replacement, and expansion of facility needs for the 40-year vista for the District. The document was prepared at the urging of the California State Water Resources Control Board (SWRCB), Division of Drinking Water (DDW), which oversees potable drinking water distribution in the State for agencies of the District's size or larger.

Specific tasks proposed to be conducted are as stated in the proposal submitted by Engineering Resources of Southern California, Inc. (ERSC) and listed below.

1. Consult with District staff to verify and review objective and methods of the proposed effort.

2. Accumulate and review District records of existing facilities.

    a. Transmission and distribution pipeline network;

    b. Well, pumps, booster pumping equipment, and interzone connections;

    c. Reservoir storage facilities; and

d. Records of water production and sales.

3. Determine water demand and delivery criteria to be utilized for system analysis. This will include both domestic and emergency requirements, that is, normal customer uses and prospective fire flow.

4. Prepare and develop a computer model of the District's entire system, source, piping network, interzone transfers, and storage. Model will include a plot of existing pipelines, wells, and reservoir sites. This will be submitted to the District for review and verification and hopefully provided can be age and pipe materials as available.

5. With the computer model, we will conduct simulations of high demand conditions to determine required sizing of facilities. Controlling condition for a small system such as the District's will always be fire flow plus maximum day demand. The result will include the preparation of a plan of required pipeline upgrades or replacements.

6. Develop a plan and report of well, pipeline and reservoir repair, replacement, and expansion to meet the needs identified by the computer model simulations. Included will be a prioritized list of replacements based on size, age, and anticipated life.

7. Consult with District staff during the conduct of the planning effort to present and review preliminary findings and receive input.

8. Prepare cost estimates for facility replacement and expansion, and schedule and long term budgeting guideline.

9. Prepare a report summarizing our efforts, findings, and recommendations and submit to the District for review.

10. Submit report approved by the District to the SWRCB/DDW for review and comment.

11. Refine report document based on DDW and District comments and submit final document.

The Apple Valley Heights County Water District was formed under Chapter 30000 of the State Water Code effective January 17, 1957. The Board is governed by a five-person Board of Directors, elected for four-year terms, with management and operation by appointed staff. The District is located in the High Desert area of San Bernardino County in an area known as Apple Valley, though not within the boundaries of the incorporated community of the Town of Apple Valley. Location of the District is shown on **Figure 1**. Boundary of the District and co-terminus Sphere of Influence are shown on **Figure 2**. Total area is 960 acres and ranges in elevation from 3120 at the northwest to over 3700 at the south and southeast, as seen on the USGS-based topo map and boundary, **Figure 3**. As indicated in the elevation ranges, the District slopes upward from the northwest to the southeast to the foothills of the Ord Mountains to the south.

District development is characterized by large parcels, 1.25 to 5.0 acres, 404 in number, single family residential only, a large majority of which are five acres in size. Land use zoning for the entire District is RS-1 that is, single family residential, one acre minimum. An aerial photo plot of parcels, boundary, and the bisecting Southern California Overhead Power line right-of-way easement is included in **Appendix A**.

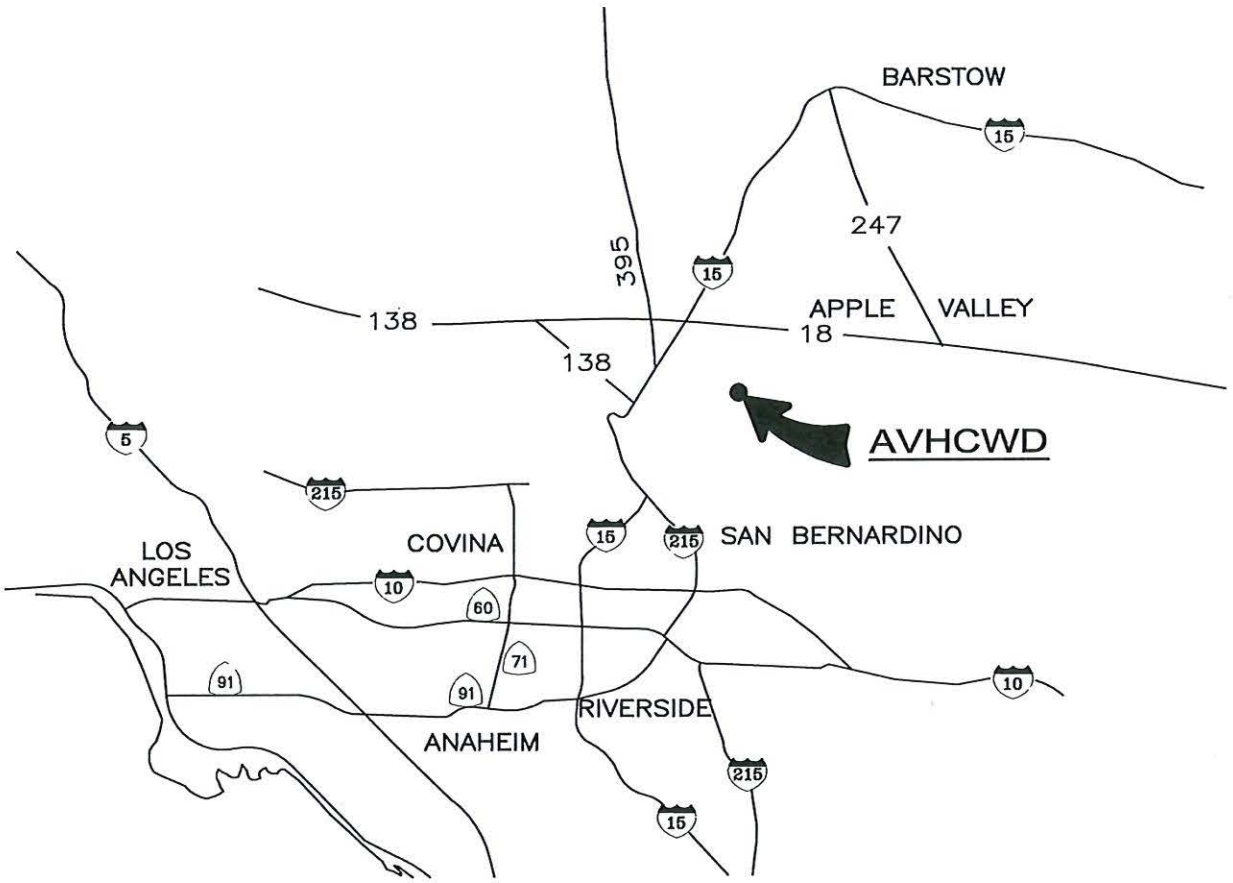
Of interest is the Consolidated Sphere of Influence adopted by the Local Agency Formation Commission for the District and two adjoining districts, displayed on **Figure 4.**

Primary access to the District is from Central Road from the north and Roundup Way from the west.

Abbreviations used in the Long Term Development Plan document are the following:

ADD	average daily demand
AF	acre-feet or acre-foot
AFY	acre-feet per year
BAP	Base Annual Production
BFPA	Base Free Production Allowance
CML	cement mortar lined
DISTRICT	Apple Valley Heights County Water District
D&W	dipped and wrapped
DDW	Division of Drinking Water
FPA	Free Production Allowance

FT	feet
GPCD	gallons per capita per day
GPD	gallons per day
GPM	gallons per minute
HCF	hundred cubic feet
KWH	kilowatt hour
MDD	maximum day demand
MG	million-gallon(s)
MGD	million-gallons per day
MWA	Mojave Water Agency
PSI	pressure-pounds per square inch
PVC	polyvinyl chloride
SCADA	Supervisory Control and Data Acquisition
SCE	Southern California Edison
SWP	State Water Project
UWMP	Urban Water Management Plan

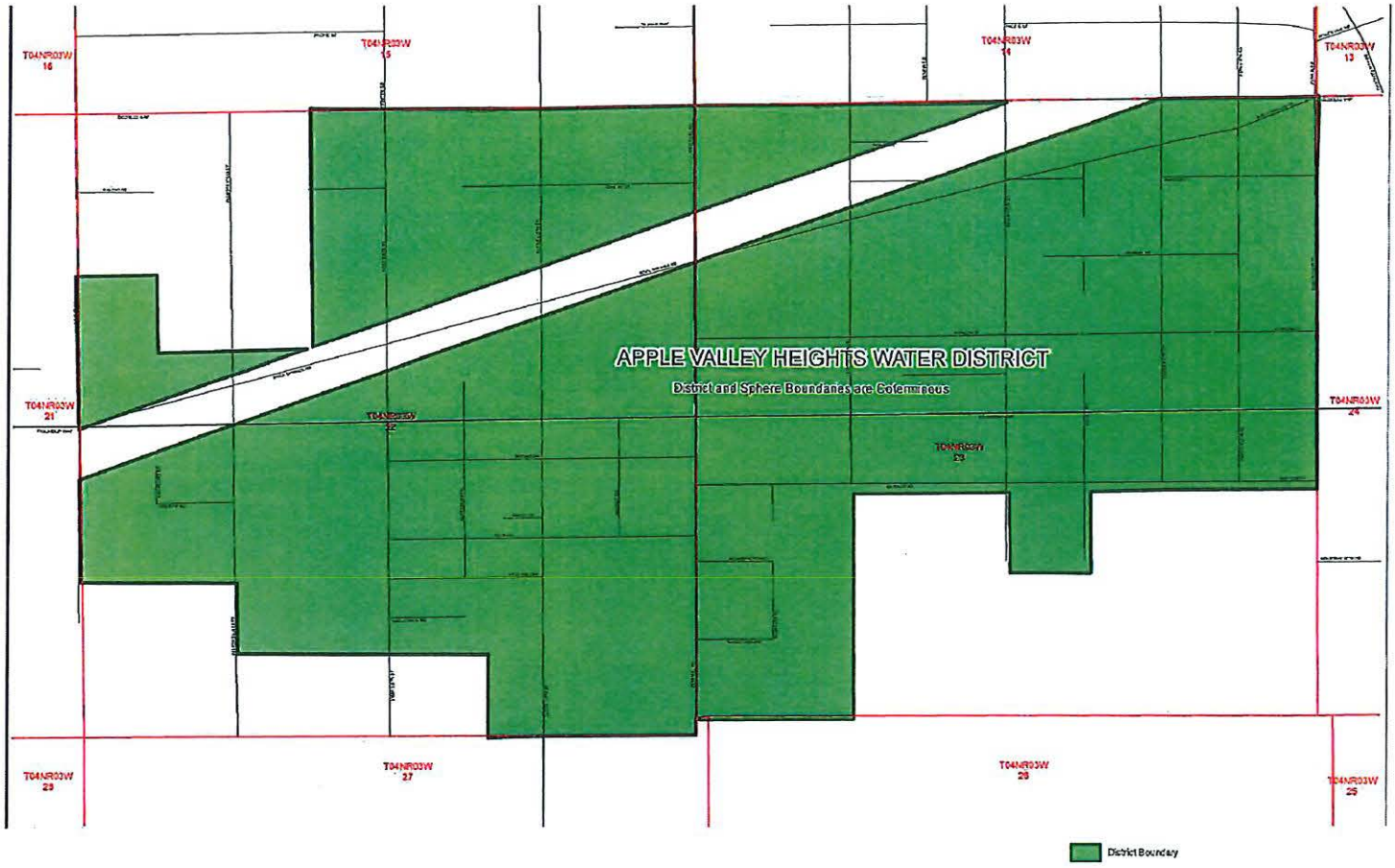


APPLE VALLEY HEIGHTS COUNTY WATER DISTRICT

FIGURE 1

NTS

VICINITY MAP

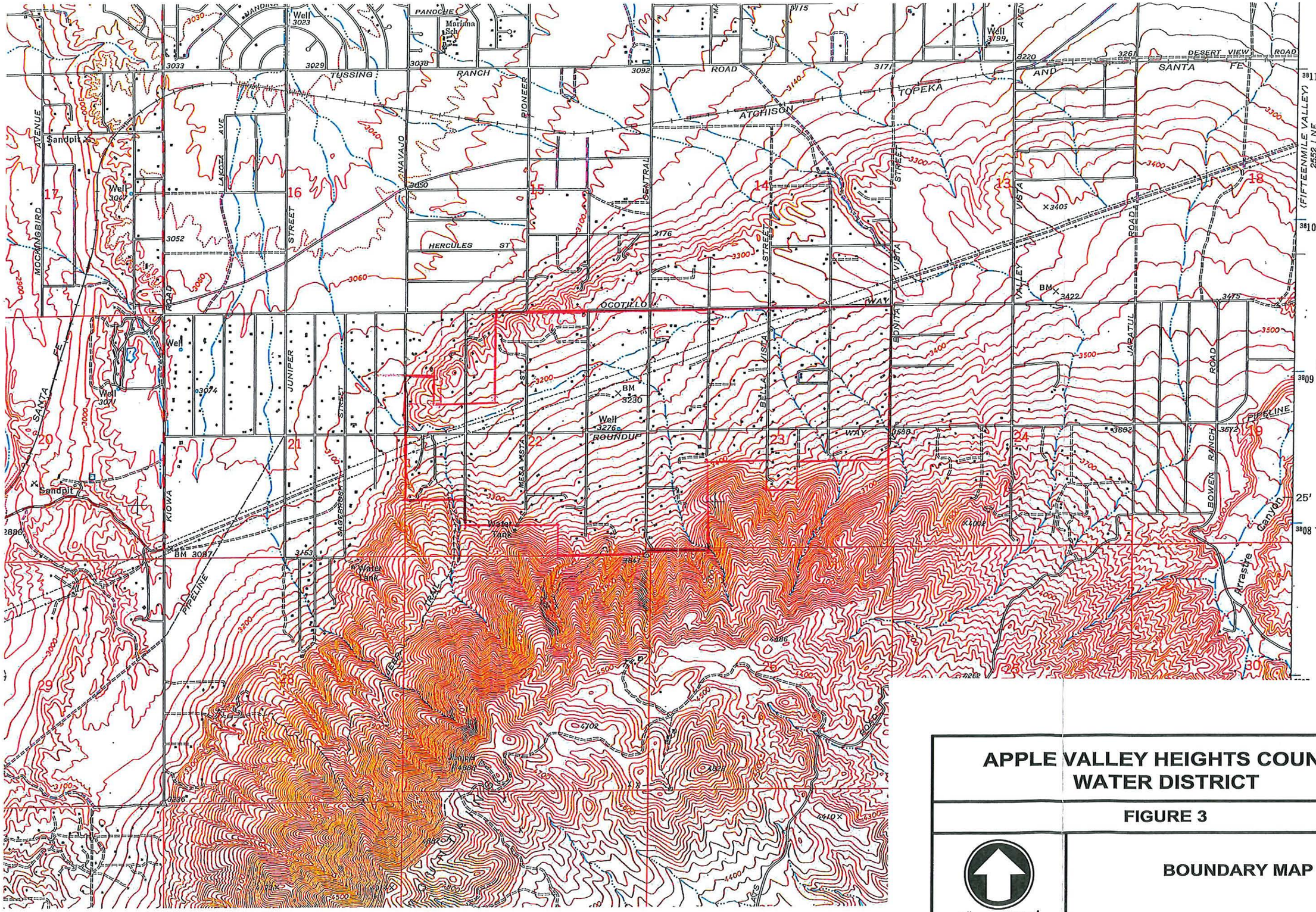


APPLE VALLEY HEIGHTS COUNTY WATER DISTRICT

FIGURE 2

NTS

DISTRICT & SPHERE OF INFLUENCE BOUNDARIES

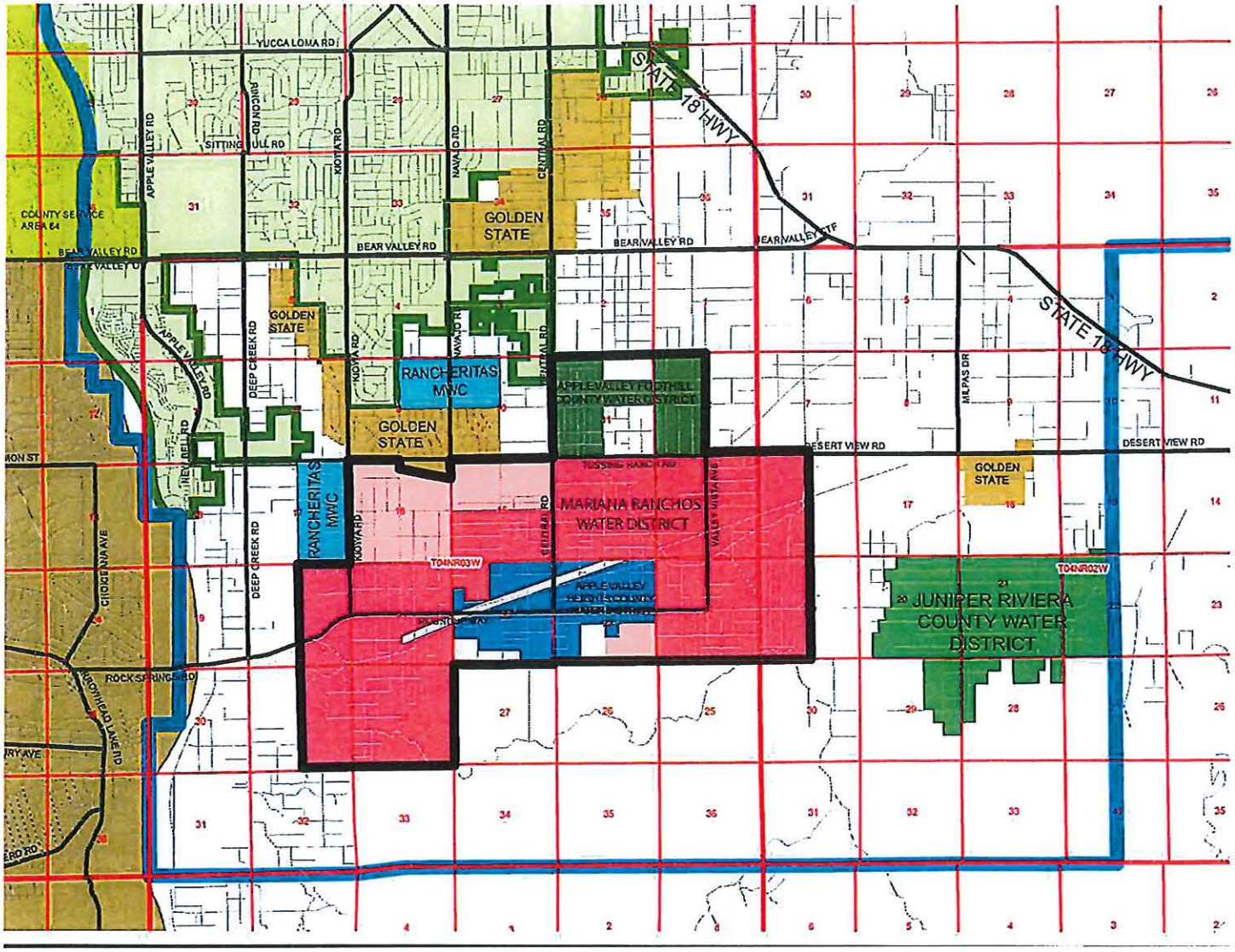


APPLE VALLEY HEIGHTS COUNTY WATER DISTRICT

FIGURE 3

1" = 2000'

BOUNDARY MAP



APPLE VALLEY HEIGHTS COUNTY WATER DISTRICT

FIGURE 4

NTS

CONSOLIDATED SPHERE OF INFLUENCE

MARIANA RANCHOS WATER DISTRICT, APPLE VALLEY HEIGHTS COUNTY WATER DISTRICT, & APPLE VALLEY FOOTHILL COUNTY WATER DISTRICT

SECTION II

EXECUTIVE SUMMARY

SECTION I - REPORT PURPOSE AND INFORMATION

Information in this section is provided concerning authorization by the Board for preparation of the Plan conducted at their Board meeting of November 2015, impetus for the Plan having been provided by the State Water Resources Control Board, Division of Drinking Water from their San Bernardino office. Per their urging, a Plan was undertaken for a 40-year vista for the District and tasks proposed to be conducted are outlined. Also contained in this section is information concerning formation history of the District and boundary map.

SECTION III - EXISTING WATER SYSTEM AND OPERATION

Information in this section is directed to description of facilities, system operation, staffing, water revenue sources, office facilities, and near-term high priority replacements for which funding is being sought from the United States Department of Agriculture, Rural Development Office and/or SWRCB. The high priority facilities include the 8" transmission pipeline in Mesa Vista Street, Ocotillo to Roundup Way, and replacement of the three 20,000-gallon Mesa Tanks.

SECTION IV - WATER SOURCE AND HISTORICAL USE

District's sole source of water is groundwater as is for all water agencies in the High Desert area. As a result, the groundwater basin had become over-drafted, resulting in an action by downstream users and a stipulated judgment in 1996 resulting in a groundwater management plan to reduce pumping to the safe yield plus imported replacement water. The District allowance of a Base Free Production Allowance is 75 afy. Use in the last 10 years has been in the range of 110 to 146 afy, therefore, make-up is required by the District.

Average water production per connection in the District for the last six years ranges from 0.35 to 0.44 afy. Highest production for the year relative to average for the year was found to be an adjusted value of 2.5.

SECTION V - PROJECT WATER REQUIREMENTS

Based on historical records, an amount of 0.40 afy is adopted for planning purposes. Concerning prospective development in the District, 280 lots are available of 404 existing. No land use changes are contemplated in the County's General Plan preparation, currently underway. An absorption rate of 2.5% per year was used, similar to that adopted by Mojave Water Agency in the Urban Water Management Plan of 2010 for the 40-year period to 2055. This, then will result in a doubling of current connections from 280 to 560. Water need, of course, then will rise over the 40-year period from the current use of 112 afy to over 200 afy. For this amount, source requirements were developed for alternate pumping times. Controlling source requirement is that of maximum day plus

fire flow. Fire flow of 750 gpm was adopted as a goal with 500 gpm as an interim objective to be supplied.

SECTION VI - LONG-RANGE SYSTEM NEEDS

Presented in this section are the development of additions and replacement needs for the District's major facilities, that is source, storage, distribution, and administrative facilities. Found to be needed over the 40-year period are, of course, expansions to meet water production requirements both annual and for needed well pump capacity to accommodate time of use operation. Pumping capacity needs will double as will proposed connections within this period. Storage requirement comprised of operational, fire flow, and emergency with a projected need of 0.5-million gallons by 2055.

As cited previously, and designated as first priority, the District has applied and is seeking exterior funding for replacement of an 8" transmission pipeline in Mesa Vista Street and the three small storage tanks at the Mesa site.

To determine needs for the pipeline distribution system, a computer model of the District's system was prepared using the program H2ONET. With this, operational simulations were made for normal and max-day flows as well as maximum day plus fire flow of 750 and 500 gpm. From this, deficiencies were identified, largely, as expected, where 4" pipe exists. Second priority, then, will be to replace pipelines to provide 500 gpm fire flow, and third priority to provide capacity to supply 750 gpm fire flow.

Anticipated need for expansion of administrative and maintenance facilities is also briefly addressed.

SECTION VII - LONG RANGE EXPANSION AND REPLACEMENT PLAN

Objective of this section is to present an estimate of projected expenditures required for the District to fund the identified expansion and replacement needs of the previous sections. For this purpose, unit costs for various features were developed and then a tabulation made for the 40-year period in 5-year increments of prospective or likely investments required. Major features and those of the first priority will, of course, be the facilities for which funding is being sought from USDA/SWRCB, that is, the Mesa Vista Street pipeline and Mesa Tank replacements. Other recommended expenditures in subsequent 5-year periods include distribution pipeline upgrades for the fire flow requirements, pumping equipment replacements, distribution pipeline replacements, expansion of administrative facilities and, in later years, possible replacement of the Central Tank and expansion of storage capacities.

SECTION III

EXISTING WATER SYSTEM AND OPERATION

BACKGROUND

Basic and original facilities owned by the District, consisting of wells, source, transmission and distribution pipelines, pump station, and storage reservoirs were, it is believed, installed following the formation of the District in 1957. Financing is thought to have been by means of a General Obligation Bond issue. Constructed at the time, it is deduced, were one or two wells, neither in use now, north of the District boundary on Pioneer Road and an 8" transmission pipeline southerly to the District. Distribution pipelines, 4", 6", and 8" in diameter were constructed throughout the District as shown on the District's hand drawn "As Built" Water Distribution System Map dated 1958. Also constructed at the time was the booster pumping station on Roundup Way and four reservoirs, two on the Mesa Site and one at the south end of Central Road, all of 20,000 gallons capacity.

Plans in the possession of the Engineer, dated 1966, show additional facilities funded by the United States Department of Housing and Urban Development. These consist of an 8" pipeline in Pioneer Road from Tussing Road to Ocotillo Road, that is to the north of the District. Facilities indicated include a connection to a pipeline and an inline booster pumping station at Tussing Road and a second reservoir at the Mesa Site. Apparently, the connection was to an adjoining water system. We have no evidence that it was constructed, however.

A significant addition was made with the adoption of Assessment District 1990-1 which added a new well, No. 3, and a new and larger reservoir of 200,000 gallons at the Central Road Site. Additionally, new boosters were installed at the Roundup Way Site also. Repayment of the bonds issued occurred over the next 20 years by special assessments on the properties, collected by the County.

In 2008, the County revised the grade at the intersection of Ocotillo Road and Central Road, necessitating replacement of the District's pipelines. Installed at that time, then, were approximately 1,000 linear feet of 8" pipeline in Central Road from Ocotillo Road south and 700 feet of 6" in Ocotillo Road to the east and west of Central Road. Pipe material is polyvinyl chloride (PVC).

EXISTING WATER SYSTEM FEATURES

Current source for the District includes Well No. 3 and Well No. 4, constructed in 2003. Storage for the District includes the 200,000-gallon Central Road Reservoir and three 20,000-gallon reservoirs at the Mesa Site. Booster pumping station on Roundup Way includes two 20-hp pumps, electrical service and controls, replaced in 2014. All of the District's four reservoirs were inspected by diving, with photographs taken, in March 2015. The Central Road Reservoir was found to be in good condition; the East and Middle Mesa Tanks were found to be in fair to good condition with repairs recommended for the floors. Mesa West Tank was found in poor condition with recommendation that it be replaced. Both reservoir sites are located on BLM land, thus use is permitted to the District.

District's major "transmission" pipeline (6" and 8") conveys water from Well Nos. 3 and 4, south in Pioneer Road/Mesa Vista Street to the Mesa Tanks. The 6" portion, Ocotillo Way to Roundup

Way, has experienced multiple breaks in recent years, necessitating repair, and sometimes refilling of the Mesa Tanks.

Distribution pipeline network is comprised of the following inventory, totaling about 13 miles

SIZING (IN.)	LENGTH (FT.)
4	21,578
6	32,453
8	14,905
Total	68,936

Mapped display of the District's entire system is shown on the H2ONET MODEL, **Sheet 1** at the back of this report, with pipeline sizes color-coded.. Notably, most north-south pipelines in the easterly portion of the District, that is, Flora Vista and east, the northerly portion of Bella Vista, and in Cholla Road, are 4" diameter. Very limited amounts of 8" exist. Numerous dead ends are also evident, 17 visible.

Aside from the 8" steel extension to the new Central Road Reservoir in 1991 and the Central Road/Ocotillo intersection replacements (PVC), virtually the entire pipeline inventory of the District was apparently installed in the late 1950's. Material is presumed to be cement-mortar lined (CML) and dipped and wrapped (D&W) steel, most common in use at the time.

All connections are metered and all meters have been replaced in the last three years.

Hydrants are installed at about 23 locations in the District. Two-inch stand pipe/blow valve at about 46 locations.

Details of current District pumping facilities are shown on **Table III-1**. Both wells are operating very efficiently as are the new Roundup Boosters.

A summary of facilities, age of installation or major rehabilitation age, and estimated life is shown in **Table III-2**. This will provide a guide for replacement planning and budgeting.

OPERATION

The District's distribution system is divided into two zones, designated Low and High. The Low Zone receives water from the District's wells to the Mesa tanks. The Roundup Booster lifts to the High Zone with storage at the Central Road Reservoir. A schematic diagram of the District's system and pressure zoning is shown at **Figure 5.** High and Low Zones are interconnected by a pressure regulating valve at the Roundup Booster Station for flow to the Low Zone, operated manually when needed to supplement and maintain minimum storage amount in the small Mesa Tanks during peak use periods. This however, leaves the Central Tank with barely adequate amount. The District has no interconnection with any adjoining system for purposes of emergency supply.

Well operation is controlled by the water level in the Mesa tanks, though limited to non-peak hours operation. It is indicated that well operation occurs between 11:00 p.m. - 8:00 a.m. in the summer and 9:00 p.m. - 8:00 a.m. in the winter. Only one well can be operated at a time. Similar controls are

in effect for the Roundup Way Boosters to the High Zone and Central Road Reservoir. Operation of each of the two wells and of the two booster pumps are alternated. Longer run hours are enacted at peak usage days, it is indicated, however.

District staff consists of the General Manager, Office Manager and one field maintenance position. Staff operates in and from a small office, a converted single family residence, on Cerra Vista, which is also site of Board meetings. SCADA readouts/displays are contained at the office site also.

REVENUE SOURCES

District operating revenues are derived from the water delivery and use by customers. Current water rates are shown on **Table III-3**. Meter reading and billing is done on a monthly basis with readings entered to a handheld device which is then downloaded to a computer to generate customer bills.

Aiding facility expansion/additions is the District's Capital Facility/connection Charge, currently in the amounts of $5,445 for 3/4" meters and $9,257 for 1" meter installations, unchanged since early 2007.

PLANNED REPLACEMENTS

District has submitted application(s) to the United States Department of Agriculture Rural Development Office and SWRCB for grant or loan to finance construction of 2,800 lineal feet of 8"

pipeline in Pioneer Road/Mesa Vista Street from Ocotillo Way to Roundup Way and to replace the three 20,000 gallon tanks with a larger tank at the Mesa Tank site.

TABLE III-1

DISTRICT PUMP INFORMATION

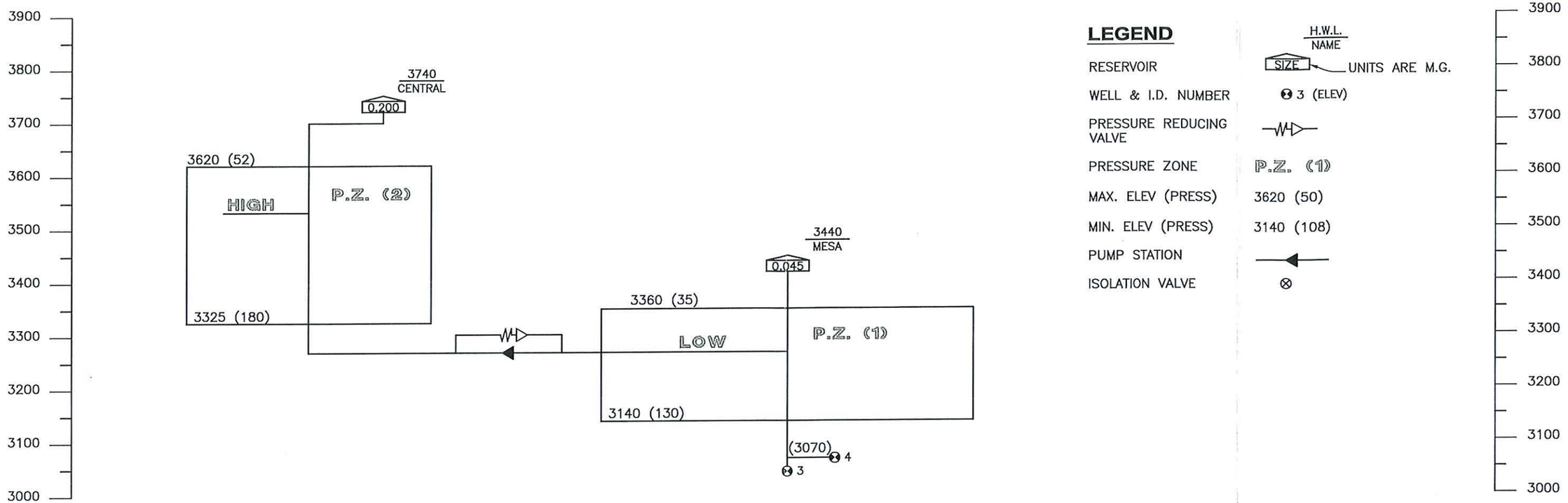
NAME	MOTOR SIZE (HP)	NORMAL TDH (FT)	DISCHARGE CAPACITY (GPM)	OVERALL PLANT EFFICIENCY (%)	ENERGY USE/ACRE FOOT & COST (KWH/$/AF)
Well #3[1]	75	678	243	62	1,124/157[3]
Well #4[2]	75	678	259	68	1,021/143[3]
Roundup Booster West[2]	20	247	241	67	379/68[4]
Roundup Booster East[2]	20	247	258	71	355/64[4]

[1] Per SCE Test of April, 2016; Ful-Flow Louvered, Steel Casing
[2] Per SCE Test of March, 2016; SS Wire Wrap Casing
[3]Cost of $0.14/KWH
[4]Cost of $0.18/KWH

TABLE III-2

WATER SYSTEM FACILITIES SUMMARY & AGE

ITEM/DETAILS	CONSTRUCTION/ REHABILITATION DATE	AGE	EXPECTED LIFE
Well No. 3 (12" Ful-Flow Casing)	1991	25	50
Well No. 3 Equipment	2013	3	10
Well No. 4 (12" SS, Wire Wrap Casing)	2003	13	50
Well No. 4 Equipment	2013	3	10
Central Road Reservoir (Bolted, 200,000 Gallon)	1991	25	50
Mesa Tanks (3) (Bolted)	1957 (2) ? (1)	59	50
Roundup Booster Pumps	2014	2	10
Transmission & Distribution Pipeline System (CML/D&W) PVC	1957 (CML/D&W) 2000-2008 (PVC)	59 8-16	75 75



APPLE VALLEY HEIGHTS COUNTY WATER DISTRICT

SCHEMATIC PROFILE – EXISTING WATER SYSTEM

FIGURE 5

ENGINEERING RESOURCES OF SOUTHERN CALIFORNIA, INC.
DEC. 2015

TABLE III-3

WATER RATES AND CHARGES

Base Rate: $48/Month

Commodity Rates:

0 - 300 cubic feet	Included in Base Rate
400 - 900 cubic feet	$2.50/hcf
1,000 - 3,900 cubic feet	$3.00/hcf
4,000+ cubic feet	$3.75/hcf

Surcharges:

Well #3 Repair	$2.00/Acct./Month
Capital Improvement Replacement Fund	$6.00/Acct./Month

SECTION IV

WATER SOURCE AND HISTORICAL USE

A. WATER SOURCE

The District obtains all of its water from an underground reservoir, the Mojave Groundwater Basin. Due to extractions exceeding the natural inflow, the City of Barstow and Southern California Water Company filed a complaint in 1990 against upstream water users to remedy the reduced amount of natural water available to them. Resulting after many years of litigation was a stipulated judgment in January 1996 apportioning safe yield of the Basin to the various overlying entities. The court appointed the Mojave Water Agency (MWA) as Watermaster of the Mojave Groundwater Basin.

Based on historical pumping, the judgment established a base annual production amount for each user extracting in excess of 10 acre feet per year (AFY) and also established a free production allowance for each entity to establish a withdrawal amount equivalent to the safe yield for natural inflow to the Basin. Amount used above the FPA require payment to MWA for replacement water.

As indicated in the 2010 Urban Water Management Plan (UWMP), prepared for MWA, for management purposes under the Mojave Basin Judgment, MWA split the Mojave River Watershed and associated groundwater basin into five "subareas". The five subareas are 1) Oeste, 2) Este, 3) Alto, 4) Centro, and 5) Baja. The District has a base annual production amount and free production allowance in the Alto Subarea (125 AFY), and Centro Subarea (29 AFY). Free production

allowance, that is, the amount that can be utilized without payment to MWA, are 75 AFY and 24 AFY in the Alto and Centro Subareas, respectively. The Mojave Basin Judgment assigns base annual production rights to each producer using 10 AFY or more, based on historical production during the period 1986-1990. District extracts no water from the Centro Subarea.

Free Production Allowance is set as a uniform percentage of BAP for each subarea each year by the Watermaster. This percentage is reduced over time until total FPA comes into balance with available non-SWP supplies. For the water year, 2011-2012, the FPA for the Alto Subarea is set at 60% of BAP for municipal uses and for the Centro Subarea at 80% of BAP.

Any water user that pumps more than their FPA must purchase SWP replenishment water from the Watermaster, equal to the amount of production in excess of FPA, or transfer unused FPA from another party within the subarea.

Shown in **Table IV-1** is information obtained from the annual Mojave Basin Area Watermaster Annual Reports concerning the District's reported production based on FPA together with replacement water needs for the Alto Subarea for the District for the years 2009-2010 through 2013-2014. As indicated, the District regularly incurs an obligation to purchase replacement water from MWA. Amounts of replacement water required to be purchased in a recent five-year period ran from 30 to 35 AFY with the exception of 2012-2013 when it was somewhat less. Replacement water purchase price in the same period ranges from $395 to $448 per acre-foot for the most recent year for which information is available.

Also evident in **Table IV-1** from the Watermaster records is the much higher verified production in the years 2003-2004 to 2008-2009 with proportionately higher replacement requirement. The significant reduction, starting in 2009-2010, is thought to be attributable to increases in water rates and efforts by the District to discourage excessive use.

B. WATER USE

Of use for long-term planning is both total water use and water use per connection or per person or capita with the use per connection thought to be more reliable. Information from District records concerning production is displayed in **Table IV-2** for the years 2009 to 2015. Information is also displayed graphically in **Figure IV-1**. Use in this period is quite stable or uniform at 108 to 117 AFY, lowering to 98 AFY in 2015. This is thought to be perhaps due to conservation efforts promoted by the District and resident decisions, and the water reduction edict promulgated by the State in 2015. Average production per connection for the seven years of 2009-2015 is 0.41 AFY.

Estimated daily per capita use ranges from a low of 95 GPD in 2015 to 119 GPD in 2012. Of interest perhaps is the per capita estimated use for the Mojave Basin Area which has declined from 214 GPD in 2000 to 152 GPD in 2010, per the 2010 UWMP document.

Provided in **Table IV-3** are monthly and daily maximum production amounts. For most water supply agencies, to maximum month averages are usually in the range of 1.50 so, except for the 2014 and 2015 figures, District experience conforms. Similarly, to average annual day ratio for most water agencies is found to be in the range of 2.25 to 2.60. Excepting 2014 and 2015, District experience

is also as that experienced elsewhere. Without the high peak day usage of 2014 and 2015, average ratio is 2.49.

Displayed in **Table IV-4** are estimates of Water Production to Use Efficiency. Bases are measured production vs. measured consumption resulting in quantities of unaccounted water which may be lost or discrepancy/inaccuracies of meter measurements. Average amount of unaccounted/loss water of 11% is not unusual, and whether due to meter measurement or actual loss is undeterminable. The troublesome leaking transmission pipeline between Pioneer Road and Roundup Way has obviously a significant impact on the statistic including the complete draining of the Mesa Tanks on occasion. Since all meters are relatively new, loss via the transmission pipeline is likely the largest contributor. Nonetheless, District should continue to address leaks aggressively. Notably, amount for 2015 is only 7%, so perhaps more attention to meter reading or leaks management is reflected. By comparison, it is indicated in the MWA UWMP that unaccounted water for the period 2000-2008 averaged 8%.

TABLE IV-1

WATER PRODUCTION AND REPLACEMENT
PER MWA WATERMASTER REPORTS
(ALTO SUBAREA)

FISCAL YEAR	VERIFIED PRODUCTION (AF)	BASE FPA (AF)	FPA (AF)	REPLACEMENT (AF)
13-14	110	75		35
12-13	118	75	23	20
11-12	110	75		35
10-11	105	75		30
09-10	111	75		36
08-09	122	75		47
07-08	130	75		55
06-07	146	75		71
05-06	132	75		57
04-05	137	75		55
03-04	125	75		28

TABLE IV-2

DISTRICT WATER USE RECORDS

CALENDAR YEAR	PRODUCTION (AF)[1]	CONNS	PRODUCTION PER CONN/YR (AF)	GPCD[3,4]
2009	117	269[2]	0.43	116
2010	108	269[2]	0.40	108
2011	107	269	0.40	108
2012	113	254	0.44	119
2013	116	270	0.43	116
2014	113	275	0.41	111
2015	98	280	0.35	95
Averages: 2010-2015			0.41	110

[1]Per District Records

[2]Estimated Conn's

[3]Bases - 3.3 Residents/Connection

[4]Calculated Per Table Data

FIGURE IV-1
Graph of Water Pumped & Use Per Connection
2009-2010 to 2014-2015

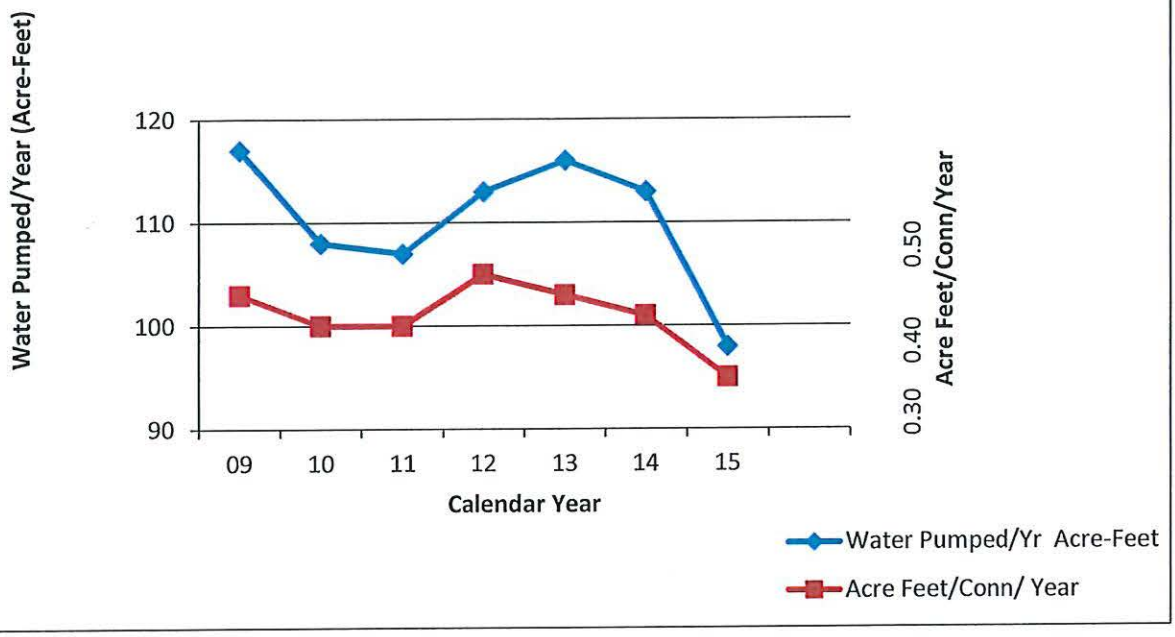


TABLE IV-3

MAXIMUM USAGE RECORDS

CALENDAR YEAR	ANNUAL USE (AF)	MAX. MONTH	AMOUNT (AF)	MAX. DAY	AMOUNT (AF)	RATIOS MAX. DAY / MAX. MONTH AVG	RATIOS MAX. DAY / AVG. DAY
2010	108	JULY	14.6	7/5	0.67	1.42	2.26
2011	107	JULY	14.46	10/17	0.61	1.31	2.08
2012	113	JULY	14.05	7/30	0.75	1.65	2.42
2013	116	JULY	15.18	9/30	0.73	1.49	3.20
2014	113	JULY	14.56	7/23	1.14	2.43	3.68
2015	98	JULY	11.77	9/9	1.01 [1]	2.66	3.76 [2]
AVERAGE							**2.75**
ADJUSTED AVERAGE							**2.49** [3]

[1] Likely several days use indicated

[2] Not used in average calculation

[3] Without 2014 Max Day Amount

TABLE IV-4

WATER PRODUCTION: USE EFFICIENCY

CALENDAR YEAR	PRODUCTION (AF)	WATER SALES TO PRODUCTION (%)	UNACCOUNTED/LOST WATER (AF)
2009	117	90	12
2010	108	89	12
2011	107	86	15
2012	113	87	14
2013	116	88	12
2014	113	89	12
2015	98	93	7
Averages		89	12

SECTION V

PROJECTED WATER REQUIREMENTS

A. PROJECTED USE PER PARCEL

Review of historical and recent water use indicates a trend downward to 0.35 acre-feet per year for 2015 for which the 280 connections, therefore, utilized 312 gallons per day each or for the 3.3 average number of residents, equivalent to 95 GPCPD, total for interior and exterior uses. Per current budget-based water rate planning being implemented by a number of water agencies, 55 to 65 GPCPD is generally used for interior use.

For the District, this leaves little allowance for exterior use, as minimal at that may be. We are aware of the historical low water use in the District and the encouragement made by staff and the state and regional agencies. It is believed prudent, however, to assume a long-term use of 0.40 AFY for the 40-year planning period, which is near the average of years 2010 to 2015. Lower per capita use is anticipated, but more residents per household are also expected, which will increase use per connection.

Projected water use does not reflect the prospective reduction contained in the MWA's UWMP. However, this is rationalized due to the considerably lower per capita use in existence now for the District vs. MWA's Alto Subbasin Area in which use is 60% higher than in the District. This, of

course, is likely due to the considerably greater incident of landscape irrigation required in the heavily populated areas in MWA.

B. PROJECTED DEVELOPMENT AND WATER REQUIREMENT

Concerning prospective development in the District, the County is undertaking a General Plan Update, however no land use changes are proposed for the Apple Valley area, we are told. Currently, there are 280 developed lots of the 404 parcels in the District with a total area of 960 acres. This equates to an average size of just under 2.5 acres with a variety of sizes, however, ranging from the one-acre minimum to 20 acres. Future water requirements will, obviously, be dependent upon the number of parcels that are developed.

MWA's UWMP population projections for the entire Agency averaged 2.5% per year and 2.7% per year projected to the year 2035 for the Alto Subbasin area where the District lies. For purposes of this Plan, an average growth or parcel absorption rate of 2.5% will be used in the 40-year period to 2055. This would result in development to double the existing 280 connections or 560 at that period (40 x 2.5% per year). This is well within the available land inventory with parcel splits. Projected number of improved parcels and resulting water uses utilizing the 0.40 AFY per connection is shown in **Table V-1**.

Annual water requirement was derived using the amount of 0.40 AFY per connection. For use, a ratio of 2.5 times average daily demand for the year has been adopted as the most reasonable based on recent experience.

Use of the data of **Table V-1** is as follows. Annual water use dictates source volume requirement, for the District, the amount of groundwater needed for extraction. demand is the groundwater extraction or delivery capacity required for District wells. Current capacity is approximately 245 GPM, that is one well, equivalent to 352,800 gallons or 0.353 mgd, if available to operate 24 hours per day but proportionally less if restricted to lower cost electric utility incentives, for example one-half that amount if operated only 12 hours per day. Amount available for 18 hours operation is also indicated. Though sufficient now, evident is the need for additional well source capacity in future years.

In a similar manner, **Table V-2** was prepared for the High Pressure Zone. There are an estimated 196 lots currently with 152 developed and connected. Then projected development, water needs, requirement, and booster pumping capacity were estimated using the same criteria as for the entire District.

As cited previously, controlling flow for pipeline delivery and sizing will be fire flow plus . Contact with a representative of the Apple Valley Fire Protection District resulted in a consensus of a fire flow rate of 750 gpm, which will be used in subsequent storage analyses. More is always better, of course, but since the flow, to be reliable, must be maintainable for two hours minimum storage is a controlling factor also.

Concerning adequacy of water availability, MWA utilized the "moderate conservation" scenario for the 2010 UWMP in which they project sufficient water supplies to meet the needs through 2035, the horizon for that document. Another is under preparation currently.

TABLE V-1

4/27/2016

PROJECTED CONNECTIONS AND WATER USE AND SOURCE REQUIREMENTS

YEAR	2015	2020	2025	2030	2035	2040	2045	2050	2055
Conns'	280	315	350	385	420	455	490	525	560
Annual Water Use, afy(1)	112	126	140	154	168	182	196	210	224
Avg. Daily Demand, gpm	69	78	87	95	104	113	122	130	139
Max Day Demand, gpm(2)	174	195	217	239	260	282	304	325	347
Max Day Demand, mgd	0.250	0.281	0.312	0.344	0.375	0.406	0.437	0.469	0.500
Req'd Reliable Source Capacity for 12 Hrs Operation, gpm	347	391	434	477	521	564	608	651	694
Req'd Reliable Source Capacity for 18 Hrs Operation, gpm	260	293	325	358	391	423	456	488	521

1. Basis-0.40afy/conn

2. Max Day = 2.5 X Avg Day

TABLE V-2

4/27/2016

PROJECTED CONNECTIONS AND WATER USE AND SOURCE REQUIREMENTS-HIGH ZONE

YEAR	2015	2020	2025	2030	2035	2040	2045	2050	2055
Connections	152	160	175	190	210	225	245	260	280
Annual Water Use, afy(1)	60.8	64	70	76	84	90	98	104	112
Avg. Daily Demand, gpm	38	40	43	47	52	56	61	64	69
Max Day Demand, gpm(2)	94	99	108	118	130	139	152	161	174
Max Day Demand, mgd	0.136	0.143	0.156	0.170	0.187	0.201	0.219	0.232	0.250
Req'd Reliable Booster Source Capacity for 12 Hrs Operation gpm	188	198	217	236	260	279	304	322	347

1. Basis-0.40afy/conn

2. Max Day= 2.5 x Avg Day

SECTION VI

LONG-RANGE SYSTEM NEEDS

Addressed in this section will be the need for additions or replacements to the District's major water supply facilities, therefore this will include consideration of water source, storage, and distribution.

A. WATER SOURCE NEEDS

Contained in **Table V-1** is an estimate of the water source needs defined as the Demand required, factored by the estimated operating time of the well pump(s) to take advantage of Southern California Edison rate incentives. For this, it is estimated that operating time during the maximum use period, that is, a summer day will be 18 hours per day, which allows for offpeak pumping. Required then is well pumping capacity sufficient to supply the need of max day use for the proposed or scheduled operating hours plus a backup of equal capacity. This is seen in **Table V-1** to increase from a current need of 260 gpm to ±520 gpm in 2055. Existing capacity is seen to be likely adequate for now and for a few years, but additional capacity will be needed if projected development occurs. Estimated time is 2020-2025. Additional capacity can be achieved by installing a larger pump and motor on the wells. Both wells were test pumped to 1,200 gpm or more, it is noted from the completion reports and thus can be equipped with larger capacity pumps, ultimately doubling the discharge to supply projected demand.

In addition to District's well source it is highly recommended that an interconnection be completed or arrangements be in place to effect quickly in case of loss of source and backup. The possibilities or options for this, and the costs, are unknown, however.

Replacement needs concerning the District's water source include equipment with greatly different ages. Wells are estimated to have a life of 50 years and thus both existing wells will need to be replaced in the latter stages of the 40-year planning period.. Pumping equipment in the wells, however, generally only has a life of 10 years and therefore would need to be replaced periodically, perhaps considering additional capacity needs.

Not included in our planning or cost estimating for any of the features are maintenance and repairs.

B. STORAGE REQUIREMENTS

Storage required is comprised of three components for District operation; that is, operating storage, fire flow, and emergency. Operating storage is generally one-third of the requirement and its use is to provide the cushion for the period of day when demand exceeds supply and storage tanks are drawn down. This storage then is replenished during lower use and lower electrical energy periods.

Fire flow is required for that purpose, of course, and for this plan we have proposed planning for a delivery rate of 750 gpm for which storage is required for two hours or 90,000 gallons.

Third component, that for emergency, is for that exact purpose in case of outage of pumps for an extended period, it allows supply for a period of time until restoration can be effected. General criteria for this amount is equal to one-half in volume, which for current needs is 125,000 gallons. Total current need by this definition, therefore, is 298,000 gallons for which the District facilities are not quite adequate. The planned addition of storage at the Mesa site will make up the deficit.

Shown on **Table VI-1** are the projected storage amounts using this criteria for the 40-year planning period. Aside from the need to construct, it will be incumbent upon the District to obtain sites upon which additional storage can be constructed as it is thought that the current sites may not accommodate any additional storage facilities. And future, as existing sites, will be on BLM land. Of interest, the proposed storage amounts slightly exceed the amount recommended by USDA Rural Development for systems of this size, that is, one volume.

Concerning replacement needs, the Central Road Reservoir is now 25 years old with a projected life of 50 years while the Mesa Tanks have already been in service longer than the projected life. This is particularly evidenced by the recent inspection report in which it was recommended that one be replaced. Proposed construction of a new 200,000-gallon tank would address this issue, of course.

Also displayed in **Table VI-1** are required reservoir additions to maintain the storage criteria set forth above.

C. DISTRIBUTION SYSTEM

Distribution system consists of the pipe network, booster pumping station, and the hydrant inventory. Distribution piping system needs to be sufficient in size to convey the combination of flow demand plus fire flow to any point or location in the District with a minimum residual pressure of 20 psi. To determine adequacy of the system, operation was simulated by use of our computer model of the existing system shown on the H2ONET MODEL shown at the back of the report. Pipe sizing was shown to be adequate to deliver max day plus fire flow of 750 gpm to all locations in the District except where served and/or supplied by four-inch pipe, which are, of course, considerable, and at four-end-of-660-foot, six-inch pipe runs, two in each pressure zone. Printouts of the modeling results are contained at

Appendix B.

Additionally, results of max day plus fire flow of 500 gpm are also provided at **Appendix C**, to provide a backup or secondary criteria. Scanning of the columns labeled "Residual Pressure (psi)" indicates pressure at each junction, either an intersection or end of pipe, for the test fire flow amount. Evident are pressures in excess of 20 psi as well as those below, in some cases actually negative due to four-inch pipe with high pressure losses.

An additional criteria for pipe sizing is that all should be a minimum of 6" that serve a hydrant; 4" is sufficient if it serves residential connections only. Additionally, all pipe installations in system network planning should seek to avoid dead ends of which there are approximately 17 in the District. In addition to pipe size, fire flow delivery will also be limited by hydrant capacity. Many locations

in the District do not have a hydrant but only a 2" or 4" standpipe or blowoff. Though a 2" is totally inadequate to deliver the planned fire flow of 750 gpm, 4" stand pipe can do so with sufficient system pressure. Hydrants are installed by water agencies for convenience in system maintenance (flushing) and use by fire protection agencies in suppressing fires. Therefore, priority should be given to replacing the 2" stand pipes in conjunction with pipeline construction to provide minimum fire flow.

Resulting from the application of these criteria is the need for planning for replacement of pipe. The first priority would be that of the leaking transmission pipeline, Mesa Vista Street, Ocotillo Way to Roundup Way. Next priority to alleviate 500-gpm fire flow delivery inadequacy at five of six sites would be replacement of 4" pipeline with 6" or 8" pipelines in Cholla Road, south of Roundup Way (1,050', 8"), Roundup Way, east of Central (1,300', 8"), Bella Vista, south of Ocotillo (1,100', 8"), and south of Roundup Way (1,000', 8"), and Bonita Vista, south of Roundup Way (300', 6"). Next priority suggested is to replace 4" pipelines to accommodate delivery of fire flow of 750 gpm in numerous street alignments, totaling 11,510 feet, virtually all 6".

Fourth priority would be to attempt to alleviate dead ends and complete looping, but this will likely happen only as development occurs. As accomplished fire flow delivery capability will be greatly improved.

In total, approximately 12,260 lineal feet of 4" pipe would be replaced with 6" or 8" to increase fire flow delivery capacity. Southerly portion of the pipeline in Bella Vista fed from Ocotillo should be converted to the High Pressure Zone

Pipeline replacements or additions are shown on **Sheet 2** at the back of this report, prioritized per the first three criteria cited above.

High Pressure Zone water needs supplied by the Roundup Way Booster Pumping Station are shown in **Table V-2**. Booster pumping station equipment was replaced in late 2014 with an estimated life of 10 years, and therefore adequate for that period. As for water source for the entire District, booster capacity for the High Zone needs to be capable of supplying requirement with backup and/or capable of replenishing fire flow draw, 90,000 gallons in 6 to 8 hours. Current capacity is sufficient for those needs for at least 15 years, past the likely life of the pumps recently installed. Larger booster capacity may be appropriate or required if High Zone water storage capacity is limited, in order to move water from Low Zone storage at a higher pumping rate.

D. ADMINISTRATIVE AND MAINTENANCE FACILITIES

Existing administrative and maintenance facilities consist solely of the converted residence on Cerra Vista. If and when development occurs in the District, there will likely be need for additional room for more staff, electronic and monitoring equipment, and maintenance/construction equipment. For this, it is envisioned that the existing office facility would be expanded, remodeled, and adapted for the greater needs and uses.

TABLE VI-1

6/23/2016

STORAGE & ADDITION/REPLACEMENT REQUIREMENTS

PERIOD ENDING	2015	2020	2025	2030	2035	2040	2045	2050	2055
EST'D MAX DAY,MG	0.250	0.281	0.312	0.344	0.375	0.406	0.437	0.469	0.500
1/3 MD, (MG)	0.083	0.094	0.104	0.115	0.125	0.135	0.146	0.156	0.167
FIRE FLOW (MG)	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090
EMERGENCY STORAGE (MG) (1/2 MD)	0.125	0.141	0.156	0.172	0.188	0.203	0.219	0.235	0.250
TOTAL AMOUNT (MG)	**0.298**	**0.324**	**0.350**	**0.377**	**0.402**	**0.428**	**0.454**	**0.481**	**0.507**
EXISTING STORAGE (MG)	0.260	0.260	0.400	0.400	0.400	0.400	0.400	0.500	0.500
ADDITIONS (MG)		0.200	0.000	0.000	0.000	0.000	0.300	0.000	0.000
DELETIONS (MG) - MESA TANKS		0.060							
DELETIONS (MG) - CENTRAL							0.200		
REVISED TOTAL (MG)		**0.400**	**0.400**	**0.400**	**0.400**	**0.400**	**0.500**	**0.500**	**0.500**

SECTION VII

LONG RANGE EXPANSION AND REPLACEMENT PLAN

System needs for the District were identified in a previous section. Developed and presented in this section are the addition or replacement of various features or facilities to meet District needs, a schedule or timing of the action, and estimate of investment or expenditures required.

Costs presented are current costs of "hardware" with no land or right-of-way cost included. Costs do include an allowance for engineering for reservoir and pipeline construction. Long-term financing costs are not included. Unit costs, therefore, used for the various additions or replacements are as follows:

FEATURE	UNIT	QUANTITY	UNIT COST	TOTAL COST
Water Source 100-HP Well Pump, Electrical Service, and Pump Panel	EA	1	$85,000	$85,000
150-HP Well Pump, Electrical Service, and Pump Panel	EA	1	$125,000	$125,000
Well Construction, 12" Casing x 600'	EA	1	$500,000	$500,000
Storage 200,000-Gallon Bolted Steel Tank, Site Preparation & Piping	EA	1	$226,000	$226,000

FEATURE	UNIT	QUANTITY	UNIT COST	TOTAL COST
300,000-Gallon Bolted Steel Tank, Site Preparation & Piping	EA		$332,000	$332,000
Distribution System 8" Pipe, PVC, Including Valves, Hydrants (No AC R&R) (Mesa Vista St.)	LF	2,650	$75	$198,750
6" Pipe, PVC, Including Valves, Hydrants (No AC R&R)	LF	11,110	$70	$777,700
8" Pipe, PVC, Including Valves, Hydrants (No AC R&R)	LF	5,150	75	$386,250
		Total Distribution Pipeline Replacement		$1,362,700
Booster Pumps Pump Replacement, 20 HP, 250-GPM	LS	1	$23,000	$23,000
Pump Replacement, 30 HP, 350-GPM	LS	1	$27,000	$27,000

Table VII-1 contains a presentation of estimated facility or feature need, timing in five-year increments, and per unit costs developed above. Amounts per five-year period, then, are totaled. Bases of projected need and timing are as described in Section VI, that is, water source equal to need plus a back-up, storage consisting of amount sufficient for operating, fire flow, and emergency needs, and distribution system piping sufficient to convey plus fire flow, minimum 6". Booster pumping stations are also sized to provide capacity.

Priorities will, of course, be the facilities indicated in the period 2016 to 2020.

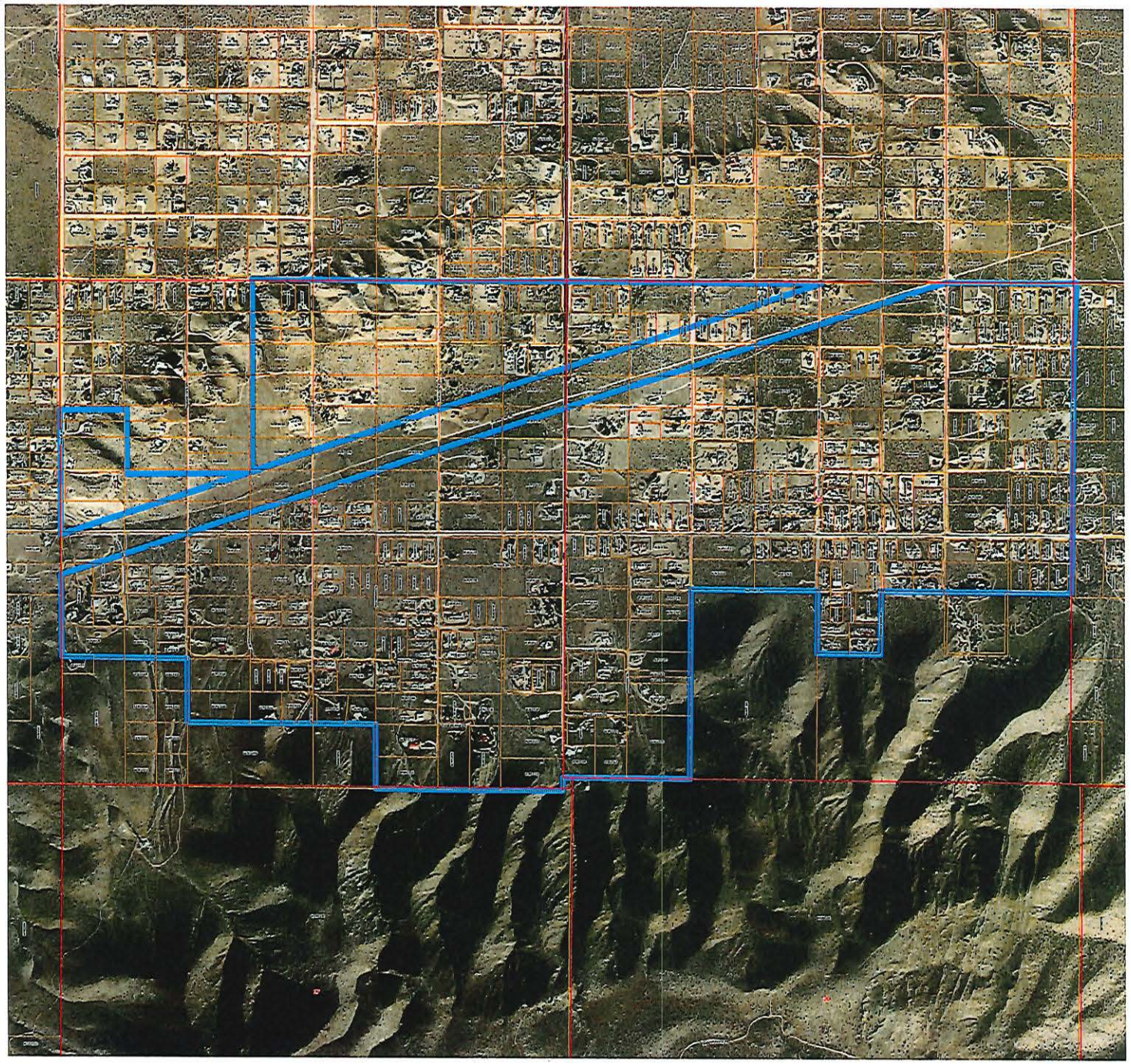
TABLE VII-1

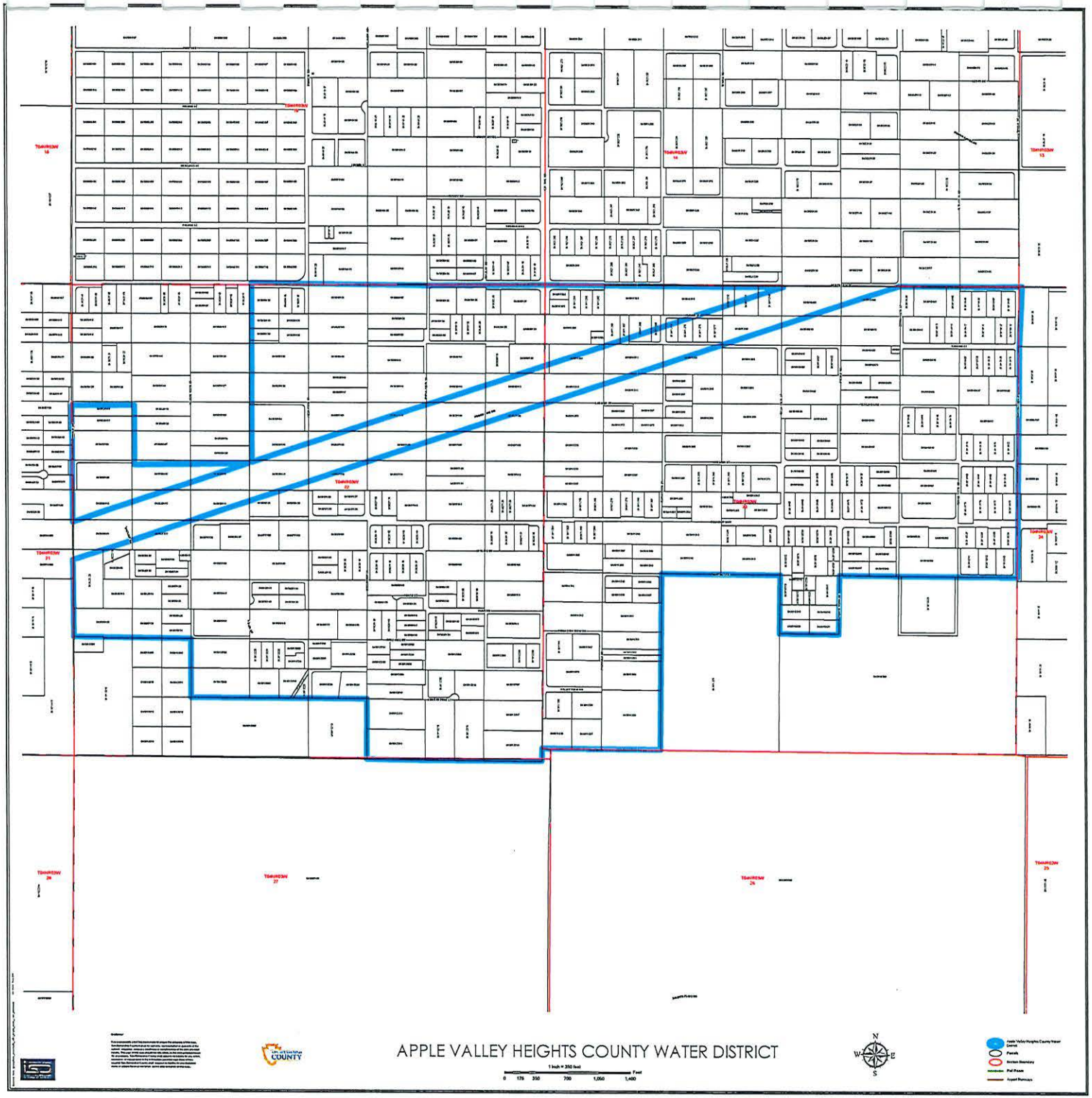
ESTIMATED REPLACEMENT AND EXPANSION SCHEDULE OF EXPENDITURES

	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040	2041-2045	2046-2050	2051-2055
Mesa Vista Transmission Pipe Replacement	$198,750							
Mesa Tank, 200,000 Gallons Capacity	$226,000							
Rehab/Replace Well Pumps		$85,000	$85,000	$85,000	$85,000	$125,000	$125,000	$125,000
Reservoir Addition, 300,000 Gallons						$332,000		
Distribution Pipelines Replacement		$166,000	$166,000	$166,000	$166,000	$166,000	$166,000	$166,000
Well #3 Replacement						$500,000		
Booster Pumps-Rehab/Replace		$23,000		$23,000		$27,000		$27,000
Distribution Pipelines Replacement				$100,000	$100,000	$100,000	$100,000	$100,000
Expand Admin Facilities/Yard			$250,000					
TOTALS	**$424,750**	**$274,000**	**$501,000**	**$374,000**	**$351,000**	**$1,250,000**	**$391,000**	**$418,000**

APPENDIX A

AERIAL PHOTO & PLOT OF PARCELS, BOUNDARY, & SOUTHERN CALIFORNIA OVERHEAD POWER LINE


APPLE VALLEY HEIGHTS COUNTY WATER DISTRICT
1 Inch = 350 feet
0 175 350 700 1,050 1,400 Feet
N
W
E
S
Air Photo Date: Feb, 2014


APPLE VALLEY HEIGHTS COUNTY WATER DISTRICT
1 Inch = 350 feet
0 175 350 700 1,050 1,400 Feet
N
W
E
S

APPENDIX B

750-GPM FIRE FLOW RESULTS
EXISTING SYSTEM

RESULTS OF MAX DAY + FIRE FLOW OF 750 GPM

Junction Fire Flow Results - 750 GPM

ID	Static Demand (gpm)	Static Pressure (psi)	Static Head (ft)	Fire-Flow Demand (gpm)	Residual Pressure (psi)	Available Flow at Hydrant (gpm)	Available Flow Pressure (psi)
J1000	3.4	123.82	3,435.75	750	49.62	909.45	20
J1001	3.4	128.14	3,435.74	750	-64.1	549.27	20
J1002	3.4	110.81	3,435.73	750	-147.02	425.4	20
J1003	3.4	115.16	3,435.77	750	70.57	1,159.83	20
J1004	3.4	116.5	3,435.77	750	6.32	700.11	20
J1005	3.4	82.44	3,435.76	750	23.05	775.04	20
J1006	3.4	86.73	3,435.76	750	12.91	711.87	20
J1007	3.4	32.83	3,435.76	750	-48.63	262.97	20
J1008	3.4	93.56	3,435.92	750	79.75	2,068.39	20
J1009	3.4	102.69	3,439.49	750	78.09	1,489.56	20
J1010	3.4	55.9	3,436.32	750	50.02	2,197.87	20
J1011	3.4	85.58	3,436.31	750	50.76	1,066.74	20
J1012	3.4	68.76	3,434.70	750	47.97	1,290.33	20
J1013	3.4	71.52	3,436.67	750	19.09	745.89	20
J1014	3.4	64.16	3,436.67	750	-2.84	594.72	20
J1015	3.4	72.08	3,437.14	750	43.11	1,055.38	20
J1016	3.4	71.56	3,435.15	750	36.64	948.77	20
J1017	3.4	58.04	3,433.94	750	32.34	965.8	20
J1018	3.4	78.88	3,434.06	750	49.57	1,153.74	20
J1019	3.4	78.1	3,434.05	750	46.66	1,094.05	20
J1020	3.4	85.85	3,434.13	750	55.66	1,209.21	20
J1021	3.4	47.2	3,433.94	750	-50.42	361.72	20
J1022	3.4	65.58	3,433.96	750	-16.41	537.08	20
J1023	3.4	62.42	3,433.96	750	-34.13	470.49	20
J1024	3.4	74.85	3,434.04	750	37.44	947.97	20
J1025	3.4	70.51	3,434.04	750	18.55	740.97	20
J1026	3.4	84.09	3,434.07	750	40.31	943.49	20
J1027	3.4	75.42	3,434.06	750	2.28	642.23	20
J1028	3.4	50.8	3,434.04	750	-181.32	244.83	20
J1029	3.4	41.81	3,436.49	750	39.13	2,565.18	20
J2000	3.2	111.9	3,738.25	750	45.65	896.78	20
J2001	3.2	175.38	3,738.26	750	146.24	2,051.57	20
J2002	3.2	169.91	3,737.63	750	142.78	2,071.38	20
J2003	3.2	200.6	3,738.97	750	171.77	2,423.66	20
J2004	3.2	189.77	3,737.98	750	162.14	2,402.06	20
J2005	3.2	143.08	3,737.01	750	122.43	2,210.01	20
J2006	3.2	137.66	3,737.00	750	12.13	727.67	20
J2007	3.2	139.98	3,736.95	750	120.57	2,258.43	20
J2008	3.2	145.41	3,737.49	750	119.2	1,867.32	20
J2009	3.2	178.85	3,737.77	750	142.91	1,825.87	20
J2010	3.2	146.35	3,737.76	750	5.13	709.5	20
J2011	3.2	141.95	3,737.60	750	97.8	1,340.21	20
J2012	3.2	158.09	3,737.36	750	81.54	1,043.67	20

J2013	3.2	190.56	3,737.29	750	-97.38	566.77	20
J2014	3.2	186.23	3,737.29	750	-116.27	544.17	20
J2015	3.2	92.99	3,737.51	750	32.85	837	20
J2016	3.2	59.58	3,737.50	750	-63.49	407.85	20
J2017	3.2	128.91	3,737.50	750	77.66	1,147.22	20
J2018	3.2	115.86	3,737.40	750	56.31	980.01	20
J2019	3.2	136.42	3,737.35	750	60.62	954.34	20
J2020	3.2	156.95	3,737.22	750	26.29	772.85	20
J2021	3.2	145.68	3,737.22	750	0.47	696.05	20
J2022	3.2	198.08	3,737.15	750	12.66	736.76	20
J2023	3.2	89.86	3,737.39	750	-37.55	543.93	20
J2024	3.2	86.37	3,737.32	750	4.52	671.56	20
J2025	3.2	110.36	3,737.20	750	-24.99	603.67	20
J2026	3.2	121.63	3,737.20	750	-28.28	608.95	20
J2027	3.2	158.43	3,737.13	750	-29.42	637.27	20
J2028	3.2	169.69	3,737.13	750	-32.71	638.64	20
J2029	3.2	182.47	3,737.13	750	-14.19	678.49	20
J2030	3.2	59.5	3,737.32	750	-79.95	377.84	20
J2031	3.2	101.55	3,734.37	750	95.47	2,893.56	20
J9000	0	104.65	3,441.52	750	76.22	1,378.35	20
J9003	0	4.39	3,436.63	750	4.39	-166,345.92	19.94
J9004	0	195.73	3,739.72	750	169.52	3,041.36	20
J9005	0	63.22	3,433.91	750	39.35	1,098.27	20
J9007	0	8.62	3,733.38	750	8.6	-21,837.79	20

APPENDIX C

500-GPM FIRE FLOW RESULTS
EXISTING SYSTEM

Existing System: 500 GPM placed on all Junction Nodes.

ID	Static Demand (gpm)	Static Pressure (psi)	Static Head (ft)	Fire-Flow Demand (gpm)	Residual Pressure (psi)	Available Flow at Hydrant (gpm)	Available Flow Pressure (psi)
J1000	3.4	125.9	3,440.55	500	89.43	918.89	20
J1001	3.4	130.22	3,440.54	500	37.82	554.78	20
J1002	3.4	112.89	3,440.53	500	-10.59	430.53	20
J1003	3.4	117.24	3,440.57	500	94.91	1,172.92	20
J1004	3.4	118.58	3,440.57	500	65.18	707.95	20
J1005	3.4	84.52	3,440.56	500	55.13	788.64	20
J1006	3.4	88.81	3,440.56	500	52.58	723.54	20
J1007	3.4	34.91	3,440.56	500	-4.94	286.38	20
J1008	3.4	95.64	3,440.72	500	88.28	2,098.67	20
J1009	3.4	104.73	3,444.21	500	92.35	1,507.02	20
J1010	3.4	58	3,441.16	500	54.89	2,265.93	20
J1011	3.4	87.68	3,441.15	500	70.85	1,084.59	20
J1012	3.4	70.82	3,439.45	500	59.43	1,320.45	20
J1013	3.4	73.57	3,441.40	500	47.3	761.53	20
J1014	3.4	66.21	3,441.39	500	33.04	609.5	20
J1015	3.4	74.12	3,441.86	500	59.25	1,076.55	20
J1016	3.4	73.61	3,439.88	500	55.41	968.93	20
J1017	3.4	60.08	3,438.67	500	46.04	995.36	20
J1018	3.4	80.93	3,438.78	500	65.2	1,175.53	20
J1019	3.4	80.15	3,438.78	500	63.4	1,114.98	20
J1020	3.4	87.9	3,438.85	500	71.77	1,229.44	20
J1021	3.4	49.25	3,438.67	500	1.01	376.72	20
J1022	3.4	67.63	3,438.68	500	26.74	550.26	20
J1023	3.4	64.47	3,438.68	500	16.68	482.87	20
J1024	3.4	76.89	3,438.76	500	57.27	967.22	20
J1025	3.4	72.56	3,438.76	500	46.03	757.3	20
J1026	3.4	86.14	3,438.80	500	63.5	959.66	20
J1027	3.4	77.47	3,438.79	500	40.86	655.04	20
J1028	3.4	52.85	3,438.77	500	-59.1	253.61	20
J1029	3.4	43.91	3,441.34	500	42.49	2,695.58	20
J2000	3.2	111.99	3,738.47	500	81.31	898.88	20
J2001	3.2	175.47	3,738.47	500	162.37	2,062.61	20
J2002	3.2	169.99	3,737.83	500	157.9	2,082.83	20
J2003	3.2	200.71	3,739.20	500	187.79	2,436.81	20
J2004	3.2	189.87	3,738.19	500	177.52	2,415.95	20
J2005	3.2	143.15	3,737.17	500	134.24	2,225.23	20
J2006	3.2	137.73	3,737.16	500	79.13	728.51	20
J2007	3.2	140.05	3,737.12	500	131.71	2,274.25	20
J2008	3.2	145.49	3,737.68	500	133.86	1,878.38	20
J2009	3.2	178.95	3,737.99	500	162.41	1,834.76	20
J2010	3.2	146.44	3,737.98	500	80.03	710.42	20
J2011	3.2	142.04	3,737.81	500	121.38	1,345.52	20
J2012	3.2	158.19	3,737.58	500	121.76	1,045.98	20

J2013	3.2	190.66	3,737.51	500	53.7	567.16	20
J2014	3.2	186.32	3,737.51	500	42.47	544.54	20
J2015	3.2	93.08	3,737.72	500	64.72	839.44	20
J2016	3.2	59.67	3,737.72	500	1.5	408.59	20
J2017	3.2	129	3,737.72	500	104.81	1,151.05	20
J2018	3.2	115.96	3,737.61	500	87.67	982.84	20
J2019	3.2	136.52	3,737.56	500	100.4	956.51	20
J2020	3.2	157.04	3,737.43	500	94.61	773.91	20
J2021	3.2	145.78	3,737.43	500	76.45	696.95	20
J2022	3.2	198.18	3,737.36	500	109.59	737.48	20
J2023	3.2	89.96	3,737.61	500	29.53	544.81	20
J2024	3.2	86.46	3,737.54	500	47.4	673.12	20
J2025	3.2	110.45	3,737.41	500	45.69	604.56	20
J2026	3.2	121.72	3,737.41	500	50.06	609.76	20
J2027	3.2	158.52	3,737.34	500	68.62	637.93	20
J2028	3.2	169.78	3,737.34	500	72.99	639.25	20
J2029	3.2	182.57	3,737.34	500	88.51	679.14	20
J2030	3.2	59.59	3,737.53	500	-6.76	378.44	20
J2031	3.2	101.57	3,734.42	500	99.05	2,903.31	20
J9000	0	106.68	3,446.21	500	92.57	1,393.72	20
J9003	0	6.5	3,441.50	500	6.5	-51,466.27	19.99
J9004	0	195.84	3,739.98	500	184.22	3,062.51	20
J9005	0	65.27	3,438.63	500	52.07	1,127.88	20
J9007	0	8.62	3,733.38	500	8.61	-21,834.56	20

APPENDIX D

500-GPM FIRE FLOW WITH REPLACEMENT PIPELINES

Additional 8" added to proposed pipe network: Fire Flow = 500 GPM

ID	Static Demand (gpm)	Static Pressure (psi)	Static Head (ft)	Fire-Flow Demand (gpm)	Residual Pressure (psi)	Available Flow at Hydrant (gpm)	Available Flow Pressure (psi)
J1000	3.4	125.9	3,440.57	500	89.47	919.23	20
J1001	3.4	130.24	3,440.57	500	86.04	840.19	20
J1002	3.4	112.9	3,440.57	500	73.5	816.08	20
J1003	3.4	117.25	3,440.59	500	94.95	1,173.57	20
J1004	3.4	118.59	3,440.59	500	91.98	1,061.28	20
J1005	3.4	84.53	3,440.58	500	55.17	789.05	20
J1006	3.4	88.82	3,440.58	500	52.62	723.86	20
J1007	3.4	34.92	3,440.58	500	-4.9	286.68	20
J1008	3.4	95.65	3,440.74	500	88.32	2,103.37	20
J1009	3.4	103.66	3,441.74	500	94.34	1,859.27	20
J1010	3.4	58	3,441.17	500	54.9	2,268.59	20
J1011	3.4	87.68	3,441.16	500	70.87	1,084.85	20
J1012	3.4	70.79	3,439.36	500	59.95	1,354.47	20
J1013	3.4	72.81	3,439.63	500	59.71	1,183.90	20
J1014	3.4	65.44	3,439.62	500	45.44	817.81	20
J1015	3.4	73.18	3,439.69	500	61.18	1,260.10	20
J1016	3.4	73.43	3,439.46	500	60.2	1,188.80	20
J1017	3.4	60.02	3,438.51	500	46.84	1,029.87	20
J1018	3.4	80.84	3,438.57	500	66.83	1,265.21	20
J1019	3.4	80.06	3,438.57	500	65.32	1,209.26	20
J1020	3.4	87.8	3,438.62	500	73.68	1,340.49	20
J1021	3.4	49.19	3,438.51	500	34.12	767.06	20
J1022	3.4	67.56	3,438.53	500	50.64	954.17	20
J1023	3.4	64.4	3,438.52	500	40.58	730.4	20
J1024	3.4	76.8	3,438.55	500	61.25	1,127.19	20
J1025	3.4	72.47	3,438.55	500	50.02	836.68	20
J1026	3.4	86.03	3,438.55	500	69.02	1,155.66	20
J1027	3.4	77.36	3,438.54	500	46.38	721.59	20
J1028	3.4	52.75	3,438.54	500	19.2	496.27	20
J1029	3.4	43.91	3,441.35	500	42.5	2,697.75	20
J2000	3.2	111.99	3,738.46	500	81.31	898.87	20
J2001	3.2	175.47	3,738.46	500	162.37	2,066.92	20
J2002	3.2	169.99	3,737.82	500	157.9	2,087.09	20
J2003	3.2	200.7	3,739.20	500	187.78	2,445.72	20
J2004	3.2	189.87	3,738.18	500	177.52	2,424.84	20
J2005	3.2	143.15	3,737.17	500	134.24	2,231.49	20
J2006	3.2	137.73	3,737.16	500	79.13	728.49	20
J2007	3.2	140.05	3,737.11	500	131.71	2,280.86	20
J2008	3.2	145.49	3,737.67	500	133.86	1,881.20	20
J2009	3.2	178.94	3,737.98	500	162.4	1,837.33	20
J2010	3.2	146.45	3,737.98	500	122.98	1,256.21	20
J2011	3.2	142.04	3,737.81	500	121.38	1,345.96	20
J2012	3.2	158.26	3,737.75	500	133.93	1,315.84	20

J2013	3.2	190.76	3,737.74	500	152.48	1,137.87	20
J2014	3.2	186.42	3,737.74	500	141.25	1,021.57	20
J2015	3.2	93.12	3,737.80	500	71.46	971.67	20
J2016	3.2	59.71	3,737.80	500	37.03	679.11	20
J2017	3.2	129.02	3,737.77	500	106.41	1,194.04	20
J2018	3.2	116	3,737.70	500	90.74	1,044.51	20
J2019	3.2	136.58	3,737.70	500	110.67	1,150.45	20
J2020	3.2	157.15	3,737.67	500	127.28	1,164.20	20
J2021	3.2	145.88	3,737.67	500	109.12	984.3	20
J2022	3.2	198.3	3,737.65	500	164.06	1,250.63	20
J2023	3.2	90	3,737.70	500	63.64	854.88	20
J2024	3.2	86.51	3,737.65	500	54.13	744.35	20
J2025	3.2	110.55	3,737.64	500	76.29	854.96	20
J2026	3.2	121.82	3,737.64	500	80.66	823.79	20
J2027	3.2	158.65	3,737.64	500	122.67	1,054.43	20
J2028	3.2	169.91	3,737.64	500	127.04	996.96	20
J2029	3.2	182.7	3,737.64	500	146.75	1,154.35	20
J2030	3.2	59.64	3,737.65	500	23.48	529.02	20
J2031	3.2	101.57	3,734.42	500	99.05	2,904.48	20

APPENDIX E

750-GPM FIRE FLOW WITH REPLACEMENT PIPELINES

Additional 8" added to proposed pipe network: Fire Flow = 750 GPM

ID	Static Demand (gpm)	Static Pressure (psi)	Static Head (ft)	Fire-Flow Demand (gpm)	Residual Pressure (psi)	Available Flow at Hydrant (gpm)	Available Flow Pressure (psi)
J1000	3.40	125.9	3,440.57	750	51.63	919.23	20
J1001	3.40	130.24	3,440.57	750	39.59	840.19	20
J1002	3.40	112.9	3,440.57	750	32.36	816.08	20
J1003	3.40	117.25	3,440.59	750	72.58	1,173.57	20
J1004	3.40	118.59	3,440.59	750	64.82	1,061.28	20
J1005	3.40	84.53	3,440.58	750	25.06	789.05	20
J1006	3.40	88.82	3,440.58	750	14.92	723.86	20
J1007	3.40	34.92	3,440.58	750	-46.62	286.68	20
J1008	3.40	95.65	3,440.74	750	81.76	2,103.37	20
J1009	3.40	103.66	3,441.74	750	85.8	1,859.27	20
J1010	3.40	58	3,441.17	750	52.08	2,268.59	20
J1011	3.40	87.68	3,441.16	750	52.82	1,084.85	20
J1012	3.40	70.79	3,439.36	750	50.83	1,354.47	20
J1013	3.40	72.81	3,439.63	750	47.9	1,183.90	20
J1014	3.40	65.44	3,439.62	750	25.97	817.81	20
J1015	3.40	73.18	3,439.69	750	50.48	1,260.10	20
J1016	3.40	73.43	3,439.46	750	48.34	1,188.80	20
J1017	3.40	60.02	3,438.51	750	35.64	1,029.87	20
J1018	3.40	80.84	3,438.57	750	54.63	1,265.21	20
J1019	3.40	80.06	3,438.57	750	52.34	1,209.26	20
J1020	3.40	87.8	3,438.62	750	61.34	1,340.49	20
J1021	3.40	49.19	3,438.51	750	20.83	767.06	20
J1022	3.40	67.56	3,438.53	750	35.32	954.17	20
J1023	3.40	64.4	3,438.52	750	17.6	730.4	20
J1024	3.40	76.8	3,438.55	750	47.44	1,127.19	20
J1025	3.40	72.47	3,438.55	750	28.55	836.68	20
J1026	3.40	86.03	3,438.55	750	53.58	1,155.66	20
J1027	3.40	77.36	3,438.54	750	15.55	721.59	20
J1028	3.40	52.75	3,438.54	750	-14.49	496.27	20
J1029	3.40	43.91	3,441.35	750	41.21	2,697.75	20
J2000	3.20	111.99	3,738.46	750	45.95	898.87	20
J2001	3.20	175.47	3,738.46	750	146.54	2,066.92	20
J2002	3.20	169.99	3,737.82	750	143.05	2,087.09	20
J2003	3.20	200.7	3,739.20	750	172.11	2,445.72	20
J2004	3.20	189.87	3,738.18	750	162.47	2,424.84	20
J2005	3.20	143.15	3,737.17	750	122.69	2,231.49	20
J2006	3.20	137.73	3,737.16	750	12.39	728.49	20
J2007	3.20	140.05	3,737.11	750	120.82	2,280.86	20
J2008	3.20	145.49	3,737.67	750	119.47	1,881.20	20
J2009	3.20	178.94	3,737.98	750	143.24	1,837.33	20
J2010	3.20	146.45	3,737.98	750	96.13	1,256.21	20
J2011	3.20	142.04	3,737.81	750	98.13	1,345.96	20
J2012	3.20	158.26	3,737.75	750	106.82	1,315.84	20

J2013	3.20	190.76	3,737.74	750	109.98	1,137.87	20
J2014	3.20	186.42	3,737.74	750	91.1	1,021.57	20
J2015	3.20	93.12	3,737.80	750	47.13	971.67	20
J2016	3.20	59.71	3,737.80	750	11.58	679.11	20
J2017	3.20	129.02	3,737.77	750	81.15	1,194.04	20
J2018	3.20	116	3,737.70	750	62.78	1,044.51	20
J2019	3.20	136.58	3,737.70	750	82	1,150.45	20
J2020	3.20	157.15	3,737.67	750	94.37	1,164.20	20
J2021	3.20	145.88	3,737.67	750	68.55	984.3	20
J2022	3.20	198.3	3,737.65	750	126.4	1,250.63	20
J2023	3.20	90	3,737.70	750	34.46	854.88	20
J2024	3.20	86.51	3,737.65	750	18.54	744.35	20
J2025	3.20	110.55	3,737.64	750	38.69	854.96	20
J2026	3.20	121.82	3,737.64	750	35.4	823.79	20
J2027	3.20	158.65	3,737.64	750	83.19	1,054.43	20
J2028	3.20	169.91	3,737.64	750	79.91	996.96	20
J2029	3.20	182.7	3,737.64	750	107.27	1,154.35	20
J2030	3.20	59.64	3,737.65	750	-16.31	529.02	20
J2031	3.20	101.57	3,734.42	750	95.54	2,904.48	20