LVMWD Project No. 2562.00

June 2014

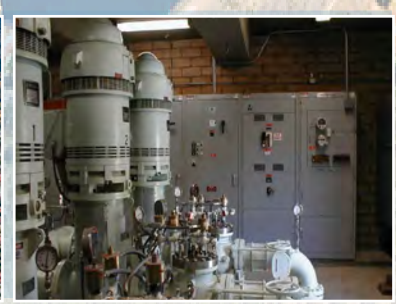
FINAL REPORT

Potable Water Master Plan Update 2014

for the:

Las Virgenes Municipal Water District





KJ Project No. 1389005*00

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Potable Water Master Plan Update 2014

30 June 2014

Prepared for

Las Virgenes Municipal Water District
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LVMWD Project No. 2562.00

K/J Project No. 1389005*00

Table of Contents

List of Tables

Table of Contents (cont'd)

List of Figures

List of Appendices

Executive Summary

Executive Summary

The Las Virgenes Municipal Water District (LVMWD, District) is located on the western edge of Los Angeles County and includes the cities of Agoura Hills, Calabasas, Hidden Hills, and Westlake Village, as well as some unincorporated county areas. While the service area and number of customers vary among the utilities, the District provides potable water, recycled water, and sanitation services to approximately 70,000 people over a 122 square mile service area. The District is guided by the following mission and planning goals.

The District's Mission Statement is 'Dedicate to Providing Quality Water and Wastewater Services' while valuing customer service, fiscal responsibility, our employees, reliable infrastructure, community involvement, environmental stewardship, and vision and innovation. Master planning is one of the several planning tools utilized by the District to achieve its mission. Among the other planning tools are the strategic plan with tactical actions and activities, Urban Water Management Plan, Infrastructure Investment Plan, financial plans, and annual budgets. The Master Plan and there other planning documents allow the District to plan and prepare for changing water supply conditions and demands, resulting from both short- and long-term changes in the environment, land use plans, regulations, and the economy.

The District's Potable Water, Recycled Water, Sanitation, and Integrated Master Plans were completed in 2007/2008. In 2010, the Urban Water Management Plan (UWMP) was completed, charting the course for SBx7-7 compliance. In 2011, a financial plan was updated, establishing rates to continue to improve the financial stability of the three funds and positioning LVMWD for a potential rate structure change to budget-based rates. LVMWD now desires to update the three utility master plans, which will establish an updated capital improvement program for the District's potable water system.

Goals and Purpose

The primary goals of this project are to update the LVMWD's 2007 Potable Water Master Plan with updated water usage data and growth planning data from the cities and the County, and provide additional project planning enhancements. These include:

- New water demand projections, which incorporate the most current information regarding population, land use and census information for the LVMWD service area projected to the year 2035. The water demand projections consider the effects of weather (including drought) and economic conditions on future water demand in order to increase defensibility in a time of increased pressure to reduce potable water demands in response to State legislation,

- A comprehensive update to the District's potable water system hydraulic model, including an interactive verification process of the water system model to increase confidence in master plan findings,

- An evaluation of infrastructure improvements to accommodate existing requirements and meet future needs, including an evaluation of system infrastructure fire flow (FF) requirements, and

- An updated capital improvement program to support the District's short and long-range capital improvement requirements.

Service Area Description

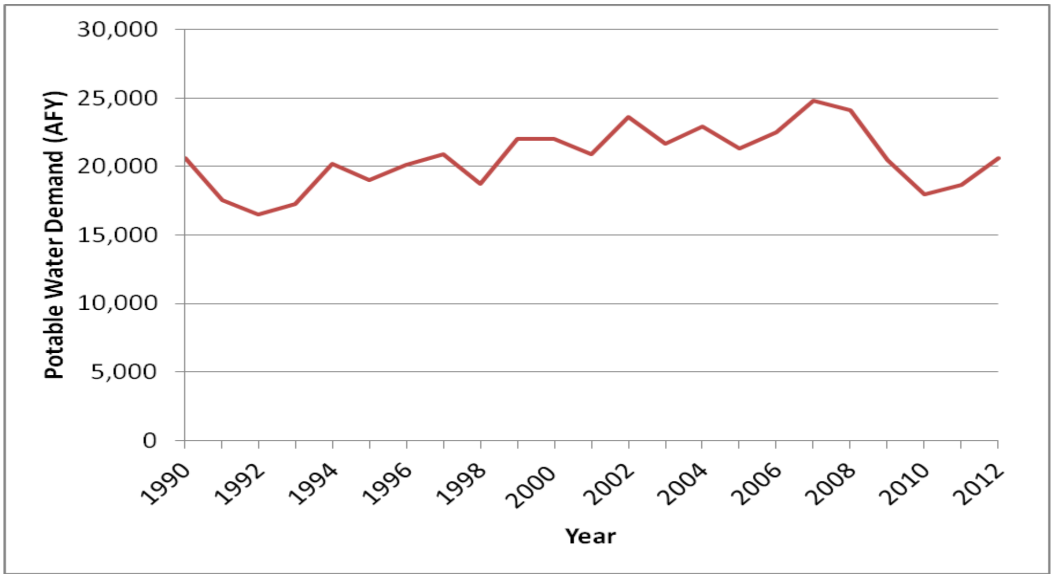
LVMWD's potable water service area includes the incorporated cities of Agoura Hills, Calabasas, Hidden Hills, and Westlake Village as well as unincorporated portions of Los Angeles County. A large portion of this area consists of undeveloped land characterized by the Santa Monica Mountains. These open space areas comprise about 35 to 40 percent of the total service area and are mostly held in public ownership, such as state and national parks that will not require water service. The remaining portion of the service area consists primarily of mixed residential and commercial uses, with only a small portion of the service area designated for industrial and agricultural land use. As such, LVMWD's water demands are primarily residential in nature and consist primarily of many small users (i.e., single family residential homes) with associated landscape irrigation.

Historical and Current Water Demands

In general, LVMWD's water demand has not grown as rapidly in the last 15 years as it did in the early history of the agency. This is generally due to a decline in the rate of development and increased customer awareness for needed conservation. In addition to these factors, recycled water use has increased, relieving the potable water system's general increase in demands.

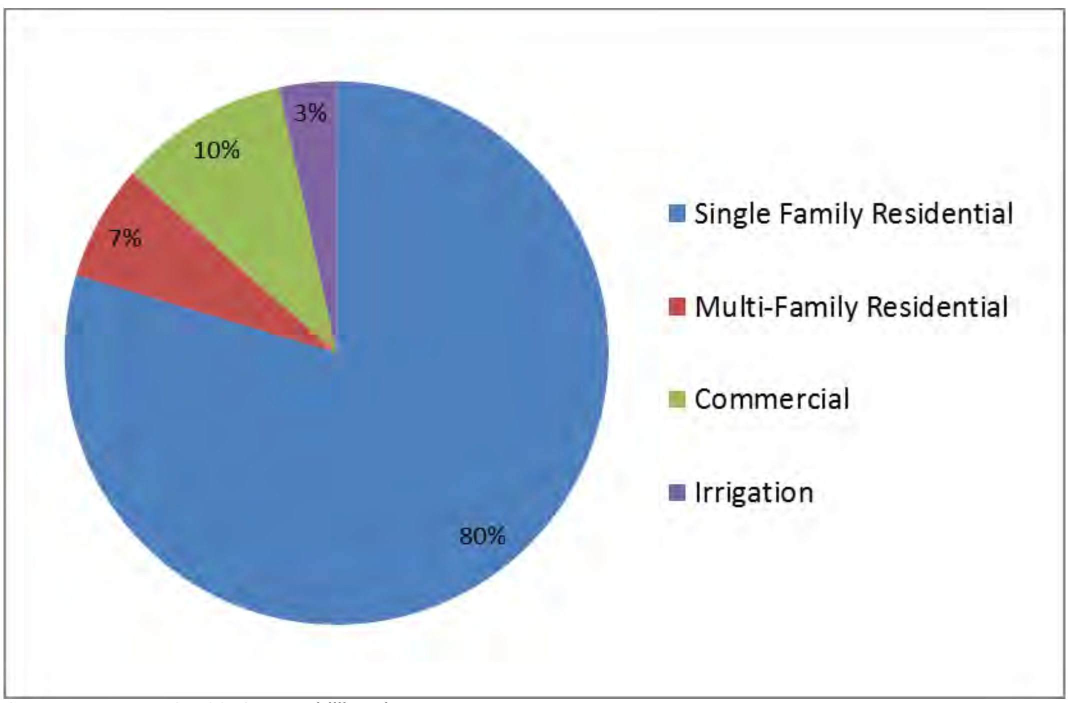
LVMWD's historical water use has varied substantially from year-to-year, with a general increasing trend through 2008. Water demands dropped in the 2009-2011 period, most likely due to a combination of factors, such as absence of hot summers, the economic downturn, and water conservation efforts by LVMWD. An increase in water demand was observed in 2012, suggesting a rebound in water use upon the end of the drought and/or improving economic conditions. LVMWD's historical water use since 1990 as compiled from the District's 2010 Urban Water Management Plan (UWMP) and account level water billing data is shown in Figure ES-1. The 2012 calendar year (CY) water usage by customer type is shown in Figure ES-2.

Figure ES-1: LVMWD Historical Water Demand 1990-2012



Source: 2010 UMWP and LVMWD water billing data (Table 2-1).

Figure ES-2: Water Demands by Customer Type



Source: LVMWD CY 2012 water billing data.

Projected Future Water Demand

In order to move from using actual water usage information to forecasting future water demands, the Master Plan needed to consider three key questions. These were: 1) how has the weather and/or the economy affected recent/current water demands, 2) how has the drought and associated rationing affected water demands, and 3) is there any statistical evidence to suggest that any or all of these factors will affect water demands in the future. To address these questions, regression analyses were performed on LVMWD's billing data (years 2003 through 2013) to evaluate the correlation between water use among various customer types and weather (ETo, precipitation) and economic (unemployment rate) factors.

Results of the regression analyses indicated that the water use for multi-family residential, commercial, irrigation, and single family residential accounts of all lot sizes correlate better with unemployment rate (R^2 of 0.646 to 0.924) than with weather related variables. In fact, depending on the customer type, water usage is predicted to increase as much as 20 to 38 percent (weighted average of 25 percent) based on the 2010 data and 15 to 24 percent (weighted average of 17 percent) based on 2012 data under good economic conditions (unemployment rate of 3.24 percent). The correlation analyses findings suggest that the projection of future water demands should incorporate an increase in water demands that is likely to occur with an improvement in the economy.

In addition to this statistical analysis performed by Kennedy/Jenks, Dr. Randall Orton, Resource Conservation Manager, studied the impacts of drought on water demands. The objective of the study was to estimate the pace and magnitude of post drought response on water demands, based on previous LVMWD's experience. Dr. Orton found annual water demand following the end of the recent drought will continue to rise, attaining its pre-drought level in approximately 6 years and 85 percent of that level in two years.

To account for the probable impact of both economic and drought recovery factors, an economic factor of 25 percent was applied to the 2010 potable water usage values, and various drought-recovery factors were also considered. As a result, water demand projections were calculated under for the following three scenarios:

- Scenario 1: Full Drought Recovery
- Scenario 2: No Drought Recovery
- Scenario 3: Partial (50 percent) Drought Recovery

Scenario 3 is believed to be the most appropriate demand scenario and is used as the basis for long range planning in this master plan. As shown in Table ES-1, the District's long range water demands are projected to reach approximately 33,750 Acre Feet by the year 2035.

Table ES-1: Water Demand Projection

Description	2015	2020	2025	2030	2035
Water Demand (AFY)	21,680	24,700	27,710	30,730	33,750

Notes: Based on a partial drought recovery projection (Scenario 3).

Inherent in the conduct of long-range planning studies is the need to consider alternative futures. This need is based on the reality that growth can't be precisely predicted and demands for service such as water that are driven by individual behavior is uncertain. It is for this reason that the projections derived herein utilized the best available data to quantify both population and water usage values, but attempted to frame or bracket these findings for the purposes of long-range water planning.

To further frame the discussion of long-range population and water demand projections, the results of several of LVMWD's previous planning efforts were also consolidated. The consolidation of previous population and water demand projections are shown in Figures ES-3 and ES-4, respectively. As shown, the findings presented herein are very comparable with all previous planning studies performed for the District since 2005.

Figure ES-3: Population Projection Comparison with Other Studies

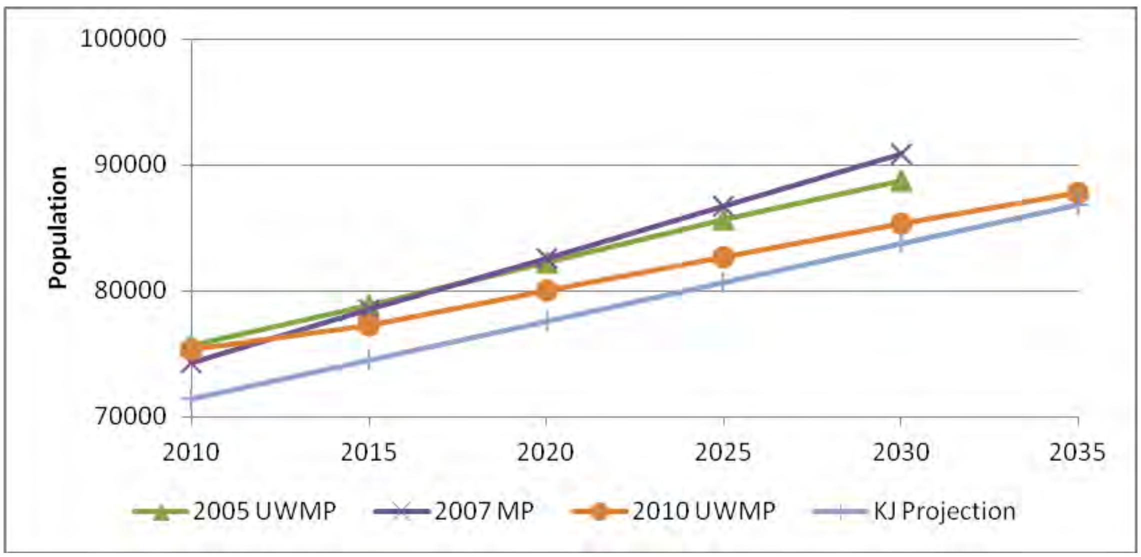
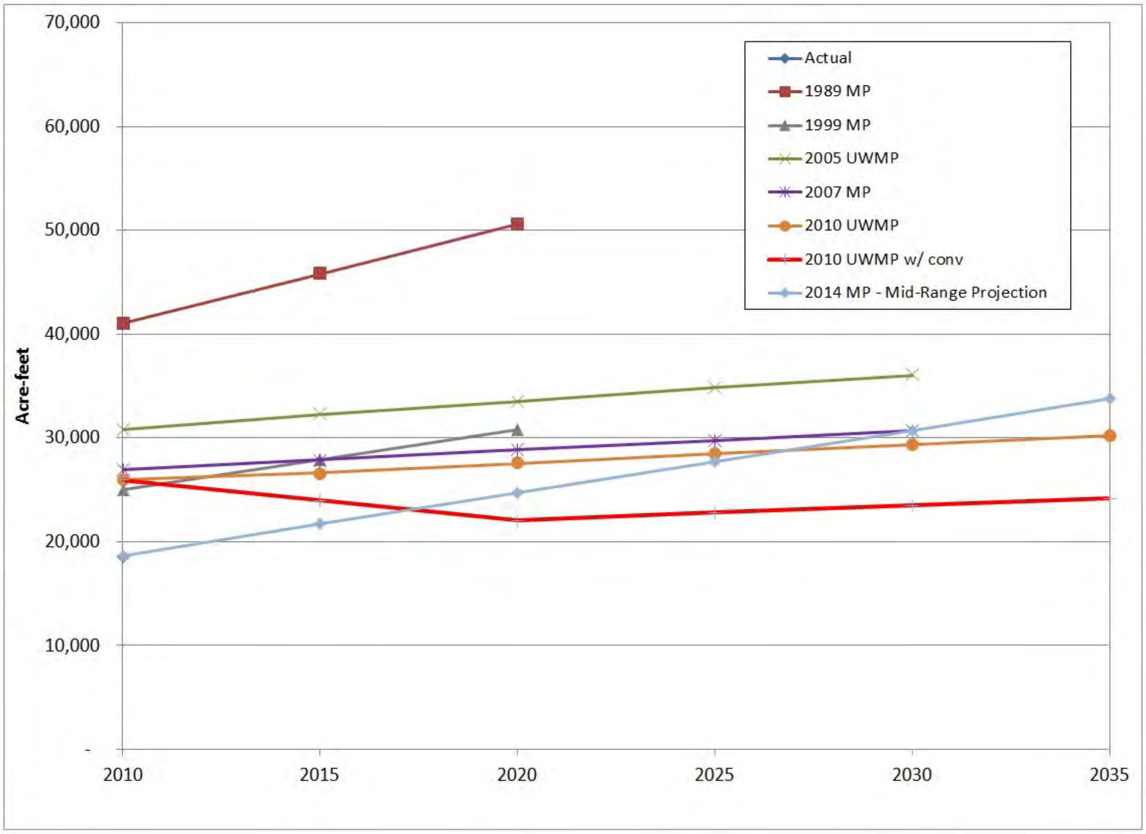


Figure ES-4: Annual Water Demand Projection Comparison with Other Studies



Summary of Existing Water Supplies and Availability

Located in the Santa Monica Mountains, LVMWD has limited availability of natural water resources and is currently limited to four sources: treated, potable water imported from Metropolitan Water District of Southern California (MWDSC), recycled water from the Tapia Water Reclamation Facility (TWRF), groundwater from the Russell Valley Basin (which is only used to supplement the TWRF), and surface runoff into Las Virgenes Reservoir. LVMWD has developed these water resources to provide increased water reliability using an approach that has included aggressive use of recycled water, minimal use of groundwater to augment recycled water supplies, and reservoir storage of water during low demand periods for use during the peak demand periods.

Imported water is LVMWD's primary water supply and supplies virtually all potable water demands. The imported water supplied to LVMWD originates from the State Water Project (SWP). The capacity of the three connections to the MWDSC system is approximately 73 cfs, (32,800 gpm). Assuming MWDSC has adequate supply, the District has ample turnout capacity to meet its long-range average annual water demands of approximately 32,750 AFY(20,920 gpm).

The District expects that MWDSC would have sufficient supplies available to accommodate LVMWD's projected demands under average year conditions, as LVMWD would get its proportional share of the increased supplies as one of MWDSC's 26 member agencies. Demand management should also continue as LVWMD continues to enhance its water conservation and recycled water programs to meet its SBX7-7 targets.

LVMWD initiated the Backbone Improvement Program in 2008 to address both a current and projected future deficiency in system storage, transmission and treatment capacity that creates a risk of low pressures, water outages, inadequate emergency supplies and fire flows. The program consists of transmission mains in Agoura Hills completed in 2012, transmission mains in Calabasas completed in 2014, a five million gallon storage tank under construction in Westlake Village and expansion of the Westlake Filtration Plant and modernization of the Westlake Pump Station. Completion of construction of all of these elements is necessary to correct the system deficiencies and ensure reliable water service.

The analysis of the potable water system in this master plan was based on these improvements being completed. If they are not completed, as planned, many of the conclusions in this report will no longer be valid.

Existing Water System

LVMWD's potable water system consists of an elaborate system of pumps, pressure zones, supply connections and reservoirs/tanks. There are 22 main pressure zones created by numerous facilities. Within these main zones are multiple sub-zones created by pressure regulation, containing no independent storage facilities. The topography plays a large role in the complexity of LVMWD's water delivery system. The complex nature of the current system is derived from a combination of the service area's rugged topography and its east to west linearity. To support the delivery of water throughout the District's service area, the District maintains over 400 miles of pipelines, 24 pumping stations, 25 storage tanks, and over 75 pressure regulating stations to improve system performance and reliability.

The 1235-foot main zone (where 1235 feet represents feet above mean sea level (msl)) is considered LVMWD's "backbone" system, which feeds almost every other system in the District. This system provides the transmission of potable water from MWDSC turnouts on the eastern portion of the LVMWD service area through the Ventura Freeway Corridor to the far west of the service area and Las Virgenes Reservoir. This main system serves approximately 90 percent of LVMWD's customers, either directly or by distribution to smaller subsystems within the service area. The potable water system was modeled with all of the backbone improvements completed, including the 5 million gallon tank.

The Cornell Pump Station is operated to move water either to the east or to the west, boost pressures and maintain the balance between supply and demand. This pump station is important during peak demand conditions, and when supplies are limited or not available from MWDSC. West of Cornell, the backbone system is sometimes referred to as the 1227 foot zone, based on the high water level of the Equestrian Trails Tank. Seasonal storage for LVMWD is provided by Las Virgenes Reservoir, which has a pump station and filtration plant to deliver the water back to the 1235 foot zone. This zone also has operational storage in the 8 million gallon (MG) Calabasas Tank, the 4.2 MG Equestrian Trails and the 3 MG Morrison Tank.

Additionally, a new 5 MG tank is currently being constructed at the filtration plant. This facility will store water at the filtration plant, which will then be pumped into the 1235 foot zone. Incorporation of this new tank in the water storage balance analyses eliminated a significant existing system storage deficiency.

System Analysis and Recommended Improvements

To evaluate the potable water system, the District's 2007 computerized hydraulic model was updated with new facility information and water billing data. Model accuracy was verified by analyzing a 24-hour scenario, and comparing tank levels in the model results with tank level measurements taken from the District's SCADA data. Once verified, the model was populated with new projections of future water demands throughout the system, and used to investigate high and low pressure locations, low pressure locations under fire flow demands, pipeline velocities, and tank refill conditions. Proceeding in this manner, the potable water system was evaluated under both current and future conditions for each of the 22 pressure zones.

In addition to the use of the updated hydraulic model, the District's storage and pumping facilities were evaluated against maximum day demand conditions to ensure that the system can operate to meet design criteria and regulatory requirements. For storage, each zone was evaluated to determine if the storage was adequate to provide sufficient operational, emergency and fire storage. The pumping facilities for each zone were evaluated to determine if there is sufficient capacity to provide maximum day demands in one of three time periods. These include 24 hours, 18 hours or 9 hours. The purpose of this analysis is to determine if the facilities have sufficient capacity to accommodate off-peak pumping, when energy costs are lower. Recommendations were made to allow the system to achieve the 18-hour pumping scheme. The storage and pumping facilities were evaluated together, as off-peak pumping requires both more pumping capacity and more storage.

Recommendations to address the findings of the potable water system analysis are divided into three categories: piping, storage, and pumping. A summary of the findings and recommended improvements for each of these areas of the system follows:

Pipeline Findings and Recommendations

Pipeline deficiencies were identified using the updated hydraulic model to locate facilities that did not meet the District's pressure and velocity criteria. District staff was engaged in a discussion of findings to promote prioritization of the distribution deficits and integration in the pipeline Capital Improvement Program (CIP). The prioritization consisted of the following four categories.

- Priority 1 - consist of projects that address existing capacity deficiencies in the system.
- Priority 2 - consist of projects that address existing capacity deficiencies that were less significant, and which were in areas, such as Hidden Hills and Monte Nido, that the District had acquired. These legacy systems were likely designed for lower fire flow requirements.
- Priority 3 - consist of projects that address relatively smaller capacity deficiencies.

- Priority 4 - consist of projects where the capacity deficiency was less than 10%. The Priority 4 projects were removed from the CIP, but will be retained in an appendix so that these areas can be looked at more closely in future master plan updates. These areas could have more significant capacity deficiencies in the future if growth in demands differs from the estimates used in this master plan update.

The District's pipeline evaluation criteria are shown in Table ES-2. The recommended distribution system pipeline improvements under both current and future demand conditions are shown in Tables ES-3 and ES-4, respectively. Note that the CIP projects identified under future demand conditions were not prioritized.

Table ES-2: Water Distribution System Evaluation Criteria

Description	Evaluation Criteria
Minimum pressure for max day or peak hour	35 psi
Minimum pressure for max day plus fire flow	20 psi
Maximum pressure	150 psi
Max velocity for existing pipes	10 fps
Max velocity for fire flow conditions	15 fps
Max velocity for new pipes	5 fps
Max headloss for existing pipes	10 ft/1000 ft
Max headloss for new pipes	5 ft/1000 ft

Table ES-3: Pipeline Improvements for Existing Demand Conditions

Existing CIP Priority	Length (Ft)	Estimated Cost
1	2,400	$927,450
2	13,297	$4,575,150
3	3,913	$1,410,750
Total	**19,611**	**$6,913,350**

Table ES-4: Pipeline Improvements for Future Demand Conditions

Future CIP	Length (Ft)	Estimated Cost
Total	28,975	$13,548,600

Note: Approximately $10.7M is associated with new Seminole System pipelines.

Storage Findings and Recommendation

The findings of the storage analysis in the 2014 Master Plan update were comparable to the findings in the 2007 Master Plan. Through this update, the Master Plan confirmed the need for the new 5 MG tank in the main zone to meet its storage requirements, and the Jed Smith and to some degree the Upper Oaks systems continue to operate with a storage deficit. With the addition of the new 5 MG tank, the existing water system contains approximately 38.8 MG of storage.

Based on the degree of deficiency and discussions with District staff, only the Jed Smith storage deficit is considered for improvement under existing demands. The estimated cost (including contingencies) to meet the 0.8 MG storage deficit in this zone is shown in Table ES-5.

Table ES-5: Storage Projects for Existing Demand Conditions

Pressure Zone	Storage Needed (gallons)	Estimated Cost
Jed Smith	820,000	$1,912,000

To meet future demand conditions, the overall system storage needs increasing to approximately 44.7 MG, indicating storage deficits in eight pressure zones and a total storage volume deficit of approximately 5.9 MG. In fact, even with the new 5 MG tank currently under construction, the volume of available storage in the main 1235 foot zone falls short of the calculated storage needs under future demands. While this small deficit is assumed to be met under MDD events from the Las Virgenes Reservoir, the level of storage needed in other zones should be included in the District's future CIP.

A summary of these findings is included in Table ES-6. Note that the storage needed for Jed Smith for future conditions is in addition to the storage needed for existing demand conditions.

Table ES-6: Storage Projects for Future Demand Conditions

Pressure Zone	Total Storage Needed (gallons)	Estimated Cost
Jed Smith	1,430,000(1)	$1,403,000
McCoy	300,000	$699,000
Mulwood	180,000	$423,000
Seminole	1,170,000	$3,951,000
Twin Lakes	1,510,000	$3,504,000
Upper Oaks	150,000	$360,000
Upper Woolsey	470,000	$1,098,000
Warner	1,040,000	$2,415,000
Total	**6,250,000**	**$13,853,000**

Notes: Total existing and future storage cost is $ 15,801,750.
(1) The 1.4 MG is total storage need including existing. Future only need is 600,000 gallons.

Pumping System Findings and Recommendation

The analysis of the capacity of the pumping facilities revealed no significant deficiencies for existing demand conditions. However, there are several pump stations that do not appear to have pumps designated as standby pumps. For some of these pump stations, the analysis shows that the capacity of the existing pumps is such that one of the pumps could be designated as a standby pump. For the other pump stations, standby pump was estimated and summarized in Table ES-7.

Table ES-7: Potential Standby Pumping Needs for Existing Conditions

Pressure Zone	Standby Pumping Needed (hp)	Standby Pumping Needed (gpm)	Estimated Cost
McCoy	69	1133	$959,900
Mulwood	39	750	$540,850
Total			**$1,500,750**

The analysis of the pumping capacity for each zone under future conditions indicated that several zones will become capacity deficient. To assure analysis and recommendation consistency, the storage and pumping for each zone were analyzed together to determine the pumping needs for each zone. Table ES-8 summarizes the capacity deficiencies identified for future demand conditions.

Table ES-8: Pumping Needs for Future Conditions

Pressure Zone	Pumping Needed (hp)	Standby Pumping Needed (gpm)	Estimated Cost
Jed Smith/Mountain Gate	47	987	$653,950
Mulwood	25	485	$348,000
McCoy	60	981	$804,750
Seminole	79	2934	$1,059,950
Twin Lakes	163	1878	$1,890,800
Total			**$4,757,450**

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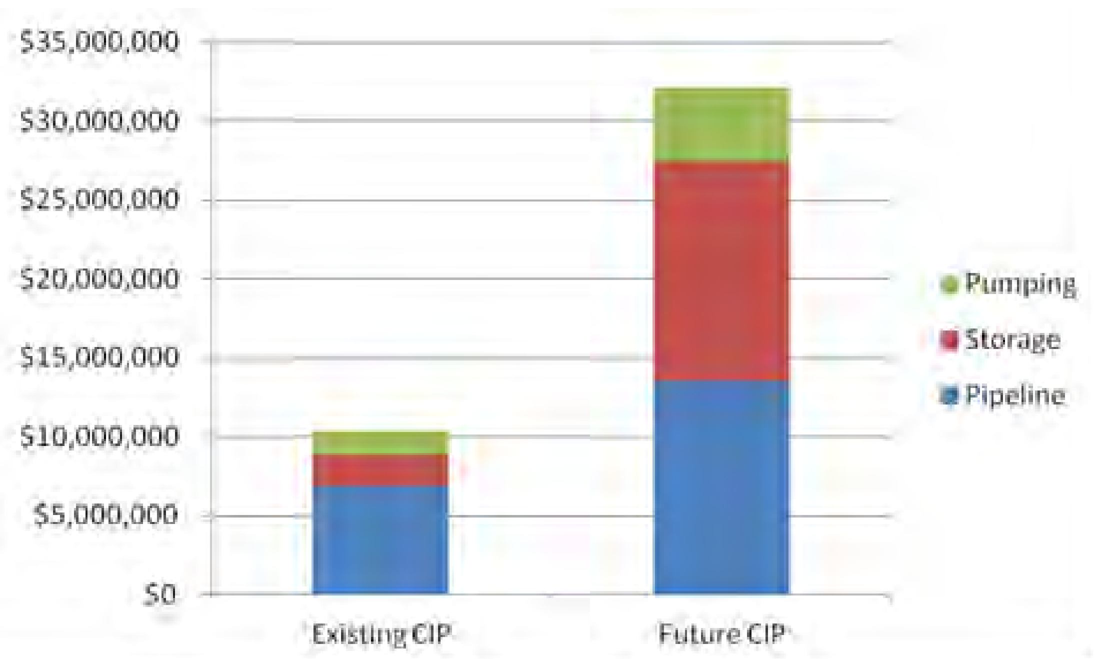
Capital Improvement Program (CIP)

Identified improvements are typically prioritized into a capital improvement program based on the assessment of a wide variety of factors. The most prevalent factor for this master plan is capacity considerations under current and future demand conditions. The identification of these capacity improvements is based on the results of the computerized hydraulic modeling and pumping/storage balance analyses discussed herein. The results are summarized by facility type for both existing and future demand conditions in Table ES-9.

Table ES-9: Capital Improvement Program Estimated Summary of Costs

CIP Description	Existing Costs	Future Costs
Pipeline CIP	$6,913,350	$13,548,600
Storage CIP	$1,912,000	$13,853,000
Pumping CIP	$1,500,750	$4,757,450
Total CIP	**$10,326,100**	**$32,159,050**

Figure ES-5: Capital Improvement Program Estimates Summary of Costs



As shown, existing system improvements represents approximately 25% of the total Capital Improvement Program. While these improvements would generally have a higher priority than future system needs, the final implementation schedule for the identified improvements will encumber a broader set of factors. These factors typically include: funding availability, pace of actual growth, implementation of potable water reduction programs such as conservation and recycled water system expansion, and other asset management and operational reliability considerations. As such, the phased timing of these improvements will be evaluated by District staff as an ongoing component of the District's budgeting process.

Section 1 – Introduction

Section 1: Introduction

1.1 Background

The Las Virgenes Municipal Water District (LVMWD, District) is located on the western edge of Los Angeles County and includes the cities of Agoura Hills, Calabasas, Hidden Hills, and Westlake Village, as well as some unincorporated county areas. While the service area and number of customers vary among the utilities, the District provides potable water, recycled water, and sanitation services to approximately 70,000 people over a 122 square mile service area. Potable Water and Recycled Water Integrated Master Plans were completed in 2007. The Sanitation Master Plan was updated essentially the same time. In 2010, the Urban Water Management Plan (UWMP) was completed, charting the course for SBx7-7 compliance. In 2011, a financial plan was updated, establishing rates to continue to improve financial stability of the three funds and positioning LVMWD for a potential rate structure change to budget-based rates. LVMWD now desires to update the three utility master plans, which will establish an updated capital improvement program for the District's potable water system.

1.2 Goals and Purpose

The primary goal of this project is to update the LVMWD's 2007 Potable Water Master Plan. Key updates/enhancements to the plan include:

- New water demand projections, which incorporate the most current information regarding population, land use and census information for the LVMWD service area projected to the year 2035. The water demand projections consider the effects of weather (including drought) and economic conditions on future water demand in order to increase defensibility in a time of increased pressure to reduce potable water demands in response to State legislation,

- A comprehensive update to the District's water system hydraulic model, including an interactive verification process of the water system model to increase confidence in master plan findings,

- An evaluation of infrastructure improvements to accommodate existing requirements and meet future needs, including a deep evaluation of system infrastructure fire flow (FF) requirements, and

- An updated capital improvement program to support the District's short and long-range capital improvement requirements.

1.2.1 Known Master Planning Issues/Challenges

There are a number of challenges that are inherently present in the utility system master planning process. Because master plans use future service area population and water demand projections in order to make recommendations on the sizing, timing, and financing of various capital projects, the validity of the projections utilized in a master plan are of primary importance. For an agency like LVMWD, whose service area encompasses multiple cities and unincorporated areas, one of the major challenges becomes the collection and integration of land use data from several different sources. In general, agencies develop and manage information in different ways or platforms, compile data differently, and utilize different definitions to describe their information and data. Within LVMWD's service area each agency has its own unique land use categories and definitions.

In addition to variability in data from the multiple agencies located within LVMWD's service area, additional challenges arise because the District's service area boundary does not precisely align with common land use planning boundaries, such as census tracts and transportation analysis zones (TAZ) boundaries.

Another common issue associated with master planning is the unquantifiable pace of growth within a service area. While land use planning and other data provide a reasonable nexus for where growth will occur, the pace at which that growth will occur is dependent on many factors that are more difficult to predict. As such, regional land use and population forecasts derived by agencies whose charter is focused on these efforts often provide the best available information to support this panning effort.

In addition to these planning-related factors, there are a number of common challenges associated with the development and verification of a system hydraulic model. These challenges range from inadequate or conflicting facility data, demand or billing data with unadjusted "bad reads", inadequate or conflicting system operating and performance data, and the presence of undocumented closed or partially closed values in the water system making it difficult to match hydraulic model findings with the actual system performance measured in the field reality.

As described in this report, every effort has been made to integrate best available information to address these inherent challenges in the development of the District's master plan. That said, LVMWD will want to be adaptive in its approach to planning and managing its capital improvement program, responding to changing growth patterns and conditions as they arise and adjusting capital improvement planning accordingly.

1.2.2 Regulatory Basis

A backdrop to the development of this master plan is the regulatory framework for operating and managing a publicly owned water system. There are a number of state and federal requirements that are established to assure public safety, performance, and water quality. While these regulations are constantly being updated, the District and other California agencies have developed ongoing programs and procedures to comply with the core regulatory requirements of their systems and meet new regulatory issues as they arise.

Among the main regulations that affect this master planning effort are those that affect the criteria that must be used to evaluate the operation of the District's facilities. California Code of Regulations Title 22 states that, "At all times, a public water system's source(s) shall have the capacity to meet the system's maximum day demand."

Fire flow requirements are established by the Los Angeles County Fire Department Regulation No. 8. The type and size of structures served by the water system determine the fire flow. The water system is required to sustain the required flow rate for the prescribed duration at a residual pressure of 20 pounds per square inch (psi).

While not directly affecting this planning effort, an additional issue facing the District's water system is the cost implications of the Bay Delta Conservation Plan (BDCP) and associated Delta Habitat Conservation and Conveyance Plan on purchased water costs from Metropolitan Water District of Southern California (MWDSC). Since MWDSC is the District's primary source of potable water, this rising cost of imported water supply represents a significant incremental increase in the costs of service for the District's customers.

1.3 Service Area

LVMWD 's potable water system comprises a 122-square mile area (74,640 acres) in western Los Angeles County, including the Los Angeles/Ventura County boundary to the northwest and the City of Los Angeles to the east. As shown in Figure 1-1, the service area includes the incorporated cities of Agoura Hills, Calabasas, Hidden Hills, and Westlake Village as well as unincorporated portions of Los Angeles County.

A large portion of the LVMWD potable water service area consists of undeveloped land characterized by the Santa Monica Mountains. These open space areas comprise about 35 to 40 percent of the total service area and are mostly held in public ownership, such as state and national parks that will not require water service. The remaining portion of the service area consists primarily of mixed residential and commercial uses, with only a small portion of the service area designated for industrial and agricultural land use. LVMWD’s water demands are thus primarily residential, as opposed to commercial, industrial, institutional, or agricultural; therefore, LVMWD’s customer base consists of many small users (i.e., single family residential homes) with associated landscape irrigation.

1.3.1 Topography and Climate

There are several unique aspects of LVMWD’s geography which must be considered when discussing regional water infrastructure. The change in elevation within LVMWD’s service area is significant, ranging from a few feet above mean sea level (msl) in the southern portions of the service area to elevations exceeding 2,500 ft-msl in the Santa Monica Mountains, located throughout the center of LVMWD’s service area. In addition, because of LVMWD’s rural location within the Santa Monica Mountains, the distribution systems are large and accommodate geographical challenges, including rapidly changing elevations. The topography and geography of the service area has resulted in a complex delivery system of 22 separate service zones. Within these main zones are multiple sub-zones created by pressure regulation, containing no independent storage facilities. Despite the complexity of the system, the system operates very well, demonstrating, in part, the experience of LVMWD staff.

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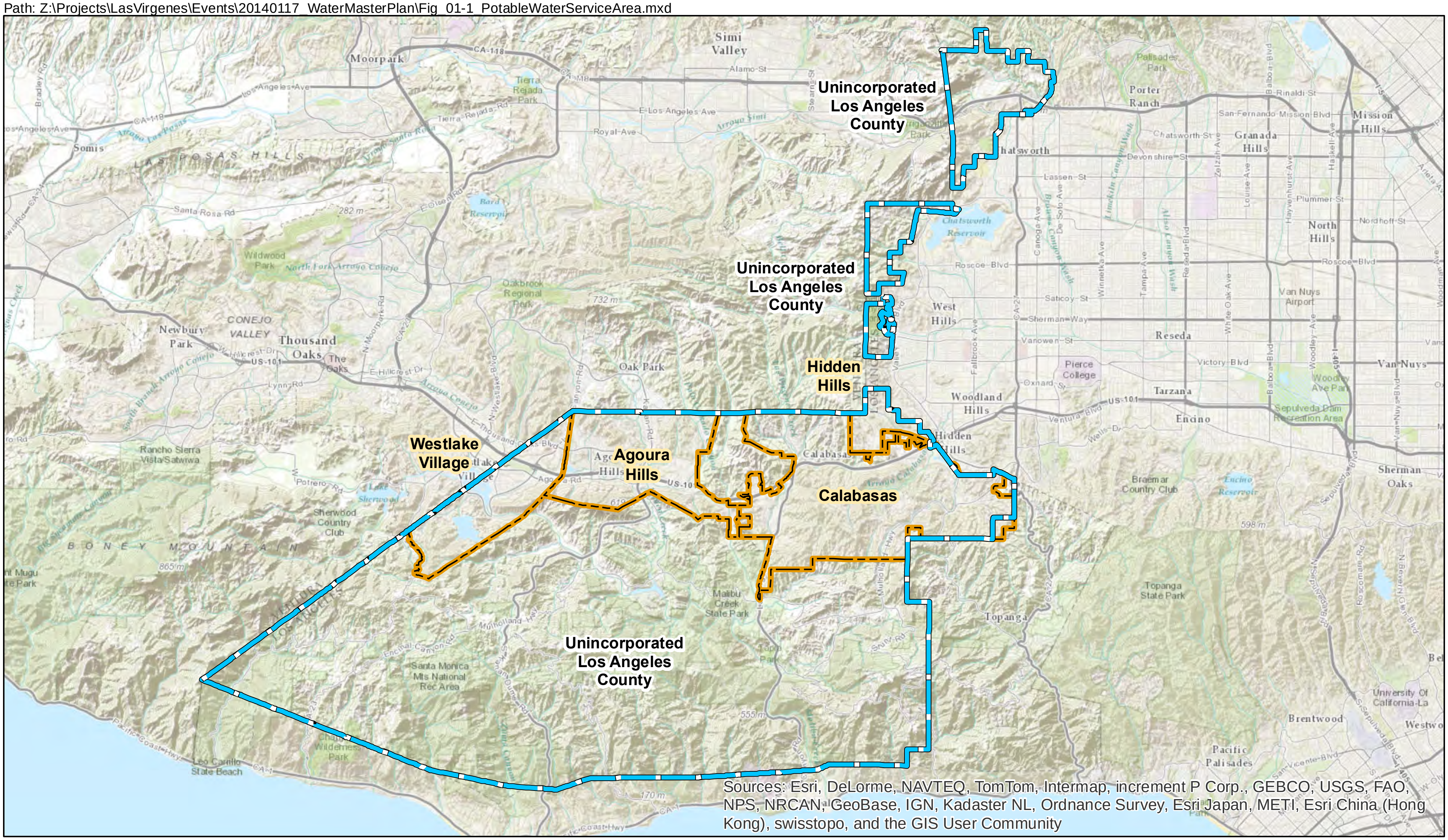


Legend

LVMWD Potable Water Service Area

City Limits

N

0 9,000 18,000

Scale: Feet

Kennedy/Jenks Consultants

Las Virgenes 2014 Water Master Plan Update
Los Angeles, County, CA

LVMWD Potable Water Service Area

KJ/ 1389005.00

Figure 1-1

The climate in LVMWD's service area is semi-arid with mild winters, warm summers and moderate rainfall, consistent with coastal Southern California. This usually mild climatological pattern is interrupted infrequently by periods of extremely hot weather, winter storms, or dry hot Santa Ana winds. Summers are dry with an average temperature of about 76°F, and winters are cool and wet with an average temperature of about 67°F. August tends to be the warmest month of the year. The standard monthly average evapotranspiration (ETo) rates, rainfall, and temperature are summarized in Table 1-1. As shown, the average annual rainfall in the District's service area is approximately 12 inches. The rainy season is from December through March, with very little rainfall the rest of the year.

Table 1-1: Weather Data for the LVMWD Service Area

	Jan	Feb	Mar	Apr	May	Jun
Standard Monthly Average ETo (inches)[a]	1.83	2.20	3.42	4.49	5.25	5.67
Average Rainfall (inches)[b]	2.42	2.84	1.46	0.82	0.25	0.01
Average Max. Temperature (Fahrenheit)[b]	67.8	66.5	68.3	69.0	71.4	73.4

	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Standard Monthly Average ETo (inches)[a]	5.86	5.61	4.49	3.42	2.36	1.83	46.43
Average Rainfall (inches)[b]	0.00	0.00	0.02	0.93	0.79	2.12	11.68
Average Max. Temperature (Fahrenheit)[b]	77.2	77.8	77.5	74.5	71.4	66.0	71.7

Notes:

(a) ETo data: California Irrigation Management Information System (CIMIS) Station 152 (CIMIS, 2010). Represents monthly average ETo from January 2000 to August 2013. http://wwwcimis.water.ca.gov/cimis/welcome.jsp

(b) Precipitation and Temperature data: California Irrigation Management Information System (CIMIS) Station 152 (CIMIS, 2010). Represents monthly average ETo from January 2000 to December 2012. http://wwwcimis.water.ca.gov/cimis/welcome.jsp

1.4 Previous Efforts and Studies

The current master plan builds upon and, where applicable, updates LVMWD's previous efforts including:

- Potable Water Master Plan for Las Virgenes Municipal Water District (Boyle, 1999)
- Potable Water Master Plan Update 2007 (Boyle, 2007)
- Recycled Water Master Plan Update 2007 (Boyle, 2007)
- Integrated Water System Master Plan Update 2007 (Boyle, 2007)
- Project Alternatives Study for the 1235-ft Backbone Improvements (AECOM, 2009)
- 2010 Urban Water Management Plan (Carollo, 2011)

1.5 Scope of Work

Kennedy/Jenks Consultants was authorized to prepare this Potable Water Master Plan Update, as well as an update to the District's Recycled Water Master Plan, Sanitation Plan, and Integrated Plan. Each of these plans is prepared under separate covers. The Scope of Services for the Potable Water Master Plan Update is comprised of eight major tasks, as described below:

1.5.1 Evaluate Existing Water System

Review existing water system information to update the existing facility information and operational conditions. Develop scenarios for hydraulic evaluation of the water distribution system to determine future system improvements.

1.5.2 Perform Statistical Evaluation of Historical/Current Demands

The focus of this analysis is to assess the influence of weather and the economy on water demands. To this end, perform a statistical analysis of current and future demands relative to historical conditions to normalize the demand data from variations in weather and economic factors and support demand evaluations of various alternative scenarios.

1.5.3 Perform Demand Projections

Perform demand projections based on the normalized current demand data and extrapolated to future conditions based several inter-related elements. These include: population projections and changes in persons per household values for each agency served, updated General Plan/Land Use Elements and/or Specific Plans coverages, a general assessment of specific densifications and land use-intensification areas, and District approach to future septic tank conversions.

1.5.4 Update Existing Hydraulic Model

Work closely with LVMWD staff to update the District's current Water Gems 2.0 model. Contrast the model with GIS to include all pipes not in the current model and refresh the model with changes in pipe diameter, age, material and other appropriate attributes. Add any feature updates and expansion of the water system, verifying operational settings and system parameters provided by LVMWD, addressing connectivity issues, developing demand sets and peaking factors based on District's billing data, and updating pump curves. Model demands will be updated for future scenarios based on the projections performed in previous tasks.

Perform model validation using SCADA data and by running a steady state scenario to match model results with the SCADA results for a selected time-frame. The results will be measured against pressure and hydraulic grade line (HGL) standards. Work with operations staff to assure system understanding, implement the resulting data in the hydraulic model, and refine model settings for further calibration as required.

1.5.5 Perform Hydraulic System Analysis

Use the updated and calibrated hydraulic model to evaluate the LVWMD's system and recommend improvements. Utilize the District's system performance criteria to analyze the water system in consultation with District staff. Recommend improvements to correct the system hydraulic deficiencies under current and future demand conditions.

1.5.6 Perform Pumping and Storage Evaluation

Perform a water balance calculation to evaluate the water system production, storage and pumping requirements compared to the estimated future demands of each pressure zone. The water balance will incorporate the findings of the water resources plan, the hydraulic analysis, and the operational strategy, as well as assess the adequacy of operational/emergency storage and pumping capacity.

1.5.7 Develop Capital Improvement Program (CIP)

Recommend CIP projects for system improvements based on demand management and hydraulic deficiencies as a result of the previous tasks. The CIP will be based on findings from the previous tasks, discussions with District staff, and phased to meet the District's funding strategies.

1.5.8 Prepare Potable Water Master Plan Report

Develop a draft Potable Water Master Plan Update report which summarizes and documents the work developed during the master planning effort. The report will incorporate and integrate evaluations from the demand management, supply management and hydraulic evaluation aspects and provide a comprehensive look at the District's current conditions and future CIP recommendations. Prepare a Final Potable Water Master Plan Update based on comments received from the District.

1.6 List of Acronyms and Abbreviations

The following abbreviations and acronyms are used in this report.

ADD	average day demands
AF	acre-feet
AFY	acre-feet per year
AWWA	American Water Works Association
cfs	cubic feet per second
CIMIS	California Irrigation Management Information System
CIP	Capital Improvement Program
District	Las Virgenes Municipal Water District
ETo	evapotranspiration
FF	fire flows

fps	feet per second
ft	feet
gal/day	gallons per day
GPCD	gallons per capita per day
gpm	gallons per minute
HCF	hundred cubic feet
HGL	hydraulic grade line
hp	horsepower
HWL	High Water Level
LADWP	Los Angeles Department of Water and Power
LF	linear foot
LVMWD	Las Virgenes Municipal Water District
MDD	maximum day demands
MFR	multi-family residential
MG	million gallons
MGD	million gallons per day
msl	mean sea level
MWDSC	Metropolitan Water District of Southern California
PH	peak hour
PPH	persons per household
PRV	pressure regulating valve
psi	pounds per square inch
SCAG	Southern California Association of Governments
SFR	single family residential
sq. ft	square feet
SWP	State Water Project
TAZ	transportation analysis zones
TM	Technical Memorandum
TWRF	Tapia Water Reclamation Facility
UWMP	Urban Water Management Plan
VCWWD #17	Ventura County Waterworks District No. 17
WDF	water duty factor
WMP	Water Master Plan

Section 2 – Water Demands

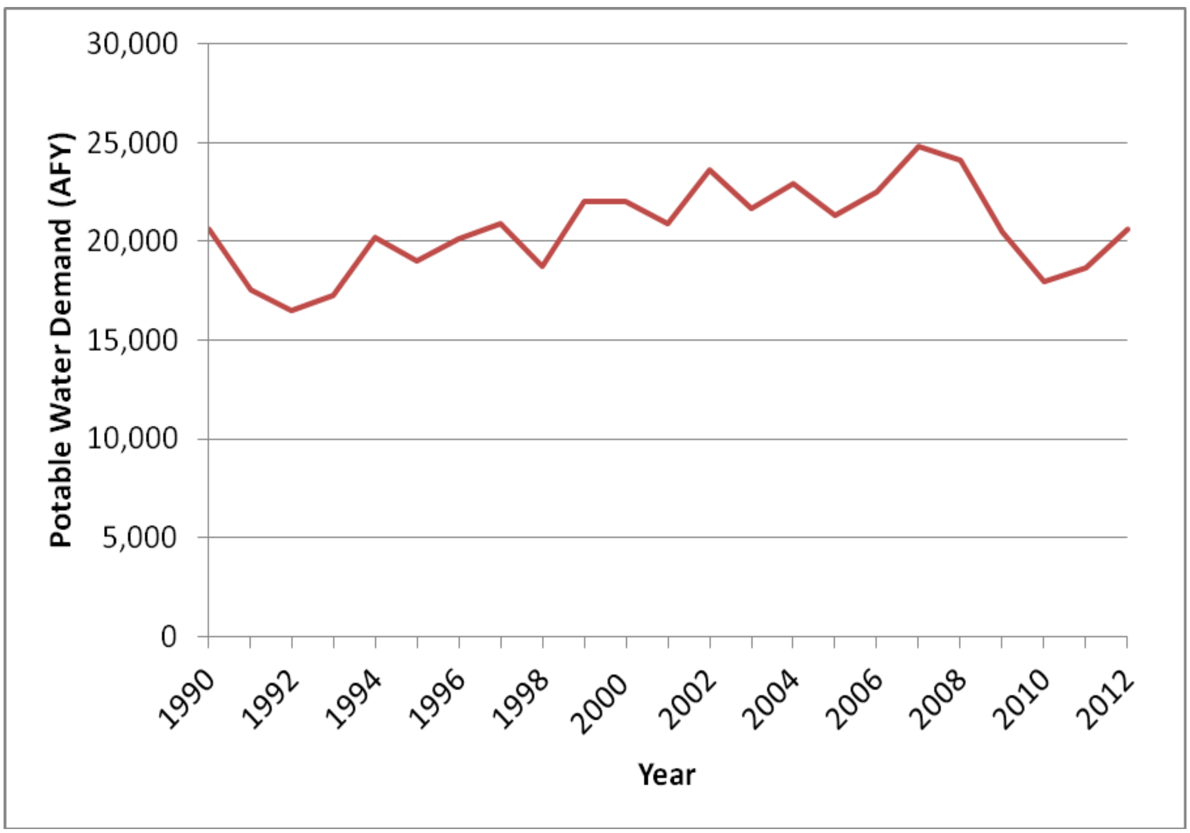
Section 2: Water Demands

2.1 Historical and Current Water Use

In general, LVMWD's demand has not grown as rapidly in the last 15 years as it did in the early history of the agency. This is generally due to a decline in the rate of development and increased customer awareness for needed conservation. In addition to these factors, recycled water use has increased, relieving the potable water system's general increase in demands.

LVMWD's historical water use has varied substantially from year-to-year, with a general increasing trend through 2008. Water demands dropped in the 2009-2011 period, most likely due to a combination of factors, such as absence of hot summers, the economic downturn, and water conservation efforts by LVMWD. An increase in water demand was observed in 2012, suggesting a rebound in water use upon the end of the drought and/or improving economic conditions. LVMWD's historical water use since 1990 is compiled from the District's 2010 Urban Water Management Plan (UWMP) and account level water billing data. This historical water use is graphically shown in Figure 2-1 and listed in Table 2-1.

Figure 2-1: LVMWD Historical Water Demand 1990-2012



Source: See Table 2-1.

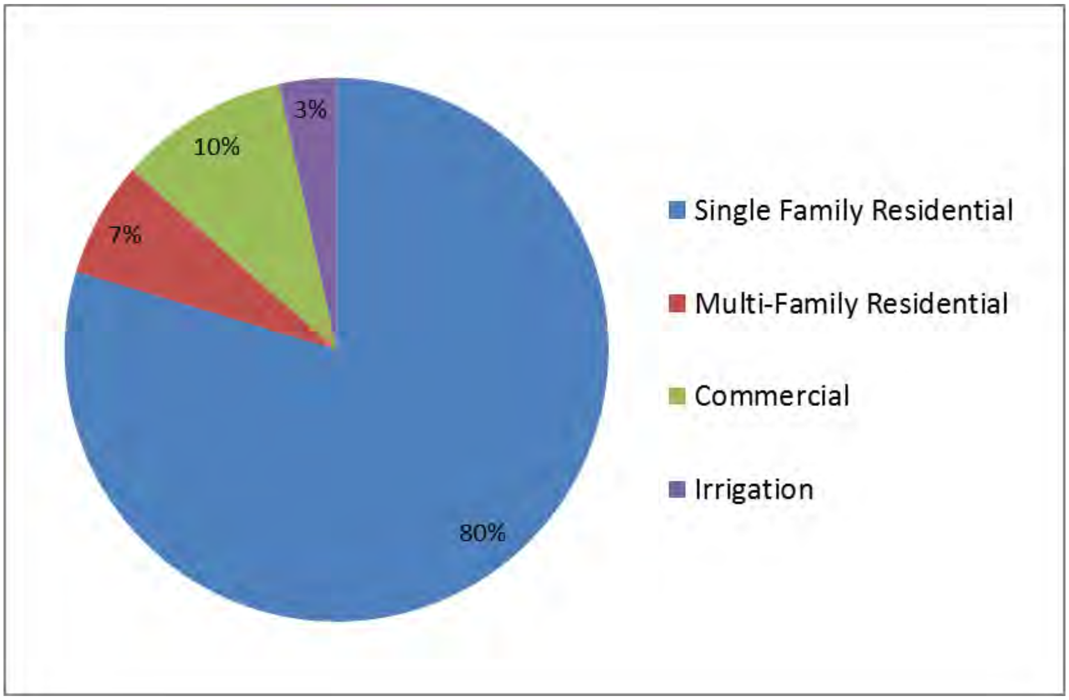
Table 2-1: Historical Water Use

Calendar Year	Potable Water Demand (AFY)[a]
1990	20,653
1991	17,580
1992	16,518
1993	17,278
1994	20,174
1995	19,026
1996	20,133
1997	20,919
1998	18,734
1999	22,046
2000	22,020
2001	20,923
2002	23,646
2003	21,651
2004	22,950
2005	21,305
2006	22,516
2007	24,823
2008	24,129
2009	20,445
2010	17,990
2011	18,696
2012	20,630

Notes
(a) Data is for calendar years. 1990-2002 Potable Water Demand data from 2010 UWMP. 2003-2012 data from LVMWD's account level billing data, which does not include unaccountable water.

The majority of LVMWD's potable water use occurs within the residential sector (Figure 2-2), which accounts for about 87 percent of the City's total consumption in 2012. During that time, eighty percent of LVMWD's total potable water was used by single family residential customers and 7 percent was used by multi-family residential customers. The remainder of LVMWD's potable water use consisted of commercial and dedicated landscape irrigation use, representing 10 percent and 3 percent of total 2012 use, respectively.

Figure 2-2: Water Demand by Customer Type



Source: LVMWD customer billing data January-December 2012.

2.1.1 Evaluation of Unaccounted for Water (Non-Revenue Water)

Water loss control represents the efforts of water utilities to provide accountability in their operation by reliably auditing their water supplies and implementing controls to minimize system losses. Historically, “unaccounted for water” was the term used to describe the difference between the collective volume of water that a water utility supplies to its distribution system that is not reflected in customer billing volumes. However, the term was interpreted and defined differently across agencies making it difficult to develop standardized comparisons of agencies’ water loss and appropriate methods for addressing it (AWWA, 2012).

Non-revenue water is defined by the American Water Works Association (AWWA) as the difference between System Input Volume and Billed Authorized Consumption. The term non-revenue water replaces unaccounted for water in AWWA’s Water Audit Model and the AWWA M36 Water Audits and Loss Control Programs Manual.

LVMWD periodically evaluates its non-revenue water using the AWWA’s Water Loss Software. The most recent evaluation suggests LVWMD’s water loss is approximately 4 percent. This is relatively low compared to the 5 to 10 percent water loss typically observed in most agencies

2.2 Future Water Use

An important element in utility Master Planning is a planning level assessment of future water demands and supply requirements. While the methods utilized to perform local demand projections vary, there are a few criteria that are commonly used to support this effort. These typically include a population projection based approach and a change in land use based approach. LVMWD has historically used both of these approaches, either as a stand-alone method or as a hybrid of the two. The approach utilized has historically been based on the end use or purpose of the planning effort. The sections below describe the data sources and methodology used to estimate LVMWD's current and projected population, as well as future water demand. A comprehensive analysis of future demands is provided in Appendix A and summarized in the following sections.

2.2.1 Land Use

LVMWD's service area is comprised of four main cities in addition to unincorporated areas of Los Angeles County. These four main cities are Agoura Hills, Calabasas, Hidden Hills and Westlake Village. Each area has unique features such as population, development, and demand characteristics. Certain developments contain large irrigated acreages or estates and some contain more densely populated areas, largely impacting demand.

The following land use data was used to evaluate LVMWD's current population, develop a future population projection, and, finally, develop a future water demand projection:

- Southern California Association of Governments (SCAG) TAZ spatial data relating to population, housing, and employment under current conditions, and developed projections for the years 2020 and 2035.

- Tract/block-level US Census Bureau spatial datasets relating to population, demographics, housing element, occupancy, and other economic and trend information. maintained by the California Department of Finance.

- Land use coverage data for LVMWD's service area from the LVMWD GIS parcels, LA County land use/zoning data and various other sources.

- Zoning and land use data from the cities of Agoura Hills, Calabasas, Hidden Hills, Westlake Village, Thousand Oaks, LA County and Ventura County staff and/or their planning consultants. This data, along with 2013 Housing Element reports for each of the cities, provided the primary information related to opportunities for re-development, zoning specifications, and vacant lot areas.

- LVMWD account level billing data from its customer information system for the last 12 years (years 2,000 through 2,012). Billing information for the 2012 calendar year reflects a total customer base of approximately19,770 potable water accounts, using approximately 20,630 acre-feet of potable water.

These data sources, along with the approach used to address the inherent variability among them, are described in greater detail in a Technical Memorandum (TM) documenting the analysis of the District's population and water demand projections. This TM, along with two additional interrelated TM's, is provided in Appendix A.

2.2.2 Population

The current and projected water demands are integral factors in the evaluation of LVMWD's future utility systems. Due to historical variation in the economy and weather conditions, population growth rates have differed among LVMWD's previous studies, suggesting the need to reassess projected demand conditions. Current population estimates and future projections were calculated based on census, SCAG databases, land use and planning data, local agency Housing Element reports, and vacant housing information derived from the census and LVMWD's water billing data.

While buildout for any community may actually never materialize, for the purposes of the analysis, build-out was estimated to occur at the year 2035. This period was chosen because it coincides with other applicable service area studies, such as the most recent UWMP and SCAG population/housing/employment projections. The sections below describe the methodology for estimating LVMWD's current and projected population.

2.2.2.1 Current Population

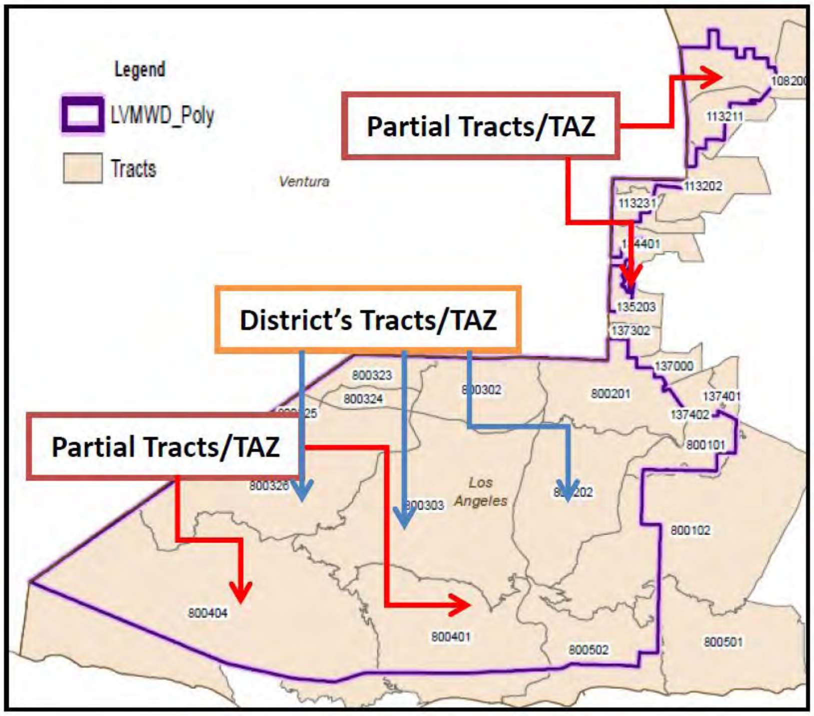
The current population was estimated based on SCAG TAZ spatial data. As shown in Figure 2-3, much of the TAZ/tract data in the upper portion of the western service area is fully contained in LVMWD's service area boundary, as this area is bounded by the County line. In contrast, almost all of the TAZ/tract data in the northern and southern portions of the unincorporated LA County areas and the southeast side of the City of Calabasas do not coincide with LVMWD's service area boundaries.

To reconcile the disparity in LVMWD and TAZ boundaries, the SCAG GIS layer was "clipped" to coincide with LVMWD's boundary layer, and the overlying TAZ areas contained within LVMWD's boundary identified. These TAZ areas were subsequently categorized into two groups:

- Fully Contained TAZ – Those TAZ which were fully contained within the LVMWD's boundary.
- Partially Contained TAZ – Those TAZ which were partially contained within LVMWD's Boundary. These included the TAZ which covered much of the LVMWD's southern border and the northeast or "Chimney" area of LVMWD's service area boundary.

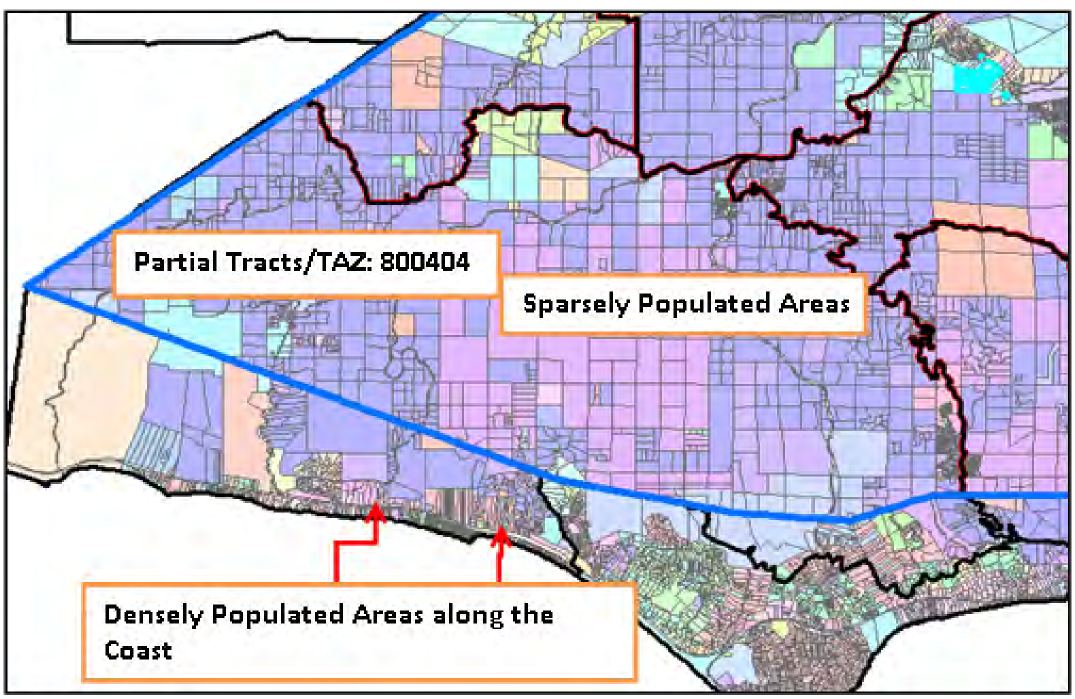
Current population estimates were based on SCAG data for 2008. For the Fully Contained TAZ, SCAG 2008 estimates were directly used for the population calculations. For the Partially Contained TAZ, the population estimates were reconciled with block-level" 2010 census data. This block-level evaluation, performed by LVMWD, provided the basis of planning for these Partially Contained TAZ areas. A focused review of Tract/TAZ 800404 has been selected to demonstrate this issue, and is graphically depicted in Figure 2-4.

Figure 2-3: Incongruent Service Area and TAZ Boundaries



Source: LVMWD Population and Water Demand Projection Technical Memorandum (Appendix A)

Figure 2-4: Example Partial Tract/TAZ Areas



Source: LVMWD Population and Water Demand Projection Technical Memorandum (Appendix A)

As shown, Tract/TAZ 800404 is partially contained within LVMWD's service area. With a detailed review of the land use coverage overlay, it is evident that the Malibu costal area is part of this TAZ, but lies outside LVMWD's boundary. Additionally, it is clear that the Malibu area is vastly more densely populated than the area of the TAZ which falls inside LVMWD's boundary. As such, proportioning the current and projected population within this TAZ based on the percentage of TAZ area that is within LVMWD's boundary would grossly overestimate LVMWD's population in this TAZ. Given this finding, a more detailed assessment was performed for all Partially Contained TAZ to improve projection accuracy.

The initial step in the partial TAZ adjustment process was to contrast the 2008 SCAG data to the block-level 2010 census estimates developed by LVMWD to derive a unique population ratio for each Partially Contained TAZ. This ratio was then applied to the SCAG estimates to estimate the population that resides in and out of LVMWD's service area. Proceeding in this manner reconciles the discrepancy in the SCAG/census datasets, and fine tunes the population estimates for these partially contained TAZ areas. The resulting 2010 population estimate using the SCAG data is 70,138. In contrast, LVMWD utilized the 2010 Census information to estimate the 2010 population to be 67,628, a difference of approximately 2,500 residents. This difference is not believed to have a material impact on the projection of future population or water demands estimates.

2.2.2.2 Future Population

Population projections were calculated based on General Plan reports, updated Housing Element studies, discussion with agency Staff, vacant housing information from the 2010 census, inactive accounts from LVMWD billing data, land use and planning data from the unincorporated areas of LA County, and aerial photography for development opportunities within LVMWD's service boundaries. The population projections for future conditions correspond to the year 2035 and are provided in Table 2-2.

As shown, the population in LVMWD's service area is projected to reach approximately 86,800 people, an increase of approximately 23 percent. This increase is attained from both new housing units and the full occupancy of available housing, as quantified in the 2010 census. A discussion of the source information and methodology utilized to derive these projections follows.

Table 2-2: Housing and Population Projections

Agency/Growth Description	Projected New Dwelling Units	Applicable Persons per Household (PPH)	Projected Additional Population
Agoura Hills [a]			
Agoura Village	293	3.345	980
N Agoura Rd	73	3.345	244
Totals	366	3.345	1,224
Calabasas [b]	746	3.045	2,272
Hidden Hills [c]			
Per HH note from SCAG	34	3.23	110
Westlake Village	84	3.01	253

Agency/Growth Description	Projected New Dwelling Units	Applicable Persons per Household (PPH)	Projected Additional Population
Westlake Village Business	401	3.01	1,207
Unincorporated LA County [(d)]			
Additional Population from Land Use Calculations	2,746	3.15	8,773
Vacant HSE Units [(e)]			
Additional Population from Vacant units	936	3.03	2,816
Totals	**5,314**		**16,655**
Population 2010 (SCAG reconciled with Census)			**70,138**
Population 2010 (Census Blocks[(f)])			**67,628**
Population Projection 2035			**86,793**

Notes
(a) May 2013 Housing Element, Agoura Village SP increased by 100 units per A. Cook, PPH from average of tracts 800323 & 800324
(b) June 2013 Housing Element, pph from average of tracts 800101 and 800202
(c) March 2013 Housing element, pph from tract 800201
(d) Based on land use acreage and density, pph from TAZ specific values, averages used in Table 2-2
(e) Vacant Units coverage based on 2010 census data, TAZ specific
(f) LVMWD estimate based on 2010 Census track and block level data

2.2.2.2.1 Local City Growth Estimates

As shown in Table 2-2, Agoura Hills, Calabasas, Hidden Hills and West lake Village are projected to increase in density and associated population over the 25 year planning period, with estimated population increases of 1,224, 2,272, 110 and 1,460, respectively. These values were calculated based on the updated 2013 Housing Element reports for each of these cities, along with discussions with City Staff and/or their planning consultants. Since updated Housing Elements are required by state statues Government Code Sections 65580-65589.8, each of these Housing Elements have been updated since LVMWD's 2007 Master Plan and 2010 UWMP were prepared. In fact, all of the applicable Housing Elements were developed in 2013.

2.2.2.2.2 Unincorporated LA County Area Growth Estimates

In contrast to the focused and area specific local city housing and growth estimates, growth estimates for the unincorporated areas of the County were derived based on land use information. As such, the applicable parcel-level land use information of acreage, land use type, maximum allowable densities, and census-oriented persons per household (PPH) data was used to estimate the increase in both dwelling units and population. Non improved parcels were filtered from the Land Use data and classified according to their zoning category. The County General Plan provided the maximum allowable density for each category.

Additional dwelling units were then calculated by applying the maximum density to the acreage of each parcel. Ultimately, a projected population was calculated by correlating the PPH values from the census data with the calculated increase in additional housing units.

2.2.2.2.3 Vacant Housing Units

In addition to the increases in population from new dwelling units or changes in PPH, increased population projections were also estimated from the 2010 census' documentation of the vacant housing units. To support this process, the American Community Survey's (2009) 5 Year data was downloaded from http://www.census.gov/acs/www. This data set included family size, demographic data, housing (HSE) units, vacant units, employment status etc. for the tracts in LVMWD's service area. Applicable average family size values for each Tract were correlated with the vacant housing dataset to estimate the additional population that would occur from the fully occupied housing stick.

As shown, an additional population of 2,816 is projected to reside within the LVMWD service area when these dwelling units are fully occupied. Of note, this vacant housing stock value was further supported by a review of LVMWD's utility billing system account data. This review found a comparable number of inactive accounts in the billing database.

2.2.3 Projected Future Demand

Water demands and duty factors were calculated based on LVMWD's 2010 utility billing data. 2010 data was chosen as the baseline data set so that actual water usage data could be correlated to the 2010 census/SCAG population projections in Section 2.2.2. Each of LVMWD's accounts was categorized under one of following customer types: residential (single family and multi-family), commercial, irrigation, reclaimed, fire protection or temporary, based on the type of service provided. Reclaimed water and temporary water usage was excluded from the potable water calculations.

LVMWD's actual 2010 account level bi-monthly billing data was used to reflect potable water sales. A four percent unaccounted (non-revenue) water factor was applied to this metered or billed water consumption data to adjust the data from water consumption to a water supply/production requirement. Unaccounted for water is water lost from the distribution system, usually in the form of leaks, prior to arriving at the customer's meter. This calculation methodology was consistent with the most recent demand forecasting approach used in LVMWD's 2010 UWMP. Results of the analysis are provided in Table 2-3. Based on 2010 water usage and the estimated 2010 population, District wide water usage is estimated to be 238 gallons per capita per day.

Table 2-3: 2010 Water Use Data and 2035 Population Projection

Type/Description	Amount
Residential (HCF)	6,622,042
Irrigation (HCF)	243,340
Commercial (HCF)	951,040
Fire (HCF)	1,977
Unaccounted (HCF) [(a)]	312,736
Total Water Usage (AFY) [(b)]	**18,664**
Total Water Usage (gallons per day)	**16,664,370**
Population 2010 (SCAG reconciled with 2010 census data) [(c)]	70,138
Population 2035	86,793

Notes

Source: Water usage based on LVMWD billing data

(a) Unaccountable water based on LVMWD billing analysis

(b) Low water demand was noted in 2010 from the economy, drought and water budget allocations

(c) LVMWD estimated 2010 population estimate using census data is 67,628

For LVMWD, there were three key questions that needed to be answered in order to move from using actual water usage information to forecasting future water demands. These were: 1) how has the weather and/or the economy affected recent/current water demands, 2) how has the drought and associated rationing affected water demands, and 3) is there any statistical evidence to suggest that any or all of these factors will affect water demands in the future. Each of these three key questions is discussed in the following sections.

2.2.3.1 Effects of Weather and Economy on Water Demands

Water use by residential, commercial and other customers can be affected by climate (e.g. evapotranspiration (ETo), precipitation) and economic factors. Generally, increased ETo is associated with increased water use. Also, time periods characterized by good economic conditions are often associated with higher water use than time periods when economic conditions are poor.

The extent of these effects may vary based on local conditions and can be significant. Increased demands may result in the need for additional system capacities, enhanced water conservation efforts in order to comply with state mandates, and/or additional water supply sources, etc. Hence, it was essential to evaluate the effect of these factors for LVMWD as a component of the water demand projection effort.

Regression analyses were performed on LVMWD's billing data (years 2003 through 2013) to evaluate the correlation between water use among various customer types and weather (ETo, precipitation) and economic (unemployment rate) factors. Results of the regression analyses indicated that, for LVMWD, the water use for multi-family residential, commercial, irrigation, and single family residential accounts of all lot sizes correlate better with unemployment rate (R^2 of 0.646 to 0.924) than weather related variables. Water use decreased with an increase in the unemployment rate. Depending on the type of water user, water usage is predicted to increase as much as 20 to 38 percent (weighted average of 25 percent) based on the 2010 data and 15 to 24 percent (weighted average of 17 percent) based on 2012 data under good economic conditions (unemployment rate of 3.24 percent). No significant correlation was observed with weather related parameters.

The correlation analyses findings suggest that an economic recovery and ensuing higher water demands should be considered in the projection of future water demands. A more detailed description of the analysis performed, along with detailed results, can be found as an element in the Population and Water Demand TM provided in Appendix A and A-1.

2.2.3.2 Drought Impacts on Water Demand

Dr. Randall Orton, Resource Conservation Manager, studied the impacts of drought on water demands. The objective of the study was to estimate the pace and magnitude of post drought response on water demands. Based on LVMWD's experience during the 1990-91 drought and an analysis of the primary factors that influence demand for potable water in the residential sector of LVMWD's service area, it was estimated that annual water demand following the end of the recent drought will continue to rise, attaining its pre-drought level in approximately 6 years and 85 percent of that level in two years, depending primarily on the incidence of wet winters. Moreover, the study suggests that over a shorter, monthly or seasonal time frame, peak summertime residential demands will likely return to their pre-drought levels in approximately 2 to 4 years. A comprehensive Technical Memorandum of this Drought Analysis can be found as an element in the Population and Water Demand TM provided in Appendix A and A-2.

2.2.3.3 Statistical Correlation with LVMWD's Water Demands

To account for the probable impact of both economic and drought recovery factors, an economic factor of 25 percent was applied to the 2010 potable water usage values. Various drought-recovery factors were also considered as potential future water demand requirements. Based on the 2035 population projection of 86,793 previously derived (Table 2-2), water demand projections were calculated for the following three scenarios, and shown in Table 2-4:

- Scenario 1: Full Drought Recovery
- Scenario 2: No Drought Recovery
- Scenario 3: Partial (50 percent) Drought Recovery

Table 2-4: Total Water Demand Projections Using 2010 Data

Scenario	Economic Factor	Drought Rebound Factor	Water Duty Factor (WDF)[(a)]	Total Water Usage (gal/day)	Total Water Usage (AFY)
Scenario 1: With Drought Rebound	25%	31%	385	33,465,165	37,470
Scenario 2: No Drought Recovery	25%	0%	309	26,807,824	30,025
Scenario 3: Partial Drought Recovery	25%	16%	347	30,128,041	33,750

Notes:
Some values may be rounded.
(a) Water duty factor is a LVMWD wide value, expressed in gallons per capita per day.

As shown in Table 2-4 above, a water demand of approximately 37,470 acre-feet per year (AFY) is projected based on a water duty factor (WDF) of 385 for a full drought recovery condition for 2035. Assuming there was no additional drought recovery, Scenario 2 indicates LVMWD would experience a water demand of 30,025 AFY and a WDF of 309. Similarly, a water demand of 33,748 AFY is derived under a partial drought recovery condition, representing 50 percent of the projected post drought recovery. Implicit in the above projections is the assumption that non-residential demands will increase in proportion to the increase in residential demands.

Note that the evaluation in Scenario 1 was based on the consideration that the influence of the economy and the drought are mutually exclusive. However, it is logical to assume that a few aspects of the drought factors will inherently be incorporated in the economic factor, and vice-versa. As such, it is reasonable to assume that only a percentage of the drought recovery factor should be applied, rather than the full 31 percent. Based on this consideration, Scenario 3 was derived to reflect a 50 percent level of drought recovery.

2.2.3.4 Sensitivity Analysis Using 2012 Billing Data

Since LVMWD has experienced an increase in water sales since 2010 with a minimal change in active accounts, a better understanding of how the water demand projection may be affected with the use of more recent 2012 water billing data is warranted. Using a procedure similar to the one used to incorporate the 2010 billing data provided an additional estimate of future demands, and, essentially, provided a sensitivity analysis to the base demand projection.

Table 2-5 shows the results of the sensitivity analysis. A more detailed description of the sensitivity analysis can be found in Appendix A. As shown, using the 2012 water billing data and revised adjustment factors suggests an increase in the level of projected water demands. Using the 2012 data, future water demands are projected to reach 31,400 to 36,500 AFY. Since the analysis using the 2010 billing data suggested a range of 30,000 to 37,500 AFY, the basis of planning appears to provide a reasonable estimate of projected water demands for LVMWD's 2013 Master Plan.

Table 2-5: Total Water Demand Projections Using 2012 Data (Sensitivity Analysis)

Scenario	Economic Factor	Drought Rebound Factor	Water Duty Factor (WDF)[a]	Water Usage (gal/day)	Water Usage (AFY)
Scenario 1: With Drought Rebound	14%	18%	374	32,438,340	36,330
Scenario 2: No Drought Recovery	14%	0%	323	28,014,930	31,380
Scenario 3: Partial Drought Recovery	14%	9%	348	30,222,670	33,860

Notes:
Some values may be rounded.
(a) Water duty factor is a LVMWD wide value, expressed in gallons per capita per day.

2.2.3.5 Summary of Projected Population and Water Demands

Inherent in the conduct of long-range planning studies is the need to consider alternative futures. This need is based on the reality that growth can't be precisely predicted and demands for service such as water that are driven by individual behavior is uncertain. It is for this reason that the projections derived herein utilized the best available data to quantify both population and water usage values, but attempted to frame or bracket these findings for the purposes of long-range water planning.

To further frame the discussion of long-range population and water demand projections, the results of several of LVMWD's previous planning efforts were consolidated. The consolidation of previous population projections is shown in Figure 2-5. The consolidation of projected water demand is shown in Figure 2-6. The 2014 Master Plan water demand projection shown in Figure 2-6 is based on the 2010 data set, and a partial drought recovery (Scenario 3). As shown, the findings presented herein are very comparable with all previous planning studies performed for the LVMWD since 2005.

Table 2-6: Water Demand Projection

Description	2015	2020	2025	2030	2035
Water Demand (AFY)	21,680	24,700	27,710	30,730	33,750

Notes: Based on 2010 data set, and a partial drought recovery (Scenario 3).

Figure 2-5: Population Projection Comparison with Other Studies

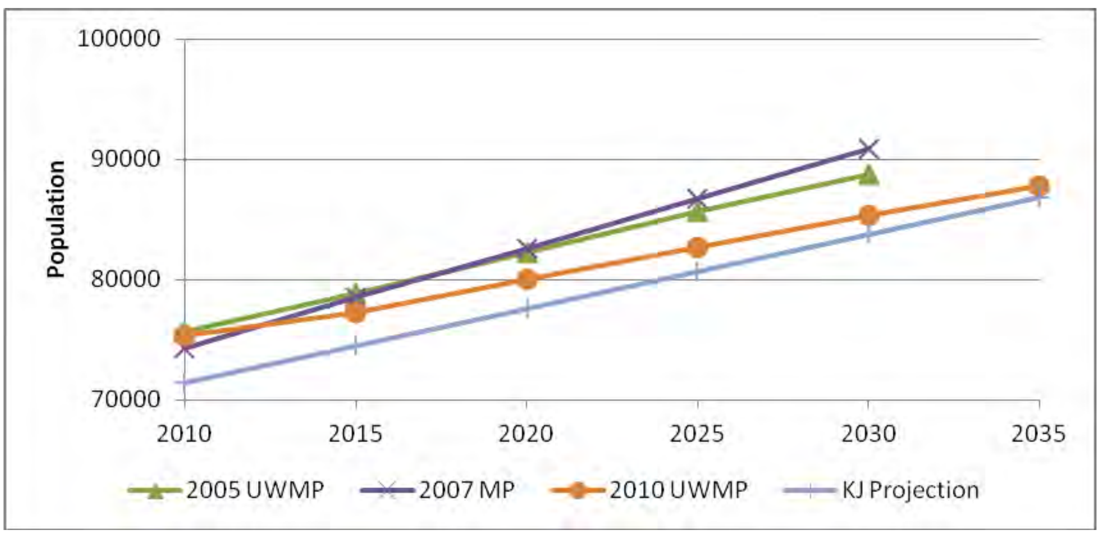
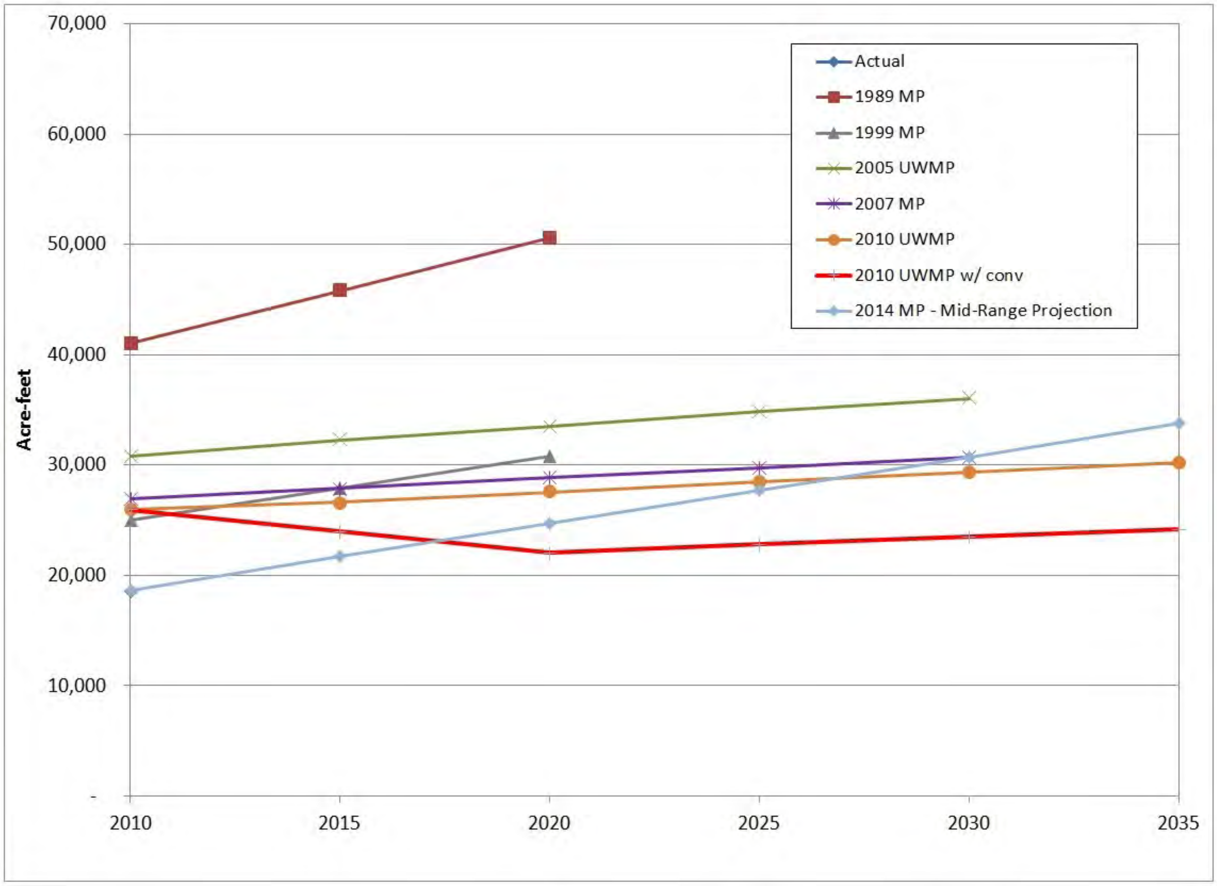


Figure 2-6: Annual Water Demand Projection Comparison with Other Studies



2.2.3.6 Duty Factors

It should be noted that the duty factors derived herein were primarily associated with the maximum allowable residential development of the District's service area, with non-residential land uses generally developing in a linear fashion to residential growth. As such, the primary Water Duty Factors reflected in the development of these projections were equated to gallons per capita per day. Proceeding in this manner, these factors will facilitate a methodical update to the District's upcoming 2015 UWMP requirements. To support the District's potential need for a list of land use-based duty factors for each agency's service area, we have incorporated these factors from the 2007 Potable Water Master Plan Update, and included the associated tables in Appendix L.

While these values were not refined to adjust to new data and/or the various statistical analyses, they have been reviewed for appropriateness in future planning. Moreover, from a system-wide perspective, the validity of this finding is evidenced by the comparable demand projections of each study, shown in Figure 2-6.

2.3 Water Conservation/SBX7-7 Compliance

Table 2-7 compares LVMWD's 2010 UWMP water demand projections to the water demand projections developed as a result of the analyses described above. A comparison of the two projections indicates that the new water demand projection is expected to be lower than that found in the 2010 UWMP through the year 2025, but higher in the final 10 years of the 25-year planning period.

Table 2-7: Comparison of 2010 UWMP & Master Plan Water Demand Projections

Description	2015	2020	2025	2030	2035
2010 UWMP Total Water Use (AFY)[(a)]	26,613	27,542	28,483	29,380	30,237
Master Plan Total Water Use (AFY)	21,681	24,698	27,716	30,733	33,750
Difference	4,932	2,844	767	(1,353)	(3,513)

Notes:
(a) Source: LVMWD 2010 UWMP, Table 5.5.

Table 2-8 compares LVMWD's 2010 UWMP population projections to the population projections developed as a result of the analyses described in this section of the master plan. In all years shown, the population projections from the 2010 UWMP are higher than those developed in this master plan.

Table 2-8: Comparison of 2010 UWMP & Master Plan Population Projections

Description	2015	2020	2025	2030	2035
2010 UWMP Population[(a)]	77,285	79,984	82,718	85,323	87,811
Master Plan Population	73,469	76,800	80,131	83,462	86,793
Difference	3,816	3,184	2,587	1,861	1,018

Notes:
(a) Source: LVMWD 2010 UWMP, Table 2.1.

Table 2-9 compares LVMWD's projected per capita water demand based on 2010 UWMP water demand and population projections to projected per capita use based on the analyses performed in this master plan. These projections are "no conservation" projections, meaning it is not automatically assumed that LVMWD will meet its State mandated water conservation targets. Rather, these projections are designed to demonstrate the amount that water demands may have to be reduced in order to meet the District's water conservation targets. As shown, the Master Plan per capita water use is less through the year 2020 and then becomes greater than 2010 UWMP projections in later years.

Table 2-9: Comparison of 2010 UWMP & Master Plan Per Capital Water Use Projections w/o Water Conservation

Description	2015	2020	2025	2030	2035
2010 UWMP GPCD	307	307	307	307	307
Master Plan GPCD	263	287	309	329	347
Difference	44	20	(2)	(22)	(40)

In its 2010 UWMP, LVMWD established its 2015 interim and 2020 water conservation targets at 277 and 246 gallons per capita per day, respectively. Based on the projections derived herein, it appears that the District may need to further reduce its per capita potable water usage in order to meet the water use efficiency targets requirements of SBX7-7. This reduction may include water conservation programs/incentives, reduction of system losses, increases in recycled water usage to offset potable demands, and other options, all of which require District resources. Considering the new water demand and population projections developed as a result of this master plan, it appears that the amount of effort needed to reduce LVMWD's demands is less than originally anticipated in the 2010 UWMP.

Section 3 – Water Sources and Supplies

Section 3: Water Sources and Supplies

3.1 Summary of Existing Water Supplies

Located in the Santa Monica Mountains, LVMWD has limited availability of natural water resources and is currently limited to four sources: treated, potable water imported from Metropolitan Water District of Southern California (MWDSC), recycled water from the Tapia Water Reclamation Facility (TWRF), groundwater from the Russell Valley Basin (which is only used to supplement the TWRF), and surface runoff into Las Virgenes Reservoir. The imported water supplied to LVMWD originates from the State Water Project (SWP). LVMWD has developed these water resources to provide increased water reliability using an approach that has included aggressive use of recycled water, minimal use of groundwater to augment recycled water supplies, and reservoir storage of water during low demand periods for use during the peak demand periods.

3.1.1 Imported Water - MWDSC

Imported water is LVMWD's primary water supply and supplies virtually all potable water demands. LVMWD's imported water supplier is MWDSC, which imports water from northern California through the SWP and the Colorado River to meet the needs of 26 member agencies across six Southern California counties. LVMWD is one of MWDSC's 26 member agencies.

Currently, the configuration of MWDSC's distribution system provides LVMWD solely with SWP water originating from northern California through the Sacramento-San Joaquin Bay-Delta. The SWP water is treated at the Jensen Filtration Plant in Granada Hills prior to delivery to LVMWD.

LVMWD maintains three connections to the MWDSC system. The current and planned design capacities for each of these connections are listed in Table 3-1. As shown in Table 3-1, LVMWD's current total instantaneous imported water supply capacity is 33,000 gallons per minute (gpm), or 73 cubic feet per second (cfs). Planned capacity is expected to increase to approximately 48,000 gpm, or 106 cfs through coordination with MWDSC as appropriate.

Table 3-1: Capacity of MWDSC Connections

Connection Name	MWD Pipeline Designation	Current Capacity (gpm/cfs)	Current Capacity (AFY)	Planned Capacity (gpm/cfs)*	Planned Capacity (AFY)
LV1	West Valley Feeder No. 1	11,000 gpm/24 cfs	17,750	11,000 gpm/24 cfs	17,750
LV2	Calabasas Feeder	20,000 gpm/45 cfs	32,280	34,000 gpm/75 cfs	54,880
LV3	West Valley Feeder No. 2	2,000 gpm/4 cfs	3,228	3,100 gpm/7 cfs	5,004
Total		**33,000 gpm/73 cfs**	**53,258**	**48,000 gpm/106 cfs**	**77,634**

Notes:
Source: 2007 Integrated Systems Master Plan (Boyle 2007a), as presented in LVMWD's 2010 UWMP Table 3.4.
*The capacity of the turnouts is limited by agreement.

3.1.2 Groundwater – Russell Valley Basin

Groundwater underlying LVMWD's service area is of poor quality and is not currently used for the potable water supply system. Currently, LVMWD operates two groundwater wells in the Russell Valley groundwater basin (Basin); Westlake Well 1 and Westlake Well 2. Both wells pump water from the Russell Valley groundwater basin with a maximum projected yield of 400 AFY. The combined capacity of these two wells is approximately 1.15 million gallons per day (MGD), or 800 gpm. Given that the need for these wells occurs in the summertime, when basin levels are at their lowest, these maximum capacity levels are rarely reached. During 2012 the maximum monthly production from these facilities was 0.80 MGD.

Due to high levels of iron and manganese in this basin, groundwater pumped from these wells needs to be treated first. To avoid the need of a separate treatment facility, the pumped groundwater is discharged into the sewer collection system when additional recycled water is needed. After mixing and conveyance, this water is treated at the TWRF and used to supplement needed recycled water system production in the summer.

The amount of groundwater pumped from the Basin through the Westlake Wells from 2005 to 2010 is presented in Table 3-2. Annual use of the groundwater wells varies significantly since LVMWD only uses the wells to supplement needed recycled water supplies during periods of peak demands.

Table 3-2: Historical Groundwater Pumped from Russell Valley Basin (AFY)

Description	2005	2006	2007	2008	2009	2010
Russell Valley Basin	235	80	265	314	182	224

Notes:
Source: LVMWD 2010 UWMP Table 3.1; Units are in acre-feet per year.

3.1.3 Las Virgenes Reservoir

While the Las Virgenes Reservoir is not truly a "source" of water, it is the primary water supply when the MWDSC supply is interrupted for maintenance or emergency conditions. The Las Virgenes Reservoir is located just south of Westlake Village and is owned and operated by LVMWD. This reservoir, with a total capacity of 9,600 AF, is filled with imported water and is withdrawn and replenished as needed, providing seasonal storage to balance the differences between supply and demands. In low demand years LVMWD puts surplus water into the reservoir, while in high demand years LVMWD draws upon the reservoir to meet the increased demands. In addition to serving as a seasonal storage facility, the Las Virgenes Reservoir also provides emergency storage capacity during imported water outages.

While the reservoir's watershed area does not supply a significant source of water in most years, it generally provides runoff sufficient to offset evaporative losses. In wet years, significant inventories can be realized. Based on an assumed watershed area of 550 acres, the watershed is estimated to receive about 770 AF annually. Average evaporation losses are estimated at about 700 AFY.

The total volume of the reservoir typically fluctuates by several hundred to more than 1,000 AF each year. Since its creation, the reservoir has remained at a volume of approximately 7,300 AF, but occasionally drops below 4,000 AF during dry months, and reaches over 9,000 AF when recharge water is purchased from MWDSC.

3.1.4 Other System Interconnections

City of Simi Valley/Ventura County Waterworks District 8. In addition to the imported water connections with MWDSC, LVMWD also receives approximately 150 acre-feet per year (AFY) of treated imported water from the City of Simi Valley/Ventura County Waterworks District 8. This water is indirectly supplied from MWDSC by means of Calleguas Municipal Water District. Interconnections with this agency provide potable water to two small areas in the hills west of the San Fernando Valley, Woolsey Canyon and Box Canyon. While these areas are geographically isolated, and not connected to the rest of the LVMWD distribution system, LVMWD may connect these customers to the main potable water distribution system at some time (2005 UWMP, Psomas). With a total capacity of 180 gpm, these connections account for less than one percent of LVMWD's potable water delivery system.

Los Angeles Department of Water and Power (LADWP). During times of MWDSC system outages, the LVMWD periodically purchases water supplied by the Los Angeles Department of Water and Power (LADWP) through two different turnouts. One turnout is located at Kittridge Street, and has a maximum capacity of 9,000 gpm. The other turnout is located at Germain Street, is a backup supply for the Twin Lakes area, and has a maximum capacity of 1,350 gpm.

Calleguas Municipal Water District (CMWD) - Future Connection. It should be noted, that an evaluation is currently underway to further explore the development of a system connection with CMWD on the west side of LVMWD's service area at Lindero Canyon Road. This study is being funded by both parties to quantify the costs and water delivery volumes available to each agency under a variety of normal and emergency conditions. The results of this study will ultimately be incorporated herein as an appendix to the Master Plan document.

3.2 Balance of Supply and Demand

Section 2.2 of this Master Plan developed water demand projections for LVMWD through the year 2035 based on projected service area population and anticipated land use changes. The results of this analysis indicate that future water demands are projected at approximately 33,750 AFY in the year 2035. In contrast, by agreement with MWDSC (Table 3-1), LVMWD's three connections to the MWDSC system is approximately 53,258 AFY. This suggests that the three connections, plus the future capacity of the Westlake Filter Plant should provide adequate supply for LVMWD’s to meet the projected average and maximum day future demands.

Section 4 – Potable Water System - Existing Facilities

Section 4: Potable Water System – Existing Facilities

LVMWD's potable water system consists of an elaborate system of pumps, pressure zones, supply connections and reservoirs/tanks. There are 22 main pressure zones created by numerous facilities. Within these main zones are multiple sub-zones created by pressure regulation, containing no independent storage facilities. The topography plays a large role in the complexity of LVMWD's water delivery system. The complex nature of the current system is derived from a combination of the service area's rugged topography and its east to west linearity.

4.1 1235-foot Main Zone

The 1235-foot main zone is considered LVMWD's "backbone" system, which feeds almost every other system in the zone. This system provides the transmission of potable water from MWDSC turnouts on the eastern portion of the LVMWD service area through the Ventura Freeway Corridor to the far west of the service area and Las Virgenes Reservoir. This main system serves approximately 90 percent of LVMWD's customers, either directly or by distribution to smaller subsystems within the service area.

The Cornell Pump Station is operated to move water either to the east or to the west, boost pressures and maintain the balance between supply and demand. This pump station is important during peak demand conditions, and when supplies are low, such as during Las Virgenes Reservoir filling or when MWDSC is not delivering. West of Cornell, the backbone system is sometimes referred to as the 1227 zone, based on the high water level of the Equestrian Trails Tank. Seasonal storage for LVMWD is provided by Las Virgenes Reservoir, which has a pump station and filtration plant to deliver the water back to the 1235 zone. This zone also has operational storage in the 8 million gallon (MG) Calabasas Tank, the 4.2 MG Equestrian Trails and the 3 MG Morrison Tank.

The backbone improvement program consists of five components. One of which has been completed, two are currently in construction, and the other two are beginning the design phase.

1. 1235 Ft. Backbone Improvement Project, Agoura Hills Pipeline & Reyes Adobe Waterline. Construction for the Agoura Hills and Reyes Adobe Waterline was completed in 2012. The waterline consist of approximately 7,944 feet of 18-inch diameter pipeline from Cornell Pump Station along Agoura Road to Kanan Road and an approximately 2,520 feet of 12-inch diameter pipe from Kanan Road along Reyes Adobe Road to Morrison Tank. The Agoura Hills Pipeline and Reyes Adobe Waterline assist in moving water from East to West in the LV system and increase the capacity of potable water supplement to the recycled water system at the Morrison Tank.

2. 5 MG Finished Water Tank. The 5 MG Finished Water Tank is currently in construction and is located near the Westlake Filter Plant. The presence of this reservoir would help to increase pressure gradients and provide additional storage capacity in the western half of the 1235 zone.

3. 1235 Ft. Backbone Improvement Project – Calabasas Pipeline. The Calabasas Pipeline is currently in construction and consists of approximately 9,730 feet of 30-inch diameter pipeline. Its alignment begins near the intersection of Mureau Road and Crummer Canyon Road. The alignment heads west along Mureau Road then heads south along Las Virgenes Road ending at the Ventura Freeway. The Calabasas Pipeline would assist in moving water from East to West in the LV system.

4. Proposed improvements to the Westlake Filter Plant pump station would increase the capacity of the of the pump station. The improvements would allow more of the peak summer demands to be met by the Westlake Filter Plant water.

5. Proposed improvements to the Westlake Filter Plant would add two new filter beds to the plant, increasing the capacity from 12 MGD to 18 MGD. The improvements would reduce the need for east-west transmission in the LV system during peak demand periods.

The potable water system is modeled and therefore analyzed with all of these backbone system improvements in place. The resulting capital improvement program is based on these important improvements being fully operational.

4.1.1 LV-2 Turnout (Calabasas Flow Control Station) and Pump Station

The majority of the potable water supply that enters LVMWD's distribution system from MWDSC enters the system via the LV-2 turnout. This turnout has historically been known as the Calabasas Flow Control Station. This particular facility is located at the boundary between the Cities of Los Angeles and Calabasas, on the south side of the Ventura Freeway. This MWDSC feeder has the ability to deliver a maximum of 105 cfs to the LV-2 turnout, which is designed for a maximum of 75 cfs. If the turnout is operated by gravity, it can deliver up to 25 cfs. For most cases, the LV-2 pump station must be turned on, and can boost flows up to 75 cfs. At the LV-2 pump station are three variable-speed motor driven pumps.

A permanent emergency generator was installed at the LV-2 Turnout. This allows the use of lights, controls and the small pump during an outage, but not the two 600 hp pumps.

4.1.2 LV-1 Turnout (Andora Metering Station) and Conduit Pump Station

The LVMWD backbone system also receives water through the LV-1 turnout. This facility delivers water from the MWDSC West Valley Feeder No. 1 to a 30-inch LVMWD pipeline. The flow from West Valley Feeder No. 1 is currently limited to 93 cfs, and the metering station capacity is limited by MWDCS to 24.5 cfs. The LV-1 Turnout is located near Topanga Canyon Boulevard and Andora Avenue in the San Fernando Valley. A small number of customers on the west side of the San Fernando Valley are also served from this pipeline.

The 30-inch pipeline also delivers water to the Conduit Pump Station, which pumps into the 1235 foot system. This pump station contains two electrically driven pumps and a single gas driven pump backup. With the two electric pumps running, the station formerly provided up to 19 cfs.

4.1.3 Cornell Pump Station

The Cornell Pump Station moves water across LVMWD's service area through the 1235 zone. If Westlake Pumping Station is not in operation all the water LVMWD acquires, is from the east. During the summer months, water is moved from the extreme east boundary of LVMWD's service area to the extreme west. When water is taken from Las Virgenes Reservoir during MWDSC shutdown, the Cornell Pump Station moves water from the reservoir to the eastern portion of the service area through the 1235 zone. Significant flexibility is required of this pump station because this zone has little elevation change across it. This facility maintains the hydraulic balance throughout the 1235 zone, and is operated depending on system requirements.

The Cornell Pump Station is located just east of Cornell Road on Agoura Road, dividing the 1235 zone into eastern and western portions, each with slightly differing hydraulic gradients at operation. Control of this pump station is available from the LVMWD Headquarters. The pump station consists of one electrically driven pump and one natural gas engine driven pump. The pumps are not operated simultaneously. The capacity of Cornell Pump Station is 22.3 cfs if pumping west, and 19.2 cfs if pumping east.

This pump station is operated with check valves in order to maintain the difference in hydraulic gradient required to move water east or west and to keep pump discharge from entering the suction side of the pump. When pumping water to the east, a motor-operated valve is closed in Argos Street.

The design and operation of the Cornell Pump Station is such that discharge pressure is limited to 1250 feet, with an override to maintain constant suction pressure. The minimum discharge gradient is 1210 feet (east or west), with a minimum suction gradient of 1165 feet.

4.1.4 Las Virgenes Reservoir, Pump Station and Filtration Plant

Las Virgenes Reservoir is a key facility for the LVMWD system, as it provides both seasonal and emergency storage. The reservoir allows LVMWD to purchase water from MWDSC in the winter and store it for summer. The storage capacity for this reservoir is 9500 acre-feet.

In order for Las Virgenes Reservoir to receive water for re-filling, Equestrian Trails Tank must be at a designated high water level. There is a "dump valve" that is programmed such that it will only open when the water in the tank is at the high water level. With an elevation that is lower than Equestrian Tank, Morrison Tank fills first, and then is taken off the system by an altitude valve. In conjunction with the dump valve, there is a pressure-sustaining valve that maintains a minimum gradient throughout the system, generally set at 1180 feet.

When water is removed from Las Virgenes Reservoir and added into the system, three engine-driven pumps are used to deliver the water to the treatment plant. After treatment, three additional pumps deliver it to the 1235 zone. This filtration plant was designed to operate with lake elevations between 1002 and 1048 feet (normal levels). This pump station has the capability to operate at levels as low as 950 feet, but efficiency is greatly affected (about 30% reduction).

A new 5 MG tank is currently being constructed at the filtration plant. Hydraulically, the new tank will be in between the filtration plant and the three pumps that deliver water to the 1235 zone. The effect of the new tank will be to allow more variance between the rate at which water is treated at the filtration plant and the rate that treated water can be delivered to the 1235 zone.

The Las Virgenes Reservoir Filtration Plant currently operates with ten filters, with the possibility of an additional two. The nominal capacity (with one filter out of service at a time) flow rate is 15 MGD, with a rated capacity of 16.7 MGD. However, the sustained capacity is significantly less – approximately 13 MGD. If the station is furnished with the additional two filters, nominal capacity will be increased to 18 MGD and rated capacity to 20 MGD. This backbone improvement project is not in this Master Plan CIP, as it is already included in the District's current budget at $8.8 Million.

4.1.5 Calabasas Tank, Equestrian Trails Reservoir, and Morrison Tank

The Calabasas Tank, Equestrian Trails Reservoir and the Morrison Tank provide the necessary storage for the 1235-foot zone. Equestrian Trails (1,227' High Water Level, HWL) and Morrison (1,212' HWL) act as one tall tank based on their elevations. This allows the gradient to vary somewhat, while still maintaining storage. The storage for Equestrian Trails Reservoir is 4.2 MG and Morrison Tank can store 3 MG. Equestrian Trails Reservoir is the only covered concrete reservoir in the system, and is partially buried. The 8 MG Calabasas Tank (1,235' HWL) is at a higher elevation than Equestrian Trails and Morrison, due to a gradient that is generally higher.

4.2 Woolsey Canyon and Box Canyon Systems

Neither Woolsey Canyon nor Box Canyon receives water from the main LVMWD system. Instead, Woolsey Canyon receives water from Ventura County Water Works District No. 17 (VCWWD #17), and Box Canyon receives water from the City of Simi Valley. The areas that these two systems supply lie on the western side of the San Fernando Valley, in the hills. Storage in the Upper Woolsey Tank is 0.5 MG.

The delivery gradient from VCWWD #17 to Woolsey Canyon is a maximum of 2129 feet. The high water level for storage in Upper Woolsey Tank is 1845, so pressure regulators are used. The filling of the tanks is determined by tank level and time of day and operated by a control valve.

The water is delivered to the Box Canyon system at a maximum gradient of 1326 feet from the City of Simi Valley. This water serves only a few homes in the area, and the rest of the service is provided by the 30-inch conduit from the LV-1 turnout. In a 1991 seismic analysis of the LVMWD storage tank, it was determined that the Upper Woolsey Tank should not be operated to its full capacity. It was recommended that the control valve setting be adjusted such that the water level in the tank remains below 19 feet. Seismic retrofits were completed 2010, anchoring the tank to bedrock with grouted rock bolts in order to retain the full capacity of the tank.

4.3 Twin Lakes (1585-foot Zone) and LV-3 Turnout

The Twin Lakes System is isolated from the rest of the main LVMWD System, instead receiving its water from the LV-3 turnout via the Twin Lakes Pump Station. Because of the isolation, there is also an emergency connection to LADWP. The Twin Lakes Pump Station has four 100 hp pumps and one 75 hp pump used as duty pumps. The pump station also has an additional 75 hp pump on standby. The total pump station capacity is 2500 gpm. The Twin Lakes system has two tanks, the smaller tank has storage capacity of 0.4 MG and the larger has 1.6 MG of capacity. This system also provides flow to the Upper Twin Lakes System and future Deerlake Ranch Hydropneumatic System.

4.3.1 Upper Twin Lakes System

The Upper Twin Lakes System is fed by the Upper Twin Lakes Pump Station, which draws water from the Twin Lakes system. The Upper Twin Lakes Pump Station has two 35 hp pumps (one duty, one standby). Nominal capacity is 400 gpm with one pump operating. The 0.385 MG Upper Twin Lakes Tank provides storage capacity for the system.

4.4 Jed Smith/Mountain Gate System (1420-foot Zone)

The Jed Smith System serves the Mountain View Estates development and much of the City of Hidden Hills, located in the upper Las Virgenes Valley. The water for this system is pumped from the 1235-foot zone to the pair of Jed Smith Tanks. The tanks have 0.63 MG of storage and 0.55 MG of storage.

This system has two pump stations, Jed Smith and Mountain Gate. Jed Smith has three 100 hp pumps, providing 1700 gpm of capacity. One pump acts as a standby unit. The Mountain Gate Pump Station has two 40-hp duty pumps, with the capacity to deliver 1000 gpm together. Both pump station draw water from the 1235 Main Zone.

4.5 Warner/Cold Canyon (1640-foot Zone)

The Warner/Cold Canyon zone is located south of the Ventura Freeway at the Mulholland Highway and Stunt Road intersection. The zone is fed by two pump stations, Warner and Cold Canyon Pump Stations, which pump from the 1235-foot zone into the two Warner Tanks with a system gradient of 1640 feet. Warner Pump Station is located just south of Calabasas Tank and Cold Canyon Pump Station lies near the intersection of Mulholland Highway and Cold Canyon Road.

There currently are four duty pumps at the Warner pump station. There are two 100-hp pumps and two 200-hp pumps. The total capacity with all four pumps in operation is 4000 gpm. At Cold Canyon are three 100-hp pumps, one of which acts as a standby. Capacity at Cold Canyon is 1000 gpm.

The Warner System supplies the Oak Ridge and Stunt Road/Saddle Peak systems, which are at higher elevations. The system is operated such that Cold Canyon Pump Station is turned on when Stunt Road Pump Station turns on to maintain pressure in the Warner/Cold Canyon zone. Cold Canyon will also turns on to maintain water level in Warner Tanks, as does Warner Pump Station. The pressure regulating station at Oak Ridge aids fire flows in the Warner System at higher elevations near the Oak Ridge Pump Station.

Warner also supplies the McCoy System through pressure regulation stations. These stations are located in Park Granada, Park Belmonte, and Parkway Calabasas. A pressure regulating station also allows the Mulwood System to be supplied by the Warner System. This station is normally on and can be turned off manually if needed.

The Warner Tanks have a combined storage capacity of 2.5 MG, with one 2.0 MG tank and one with 0.5 MG of capacity. Warner also supplies a maximum of 1200 gpm to the recycled water system. This potable supplement is furnished to Cordillera Tank when demands exceed supply for recycled water.

4.5.1 Oak Ridge System

The Oak Ridge System is supplied by the Oak Ridge Pump Station, and is fed by the Warner Zone. At the Oak Ridge Pump Station are two 20 hp pumps, one duty and one standby, which transfer water to the Oak Ridge Tank at a total capacity of 260 gpm. This zone operates with a gradient of 1826 feet, delivering water to a small group of homes on the Southeast corner of Calabasas, near the Mulholland Highway. The 0.32 Oak Ridge Tank provides storage to the zone.

4.5.2 Stunt Road / Saddle Peak System (2513-foot Zone)

The Saddle Peak System serves a large, rugged area. The Stunt Road Pump Station receives water the Stunt Road Pump Station which pumps water from the Warner Tanks Zone. The Stunt Road Pump Station has one duty and one standby pump. This zone is located in the southeast corner of LVMWD's service area. This area is LVMWD's highest zone (with a gradient of 2513 feet), so the pumps are 225 hp each, with a pump station capacity of 550 gpm.

4.6 McCoy System (1450-foot Zone)

The McCoy System is fed primarily through the McCoy Pump Station, which draws water from the 1235-foot zone, but the system can also receive water from the Warner System through pressure regulating stations. The McCoy Pump Station delivers water to the lower residential areas along Parkway Calabasas. This pump station uses three 125 hp duty pumps with no standby pump. Back up is provided by the pressure reducing stations. The 2 MG McCoy tank provides storage for the zone. The McCoy System supplies the Upper and Lower Oaks systems.

4.6.1 Lower Oaks System (1616-foot Zone)

The Lower Oaks System is fed by the Lower Oaks Pump Station. The Lower Oaks Pump Station pumps from the McCoy System. The Lower Oaks System serves the New Millennium development near the end of Parkway Calabasas Road. The capacity of the Lower Oaks Pump Station is designed to be 640 gpm with the use of two 40 hp duty pumps with a third pump for standby. The 1.0 MG Lower Oaks serves this zone.

4.6.2 Upper Oaks System (1753-foot Zone)

The Upper Oaks System is fed by the Upper Oaks Pump Station, which pumps from the McCoy System. The Upper Oaks System provides water to residences located in the New Millennium development near the end of Parkway Calabasas Road. These homes require a slightly higher gradient than the homes served by Lower Oaks System. The Upper Oaks Pump Station utilizes 400 gpm capacity from two 25 hp pumps, one duty and one standby. The Lower Oaks and Upper Oaks Pumping Facilities are housed in a single building. The 0.26 MG Upper Oaks Tank supplies storage capacity for this pressure zone. The Upper Oaks system also contains a potable water supplement to the recycled water system.

4.7 Mulwood System (1450-foot Zone)

Mulwood is fed by the Mulwood Pump Station which draw water from the from the 1235 zone. The Mulwood System also has the capacity to receive water by PRV from Warner. The Mulwood Pump Station is located on Old Topanga Canyon Road, near Calabasas High School. This pump station has three pumps, each 50 hp, providing 1750 gpm of capacity. The third and most recently installed pump was added in 2010 based on insufficient flow rates during summer months. The Mulwood PRV is designed to act as a backup pump. The Mulwood System also provides water to the Dardenne System. The 1.6 MG Mulwood Tank provides storage for the zone.

4.7.1 Dardenne System (1618-foot Zone)

The Dardenne System is fed by the Dardenne Pump Station which draws water from the Mulwood System. The pump station has two pumps; one duty and one standby, each are rated at 40 hp. With only one pump in operation, the capacity at this station is 250 gpm. There is a small subdivision at the top of Dardenne and Cairnloch Streets in the City of Calabasas that is served by the Dardenne System. The 0.5 Dardenne Tank provides storage for the zone.

4.8 Hydropnuematic Systems (JBR and Old Agoura)

There are two independent hydropneumatic pumping facilities in the LVMWD system. Both Agoura Pump Station and JBR Pump Station draw water from the 1235-foot zone. Another Hydropneumatic facility, Deerlake Ranch pump station (which will be developer funded), has been designed but its construction was put on hold as the housing market crashed in 2007.

Hydropneumatic Stations operate differently than the rest of LVMWD, in that they do not work against water in an elevated, open tank. They operate with a small, pressurized tank that is generally located at the pump station. The hydropneumatic tank acts as a flow buffer, reducing the number of pump cycles. To provide fire flows in times of power outage, an engine driven pump or generator is required, unless flow can be provided by gravity bypass.

4.8.1 Agoura Pump Station System (1350-foot Zone)

There are two 15 hp duty pumps at Agoura Pump Station, providing 500 gpm. There is also one 75 hp, electrically driven, pump that is dedicated to fire flows that can provide an additional 1000 gpm to the system. The coverage area for the Agoura System is above Balkins Drive in the City of Agoura Hills.

4.8.2 JBR Pump Station System (1240-foot Zone)

JBR Pump Station operates similarly to Agoura Pump Station, in that there is one 75 hp (natural gas powered) pump dedicated to fire flows (1250 gpm). The duty pump for this system is one 10 hp pump that provides up to 280 gallons. This pump station has the ability to receive water, without pumping, from the 1235 zone if the gradients are high. A check valve assures that water does not flow back into the 1235 zone while the pump is in operation.

4.9 Kimberly System (1517-foot Zone)

The Kimberly System draws water from the 1235 zone. The system serves the northeast corner of Agoura Hills. The pumping station consists of two duty pumps and one standby pump. All three pumps are rated at 30 hp and the pump station capacity is 333 gpm. The Kimberly Tank has storage capacity of 0.47 MG.

4.10 Seminole System (2153-foot Zone)

The Seminole System is the highest lift zone in LVMWD’s service area, located in the southwest corner. The Seminole System also delivers water to the Latigo and Three Springs Systems with the use of pressure reducing stations. The Seminole Pump Station is located on Mulholland Highway, west of Malibu Lake. Due to the large head requirements, there are four 300 hp motors, three duty and one standby. The capacity of this pump station is 2250 gpm. Based on recommendations made in 2007, a new pump house and a new pump were built in 2010. There are two tanks in the Seminole System, one that has 0.5 MG capacity and one with 1.5 MG capacity.

4.10.1 Latigo System (1775-Foot Zone)

The Latigo System contains no pumping facilities; water is delivered from the Seminole System through the Ramera Ridge PRV. Latigo does, however, have a tank with a capacity of 1.5 MG. This system serves customers near Malibu.

4.10.2 Three Springs System (1425-foot Zone)

The Three Springs System has the ability to receive water from multiple sources. At lower flows the Westlake Boulevard Pressure Regulating Station feeds the system from the Seminole System. At higher flows, there are two 10-hp pumps that draw from the 1235 zone. The capacity of this pump station is 320 gpm. The operation of this system allows the use of no tank, but an operating scheme as follows:

1. For small flows, up to 25 gpm, water is supplied by Westlake Boulevard PRS. This PRS also measures the flow rate.

2. When flow surpasses 25 gpm, the lead pump is turned on. The pump operates at a pressure that is slightly higher than that of the PRS, so the PRS is inoperable.

3. When demand causes a significant pressure drop, the PRS opens to again maintain pressure.

4. When flow reaches 80 gpm, the lag pump turns on.

5. If demands increase further, a 3-inch bypass at the PRS opens.

6. For excessively high demands, a valve on the 8-inch main near the PRS will open. The purpose of this valve is for fire flows. The operators receive an alarm notification if maximum flow occurs on the 3-inch bypass.

7. As flows are reduced, the system operates in reverse: lag pump turns off at 75 gpm and the lead pump turns off at 25 gpm.

4.11 Saddletree System (1302-foot Zone)

There is a small residential area at the top of Saddletree Road in Westlake Village that is served by the Saddletree System. The water for this system is pumped from the 1235 zone by two 15 hp duty pumps. This pump station has the ability to pump up to 330 gpm to Saddletree Tank, which has a storage capacity of 0.28 MG.

4.12 Ranchview System (1302-foot Zone)

The Ranchview system serves approximately 84 homes on the west side of Las Virgenes Road, 0.5 miles north of the Ventura Freeway. This system is fed from the 1235-foot zone. The pump station has been designed to run off-peak, with a design capacity of 400 gpm. This is accomplished with two 25 hp pumps, one duty and one standby. The Ranchview Tank has a capacity of 0.32 MG of total storage.

4.13 Pressure Regulating Stations

Pressure regulation stations are integral parts of the LVMWD system. These stations provide capacity, redundancy and reliability to the system. These stations decrease the amount of pump stations that are required by allowing two or more different pressure zones to be supplied by a single pumping station. There are 75 pressure-regulating stations in operation. In some particular instances, LVMWD will provide pressure reduction valves at individual service connections (on LVMWD's side) instead of having a pressure reduction in the main.

4.14 Pipelines

The potable water system has pipes of varying ages. Most of the major facilities were constructed after 1963. When the original Master Plan of LVMWD's system was developed, most of the pipe was considered relatively young. Some developments, however, are much older and pipes in these areas are smaller and were designed with different criteria. Specifically, fire flow requirements have increased since these buildings were constructed (some Buildings are as old as the 1930's). Examples of these older areas are Hidden Hills and Monte Nido.

LVMWD Report No. 2358, "Distribution System Performance," July 2006 provides an assessment of these existing assets with recommendations for annual rehabilitation and replacement.

There are nearly 400 miles of pipelines that are 4 inches or greater in size. The largest of these lines are tabulated below:

- 24-inch in Las Virgenes Road
- 24-inch in Triunfo Canyon Road
- 36-inch connecting Westlake Reservoir and Pump Station to West Side of System
- 42-inch from LV-2 to Warner pump station, along the Ventura Freeway
- 30-inch from LV-1 to Calabasas Tank
- 42-inch from Warner pump station to western end of Calabasas Road
- 30-inch from end of Calabasas Road to Cornell pump station
- 24-inch from Cornell to West Side of System

Section 5 – Hydraulic System Analysis

Section 5: Hydraulic System Analysis

The focus of this section of the Potable Water Master Plan is the analysis of the District's water system. To meet this need, this section documents and develops various system evaluation criteria, and applies these criteria to a hydraulic analysis of the system under current and future conditions to identify areas of needed improvement. The costs of improvements needed to mitigate these deficiencies are subsequently provided in Section 6: of this report. A discussion of the system criteria and hydraulic analysis are provided in the following subsections.

5.1 Design and Planning Criteria

5.1.1 Peaking Factors

Peaking factors were used in the model to relate Average Day Demand to Maximum Day and Peak Hour Demand.

- The Average Day Demand (ADD) is the yearly use divided over 365 days.

- The Maximum Day Demand (MDD) is the maximum consumption that can be presumed on any day, and generally occurs in the late summer. The peaking factor for MDD is the ratio of MDD/ADD.

- The Peak Hour Demand (PH) is the maximum consumption presumed during the largest demand hour of the maximum demand day. The peaking factor for peak hour is the ratio PHD/MDD.

The MDD and PH peaking factors were built into the model as part of the 2007 Water Master Plan. Kennedy/Jenks verified the peaking factors during data validation. During data validation, the model results were compared with ADD and MDD to compare peaking factors and diurnal patterns used. The same peaking factors were re-used for the 2014 Water Master Plan modeling efforts. In the 2007 Water Master Plan, each subsystem was assigned one of several different MDD peaking factors. Table 5-1 summarizes the demand patterns and maximum day peaking factors used in the model for each zone. The complete average day diurnal demand patterns are provided in Appendix B.

Table 5-1: Maximum Day Demand Peaking Factors

Pressure Zone	Demand Pattern	Multiplier to convert from ADD to MDD
Main Zone	Main MDD	2.1
Jed Smith, Kimberly, JBR, Agoura, Mountain Gate, Ranchview	JS/MG	1.8
Warner	Warner MDD	2.4
Seminole 2159 (1065)	Seminole MDD	3.4
McCoy, Oak Ridge, Three Springs, Mulwood, Dardenne, Saddletree, Upper Oaks, Lower Oaks	McCoy MDD	1.5
Stunt, Latigo	Saddlepeak MDD	1.4
Upper Woolsey, Twin Lakes, Box Canyon VCWD #8 Twin Lakes Box Canyon VCWD #8	Twin Lakes MDD	3.2

5.1.2 Distribution Facilities Criteria

The evaluation of the existing and future potable water distribution systems and the design of the CIP is based on the criteria in Table 5-2.

Table 5-2: Water Distribution System Evaluation Criteria

Description	Evaluation Criteria	2007 Master Plan Evaluation Criteria
Minimum pressure for max day or peak hour	35 psi	43 psi
Minimum pressure for max day plus fire flow	20 psi	20psi
Maximum pressure	150 psi	150 psi
Max velocity for existing pipes	10 fps	10 (15 fps for FF)
Max velocity for new pipes	5 fps	5 fps (15 fps for FF)
Max headloss for existing pipes	10 ft/1000 ft	10 ft/1000 ft
Max headloss for new pipes	5 ft/1000 ft	5 ft/1000 ft

5.1.3 Storage Criteria

The storage analysis consisted of evaluating the volume of the existing storage facilities within each pressure zone, or group of pressure zones to determine if that volume was equal to or greater than the minimum required storage. The minimum required storage is equal to the sum of operational storage, emergency storage, and fire storage as shown below.

5.1.3.1 Operational Storage

Operational storage is the portion of the reservoir that is used and refilled through everyday demands in the system. The required volume of the operational storage depends on the associated pumping scheme of 24, 18, or 9-hour pumping, as described in the following section. In general, a tank that is allowed to refill with a 24-hour pumping schedule requires less operational storage than a tank that is required to refill with a 9-hour pumping schedule. The criteria used to evaluate the operational storage for each zone as follows:

- Operational Storage for 24-Hour Pumping = 7 hours of MDD = 420 minutes * MDD (in gpm)
- Operational Storage for 18-Hour Pumping = 10 hours of MDD = 600 minutes * MDD (in gpm)
- Operational Storage for 9-Hour Pumping = 20 hours of MDD = 1200 minutes * MDD (in gpm)

5.1.3.2 Emergency Storage

Emergency storage is the portion of the reservoir with a volume equal to 5 hours of MDD. This approximates the time needed to implement emergency measures when a pump station or turnoff is inoperable.

5.1.3.3 Fire Storage

Fire storage is the portion of the reservoir with a volume equal to the maximum fire flow rate requirements over the maximum fire duration. Fire storage is needed for zones without emergency pumping provisions. The required storage for firefighting is calculated by the methods that are set forth by the Los Angeles County Fire Prevention Regulation No. 8. The District chose to provide sufficient storage and flow capacity in the 1235 foot zone for two independent fire events, one in the eastern half and one in the western half, because this zone can be operated as two separate subzones and zone spans a large distance. The 1235 foot zone excluded, all other zones are designed and operated within the Fire Department Regulations for one fire per zone.

5.1.4 Pumping Criteria

Cost of on-peak energy use has caused the District to shift the hours of pump operation for many of the pump stations in the system. As a result, the District assessed the ability of its pump stations and reservoirs to accommodate off-peak pumping.

Based on the current time-of-use, previous master plans recommended three different pumping schemes, 24-hour, 18-hour and 9-hour pumping. The descriptions of each pumping scheme are listed here.

24-Hour Pumping – The 24-hour pumping scheme means that the zone could require pumping at any time during the day. The 24-hour pumping scheme provides almost no protection for unforeseen events such as larger-than-expected demands, insufficient pump capacities, or inoperable facilities.

18-Hour Pumping – The 18-hour pumping scheme can provide pumping to satisfy MDD demands in 18 hours, thus providing for more flexibility to the system. This increased flexibility allows for downtime to provide for maintenance to the system, additional pumping hours, and interruptions of power, while still providing water service to the customers. This pumping mode allows for pumps to be turned off during the highest portion of peak energy charges (known as “mid-peak” pumping), thus reducing energy costs.

9-Hour Pumping – the 9-hour pumping scheme is considered “off-peak,” meaning that the required pumping to satisfy MDD can be done in the “off-peak” hours. This alternative was used in the 2007 Master Plan, and is required by Southern California Edison. This pumping scheme allows for the largest amount of operational flexibility, but also requires the largest amount of reservoir storage. Off-peak pumping generally occurs between 11:00 p.m. and 8:00 p.m. when demands are lowest.

Only the 1235 foot Main Zone, JBR Zone, and Three Springs Zone are allowed to use a 24-hour pumping scheme. The 1235 Main Zone and the Cornell Pump Station is the largest zone, which carries water from East to West. The Agoura Zone and Three Springs Zone do not have storage tanks and require that their pump stations provide fire flow in addition to MDD. The Three Springs Zone also does not have a tank, and so relies on pumping to provide MDD and fire flow.

In conformance with previous master plans, this analysis recommends upgrades for the remaining pump stations failing to achieve at least an 18-hour pumping scheme. Where 9-hour pumping is achievable in both the pump station and the reservoir, a 9-hour pumping recommendation is made. However, no CIP recommendations were made to achieve this pumping scheme.

Some pump stations that might fail to achieve an 18-hour pumping schedule, could be temporarily run for longer intervals during the day. However, a comparison between energy costs and construction costs should be performed.

Age of the pump was not assessed in this analysis. The age of the pump highly affects pump output and efficiency. Neither were modifications to pump impellers to improve a performance.

Pump, nominal pump, and pump station capacities are only considered to be best estimates.

5.1.5 Fire Flow Requirements/Fire Flow Upgrade Areas

Fire flow requirements are governed by the Los Angeles County Fire Prevention Regulation No. 8 and were based on the land use for each parcel. The fire flow requirements consist of a required fire flow and duration. Fire flows were assigned to each parcel based on the land use identified through the analysis of the maps received from LVMWD. The fire flow requirements are listed in Table 5-3.

Table 5-3: Maximum Day Demand Peaking Factors

Building Type	Fire Flow (gpm)	Flow Duration (hours)	Hydrant Spacing (max ft.)
Single family dwelling and detached condominiums 1 to 4 Units less than 5,000 sq. ft.	1,250	2	600
Detached condominiums 5 or more units less than 5,000 square feet	1,500	2	300
Two family dwellings (duplexes)	1,500	2	600
Multi-family dwellings, hotels, high-rise commercial, industrial	5,000	5	300
Other Structures and For Single Family Dwellings Greater than 5,000 sq. ft.			
Building Size (1st Floor Area)			
First Floor Area under 3,000 sq. ft.	1000	2	300
3,000 to 4,999 sq. ft.	1250	2	300
5,000 to 7,999 sq. ft.	1500	2	300
8,000 to 9,999 sq. ft.	2000	2	300
10,000 to 14,999 sq. ft.	2500	2	300
15,000 to 19,999 sq. ft.	3000	3	300
20,000 to 24,999 sq. ft.	3500	3	300
25,000 to 29,999 sq. ft.	4000	4	300
30,000 to 34,999 sq. ft.	4500	4	300
35,000 or more sq. ft.	5000	5	300

Previous fire flow evaluation efforts identified flow rates based on square footage of the existing building in specific areas. However a more conservative approach would be to assign the required flow rate based on the land use, because building sizes may change in the future. In this way, the District's system will be adequately to accommodate potential redevelopment of the parcels. While the four cities within the Las Virgenes Municipal Water District have varying land use and planning information, each had land uses that appeared to correspond with the land uses above that require 5,000 gpm. For these parcels, a fire flow demand of 5,000 gpm was assumed. This affected the analysis of the distribution system, as well as the storage analysis.

The fire flow demands were not changed from the values assigned for the 2007 Water Master Plan Update.

5.2 Hydraulic Analysis of Existing System

The model was updated to include known projects that have been constructed since the development of the model for the 2007 Water Master Plan. These include both pipeline and pumping improvements as follows:

- **New Pipelines Added to the Model**
    - 2007 CIP 2A – East-West Pipe, End of Calabasas Road to LV Road is an addition of a 30-inch pipeline from Mureau Road near Round Meadow Road, west to Las Virgenes Road, then south on Las Virgenes Road, and cross under U.S. 101 to connect to an existing water main near Agoura Road.
    - 2007 CIP 2B and 2C – Morrison Tank Pipeline Improvements is an addition of an 12-inch steel pipe that starts from the Morrison Reservoir near East Thousand Oaks Blvd heading south along Reyes Adobe Road to Kanan Road. From there it is about 2,520 feet of 18-inch pipe with an alignment that heads east along Agoura Road to the Cornell Pump Station.
    - Lower and Upper Oaks Subsystems – These two subsystems were not modeled in the previous Master Plan. The new model includes the subsystem pumping, piping and storage.
    - Miscellaneous Pipes Added to the Model
        - 8-inch Pipe along Caitlyn Circle in Westlake Village
        - 10-inch Pipe along Russell Ranch Road Westlake Village
        - 12-inch Pipe along Canwood Street in Agoura Hills
        - 10-inch Pipe along an unnamed road connecting Lasher Road with Old Scandia Lane.

- **New Pumps Added to the Model**

    - 2007 CIP 5 – Warner Pump Station Expansion. Adds a 1,000 gpm pump to the Warner Pump Station.

    - 2007 CIP 6 – Mulwood Pump Station Expansion. Adds a 750 gpm pump to the Mulwood Pump Station.

    - 2007 CIP 7 – Twin Lakes Pump Station Expansion. Adds two pumps to add 450 gpm pumping to the Twin Lakes Pump Station.

    - 2007 CIP 10A – Standby Pump at Seminole Pump Station. Adds a 750 gpm pump to the Seminole Pump Station.

    - Lower and Upper Oaks Pump Station

5.2.1.1 Features of Model

Significant demands on the system modeled are the Morrison Recycled Water Supplement, The Cordillera Recycled Water Supplement, Reservoir 2 Recycled Water Supplement, and the District 29 turnout. The District 29 turnout was modeled at a constant 1,000 gpm demand. The recycled water supplement turnouts were modeled with the demands shown in Table 5-4..

Table 5-4: Recycled Water Supplements for Existing Conditions

	Peak Hour	MDD
Morrison PS	1300 gpm	350 gpm
Cordillera Tank	0 gpm	0 gpm
Reservoir 2 (next to LVMWD HQ)	1200 gpm	1200 gpm

5.2.1.2 Model Validation

The model was put through a validation process to check the performance and accuracy of the model. Validation was done by running the MDD scenario and comparing the results against in-field measurements taken from the SCADA system for 14 July 2013. The validation also checked the ADD scenario against in-field measurements taken from the SCADA system for May 1 2013. Specifically, the comparison focused on the water levels in all the tanks. Graphs were prepared the help visualize the rise and fall of the water levels in each tank in the system using both the data provided by the District and the results from the model. The results showed good agreement throughout the day between the two sets of data, indicating that the model is accurately representing what is actually occurring in the system in terms of distribution of demands, peaking factors, operational settings and controls.

The results of the validation were submitted to the District on 15 October 2013 and modeling work continued upon approval. All model validation graphs for both ADD and MDD are provided in Appendix C.

No fire hydrant testing was performed to further calibrate the potable water hydraulic model as part of the development of this master plan update.

5.2.2 Existing Conditions Scenarios Modeled

Several existing scenarios were modeled. The model conditions for both MDD and FF simulations are listed in Table 5-5.

- 2013 MDD with no improvements – The 2013 MDD Scenario is a 72-hour extended period simulation. This scenario was based on the original model from the 2007 Water Master Plan, and was updated for 2013 with the system improvements that were identified. The demands were imported from water meter records from 2012 and averaged over the year to derive an ADD. The maximum day diurnal patterns developed for the 2007 Master Plan Update were applied to the ADD to produce maximum day demands. The pump controls in the model were created based printouts from the District's SCADA system to reflect current system operations.

- 2013 MDD with FF – The 2013 MDD with FF Scenario is a static simulation, which uses MDD demands in conjunction with fire flow demands. Fire flow simulations assign the appropriate fire flow to each hydrant in the model. The model does not have hydrants, so individual junctions were identified for use as fire hydrants based on information from the geodatabase provided by the District that identified hydrant locations. The individual fire flow requirements for each hydrant were identified based on land use according to the information in Table 5-3. This simulation operates by applying the maximum day demands at the appropriate junctions throughout the system, while applying fire flow demands at the hydrant locations. The simulation sequentially steps through all of the hydrants in the system applying the fire flow demands one at a time. This simulates the effect of the maximum day demands on the entire system, while testing the localized effect of fire flow demands at the hydrant locations.

- 2013 MDD with FF and Proposed CIP– The 2013 MDD with FF and Proposed CIP Scenario is a static simulation, which has the same settings and controls of the 2013 MDD with FF scenario above. However, the proposed pipeline improvement projects are active in this scenario. This scenario operates in the same way as the fire flow scenario above, but was used to test improvement projects to ensure that they were properly located and sized. For the fire flow scenarios, system settings were applied to simulate a conservative approach for evaluating system performance. This included assuming that pump stations were turned off in zones with storage, so that fire flows were supplied only from storage. Tank levels were set at minimum levels to test that minimum system pressures can be provided when tank levels are lowest. The details of the maximum day and the maximum day plus fire flow scenarios are summarized in Table 5-5 below.

Table 5-5: Model Simulation Conditions

Description	Max Day Demand	Fire Flow (Max Day)
	MDD	FF+MDD
Pump Stations	On-off (cycle)	Off
Turnouts	On-off (cycle)	LV-2 and Westlake Filter Plant On
Reservoir Level	Varies	Minimum Regulatory
Minimum Pressure	35 psi	20 psi hydrant
Maximum Pressure	150 psi	N/A
Maximum Pipeline Flow Velocity	5 fps	N/A
Maximum Pipeline Headloss	5 ft./ 100 ft.	N/A

5.2.3 Existing System Evaluation (Distribution, Storage, Pumping, Fire Flow)

5.2.3.1 Pumping

The pumping facilities for each subsystem were evaluated to determine if there is sufficient pumping capacity to meet the criteria stated in Section 5.1.4. The system pumping capacity was evaluated against 2013 demand conditions in Table 5-6.

Typically, in water system planning, it is assumed that the largest pump at a station may be out of service. The capacity of the pump station without the largest pump is referred to as the firm capacity of the pump station. In the Jed Smith and Mountain Gate area, two pump stations serve the same zone. In this situation, it is assumed that the largest pump in either pump station may be out of service. The firm capacity is examined for the entire pressure zone, assuming that only one pump is out of service at a time.

The analysis of the pumping facilities for the LVMWD system revealed deficiencies in the Jed Smith/Mountain Gate Pump Stations and Three Springs Pump Station.

The zones that are able to satisfy both the pumping and storage requirements of the 9-hour recommendation include: Dardenne, Latigo, Ranchview, Saddle Peak, and Upper Twin Lakes.

The zones that are able to satisfy both the pumping and storage requirements for the 18-hour recommendation (without CIP) include: Kimberly, Lower Oaks, Saddle Tree, Seminole, Twin Lakes, Upper Oaks, and Woolsey.

The 2013 pumping analysis shows that the Jed Smith and Mountain Gate Pump Stations need to be upgraded to provide for a deficit of 261 gpm. Additionally, there is a deficit for the Three Springs Pump Station that is 71 gpm, which is needed to achieve 24-hour pumping given that this zone has no storage.

Table 5-6 - Pumping Capacity Analysis for Existing System

Pump Station(s)	Discharge Zone	Nominal Pump Station Capacity GPM	No. of Existing Pumps	No. of Duty Pumps	Current Pump Capacity	No. of Standby Pumps	Current Pump Station Capacity (gpm)	Provides Flow To	MDD (gpm)	Required Flow at MDD: 24-hr Basis	Required Flow at MDD: 18-hr Basis	Required Flow at MDD: 9-hr Basis	Required Flow at Peak Hour	Recom-mended Tank Basis	Capacity for: 9-Hour	Capacity for: 18-Hour	Capacity for: 24-hour	Deficit for: Off-Peak (GPM)	Deficit for: 18-Hour (GPM)	Deficit for: 24-Hour (GPM)	Approx. TDH	Off Peak Horse Power	18-Hour Horse Power	Cost of Upgrade: Off-Peak ($)	Cost of Upgrade: 18-Hour ($)
								Agoura MDD	32	32															
Agoura	Agoura Zone	1500	3	3		0	1500	Agoura Fire Flow		1250	N/A	N/A	1330	N/A	N/A	N/A	yes	none	none	none	N/A	N/A	N/A	N/A	N/A
								Total		**1282**															
Dardenne	Dardenne Tank	500	2	1	420	1	840	Dardenne MDD	210	210	281	561	N/A	Off-Peak	yes	yes	yes	none	none	none	N/A	N/A	N/A	N/A	N/A
	JBR Zone							JBR MDD	80	80															
JBR		1250	2				2200	JBR Fire Flow		1250	N/A	N/A	1513	N/A	N/A	N/A	yes	none	none	none	N/A	N/A	N/A	N/A	N/A
								JBR Total		**1330**															
Kimberly	Kimberly Tank	500	3	2	190	1	380	Kimberly MDD	183	183	243	487	N/A	18-hour	no	yes	yes	(107)	none	none	338	9	N/A	$ 88,000	N/A
Lower Oaks	Lower Oaks Tank	1280	3	2	640	1	1280	Lower Oaks MDD	513	513	684	1368	N/A	18-hour	no	yes	yes	(88)	none	none	134	3	N/A	$ 29,000	N/A
	Lower Oaks PS							Lower Oaks MDD	513																
McCoy	Upper Oaks PS	3400	3	3	1133	0	3400	Upper Oaks MDD	239				N/A	18-hour	no	yes	yes	(2490)	none	none	241	152	N/A	$ 1,401,000	N/A
	McCoy Tank							McCoy MDD	1456																
								Total	**2209**	**2209**	**2945**	**5890**													
Jed Smith		1700	3	2	850	1	1700	JS MDD	1198												187				
Mountain Gate	Jed Smith Tanks	1000	2	2	492	0	984	MG MDD	884				N/A	18-hour	no	no	yes	(2867)	(92)	none	189	137	4	$ 1,840,050	$ 60,900
		2700	5	4		1	2684	**Total**	**2082**	**2082**	**2776**	**5551**													
	Mulwood Tank			2	490	0		Mulwood MDD	973																
Mulwood	Dardenne PS	1750	3	1	750	0	1750	Dardenne MDD	210				N/A	18-hour	no	yes	yes	(1406)	none	none	205	73	N/A	$ 1,015,000	N/A
								Total	**1184**	**1184**	**1578**	**3156**													
Oak Ridge	Oak Ridge Tank	260	2	2	235	0	470	Oak Ridge MDD	103	103	137	273	N/A	Off-Peak	yes	yes	yes	none	none	none	N/A	N/A	N/A	N/A	N/A
Ranchview	Ranchview Tank	400	2			1	800	Ranchview MDD	169	169	226	452	N/A	Off-Peak	yes	yes	yes	none	none	none	N/A	N/A	N/A	N/A	N/A
Saddle Tree	Saddle Tree Tank	330	2			0	356	Saddle Tree MDD	87	87	116	232	N/A	18-hour	yes	yes	yes	none	none	none	N/A	N/A	N/A	N/A	N/A
	Seminole Tank							Seminole MDD	1319																
Seminole	Latigo	2350	4	3	750	1	2250	Latigo MDD	158				N/A	18-hour	no	yes	yes	(2198)	none	none	1069	59	N/A	$ 825,050	N/A
	Three-Springs Zone							Three-Springs MDD	191																
								Total	**1668**	**1668**	**2224**	**4448**													
Stunt Road	Saddle Peak Tank	550	2	1	624	1	624	Saddle Peak MDD	199	199	265	530	N/A	Off-Peak	yes	yes	yes	none	none	none	N/A	N/A	N/A	N/A	N/A
Three-Springs																									
(Fire Flow handled by	Three-Springs Zone	320	2	2	60	0	120							N/A	no	no	no	N/A	N/A	(71)	N/A	N/A	N/A	N/A	N/A
Seminole Tank)								Three-Springs MDD	191	191	N/A	N/A	673												
	Upper Twin Lakes Tank			2	430			Upper Twin Lakes MDD	60																
Twin Lakes	Twin Lakes Tank	2500	6	1	585	1	2500	Twin Lakes MDD	1473				N/A	18-hour	no	yes	yes	(1588)	none	none	343	138	N/A	$ 1,396,350	N/A
				2	225			**Total**	**1533**	**1533**	**2044**	**4088**													
Upper Oaks	Upper Oaks Tank	800	2	2	400	0	800	Upper Oaks MDD	239	239	319	638	N/A	18-hour	no	no	no	none	none	none	N/A	N/A	N/A	N/A	N/A
Upper Twin Lakes	Upper Twin Lakes Tank	400	2	2	200	0	400	Upper Twin Lakes MDD	60	60	80	160	N/A	Off-Peak	yes	yes	yes	none	none	none	N/A	N/A	N/A	N/A	N/A
	Warner Tank							Warner MDD	1513																
	Cordillera Tank							Cordillera	500																
Warner (1 &2)	Oak Ridge PS		2	2	822			Oak Ridge MDD	103																
Warner (3)	Stunt Road PS	3840	1	1	1448		4092	Saddlepeak MDD	199				N/A	18-hour	no	yes	yes	(979)	none	none	Warner		N/A	$ 930,900	N/A
Warner (4)			1	1	1000																394	98			
Cold Canyon	Park Granada PRS	1000	3	2	550	1	1100	Park Granada	0												Cold Canyon				
Warner + Cold Canyon	**Total**	**4840**	**7**				**5192**	**Total**	**2314**	**2314**	**3086**	**6171**									**451**	**112**			

Notes:
1) Pump station capacity for pump stations were taken from 2007 Masterplan. Lower Oaks PS, Mulwood PS, Seminole, PS, Twin Lakes PS, and Upper Oaks PS were updated using the 2013 model.
2) Improvements to Mulwood PS has eliminated need for Mulwood PRS.

5.2.3.2 Storage Facility Evaluation

The storage analysis consisted of evaluating the volume of the existing storage facilities within each pressure zone, or group of pressure zones to determine if that volume was equal to or greater than the minimum required storage. The results of the storage analysis for existing demands are presented in Table 5-7.

The Three Springs Zone does not have a storage tank. Previous versions of the Master Plan have identified a need for a 0.5 MG tank. A Three Springs Tank is still recommended.

The 2013 reservoir analysis shows that Jed Smith, McCoy, Mulwood and Warner Tank have significant deficits in their storage capacity. The 2007 analysis only found a deficiency in Jed Smith Tanks. A summary of the current storage and pumping facility capacities is provided in Table 5-8.

The large deficiencies in required tank storage observed for the McCoy, Mulwood, and Warner zones between 2007 and 2013 are caused by the change in FF requirement as discussed in Section 5.1.5.

Note that the 1235 West Zone reflects a surplus capacity under existing demand conditions. This condition is because a new 5 Million Gallon Tank near the Las Virgenes Reservoir has been included in the analysis. In reality, this facility is not yet operational as the award for its construction was only awarded in January of 2014. Without this facility, the 1235 West Zone would show a storage capacity deficit under existing conditions. Even with this facility in place, the analysis of future conditions indicates a small storage deficit in this zone. No deficiency or capital improvement is reflected herein as the level of deficiency is presumed to be negligible considering the accuracy of future conditions.

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1389005*00
May 2014

Table 5-7 - Storage Capacity Analysis for Existing System

Reservoir/Tank	Tank High Water Elevation	Fire Flow (gpm)	Fire Duration (hours)	Required Fire Storage (gal)	MDD (GPM)	5-Hour Emergency Storage (gal)	Daily Regulatory Storage (gallons)			Total Storage Required (MG)[1]			Possible Operations Off-Peak[2]	Recommended Storage (MG)	Existing Tank Capacity (MG)	Surplus (Deficit) Capacity (MG)	Basis of Recom-mendation	Need More Storage	Cost of New Storage	Note
							24-Hour Basis	18-Hour Basis	9-Hour Basis	24-Hour Basis	18-Hour Basis	9-Hour Basis								
Dardenne Tank	1,618	1,250	2	150,000	210	63,132	88,385	126,264	252,528	0.30	0.34	0.47	Yes	0.47	0.5	0.03	9-hour	NO		
Jed Smith Tanks	1,420	1,250	2	150,000	2,082	624,504	874,306	1,249,008	2,498,016	1.65	2.02	3.27	No	2.02	1.2	(0.82)	18-hour	YES	$ 1,911,600	
Kimberly Tanks	1,517	1,250	2	150,000	183	54,771	76,679	109,542	219,084	0.28	0.31	0.42	Yes	0.42	0.47	0.05	18-hour	NO		
Latigo Tank	1,775	1,250	2	150,000	158	47,493	66,490	94,986	189,972	0.26	0.29	0.39	Yes	0.39	1.5	1.11	9-hour	NO		
Lower Oaks	1,616	2,500	2	300,000	513	153,921	215,489	307,842	615,684	0.67	0.76	1.07	Yes	1.07	1.1	0.03	18-hour	NO		
McCoy Tank	1,476	2,500	2	300,000	1,453	436,029	610,441	872,058	1,744,116	1.35	1.61	2.48	No	1.61	2	0.39	18-hour	NO		
Mulwood Tank	1,450	3,000	3	540,000	973	291,954	408,736	583,908	1,167,816	1.24	1.42	2.00	No	1.42	1.6	0.18	18-hour	NO		
Oak Ridge Tank	1,826	1,250	2	150,000	103	30,762	43,067	61,524	123,048	0.22	0.24	0.30	Yes	0.24	0.32	0.08	18-hour	NO		
Ranchview	1,302	1,250	2	150,000	169	50,826	71,156	101,652	203,304	0.27	0.30	0.40	Yes	0.40	0.4	(0.00)	9-hour	NO		
Saddle Peak Tank	2,513	2,500	2	300,000	199	59,613	83,458	119,226	238,452	0.44	0.48	0.60	Yes	0.60	2.2	1.60	9-hour	NO		
Saddle Tree Tank	1,420	1,500	2	180,000	87	26,160	36,624	52,320	104,640	0.24	0.26	0.31	No	0.26	0.28	0.02	18-hour	NO		
Seminole Tanks	2,153	2,500	2	300,000	1,319	395,820	554,148	791,640	1,583,280	1.25	1.49	2.28	No	1.49	1.7	0.21	18-hour	NO		
Twin Lakes Tank	1,585	3,500	3	630,000	1,473	441,924	618,694	883,848	1,767,696	1.69	1.96	2.84	No	1.96	2	0.04	18-hour	NO		
Upper Oaks	1,753	1,250	2	150,000	239	71,829	100,561	143,658	287,316	0.32	0.37	0.51	No	0.37	0.3	(0.07)	18-hour	YES	~~$ 113,000~~	Can ignore
Upper Twin Lakes	1,805	1,250	2	150,000	60	18,000	25,200	36,000	72,000	0.19	0.20	0.24	Yes	0.24	0.39	0.15	9-hour	NO		
Upper Woolsey Tank	1,845	2,500	2	300,000	228	68,265	95,571	136,530	273,060	0.46	0.50	0.64	No	0.50	0.5	(0.00)	18-hour	NO		
Warner Tanks	1,640	3,000	3	540,000	2,136	640,800	897,120	1,281,600	2,563,200	2.08	2.46	3.74	No	2.46	2.5	0.04	18-hour	NO		
1235 Zone West																				
5MG Tank (New)	1,083														4.62					
Equestrian Tank	1,227														4.2					
Morrison Tank	1,212														3					
Subtotal West		5,000	5	1,500,000	10,348	3,104,460	4,346,244	6,208,920	12,417,840	8.95	10.81	17.02	24-hour	8.95	11.82	2.87	24-hour			
1235 Zone East																				
Calabasas Tank	1,235	5,000	5	1,500,000	6,724	2,017,287	2,824,202	4,034,574	8,069,148	6.34	7.55	11.59	24-hour	6.34	8	1.66	24-hour			
Zone Total		10,000	5	3,000,000	17,072	5,121,747	7,170,446	10,243,494	20,486,988	15.29	18.37	28.61	24-hour	15.29	19.82	4.53				
TOTAL ALL STORAGE				**7,590,000**	**29,189**	**8,597,550**								**31.21**	**38.78**				**$ 1,911,600**	

$ 1.72	= Cost per gallon for new storage, assuming concrete reservoirs, and including site work

Notes:

1) Factors for converting MDD to 24, 18, and 9-hour basis are 420, 600, and 1200 respectively.

2) Based on comparing volume required for the 9-hour pumping basis and the existing tank volume

Table 5-8: Summary of Current Reservoir and Pump Station Capacities

System	Reservoir Adequate for: 9-Hour	Reservoir Adequate for: 18-Hour	Pump Station Adequate for: 9-Hour	Pump Station Adequate for: 18-Hour	Recommendation	Notes
Agoura	N/A	N/A	N/A	N/A	N/A	
JBR	N/A	N/A	N/A	N/A	N/A	
Dardenne	Yes	Yes	Yes	Yes	9-hour	
Jed Smith/ Mt. Gate	No	No	No	No	18-hour	Need 0.82 MG storage & pumping upgrade
Kimberly	Yes	Yes	No	Yes	18-hour	
Latigo	Yes	Yes	N/A	N/A	9-hour	
Lower Oaks	No	Yes	No	Yes	18-hour	
McCoy	No	No	No	Yes	18-hour	Need 0.81 MG storage[(a)]
Mulwood	No	No	No	Yes	18-hour	Need 0.78 MG storage[(a)]
Oak Ridge	Yes	Yes	Yes	Yes	18-hour	See Note (a)
Ranchview	Yes	Yes	Yes	Yes	9-hour	
Saddle Peak/Stunt Road	Yes	Yes	Yes	Yes	9-hour	See Note (a)
Saddle Tree	No	Yes	Yes	Yes	18-hour	
Seminole	No	Yes	No	Yes	18-hour	
Three Springs	N/A	N/A	N/A	N/A	N/A	
Twin Lakes	No	Yes	No	Yes	18-hour	
Upper Oaks	No	No (Minor)	Yes	Yes	18-hour	No upgrade needed
Upper Twin Lakes	Yes	Yes	Yes	Yes	9-hour	
Warner	No	No	No	Yes	18-hour	Need 0.92 MG storage
Woolsey	No	Yes	N/A	N/A	N/A	

Note (a) Oak Ridge needs standby pumping. McCoy, Mulwood and Saddlepeak may need standby pumping.

5.2.3.3 Distribution Facilities Evaluation

The simulation for MDD + FF revealed capacity deficiencies in various parts of the system resulting from the inability of the system to provide adequate fire flow demands. The distribution facilities was compared against the fire flows listed in Table 5-3 using the criterion that minimum residual pressure shall be no less than 20 psi at the flowing hydrant. Fire hydrant locations were identified based on GIS files provided by the District. For areas where there was a mix of land-uses, the fire flow from the land-use with the largest fire flow demand was assigned to the node in the model representing the hydrant location.

The majority of the capacity deficiencies occurred in the 1235 Main Zone. However, capacity deficiencies occurred in most of the zones in the system. These problems are highlighted in the CIP for pipelines in Section 6.2.1.

The pipeline deficiencies that appeared in the 1235 Main Zone were spread throughout the zone. Many of the fire flow deficiencies resulted from changing the required fire flow to the more conservative fire flow requirement as described in Section 5.1.5. In these areas, commercial and industrial fire flows were assigned to 5,000 gpm to accommodate unknown building sizes on parcels with these land uses.

The FF deficiencies observed in the Mulwood zone are directly attributable to the increased FF requirement as discussed in Section 5.1.5. Although McCoy and Mulwood zones had modified FF requirements, these requirements did not affect the evaluation of the piping in either zone.

Google Earth was used to analyze areas with land uses that would dictate a fire flow demand of 5,000 gpm. In some instances the parcels corresponded to locations of tanks for the potable water system. In others, the parcels appeared to be drainage basins used for stormwater management. For locations such as these, where a fire flow demand of 5,000 gpm appeared to be unreasonable, the fire flow demand was removed from the hydraulic model, and any deficiencies identified as a result of these fire flows were ignored.

5.3 Hydraulic Analysis of Future System

As indicated in Section 2.2, future demands were developed for the LVMWD system based on a variety of factors including land use, population, vacancies, climate and economy. The system was analyzed after these demands were incorporated into the model.

The 2013 pump controls for the model were used again for the future model. However, because of the increased demands throughout the system, some zones require additional pumping to allow the model to run properly. These zones matched the zones identified in the previous Master Plan (Seminole, Mountain Gate, Adamor HP, and Warner). For the new pumps, pump definitions were already created in 2007 version of the model. However the pump controls for these new pumps were not added. For simplicity, there were no new pump controls, and the new pumps were turned on and throttled as required to make the model work.

The construction of the Adamor Hydropneumatic Pump Station was previously identified as CIP 4B in the 2007 Water Master Plan. The purpose of the Adamor Hydropneumatic Zone is to reduce the demand put on the Jed Smith/Mountain Gate system. The need for the Adamor HP zone was included in the future analysis based on the results indicating the lack of storage in the Jed Smith/Mountain Gate Zone.

Due to the increased demand, some of the additional storage recommended in the previous CIP was incorporated into the future model to improve system operation. An additional Seminole Tank (2007 CIP 10D) was included in the model and is recommended again as future CIP. Additions to Twin Lakes Tanks and Warner Tanks were included in the model also based on results indicating the need for more storage in those zones.

New piping was also added as part of the increased pumping at the Seminole Pump Station as described in2007 CIP 10D. The new piping was associated with the improvements to Seminole Pump Station and Adamor HP.

Significant demands on the system modeled are the Morrison Recycled Water Supplement, The Cordillera Recycled Water Supplement, the Reservoir 2 Recycled Water Supplement, and the District 29 turnout. The District 29 turnout was modeled at a constant 1,000 gpm demand. The remaining demands are shown in Table 5-9.

Table 5-9: Recycled Water Supplements for Future Conditions

	Peak Hour	MDD
Morrison PS	2000 gpm	1000 gpm
Cordillera Tank	1200 gpm	1200 gpm
Reservoir 2 (next to LVMWD HQ)	2000 gpm	2000 gpm

5.3.1 Future Scenarios Modeled

The future scenarios that were developed and analyzed in the model include:

- 2035 MDD with no improvements – The 2035 MDD scenario is a 72-hour extended period simulation, which consists of the facilities in the 2013 model, but with the 2035 demands imported and assigned to the appropriate junctions. The pump controls were also unchanged between the 2013 and the 2035 model. However, the resulting model was unstable because certain zones would run dry on the existing pump controls. Additional pumps and facilities were added to run a stable 72-hour simulation.

- 2035 MDD with FF – The 2035 MDD with FF scenario is a static simulation, which uses the 2035 MDD demands in conjunction with the fire flows as assigned in the 2013 fire flow analysis. The settings for this scenario consist of the tanks set at the lowest point and the pumps turned off. The water supply to the system at LV-2 and Westlake Filter Plant were turned left on.

- 2035 MDD with FF and Proposed CIP – the 2035 MDD with FF and Proposed CIP scenario is a static simulation, which has the same settings and controls of the 2035 MDD with FF scenario above. However, the proposed pipeline improvement projects are active in this scenario. This scenario operates in the same way as the fire flow scenario above, but was used to test improvement projects to ensure that they were properly located and sized.

5.3.2 Future System Evaluation (Distribution, Storage, Pumping, and Fire Flow)

Las Virgenes Reservoir and West Lake Filter Plant were used as a water supply in the 2013 and future model runs for MDD and FF conditions. The effect of having the West Lake Filter Plant on was that it provides a flow of 9,000 gpm into the system. After additions to the plant are completed, the future capacity of Westlake filter plant will be approximately 12,000 gpm.

The 5 MG finished water reservoir was not modeled for the 2035 scenario because the flow into the system appears to be hydraulically separate from the model, refilling with finished water from the Westlake Filter Plant and discharged through the pumps of the Westlake Filter Plant. However, the 5 MG finished water reservoir was represented in the model by varying the flow from the Westlake Filter Plant. The future maximum flow rate of the Westlake Filter Plant is 12,000 gpm. In the model, the Westlake Filter Plant junction was allowed to supply more than 12,000 gpm as needed, using the 5MG reservoir to supplement the flow.

5.3.2.1 Pumping Facility Evaluation

Similar to the 2013 evaluation, pumping facilities for each subsystem were evaluated to determine if there is sufficient pumping capacity to meet the criteria stated in Section 5.1.4. The system pumping capacity was evaluated against 2035 demand conditions in Table 5-10.

2035 pumping analysis shows large deficits throughout the system. Most notably the McCoy Pump Station needs to be upsized to accommodate a projected deficit of 981 gpm; the Jed Smith or Mountain Gate pump station need to be upsized to accommodate a projected deficit of 1,700 gpm; the Mulwood Pump Station needs to be upsized to accommodate a projected deficit for 485 gpm; the Seminole Pump Station needs to be upsized to accommodate a projected deficit for 1,920 gpm; the Twin Lakes Pump Station needs to be upsize to accommodate a projected deficit for 1,880 gpm.

The 2007 Potable Water Master Plan previously identified the need for expansion of the Mountain Gate Pump Station, expansion of the Jed Smith Pump Station, construction of a new Three Springs Pump Station and construction of a second Seminole Pump Station.

Table 5-10 - Pumping Capacity Analysis for Future System

Pump Station(s)	Discharge Zone	Nominal Pump Station Capacity GPM	No. of Existing Pumps	No. of Duty Pumps	Current Pump Capacity	No. of Standby Pumps	Current Pump Station Capacity (gpm)	Provides Flow To	MDD (gpm)	Required Flow at MDD: 24-hr Basis	Required Flow at MDD: 18-hr Basis	Required Flow at MDD: 9-hr Basis	Required Flow at Peak Hour	Recom-mended Tank Basis	Capacity for: 9-Hour	Capacity for: 18-Hour	Capacity for: 24-hour	Deficit for: Off-Peak (GPM)	Deficit for: 18-Hour (GPM)	Deficit for: 24-Hour (GPM)	Approx. TDH	Off Peak Horse Power	18-Hour Horse Power	Cost of Upgrade: Off-Peak ($)	Cost of Upgrade: 18-Hour ($)
								Agoura MDD	53	53															
Agoura	Agoura Zone	1500	3	3		0	1500	Agoura Fire Flow		1250	N/A	N/A	1384	N/A	N/A	N/A	yes	none	none	none	N/A	N/A	N/A	N/A	N/A
								Total		**1303**															
Dardenne	Dardenne Tank	500	2	1	420	1	840	Dardenne MDD	297	297	396	791	N/A	18-hour	yes	yes	yes	none	none	none	N/A	N/A	N/A	N/A	N/A
	JBR Zone							JBR MDD	112	112															
JBR		1250	2				2200	JBR Fire Flow		1250	N/A	N/A	1621	N/A	N/A	N/A	yes	none	none	none	N/A	N/A	N/A	N/A	N/A
								JBR Total		**1362**															
Kimberly	Kimberly Tank	500	3	2	190	1	380	Kimberly MDD	259	259	345	691	N/A	18-hour	no	yes	yes	(311)	none	none	338	27	N/A	$ 369,750	N/A
Lower Oaks	Lower Oaks Tank	1280	3	2	640	1	1280	Lower Oaks MDD	724	724	965	1930	N/A	18-hour	no	yes	yes	(650)	none	none	134	22	N/A	$ 305,950	N/A
	Lower Oaks PS							Lower Oaks MDD	724																
	Upper Oaks PS							Upper Oaks MDD	339																
McCoy	McCoy Tank	3400	3	3	1133	0	3400	McCoy MDD	2223				N/A	18-hour	no	no	yes	(5362)	(981)	none	241	326	60	$ 4,376,100	$ 804,750
								Total	**3286**	**3286**	**4381**	**8762**													
Jed Smith		1700	3	2	850	1	1700	JS MDD	1709												187				
Mountain Gate	Jed Smith Tanks	1000	2	2	492	0	984	MG MDD	1044				N/A	18-hour	no	no	no	(4657)	(987)	(69)	189	223	47	$ 2,988,450	$ 653,950
		2700	5	4		1	2684	Total	2753	2753	3671	7341													
	Mulwood Tank			2	490	0		Mulwood MDD	1380																
Mulwood	Dardenne PS	1750	3	1	750	0	1750	Dardenne MDD	297				N/A	18-hour	no	no	yes	(2721)	(485)	none	205	141	25	$ 1,963,300	$ 348,000
								Total	**1677**	**1677**	**2235**	**4471**													
Oak Ridge	Oak Ridge Tank	260	2	2	235	0	470	Oak Ridge MDD	145	145	193	386	N/A	18-hour	yes	yes	yes	none	none	none	N/A	N/A	N/A	N/A	N/A
Ranchview	Ranchview Tank	400	2			1	800	Ranchview MDD	247	247	329	658	N/A	18-hour	yes	yes	yes	none	none	none	N/A	N/A	N/A	N/A	N/A
Saddle Tree	Saddle Tree Tank	330	2			0	356	Saddle Tree MDD	130	130	173	346	N/A	18-hour	yes	yes	yes	none	none	none	N/A	N/A	N/A	N/A	N/A
	Seminole Tank							Seminole MDD	3446																
	Latigo							Latigo MDD	442																
Seminole		2350	4	3	750	1	2250						N/A	18-hour	no	no	no	(8119)	(2934)	(1638)	1069	219	79	$ 2,538,950	$ 1,059,950
								Total	**3888**	**3888**	**5184**	**10369**													
Stunt Road	Saddle Peak Tank	550	2	1	624	1	624	Saddle Peak MDD	394	394	525	1050	N/A	18-hour	no	yes	yes	(426)	none	none	900	97	N/A	$ 1,299,200	N/A
Three-Springs																									
(Fire Flow handled by	Three-Springs Zone	320	2	2	60	0	120							N/A	no	no	no	N/A	N/A	120	N/A	N/A	N/A	N/A	N/A
Seminole Tank)								Three-Springs MDD	0	0	N/A	N/A	0												
	Upper Twin Lakes Tank			2	430			Upper Twin Lakes MDD	85																
Twin Lakes	Twin Lakes Tank	2500	6	1	585	1	2500	Twin Lakes MDD	3199				N/A	18-hour	no	no	no	(6257)	(1878)	(784)	343	542	163	$ 5,498,400	$ 1,890,800
				2	225			**Total**	**3284**	**3284**	**4378**	**8757**													
Upper Oaks	Upper Oaks Tank	800	2	2	400	0	800	Upper Oaks MDD	339	339	452	903	N/A	18-hour	yes	yes	yes	none	none	none	N/A	N/A	N/A	N/A	N/A
Upper Twin Lakes	Upper Twin Lakes Tank	400	2	2	200	0	400	Upper Twin Lakes MDD	85	85	113	226	N/A	Off-Peak	yes	yes	yes	none	none	none	N/A	N/A	N/A	N/A	N/A
	Warner Tank							Warner MDD	2833																
	Cordillera Tank							Cordillera	500																
Warner (1 &2)	Oak Ridge PS		2	2	822			Oak Ridge MDD	145																
Warner (3)	Stunt Road PS	3840	1	1	1448		4092	Saddlepeak MDD	394				N/A	18-hour	no	yes	yes	(5133)	none	none	Warner			$ 3,774,350	N/A
Warner (4)			1	1	1000																394	511	N/A		
Cold Canyon	Park Granada PRS	1000	3	2	550	1	1100	Park Granada	0												Cold Canyon				
Warner + Cold Canyon	**Total**	**4840**	**7**				**5192**	**Total**	**3872**	**3872**	**5162**	**10325**									**451**	**585**			

Notes:
1) Pump station capacity for pump stations were taken from 2007 Masterplan. Lower Oaks PS, Mulwood PS, Seminole, PS, Twin Lakes PS, and Upper Oaks PS were updated using the 2013 model.
2) Improvements to Mulwood PS has eliminated need for Mulwood PRS.

5.3.2.2 Storage Facility Analysis

The storage analysis consisted of evaluating the volume of the existing storage facilities within each pressure zone, or group of pressure zones to determine if that volume was equal to or greater than the minimum required storage. The system storage capacity was evaluated under 2035 demand conditions in Table 5-11.

The 2035 reservoir analysis shows significant storage deficits throughout the system, appearing in the Jed Smith, McCoy, Mulwood, Seminole, Twin Lakes, Upper Woolsey, and Warner Tanks. The 2007 Potable Water Master Plan only forecasted deficits in Jed Smith, Seminole, and Upper Oaks tanks. Minor deficits were identified for the Upper Oaks and Saddle Tree tanks, but these appear to be small enough not to address.

As in the analysis of the existing system, the modified FF requirements from Section 5.1.5 are largely responsible for the increased storage requirements observed in the McCoy, Mulwood and Warner tanks.

A summary of the current storage and pumping facility capacities is provided in Table 5-12.

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1389005*00
May 2014

Table 5-11 - Storage Capacity Analysis for Future System

Reservoir/Tank	Tank High Water Elevation	Fire Flow (gpm)	Fire Duration (hours)	Required Fire Storage (gal)	MDD (GPM)	5-Hour Emergency Storage (gal)	Daily Regulatory Storage (gallons)			Total Storage Required (MG)[1]			Possible Operations Off-Peak[2]	Recommended Storage (MG)	Existing Tank Capacity (MG)	Surplus (Deficit) Capacity (MG)	Basis of Recom-mendation	Need More Storage	Cost of New Storage (Includes 2013 Storage)
							24-Hour Basis	18-Hour Basis	9-Hour Basis	24-Hour Basis	18-Hour Basis	9-Hour Basis							
Dardenne Tank	1,618	1,250	2	150,000	297	89,013	124,618	178,026	356,052	0.36	0.42	0.60	No	0.42	0.5	0.08	18-hour	NO	
Jed Smith Tanks	1,420	1,250	2	150,000	2,753	825,870	1,156,218	1,651,740	3,303,480	2.13	2.63	4.28	No	2.63	1.2	(1.43)	18-hour	YES	$ 3,314,250
Kimberly Tanks	1,517	1,250	2	150,000	259	77,727	108,818	155,454	310,908	0.34	0.38	0.54	No	0.38	0.47	0.09	18-hour	NO	
Latigo Tank	1,775	1,250	2	150,000	442	132,684	185,758	265,368	530,736	0.47	0.55	0.81	Yes	0.81	1.5	0.69	9-hour	NO	
Lower Oaks	1,616	2,500	2	300,000	724	217,104	303,946	434,208	868,416	0.82	0.95	1.39	No	0.95	1.1	0.15	18-hour	NO	
McCoy Tank	1,476	2,500	2	300,000	2,223	666,990	933,786	1,333,980	2,667,960	1.90	2.30	3.63	No	2.30	2	(0.30)	18-hour	YES	$ 699,300
Mulwood Tank	1,450	3,000	3	540,000	1,380	413,940	579,516	827,880	1,655,760	1.53	1.78	2.61	No	1.78	1.6	(0.18)	18-hour	YES	$ 422,550
Oak Ridge Tank	1,826	1,250	2	150,000	145	43,383	60,736	86,766	173,532	0.25	0.28	0.37	No	0.28	0.32	0.04	18-hour	NO	
Ranchview	1,302	1,250	2	150,000	247	73,998	103,597	147,996	295,992	0.33	0.37	0.52	No	0.37	0.4	0.03	18-hour	NO	
Saddle Peak Tank	2,513	2,500	2	300,000	394	118,128	165,379	236,256	472,512	0.58	0.65	0.89	Yes	0.89	2.2	1.31	18-hour	NO	
Saddle Tree Tank	1,420	1,500	2	180,000	130	38,916	54,482	77,832	155,664	0.27	0.30	0.37	No	0.30	0.28	(0.02)	18-hour	YES	$ 39,150
Seminole Tanks	2,153	2,500	2	300,000	3,446	1,033,800	1,447,320	2,067,600	4,135,200	2.78	3.40	5.47	No	3.40	1.7	(1.70)	18-hour	YES	$ 3,950,100
Twin Lakes Tank	1,585	3,500	3	630,000	3,199	959,730	1,343,622	1,919,460	3,838,920	2.93	3.51	5.43	No	3.51	2	(1.51)	18-hour	YES	$ 3,504,600
Upper Oaks	1,753	1,250	2	150,000	339	101,610	142,254	203,220	406,440	0.39	0.45	0.66	No	0.45	0.3	(0.15)	18-hour	YES	$ 359,100
Upper Twin Lakes	1,805	1,250	2	150,000	85	25,380	35,532	50,760	101,520	0.21	0.23	0.28	Yes	0.28	0.39	0.11	9-hour	NO	
Upper Woolsey Tank	1,845	2,500	2	300,000	747	224,220	313,908	448,440	896,880	0.84	0.97	1.42	No	0.97	0.5	(0.47)	18-hour	YES	$ 1,097,550
Warner Tanks	1,640	3,000	3	540,000	3,333	1,000,020	1,400,028	2,000,040	4,000,080	2.94	3.54	5.54	No	3.54	2.5	(1.04)	18-hour	YES	$ 2,415,150
1235 Zone West																			
5MG Tank	1,083														4.62				
Equestrian Tank	1,227														4.2				
Morrison Tank	1,212														3				
Subtotal West		5,000	5	1,500,000	15,625	4,687,599	6,562,639	9,375,198	18,750,396	12.75	15.56	24.94	24-hour	12.75	11.82	(0.93)	24-hour		
1235 Zone East																			
Calabasas Tank	1,235	5,000	5	1,500,000	9,989	2,996,580	4,195,212	5,993,160	11,986,320	8.69	10.49	16.48	24-hour	8.69	8	(0.69)	24-hour		
Zone Total		10,000	5	3,000,000	25,614	7,684,179	10,757,851	15,368,358	30,736,716	21.44	26.05	41.42	24-hour	21.44	19.82	(1.62)			
TOTAL ALL STORAGE				**7,590,000**	**46,553**	**13,726,692**								**44.71**	**38.78**				**$ 15,801,750**

$ 1.72	= Cost per gallon for new storage, assuming concrete reservoirs, and including site work

Notes:
1) Factors for converting MDD to 24, 18, and 9-hour basis are 420, 600, and 1200 respectively.
2) Based on comparing volume required for the 9-hour pumping basis and the existing tank volume.

Table 5-12: Summary of 2035 Reservoir and Pump Station Capacities

System	Reservoir Adequate for: 9-Hour	Reservoir Adequate for: 18-Hour	Pump Station Adequate for: 9-Hour	Pump Station Adequate for: 18-Hour	Notes[(a)]
Agoura	N/A	N/A	N/A	N/A	
JBR	N/A	N/A	N/A	N/A	
Dardenne	No	Yes	Yes	Yes	
Jed Smith/ Mt. Gate	No	No	No	No	Need 1.43 MG storage & pumping upgrade
Kimberly	Yes	Yes	No	Yes	
Latigo	Yes	Yes	N/A	N/A	
Lower Oaks	No	Yes	No	Yes	
McCoy	No	No	No	No	Need 1.5 MG storage & pumping upgrade
Mulwood	No	No	No	No	Need 1.14 MG storage & pumping upgrade
Oak Ridge	No	Yes	Yes	Yes	
Ranchview	No	Yes	Yes	Yes	
Saddle Peak/Stunt Road	Yes	Yes	No	Yes	
Saddle Tree	No	No (Minor)	Yes	Yes	
Seminole	No	No	No	No	Need 1.7 MG storage & pumping upgrade
Three Springs	N/A	N/A	N/A	N/A	
Twin Lakes	No	No	No	No	Need 1.51 MG storage & pumping upgrade
Upper Oaks	No	No	Yes	Yes	Need 0.15 MG storage
Upper Twin Lakes	Yes	Yes	Yes	Yes	
Warner	No	No	No	No	Need 2.0 MG storage & pumping upgrade
Woolsey	No	No	N/A	N/A	

Note (a) Storage capacity deficiencies for future conditions include the deficiencies identified for existing conditions. Standby pumping deficiencies are assumed to have been addressed under existing conditions.

5.3.2.3 Distribution Facility Evaluation

The simulation for MDD + FF revealed capacity deficiencies in various parts of the system resulting from the system's inability to meet fire flow demands. The hydrants and required fire flows for the future system were kept identical to those used in the 2013 fire flow evaluation.

The 2035 distribution evaluation includes and confirms the CIP recommendations from the 2013 evaluation. The analysis found that the recommendations made for 2013 were still needed in the 2035 scenario. The recommendations were implemented in the 2035 model, and the model was again analyzed for further improvements.

Seminole and Warner zones experienced the most wide spread capacity deficiencies caused by piping in this simulation. For the Seminole subsystem, the area along Mulholland Highway toward the south-west had significant fire flow deficiencies. The Warner Zone also exhibits large areas with fire flow deficiencies along Mulholland Highway. The Jed Smith zone experienced fire flow deficiencies throughout the zone, including Eldorado Meadow Road.

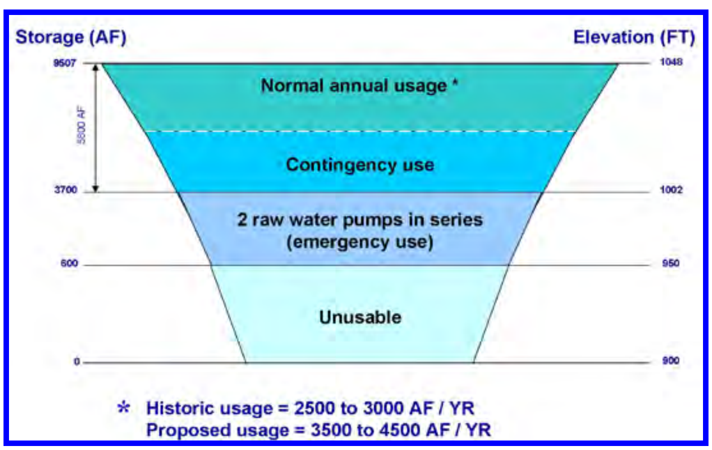
5.4 Additional System Specific Evaluations

Other operational scenarios were considered to determine their effect on the system and the possibility of improving system performance and reliability.

5.4.1 Optimize the Las Virgenes Reservoir Operations with Potential Calleguas MWD Connection

The 2007 Water Master Plan Update indicated that the amount of water that can be drawn from Las Virgenes Reservoir is approximately 4,800 acre feet per year, as this optimizes use of the transmission system by balancing summer demands with winter refill (shown in Figure 5-1). Additionally, a separate study is evaluating a potential connection with Calleguas MWD (CMWD) that could enhance refilling the Las Virgenes Reservoir in the winter. This would allow for greater use of the Las Virgenes Reservoir in the higher demand months.

Figure 5-1: Las Virgenes Reservoir Operations



5.4.2 Twin Lakes Emergency Supply

The Twin Lakes area has no permanent backup supply for when the MWDSC feeder is out of service. When these outages occur, water is delivered through a temporary connection to a LADWP hydrant and meter. As this area grows, this connection will be inadequate.

A pipeline connection to the 30-inch conduit that draws from the LV-1 turnout was planned to be built in 2008, but has yet to be constructed. While the Twin Lakes pump station has been expanded, it still draws from only the MWDSC feeder or the LADWP hydrant. The effect of this is that the Twin Lakes area will likely still be vulnerable when demands increase in the future and when the MWDSC feeder is out of service. Demands in this area should be monitored as development proceeds to determine when the LADWP hydrant will be insufficient. Maximum Day demands in the Twin Lakes area have increased from approximately 1,200 gpm in 2007 to approximately 1,500 gpm in 2013, and are projected to increase to approximately 3,300 gpm by 2035. While the capacity of the LADWP hydrant is not known, it is expected that it will not have adequate capacity in the relatively near future. The capacity of this connection should be investigated so that it can be estimated how long this connection will be adequate as a backup supply for the Twin Lakes area. This will provide a time frame for when the District will need to pursue the connection to the 30-inch conduit in this area as a more permanent backup supply.

5.4.3 Reconnection of LV-1 Turnout

The proposed reconnection of the LV-1 turnout was extensively discussed in the 2007 Water Master Plan Update. In summary, the MWDSC supply to the LV-1 connection comes from the West Valley Feeder No. 1. Reconnecting the LV-1 turnout to the West Valley Feeder No. 2 would raise the HGL from approximately 1135 feet to 1235 feet, and provide several other benefits, which include:

- Improved suction pressure for Twin Lakes pump station
- Eliminate the need for the Conduit Pump Station much of the time
- Increase the available flow from the Conduit Pump Station when it is needed
- Increase the HGL in the Box Canyon area
- Reduce pumping costs at the future Woolsey pump station
- Reduce age of the water flowing through the turnout

The District discussed this issue in further detail in LVMWD Report 2143.00, West Hills Facilities Study. Further study may be required, as increased system pressures may not be tolerated by the existing infrastructure. This could include some class 100 pipeline, as well as lower portions of the Box Canyon area. Pressure regulation may be required for some customers.

While this project may be possible in the future, it is no longer being pursued by LVMWD, as an agreement with MWD could not be negotiated.

5.4.4 Woolsey Canyon

Customers in this area are currently served by Ventura County Waterworks District No. 17. A new pump station for Woolsey Canyon was included in the 2007 Water Master Plan Update that would provide alternative supply. This was originally deemed necessary to accommodate expected increased demands. However, these increases are no longer expected to occur due to the surrounding area having been zoned by Los Angeles County as "significant ecological area", reducing projections of future demand. The pump station would still benefit the system by providing more dependable service, and provide alternative service if the service agreement with VCWD No. 17 is cancelled, which can potentially occur with a one-year notice. Communication between the District and VCWD No. 17 should continue, as increased demands may begin to exceed the delivery capacity of the system.

5.4.5 MWD Outage Analysis

The majority of potable water supply for LVMWD comes from MWDSC. However, there are times when this supply is not available, such as during planned outages for maintenance, which generally occur every three to four years. For LVMWD to continue to serve its customers during these planned outages, alternative supply options must be available. Alternative supply options also help LVMWD deal with unplanned outage to may disrupt the MWD supply, such as natural disasters. To evaluate alternative supply options, the demands were estimated for various times during the year. Winter demands were estimated at 75% of the average day demands. Summer demands were estimated at 210% of average day demands. The demands in the summer and fall periods were estimated at 100% of average day demands.

As mentioned in Section 3.1.4, LVMWD has multiple supply options available through interconnections with adjacent agencies, and with District storage. LADWP provides supply at two connections to LVMWD, one at Kittridge and one at Germain. However, the connection at Germain is not considered permanent, as it is through a hydrant serving the Twin Lakes area. Supply to Box Canyon and Woolsey is provided by Ventura County Water Works District No. 17. The remaining alternative supply is available from the Las Virgenes Reservoir through the Westlake Filtration Plant. Table 5-13 displays the current capacities for each of these supplies, as well as the estimated future capacities. Table 5-14 compares the demands and the supplies and provides an estimate of the supply deficiency both with and without the LADWP connections.

Table 5-13: Summary of Non-MWD Supply for LVMWD

Supplies	Current Capacity (gpm)	Future Capacity (gpm)
LADWP, Kittridge	9,000	9,000
Westlake FP	9,000	11,800
LADWP, Germain	1,350	1,350
VCWW & Simi	180	180
Total	**19,530**	**22,330**

Table 5-14: Summary of Demands and Supply Deficit

Demands	Demands (gpm)	Supply Deficit with LADWP	Supply Deficit without LADWP
2013 Winter	8,645	0%	0%
2013 Spring/Fall	11,526	0%	-20%
2013 Summer	24,205	-19%	-62%
2035 Winter	15,692	0%	-24%
2035 Spring/Fall	20,922	0%	-43%
2035 Summer	43,937	-49%	-73%

5.4.6 New Zone Development

If growth occurs in certain areas within the District, new pressure zones may be needed. Boundaries for the pressure zones would be based on a combination of elevations, topography and proximity to tanks, pump stations and major transmission pipelines. The boundaries of the pressure zones may vary depending on the extent of the development, the design of the pipeline network and final grading of the lots within the development. Per District policy, the cost of mains, pump stations and tanks for any new zones will generally be the financial responsibility of the developer. Table 5-15 provides an overview of possible new pressure zones.

Table 5-15 Possible New Pressure Zones

Zone	Approximate Gradient (ft)	Comments
Southern Twin Lakes	1750	South of existing Twin Lakes zone. May be a low density development. Can get supply from LV-3, but would not be served from Twin Lakes PS.
Kittridge	1300	Between existing Woolsey and Jed Smith zones. Too high to be supplied by 1235-ft zone. Will require a pump station. Preliminary WSDR was prepared in 2007.
Upper Agoura	1350	North of existing Agoura Zone. Will replace JBR and Agoura Pump Stations and serve new areas.
Ladyface	1400	East of existing Saddletree zone. Near Agoura Hills; too high for 1235-ft zone. To be supplied from 1235-ft zone.
Udell	1400	East of proposed Ladyface zone. Near Agoura Hills; too high for 1235-ft zone. To be supplied from 1235-ft zone.
Deerlake Ranch	1656	East of existing Twin Lakes zone. Hydropneumatic zone. To get supply from Twin Lakes Zone.

Section 6 – Proposed Capital Improvements

Section 6: Proposed Capital Improvements

6.1 Introduction

An important element of the District Water Master Plan is the development of a Capital Improvement Program (CIP). This section incorporates the findings of the previous sections and outlines the estimated costs of the potential system improvements. The cost estimation phase incorporates the approximate prices for the proposed water facilities and is based on 2014 dollar values.

Identified improvements are typically prioritized into a capital improvement program based on the assessment of a wide variety of factors. The most prevalent factor for this master plan is capacity considerations under current and future demand conditions. Capacity improvements are required to accommodate the current and projected demands with the District water system facilities. The identification of these capacity improvements is based primarily on the results of the computerized hydraulic modeling analyses discussed in Section 5:

Age-related CIP were not assessed in this analysis. The costs of the recommended collection system capital improvements are discussed herein.

6.2 Planning Level Unit Costs

Unit cost estimates are derived to support the development of the District's CIP. The costs derived herein should be considered as representative costs for future improvements and are for budgetary and planning purposes.

The base planning unit costs provided in the section below were derived based on construction bid costs. More accurate estimates should be derived during the design phase of capital improvement implementation. The base planning unit costs do not include, engineering, environmental, construction management, legal and administrative costs. They also do not include surveying and geotechnical investigations. Contingencies and Right-of-Way acquisition are also not included.

Costs of CIP project identified in Section 6.3 account for engineering, environmental, construction management, legal and administrative costs. These costs are included as a 20 percent allowance for pipelines and reservoirs and a 30 percent allowance for pump stations. Allowances for surveying and geotechnical investigations are allocated and added to the project costs as well. Also, a contingency of 15 percent are included in the overall budgetary costs.

Adjustments for inflation can be implemented based upon future changes in the Engineering New Record (ENR) Construction Cost Index. All costs represented herein are based on the October 2013 ENR Los Angeles Index of 11320.93.

6.2.1 Pipelines

Base planning unit costs for pipelines are based on historical costs for publicly bid projects in California. The unit costs for pipelines in existing development include materials, installation, as well as an allowance for valves, fire hydrants, pavement replacement, mobilizations, traffic control, etc. The unit costs for pipelines in new development were based on industry estimating guides and include an allowance for normal appurtenances, but do not include paving and mobilization. The unit costs were scaled up from the 2007 Water Master Plan to 2013, by using the 2007 ENR Construction Cost Index for the Los Angeles area of 8871 to the October 2013 ENR index for Los Angeles of 11320.93.

These costs do not include allowances for design, environmental, survey, permits, construction management, survey, geotechnical evaluations, right-of-way acquisition, or contingencies. The planning level unit costs for pipelines in existing development and in new development are outlined in Table 6-1 below.

Table 6-1: Summary of Base Planning Unit Costs for Pipeline

Diameter	2007 Existing Development ($/LF)	2007 New Development ($/LF)	2013 Existing Development ($/LF)	2013 New Development ($/LF)
4	$150	$75	$190	$100
6	$175	$90	$220	$110
8	$190	$100	$240	$120
10	$210	$105	$270	$140
12	$225	$110	$290	$150
14	$240	$115	$310	$160
16	$250	$130	$320	$170
18	$270	$150	$350	$200
24		$300		$380

Source: Escalated from LVMWD 2007 WMP.

6.2.2 Reservoirs

The base planning unit costs for reservoir costs are based on above ground Welded Steel Water Tanks and Concrete Reservoirs. The unit cost for new reservoirs is originally based on 2007 estimates for costs per gallon for tank construction and associated site work. The unit costs were scaled up from the 2007 Water Master Plan to 2013, by using the 2007 ENR Construction Cost Index for the Los Angeles area of 8871 to the October 2013 ENR index for Los Angeles of 11320.93.

These costs do not include allowances for design, environmental, survey, permits, construction management, survey, geotechnical evaluations, land acquisition, or contingencies. The base planning unit costs for reservoirs are outlined in Table 6-2 below.

Table 6-2: Summary of Base Planning Unit Costs for Reservoirs

Cost/Gallon per Reservoir Type		ENR Escalated to 2013
$0.80	For Welded Steel Tanks	$1.02
+$0.40	for Site Work	$0.51
$0.90	For Concrete Reservoirs	$1.15
+$0.45	for Site Work	$0.57

Source: Escalated from LVMWD 2007 WMP.

6.2.3 Booster Stations

The base planning unit costs for pump station improvements are based previously publicly bid project. The costs are provided based on the system analysis estimate of additional pumping capacity and the associated increase in horsepower required. For LVMWD, the base planning unit costs are based on the estimated horsepower for the new pump station. The unit costs were scaled up from the 2007 Water Master Plan to 2013, by scaling up from the 2007 ENR Construction Cost Index for the Los Angeles area of 8871 to the October 2013 ENR index for Los Angeles of 11320.93.

These costs do not include allowances for design, environmental, survey, permits, construction management, survey, geotechnical evaluations, land acquisition, or contingencies. The pump station costs do not include the associated pipelines that are outside of buildings. The base planning unit costs for pump stations are outlined in Table 6-3 below.

Table 6-3: Summary of Base Planning Unit Costs for Pump Stations

Size (hp)	Construction Cost ($/hp, 2007)	ENR Escalated Construction Cost ($/hp, 2013)
50	$7,500	$9,600
100	$7,250	$9,250
200	$6,250	$8,000
300	$5,500	$7,000
400	$4,500	$5,750
500	$4,000	$5,100
600	$3,500	$4,450

Source: Escalated from LVMWD 2007 WMP.

6.3 Capital Improvement Program

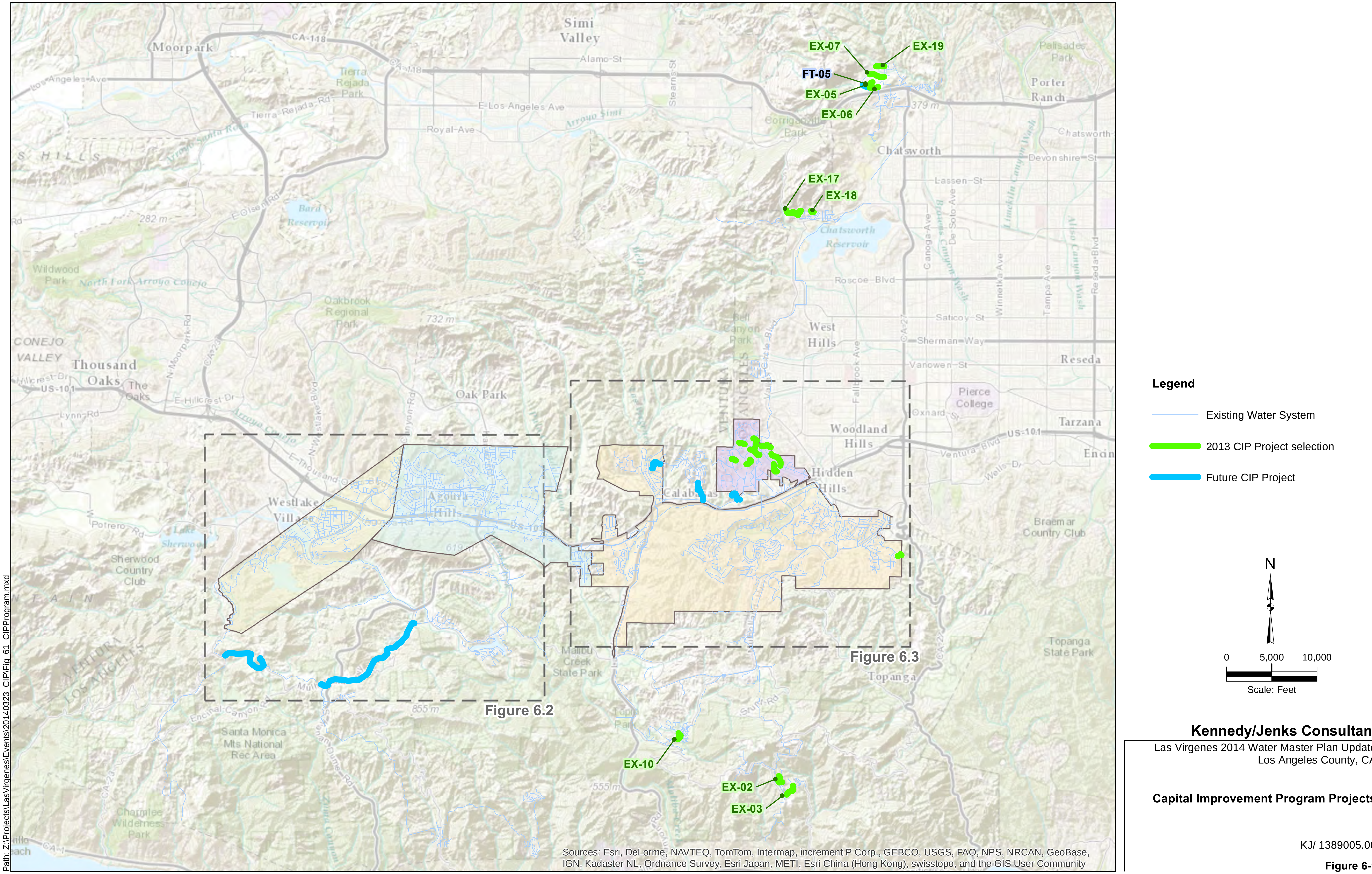
Following is a discussion of the improvement projects that have been identified for both existing and future demand conditions. These are separated into pipeline, storage and pumping projects.

6.3.1 Pipeline Projects

The analysis of the distribution system using the model as described in Section 5: resulted in pipeline projects that are either upsizing of existing pipelines, or new pipelines that generally parallel an existing pipeline. These projects are shown on Figure 6-1, Figure 6-2 and Figure 6-3. Projects for both existing and future demand conditions are shown on these figures.

Pipeline deficiencies were identified using the updated hydraulic model to locate facilities that did not meet the District's pressure and velocity criteria. District staff was engaged in a discussion of findings to promote prioritization of the distribution deficits and integration in the pipeline Capital Improvement Program (CIP). The prioritization consisted of the following four categories.

- Priority 1 - consists of projects that address existing capacity deficiencies in the system.
- Priority 2 - consists of projects that address existing capacity deficiencies that were less significant, and which were in areas, such as Hidden Hills and Monte Nido, that the District had acquired. These legacy systems were likely designed for lower fire flow requirements.
- Priority 3 - consists of projects that address relatively smaller capacity deficiencies.
- Priority 4 - consists of projects where the capacity deficiency was less than 10%. The Priority 4 projects were removed from the CIP, but will be retained in an appendix so that these areas can be looked at more closely in future master plan updates. These areas could have more significant capacity deficiencies in the future if growth in demands differs from the estimates used in this master plan update.



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Las Virgenes 2014 Water Master Plan Update
Los Angeles County, CA

Capital Improvement Program Projects

KJ/ 1389005.00

Figure 6-1

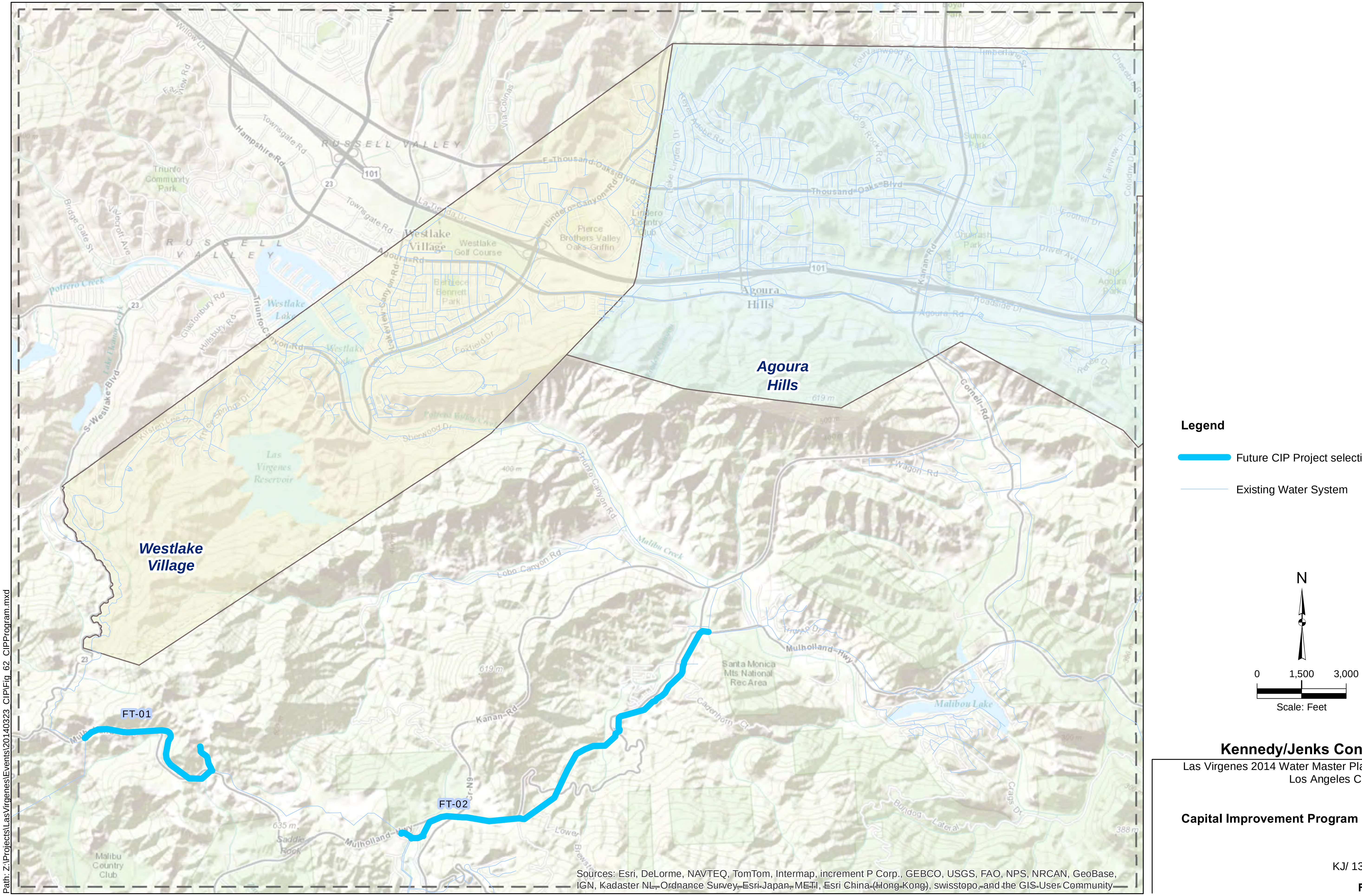

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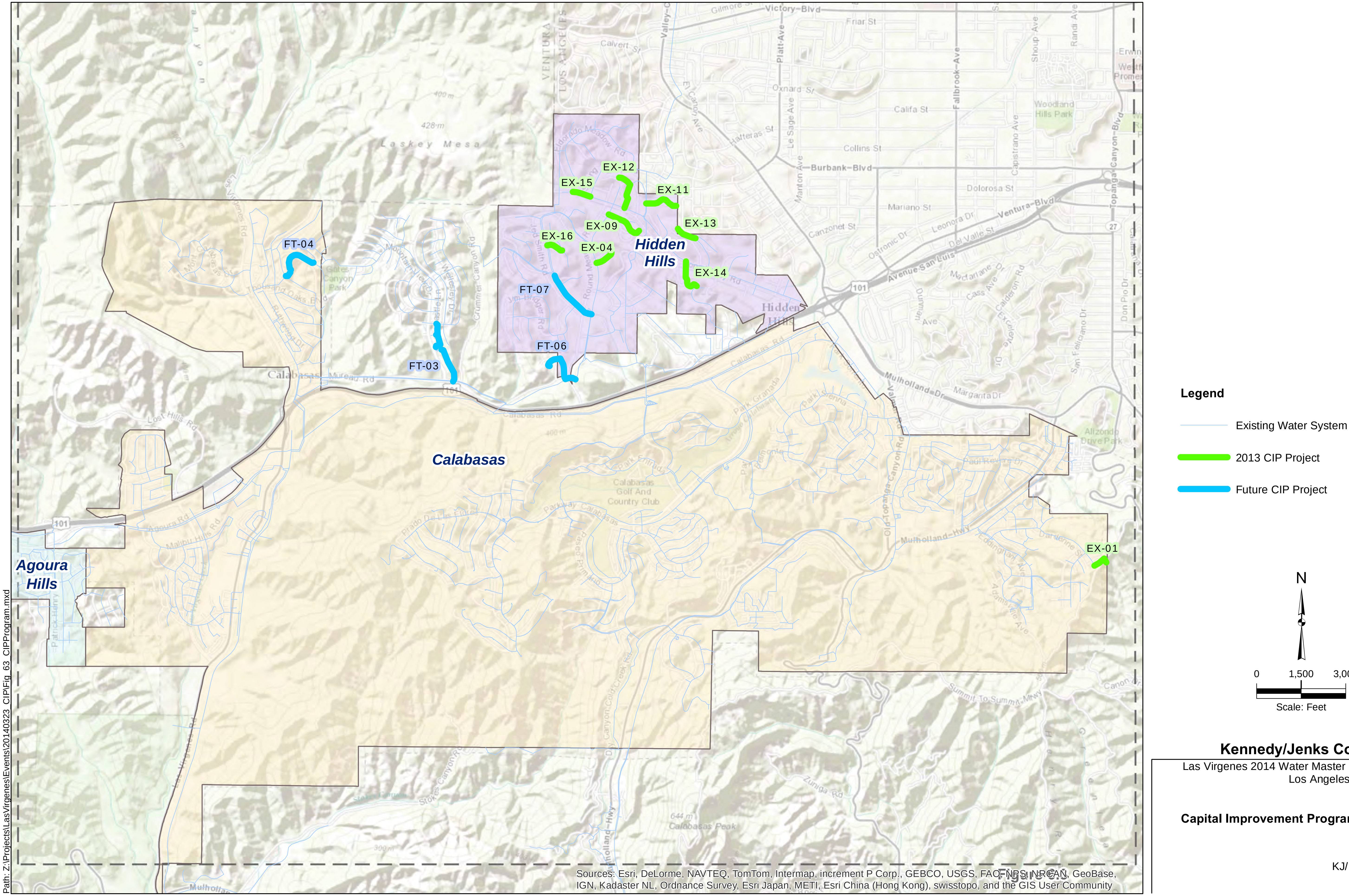
Figure 6-2



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Las Virgenes 2014 Water Master Plan Update
Los Angeles County, CA

Capital Improvement Program Projects

KJ/ 1389005.00

Figure 6-3

Table 6-4 summarizes the pipeline projects that were identified for existing demand conditions. These projects were all identified when evaluating the system for maximum day plus fire flow conditions. The information provided for each project includes the pressure zone, the total length of new pipeline, the base cost and the base cost plus 35%, which includes an allowance for engineering, environmental, construction management, legal, administrative costs and a contingency. Also included is the priority of each of the projects.

Table 6-4: Summary of Pipeline Projects for Existing Demand Conditions

Project ID	Pressure Zone	Length (ft)	Base Cost	Base Cost + 35%	Priority
EX-01	Dardenne (1618)	554	$161,000	$217,000	3
EX-02	Stunt (1991)	1,236	$297,000	$401,000	2
EX-03	Stunt (1677)	1,432	$387,000	$522,000	1
EX-04	Jed Smith	838	$243,000	$328,000	2
EX-05	Twin Lakes (1585)	739	$177,000	$239,000	3
EX-06	Twin Lakes (1585)	967	$261,000	$352,000	3
EX-07	Twin Lakes (1585)	1,652	$446,000	$602,000	3
EX-08	Main Zone (1200')	634	$152,000	$205,000	2
EX-09	Main Zone (1200')	653	$157,000	$212,000	2
EX-10	Main Zone (1200')	903	$216,000	$292,000	2
EX-11	Main Zone (1200')	1,120	$269,000	$363,000	2
EX-12	Main Zone (1200')	1,302	$338,000	$456,000	2
EX-13	Main Zone (1200')	1,836	$519,000	$701,000	2
EX-14	Main Zone (1200')	1,162	$314,000	$424,000	2
EX-15	Main Zone (1200')	611	$147,000	$198,000	2
EX-16	Main Zone (1200')	554	$150,000	$203,000	2
EX-17	Box Canyon VCWD #8 (1326')	2,048	$491,000	$663,000	2
EX-18	Box Canyon VCWD #8 (1326')	400	$96,000	$130,000	2
EX-19	Twin Lakes (1585')	968	$300,000	$405,000	1
Total		**19,611**	**$5,121,000**	**$6,913,000**	2

Table 6-5 summarizes the pipeline projects that were identified for future demand conditions. Projects FT-01 through FT-04 were identified in the 2007 Master Plan Update and were confirmed for the 2035 demand conditions as being necessary to provide adequate pressure during future maximum day conditions. Projects FT-05 through FT-14 were identified to address capacity issues under future maximum day plus fire flow conditions.

Table 6-5: Summary of Pipeline Projects for Future Demand Conditions

Project ID	Pressure Zone	Length (ft)	Base Cost	Base Cost + 35%
FT-01	Seminole (2159')	6,769	$2,571,000	$3,471,000
FT-02	Main Zone (1200')	14,164	$5,375,000	$7,256,000
FT-03	Mountain Gate (1420')	2,182	$553,000	$747,000
FT-04	Adamor	1,520	$365,000	$493,000
FT-05	Twin Lakes (1585')	838	$226,000	$305,000
FT-06	Jed Smith	1,650	$446,000	$602,000
FT-07	Jed Smith (1420')	1,851	$500,000	$675,000
Total		**28,975**	**$10,036,000**	**$13,549,000**

6.3.2 Reservoir Projects

As mentioned in Section 5:, storage deficiencies were identified in three pressure zones for existing demand conditions. This was primarily due to increased fire flow demands for each of these three zones. A storage deficiency was also identified for the Jed Smith zone, as had previously been identified in the 2007 Water Master Plan Update. Table 6-6 summarizes the reservoir projects that were identified for existing demand conditions. The information includes the pressure zone, the volume of storage needed, the base cost and the base cost plus 35%, which includes an allowance for engineering, environmental, construction management, legal, administrative costs and a contingency.

Table 6-6: Summary of Storage Projects for Existing Demand Conditions

Pressure Zone	Storage Needed (gallons)	Base Cost	Base Cost + 35%
Jed Smith	820,000	$1,416,000	$1,912,000

Table 6-7 summarizes the reservoir projects that were identified for future demand conditions. For the four pressure zones for which projects were identified for existing demand conditions, the capacity deficiency is projected to increase for future demand conditions. Table 6-7 displays both the total storage needed to meet the future demand conditions, as well as the incremental increase in storage needed in addition to the existing storage projects identified. The base costs for these four zones are based on the increase in storage needed for future demand conditions, rather than the total storage needed, to prevent double counting of storage.

Table 6-7: Summary of Storage Projects for Future Demand Conditions

Pressure Zone	Total Storage Needed (gallons)	Increase in Storage Needed from Existing Conditions (gallons)	Base Cost	Base Cost + 35%
Jed Smith	1,430,000	600,000	$1,039,000	$1,403,000
McCoy	300,000	N/A	$518,000	$699,000
Mulwood	180,000	N/A	$313,000	$423,000
Seminole	1,170,000	N/A	$2,926,000	$3,951,000
Twin Lakes	1,510,000	N/A	$2,596,000	$3,504,000
Upper Oaks	150,000	N/A	$266,000	$360,000
Upper Woolsey	470,000	N/A	$813,000	$1,098,000
Warner	1,040,000	N/A	$1,789,000	$2,415,000
Total	**6,250,000**	**600,000**	**$ 10,260,000**	**$13,853,000**

6.3.3 Pumping Projects

The analysis of the pumping capacity for each zone revealed no significant deficiencies for existing conditions. A small deficiency was identified for the Jed Smith pressure zone, but the deficiency is small enough that it can be ignored.

There are several pump stations that do not appear to have pumps designated as standby pumps. For some of these pump stations, the analysis shows that the capacity of the existing pumps is such that one of the pumps could be designated as a standby pump. For the other pump stations, standby pump was estimated and summarized in Table 6-8.

Table 6-8: Summary of Potential Standby Pumping Needs for Existing Conditions

Pressure Zone	Standby Pumping Needed (hp)	Base Cost	Base Cost + 45%
McCoy	69	$662,000	$959,900
Mulwood	39	$373,000	$540,850
Oak Ridge	Existing Pumps Appear Sufficient		
Saddle Tree	Existing Pumps Appear Sufficient		
Upper Oaks	Existing Pumps Appear Sufficient		
Upper Twin Lakes	Existing Pumps Appear Sufficient		
Total		**$1,035,000**	**$1,500,750**

The analysis of the pumping capacity for each zone revealed that several are expected to have deficiencies for future demand conditions. Except for the Main Zone and the hydropneumatic zones, all zones were assumed to require a minimum of 18-hour pumping performance. No improvements were recommended to achieve 9-hour pumping performance. The storage and pumping for each zone were analyzed together so that a consistent recommendation for each zone could be determined. Table 6-9 summarizes the pumping needs for each zone.

Table 6-9: Summary of Pumping Needs for Future Conditions

Pressure Zone	Pumping Needed (hp)	Base Cost	Base Cost + 45%
Jed Smith/Mountain Gate	47	$451,000	$653,950
Mulwood	25	$240,000	$348,000
Seminole	79	$731,000	$1,059,950
Twin Lakes	163	$1,304,000	$1,890,800
Total		**$2,726,000**	**$3,952,700**

The Mulwood zone is the one zone where both standby pumping and future pumping capacity needs have been identified. It is recommended that these be considered together, as dealing with the current need for standby pumping in a way that facilitates future expansion to address future pumping needs is recommended.

6.4 Capital Improvement Program

As previously discussed, a number of capacity related improvements have been identified for LVMWD. These improvements are located throughout LVMWD's service area and consist of new storage tanks, pumping improvements, and increases in pipeline capacity. The costs and prioritization of these improvements are provided herein.

6.4.1 Capacity Related Prioritization Criteria

Some general criteria are required to prioritize the identified improvements to promote an efficient capital improvement implementation plan. The criteria for the three primary asset categories (tanks, pumps, and pipes) are as follows:

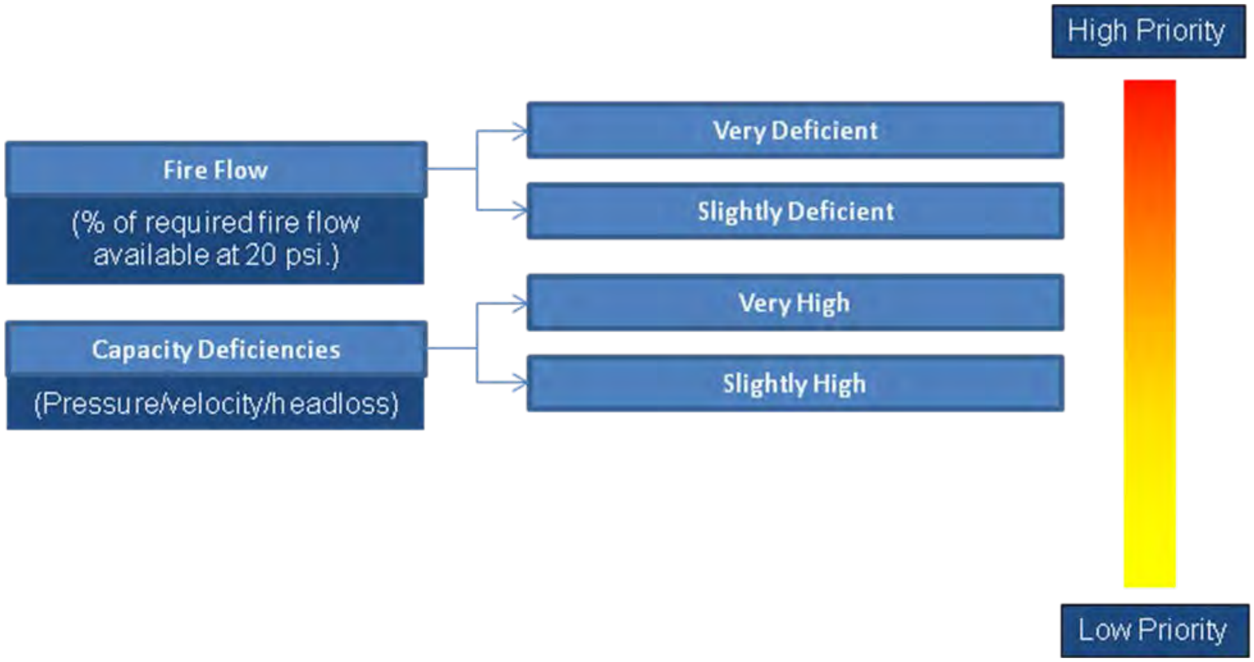
Storage Tank Capacity Improvements - Storage deficiencies under current conditions are greater priority than future storage deficits. Current storage deficits are prioritized by the severity of the deficiency by pressure zone. Storage deficiencies that indicate insufficient storage for fire flow demands are a higher priority that storage deficiencies for operational or emergency storage.

Pumping Capacity Improvements - Pumping deficiencies under current conditions are greater priority than future pumping deficits. Current pumping deficits are prioritized by the severity of the deficiency by pressure zone.

Pipeline Capacity Improvements - Similar to the storage and pumping prioritization, pipelines that were identified to have capacity deficiencies under current conditions have a higher priority than those pipelines that exhibited a capacity deficit only under future demand conditions. Additionally, fire flow related capacity deficiencies have a higher priority than peak hour pressure-related capacity deficiencies, which have a higher priority than deficiencies related to excessive velocity or headloss. The degree of deficiency also provides a tertiary criterion for phasing improvements among both fire flow and capacity improvements.

The general pipeline improvement prioritization process is shown in Figure 6-4 below, and was incorporated into the development of the pipeline prioritization presented in section 6.3.1.

Figure 6-4: General Pipeline Improvement Project Prioritization



6.4.2 Capital Improvement Project Triggers

An important element of a capacity-based capital improvement program is a timeline for implementation of the identified projects. The future piping, storage and pumping projects were identified as being required under the projected demand conditions in the year 2035. As with any improvements that are based on future conditions, the deficiencies identified may actually appear prior to, or later than any specific planning year. For this reason, CIP triggers provide an additional means of tracking changing conditions and needed system improvements.

For the District, most of the water system pressure zones that have future deficiencies actually have available or excess piping, storage or pumping capacity under current demand conditions. As demands increase over time, this available capacity will decrease, until at some point, the available capacity is used to meet the then current needs of the system. It is at that point that the system deficiency is realized, and will continue to grow until the full build-out projection materializes, assumed to be 2035. This future CIP trigger approach works well for anticipated storage and pumping pressure zone improvements.

In contrast, trigger points for pipeline projects are not as easily defined, particularly for projects that are based on fire flow demands. However, with a focus on pressure zone related maximum day demands, the identified pipeline projects were examined to determine if a trigger could be derived to establish a demand based implementation schedule. The results of this pipeline trigger evaluation are as follows:

1) FT-01 – This project is associated with increased demands in the Seminole Zone. Future storage and pumping projects are identified for the Seminole Zone. It is recommended that project FT-01 be implemented along with the storage and pumping projects. The Seminole pumping station is almost already in need of expansion, while the Seminole storage surplus is estimated to be depleted in approximately 2016. Therefore, project FT-01 should also be pursued within the next two years.

2) FT-02 – This project is also associated with the increased demands in the Seminole Zone and should be implemented along with the storage and pumping projects. Therefore, as above, project FT-02 should also be pursued within the next two years.

3) FT-03 – This project is associated with the expansion of the Mountain Gate pumping facilities. While there is a current pumping capacity deficit for the Jed Smith and Mountain Gate facilities, the deficit increases for future demands conditions. Project FT-03 is not needed when the current pumping deficit is addressed, when the next project to expand the Mountain Gate pump station is implemented, project FT-03 should also be pursued.

4) FT-04 – This project is associated with an alternative to expanding the pumping capacity for the Jed Smith/Mountain Gate system. Previous studies had proposed the creation of a new Adamor pressure zone from a portion of the Jed Smith/Mountain Gate system. While this new pressure zone is not being pursued at this time, if it is pursued in the future, project FT-04 should be implemented along with the new pressure zone.

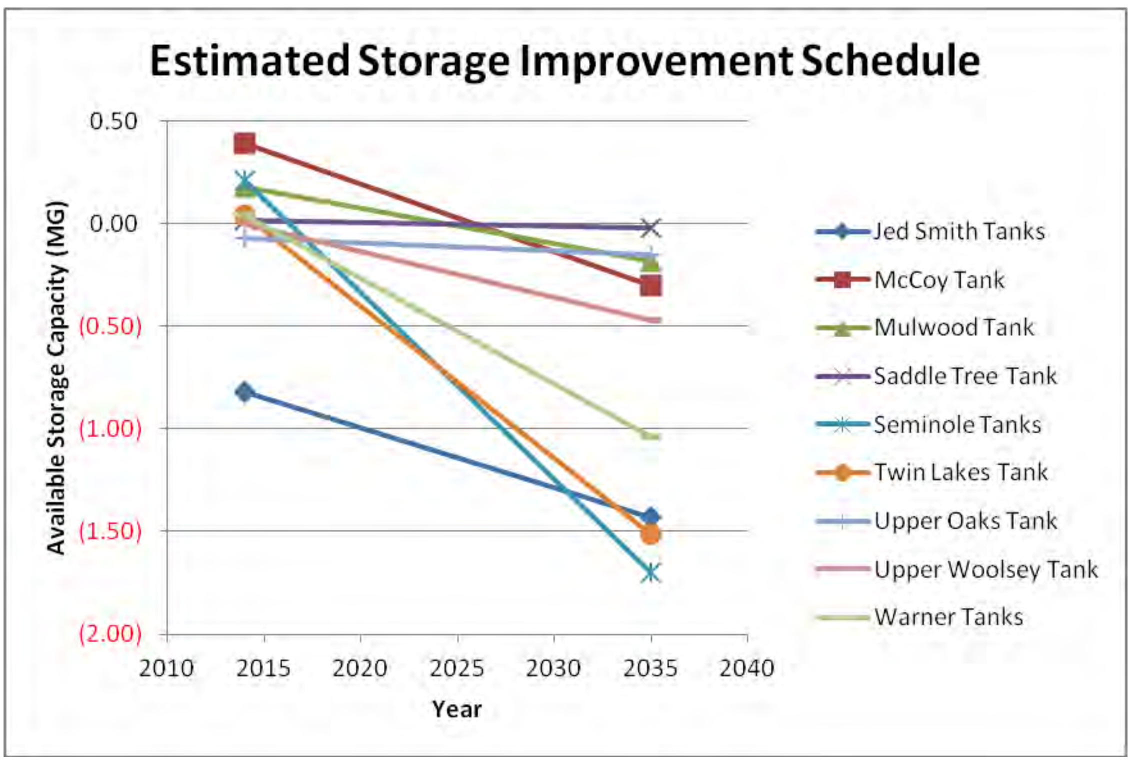
For the identified storage and pumping projects, each pressure zone and associated deficiencies were analyzed to estimate the timing of the needed improvements. To provide this estimate, the current available capacity and the future deficit were compared with an assumption that the growth in demand would be completely linear. The year that the project would be required was interpolated from that data. It is recommended that planning and design for each of the projects be initiated at least a year prior to the year that the project will be required. A summary of the data calculating the triggers for the future storage projects is presented in Table 6-10. A graph representing the interpolation of the demand data to estimate when the storage projects will be required is presented in Figure 6-5.

Since it should be assumed that growth in demands will not be linear, the estimated year of improvement finding should be considered in conjunction with an actual demand value that should promote any particular improvement. For this demand trigger analysis, an estimate of the maximum day demands that each of the current storage facilities can support is also derived and presented in Table 6-10. From this approach, the District should be able to monitor the maximum day demands for each zone to better derive a "just in time" improvement plan for each of the future storage projects.

Table 6-10: Triggers for Future Storage Projects

Pressure Zone	Current Available Storage Capacity (MG)	Future Available Storage Capacity (MG)	Estimated Year of No Remaining Surplus	Current Demand MDD (gpm)	Future Demand MDD (gpm)	Demand that Existing Storage Can Support (gpm)
Jed Smith Tanks	(0.82)	(1.43)	2014	2082	2753	<2082
McCoy Tank	0.39	(0.30)	2026	1453	2223	1888
Mulwood Tank	0.18	(0.18)	2025	973	1380	1177
Saddle Tree Tank	0.02	(0.02)	2025	87	130	109
Seminole Tanks	0.21	(1.70)	2016	1319	3446	1553
Twin Lakes Tank	0.04	(1.51)	2015	1473	3199	1518
Upper Oaks	(0.07)	(0.15)	2014	239	339	<239
Upper Woolsey Tank	0.00	(0.47)	2014	228	747	228
Warner Tanks	0.04	(1.04)	2015	2136	3333	2180

Figure 6-5: Storage Capacity Improvement Project Triggers

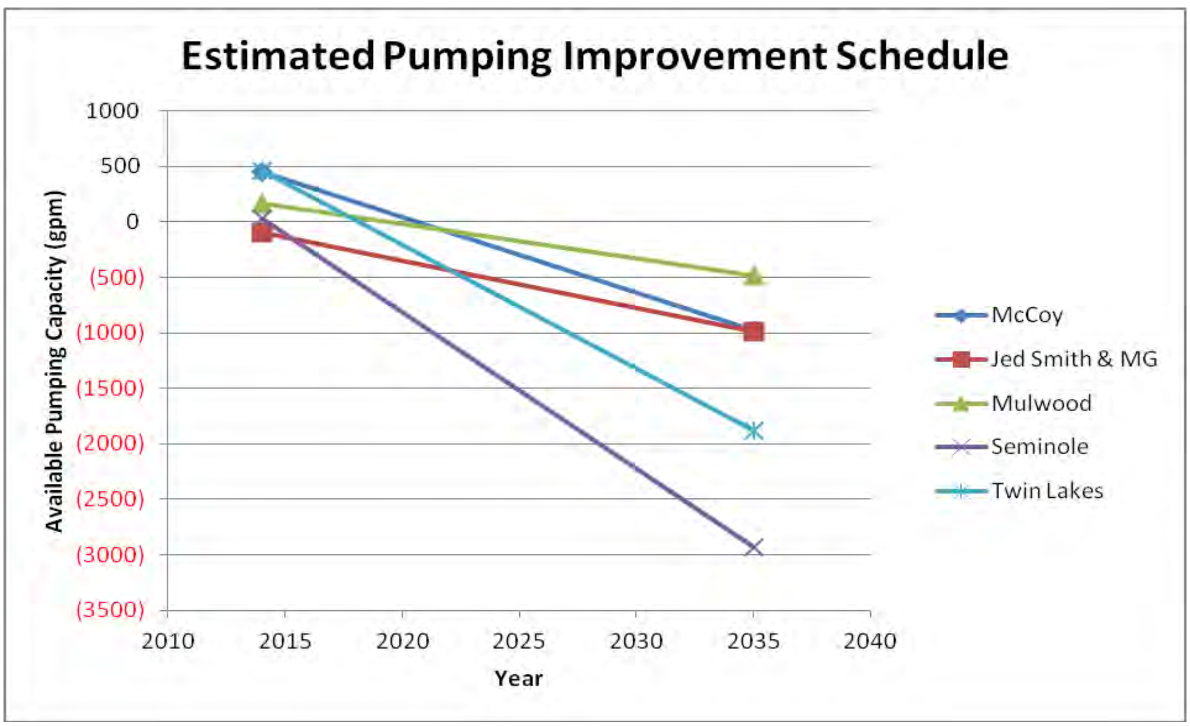


Using this pressure zone analysis approach for the pumping improvements, a similar interpolation calculation was performed to estimate the year in which the pumping capacity improvement projects will be required. A summary of the interpolation calculation is presented in Table 6-11, with the corresponding graph of the estimated timeline of pumping projects improvements presented in Figure 6-6. Similar to the storage demand trigger analysis, an estimate of the maximum day demands that each of the pumping facilities can support is also derived and presented in Table 6-11.

Table 6-11: Triggers for Future Pumping Projects

Pump Stations	Current Available Pumping Capacity (GPM)	Future Available Pumping Capacity (GPM)	Estimated Year of No Remaining Surplus	Current Demand MDD (gpm)	Future Demand MDD (gpm)	Demand that Existing Pumping Can Support (gpm)
McCoy	455	(981)	2021	2209	3286	2550
Jed Smith & MG	(92)	(987)	2014	2082	2753	<2082
Mulwood	172	(485)	2019	1184	1677	1313
Seminole	26	(2934)	2014	1668	3888	1688
Twin Lakes	456	(1878)	2018	1533	3284	1875

Figure 6-6: Pumping Capacity Improvement Project Triggers



6.4.3 Summary by Pressure Zone

In this section, the capacity improvement projects are summarized by pressure zone, as there are some zones with piping, storage and pumping projects. For both the existing and future CIP, the projects are grouped by zone and presented with quantities, units and estimates costs. The summary by pressure zone is presented in Table 6-12 and Table 6-13.

Table 6-12: Current CIP by Pressure Zone

Zone	Project	Type	Quantity	Units	Cost
Box Canyon	EX-17	Piping	2,048	LF	$491,000
Box Canyon	EX-18	Piping	400	LF	$96,000
Dardenne	EX-01	Piping	555	LF	$161,000
Jed Smith	EX-04	Piping	838	LF	$243,000
Jed Smith	---	Storage	820,000	Gallons	$1,912,000
Main Zone	EX-08	Piping	634	LF	$152,000
Main Zone	EX-09	Piping	653	LF	$157,000
Main Zone	EX-10	Piping	903	LF	$216,000
Main Zone	EX-11	Piping	1,120	LF	$269,000
Main Zone	EX-12	Piping	1,302	LF	$338,000
Main Zone	EX-13	Piping	1,836	LF	$519,000
Main Zone	EX-14	Piping	1,162	LF	$314,000
Main Zone	EX-15	Piping	611	LF	$147,000
Main Zone	EX-16	Piping	554	LF	$150,000
McCoy	---	Standby Pumping	1,133	gpm	$959,900
Mulwood	---	Standby Pumping	750	gpm	$540,850
Stunt	EX-02	Piping	1,236	LF	$297,000
Stunt	EX-03	Piping	1,432	LF	$387,000
Twin Lakes	EX-05	Piping	739	LF	$177,000
Twin Lakes	EX-06	Piping	967	LF	$261,000
Twin Lakes	EX-07	Piping	1,652	LF	$446,000
Twin Lakes	EX-19	Piping	968	LF	$300,000

Table 6-13: Future CIP by Pressure Zone

Zone	Project	Type	Quantity	Units	Cost
McCoy	---	Storage	300,000	Gallons	$699,000
McCoy	---	Pumping	981	gpm	$804,750
Mountian Gate	FT-03	Piping	2,181	LF	$553,000
Adamor/Mountain Gate	FT-04	Piping	1,520	LF	$365,000
Jed Smith	FT-06	Piping	1,650	LF	$446,000
Jed Smith	FT-07	Piping	1,851	LF	$500,000
Jed Smith	---	Storage	1,430,000	Gallons	$1,403,000
Jed Smith & MG	---	Pumping	987	gpm	$653,950
Mulwood	---	Storage	180,000	Gallons	$423,000
Mulwood	---	Pumping	485	gpm	$348,000
Seminole	FT-01	Piping	6,769	LF	$2,571,000
Main Zone/Seminole	FT-02	Piping	14,165	LF	$5,375,000
Seminole	---	Storage	1,170,000	Gallons	$3,951,000
Seminole	---	Pumping	2,934	gpm	$1,059,950
Twin Lakes	FT-05	Piping	838	LF	$226,000
Twin Lakes	---	Storage	1,510,000	Gallons	$3,504,000
Twin Lakes	---	Pumping	1,878	gpm	$1,890,800
Upper Oaks	---	Storage	150,000	Gallons	$360,000
Upper Woolsey	---	Storage	470,000	Gallons	$1,098,000
Warner	---	Storage	1,040,000	Gallons	$2,415,000

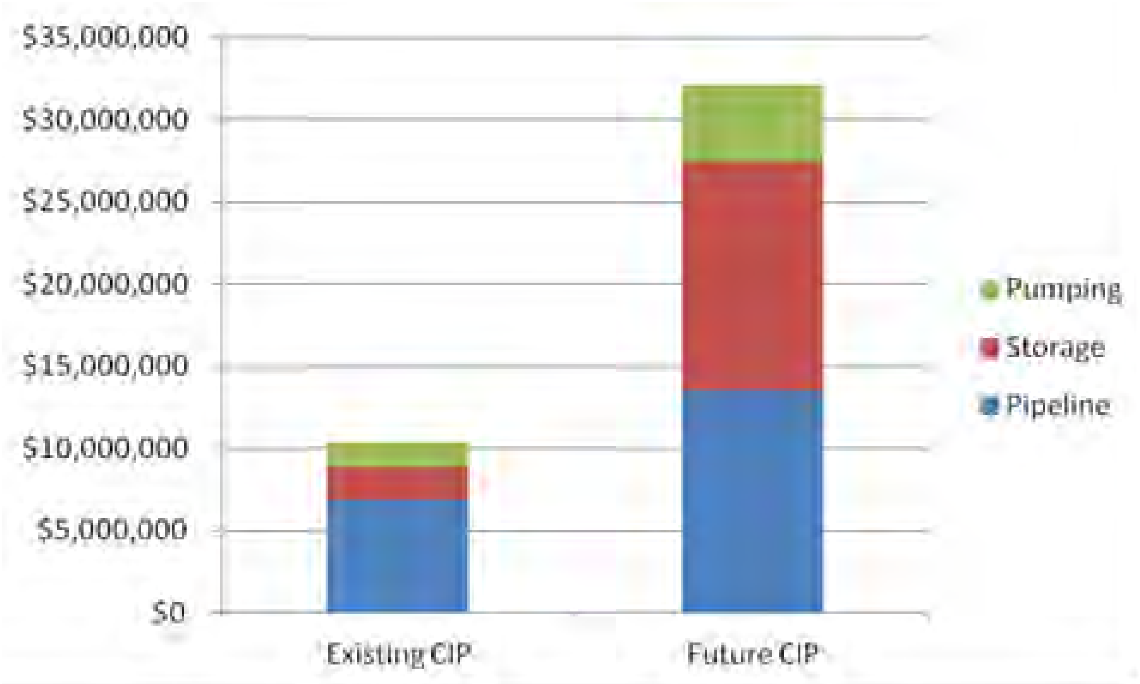
6.4.4 Capital Improvement Program Summary

A capacity-based capital improvement program is derived by applying the unit costs and prioritization criteria to the improvements identified in Section 6:. The results are summarized by facility type in Table 6-14 and Figure 6-7 for both existing and future demand conditions.

Table 6-14: Capital Improvement Program Summary Costs

CIP Description	Existing Cost	Future Cost
Pipe CIP	$6,913,350	$13,548,600
Storage CIP	$1,912,000	$13,853,000
Pumping CIP	$1,500,750	$4,757,450
Total CIP	**$10,326,100**	**$32,159,050**

Figure 6-7: Capital Improvement Program Estimates Summary of Costs



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Appendix A

LVMWD Population and Water Demand Projection Technical Memorandum

5 August 2013

Technical Memorandum

To: John Zhao, David Lippman

From: Roger Null, Tarun Gill

Subject: LVMWD Population and Water Demand Projection - Final
K/J 1389005*00

An important element in utility Master Planning is a planning level assessment of future water demands and supply requirements. While the methods utilized to perform local demand projections vary, there are a few criteria that are commonly used to support this effort. These typically include a population projection based approach and a change in land use based approach. The District has historically used both of these approaches, either as a stand-alone method or as a hybrid of the two in its previous and ongoing forecasting activities. The approach utilized has historically been based on the end use or purpose of the planning effort.

The two most recent and important planning efforts commissioned by the District were the 2010 Urban Water Management Plan (UWMP), and the 2007 Integrated Potable Water, Recycled Water, and Sanitation Master Plans (2007 Master Plan). As required by California Government Code, the UWMP is updated every 5 years. To integrate changing conditions and regulations, the District also updates its Master Plan every 5 to 7 years. This Technical Memorandum describes in detail the methodology used for population and water demand projections for the District's service area as an element of this 2013 Integrated Potable Water, Recycled Water, and Sanitation Master Plan Update.

A discussion of the data sources used for these previous planning efforts and the methodology used for the current Master Plan (MP) to develop population and water demand projections are described herein.

1. Data Sources

1.1 Southern California Association of Governments (SCAG) Data

SCAG is responsible for the development of demographic projections and various integrated land use, housing, employment, transportation programs, measures, and strategies of the South Coast Air Quality Management Plan. It maintains two sets of transportation analysis zones (TAZ) data for the Regional Transportation Plan (2012-2035) along with socioeconomic data for the region. The more comprehensive data is comprised by 4,109 zones (Tier 1) across the SCAG region. Within each TAZ, SCAG has derived spatial data relating to population, housing, and employment under current conditions, and developed projections for the years 2020 and 2035. This detailed and comprehensive dataset was used for this Master Plan project.

1.2 Census Data

The US Census Bureau Other develops and maintains other digital and spatial datasets relating to population, demographics, housing element, occupancy, and other economic and trend information. Census data for California is maintained by the California Department of Finance. This dataset has been used in prior District studies for estimating population at a census tract/block level. This tract/block data is more detailed than the TAZ level data developed and maintained by SCAG.

1.3 Land Use Data

Land use coverage data for the service area was collected from the District GIS parcels, LA County land use/zoning data and various other sources. Kennedy/Jenks also corresponded with the cities of Agoura Hills, Calabasas, Hidden Hills, Westlake Village, Thousand Oaks, LA County and Ventura County staff and/or their planning consultants to obtain zoning and land use data for each of these individual agencies. In cases where GIS data was not provided, Kennedy/Jenks digitized the CAD data received to build spatial GIS coverages for these areas. This data, along with 2013 Housing Element reports for each of the cities, provided the primary information related to opportunities of re-development, zoning specifications, and vacant lot areas for each service area.

1.4 District's Utility Billing Data

The District utilizes a customer information system to maintain its account-level information. LVMWD billing data classifies it's accounts into the following customer class categories: residential, commercial, irrigation, fire protection, reclamation and temporary usage. Review of this information indicates that the District's customer base is primarily residential, representing approximately 85-90% of the active accounts. The balance of the accounts is made up with various commercial, industrial, and institutional customers. Billing information for the 2012 calendar year calendar reflects a total customer base of approximately 20,350 water accounts, using approximately 25,570 acre-feet of water. Account level billing data for the last 12 years was used in the analysis of water demands for this Master Plan.

1.5 Data Variability

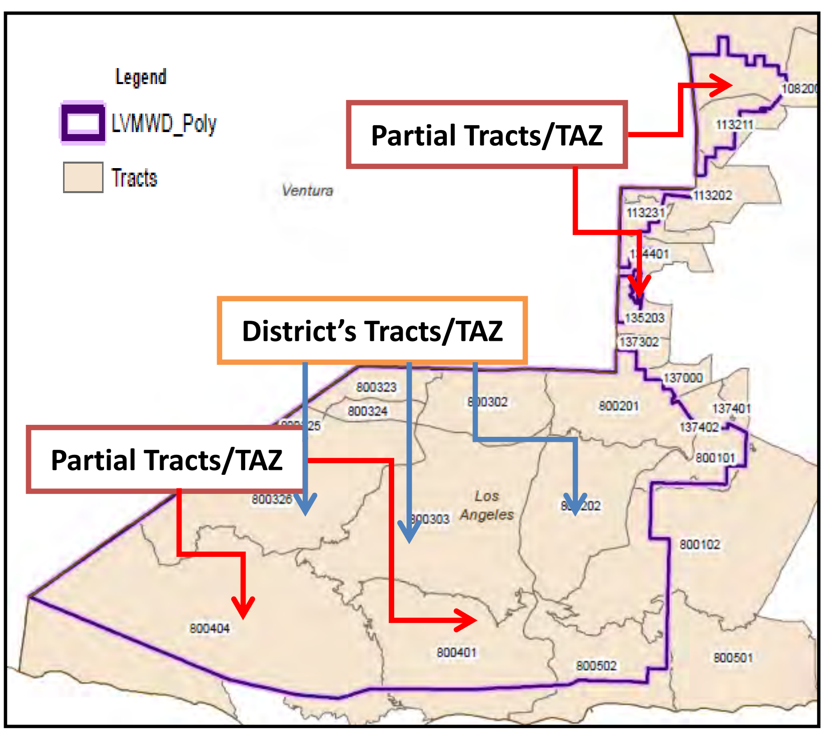
As discussed, there are several interrelated data sources that provide valuable insight to the assessment of future population projections and the needs for water or wastewater services. A common facet that comes with using information from multiple agencies is data variability. In general, agencies develop and manage information in different ways or platforms, compiles or batches data differently, and utilizes different definitions to describe their information and data. This broad inconsistency is most prevalent in the land use and zoning element, as these planning categories are almost always unique for various agencies. This is the case for the agencies served by the District, as each agency has unique land use categories and definitions.

A second facet associated with multiple data sources is the inherent inconsistency in information assigned to an individual account or parcel from various agencies. These inconsistencies are often in the form of spelling or abbreviation of street names, the approach used for segregating various data fields, and even the type of customer being served (commercial vs. residential for example). In all cases, the reconciliation of information typically requires a substantial level of data scrubbing, digital data correlation, and due diligence to develop a data set that spatially represents both current and future conditions.

Finally, in addition to the common multiple agency data variability, the District incurs an additional question surrounding the use of available spatial data. This question arises from the fact that many of the applicable data sets do not coincide with the District's service area boundaries, leaving some data sets subject to interpretation. This condition is prevalent with the data segregated by TAZ/tract from SCAG, the US Census Bureau, and Los Angeles County. The fully contained and partial TAZ/tract areas are graphically depicted in Figure 1.

As shown, much of the TAZ/tract data in the upper portion of the western service area is fully contained in the District's service area boundary, as this area is bounded by the County line. In contrast, almost all of the TAZ/tract data in the northern and southern portions of the unincorporated LA County areas and the southeast side of the City of Calabasas do not coincide with the District's service area boundaries. As such, each of these areas requires a specific evaluation to assess the applicable portion of the current and future population and housing information contained in the Census and SCAG data.

Figure 1: Inconsistent Service Area and TAZ Boundaries



2. Current and Projected Population Estimates

The current and projected demands are integral factors in the evaluation of the District's future utility systems. Due to the historical variation in the economy and weather conditions, the growth rates have differed from previous studies, suggesting the need to reassess projected demand conditions. Current population estimates and future projections were calculated based on census, SCAG databases, land use and planning data, local agency Housing Element reports, and vacant housing information derived from the census and the District's water billing data.

While buildout for any community may actually never materialize, for the purposes of this study, build-out is estimated to occur at the year 2035. This period was chosen as it coincides with other applicable service area studies, such as the most recent UWMP, SCAG population/housing/employment projections, etc. The sections below describe the methodology for estimating the District's current and projected population.

2.1 Current Population Estimate

The current population was estimated based on Southern California Association of Governments (SCAG) spatial data. SCAG is the lead agency responsible for the development of current and projected spatial data related to population, housing and employment for the region. To reconcile the disparity in the District and TAZ boundaries, the SCAG GIS layer was "clipped" to coincide with the District's boundary layer, and the overlying TAZ areas contained within the District's boundary identified. These TAZ areas were subsequently categorized into two groups:

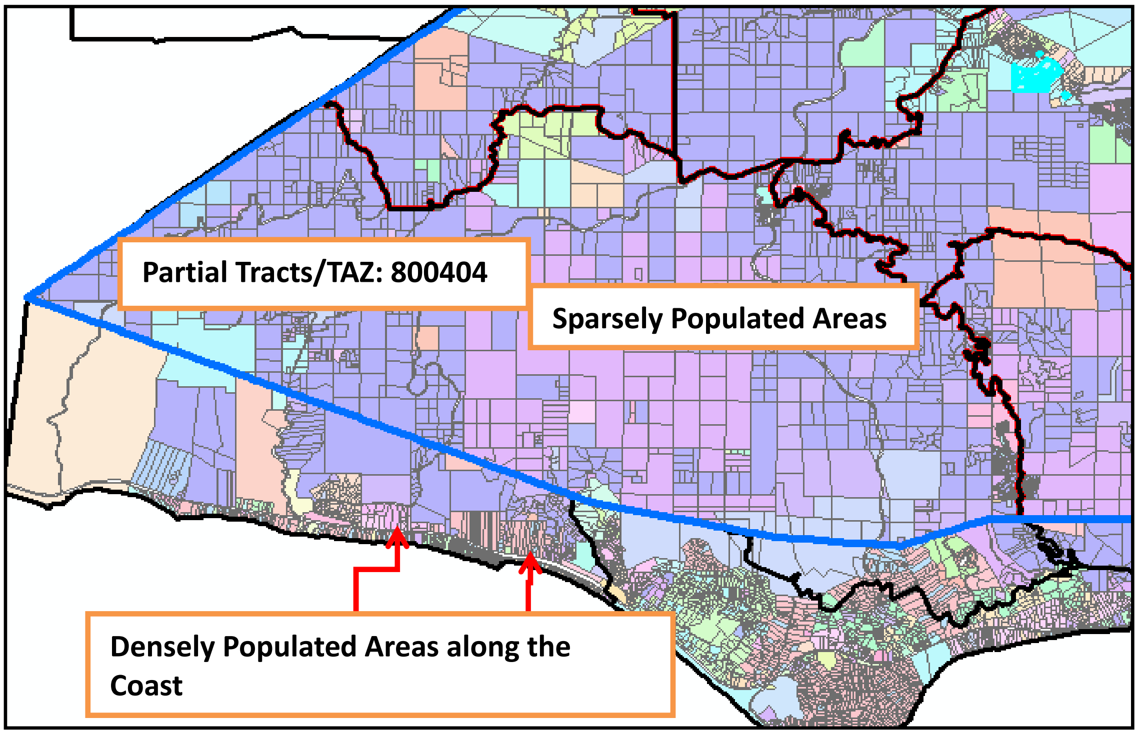
- Fully Contained TAZ – Those TAZ which were fully contained within the District's boundary.

- Partially Contained TAZ – Those TAZ which were partially contained within the District's Boundary. These included the TAZ which covered much of the District's southern border and the northeast or "Chimney" area of the District's service area boundary.

Current population estimates were based on SCAG data for 2008. For the Fully Contained TAZ, SCAG 2008 estimates were directly used for the population calculations. For the Partially Contained TAZ (reflected in figure 1), the population estimates were reconciled with the "block-level" 2010 census data. This block-level evaluation, performed by the District, provided the basis of planning for these Partially Contained TAZ areas.

A focused review of Tract/TAZ 800404 has been selected to demonstrate this issue, and is graphically depicted in Figure 2. As shown, Tract/TAZ 800404 is partially contained within the District's service area. With a detailed review of the land use coverage overlay, it is evident that the Malibu costal area is part of this TAZ, but lies outside the District's boundary. Additionally, it is clear that the Malibu area is vastly more densely populated than the area of the TAZ which falls inside the District's boundary. As such, proportioning the current and projected population within this TAZ based on the percentage of TAZ area that is within the District's boundary would grossly overestimate the District's population in this TAZ. Given this finding, a more detailed assessment was performed for all Partially Contained TAZ to improve projection accuracy.

Figure 2: Example of Partial Tract/TAZ Areas



The initial step in the partial TAZ adjustment process was to contrast the 2008 SCAG data to the block-level 2010 census estimates developed by the District and derive a unique population ratio for each Partially Contained TAZ. This ratio was then applied to the SCAG estimates to estimate the population that in resides in and out of the District's service area. Proceeding in this manner reconciles the discrepancy in the SCAG/census datasets, and fine tunes the population estimates for these partially contained TAZ areas. The resulting 2010 population estimate using the SCAG data is 70,138. In contrast, the District utilized the 2010 Census information to estimate the 2010 population to be 67,628, a difference of approximately 2,500 residents. This difference is not believed to have a material impact on the projection of future population or water demands estimates.

2.2 Population Projections

Population projections were calculated based on General Plan reports, updated Housing Element studies, discussion with agency Staff, vacant housing information from the 2010 census, inactive accounts from District billing data, land use and planning data from the unincorporated areas of LA County, and Ariel photography for development opportunities within the District's service boundaries. The population projections for future conditions correspond to the year 2035 and are provided in Table 1.

As shown, the population in the District's service area is projected to reach approximately 86,800 people, an increase of approximately 23 percent. This increase is attained from both new housing units and the full occupancy of available housing as quantified in the 2010 census. A discussion of the source information and methodology utilized to derive these projections follows Table 1.

Table 1: Housing and Population Projections

Agency/Growth Description	Projected New Dwelling Units	Applicable Persons per Household (PPH)	Projected Additional Population
Agoura Hills (1)			
Agoura Village	293	3.345	980
N Agoura Rd	73	3.345	244
Calabasas (2)	746	3.045	2,272
Hidden Hills (3)			
Per HH note from SCAG	34	3.23	110
Westlake Village	84	3.01	253
Westlake Village Business	401	3.01	1,207
Unincorporated LA County (4)			
Additional Population from Land Use Calculations	2,746	3.15	8,773
Vacant HSE Units (5)			
Additional Population from Vacant units	936	3.03	2,816
Totals	**5,314**		**16,655**
Population 2010 (SCAG reconciled with Census)			**70,138**
Population 2010 (Census Blocks(6))			**67,628**
Population Projection 2035			**86,793**

1) May 2013 Housing Element, Agoura Village SP increased by 100 units per A. Cook, PPH from average of tracts 800323 & 800324
2) June 2013 Housing Element, pph from average of tracts 800101 and 800202
3) March 2013 Housing element, pph from tract 800201
4) Based on land use acreage and density, pph from TAZ specific values, averages used in Table 1
5) Vacant Units coverage based on 2010 census data, TAZ specific
6) District estimate based on 2010 Census track and block level data

- **Local City Growth Estimates**

As shown in Table 1, Agoura Hills, Calabasas, Hidden Hills and West lake Village are projected to increase in density and associated population over the 25 year planning period, with estimated population increase of 1,224, 2,272, 110 and 1,460, respectively. These values were calculated based on the updated 2013 Housing Element reports for each of these cities, along with discussions with City Staff and /or their planning consultants. Since updated Housing Elements are required by state statues Government Code Sections 65580-65589.8, each of these Housing Elements have been updated since the District's 2007 Master Plan and 2010 UWMP were prepared. In fact, all of the applicable Housing Elements have been developed in 2013.

- **Unincorporated LA County Area Growth Estimates**

In contrast to the focused and area specific local city housing and growth estimates, growth estimates for the unincorporated areas of the County were derived based on land use information. As such, the applicable parcel-level land use information of acreage, land use type, maximum allowable densities, and census-oriented persons per household (PPH) data was used to estimate the increase in both dwelling units and population. Non improved parcels were filtered from the Land Use data and classified according to their zoning category. The County General Plan provided the maximum allowable density for each category. Additional dwelling units were calculated by applying the maximum density to acreage of each parcel. Ultimately, a projected population was calculated by correlating the persons per household values from the census data with the calculated increase in additional housing units.

- **Vacant Housing Units**

In addition to the increases in population from new dwelling units or changes in persons per household, increased population projections were also estimated from the 2010 census' documentation of the vacant housing units. To support this process, the American Community Survey's (2009) 5 Year data was downloaded from http://www.census.gov/acs/www. This data set included family size, demographic data, housing (HSE) units, vacant units, employment status etc. for the tracts in the District's service area. Applicable average family size values for each Tract were correlated with the vacant housing dataset to estimate the additional population that would occur from the fully occupied housing stick.

As shown, an additional population of 2,816 is projected to reside in the District when these dwelling units are fully occupied. Of note, this vacant housing stock value was further supported by a review of the District's utility billing system account data. This review found a comparable number of inactive accounts in the billing database.

3. Water Demand Projections

3.1 Total Potable Water Demand Projections based on 2010 Data

Water demands and duty factors for were calculated based on the District's 2010 utility billing data. 2010 data was chosen as the baseline data set so that actual water usage data could be correlated to the 2010 census/SCAG population data derived in Section 2. Each of the District's accounts was categorized under one of following types: residential (single family and multifamily), commercial, irrigation, reclaimed, fire protection and temporary based on the type of service provided. Reclaimed water and temporary water usage was excluded from the potable water calculations.

The District's actual 2010 account level bi-monthly billing data was used to reflect potable water sales. A four percent unaccounted (non-revenue) water factor was applied to this metered or billed water consumption data to adjust the data from water consumption to a water supply/production requirement. This calculation methodology was consistent with the most recent demand forecasting approach used in the District's 2010 UWMP. The results of the 2010 evaluation are provided in Table 2. Based on this water usage and the estimated 2010 population, results in a District wide water usage value of 238 gallons per capita per day.

Table 2: 2010 Water Usage Data

Type	Amount
Residential (HCF)	6,622,042
Irrigation (HCF)	243,340
Commercial (HCF)	951,040
Fire (HCF)	1,977
Unaccounted (HCF) (1)	312,736
Total Water Usage (AFY) (2)	**18,664**
Total Water Usage (gallons per day)	**16,664,370**
Population 2010 (SCAG reconciled with 2010 census data) (3)	70,138
Population 2035	86,793

Source: Water usage based on District billing data
(1) Unaccountable water based on District billing analysis
(2) Low water demand was noted in 2010 from the economy, drought and water budget allocations
(3) District estimated 2010 population estimate using census data is 67,628

For the District, there are three key questions that need to be answered to move from using actual water usage information to forecasting future water demands. These are: 1) how has the weather and/or the economy affected recent/current water demands, 2) how has the drought and associated rationing affected water demands, and 3) is there any statistical evidence to suggest that any or all of these factors will affect water demands in the future. Each of these is discussed as follows:

3.1.1 Weather and Economic Impacts

To assess the potential impact of these variables on water usage, a regression analysis of the District's billing data from the year 2003 through 2013 was performed. This analysis evaluated the correlation between water use among various customer types and weather (precipitation, ET) and economic (unemployment rate) factors for the District's customers over this same time period. Although it was found that there wasn't a high correlation with ET or rainfall, the results of a demand analyses indicate that both water demands and wastewater discharges correlated with the changing economic conditions within the District's service area. When the economy is "good" with a low unemployment rate, both water usage and wastewater generation increase.

The analysis suggested that water usage is predicted to increase as much as 20 to 38 (weighted average of 25%) percent based on the 2010 data and 15 to 24 (weighted average of 17%) percent based on 2012 data, under good economic conditions for various customer types. Based on this analysis, an economic factor of 25% was applied to the 2010 data to project future potable water demands in Table 3. A comprehensive Technical Memorandum of this statistical analysis if provided in Appendix A-1.

3.1.2 Drought Impacts

Dr. Randall Orton, Resource Conservation Manager, studied the impacts of drought on water demands. The objective of the study was to estimate the pace and magnitude of post drought response on water demands. Based on the District's experience during the 1990-91 drought and an analysis of the primary factors that influence demand for potable water in the residential sector of LVMWD's service area, it was estimated that the annual demand following the end of the recent drought will continue to rise, attaining its pre-drought level in approximately six years and 85 percent of that level in two years, depending primarily on the incidence of wet winters. Moreover, the study suggests that over a shorter, monthly or seasonal time frame, peak summertime residential demands will likely return to their pre-drought levels in approximately 2-4 years.

Based on this study, a drought recovery factor of 31% was derived and applied to the water demand projection to represent an "upper limit" of a full drought recovery. A sensitivity analysis was also performed to bracket various demand projections under consideration. A comprehensive Technical Memorandum of this Drought Analysis if provided in Appendix A-2.

3.1.3 Statistical Correlation with District's Water Demands

To account for the probable impact of both economic and drought recovery factors, an economic factor of 25% was then applied to the 2010 potable water usage values. Various drought-recovery factors were also considered as potential future water demand requirements. Based on the 2035 population projection of 86,793 previously derived, water demand projections were calculated for the following three scenarios, and shown in Table 3:

- Scenario 1: Full Drought Recovery
- Scenario 2: No Drought Recovery
- Scenario 3: Partial (50%) Drought Recovery

Table 3: Total Water Demand Projections Using 2010 Data

Scenario	Economic Factor	Drought Rebound Factor	Water Duty Factor (WDF)(1)	Total Water Usage (gal/day)	Total Water Usage (AFY)
Scenario 1: With Drought Rebound	25%	31%	385	33,465,165	37,470
Scenario 2: No Drought Recovery	25%	0%	309	26,807,824	30,025
Scenario 3: Partial Drought Recovery	25%	16%	347	30,128,041	33,750

Note: Some values may be rounded.
(1) Water duty factor is a District wide value, expressed in gallons per capita per day.

As shown in Table 3 above, a water demand of approximately 37,470 AFY is projected based on a WDF of 385 for a full drought recovery condition for 2035. Assuming there was no additional drought recovery, Scenario 2 indicates the District would experience a water demand of 30,025 AFY and a WDF of 309. Similarly, a water demand of 33,748 AFY is derived for a partial drought recovery condition, representing 50 percent of the projected post drought recovery. Implicit in the above projections is the assumption that non-residential demands will increase in proportion to the increase in residential demands.

Note than the evaluation in Scenario 1 was based on the consideration that the influence of the economy and the drought are mutually exclusive. However, it is logical to assume that a few aspects of the drought factors will inherently be incorporated in the economic factor, and vice-versa. As such, it is reasonable to assume that a percentage of the drought recovery factor should be applied, rather than the full 31%. Based on this consideration, Scenario 3 was derived to reflect a 50% level of drought recovery.

3.2 Sensitivity Analysis Using 2012 Data

Since the District has experienced an increase in water sales since 2010 with a minimal change in active accounts, it is appropriate to consider how the water demand projection may be affected with the use of more recent 2012 water billing data. Using a procedure similar to the one used to incorporate the 2010 data would provide an additional estimate of future demands, essentially providing a sensitivity analysis to the base demand projection. The baseline water usage information for 2012 is provided in Table 4. This data provides the basis for the revised water demands and duty factors.

Table 4: 2012 Water Usage Data

Type	Amount
Residential (HCF)	7,656,100
Irrigation (HCF)	301,827
Commercial (HCF)	999,922
Fire (HCF)	974
Unaccounted (HCF)	358,353
Total Water Usage (AFY)	21,387
Total Water Usage (gallons per day)	19,095,105
Population 2010 (SCAG reconciled with 2010 census data)*	70,138
Population 2035	86, 793

*District calculated 2010 demands based on census is 67,628

Similar to the baseline demand projection using the 2010 billing data, the 2012 billing data was also subject to the economic and drought recovery factors. Since the drought/mandatory rationing was suspended approximately two years ago, it is logical to assume that a portion of the drought recovery is embedded in the 2012 usage data. There is an actual increase of 15% in water demand between 2010 and 2012.

For this sensitivity analysis, we have conservatively assumed that two years of a five year rebound has occurred, suggesting that 2/5ths of the drought rebound or 12% is included in the 15% actual increase in water demand from 2010 to 2012. The rest of the 3% (15%-12%) increase in water demand from 2010 to 2012 is considered to be the result of economic improvement. Therefore 60% of the drought rebound or 18% has yet to happen and will be used for the water demand projection in 2035.

In addition to the drought factor, the statistically derived economic factor of 17% was also adjusted to integrate the increased water usage. For this factor, the weighted average of 17% was further reduced by the 3% economic factor already included in the 2012 usage increase from 2010. Therefore the 17% economic recovery factor was reduced to 14% for the 2012 sensitivity analysis. The results of this sensitivity analysis using the 2012 billing data are provided in Table 5.

Table 5: Total Water Demand Projections Using 2012 Data (Sensitivity Analysis)

Scenario	Economic Factor	Drought Rebound Factor	Water Duty Factor (WDF)(1)	Water Usage (gal/day)	Water Usage (AFY)
Scenario 1: With Drought Rebound	14%	18%	374	32,438,340	36,330
Scenario 2: No Drought Recovery	14%	0%	323	28,014,930	31,380
Scenario 3: Partial Drought Recovery	14%	9%	348	30,222,670	33,860

Note: Some values may be rounded.
(1) Water duty factor is a District wide value, expressed in gallons per capita per day.

As shown, using the 2012 water billing data and revised adjustment factors suggests an increase in the level of projected water demands. Using the 2012 data, future water demands are projected to reach 31,400 to 36,500 AFY. Since the analysis using the 2010 billing data suggested a range of 30,000 to 37,500 AFY, the basis of planning appears to provide a reasonable estimate of projected water demands for the District's 2013 Master Plan.

4. Summary of Projected Population and Water Demands

Inherent in the conduct of long-range planning studies is the need to consider alternative futures. This need is based on the reality that growth can't be precisely predicted and demands for service such as water that are driven by individual behavior is uncertain. It is for this reason that the projections derived herein utilized the best available data to quantify both population and water usage values, but attempted to frame or bracket these findings for the purposes of long-range water planning. To further frame the discussion of long-range population and water demand projections, the results of several of the District's previous planning efforts have been consolidated. The consolidation of previous population projections is shown in Figure 3. The consolidation of projected water demand is shown in Figure 4. Of note, the Kennedy/Jenks water demand projection shown in Figure 4 is based on the 2010 data set, and a partial drought recovery (Scenario 3).

As shown, the findings presented herein are very comparable with all previous planning studies performed for the District since 2005. At this stage in the planning process, final direction is requested on the appropriate level of demand forecasting conservatism that should be incorporated in the 2013 Master Plan. This direction, combined with the District's water conservation program and SBx7-7 compliance plan would constitute the District's total demand management plan and provide the framework for evaluating the District's potable water, recycled water, and sanitation facilities.

Figure 3: Population Projection Comparison with Earlier Studies

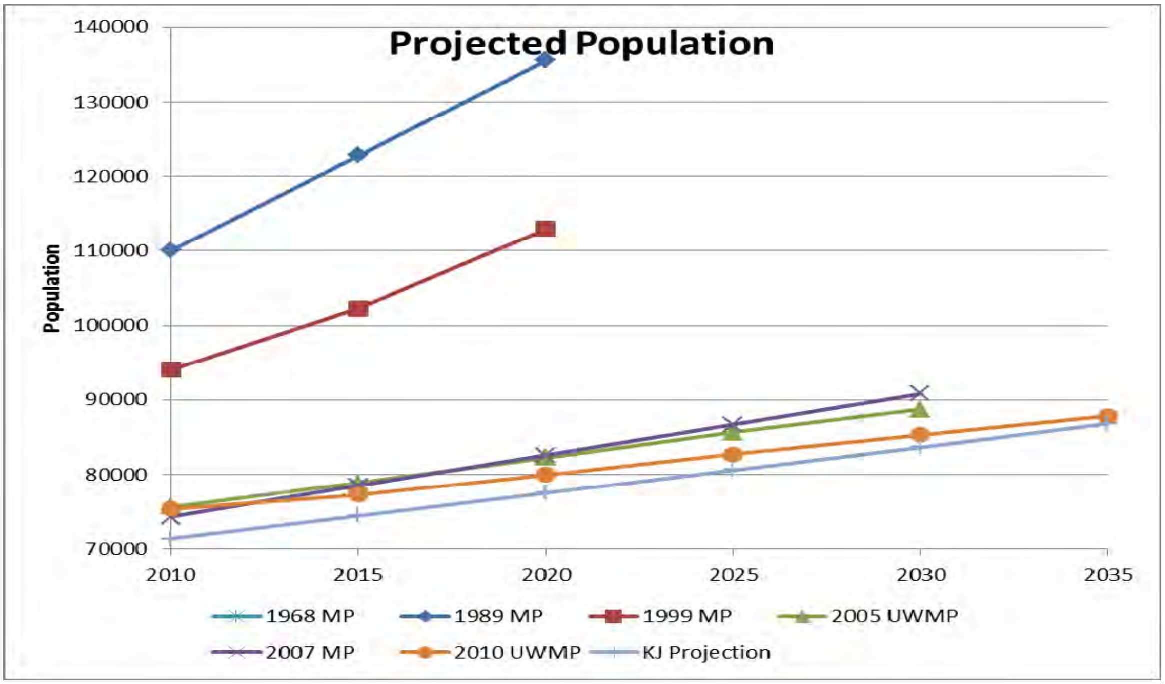
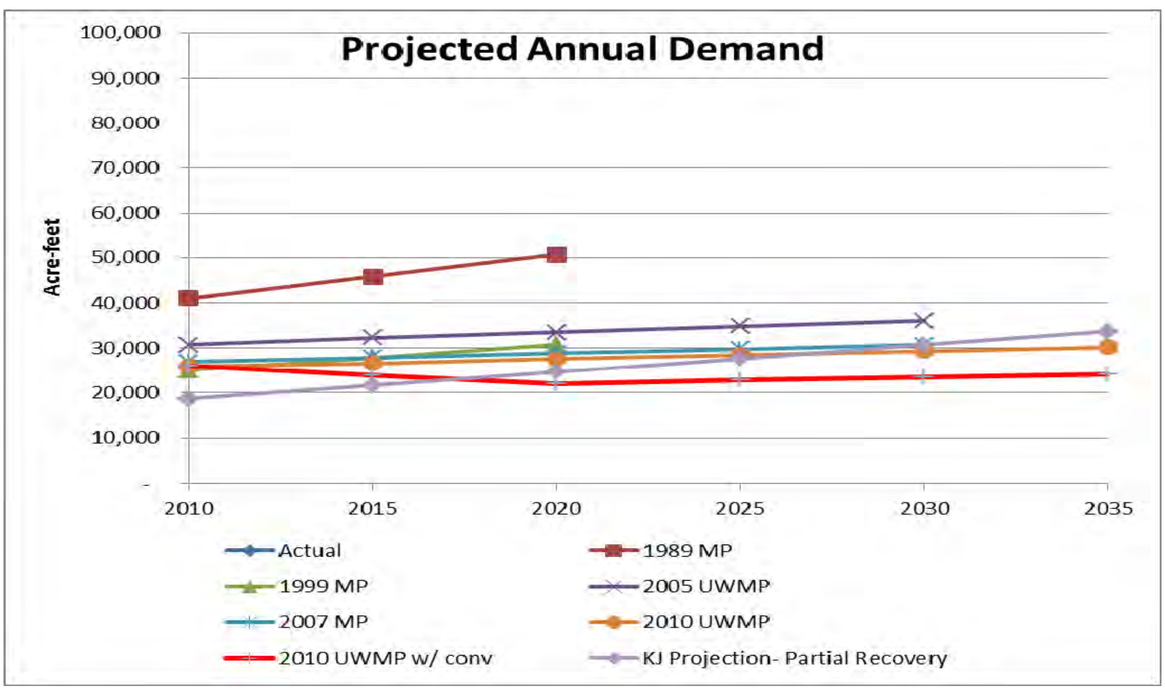


Figure 4: Water Demand Projection Comparison with Earlier Studies



Water Demand and Wastewater Generation Projection - Appendix A-1

Economic Analysis Technical Memorandum

30 June 2013

Memorandum

To: John Zhao, David Lippman

From: Roger Null, Dakota Corey

Subject: Effects of the Economy and Climate on Water Demands and Wastewater Discharges
K/J 1389005*00

Water use by residential, commercial and other customers can be affected by climate (e.g. evapotranspiration (ET), precipitation) and economic factors. Generally, increased ET is associated with increased water use. Also, time periods characterized by good economic conditions are often associated with higher water use than time periods when economic conditions are poor. Likewise, the amount of wastewater generated in a community may increase with improved economic conditions.

The extent of these effects may vary based on local conditions and can be significant. For example, Kennedy/Jenks Consultants has found in the City of Santa Monica, enhanced economic conditions could result in a ten percent increase in water demands. Increased demands may result in the need for additional system capacities, enhanced water conservation efforts in order to comply with state mandates, and/or additional water supply sources, etc. Hence, it is essential to evaluate the effect of these factors for Las Virgenes Municipal Water District (LVWMD) as a component of the larger master planning effort.

Effects of Economy and Climate on Water Demands

Regression analyses were performed to evaluate the correlation between water use among various customer types and weather (ET, precipitation) and economic (unemployment rate) factors. LVMWD has four primary potable water customer account types, including single family residential (SFR), multi-family residential (MFR), commercial and irrigation. However, evaluation of the SFR accounts revealed a drastic range in landscape sizes (parcel area minus building area). LVWMD’s service area contains approximately 1,300 SFR accounts with landscape areas less than or equal to 2,500 square feet, over 3,800 SFR accounts with landscape areas larger than 25,000 square feet, and more than 13,000 SFR accounts in between.

Due to this significant variation and the assumption that there is a correlation between lot size and income, the SFR accounts were broken down into five categories based on lot size. MFR, commercial, and irrigation accounts remained unchanged for a total of eight different customer categories. These water use customer categories are shown in Table 1.

Table 1: Water Use Customer Categories

Water Use Type	Number of Accounts
SFR	-
Up to 2,500 sq.ft[(a)]	1,290
2,500 to 5,000 sq.ft[(a)]	3,487
5,000 to 10,000 sq.ft[(a)]	6,206
10,000 to 25,000 sq.ft[(a)]	3,422
Larger than 25,000 sq.ft[(a)]	3,811
All SFR Together	18,216
MFR	553 (7,265 dwelling units)
Commercial	839
Irrigation	257

Notes: Water usage and accounts are for analysis purpose and will not identically match billing data.
(a) Landscape Area = Parcel Area – Built Area

Weather data for these analyses were obtained from the California Irrigation Management Information System (CIMIS) database. Since CIMIS data is limited in the immediate LVMWD service area, data from Station #152 (Camarillo) was used for the weather regression analysis. Unemployment data for cities located within LVMWD's service area was obtained from the State of California Employment Development Department database. The economic regression analysis used the average unemployment rate of the four cities located within LVMWD's service area – Agoura Hills, Calabasas, Hidden Hills, and Westlake Village.

Results of the regression analyses indicated that, for LVMWD, the water use for MFR, commercial, irrigation, and SFR accounts of all lot sizes correlate better with unemployment rate (R^2 of 0.646 to 0.924) than weather related variables. Water use decreased with an increase in the unemployment rate. No significant correlation was observed with weather related parameters.

Table 2 shows the equations developed for the correlation of the eight customer categories, labeled as water use types in the table, with unemployment. Graphical results of the economic and weather related water demand analysis are provided in Appendix A-1.1.

Table 2: Regression Equations Used for Each Water Use Type

Water Use Type	Correlation Equation with Unemployment[a]
SFR	
Up to 2,500 sq.ft[b]	y = -119.94x + 32.378
2,500 to 5,000 sq.ft[b]	y = -200.77x + 50.007
5,000 to 10,000 sq.ft[b]	y = -270.51x + 69.697
10,000 to 25,000 sq.ft[b]	y = -353.29x + 104.52
Larger than 25,000 sq.ft[b]	y = -587.28x + 151.62
All SFR Together	y = -308.6x + 85.12
MFR	y = -56.714x + 18.004
Commercial	y = -873.22x + 261.24
Irrigation	y = -1505.2x + 320.06

Notes:
(a) y = Water use (AF/Connection); x = Unemployment rate (%)
(b) Landscape Area = Parcel Area – Built Area

The equations in Table 3 were used to determine the coefficients of determination (R^2) for each water use type. Higher values of R^2 (1 being the maximum), indicate that the regression line fits the data set well. For this data set, it is assumed that R^2 values higher than 0.6 indicate a significant relationship between the data set and the correlation equation. The R^2 values for this data set are listed in Table 3.

Table 3 also displays additional information such as the 2012 water use and the percentage of use for each customer type. The “Adjustment Factor for Good Economic Conditions” column shows approximately how much the water use would increase if the unemployment rate were to decrease to the 10th percentile unemployment rate of 3.24 percent from the 7 percent in 2012. Depending on the type of water user, demands are expected to increase 15 to 24 percent. This is important because year 2012 was a recessionary period with a high unemployment rate in the LVMWD service area (approximately 7 percent), which resulted in lower water use. The correlation analyses findings suggest that an economic recovery and ensuing higher water demands should be considered in the projection of future water demands.

Table 3: R^2 Values for Each Water Use Type

Water Use Type	2012 Water Use (HCF)	R^2 Value for Unemployment	Adjustment Factor for Good Economic Conditions[(a)]
Residential	-	-	-
Up to 2,500 sq.ft[(b)]	181,229 (2.05%)	**0.924**	17.3%
2,500 to 5,000 sq.ft[(b)]	740,440 (8.37%)	**0.904**	19.3%
5,000 to 10,000 sq.ft[(b)]	1,913,529 (21.64%)	**0.843**	18.4%
10,000 to 25,000 sq.ft[(b)]	1,671,973 (18.91%)	**0.695**	15.3%
Larger than 25,000 sq.ft[(b)]	2,535,102 (28.67%)	**0.646**	18.4%
All SFR Together	7,042,273 (79.64%)	**0.714**	16.8%
MFR	605,307 (6.85%)	**0.679**	14.0%
Commercial	892,365 (10.09%)	**0.711**	15.1%
Irrigation	301,458 (3.41)	**0.867**	24.3%
Totals	**8,841,403**	--	--

Notes: Water usage and accounts are for analysis purpose and will not identically match billing data.
(a) Adjustment Factor for Good Economic Conditions = Percent Change in water use relative to 2012 use if the unemployment rate were to decrease to the 10th percentile unemployment rate of 3.24% from the 7% in 2012
(b) Landscape Area = Parcel Area – Built Area

Effects of Economy on Wastewater Demand

Wastewater originates as a result of indoor water use – toilets, laundry machines, sinks and other indoor fixtures all contribute to the wastewater stream. While climate may affect water use, it is not expected to materially affect the generation of wastewater since wastewater does not include outdoor water use. Thus, only the effects of economic conditions were analyzed in relation to wastewater discharges in the District's service area.

Evaluation of winter water use data (the March billing cycle, which includes both February and March water use) were performed based on the built area, or the building footprint (measured in square feet), of the SFR units (Table 4). Winter water use data was used to approximate wastewater generation under the assumption that landscape irrigation and other outdoor water use should not be necessary in the wetter winter months. Under this assumption, most of the water used during the winter months should thus end up in the wastewater system. The SFR units were grouped in to six different built area categories.

Table 4: Winter Water Use Customer Categories

Water Use Type[a]	Number of Accounts
SFR	**-**
Up to 2,000 sq.ft[b]	6,206
2,000 to 3,000 sq.ft[b]	5,683
3,000 to 4,000 sq.ft[b]	3,298
4,000 to 5,000 sq.ft[b]	1,514
5,000 to 7,500 sq.ft[b]	1,269
> 7,500 sq.ft[b]	245
All SFRs Together	18,216
MFR	553 (7265 Dwelling units)
Commercial	839

Note: Water usage and accounts are for analysis purpose and will not identically match billing data.
(a) Irrigation customers are not included in estimates of winter water use.
(b) Built area.

The data indicated two distinct trends. At unemployment rates up to approximately 6.5 percent the water use did not vary significantly. However, at unemployment rates from 7 percent to 8.4 percent the water use gradually decreased with an increase in unemployment rate. As a result, when winter water use was correlated with unemployment rates throughout the project period (range of unemployment rates of 3.3 to 8.4 percent), the R^2 was poor (R^2 = 0.28 to 0.45;). However, when water use was correlated to unemployment rates higher than 6.5 percent, the correlation improved to 0.92 or higher; Table 5). Graphical results of the economic wastewater analysis are provided in Appendix A-1.2.

Table 5: Comparison of R^2 Values Under Different Unemployment Rates

Water Use Type[a]	R^2 When All Unemployment Rates (3.3 – 8.4%) are Considered	R^2 at Unemployment Rate Higher than 6.5%
SFR		
Up to 2,000 sq.ft[b]	0.387	0.936
2,000 to 3,000 sq.ft[b]	0.450	0.983
3,000 to 4,000 sq.ft[b]	0.340	0.927
4,000 to 5,000 sq.ft[b]	0.311	0.974
5,000 to 7,500 sq.ft[b]	0.267	0.979
> 7,500 sq.ft[b]	0.298	0.969
All SFRs Together	0.287	0.980
MFR	0.687	0.952
Commercial	0.585	0.816

Note: (a) Irrigation customers are not included in estimates of winter water use.
(b) Built area.

Table 6 shows the equations developed for the different water use types.

Table 6: Regression Equations Used for Each Water Use Type

Water Use Type[a]	Average Bi-monthly Water Use Correlation at Unemployment Rates above 6.5% (HCF/Account)[b]
SFR	
Up to 2,000 sq.ft[c]	y = -639.03x + 76.05
2,000 to 3,000 sq.ft[c]	y = -799.94x + 92.46
3,000 to 4,000 sq.ft[c]	y = -1253.2x + 140.66
4,000 to 5,000 sq.ft[c]	y = -2038.7x + 220.49
5,000 to 7,500 sq.ft[c]	y = -3309.1x + 337.0
> 7,500 sq.ft[c]	y = -6971.4x + 687.29
All SFRs Together	y = -1194.8x + 131.96
MFR	y = -70.327x + 17.465
Commercial	y = -894.52x + 229.77

Notes:
(a) Irrigation customers are not included in estimates of winter water use.
(b) Y – Bi-monthly water use (HCF/Account); X – Unemployment Rate (%)
(c) Built area.

Table 7 shows the estimated percent change in winter water use at various unemployment rates relative to 2012 water use. Accordingly, at the 10th percentile low unemployment rate of 3.54 percent (i.e. good economic conditions), winter water use is estimated to be 14-16 percent higher for SFR units, and 10.5 percent higher in MFR units. No difference is seen between the 50th percentile unemployment rate of 4.4 percent and the 10th percentile unemployment rate of 3.54 percent since, in both cases, the unemployment rate is less than 6.5 percent. However, at higher levels of unemployment such at the 90th percentile (7.84 percent) winter water use is expected to be lower. Thus, as the economy improves and eventually meets the threshold of approximately 6.5 percent or less, wastewater generation within LVWMD's service area is expected to increase.

Table 7: Percent Change in Water Use Relative to 2012 Winter Water Use (Unemployment Rate of 7%)

Water Use Type[a]	90th Percentile High Unemployment (7.84%)	50th Percentile Unemployment (4.4%)	10th Percentile Low Unemployment (3.54%)
SFR			
Up to 2,000 sq.ft[b]	95.9%	114.6%	114.6%
2,000 to 3,000 sq.ft[b]	95.7%	115.2%	115.2%
3,000 to 4,000 sq.ft[b]	95.6%	115.9%	115.9%
4,000 to 5,000 sq.ft[b]	95.8%	114.7%	114.7%
5,000 to 7,500 sq.ft[b]	95.9%	114.0%	114.0%
> 7,500 sq.ft[b]	92.8%	114.3%	114.3%
All SFRs Together	96.3%	113.1%	113.1%
MFR	95.3%	110.5%	110.5%
Commercial	95.5%	110.2%	110.2%

Note: (a) Irrigation customers are not included in estimates of winter water use.
(b) Built area.

Summary and Recommendation

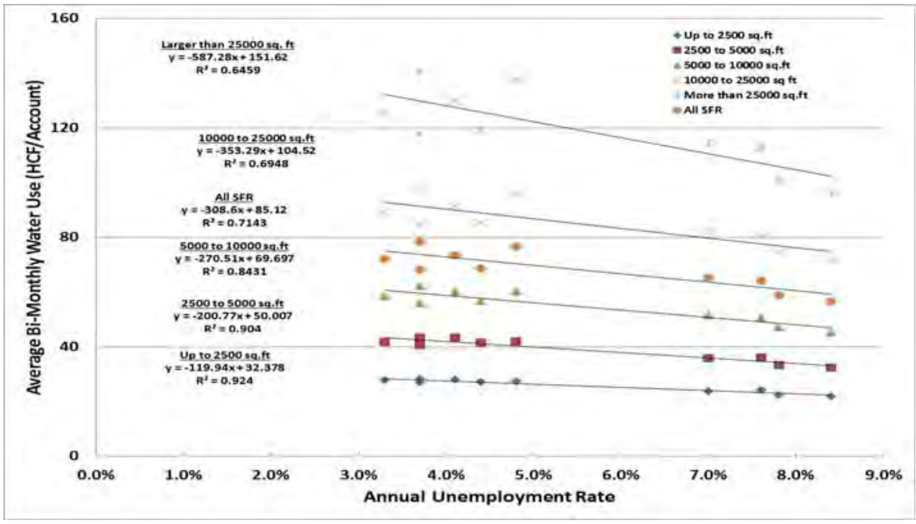
Results of the demand analyses indicate that both water and wastewater demand are correlated with economic conditions within LVWMD's service area. When the economy is "good" with a low unemployment rate, both water usage and wastewater generation increase. Water usage is predicted to increase as much as 14 to 24 percent, depending upon the customer type, under good economic conditions. Similarly, wastewater demand is expected to increase 10 to 16 percent depending on the type of water user under good economic conditions. The correlation between water and wastewater demand and economic conditions is strong, with R^2 values ranging from 0.6 to 0.9.

Due to the level of statistical significance between unemployment rates and water usage, it would appear appropriate to factor in a return to a good economy in LVMWD's water demand and wastewater flow projections. However, given the implications of this decision on future capital improvement requirements, resolution and final direction regarding the use of these factors is a District policy decision. As such, the final projection values will be derived following direction by LVWMD.

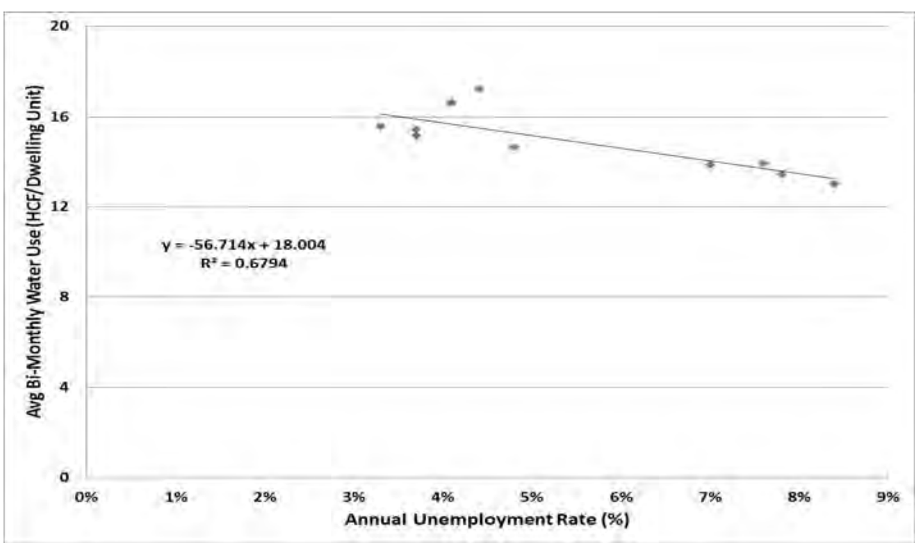
Water Demand and Wastewater Generation Projection Appendix A-1.1

Water Use Figures

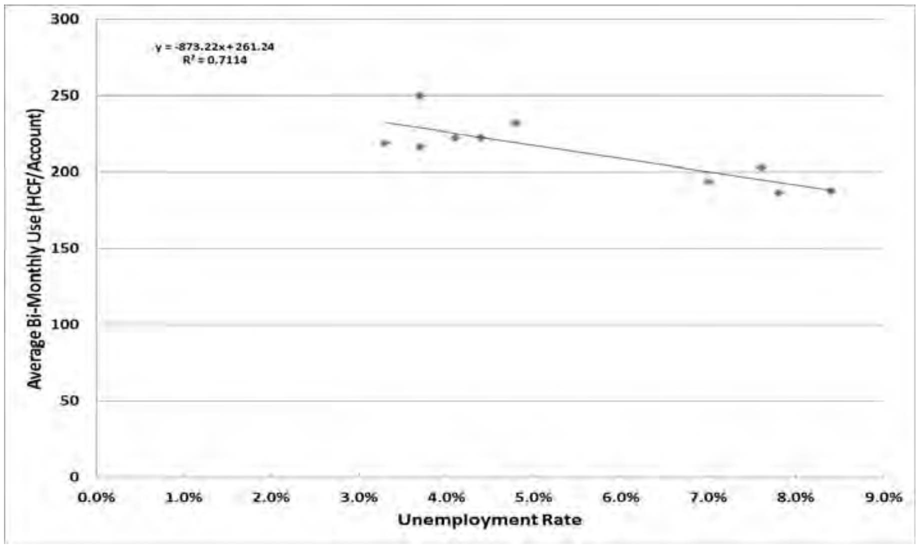
Effect of Economy (Unemployment Rate) on SFR Water Use



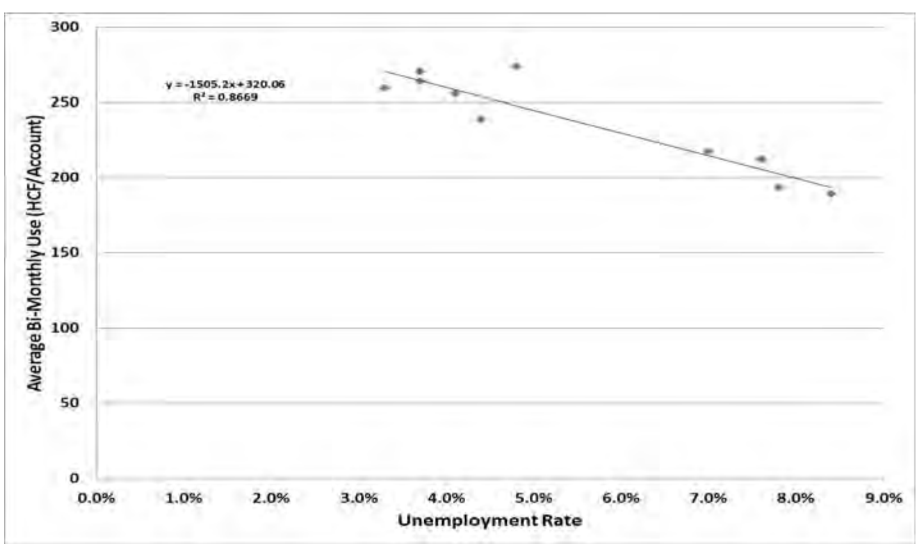
Effect of Economy (Unemployment Rate) on MFR Water Use



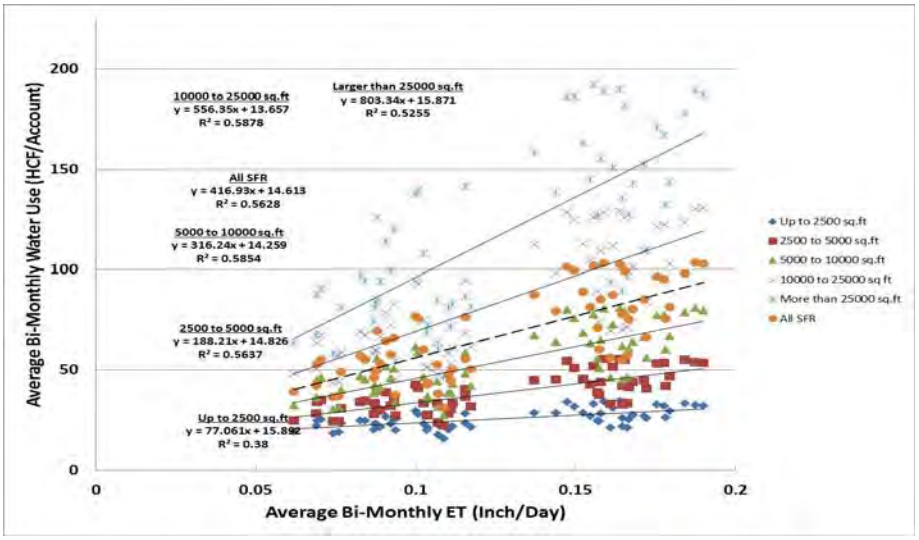
Effect of Economy (Unemployment Rate) on Commercial Water Use



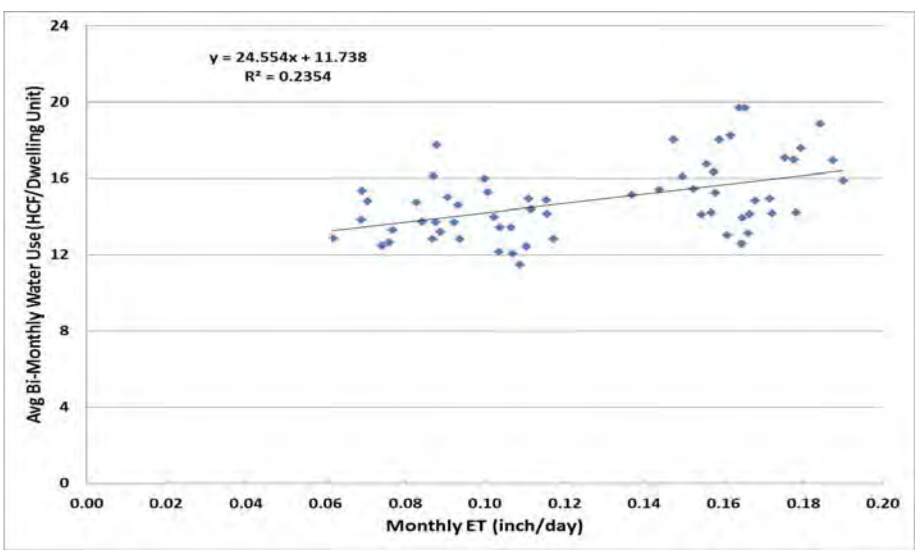
Effect of Economy (Unemployment Rate) on Irrigation Water Use



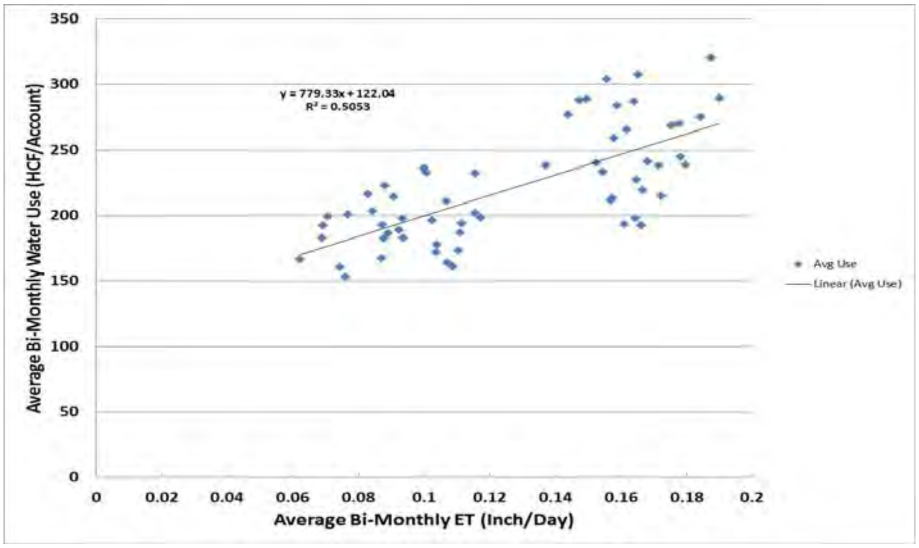
Effect of Weather (ET) on SFR Water Use



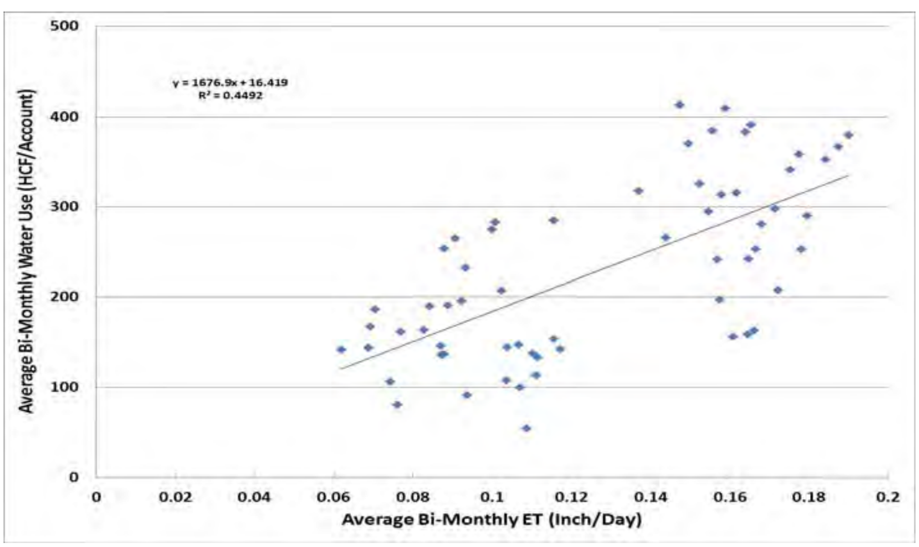
Effect of Weather (ET) on MFR Water Use



Effect of Weather (ET) on Commercial Water Use



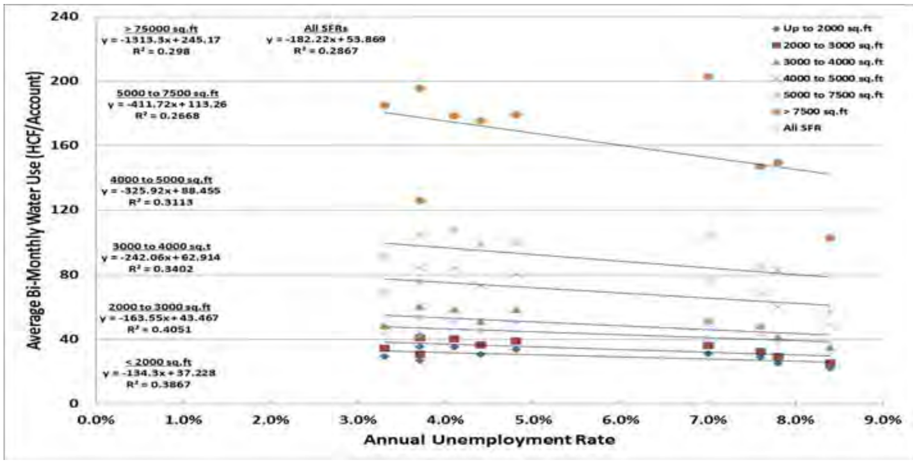
Effect of Weather (ET) on Irrigation Water Use



Water Demand and Wastewater Generation Projection Appendix A-1.2

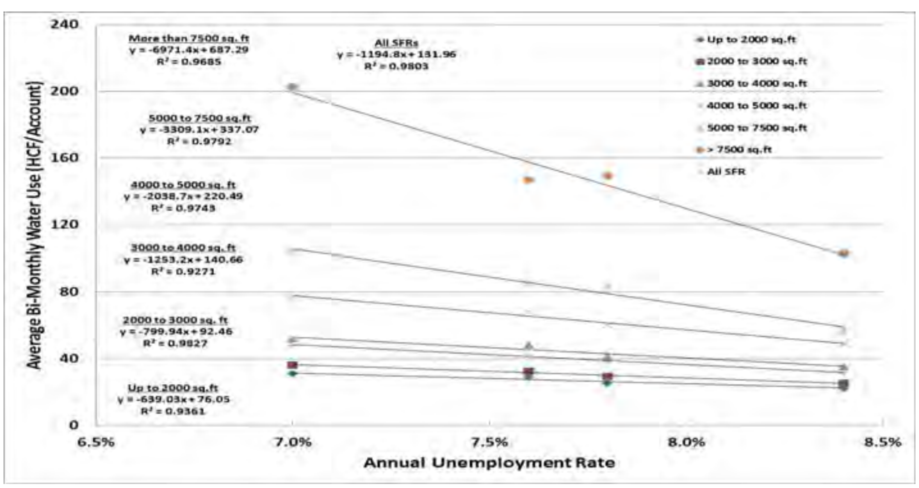
Winter Water Use (Wastewater) Figures

Effect of Economy on SFR Winter Water Use (Using Unemployment Rates Throughout the Project Period)



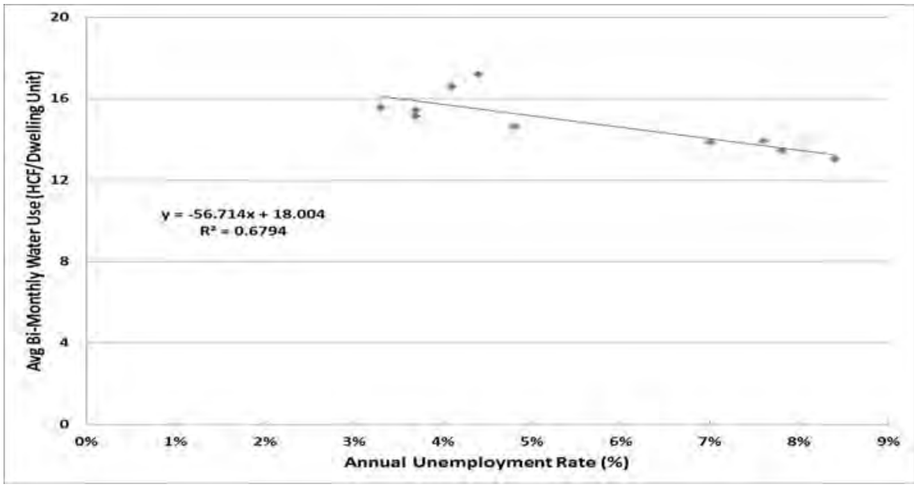
Poor correlation ($R^2 < 0.5$) obtained when unemployment rates throughout the project period were considered

Effect of Economy on SFR Winter Water Use (Using Unemployment Rates Higher than 6.5% Only)

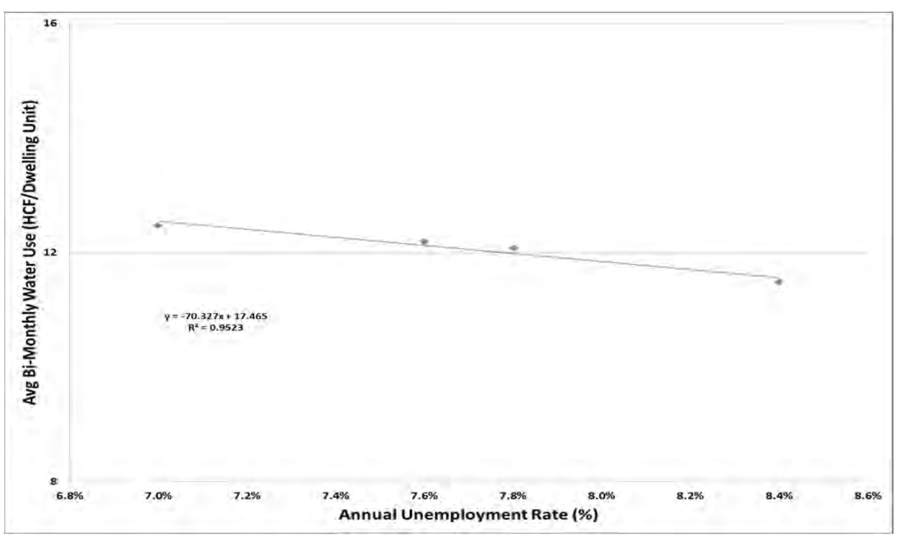


Good correlation ($R^2 < 0.9$) obtained when unemployment rates greater than 6.5% were considered.

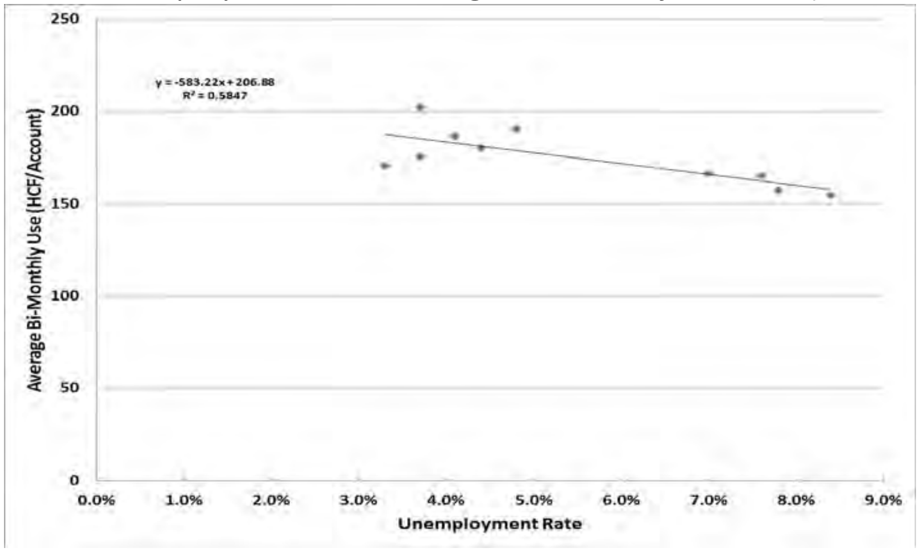
Effect of Economy on MFR Winter Water Use (Using Unemployment Rates Throughout the Project Period)



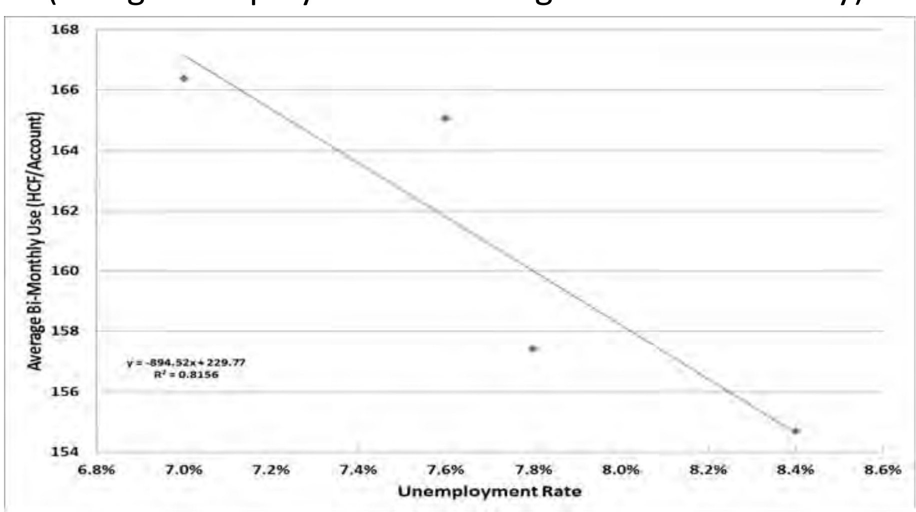
Effect of Economy on MFR Winter Water Use (Using Unemployment Rates Higher than 6.5% Only)



Effect of Economy on Commercial Winter Water Use (Using Unemployment Rate throughout the Project Period)



Effect of Economy on Commercial Winter Water Use (Using Unemployment Rates Higher than 6.5% Only)



Correlation (R^2 ~ 0.82) significantly improved when unemployment rates greater than 6.5% only were considered.

Water Demand and Wastewater Generation Projection - Appendix A-2

Drought Recovery Technical Memorandum

April 11, 2012

TO: CARLOS REYES

FROM: RANDAL ORTON[1]

SUBJECT: POST-DROUGHT WATER DEMAND

Per your request, we compiled and examined District data[2] on potable water demand over the period 1972 through February 2012, focusing on changes in residential demand[3] during and immediately following both the 1991-2 and 2009-11 state-wide drought water shortage emergencies. Our objective was to estimate how quickly water demand following the recent drought might rise based on our experience following the 1991-2 drought, and to determine what factors most-strongly influence the recovery rate.

Based on our experience with the previous drought recovery (1992 – 1997), we estimate *annual* potable water demand may recover to its pre-drought level in 5-6 years (2016-17) if local weather is drier than normal, but may be delayed until 2017-18 if wetter conditions prevail. Peak summertime monthly demand will likely recover sooner (2014-15), regardless of weather, and peak summertime daily demands are expected to recover sooner still (2012-13).

DISCUSSION

Over the last 20 years, the District has declared a water shortage emergency twice in response to persistent, statewide droughts, once in the 1991-2 drought and again in the 2009-11 drought. Water use during both of these droughts fell about 30 percent from their pre-drought levels in response to conservation measures and financial penalties for over-usage (Fig. 1). Water demand

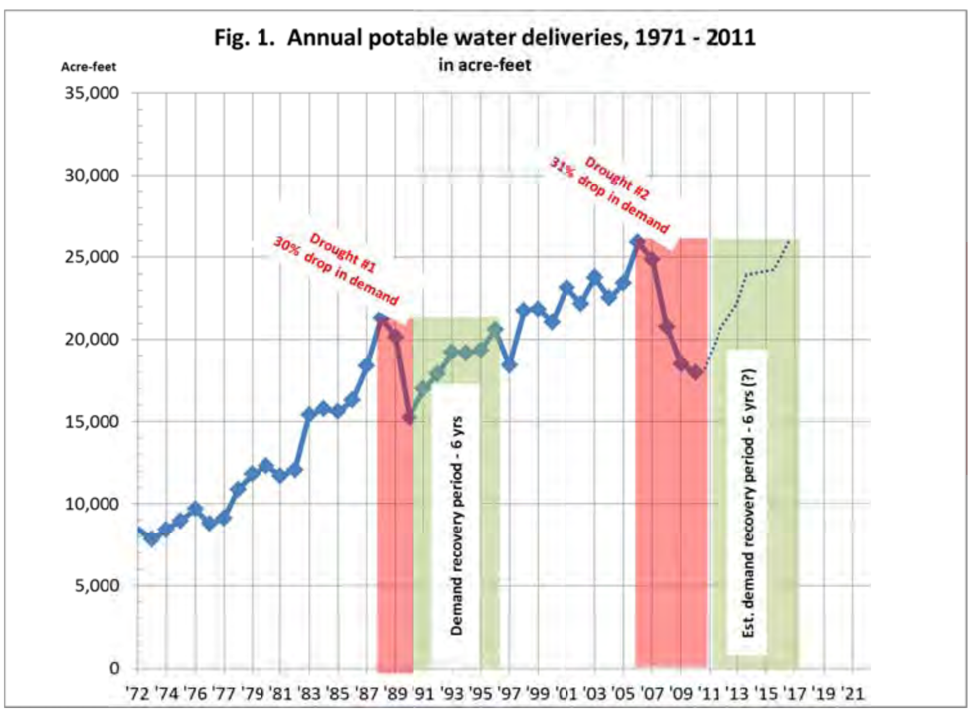


Fig. 1. Annual potable water deliveries, 1971 - 2011

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[1] D. Holliday (IS), M. Hamilton (F&A), G. Weston (CS), S. Harris (RC) and J. Dougall (RC) assisted in data compilation and analysis.
[2] Lvdata/district information/annuals/xls.
[3] We considered residential demand only, as it accounts for about 95% of total annual demand in the LVMWD service area.

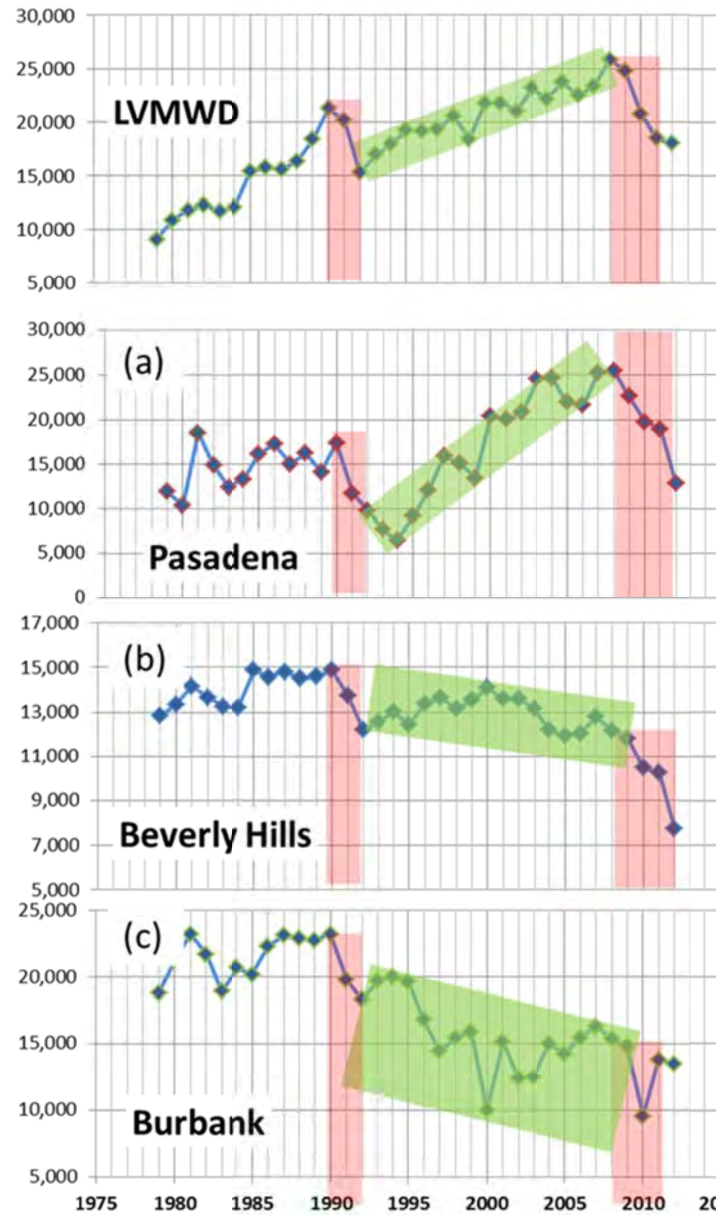
returned to its pre-drought level in about 6 years following the 1991-92 drought emergency, suggesting a similar period might elapse before current water demands return to their 2009 pre-drought levels. Further, the post-drought rise in demand was steeper in the first three years after the drought, recovering over 85 percent of pre-drought demand in just two years, and 95 percent of pre-drought demand in three years (Fig. 1).

However, different water districts experience drought and post-drought demands differently (Fig. 1b), and the validity of using the earlier drought recovery history to predict future, post-drought water demand depends on our ability to account for the major factors that influence per capita water use in the LVMWD service area, and to show that these factors are comparable for both the historical and current post-drought periods. These factors include:

1. Growth in overall demand due to new connections;
2. Changes in the average residential lot size;
3. Differences in weather
4. Differences in water conserving fixture installation rates (demand hardening)
5. Economic factors, such as differences in the consumer price index (CPI) adjusted for inflation.

Where these factors differ between the two periods being compared, it may still be possible to adjust or normalize the differences and maintain the validity of the comparison. However, this step proved unnecessary for factors 1-3, as none of these factors were appreciably different in recent years in comparison with the 6 yrs

Fig. 1b. Other agencies, other experiences – 3 examples. (a) Pasadena experienced both a similar recovery in post-drought and increased usage beyond the recovery period; (b) Beverly Hills only recovered to about 85% of pre-drought demand; (c) Usage in Burbank continued to decline after the 1990-91 drought, but quickly recovered after the 2008-11 drought to pre-2008 levels.



following the 1991-2 drought, as discussed below. The remainder of the memo provides additional detail for each factor we analyzed.

New Connections

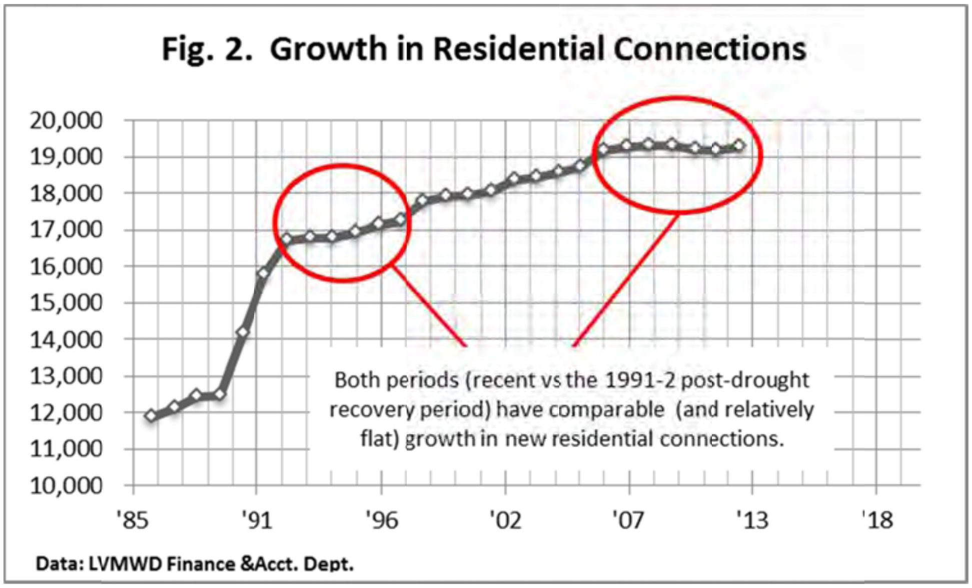


Fig. 2. Growth in Residential Connections

An immediate question is whether the relatively rapid rise in demand following the 1991-2 drought in Fig. 1 was an artifact of growth in new connections (rather than growth in per capita demand to pre-drought levels). Fig. 2 shows this not to be the case; both the post-1991-2 period through 1997 and recent years (2006-12) had comparable, relatively flat growth in new residential connections, with the exception of 1998, the last year of the post-1991-2 drought recovery period, when 526 new residential connections were added to the potable water system. However, by that year demand had already returned to its 1989 pre-drought peak (Fig. 1). In short, the number of residential connections was relatively stable for both the earlier drought recovery (1992-8) and current conditions (2006-12), with changes in demand related more to changes in per capita water use and weather.

Median residential lot size

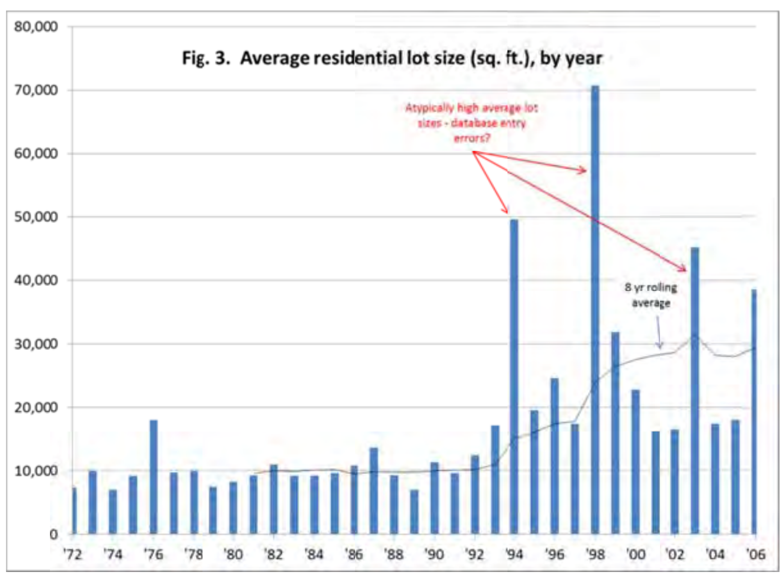
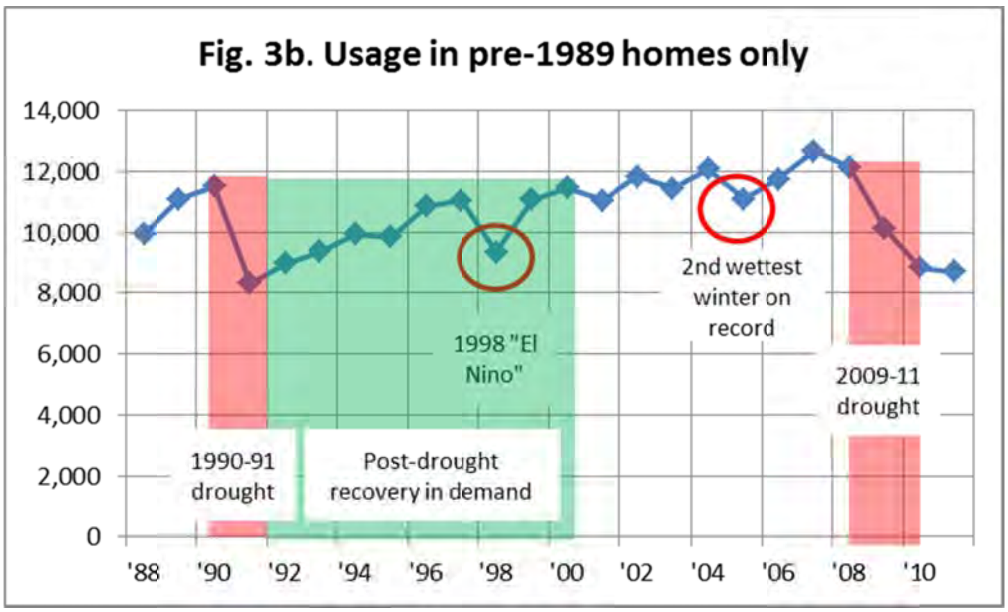


Fig. 3. Average residential lot size (sq. ft.), by year

We used two methods to account for differences in residential lot sizes in our comparison of current water use with usage following the 1990-1 drought. The first method was to compile data on median[4] lot size for the residential customer base for both periods (i.e. 1992-98 vs 2011-12). These values differed by less than ten percent, with median lot size today somewhat smaller than in 1992-98. Further, a large fraction of the ten percent difference may be an artifact of how multifamily residential lot sizes

[4] As a measure of central tendency, the median is less sensitive than the average to extreme values and outliers.

are recorded in the Customer Information System (CIS). Several years had atypically high average residential lot sizes ranging from 100–200 percent higher than the long term, 1972-2012 average (Fig. 3). Inspection of the data from those years found several instances where the square footage of the entire multifamily complex was entered for each of its constituent apartments or condominiums, artificially raising the median lot size. In those cases we found, we estimated the correct lot size by simply dividing the reported lot size (which was identical for every apartment or condo) by the number of units in the complex. However, this correction was limited to our working spreadsheet – we made no changes to the data in CIS – so you may wish to discuss this issue with Customer Service and Information Systems staff[5].



The second method to control for differences in average lot size between the two post-drought periods was to limit our analysis of water use after the recent drought to only those customers who were also connected to the potable water system during the 1991-2 drought cycle (Fig. 3b). Changes in demand in these homes are much less likely to be due to changes in lot sizes, on the assumption that their landscaped footprint changed very little over this period[6]. Post-drought recovery in demand took about nine years for these homes, versus six years for the general residential population, although 95 percent of pre-drought demand was recovered in 5 years, and 85 percent of demand was recovered in three years (Fig. 3b). Interestingly, after reaching pre-drought levels, demand in these homes then continued to rise a little, peaking in 2007 (an exceptionally dry year) at 12,645 AF.

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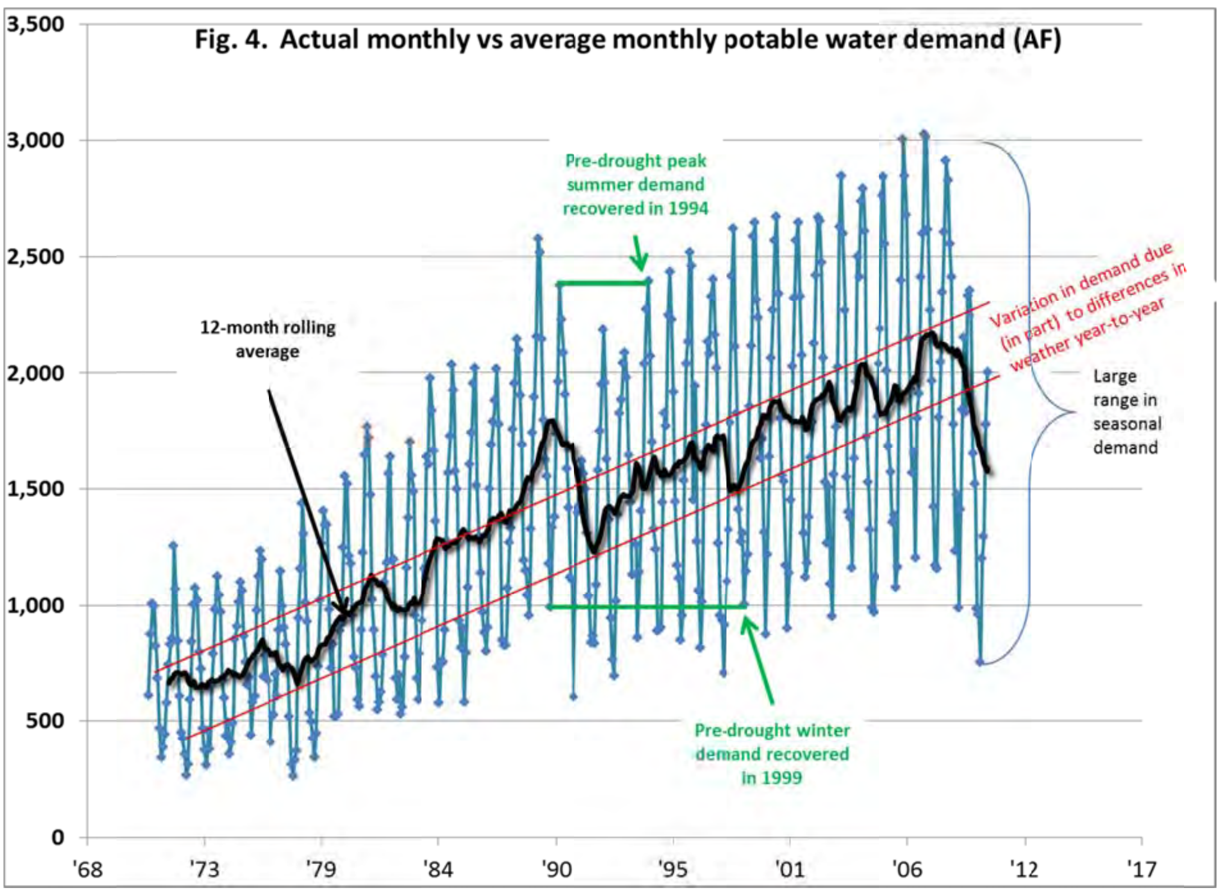
[5] There may be an easier way to identify incorrect lot size data entries for multifamily parcels than visual verification off the District GIS. The total number of accounts potentially affected can be estimated by sorting on lot size and noting all runs of identical lot sizes and install dates and adjacent addresses. This will be an overestimate of the actual number of data entry errors for lot size, because it is not impossible in tract homes for adjacent lots to have identical sizes and water meter install dates.

[6] While not performed for this analysis, this assumption could be tested in a subset of homes if IR aerial imagery is available for 1991 and can be compared with recent IR imagery on the District GIS for a subset of homes (5-10 percent of the total would probably be enough).

Weather

Water demand over any given year is strongly linked to weather in the LVMWD service area due to the prevalence of irrigated landscape coupled with large seasonal swings in rain and temperature and (Fig. 4). What this means for post-drought demand recovery is that peak summertime demands are expected to return to their pre-drought levels faster than off peak winter demand. This was the case following the 1991-2 drought, when post-drought peak demand returned to its pre-drought, July 1990 level in two years, versus 7 years for winter demand to return to its pre-drought level. Year to year variation in weather also affects annual demand, but on a monthly basis year to year differences (e.g. June 2011 versus June 2012) due to weather are on the order of 150-350 AF (bracketed by the red lines in Fig. 4), yielding annual differences in demand due to weather on the order of 1,800 – 3,600 AF, which falls to about 1,700 AF on a billing cycle basis[7]. Drop in demand due to wet weather occurs in about one year in four (27%), but is less important over the multi-year timescale of the expected post-drought rise in demand, as consecutive wet years are uncommon. Conversely, unusually dry years (e.g. 2007) can increase demand with about the same frequency. In short, *normal* variation in weather may be expected to delay or advance the rise in post-drought demand by a year or two at most.



[7] see Fig. 5 and associated discussion on p. 6

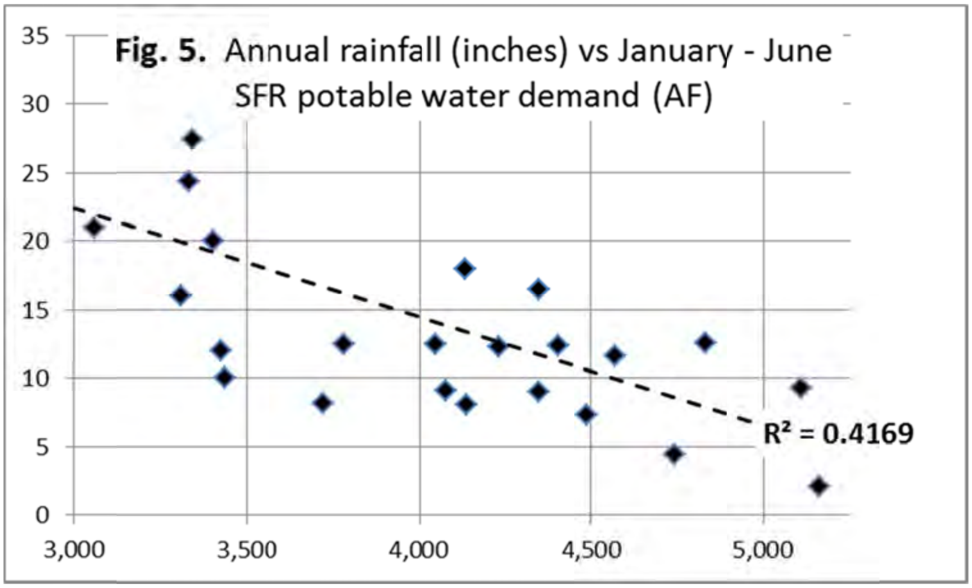
In predicating our estimates on the basis of normal variation in weather, one question is whether the weather in the period following the 1991-2 drought was normal in relation to the long term record, or if the rise in demand was associated with unusually *drier* weather? Inspection of rainfall records following the 1991-2 drought also show that the post-drought rise in demand was not associated with drier weather. On the contrary, this period was somewhat wetter than the 40-year long term average, and comparable to 2011, the first year following the end of the 2009-11 drought (Table 1).

Table 1. 1991-2 post drought period was significantly wetter than the long term mean.

Period	Annual rainfall
1991-2 drought	16.5"
1993-98 post drought recovery	**19.3"**
2009-11 drought	15.0"
2011 (post-drought)	20.0"
Long term average (1971-2011)	**15.2"**

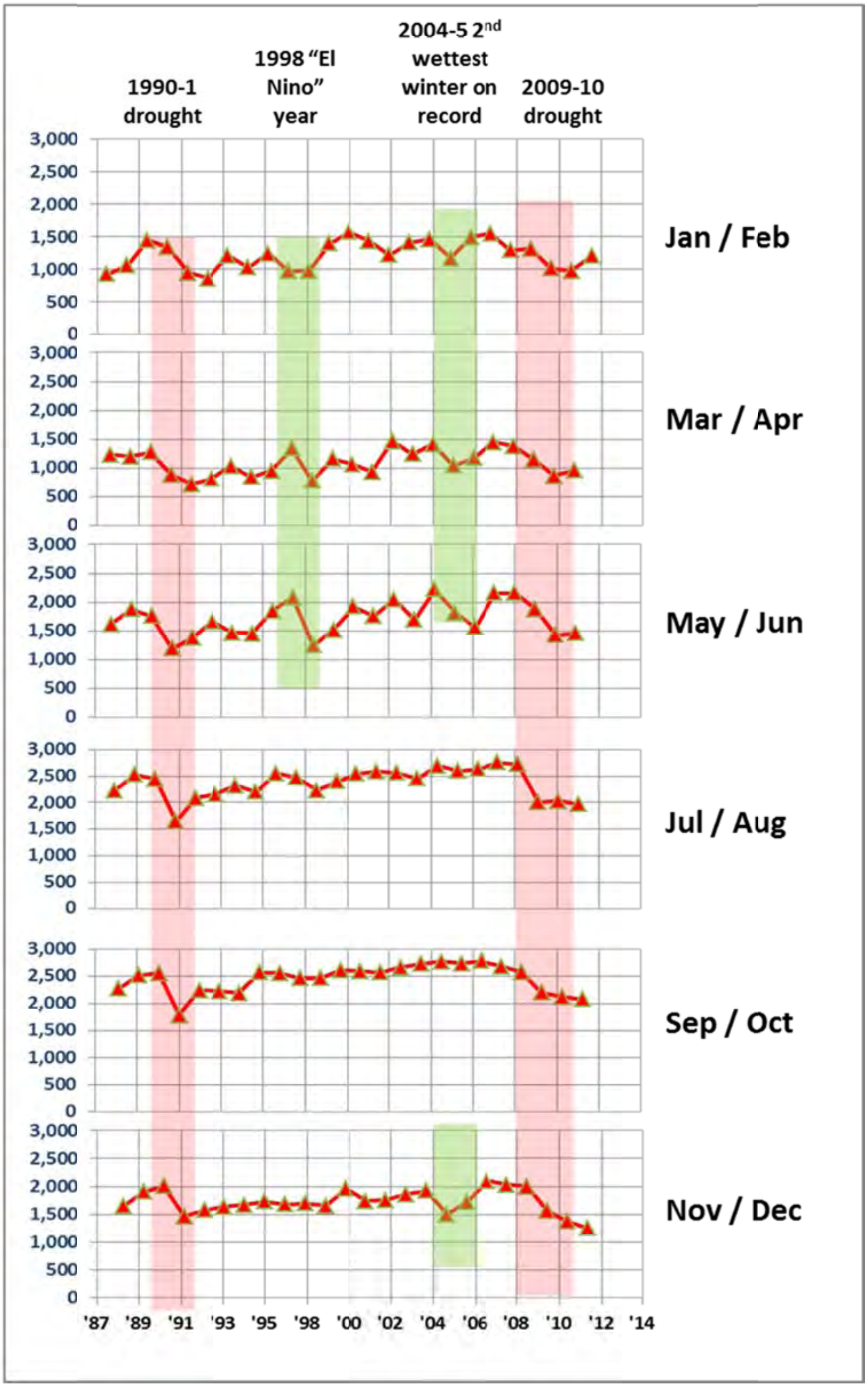
A series of wet years[8] would obviously depress the rise in demand already occurring following the end of the 2009-11 drought, but the frequency of consecutive wet years based on the long term record is low, about once every twenty years. *Nonetheless, even a single winter, if sufficiently wet, can reduce demand in winter months as much as an emergency drought response.* This occurred during the 1998 "El Nino" event and again in the winter of 2004-05, the 2nd wettest winter on record (Fig. 6). Figure 6 also shows that summertime demand over billing cycle timesteps are remarkably independent of year to year differences in weather, but decreased in response to emergency drought demand reduction efforts. Overall, changes in demand due to year to year differences in weather have not affected the overall trend in demand since the end of the 1990-1 drought, merely the variance in demand around the trendline (Fig. 4). Some idea of the magnitude of rainfall's effect on demand can be determined from Fig. 5, where Jan-June demand falls about 1,700 AF over the range of observed rainfall (2.1 – 27.4") . Note the spread in the data, however reflected in the relatively modest correlation coefficient (R^2 = 0.42).

Fig. 5. Annual rainfall (inches) vs January - June SFR potable water demand (AF)



[8] Where a wet year is defined as year where the amount of rain received is greater than one standard deviation from the long term mean

Fig. 6. Potable water deliveries to Single Family Residences (SFR) by billing period. Reduction in SFR demand due to unusually wet weather is comparable to drought response.



Differences in water conserving fixture installation rates (demand hardening)

In addition to weather and lot sizes, per capita demand depends in part on the intensity of conservation effort in homes. Behavioral conservation practices are notoriously difficult to quantify, but we have data on water conserving plumbing fixture installation rates over the entire period of record (1990 – 2011). We have also data on home build dates, which is important as building standards have become more stringent over time with respect to plumbing fixtures. However, for the purposes of demand forecasting, what matters most is *new* conservation, as residential demand up to the 2009-11 drought already includes all previous conservation measures. Table 2 compiles conservation fixture data since 2008, and suggests that new water conserving fixtures installed during the recent drought will likely reduce overall residential demand by about 600 AF over the recovery period, or about 2.3 percent of peak demand in 2007 and 2.5 percent of annual residential demand in 2008, the year before mandatory conservation rates took effect in the 2009-11 drought.

Table 2. Water conserving fixture installations 2008 to current	**INDOOR**		**OUTDOOR**			**TOTAL**
	HECW	HET	Rotating Nozzle	Synthetic Turf	WBIC	
No. installed	956	99	26	6	17	1,104
AF / YR SAVED	29.8	6.5	6.5	1.3	1.9	46.0
AF (lifetime of device)	419.0	131.1	27.3	12.3	18.0	607.8
AF/YR saved per installation	0.03	0.07	0.25	0.22	0.11	
AF/LIFETIME/DEVICE	0.44	1.32	1.05	2.05	1.06	

HECW: High Efficiency Clothes Washer. **HET**: High Efficiency Toilet. **WBIC**: Weather-Based Irrigation Controller

Economic factors.

We looked at two economic indicators (annual percent change in CPI relative to previous year for Los Angeles, Orange and Riverside Counties, and western Single Family Residential housing starts) to compare current economic conditions with those following the 1991-2 drought. The CPI for 2011 was 2.7% higher than 2010, nearly identical to the rise in the CPI of the first year of the 1991-92 post drought recovery (2.6%). The percent change in new home construction for 2011 vs 2010 as 2.8%, which also falls within the range seen in the period following the 1991-2 drought (Fig. 7).

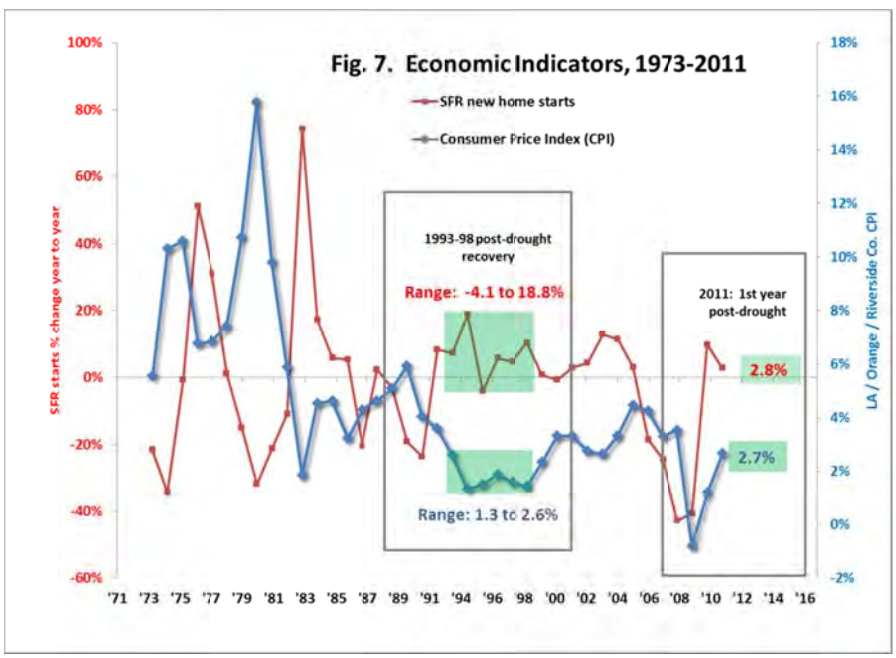


Fig. 7. Economic Indicators, 1973-2011

The inflation-adjusted cost of living, as measured by the annual rate of change in the CPI, was basically flat in the six years following the 1991-2 drought, having seen a steep decline in the preceding five years, whereas the current rate follows two years of steep increases and is already slightly higher than any year during the 1991-2 post-drought recovery. If the annual change in CPI continues to climb, it will exceed the rate of change observed during the previous post-drought recovery period (1993-97), and could in theory slow the rise in potable water demand observed since the end of the last drought. However, residential demand continued to rise when this occurred over the 1998-2005 period (compare Fig. 1 with Fig. 7 for this time period).

Economic factors – rates. While general economic indicators do not appear to be good predictors of potable water demand in the residential sector, steep declines in usage during both the 1990-1 and 2009-11 droughts demonstrate that residential demand is very sensitive to large changes in rates for delivered water. While the public outreach message associated with drought penalties for overuse are very different than general rate increases, the sensitivity of demand to the cost of water during droughts suggests that even general rate increases may reduce demand, depending on the magnitude of the increase. While not part of this study, it may be possible to quantify this effect or at least determine its potential magnitude by compiling water usage for a subset of long-term customers and looking for correlations between their usage and rate increases.

Post-drought recovery and the UWMP. Finally, our longer estimates for post-drought demand recovery fall within a year or two of the 2020 deadline for urban water providers to demonstrate a 20 percent drop in demand under the Urban Water Management Planning Act (UWMP). This requirement should be considered in the District's financial and demand planning, particularly if future rate increases appear to delay demand recovery sufficiently to intersect with the demand target required by 2020 under the UWMP act.

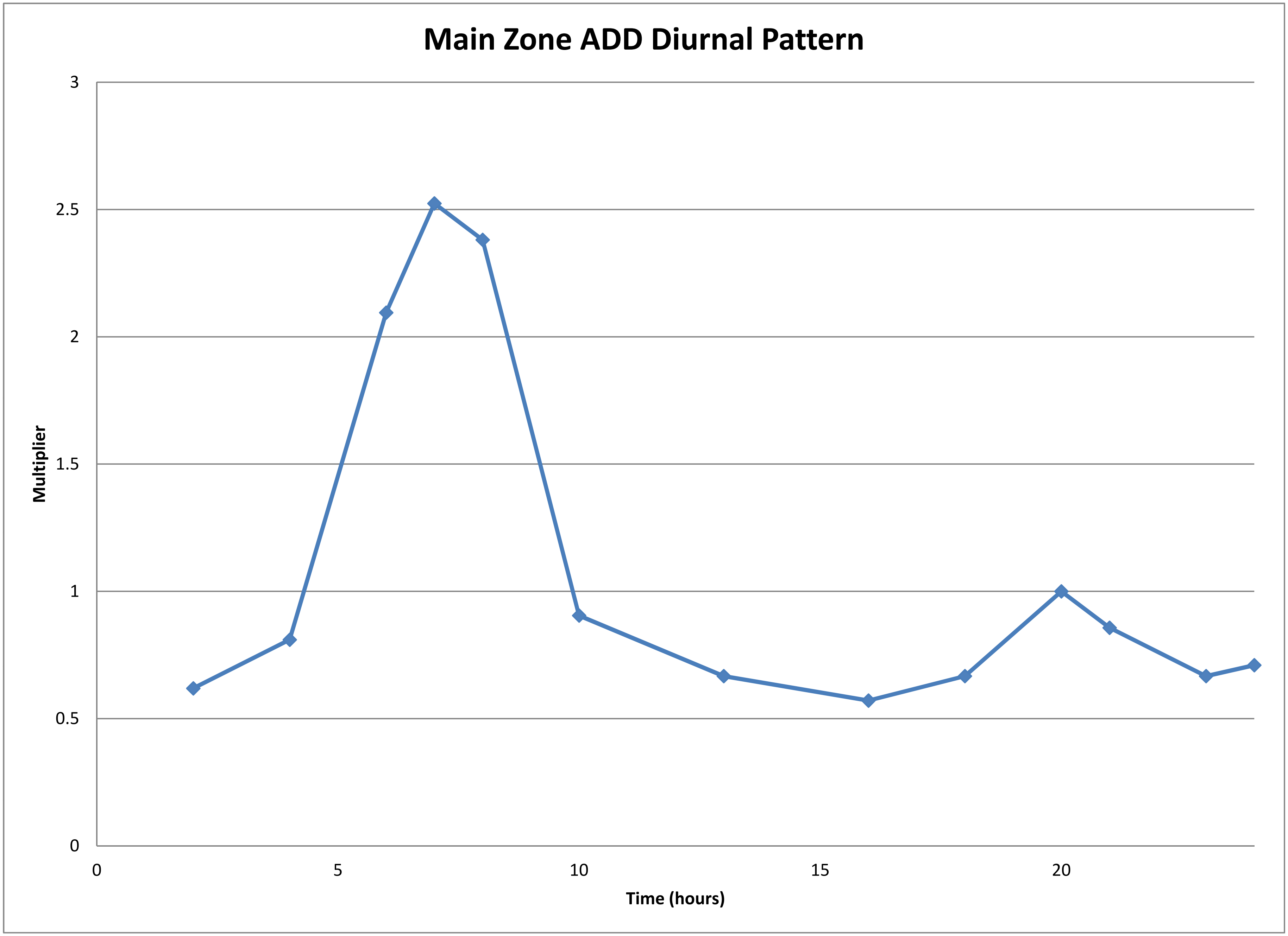
SUMMARY

Based on our experience in previous droughts (1990-1) and an analysis of the main factors that influence demand for potable water in the residential sector of our service area, we believe annual demand following the end of the recent drought will continue to rise, attaining its pre-drought level in six to seven years and 85 percent of that level in two years, depending primarily on the incidence of wet winters. Over shorter timescales, on a billing cycle and monthly usage basis, peak summertime residential demands will likely return to their pre-drought levels sooner although it is difficult to provide a more precise estimate than approximately 2-4 years.

Installation of water conserving plumbing and irrigation fixtures are estimated to reduce ultimate demand by about 2.5% of pre-drought demand. Higher than average increases in the cost of living (CPI) could also reduce the rate of recovery, although this did not occur when it happened before from 1998-2005.

Appendix B

Diurnal Patterns



Main Zone ADD Diurnal Pattern
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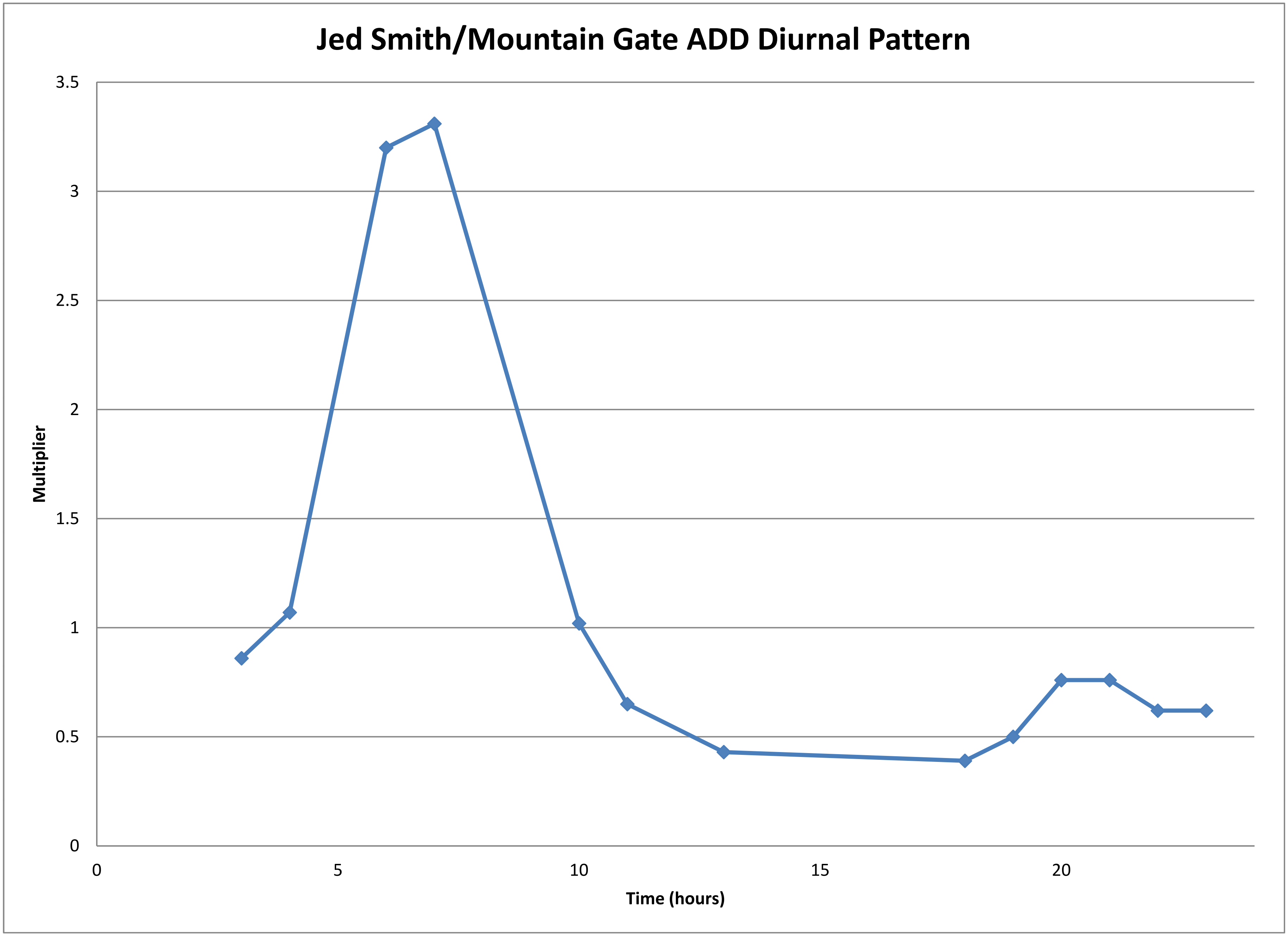
2
1.5
1
0.5
0
0
5
10
15
20


Jed Smith/Mountain Gate ADD Diurnal Pattern
Multiplier
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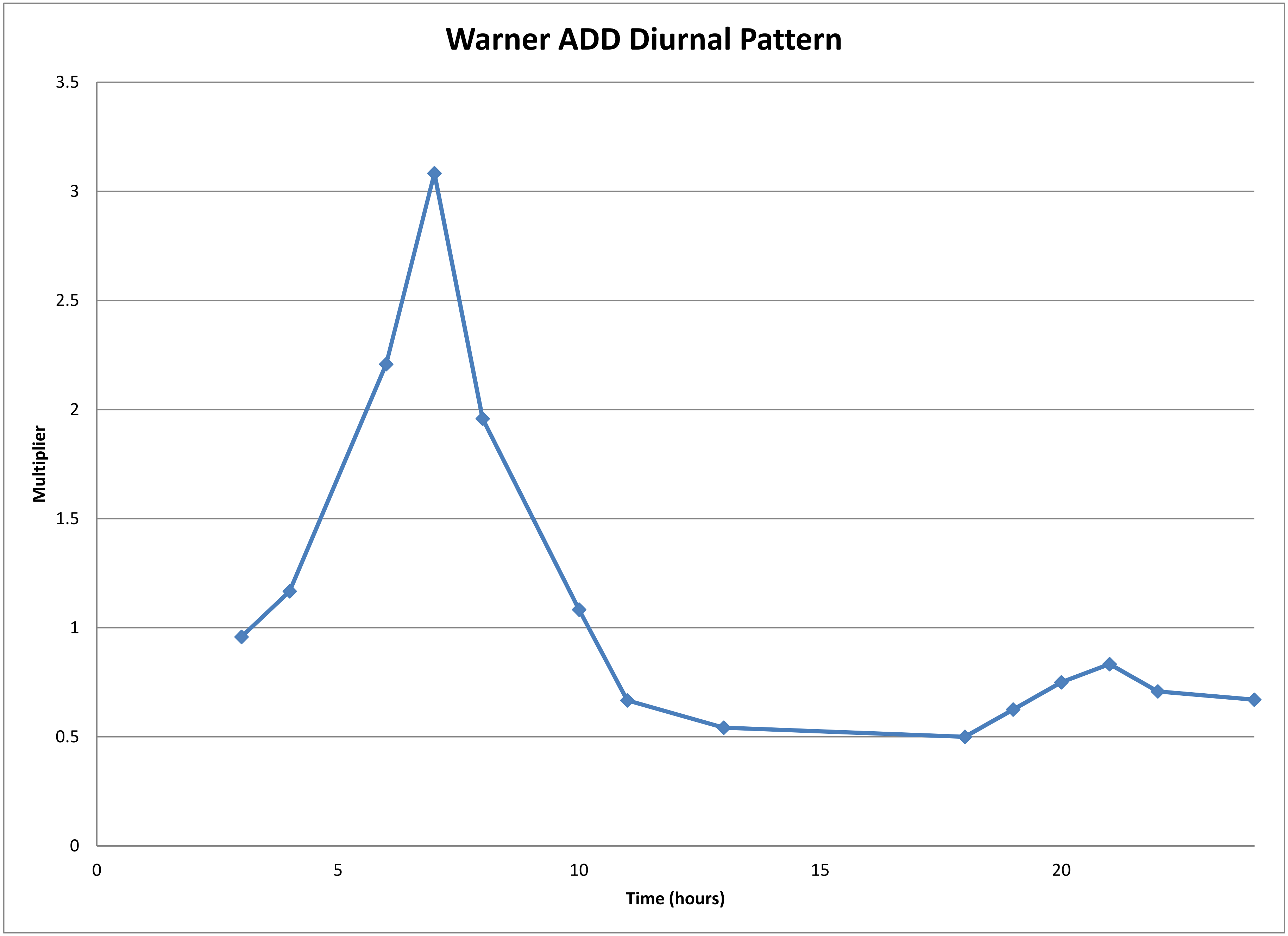
1.5
2
2.5
3
3.5
0
5
10
15
20
Time (hours)



Warner ADD Diurnal Pattern
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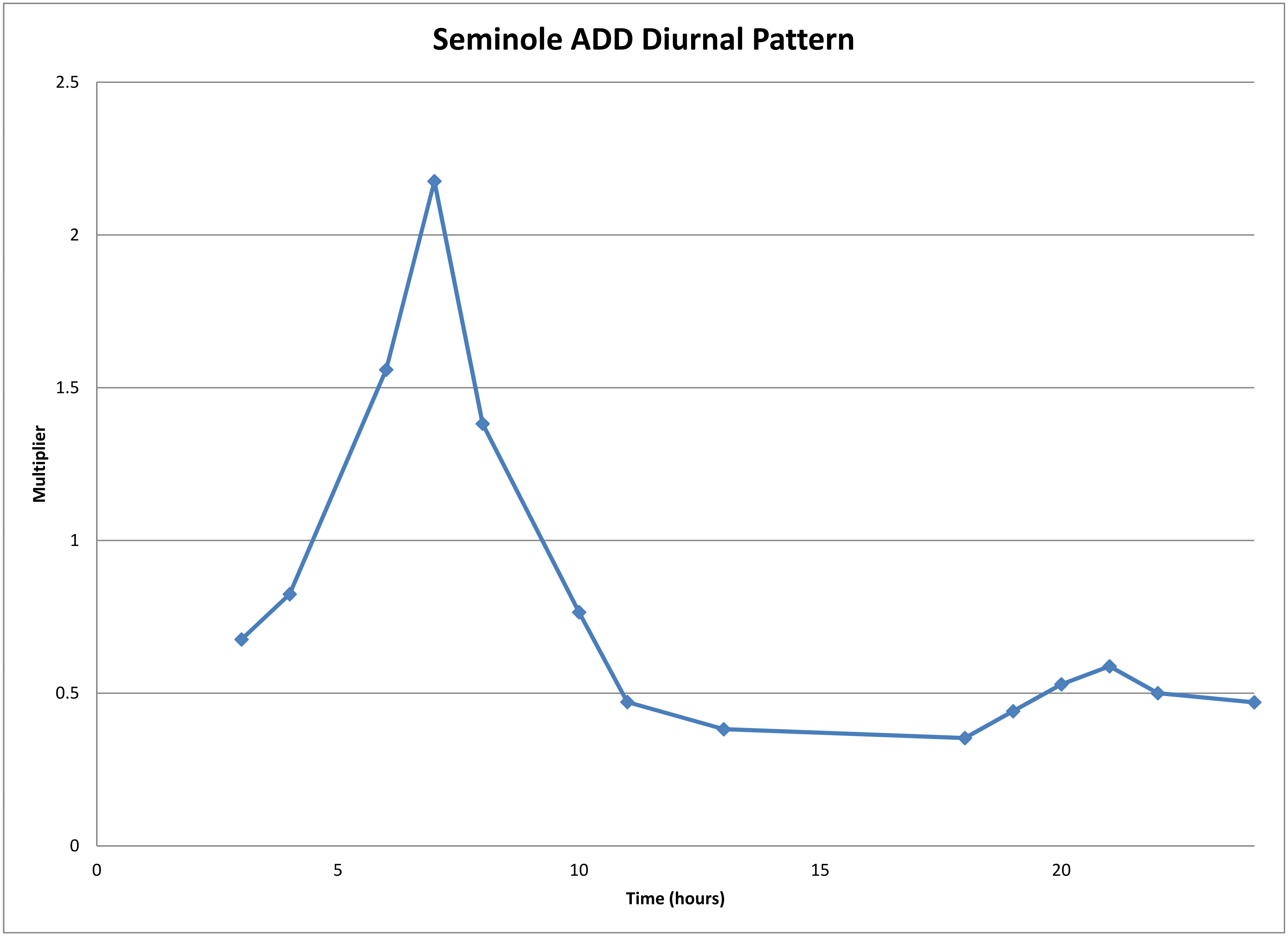
2
2.5
3
3.5
0
5
10
15
20


Seminole ADD Diurnal Pattern
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1.5
1
0.5
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Multiplier
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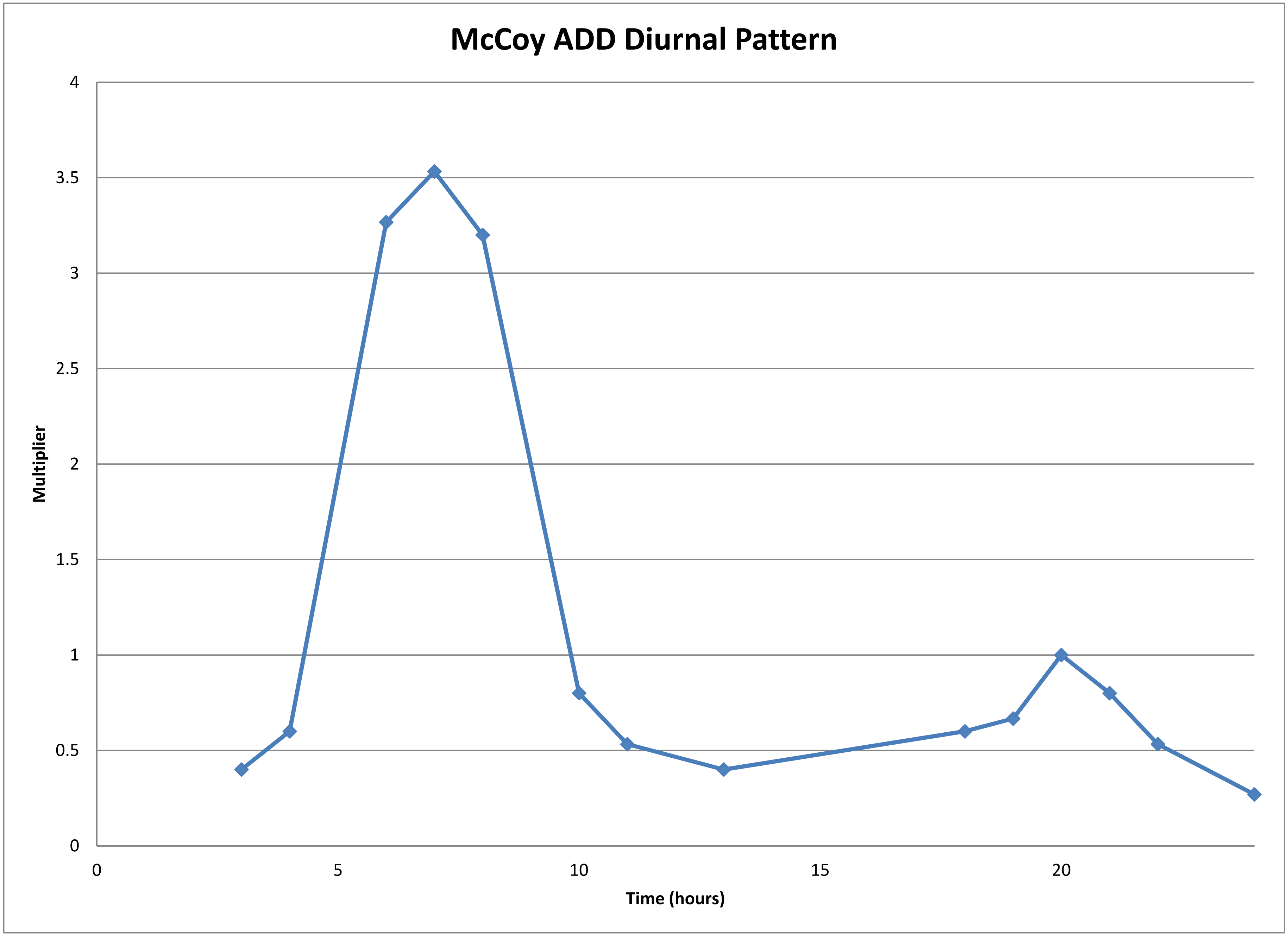
5
10
15
20
Time (hours)


McCoy ADD Diurnal Pattern
Multiplier
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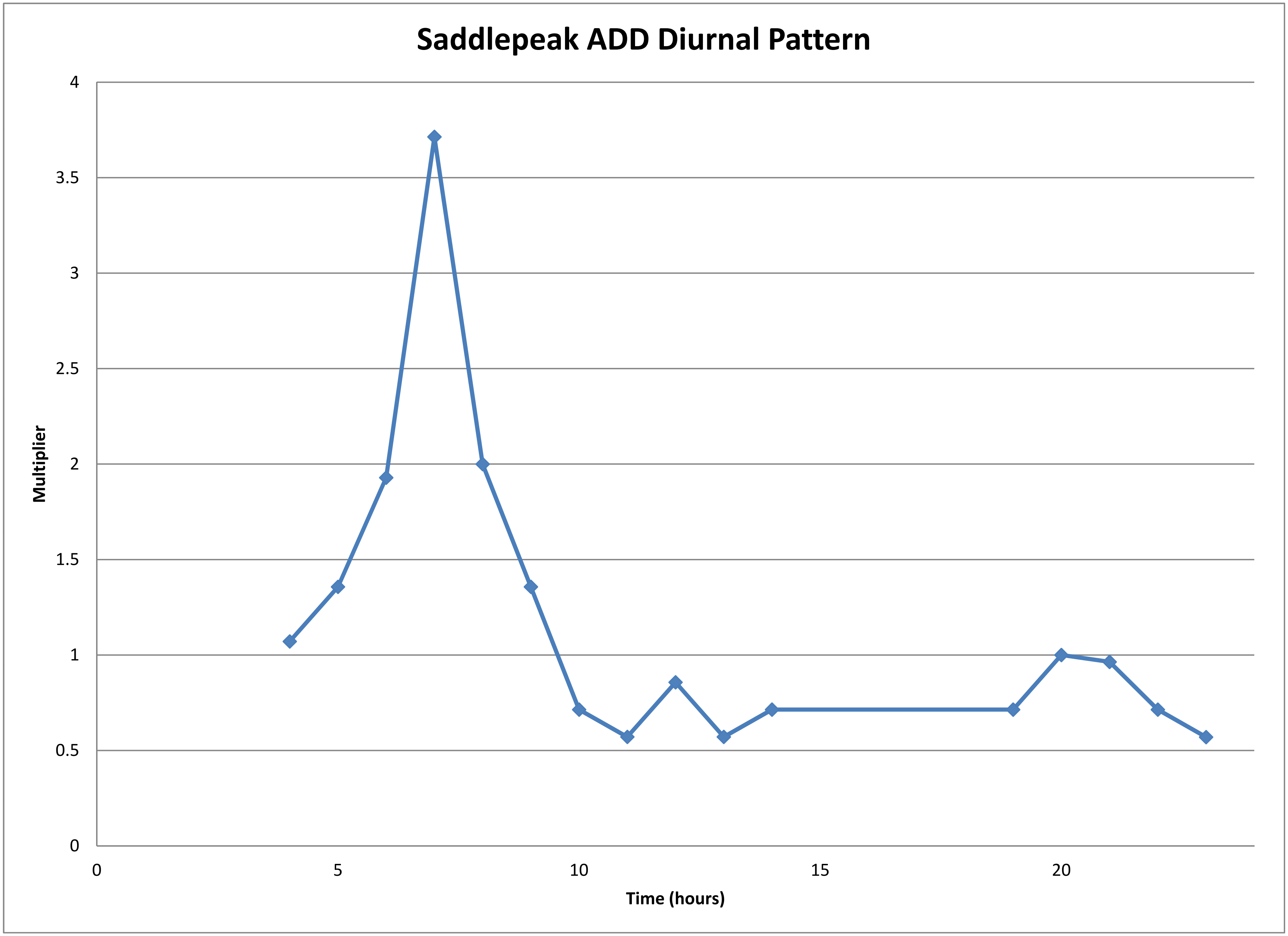
5
10
15
20


Saddlepeak ADD Diurnal Pattern
Multiplier
Time (hours)
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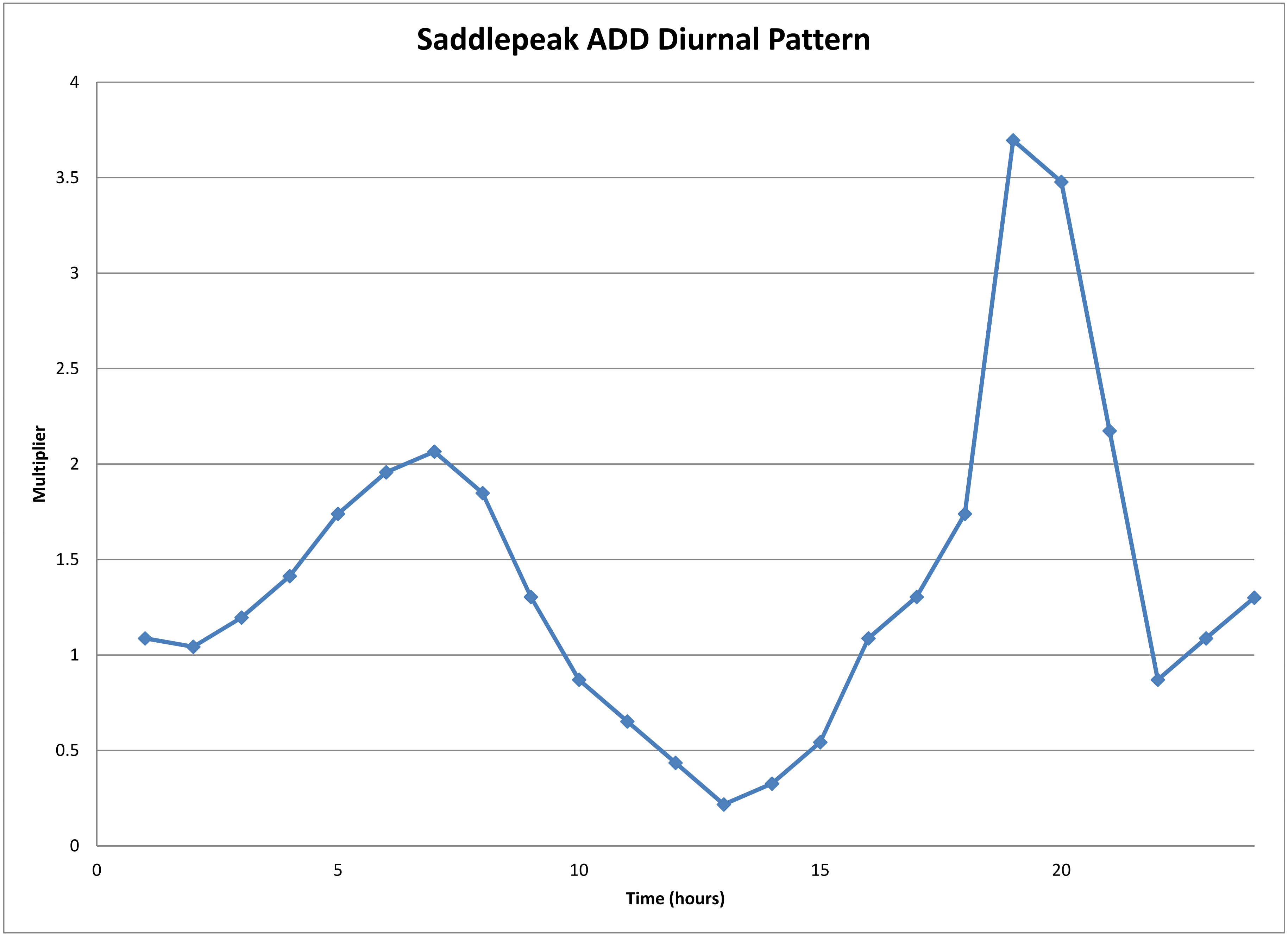
1.5
2
2.5
3
3.5
4
0
5
10
15
20


Saddlepeak ADD Diurnal Pattern
Multiplier
Time (hours)
0
0.5
1
1.5
2
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3
3.5
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5
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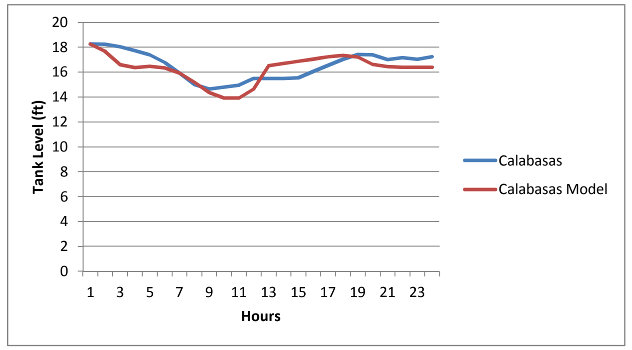
15
20

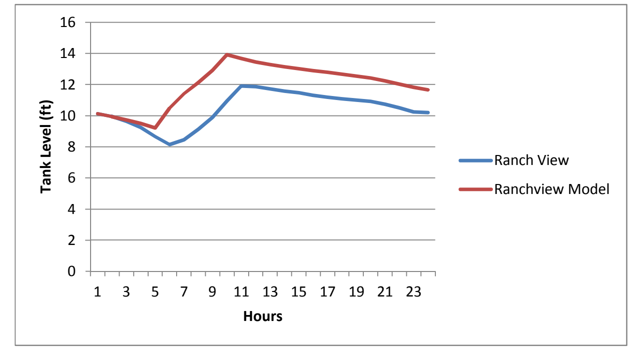
Appendix C

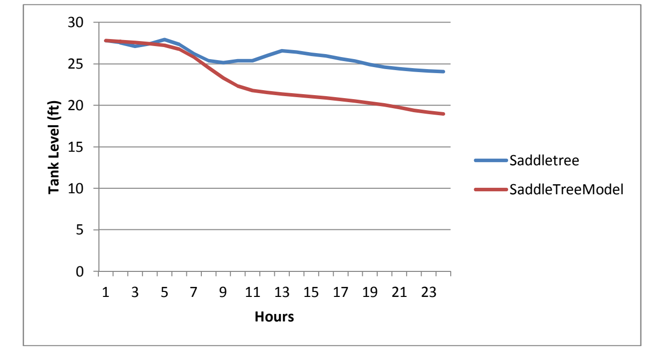
Model Verification - Tanks

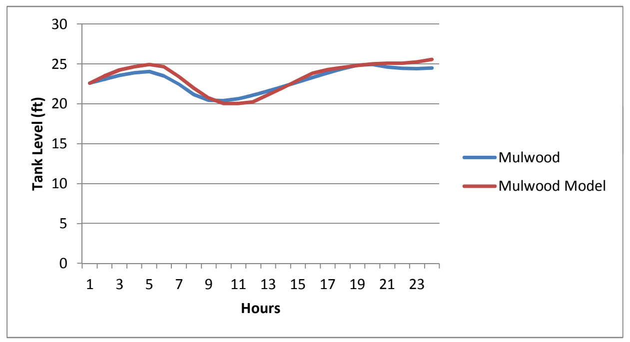
Model Verification - Tanks

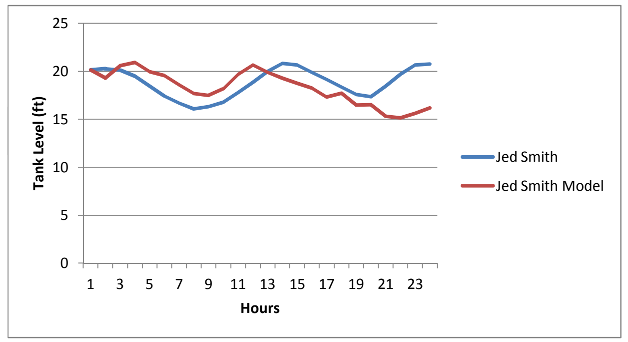
May 1, 2013 ADD Conditions

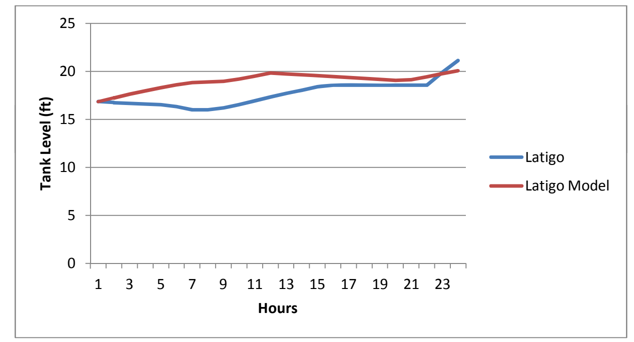


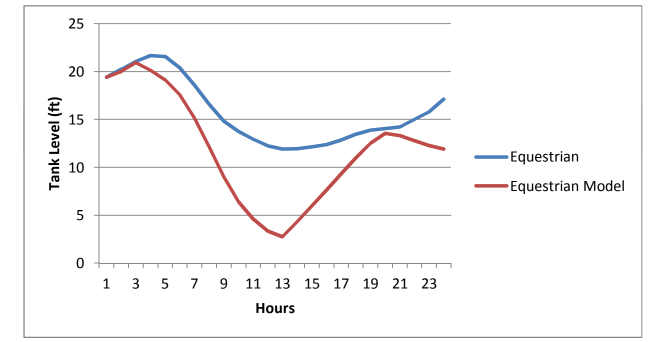


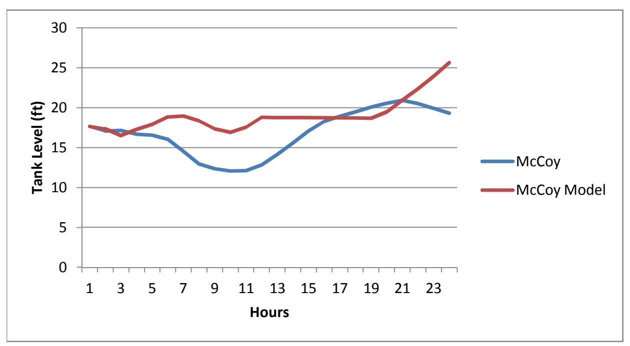


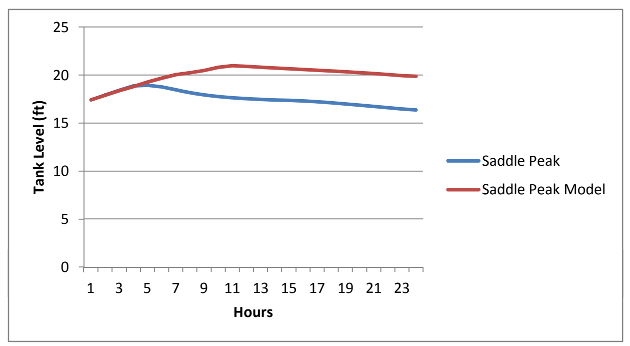


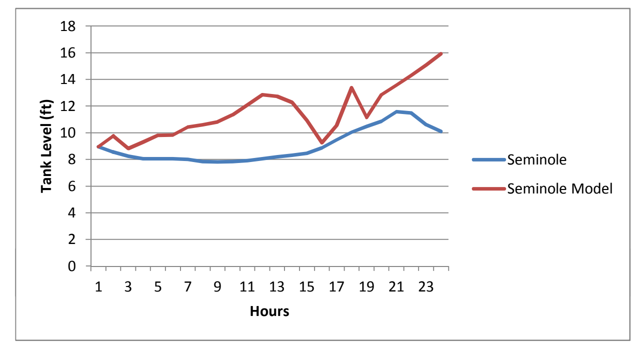


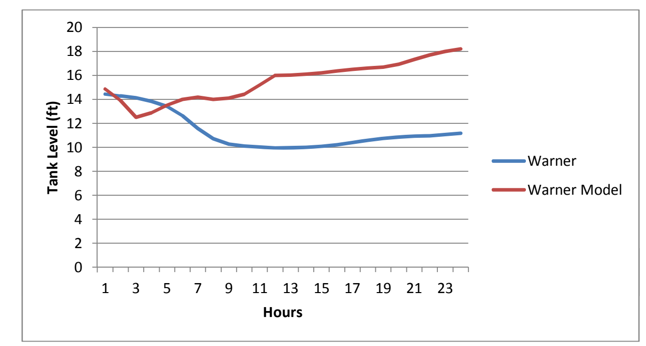


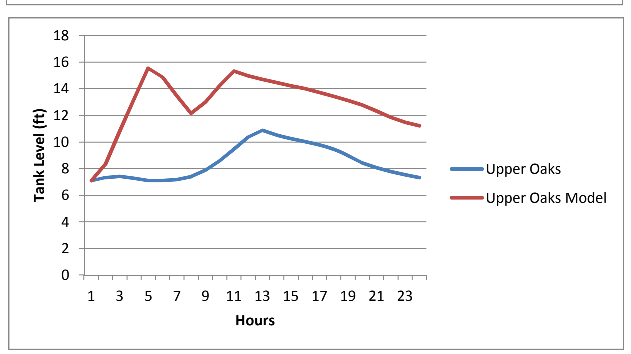


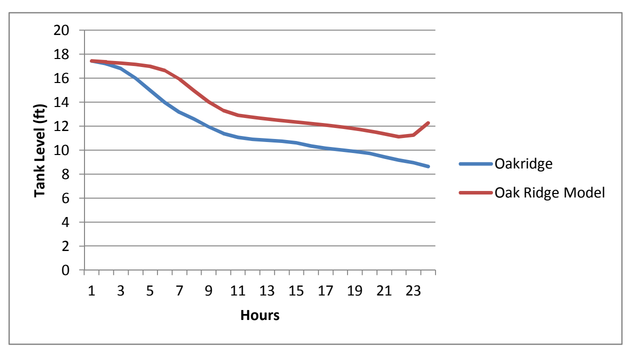


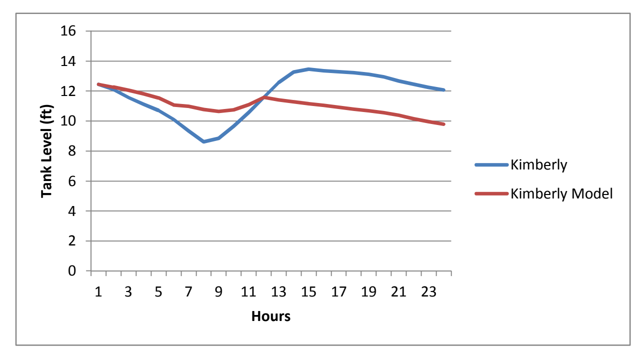


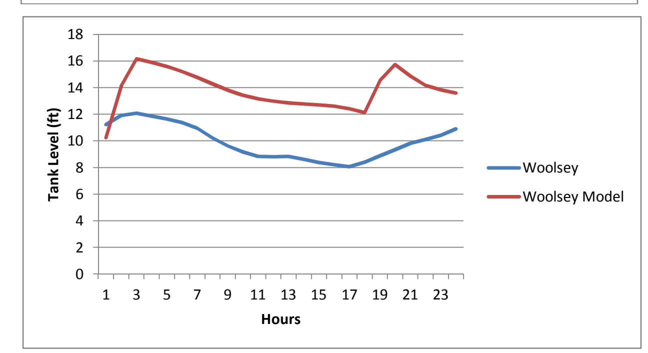


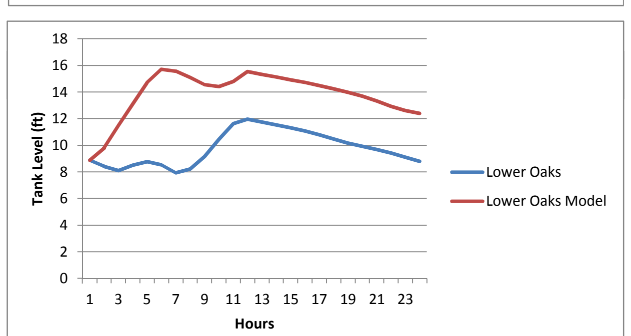


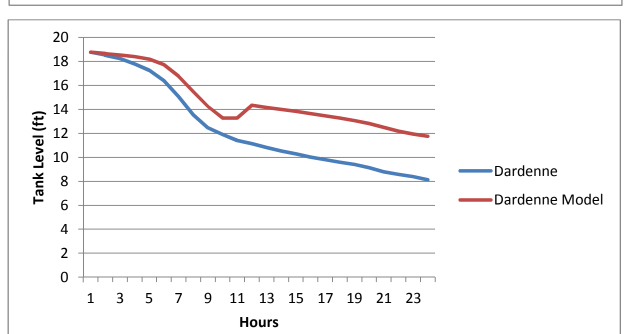


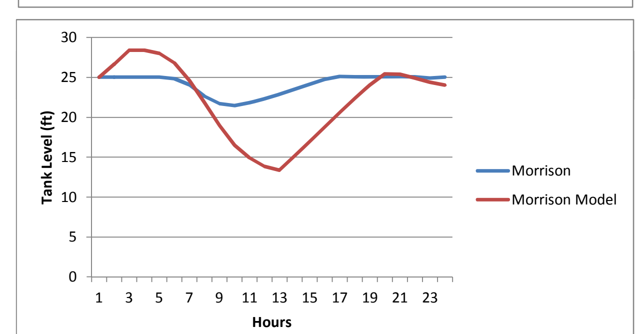






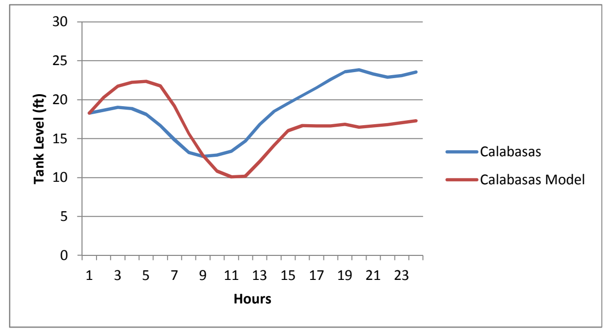


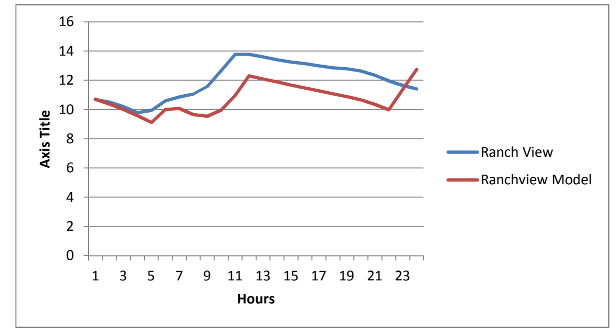


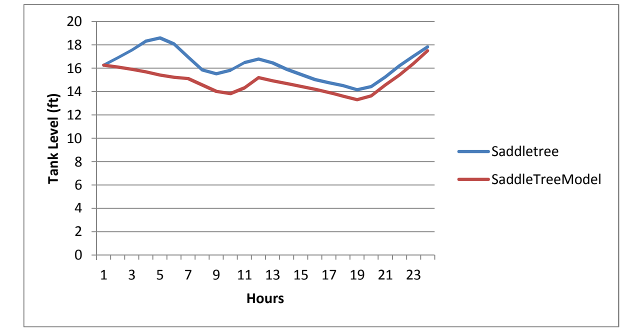


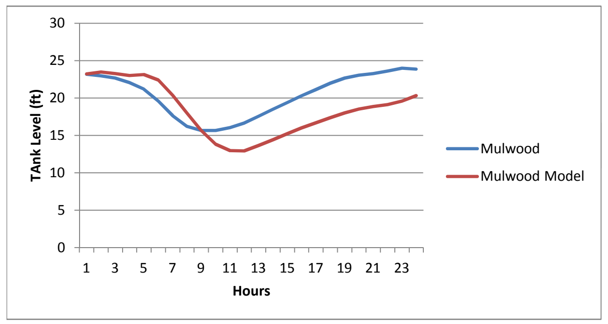
Model Verification - Tanks

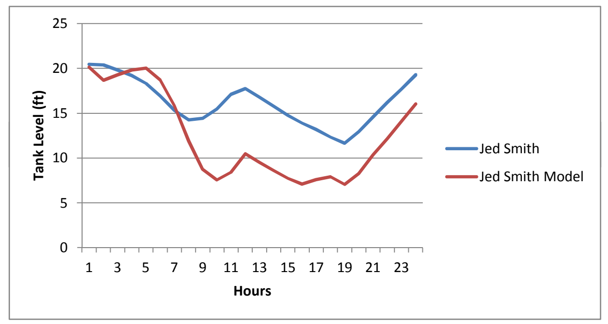
July 17, 2013 MDD Conditions

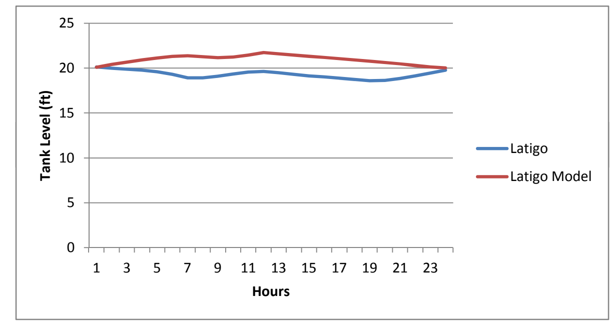


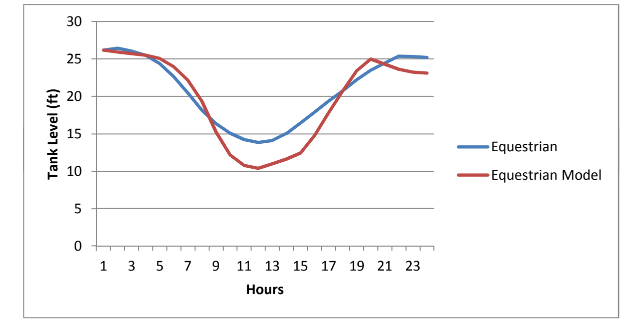


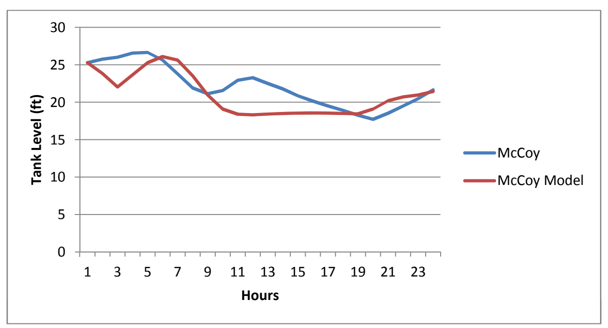


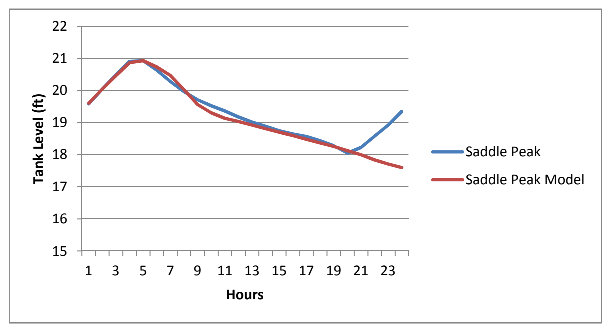


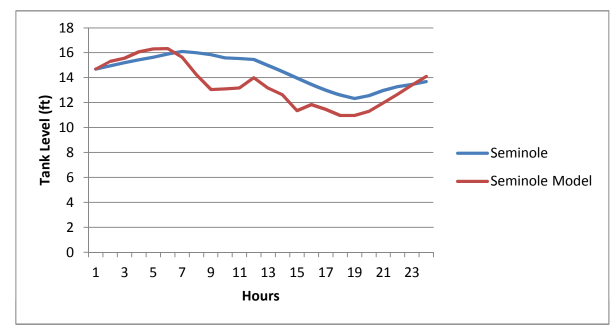


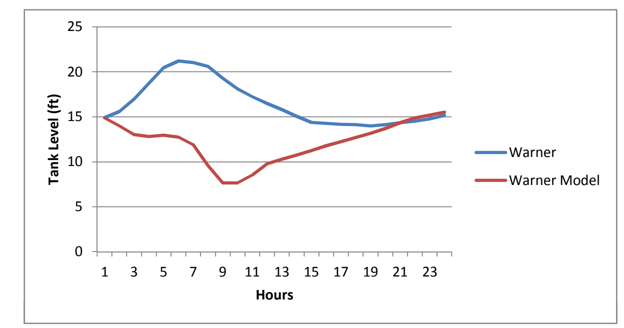


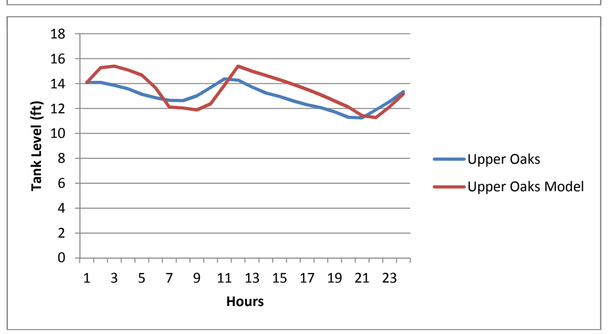


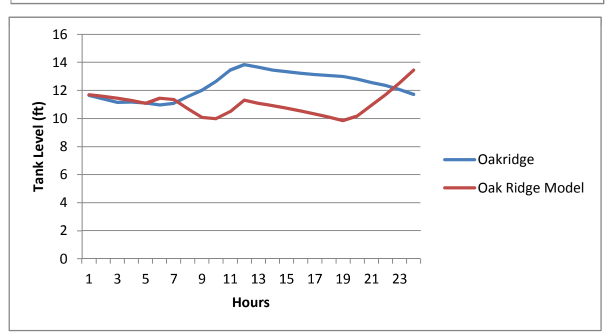


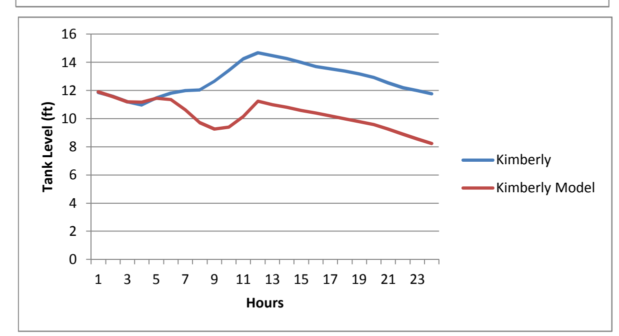


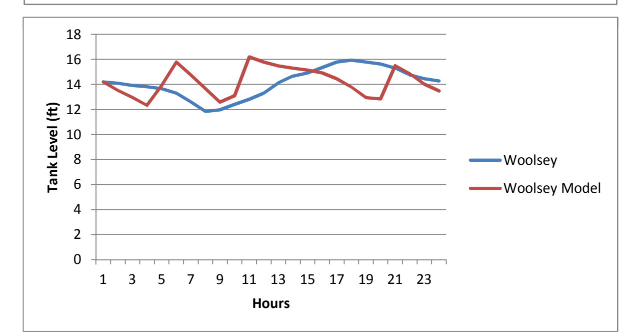


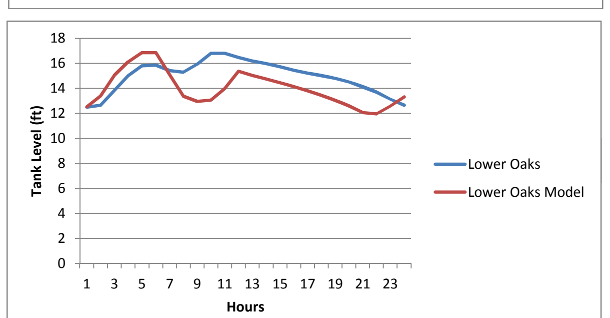


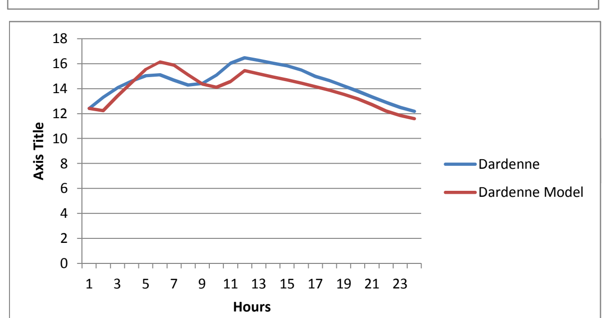


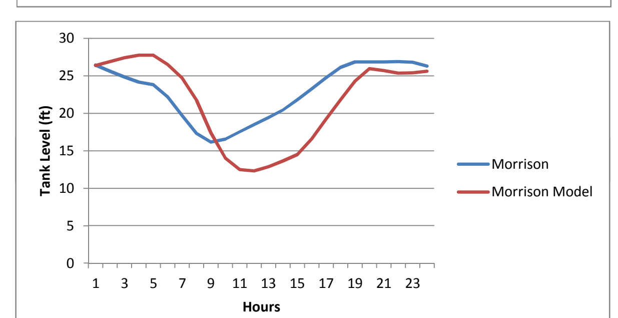






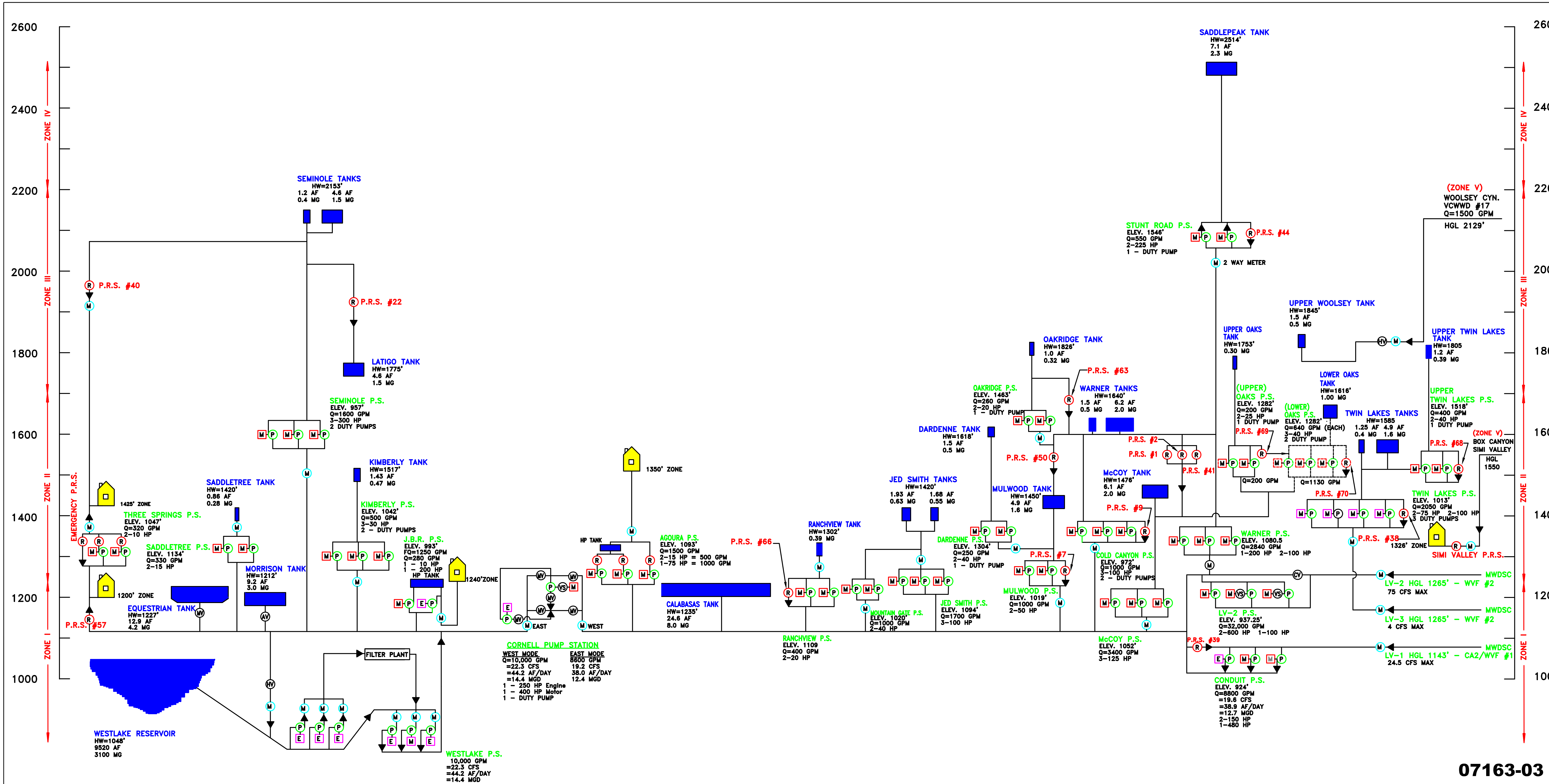






Appendix D

Hydraulic Gradient Diagram



07163-03

LEGEND

P E	ENGINE DRIVE PUMP
P M	ELECTRIC MOTOR DRIVE PUMP
M	METER
MV	MOTOR CONTROLLED VALVE
VS	VARIABLE SPEED DRIVE
R	PRESSURE REGULATOR
	ZONES WITHOUT TANKS
CV	CHECK VALVE
HP	HYDRO-PNEUMATIC
HV	HYDRAULIC CONTROL VALVE
Q	DESIGN FLOW OF DUTY PUMPS
FQ	DESIGN FLOW OF FIRE SERVICE PUMP
AV	ALTITUDE VALVE
-------	FUTURE FACILITIES

SCALE

VERTICAL GRADIENT SCALE
1 UNIT = 100'

2 200'
1 100'
0 0'

HORIZONTAL TANK VOLUME SCALE
1 UNIT = 3 MG

0 1
0 1 2 3
MG MG MG MG

REV. NO.	DATE	DESCRIPTION	APPVD.	DATE
6	4-04-07	MISC. CORRECTIONS	m.d.b.	4-04-07
5	7-14-05	MISC. CORRECTIONS	D.R.L.	7-25-05
4	10-18-04	MISC. CORRECTIONS		11-17-04
3	5-24-02	MISC. CORRECTIONS	J.E.C.	5-24-02
2	3-1-95	MISC. CORRECTIONS	G.M.B.	3-1-95
1	5-12-92	ADDED ZONE LIMITS. MISC. CORRECTIONS	J.E.C.	5-12-92

REVISIONS

LAS VIRGENES MUNICIPAL WATER DISTRICT

POTABLE WATER GRADIENT DIAGRAM

(PUMPING-STORAGE FACILITIES)

PREPARED BY:
LVMWD ENGINEERING
4232 LAS VIRGENES ROAD
CALABASAS, CA 91302
DATE: JULY 9, 1991

APPROVED FOR LAS VIRGENES MUNICIPAL WATER DISTRICT
BY: James E. Colbaugh
DIRECTOR OF PLANNING & ENGINEERING
DATE: JULY 30, 1991 R.C.E. 22931

SCALE:	DATE:	TRACT:	SHEET
SEE BAR SCALE AT LEFT	JULY 30, 1991	N/A	1 OF 1

Appendix E

Potable Water Tanks Operating Data

LVMWD
Potable Water Tanks
Maximum High Water Level (HWL)

Tank Name	Location	NHW Level ft.	Diameter ft.	Volume gal.	Nominal Capacity MG	Normal NHW HGL	I/O Pipe in.
Calabasas	Shumacher Rd., Calabasas	31.0	210.0	8,027,338	8.00	1235	30/24
Dardenne	Dardenne St., Calabasas	22.0	62.0	496,566	0.50	1618	8
Equestrian Trails *	31425 Glenbridge Rd., Wstlake.	33.8	*	4,200,000	4.20	1227	24
Jed Smith No. 1	Colette Way, Calabasas	22.0	70.0	632,980	0.60	1420	12
Jed Smith No. 2	Colette Way, Calabasas	22.0	65.0	545,784	0.60	1420	12
Kimberly	Kimberly Dr., Agoura	22.0	60.0	465,047	0.50	1517	8
Latigo	3802 Latigo Cyn., Malibu	30.5	92.0	1,515,817	1.50	1775	12
Lower Oaks	25591 Prado De Amarillo, Calabasas	24.3	88.0	1,104,951	1.00	1616	12
McCoy	Cordova Dr., Calabasas	30.0	106.0	1,979,266	2.00	1476	16
Morrison	5884 Ridgebrook Dr., Agoura	30.0	130.0	2,977,003	3.00	1212	16
Mulwood	Adamsville Ave., Calabasas	30.0	95.0	1,589,790	1.60	1450	14
Oak Ridge	Mountain Park Dr., Calabasas	22.0	50.0	322,949	0.30	1826	12
Ranch View	26757 1/2 Provence Drive	20.0	58.0	395,055	0.39	1302	8
Saddle Peak	Mildas Dr., Calabasas	30.7	113.0	2,301,794	2.30	2513	14
Saddletree	Glenbridge Rd., Westlake	30.0	40.0	281,846	0.30	1420	10
Seminole No. 1	32355 Mulholland Hwy., Agoura	22.0	52.5	356,051	0.40	2153	12
Seminole No. 2	32355 Mulholland Hwy., Agoura	22.0	110.0	1,563,073	1.60	2153	12
Twin Lakes No. 1	Iverson Rd., Chatsworth	24.0	52.5	388,420	0.40	1585	12
Twin Lakes No. 2	Iverson Rd., Chatsworth	30.0	95.0	1,589,790	1.60	1585	12
Upper Oaks	Prado Del Grandioso, Calabasas	17.0	55.0	301,957	0.26	1753	12
Upper Twin Lakes	Peak Road, Chatsworth	18.0	62.0	406,282	0.39	1805	8
Upper Woolsey ***	Woolsey Cyn. Rd., Ventura Co.	19.0	55.0	337,482	0.50	1845	8
Warner No. 1 ***	Pk. Belmont, Calabasas	27.0	52.5	436,972	0.50	1640	16
Warner No. 2 ***	Pk. Belmont, Calabasas	27.0	105.0	1,747,888	2.00	1640	16
Westlake Reservoir **	Torchwood Pl., Westlake		**		3100.00	1048	
Total				33,964,101	3134.44		

NHW, Normal High Water, level is 4 inches below overflow

* Equestrian Trails tank is a concrete tank, shaped essentially as a rectangular solid and a trapezoid solid bottom.

** Westlake reservoir is a large freshwater reservoir with irregular depths and boundaries.

*** Reduced tank level based on seismic conditions

F:\LVMWD\23016.00 - Potable Recycled Water MP Update\0001\Documents\Reports\LVMWD HWL.xls

Appendix F

Potable Water Stations Operating Data

SCADA Information
Potable Pump Stations
Operating Data Capacity

Pump Station	Location	From Zone	To Zone	# of Pumps	# of duty Pumps	Total Flow gpm/cfs	# of pumps with gen
Agoura	5753 Fairview Drive, Agoura Hills	1235	1350	3	3	1500	**2-15hp-???**
Cold Canyon	1830 Cold Canyon Road, Calabasas	1235	1640	3	2	1000	1
Conduit LV-1	6651 Valley Circle, West Hills	1143 mwd	1235	3	2	24cfs	1 natural gas
Cornell	28915 Agoura Road, Agoura Hills	1235	booster	2	1	22-25cfs W/19-22cfs E	1 natural gas
Dardenne	22316 Dardenne Street, Calabasas	1450	1618	2	1	250	1
JBR	28703 Timberlane Street, Agoura Hills	1227	booster	2	1	1250	1 natural gas
Jed Smith	* Round Meadow/Jed Smith, Hidden Hills.	1235	1420	3	3	1700	1
Kimberly	29614 Kimberly Drive, Agoura Hills	1227	1517	3	2	500	1
Lower Oaks	* Prado De La Flores, Calabasas	1475	1616	3	2	1130	1
LV-2 Calabasas	23589 Calabasas Road, Calabasas	1265 mwd	1235	3	3	8-75 cfs	**1-???**
McCoy	24282 Parkway Calabasas	1235	1475	3	3	3400	1
Mountain Gate	5175 N. Mountain Gate Drive, Calabasas	1235	1420	2	2	1000	1
Mulwood	3980 Old Topanga, Calabasas	1235	1450	2	2	1000	1
Oak Ridge	3444 N. Oakridge Terrace, Calabasas	1640	1826	2	1	260	1
Ranch View	26757 1/2 Provence Drive, Calabasas	1235	1302	2	2	400	1
Saddletree	31606 Saddletree, Westlake Village	1227	1420	2	2	330	1
Seminole	30619 Mulholland, Agoura	1227	2153	3	2	1600	1
Stunt Road	1129 Stunt Road, Calabasas	1640	2513	2	1	550	1
Three Springs	2000 Kirsten Lee Drive, Westlake Village	1200	1425	2	2	320	1
Twin Lakes LV-3	* End of Devonshire, Chatsworth	1265 mwd	1585	4	3	1800	**1-???**
Upper Oaks	* Prado De La Flores, Calabasas	1475	1753	2	1	200	**1-???**
Upper Twin Lakes	* Taima Ave., Chatsworth	1585	1805	2	1	400	1
Warner	2442 Calabasas Road, Calabasas	1235	1640	3	3	2840	**1-???**
Westlake	2860 Three Springs Drive, Westlake Village	1048	1227	3	3	10,000	**???**

* Address not available.
<u># of duty pumps</u> is number of pumps that can run at one time (per design of station).
<u># of pumps with gen</u> refers to number of pumps that can run on generator power.

F:\LVMWD\23016.00 - Potable Recycled Water MP Update\0001\Documents\Reports\SCADA info.xls

Appendix G

MWDSC 2007 Outage Data

LVMWD MONTHLY WATER SYSTEM SUMMARY REPORT

POTABLE WATER

MONTH/YEAR: Jan-07

DAY	REVISED LV-1 FLOW AF	LADWP KITTRIDGE INTERTIE AF*	LV-2 FLOW AF	WESTLAKE TO (-) AF	WESTLAKE FROM (+) AF	BACKBONE NET CHG IN TNK STRG AF	REVISED TOTAL BKBONE USG AF		LV-3 FLOW AF	NET CHG TNK STRG	TWIN LKS TOTAL USAGE AF	REVISED TOTAL POT USG AF
1	0.0		46.9	0.0	0.0	1.1	48.0		1.6	-0.2	1.4	49.4
2	0.0		53.1	0.0	0.0	-4.1	49.0		1.6	0.1	1.7	50.7
3	0.0		53.7	0.0	0.0	-0.6	53.1		1.9	0.3	2.2	55.3
4	0.0		50.5	0.0	0.0	-2.2	48.3		2.1	-0.3	1.8	50.1
5	0.0		44.6	0.0	0.0	4.5	49.1		2.0	-0.6	1.4	50.5
6	0.0		54.5	0.0	0.0	-2.9	51.6		1.6	0.5	2.1	53.7
7	0.0		50.3	0.0	0.0	1.0	51.3		0.7	0.9	1.6	53.0
8	0.0		61.9	0.0	0.0	-4.3	57.6		3.1	-1.5	1.6	59.2
9	0.0		63.0	0.0	0.0	-1.5	61.5		2.1	0.4	2.5	64.0
10	0.0		43.6	0.0	8.0	3.4	55.1		1.4	1.0	2.4	57.5
11	0.0		25.4	0.0	25.4	2.7	53.5		1.6	-0.1	1.5	54.9
12	0.0		16.1	0.0	30.1	-10.2	36.0		0.0	-2.0	-2.0	34.0
13	0.0		0.0	0.0	22.7	-0.4	22.3		0.0	0.0	0.0	22.3
14	0.0		0.0	0.0	21.5	11.3	32.8		1.3	0.5	1.8	34.6
15	0.0		0.0	0.0	35.5	-3.3	32.2		0.0	-0.5	-0.5	31.7
16	0.0		0.0	0.0	34.5	-2.0	32.5		0.0	-0.2	-0.2	32.3
17	0.0		0.0	0.0	31.9	-8.2	23.7		0.0	-0.3	-0.3	23.4
18	0.0		0.0	0.0	16.3	-0.8	15.5		0.0	-0.3	-0.3	15.2
19	0.0		0.0	0.0	20.9	0.8	21.7		0.0	0.7	0.7	22.5
20	0.0		0.0	0.0	21.9	-0.8	21.0		0.0	-0.2	-0.2	20.8
21	0.0		0.0	0.0	21.3	-1.8	19.5		0.0	-0.2	-0.2	19.3
22	0.0		0.0	0.0	22.3	6.6	28.8		0.0	-0.1	-0.1	28.8
23	0.0		0.0	0.0	29.7	-0.7	29.0		0.0	0.5	0.5	29.6
24	0.0		0.0	0.0	30.4	-0.4	29.9		0.0	-0.1	-0.1	29.8
25	0.0		4.4	0.0	31.1	-6.5	29.0		0.0	-0.4	-0.4	28.6
26	0.0		0.5	0.0	24.4	5.0	30.0		0.0	0.3	0.3	30.3
27	0.0		0.0	0.0	19.4	2.6	22.1		0.0	-0.3	-0.3	21.8
28	0.0		0.0	0.0	15.3	-2.7	12.6		0.0	0.0	0.0	12.6
29	0.0		22.7	0.0	9.5	4.2	36.4		0.2	0.4	0.6	37.0
30	0.0		42.6	17.7	0.0	5.3	30.2		0.0	1.3	1.3	31.6
31	0.0		48.7	26.5	0.0	4.0	26.2		0.0	1.8	1.8	28.0
TOTAL	0.0	0.0	682.5	44.2	472.1	-1.0	1109.3	0.0	21.2	1.6	22.8	1132.1
AVG	0.0	0.0	22.0	1.4	15.2	0.0	35.8	0.0	0.7	0.1	0.7	36.5

usage max day = 64.0

usage avg day = 52.9

BOX CYN	2.0	PW SUBTOTAL 1,145.0
WOOLSEY	10.9	
DWP KITTRIDGE	456.3	LADWP Total
DWP GERMAIN	37.6	
LESS TO R.W.	0.0	
TOTAL	1638.9	

NOTES:
MWD shutdown for two weeks, LV-1,LV-2,LV-3 off-line and inter-ties at Germain, Kittridge (DWP)and Long Valley(DWP) activated. Westlake Filter Plant put on-line operating between 5 and 12 MGD.

ENTER DAYS IN MONTH: 31

ENTER NAME:
BY: M.E/F.A

ENTER DATE: 07-Feb-07

2007 Dayflow Report

2007 Date	Lake Elevation	Change	Change Month	Change Plant Run	Total Flow MGD	Total Acre Feet	TAF Month	TAF Plant Run
01/01/07		0.00	0.00	0.00		0.00	0.00	0.00
01/02/07		0.00	0.00	0.00		0.00	0.00	0.00
01/03/07		0.00	0.00	0.00		0.00	0.00	0.00
01/04/07		0.00	0.00	0.00		0.00	0.00	0.00
01/05/07		0.00	0.00	0.00		0.00	0.00	0.00
01/06/07		0.00	0.00	0.00		0.00	0.00	0.00
01/07/07	1028.38	0.00	0.00	0.00		0.00	0.00	0.00
01/08/07	1028.35	-0.03	-0.03	-0.03		0.00	0.00	0.00
01/09/07	1028.35	0.00	-0.03	-0.03		0.00	0.00	0.00
01/10/07	1028.24	-0.11	-0.14	-0.14	2.6	8.04	8.04	8.04
01/11/07	1028.00	-0.24	-0.38	-0.38	8.3	25.35	33.39	33.39
01/12/07	1027.83	-0.17	-0.55	-0.55	9.8	30.11	63.50	63.50
01/13/07	1027.67	-0.16	-0.71	-0.71	7.4	22.68	86.17	86.17
01/14/07	1027.49	-0.18	-0.89	-0.89	7.0	21.55	107.72	107.72
/15/07	1027.20	-0.29	-1.18	-1.18	11.6	35.51	143.23	143.23
01/16/07	1026.90	-0.30	-1.48	-1.48	11.3	34.52	177.76	177.76
01/17/07	1026.81	-0.09	-1.57	-1.57	10.4	31.92	209.68	209.68
01/18/07	1026.67	-0.14	-1.71	-1.71	5.3	16.27	225.95	225.95
01/19/07	1026.50	-0.17	-1.88	-1.88	6.8	20.93	246.88	246.88
01/20/07	1026.32	-0.18	-2.06	-2.06	7.1	21.85	268.73	268.73
01/21/07	1026.15	-0.17	-2.23	-2.23	7.0	21.33	290.06	290.06
01/22/07	1025.91	-0.24	-2.47	-2.47	7.3	22.25	312.31	312.31
01/23/07	1025.71	-0.20	-2.67	-2.67	9.7	29.71	342.02	342.02
01/24/07	1025.46	-0.25	-2.92	-2.92	9.9	30.38	372.40	372.40
01/25/07	1025.26	-0.20	-3.12	-3.12	10.1	31.12	403.53	403.53
01/26/07	1025.04	-0.22	-3.34	-3.34	8.0	24.43	427.96	427.96
01/27/07	1025.02	-0.02	-3.36	-3.36	6.3	19.46	447.41	447.41
01/28/07	1024.91	-0.11	-3.47	-3.47	5.0	15.34	462.76	462.76
01/29/07	1024.89	-0.02	-3.49	-3.49	3.1	9.54	472.30	472.30
01/30/07	1025.08	0.19	-3.30	-3.30	0.0	0.00	472.30	472.30
01/31/07	1025.25	0.17	**-3.13**	-3.13	0.0	0.00	**472.30**	472.30
02/01/07		-1025.25	-1025.25	-1028.38		0.00	0.00	472.30
02/02/07		0.00	0.00	-1025.25		0.00	0.00	472.30

1/14/07 — 1/28/07

Appendix H

Los Angeles County Fire Department Regulation No. 8

I. INTRODUCTION

A. Purpose: To provide Department standards for fire flow, hydrant spacing and specifications.

B. Scope: Informational to the general public and instructional to all individuals, companies, or corporations involved in the subdivision of land, construction of buildings, or alterations and/or installation of fire protection water systems and hydrants.

C. Author: The Deputy Chief of the Prevention Services Bureau through the Assistant Fire Chief (Fire Marshal) of the Fire Prevention Division is responsible for the origin and maintenance of this regulation.

D. Definitions:

1. GPM – gallons per minute

2. psi – pounds per square inch

3. Detached condominiums – single detached dwelling units on land owned in common

4. Multiple family dwellings – three or more dwelling units attached

II. RESPONSIBILITY

A. Land Development Unit

1. The Department's Land Development Unit shall review all subdivisions of land and apply fire flow and hydrant spacing requirements in accordance with this regulation and the present zoning of the subdivision or allowed land use as approved by the County's Regional Planning Commission or city planning department.

B. Fire Prevention Engineering Section

1. The Department's Fire Prevention Engineering Section shall review building plans and apply fire flow and hydrant spacing requirements in accordance with this regulation.

III. POLICY

A. The procedures, standards, and policies contained herein are provided to ensure the adequacy of, and access to, fire protection water and shall be enforced by all Department personnel.

IV. PROCEDURES

A. Land development: fire flow, duration of flow, and hydrant spacing

The following requirements apply to land development issues such as: tract and parcel maps, conditional use permits, zone changes, lot line adjustments, planned unit developments, etc.

		Fire Flow	Duration of Flow	Public Hydrant Spacing
1.	Residential Fire Zones 3 Very High Fire Hazard Severity Zone (VHFHSZ)			
a.	Single family dwelling and detached condominiums (1 – 4 Units) (Under 5,000 square feet)	1,250 GPM	2 hrs.	600 ft.
b.	Detached condominium (5 or more units) (Under 5,000 square feet)	1,500 GPM	2 hrs.	300 ft.
c.	Two family dwellings (Duplexes)	1,500 GPM	2 hrs.	600 ft.

NOTE: FOR SINGLE FAMILY DWELLINGS OVER 5,000 SQUARE FEET. SEE, TABLE 1 FOR FIRE FLOW REQUIREMENTS PER BUILDING SIZE.

2. Multiple family dwellings, hotels, high rise, commercial, industrial, etc.

   a. Due to the undetermined building designs for new land development projects ***(undeveloped land),*** the required fire flow shall be: 5,000 GPM 5 hrs. 300 ft.

      NOTE: REDUCTION IN FIRE FLOW IN ACCORDANCE WITH TABLE 1.

   b. Land development projects consisting of lots having existing structures shall be in compliance with Table 1 (fire flow per building size). This standard applies to multiple family dwellings, hotels, high rise, commercial, industrial, etc.

      NOTE: FIRE FLOWS PRECEDING ARE MEASURED AT 20 POUNDS PER SQUARE INCH RESIDUAL PRESSURE.

B. Building plans

The Department's Fire Prevention Engineering Section shall review building plans and apply fire flow requirements and hydrant spacing in accordance with the following:

1. Residential

Building Occupancy Classification	Fire Flow	Duration of Flow	Public Hydrant Spacing
a. Single family dwellings - Fire Zone 3 (Less than 5000 square feet)			
On a lot of one acre or more	750 GPM	2 hrs.	600 ft.
On a lot less than one acre	1,250 GPM	2 hrs	600 ft.
b. Single family dwellings - VHFHSZ (Less than 5,000 square feet)			
On a lot of one acre or more	1,000 GPM	2 hrs.	600 ft.
On lots less than one acre	1,250 GPM	2 hrs.	600 ft.

NOTE: FOR SINGLE FAMILY DWELLINGS GREATER THAN 5,000 SQUARE FEET IN AREA SEE TABLE

c. Two-family dwelling units

Duplexes	1,500 GPM	2 hrs.	600 ft.

2. Mobile home park

a. Recreation bldg. — Refer to Table 1 for fire flow according to building size

b. Mobile home park	1,250 GPM	2 hrs.	600 ft.

3. Multiple residential, apartments, single family residences (greater than 5,000 square feet), private schools, hotels, high rise, commercial, industrial, etc. (R-1, E, B, A, I, H, F, M, S) (see Table 1).

C. Public fire hydrant requirements

1. Fire hydrants shall be required at intersections and along access ways as spacing requirements dictate.

2. Spacing

a. Cul-de-sac

When cul-de-sac depth exceeds 450' (residential) or 200' (commercial), hydrants shall be required at mid-block. Additional hydrants will be required if hydrant spacing exceeds specified distances.

b. Single family dwellings

Fire hydrant spacing of 600 feet

NOTE: The following guidelines shall be used in meeting single family dwellings hydrant spacing requirements:

(1) Urban properties (more than one unit per acre): No portion of lot frontage should be more than 450' via vehicular access from a public hydrant.

(2) Non-Urban Properties (less than one unit per acre): No portion of a structure should be placed on a lot where it exceeds 750' via vehicular access from a properly spaced public hydrant that meets the required fire flow.

c. All occupancies

Other than single family dwellings, such as commercial, industrial, multi-family dwellings, private schools, institutions, detached condominiums (five or more units), etc.

Fire hydrant spacing shall be 300 feet.

NOTE: The following guidelines shall be used in meeting the hydrant spacing requirements.

(1) No portion of lot frontage shall be more than 200 feet via vehicular access from a public hydrant.

(2) No portion of a building should exceed 400 feet via vehicular access from a properly spaced public hydrant.

d. Supplemental fire protection

When a structure cannot meet the required public hydrant spacing distances, supplemental fire protection shall be required.

NOTE: Supplemental fire protection is not limited to the installation of on-site fire hydrants; it <u>may</u> include automatic extinguishing systems.

3. Hydrant location requirements - both sides of a street

Hydrants shall be required on both sides of the street whenever:

a. Streets having raised median center dividers that make access to hydrants difficult, causes time delay, and/or creates undue hazard.

b. For situations other than those listed in "a" above, the Department's inspector's judgment shall be used. The following items shall be considered when determining hydrant locations:

(1) Excessive traffic loads, major arterial route, in which traffic would be difficult to detour.

(2) Lack of adjacent parallel public streets in which traffic could be redirected (e.g., Pacific Coast Highway).

(3) Past practices in the area.

(4) Possibility of future development in the area.

(5) Type of development (i.e., flag-lot units, large apartment or condo complex, etc.).

(6) Accessibility to existing hydrants

(7) Possibility of the existing street having a raised median center divider in the near future.

D. On-site hydrant requirements

1. When any portion of a proposed structure exceeds (via vehicular access) the allowable distances from a public hydrant and on-site hydrants are required, the following spacing requirements shall be met:

a. Spacing distance between on-site hydrants shall be 300 to 600 feet.

(1) Design features shall assist in allowing distance modifications.

b. Factors considered when allowing distance modifications.

(1) Only sprinklered buildings qualify for the maximum spacing of 600 feet.

(2) For non-sprinklered buildings, consideration should be given to fire protection, access doors, outside storage, etc. Distance between hydrants should not exceed 400 feet.

2. Fire flow

a. All on-site fire hydrants shall flow a minimum of 1,250 gallons per minute at 20 psi for a duration of two hours. If more than one on-site fire hydrant is required, the on-site fire flow shall be at least 2,500 gallons per minute at 20 psi, flowing from two hydrants simultaneously. On site flow may be greater depending upon the size of the structure and the distance from public hydrants.

NOTE: ONE OF THE TWO HYDRANTS TESTED SHALL BE THE FARTHEST FROM THE PUBLIC WATER SOURCE.

3. Distance from structures

All on-site hydrants shall be installed a minimum of 25 feet from a structure or protected by a two-hour firewall.

4. Shut-off valves

All on-site hydrants shall be equipped with a shut-off (gate) valve, which shall be located as follows:

a.	Minimum distance to the hydrant	10 feet
b.	Maximum distance from the hydrant	25 feet

5. Inspection of new installations

All new on-site hydrants and underground installations are subject to inspection of the following items by a representative of the Department:

a. Piping materials and the bracing and support thereof.

b. A hydrostatic test of 200 psi for two hours.

c. Adequate flushing of the installation.

d. Flow test to satisfy required fire flow.

(1) Hydrants shall be painted with two coats of red primer and one coat of red paint, with the exception of the stem and threads, prior to flow test and acceptance of the system.

6. Maintenance

It shall be the responsibility of the property management company, the homeowners association, or the property owner to maintain on-site hydrants.

a. Hydrants shall be painted with two coats of red primer and one coat of red, with the exception of the stem and threads, prior to flow test and acceptance of the system.

b. No barricades, walls, fences, landscaping, etc., shall be installed or planted within three feet of a fire hydrant.

E. Public hydrant flow procedure

The minimum acceptable flow from any existing public hydrant shall be 1,000 GPM unless the required fire flow is less. Hydrants used to satisfy fire flow requirements will be determined by the following items:

1. Only hydrants that meet spacing requirements are acceptable for meeting fire flow requirements.

2. In order to meet the required fire flow:

   a. Flow closest hydrant and calculate to determine flow at 20 pounds per square inch residual pressure. If the calculated flow does not meet the fire flow requirement, the next closest hydrant shall be flowed simultaneously with the first hydrant, providing it meets the spacing requirement, etc.

   b. If more than one hydrant is to be flowed in order to meet the required fire flow, the number of hydrants shall be flowed as follows:

One hydrant	1,250 GPM and below
Two hydrants	1,251– 3,500 GPM flowing simultaneously
Three hydrants	3,501– 5,000 GPM flowing simultaneously

F. Hydrant upgrade policy

1. Existing single outlet 2 1/2" inch hydrants shall be upgraded to a double outlet 6" x 4" x 2 1/2" hydrant when the required fire flow exceeds 1,250 GPM.

2. An upgrade of the fire hydrant will not be required if the required fire flow is between the minimum requirement of 750 gallons per minute, up to and including 1,250 gallons per minute, and the existing public water system will provide the required fire flow through an existing wharf fire hydrant.

3. All new required fire hydrant installations shall be approved 6" x 4" x 2 1/2" fire hydrants.

4. When water main improvements are required to meet GPM flow, and the existing water main has single outlet 2 1/2" fire hydrant(s), then a hydrant(s) upgrade will be required. This upgrade shall apply regardless of flow requirements.

G. Hydrant specifications

All required public and on-site fire hydrants shall be installed to the following specifications prior to flow test and acceptance of the system.

1. Hydrants shall be:

   a. Installed so that the center line of the lowest outlet is between 14 and 24 inches above finished grade

   b. Installed so that the front of the riser is between 12 and 24 inches behind the curb face

   c. Installed with outlets facing the curb at a 45-degree angle to the curb line if there are double outlet hydrants

   d. Similar to the type of construction which conforms to current A.W.W.A. Standards

   e. Provided with three-foot unobstructed clearance on all sides

   f. Provided with approved plastic caps

   g. Painted with two coats of red primer and one coat of traffic signal yellow for public hydrants and one coat of red for on-site hydrants, with the exception of the stems and threads

2. Underground shut-off valves are to be located:

   a. A minimum distance of 10 feet from the hydrant

   b. A maximum distance of 25 feet from the hydrant

   Exception: Location can be less than 10 feet when the water main is already installed and the 10-foot minimum distance cannot be satisfied.

3. All new water mains, laterals, gate valves, buries, and riser shall be a minimum of six inches inside diameter.

4. When sidewalks are contiguous with a curb and are five feet wide or less, fire hydrants shall be placed immediately behind the sidewalk. Under no circumstances shall hydrants be more than six feet from a curb line.

5. The owner-developer shall be responsible for making the necessary arrangements with the local water purveyor for the installation of all public facilities.

6. Approved fire hydrant barricades shall be installed if curbs are not provided (see Figures 1, 2, and 3 following on pages 11 and 12).

Barricade/Clearance Details

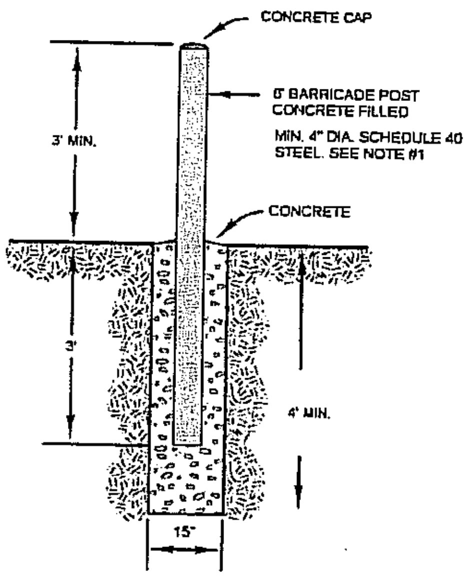
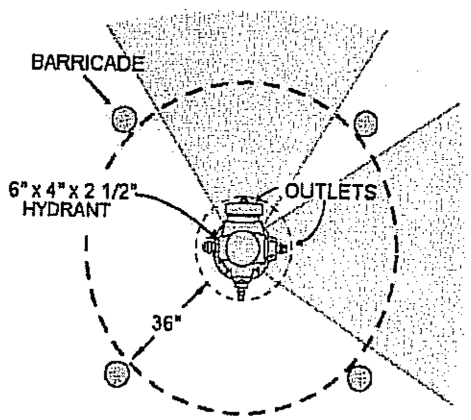


Figure 1



PLAN
FIRE HYDRANT BARRICADES
(TYPICAL)

Figure 2

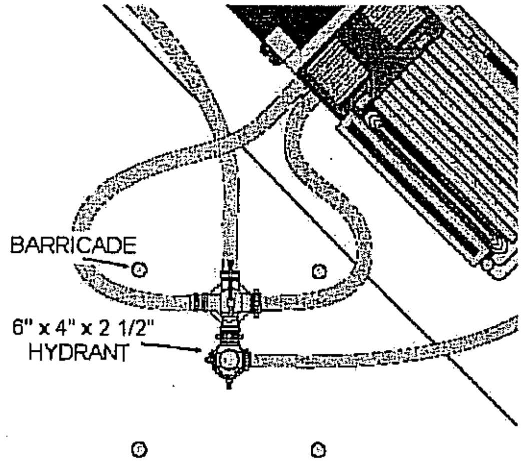


Figure 3

Notes:

1. Constructed of steel not less than four inches in diameter, six inches if heavy truck traffic is anticipated, schedule 40 steel and concrete filled.

2. Posts shall be set not less than three feet deep in a concrete footing of not less than 15 inches in diameter, with the top of the posts not less than three feet above ground and not less than three feet from the hydrant

3. Posts, fences, vehicles, growth, trash storage and other materials or things shall not be placed or kept near fire hydrants in a manner that would prevent fire hydrants from being immediately discernable.

4. If hydrant is to be barricaded, no barricade shall be constructed in front of the hydrant outlets (Figure 2, shaded area).

5. The exact location of barricades may be changed by the field inspector during a field inspection.

6. The steel pipe above ground shall be painted a minimum of two field coats of primer.

7. Two finish coats of "traffic signal yellow" shall be used for fire hydrant barricades.

8. Figure 3 shows hydrant hook up during fireground operations. Notice apparatus (hydra-assist-valve) connected to hydrant and the required area. Figure 3 shows the importance of not constructing barricades or other obstructions in front of hydrant outlets.

H. Private fire protection systems for rural commercial and industrial development

Where the standards of this regulation cannot be met for industrial and commercial developments in rural areas, alternate proposals which meet NFPA Standard 1142 may be submitted to the Fire Marshal for review. Such proposals shall also be subject to the following:

1. The structure is beyond 3,000 feet of any existing, adequately-sized water system.

   a. Structures within 3,000 feet of an existing, adequately-sized water system, but beyond a water purveyor service area, will be reviewed on an individual basis.

2. The structure is in an area designated by the County of Los Angeles' General Plan as rural non-urban.

I. Blue reflective hydrant markers replacement policy

1. Purpose: To provide information regarding the replacement of blue reflective hydrant markers, following street construction or repair work.

   a. Fire station personnel shall inform Department of Public Works Road Construction Inspectors of the importance of the blue reflective hydrant markers, and encourage them to enforce their Department permit requirement, that streets and roads be returned to their original condition, following construction or repair work.

   b. When street construction or repair work occurs within this Department's jurisdiction, the nearest Department of Public Works Permit Office shall be contacted. The location can be found by searching for the jurisdiction office in the "County of Los Angeles Telephone Directory" under "Department of Public Works Road Maintenance Division." The importance of the blue reflective hydrant markers should be explained, and the requirement encouraged that the street be returned to its original condition, by replacing the hydrant markers.

TABLE 1 *

BUILDING SIZE (First floor area)		Fire Flow *(1) (2)	Duration	Hydrant Spacing
Under 3,000	sq. ft.	1,000 GPM	2 hrs.	300 ft.
3,000 to 4,999	sq. ft.	1,250 GPM	2 hrs.	300 ft.
5,000 to 7,999	sq. ft.	1,500 GPM	2 hrs.	300 ft.
8,000 to 9,999	sq. ft.	2,000 GPM	2 hrs.	300 ft.
10,000 to 14,999	sq. ft.	2,500 GPM	2 hrs.	300 ft.
15,000 to 19,999	sq. ft.	3,000 GPM	3 hrs.	300 ft.
20,000 to 24,999	sq. ft.	3,500 GPM	3 hrs.	300 ft.
25,000 to 29,999	sq. ft.	4,000 GPM	4 hrs.	300 ft.
30,000 to 34,999	sq. ft.	4,500 GPM	4 hrs.	300 ft.
35,000 or more	sq. ft.	5,000 GPM	5 hrs.	300 ft.

* See applicable footnotes below:

(FIRE FLOWS MEASURED AT 20 POUNDS PER SQUARE INCH RESIDUAL PRESSURE)

(1) Conditions requiring additional fire flow.

a. Each story above ground level - add 500 GPM per story.

b. Any exposure within 50 feet - add a total of 500 GPM.

c. Any high-rise building (as determined by the jurisdictional building code) the fire flow shall be a minimum of 3,500 GPM for 3 hours at 20 psi.

d. Any flow may be increased up to 1,000 GPM for a hazardous occupancy.

(2) Reductions in fire flow shall be cumulative for type of construction and a fully sprinklered building. The following allowances and/or additions may be made to standard fire flow requirements:

a. A 25% reduction shall be granted for the following types of construction: Type I-F.R, Type II-F.R., Type II one-hour, Type II-N, Type III one-hour, Type III-N, Type IV, Type IV one hour, and Type V one-hour. This reduction shall be automatic and credited on all projects using these types of construction. Credit will not be given for Type V-N structures (to a minimum of 2,000 GPM available fire flow).

b. A 25% reduction shall be granted for fully sprinklered buildings (to a minimum of 2,000 GPM available fire flow).

c. When determining required fire flows for structures that total 70,000 square feet or greater, such flows shall not be reduced below 3,500 GPM at 20 psi for three hours.

Appendix I

Pressure Reducing Station Information

STATION	NAME	ELEV.	HGL IN	HGL OUT	STATIC PRESSURE IN	STATIC PRESSURE INTER		STATIC PRESSURE OUT	NOTES
1	Warner Ranch - Calabasas Parkway	1070	1640	1465	247			171	Tied to #2, #41, McCoy Tank
2	Warner - Park Belmonte	1425	1640	1465	93			18	Tied to #1, #41, McCoy Tank
3	Conduit Relief	888	1180						Pressure relief for PRV #39
4	Unassigned								
5	Mulholland Highway and Declaration	1070	1450	1415	164			149	Tied to #6, both Lead
6	Mulholland Highway and Paul Revere	1148	1450	1415	131			116	Tied to #5, both Lead
7	Old Topanga Cyn. - Bluebird	1006	1450	1235 / 1225	192			80	In Mulwood P.S. Fireflow, emergency only
8	Mulholland and Stokes Canyon	617	1235	929	268			135	
9	Cold Canyon and Mulholland	976	1640	1090 / 1240	288			50	In Cold Canyon P.S. Fireflow, emerg only
10	Cold Canyon and Wonderview	633	1235	860	260	180		98	Tied to #11
11	Cold Canyon and Thornhill	580	1235	860	284	204		121	Tied to #10
12	Piuma Road and Crater Camp Dr.	450	1235	785	340	180		145	
13	Parkmor and Las Virgenes Rd.	783	1235	1060	195			120	Tied to #14
14	Ruthwood and Thousand Oaks Blvd.	830	1235	1060	175			100	Tied to #13
15	Ludgate Dr. and Saratoga Hills	775	1235	1098	199			140	Tied to #16
16	Ambridge Dr.	769	1235	1098	201			142	Tied to #15
17	Liberty Canyon and Country Glen	750	1235	1090	210			147	Tied to #18
18	Rondell	777	1235	1090	198			135	Tied to #17
19	Westlake - Triunfo	869	1227	1100	155			100	Tied to #56, both Lead
20	Westlake - Waterside	884	1227	1100	149			94	Tied to #21
21	Westlake - Watergate	891	1227	1100	145			90	Tied to #20
22	Ramera Ridge	1583	2153	1775	247	145		80	Fills Latigo Tank & provides fireflow
23	Old Chimney Road	1054	1775	1250	312	175		85	Tied to #24
24	Latigo Canyon Road	1073	1775	1250	304	160		77	Tied to #23
25	Barrymore Road	1024	1775	1150	326 / 326	150 / 200	100	55 / 50	Tied to #26
26	Corral Canyon Road	910	1775	1150	375	235		104	Tied to #25
27	Rambla Pacifico and Schueren Rd.	1806	2514	1991	306	170		80	Feeds #28
28	Rambla Pacifico and Las Flores	1539	1991	1677	196	120		60	Feeds #29
29	Rambla Pacifico Easement	1108	1677	1177	246	150	105	30	
30	Woolsey Canyon - Upper	1737	2129	1840	170			45	Emergency only, mainline valve is gutted
31	Woolsey Canyon - Lower	1395	1840	1540	183			58	
32	Warner Pump Station	1072	1640	1475	246			174	
33	Salvation Army	476	1235	695	329	145		130	Large customer service regulator
34	Valley Heights Dr. and Argos St.	895	1235	1055	147			70	Tied to #35
35	Parheath Dr. and Argos St.	888	1235	1055	150			72	Tied to #34

STATION	NAME	ELEV.	HGL		STATIC PRESSURE				NOTES
			IN	OUT	IN	INTER		OUT	
36	Calabasas High School	1050	1450	1340	173			125	Large customer service regulator
37	Malibu Country Club	1400	2153	1647	326	200		105	Large customer service regulator
38	Twin Lakes Pump Station	1013	1590	1300	250			125	Supplies water only with pumps off
39	Conduit Pump Station	916	1235	1180	138			114	Supplies water only with pumps off
40	Westlake Boulevard	1240	2153	1425	395	294	188	95	Tied to Three Spring P.S.
41	Park Granada	1345	1640	1465	128			52	Tied to #1, #2, McCoy Tank.
42	Park Sorrento (RW)	950	1529	1260	250			134	Recycled Water Station
43	Calle Robleda	904	1235	1160	143			111	
44	Stunt Road Pump Station	1546	2513	1570	420	220	60	15	Fireflow & Emergency Only
45	Kimberly Pump Station	1036	1517	1290	208			110	
46	East/West Bypass (RW)	761	1529	1225	332			197	Recycled Water feeds east to west
47	Las Virgenes Rd. and Agoura Rd.	764	1235	1000	204			102	Tied to #48, #49, #52, #54
48	Agoura Rd. and Lost Hills Rd.	777	1235	1000	198			96	Tied to #47, #49, #52, #54
49	Las Virgenes Rd. Across from H.Q.	733	1235	1000	214			115	Tied to #47, #48, #52, #54
50	Mulwood - Mulholland Hwy.	1040	1640	1498 / 1430	260			198 / 169	3rd pump to Mulwood Tank, Relief set 208
51	Malibu Valley Rd & Agoura Rd. (RW)	810	1225	977	177			72	Recycled Water Station
52	Malibu Hills Rd. and Agoura Rd.	815	1235	1000	181			80	Tied to #47, #48, #49, #54
53	Lake Lindero Dr.	1203	1517	1420	136			93	
54	Las Virgenes Rd. & Meadow Creek	720	1235	1000	223			121	Tied to #47, #48, #49, #52
55	Hindu Temple Old L.V. Rd.	616	1235	1062	268	180		75	Large customer service regulator
56	Fastwater Court East	888	1227	1100	147			91	Tied to 19, both LD
57	Fastwater Court West	888	1227	1200	147			135	Supplies suction to Three Springs Pump Station
58	~~Agoura Rd. & La Venta (RW)~~	~~892~~	~~1225~~	~~1225~~ / ~~1140~~	~~144~~			~~144~~ / ~~107~~	Recycled Water, Owned by Calleguas
59	~~Lake Sherwood (RW)~~	~~955~~	~~1225~~	~~1225~~ / ~~1040~~	~~117~~			~~117~~ / ~~37~~	Recycled Water, Owned by Calleguas
60	Waring Dr. and Mulholland	766	1235	1100	203			145	
61	Mountain Gate Park	1048	1420	1310	161			113	
62	Park Helena	1133	1475	1390	148			111	Inlet from McCoy
63	Oakridge	1490	1825	1590	145			43	
64	Abercrombie	1061	1640	1235	250			76	
65	LVMWD Ops	765	1235	1108	205			150	Large customer service regulator
66	Ranchview	1011	1302	1235 / 1430	126				In Ranchview P.S. Fireflow, emerg only
67	Encinal Cyn	1600	2153	1690	240			39	
68	Upper Twin Lakes	1518	1805	1585	124			95	In Upper Twin lakes P.S. Fireflow, emerg only
69	Upper Oaks	1281	1750	1616	204			59	In Oaks P.S. Fireflow, emerg only
70	Lower Oaks	1281	1615	1475	145			61	In Oaks P.S. Fireflow, emerg only

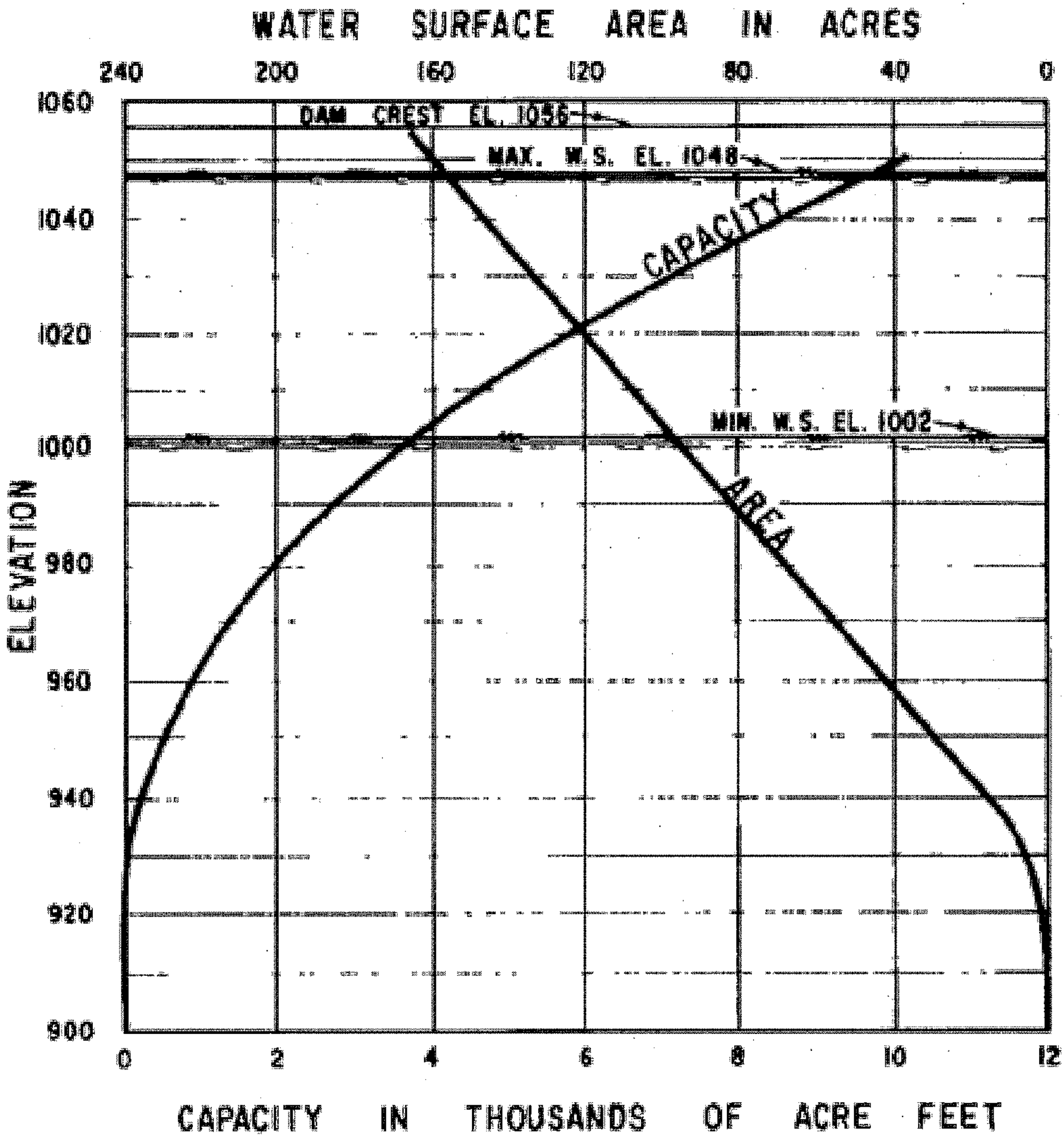
* Shadowed rows denote
Recycled Water Stations

105	Eldorado Meadow Intertie		1420	1235	145			80	Emergency only
106	Box Canyon		1326	1180					No valve installed
107	Three Springs Pump Station PR	1050	1460	1200	177			65	Emergency only

* Shadowed rows denote
Recycled Water Stations

Appendix J

Las Virgenes Reservoir Storage Information



RESERVOIR AREA - CAPACITY CURVES

WESTLAKE RESERVOIR VOLUMES

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1000.00	3490.6	3491.6	3492.5	3493.5	3494.4	3495.4	3496.4	3497.3	3498.3	3499.2	1000.00
1000.10	3500.2	3501.2	3502.1	3503.1	3504.0	3505.0	3506.0	3506.9	3507.9	3508.8	1000.10
1000.20	3509.8	3510.8	3511.7	3512.7	3513.6	3514.6	3515.6	3516.5	3517.5	3518.4	1000.20
1000.30	3519.4	3520.4	3521.3	3522.3	3523.2	3524.2	3525.2	3526.1	3527.1	3528.0	1000.30
1000.40	3529.0	3530.0	3530.9	3531.9	3532.8	3533.8	3534.8	3535.7	3536.7	3537.6	1000.40
1000.50	3538.6	3539.6	3540.5	3541.5	3542.4	3543.4	3544.4	3545.3	3546.3	3547.2	1000.50
1000.60	3548.2	3549.2	3550.1	3551.1	3552.0	3553.0	3554.0	3554.9	3555.9	3556.8	1000.60
1000.70	3557.8	3558.8	3559.7	3560.7	3561.6	3562.6	3563.6	3564.5	3565.5	3566.4	1000.70
1000.80	3567.4	3568.4	3569.3	3570.3	3571.2	3572.2	3573.2	3574.1	3575.1	3576.0	1000.80
1000.90	3577.0	3578.0	3578.9	3579.9	3580.8	3581.8	3582.8	3583.7	3584.7	3585.6	1000.90
EVAP.	2.800	2.805	2.810	2.815	2.820	2.825	2.829	2.834	2.839	2.844	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1001.00	3586.6	3587.6	3588.5	3589.5	3590.4	3591.4	3592.4	3593.3	3594.3	3595.2	1001.00
1001.10	3596.2	3597.2	3598.1	3599.1	3600.0	3601.0	3602.0	3602.9	3603.9	3604.8	1001.10
1001.20	3605.8	3606.8	3607.7	3608.7	3609.6	3610.6	3611.6	3612.5	3613.5	3614.4	1001.20
1001.30	3615.4	3616.4	3617.3	3618.3	3619.2	3620.2	3621.2	3622.1	3623.1	3624.0	1001.30
1001.40	3625.0	3626.0	3626.9	3627.9	3628.8	3629.8	3630.8	3631.7	3632.7	3633.6	1001.40
1001.50	3634.6	3635.6	3636.5	3637.5	3638.4	3639.4	3640.4	3641.3	3642.3	3643.2	1001.50
1001.60	3644.2	3645.2	3646.1	3647.1	3648.0	3649.0	3650.0	3650.9	3651.9	3652.8	1001.60
1001.70	3653.8	3654.8	3655.7	3656.7	3657.6	3658.6	3659.6	3660.5	3661.5	3662.4	1001.70
1001.80	3663.4	3664.4	3665.3	3666.3	3667.2	3668.2	3669.2	3670.1	3671.1	3672.0	1001.80
1001.90	3673.0	3674.0	3674.9	3675.9	3676.8	3677.8	3678.8	3679.7	3680.7	3681.6	1001.90
EVAP.	2.849	2.854	2.859	2.864	2.869	2.874	2.878	2.883	2.888	2.893	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1002.00	3682.6	3683.6	3684.6	3685.6	3686.5	3687.5	3688.5	3689.5	3690.5	3691.5	1002.00
1002.10	3692.5	3693.4	3694.4	3695.4	3696.4	3697.4	3698.4	3699.4	3700.3	3701.3	1002.10
1002.20	3702.3	3703.3	3704.3	3705.3	3706.3	3707.3	3708.2	3709.2	3710.2	3711.2	1002.20
1002.30	3712.2	3713.2	3714.2	3715.1	3716.1	3717.1	3718.1	3719.1	3720.1	3721.1	1002.30
1002.40	3722.0	3723.0	3724.0	3725.0	3726.0	3727.0	3728.0	3728.9	3729.9	3730.9	1002.40
1002.50	3731.9	3732.9	3733.9	3734.9	3735.8	3736.8	3737.8	3738.8	3739.8	3740.8	1002.50
1002.60	3741.8	3742.7	3743.7	3744.7	3745.7	3746.7	3747.7	3748.7	3749.6	3750.6	1002.60
1002.70	3751.6	3752.6	3753.6	3754.6	3755.6	3756.6	3757.5	3758.5	3759.5	3760.5	1002.70
1002.80	3761.5	3762.5	3763.5	3764.4	3765.4	3766.4	3767.4	3768.4	3769.4	3770.4	1002.80
1002.90	3771.3	3772.3	3773.3	3774.3	3775.3	3776.3	3777.3	3778.2	3779.2	3780.2	1002.90
EVAP.	2.898	2.901	2.904	2.906	2.909	2.912	2.915	2.917	2.920	2.923	EVAP.

WESTLAKE RESERVOIR VOLUMES

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1003.00	3781.2	3782.2	3783.2	3784.2	3785.1	3786.1	3787.1	3788.1	3789.1	3790.1	1003.00
1003.10	3791.1	3792.0	3793.0	3794.0	3795.0	3796.0	3797.0	3798.0	3798.9	3799.9	1003.10
1003.20	3800.9	3801.9	3802.9	3803.9	3804.9	3805.9	3806.8	3807.8	3808.8	3809.8	1003.20
1003.30	3810.8	3811.8	3812.8	3813.7	3814.7	3815.7	3816.7	3817.7	3818.7	3819.7	1003.30
1003.40	3820.6	3821.6	3822.6	3823.6	3824.6	3825.6	3826.6	3827.5	3828.5	3829.5	1003.40
1003.50	3830.5	3831.5	3832.5	3833.5	3834.4	3835.4	3836.4	3837.4	3838.4	3839.4	1003.50
1003.60	3840.4	3841.3	3842.3	3843.3	3844.3	3845.3	3846.3	3847.3	3848.2	3849.2	1003.60
1003.70	3850.2	3851.2	3852.2	3853.2	3854.2	3855.2	3856.1	3857.1	3858.1	3859.1	1003.70
1003.80	3860.1	3861.1	3862.1	3863.0	3864.0	3865.0	3866.0	3867.0	3868.0	3869.0	1003.80
1003.90	3869.9	3870.9	3871.9	3872.9	3873.9	3874.9	3875.9	3876.8	3877.8	3878.8	1003.90
EVAP.	2.926	2.928	2.931	2.934	2.937	2.939	2.942	2.945	2.948	2.950	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1004.00	3879.8	3880.8	3881.8	3882.8	3883.8	3884.8	3885.9	3886.9	3887.9	3888.9	1004.00
1004.10	3889.9	3890.9	3891.9	3892.9	3893.9	3894.9	3896.0	3897.0	3898.0	3899.0	1004.10
1004.20	3900.0	3901.0	3902.0	3903.0	3904.0	3905.0	3906.0	3907.1	3908.1	3909.1	1004.20
1004.30	3910.1	3911.1	3912.1	3913.1	3914.1	3915.1	3916.1	3917.2	3918.2	3919.2	1004.30
1004.40	3920.2	3921.2	3922.2	3923.2	3924.2	3925.2	3926.2	3927.2	3928.3	3929.3	1004.40
1004.50	3930.3	3931.3	3932.3	3933.3	3934.3	3935.3	3936.3	3937.3	3938.4	3939.4	1004.50
1004.60	3940.4	3941.4	3942.4	3943.4	3944.4	3945.4	3946.4	3947.4	3948.4	3949.5	1004.60
1004.70	3950.5	3951.5	3952.5	3953.5	3954.5	3955.5	3956.5	3957.5	3958.5	3959.6	1004.70
1004.80	3960.6	3961.6	3962.6	3963.6	3964.6	3965.6	3966.6	3967.6	3968.6	3969.6	1004.80
1004.90	3970.7	3971.7	3972.7	3973.7	3974.7	3975.7	3976.7	3977.7	3978.7	3979.7	1004.90
EVAP.	2.953	2.956	2.960	2.963	2.967	2.970	2.973	2.977	2.980	2.984	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1005.00	3980.8	3981.8	3982.8	3983.8	3984.8	3985.8	3986.8	3987.8	3988.8	3989.8	1005.00
1005.10	3990.8	3991.9	3992.9	3993.9	3994.9	3995.9	3996.9	3997.9	3998.9	3999.9	1005.10
1005.20	4000.9	4001.9	4003.0	4004.0	4005.0	4006.0	4007.0	4008.0	4009.0	4010.0	1005.20
1005.30	4011.0	4012.0	4013.1	4014.1	4015.1	4016.1	4017.1	4018.1	4019.1	4020.1	1005.30
1005.40	4021.1	4022.1	4023.1	4024.2	4025.2	4026.2	4027.2	4028.2	4029.2	4030.2	1005.40
1005.50	4031.2	4032.2	4033.2	4034.3	4035.3	4036.3	4037.3	4038.3	4039.3	4040.3	1005.50
1005.60	4041.3	4042.3	4043.3	4044.3	4045.4	4046.4	4047.4	4048.4	4049.4	4050.4	1005.60
1005.70	4051.4	4052.4	4053.4	4054.4	4055.5	4056.5	4057.5	4058.5	4059.5	4060.5	1005.70
1005.80	4061.5	4062.5	4063.5	4064.5	4065.5	4066.6	4067.6	4068.6	4069.6	4070.6	1005.80
1005.90	4071.6	4072.6	4073.6	4074.6	4075.6	4076.7	4077.7	4078.7	4079.7	4080.7	1005.90
EVAP.	2.987	2.990	2.994	2.997	3.001	3.004	3.007	3.011	3.014	3.018	EVAP.

WESTLAKE RESERVOIR VOLUMES

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1006.00	4081.7	4082.7	4083.8	4084.8	4085.8	4086.9	4087.9	4088.9	4090.0	4091.0	1006.00
1006.10	4092.1	4093.1	4094.1	4095.2	4096.2	4097.2	4098.3	4099.3	4100.3	4101.4	1006.10
1006.20	4102.4	4103.4	4104.5	4105.5	4106.5	4107.6	4108.6	4109.6	4110.7	4111.7	1006.20
1006.30	4112.8	4113.8	4114.8	4115.9	4116.9	4117.9	4119.0	4120.0	4121.0	4122.1	1006.30
1006.40	4123.1	4124.1	4125.2	4126.2	4127.2	4128.3	4129.3	4130.3	4131.4	4132.4	1006.40
1006.50	4133.5	4134.5	4135.5	4136.6	4137.6	4138.6	4139.7	4140.7	4141.7	4142.8	1006.50
1006.60	4143.8	4144.8	4145.9	4146.9	4147.9	4149.0	4150.0	4151.0	4152.1	4153.1	1006.60
1006.70	4154.2	4155.2	4156.2	4157.3	4158.3	4159.3	4160.4	4161.4	4162.4	4163.5	1006.70
1006.80	4164.5	4165.5	4166.6	4167.6	4168.6	4169.7	4170.7	4171.7	4172.8	4173.8	1006.80
1006.90	4174.9	4175.9	4176.9	4178.0	4179.0	4180.0	4181.1	4182.1	4183.1	4184.2	1006.90
EVAP.	3.021	3.025	3.029	3.033	3.037	3.041	3.045	3.049	3.053	3.057	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1007.00	4185.2	4186.2	4187.3	4188.3	4189.3	4190.4	4191.4	4192.4	4193.5	4194.5	1007.00
1007.10	4195.6	4196.6	4197.6	4198.7	4199.7	4200.7	4201.8	4202.8	4203.8	4204.9	1007.10
1007.20	4205.9	4206.9	4208.0	4209.0	4210.0	4211.1	4212.1	4213.1	4214.2	4215.2	1007.20
1007.30	4216.3	4217.3	4218.3	4219.4	4220.4	4221.4	4222.5	4223.5	4224.5	4225.6	1007.30
1007.40	4226.6	4227.6	4228.7	4229.7	4230.7	4231.8	4232.8	4233.8	4234.9	4235.9	1007.40
1007.50	4237.0	4238.0	4239.0	4240.1	4241.1	4242.1	4243.2	4244.2	4245.2	4246.3	1007.50
1007.60	4247.3	4248.3	4249.4	4250.4	4251.4	4252.5	4253.5	4254.5	4255.6	4256.6	1007.60
1007.70	4257.7	4258.7	4259.7	4260.8	4261.8	4262.8	4263.9	4264.9	4265.9	4267.0	1007.70
1007.80	4268.0	4269.0	4270.1	4271.1	4272.1	4273.2	4274.2	4275.2	4276.3	4277.3	1007.80
1007.90	4278.4	4279.4	4280.4	4281.5	4282.5	4283.5	4284.6	4285.6	4286.6	4287.7	1007.90
EVAP.	3.061	3.065	3.069	3.073	3.077	3.081	3.085	3.089	3.093	3.097	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1008.00	4288.7	4289.8	4290.8	4291.9	4292.9	4294.0	4295.1	4296.1	4297.2	4298.2	1008.00
1008.10	4299.3	4300.4	4301.4	4302.5	4303.5	4304.6	4305.7	4306.7	4307.8	4308.8	1008.10
1008.20	4309.9	4311.0	4312.0	4313.1	4314.1	4315.2	4316.3	4317.3	4318.4	4319.4	1008.20
1008.30	4320.5	4321.6	4322.6	4323.7	4324.7	4325.8	4326.9	4327.9	4329.0	4330.0	1008.30
1008.40	4331.1	4332.2	4333.2	4334.3	4335.3	4336.4	4337.5	4338.5	4339.6	4340.6	1008.40
1008.50	4341.7	4342.8	4343.8	4344.9	4345.9	4347.0	4348.1	4349.1	4350.2	4351.2	1008.50
1008.60	4352.3	4353.4	4354.4	4355.5	4356.5	4357.6	4358.7	4359.7	4360.8	4361.8	1008.60
1008.70	4362.9	4364.0	4365.0	4366.1	4367.1	4368.2	4369.3	4370.3	4371.4	4372.4	1008.70
1008.80	4373.5	4374.6	4375.6	4376.7	4377.7	4378.8	4379.9	4380.9	4382.0	4383.0	1008.80
1008.90	4384.1	4385.2	4386.2	4387.3	4388.3	4389.4	4390.5	4391.5	4392.6	4393.6	1008.90
EVAP.	3.101	3.105	3.108	3.112	3.115	3.119	3.122	3.126	3.129	3.133	EVAP.

WESTLAKE RESERVOIR VOLUMES

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1009.00	4394.7	4395.8	4396.8	4397.9	4398.9	4400.0	4401.1	4402.1	4403.2	4404.2	1009.00
1009.10	4405.3	4406.4	4407.4	4408.5	4409.5	4410.6	4411.7	4412.7	4413.8	4414.8	1009.10
1009.20	4415.9	4417.0	4418.0	4419.1	4420.1	4421.2	4422.3	4423.3	4424.4	4425.4	1009.20
1009.30	4426.5	4427.6	4428.6	4429.7	4430.7	4431.8	4432.9	4433.9	4435.0	4436.0	1009.30
1009.40	4437.1	4438.2	4439.2	4440.3	4441.3	4442.4	4443.5	4444.5	4445.6	4446.6	1009.40
1009.50	4447.7	4448.8	4449.8	4450.9	4451.9	4453.0	4454.1	4455.1	4456.2	4457.2	1009.50
1009.60	4458.3	4459.4	4460.4	4461.5	4462.5	4463.6	4464.7	4465.7	4466.8	4467.8	1009.60
1009.70	4468.9	4470.0	4471.0	4472.1	4473.1	4474.2	4475.3	4476.3	4477.4	4478.4	1009.70
1009.80	4479.5	4480.6	4481.6	4482.7	4483.7	4484.8	4485.9	4486.9	4488.0	4489.0	1009.80
1009.90	4490.1	4491.2	4492.2	4493.3	4494.3	4495.4	4496.5	4497.5	4498.6	4499.6	1009.90
EVAP.	3.136	3.140	3.143	3.147	3.150	3.154	3.157	3.161	3.164	3.168	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1010.00	4500.7	4501.8	4502.9	4504.0	4505.0	4506.1	4507.2	4508.3	4509.4	4510.5	1010.00
1010.10	4511.5	4512.6	4513.7	4514.8	4515.9	4517.0	4518.1	4519.1	4520.2	4521.3	1010.10
1010.20	4522.4	4523.5	4524.6	4525.6	4526.7	4527.8	4528.9	4530.0	4531.1	4532.2	1010.20
1010.30	4533.2	4534.3	4535.4	4536.5	4537.6	4538.7	4539.7	4540.8	4541.9	4543.0	1010.30
1010.40	4544.1	4545.2	4546.2	4547.3	4548.4	4549.5	4550.6	4551.7	4552.8	4553.8	1010.40
1010.50	4554.9	4556.0	4557.1	4558.2	4559.3	4560.3	4561.4	4562.5	4563.6	4564.7	1010.50
1010.60	4565.8	4566.9	4567.9	4569.0	4570.1	4571.2	4572.3	4573.4	4574.4	4575.5	1010.60
1010.70	4576.6	4577.7	4578.8	4579.9	4581.0	4582.0	4583.1	4584.2	4585.3	4586.4	1010.70
1010.80	4587.5	4588.5	4589.6	4590.7	4591.8	4592.9	4594.0	4595.1	4596.1	4597.2	1010.80
1010.90	4598.3	4599.4	4600.5	4601.6	4602.6	4603.7	4604.8	4605.9	4607.0	4608.1	1010.90
EVAP.	3.171	3.175	3.179	3.182	3.186	3.190	3.194	3.197	3.201	3.205	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1011.00	4609.2	4610.2	4611.3	4612.4	4613.5	4614.6	4615.7	4616.7	4617.8	4618.9	1011.00
1011.10	4620.0	4621.1	4622.2	4623.2	4624.3	4625.4	4626.5	4627.6	4628.7	4629.8	1011.10
1011.20	4630.8	4631.9	4633.0	4634.1	4635.2	4636.3	4637.3	4638.4	4639.5	4640.6	1011.20
1011.30	4641.7	4642.8	4643.9	4644.9	4646.0	4647.1	4648.2	4649.3	4650.4	4651.4	1011.30
1011.40	4652.5	4653.6	4654.7	4655.8	4656.9	4658.0	4659.0	4660.1	4661.2	4662.3	1011.40
1011.50	4663.4	4664.5	4665.5	4666.6	4667.7	4668.8	4669.9	4671.0	4672.1	4673.1	1011.50
1011.60	4674.2	4675.3	4676.4	4677.5	4678.6	4679.6	4680.7	4681.8	4682.9	4684.0	1011.60
1011.70	4685.1	4686.1	4687.2	4688.3	4689.4	4690.5	4691.6	4692.7	4693.7	4694.8	1011.70
1011.80	4695.9	4697.0	4698.1	4699.2	4700.2	4701.3	4702.4	4703.5	4704.6	4705.7	1011.80
1011.90	4706.8	4707.8	4708.9	4710.0	4711.1	4712.2	4713.3	4714.3	4715.4	4716.5	1011.90
EVAP.	3.209	3.212	3.216	3.220	3.224	3.227	3.231	3.235	3.239	3.242	EVAP.

WESTLAKE RESERVOIR VOLUMES

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1012.00	4717.6	4718.7	4719.8	4720.9	4722.0	4723.1	4724.3	4725.4	4726.5	4727.6	1012.00
1012.10	4728.7	4729.8	4730.9	4732.0	4733.1	4734.2	4735.4	4736.5	4737.6	4738.7	1012.10
1012.20	4739.8	4740.9	4742.0	4743.1	4744.2	4745.3	4746.4	4747.6	4748.7	4749.8	1012.20
1012.30	4750.9	4752.0	4753.1	4754.2	4755.3	4756.4	4757.5	4758.7	4759.8	4760.9	1012.30
1012.40	4762.0	4763.1	4764.2	4765.3	4766.4	4767.5	4768.6	4769.7	4770.9	4772.0	1012.40
1012.50	4773.1	4774.2	4775.3	4776.4	4777.5	4778.6	4779.7	4780.8	4782.0	4783.1	1012.50
1012.60	4784.2	4785.3	4786.4	4787.5	4788.6	4789.7	4790.8	4791.9	4793.0	4794.2	1012.60
1012.70	4795.3	4796.4	4797.5	4798.6	4799.7	4800.8	4801.9	4803.0	4804.1	4805.3	1012.70
1012.80	4806.4	4807.5	4808.6	4809.7	4810.8	4811.9	4813.0	4814.1	4815.2	4816.3	1012.80
1012.90	4817.5	4818.6	4819.7	4820.8	4821.9	4823.0	4824.1	4825.2	4826.3	4827.4	1012.90
EVAP.	3.246	3.250	3.253	3.257	3.260	3.264	3.267	3.271	3.274	3.278	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1013.00	4828.6	4829.7	4830.8	4831.9	4833.0	4834.1	4835.2	4836.3	4837.4	4838.5	1013.00
1013.10	4839.6	4840.8	4841.9	4843.0	4844.1	4845.2	4846.3	4847.4	4848.5	4849.6	1013.10
1013.20	4850.7	4851.8	4853.0	4854.1	4855.2	4856.3	4857.4	4858.5	4859.6	4860.7	1013.20
1013.30	4861.8	4862.9	4864.1	4865.2	4866.3	4867.4	4868.5	4869.6	4870.7	4871.8	1013.30
1013.40	4872.9	4874.0	4875.1	4876.3	4877.4	4878.5	4879.6	4880.7	4881.8	4882.9	1013.40
1013.50	4884.0	4885.1	4886.2	4887.4	4888.5	4889.6	4890.7	4891.8	4892.9	4894.0	1013.50
1013.60	4895.1	4896.2	4897.3	4898.4	4899.6	4900.7	4901.8	4902.9	4904.0	4905.1	1013.60
1013.70	4906.2	4907.3	4908.4	4909.5	4910.7	4911.8	4912.9	4914.0	4915.1	4916.2	1013.70
1013.80	4917.3	4918.4	4919.5	4920.6	4921.7	4922.9	4924.0	4925.1	4926.2	4927.3	1013.80
1013.90	4928.4	4929.5	4930.6	4931.7	4932.8	4934.0	4935.1	4936.2	4937.3	4938.4	1013.90
EVAP.	3.282	3.285	3.289	3.292	3.296	3.299	3.303	3.306	3.310	3.313	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1014.00	4939.5	4940.6	4941.8	4942.9	4944.0	4945.2	4946.3	4947.4	4948.6	4949.7	1014.00
1014.10	4950.8	4952.0	4953.1	4954.2	4955.4	4956.5	4957.6	4958.8	4959.9	4961.0	1014.10
1014.20	4962.2	4963.3	4964.4	4965.6	4966.7	4967.8	4969.0	4970.1	4971.2	4972.4	1014.20
1014.30	4973.5	4974.6	4975.8	4976.9	4978.0	4979.2	4980.3	4981.4	4982.6	4983.7	1014.30
1014.40	4984.8	4986.0	4987.1	4988.2	4989.4	4990.5	4991.6	4992.8	4993.9	4995.0	1014.40
1014.50	4996.2	4997.3	4998.4	4999.6	5000.7	5001.8	5003.0	5004.1	5005.2	5006.4	1014.50
1014.60	5007.5	5008.6	5009.8	5010.9	5012.0	5013.2	5014.3	5015.4	5016.6	5017.7	1014.60
1014.70	5018.8	5020.0	5021.1	5022.2	5023.4	5024.5	5025.6	5026.8	5027.9	5029.0	1014.70
1014.80	5030.2	5031.3	5032.4	5033.6	5034.7	5035.8	5037.0	5038.1	5039.2	5040.4	1014.80
1014.90	5041.5	5042.6	5043.8	5044.9	5046.0	5047.2	5048.3	5049.4	5050.6	5051.7	1014.90
EVAP.	3.317	3.321	3.324	3.328	3.332	3.335	3.339	3.343	3.346	3.350	EVAP.

WESTLAKE RESERVOIR VOLUMES

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1015.00	5052.9	5054.0	5055.1	5056.3	5057.4	5058.5	5059.7	5060.8	5061.9	5063.1	1015.00
1015.10	5064.2	5065.3	5066.5	5067.6	5068.7	5069.9	5071.0	5072.1	5073.3	5074.4	1015.10
1015.20	5075.5	5076.7	5077.8	5078.9	5080.1	5081.2	5082.3	5083.5	5084.6	5085.7	1015.20
1015.30	5086.9	5088.0	5089.1	5090.3	5091.4	5092.5	5093.7	5094.8	5095.9	5097.1	1015.30
1015.40	5098.2	5099.3	5100.5	5101.6	5102.7	5103.9	5105.0	5106.1	5107.3	5108.4	1015.40
1015.50	5109.5	5110.7	5111.8	5112.9	5114.1	5115.2	5116.3	5117.5	5118.6	5119.7	1015.50
1015.60	5120.9	5122.0	5123.1	5124.3	5125.4	5126.5	5127.7	5128.8	5129.9	5131.1	1015.60
1015.70	5132.2	5133.3	5134.5	5135.6	5136.7	5137.9	5139.0	5140.1	5141.3	5142.4	1015.70
1015.80	5143.5	5144.7	5145.8	5146.9	5148.1	5149.2	5150.3	5151.5	5152.6	5153.7	1015.80
1015.90	5154.9	5156.0	5157.1	5158.3	5159.4	5160.5	5161.7	5162.8	5163.9	5165.1	1015.90
EVAP.	3.354	3.357	3.361	3.364	3.368	3.372	3.375	3.379	3.383	3.386	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1016.00	5166.2	5167.4	5168.5	5169.7	5170.8	5172.0	5173.1	5174.3	5175.5	5176.6	1016.00
1016.10	5177.8	5178.9	5180.1	5181.2	5182.4	5183.6	5184.7	5185.9	5187.0	5188.2	1016.10
1016.20	5189.4	5190.5	5191.7	5192.8	5194.0	5195.1	5196.3	5197.5	5198.6	5199.8	1016.20
1016.30	5200.9	5202.1	5203.2	5204.4	5205.6	5206.7	5207.9	5209.0	5210.2	5211.3	1016.30
1016.40	5212.5	5213.7	5214.8	5216.0	5217.1	5218.3	5219.4	5220.6	5221.8	5222.9	1016.40
1016.50	5224.1	5225.2	5226.4	5227.5	5228.7	5229.9	5231.0	5232.2	5233.3	5234.5	1016.50
1016.60	5235.7	5236.8	5238.0	5239.1	5240.3	5241.4	5242.6	5243.8	5244.9	5246.1	1016.60
1016.70	5247.2	5248.4	5249.5	5250.7	5251.9	5253.0	5254.2	5255.3	5256.5	5257.6	1016.70
1016.80	5258.8	5260.0	5261.1	5262.3	5263.4	5264.6	5265.7	5266.9	5268.1	5269.2	1016.80
1016.90	5270.4	5271.5	5272.7	5273.8	5275.0	5276.2	5277.3	5278.5	5279.6	5280.8	1016.90
EVAP.	3.390	3.394	3.397	3.401	3.404	3.408	3.411	3.415	3.418	3.422	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1017.00	5282.0	5283.1	5284.3	5285.4	5286.6	5287.7	5288.9	5290.1	5291.2	5292.4	1017.00
1017.10	5293.5	5294.7	5295.8	5297.0	5298.2	5299.3	5300.5	5301.6	5302.8	5303.9	1017.10
1017.20	5305.1	5306.3	5307.4	5308.6	5309.7	5310.9	5312.0	5313.2	5314.4	5315.5	1017.20
1017.30	5316.7	5317.8	5319.0	5320.1	5321.3	5322.5	5323.6	5324.8	5325.9	5327.1	1017.30
1017.40	5328.3	5329.4	5330.6	5331.7	5332.9	5334.0	5335.2	5336.4	5337.5	5338.7	1017.40
1017.50	5339.8	5341.0	5342.1	5343.3	5344.5	5345.6	5346.8	5347.9	5349.1	5350.2	1017.50
1017.60	5351.4	5352.6	5353.7	5354.9	5356.0	5357.2	5358.3	5359.5	5360.7	5361.8	1017.60
1017.70	5363.0	5364.1	5365.3	5366.4	5367.6	5368.8	5369.9	5371.1	5372.2	5373.4	1017.70
1017.80	5374.6	5375.7	5376.9	5378.0	5379.2	5380.3	5381.5	5382.7	5383.8	5385.0	1017.80
1017.90	5386.1	5387.3	5388.4	5389.6	5390.8	5391.9	5393.1	5394.2	5395.4	5396.5	1017.90
EVAP.	3.425	3.429	3.432	3.436	3.439	3.443	3.446	3.450	3.453	3.457	EVAP.

WESTLAKE RESERVOIR VOLUMES

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1018.00	5397.7	5398.9	5400.1	5401.2	5402.4	5403.6	5404.8	5406.0	5407.2	5408.3	1018.00
1018.10	5409.5	5410.7	5411.9	5413.1	5414.2	5415.4	5416.6	5417.8	5419.0	5420.1	1018.10
1018.20	5421.3	5422.5	5423.7	5424.9	5426.1	5427.2	5428.4	5429.6	5430.8	5432.0	1018.20
1018.30	5433.1	5434.3	5435.5	5436.7	5437.9	5439.1	5440.2	5441.4	5442.6	5443.8	1018.30
1018.40	5445.0	5446.1	5447.3	5448.5	5449.7	5450.9	5452.0	5453.2	5454.4	5455.6	1018.40
1018.50	5456.8	5458.0	5459.1	5460.3	5461.5	5462.7	5463.9	5465.0	5466.2	5467.4	1018.50
1018.60	5468.6	5469.8	5471.0	5472.1	5473.3	5474.5	5475.7	5476.9	5478.0	5479.2	1018.60
1018.70	5480.4	5481.6	5482.8	5483.9	5485.1	5486.3	5487.5	5488.7	5489.9	5491.0	1018.70
1018.80	5492.2	5493.4	5494.6	5495.8	5496.9	5498.1	5499.3	5500.5	5501.7	5502.9	1018.80
1018.90	5504.0	5505.2	5506.4	5507.6	5508.8	5509.9	5511.1	5512.3	5513.5	5514.7	1018.90
EVAP.	3.460	3.464	3.467	3.471	3.474	3.478	3.481	3.485	3.488	3.492	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1019.00	5515.9	5517.0	5518.2	5519.4	5520.6	5521.8	5522.9	5524.1	5525.3	5526.5	1019.00
1019.10	5527.7	5528.8	5530.0	5531.2	5532.4	5533.6	5534.8	5535.9	5537.1	5538.3	1019.10
1019.20	5539.5	5540.7	5541.8	5543.0	5544.2	5545.4	5546.6	5547.8	5548.9	5550.1	1019.20
1019.30	5551.3	5552.5	5553.7	5554.8	5556.0	5557.2	5558.4	5559.6	5560.7	5561.9	1019.30
1019.40	5563.1	5564.3	5565.5	5566.7	5567.8	5569.0	5570.2	5571.4	5572.6	5573.7	1019.40
1019.50	5574.9	5576.1	5577.3	5578.5	5579.7	5580.8	5582.0	5583.2	5584.4	5585.6	1019.50
1019.60	5586.7	5587.9	5589.1	5590.3	5591.5	5592.6	5593.8	5595.0	5596.2	5597.4	1019.60
1019.70	5598.6	5599.7	5600.9	5602.1	5603.3	5604.5	5605.6	5606.8	5608.0	5609.2	1019.70
1019.80	5610.4	5611.6	5612.7	5613.9	5615.1	5616.3	5617.5	5618.6	5619.8	5621.0	1019.80
1019.90	5622.2	5623.4	5624.5	5625.7	5626.9	5628.1	5629.3	5630.5	5631.6	5632.8	1019.90
EVAP.	3.495	3.499	3.502	3.506	3.509	3.513	3.516	3.520	3.523	3.527	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1020.00	5634.0	5635.2	5636.4	5637.6	5638.8	5640.0	5641.3	5642.5	5643.7	5644.9	1020.00
1020.10	5646.1	5647.3	5648.5	5649.7	5650.9	5652.1	5653.3	5654.5	5655.8	5657.0	1020.10
1020.20	5658.2	5659.4	5660.6	5661.8	5663.0	5664.2	5665.4	5666.6	5667.8	5669.0	1020.20
1020.30	5670.3	5671.5	5672.7	5673.9	5675.1	5676.3	5677.5	5678.7	5679.9	5681.1	1020.30
1020.40	5682.3	5683.5	5684.8	5686.0	5687.2	5688.4	5689.6	5690.8	5692.0	5693.2	1020.40
1020.50	5694.4	5695.6	5696.8	5698.1	5699.3	5700.5	5701.7	5702.9	5704.1	5705.3	1020.50
1020.60	5706.5	5707.7	5708.9	5710.1	5711.3	5712.6	5713.8	5715.0	5716.2	5717.4	1020.60
1020.70	5718.6	5719.8	5721.0	5722.2	5723.4	5724.6	5725.8	5727.1	5728.3	5729.5	1020.70
1020.80	5730.7	5731.9	5733.1	5734.3	5735.5	5736.7	5737.9	5739.1	5740.3	5741.6	1020.80
1020.90	5742.8	5744.0	5745.2	5746.4	5747.6	5748.8	5750.0	5751.2	5752.4	5753.6	1020.90
EVAP.	3.530	3.534	3.539	3.543	3.548	3.552	3.556	3.561	3.565	3.570	EVAP.

WESTLAKE RESERVOIR VOLUMES

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1021.00	5754.9	5756.1	5757.3	5758.5	5759.7	5760.9	5762.1	5763.3	5764.5	5765.7	1021.00
1021.10	5766.9	5768.1	5769.4	5770.6	5771.8	5773.0	5774.2	5775.4	5776.6	5777.8	1021.10
1021.20	5779.0	5780.2	5781.4	5782.6	5783.9	5785.1	5786.3	5787.5	5788.7	5789.9	1021.20
1021.30	5791.1	5792.3	5793.5	5794.7	5795.9	5797.1	5798.4	5799.6	5800.8	5802.0	1021.30
1021.40	5803.2	5804.4	5805.6	5806.8	5808.0	5809.2	5810.4	5811.6	5812.9	5814.1	1021.40
1021.50	5815.3	5816.5	5817.7	5818.9	5820.1	5821.3	5822.5	5823.7	5824.9	5826.2	1021.50
1021.60	5827.4	5828.6	5829.8	5831.0	5832.2	5833.4	5834.6	5835.8	5837.0	5838.2	1021.60
1021.70	5839.4	5840.7	5841.9	5843.1	5844.3	5845.5	5846.7	5847.9	5849.1	5850.3	1021.70
1021.80	5851.5	5852.7	5853.9	5855.2	5856.4	5857.6	5858.8	5860.0	5861.2	5862.4	1021.80
1021.90	5863.6	5864.8	5866.0	5867.2	5868.4	5869.7	5870.9	5872.1	5873.3	5874.5	1021.90
EVAP.	3.574	3.578	3.583	3.587	3.592	3.596	3.600	3.605	3.609	3.614	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1022.00	5875.7	5876.9	5878.2	5879.4	5880.6	5881.9	5883.1	5884.3	5885.6	5886.8	1022.00
1022.10	5888.1	5889.3	5890.5	5891.8	5893.0	5894.2	5895.5	5896.7	5897.9	5899.2	1022.10
1022.20	5900.4	5901.6	5902.9	5904.1	5905.4	5906.6	5907.8	5909.1	5910.3	5911.5	1022.20
1022.30	5912.8	5914.0	5915.2	5916.5	5917.7	5918.9	5920.2	5921.4	5922.6	5923.9	1022.30
1022.40	5925.1	5926.4	5927.6	5928.8	5930.1	5931.3	5932.5	5933.8	5935.0	5936.2	1022.40
1022.50	5937.5	5938.7	5939.9	5941.2	5942.4	5943.7	5944.9	5946.1	5947.4	5948.6	1022.50
1022.60	5949.8	5951.1	5952.3	5953.5	5954.8	5956.0	5957.2	5958.5	5959.7	5960.9	1022.60
1022.70	5962.2	5963.4	5964.7	5965.9	5967.1	5968.4	5969.6	5970.8	5972.1	5973.3	1022.70
1022.80	5974.5	5975.8	5977.0	5978.2	5979.5	5980.7	5982.0	5983.2	5984.4	5985.7	1022.80
1022.90	5986.9	5988.1	5989.4	5990.6	5991.8	5993.1	5994.3	5995.5	5996.8	5998.0	1022.90
EVAP.	3.618	3.622	3.626	3.629	3.633	3.637	3.641	3.645	3.648	3.652	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1023.00	5999.3	6000.5	6001.7	6003.0	6004.2	6005.4	6006.7	6007.9	6009.1	6010.4	1023.00
1023.10	6011.6	6012.8	6014.1	6015.3	6016.5	6017.8	6019.0	6020.3	6021.5	6022.7	1023.10
1023.20	6024.0	6025.2	6026.4	6027.7	6028.9	6030.1	6031.4	6032.6	6033.8	6035.1	1023.20
1023.30	6036.3	6037.6	6038.8	6040.0	6041.3	6042.5	6043.7	6045.0	6046.2	6047.4	1023.30
1023.40	6048.7	6049.9	6051.1	6052.4	6053.6	6054.8	6056.1	6057.3	6058.6	6059.8	1023.40
1023.50	6061.0	6062.3	6063.5	6064.7	6066.0	6067.2	6068.4	6069.7	6070.9	6072.1	1023.50
1023.60	6073.4	6074.6	6075.9	6077.1	6078.3	6079.6	6080.8	6082.0	6083.3	6084.5	1023.60
1023.70	6085.7	6087.0	6088.2	6089.4	6090.7	6091.9	6093.1	6094.4	6095.6	6096.9	1023.70
1023.80	6098.1	6099.3	6100.6	6101.8	6103.0	6104.3	6105.5	6106.7	6108.0	6109.2	1023.80
1023.90	6110.4	6111.7	6112.9	6114.2	6115.4	6116.6	6117.9	6119.1	6120.3	6121.6	1023.90
EVAP.	3.656	3.660	3.664	3.667	3.671	3.675	3.679	3.683	3.686	3.690	EVAP.

WESTLAKE RESERVOIR VOLUMES

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1024.00	6122.8	6124.1	6125.3	6126.6	6127.9	6129.1	6130.4	6131.6	6132.9	6134.2	1024.00
1024.10	6135.4	6136.7	6138.0	6139.2	6140.5	6141.8	6143.0	6144.3	6145.5	6146.8	1024.10
1024.20	6148.1	6149.3	6150.6	6151.9	6153.1	6154.4	6155.7	6156.9	6158.2	6159.4	1024.20
1024.30	6160.7	6162.0	6163.2	6164.5	6165.8	6167.0	6168.3	6169.5	6170.8	6172.1	1024.30
1024.40	6173.3	6174.6	6175.9	6177.1	6178.4	6179.7	6180.9	6182.2	6183.4	6184.7	1024.40
1024.50	6186.0	6187.2	6188.5	6189.8	6191.0	6192.3	6193.6	6194.8	6196.1	6197.3	1024.50
1024.60	6198.6	6199.9	6201.1	6202.4	6203.7	6204.9	6206.2	6207.5	6208.7	6210.0	1024.60
1024.70	6211.2	6212.5	6213.8	6215.0	6216.3	6217.6	6218.8	6220.1	6221.4	6222.6	1024.70
1024.80	6223.9	6225.1	6226.4	6227.7	6228.9	6230.2	6231.5	6232.7	6234.0	6235.3	1024.80
1024.90	6236.5	6237.8	6239.0	6240.3	6241.6	6242.8	6244.1	6245.4	6246.6	6247.9	1024.90
EVAP.	3.694	3.698	3.703	3.707	3.712	3.716	3.720	3.725	3.729	3.734	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1025.00	6249.2	6250.4	6251.7	6252.9	6254.2	6255.5	6256.7	6258.0	6259.3	6260.5	1025.00
1025.10	6261.8	6263.0	6264.3	6265.6	6266.8	6268.1	6269.4	6270.6	6271.9	6273.2	1025.10
1025.20	6274.4	6275.7	6276.9	6278.2	6279.5	6280.7	6282.0	6283.3	6284.5	6285.8	1025.20
1025.30	6287.1	6288.3	6289.6	6290.8	6292.1	6293.4	6294.6	6295.9	6297.2	6298.4	1025.30
1025.40	6299.7	6301.0	6302.2	6303.5	6304.7	6306.0	6307.3	6308.5	6309.8	6311.1	1025.40
1025.50	6312.3	6313.6	6314.9	6316.1	6317.4	6318.6	6319.9	6321.2	6322.4	6323.7	1025.50
1025.60	6325.0	6326.2	6327.5	6328.8	6330.0	6331.3	6332.5	6333.8	6335.1	6336.3	1025.60
1025.70	6337.6	6338.9	6340.1	6341.4	6342.6	6343.9	6345.2	6346.4	6347.7	6349.0	1025.70
1025.80	6350.2	6351.5	6352.8	6354.0	6355.3	6356.5	6357.8	6359.1	6360.3	6361.6	1025.80
1025.90	6362.9	6364.1	6365.4	6366.7	6367.9	6369.2	6370.4	6371.7	6373.0	6374.2	1025.90
EVAP.	3.738	3.742	3.747	3.751	3.756	3.760	3.764	3.769	3.773	3.778	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1026.00	6375.5	6376.8	6378.1	6379.4	6380.7	6382.0	6383.3	6384.5	6385.8	6387.1	1026.00
1026.10	6388.4	6389.7	6391.0	6392.3	6393.6	6394.9	6396.2	6397.5	6398.8	6400.0	1026.10
1026.20	6401.3	6402.6	6403.9	6405.2	6406.5	6407.8	6409.1	6410.4	6411.7	6413.0	1026.20
1026.30	6414.3	6415.6	6416.8	6418.1	6419.4	6420.7	6422.0	6423.3	6424.6	6425.9	1026.30
1026.40	6427.2	6428.5	6429.8	6431.1	6432.3	6433.6	6434.9	6436.2	6437.5	6438.8	1026.40
1026.50	6440.1	6441.4	6442.7	6444.0	6445.3	6446.6	6447.9	6449.1	6450.4	6451.7	1026.50
1026.60	6453.0	6454.3	6455.6	6456.9	6458.2	6459.5	6460.8	6462.1	6463.4	6464.6	1026.60
1026.70	6465.9	6467.2	6468.5	6469.8	6471.1	6472.4	6473.7	6475.0	6476.3	6477.6	1026.70
1026.80	6478.9	6480.2	6481.4	6482.7	6484.0	6485.3	6486.6	6487.9	6489.2	6490.5	1026.80
1026.90	6491.8	6493.1	6494.4	6495.7	6496.9	6498.2	6499.5	6500.8	6502.1	6503.4	1026.90
EVAP.	3.782	3.786	3.791	3.795	3.799	3.804	3.808	3.812	3.817	3.821	EVAP.

WESTLAKE RESERVOIR VOLUMES

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1027.00	6504.7	6506.0	6507.3	6508.6	6509.9	6511.2	6512.5	6513.7	6515.0	6516.3	1027.00
1027.10	6517.6	6518.9	6520.2	6521.5	6522.8	6524.1	6525.4	6526.7	6528.0	6529.2	1027.10
1027.20	6530.5	6531.8	6533.1	6534.4	6535.7	6537.0	6538.3	6539.6	6540.9	6542.2	1027.20
1027.30	6543.5	6544.8	6546.0	6547.3	6548.6	6549.9	6551.2	6552.5	6553.8	6555.1	1027.30
1027.40	6556.4	6557.7	6559.0	6560.3	6561.5	6562.8	6564.1	6565.4	6566.7	6568.0	1027.40
1027.50	6569.3	6570.6	6571.9	6573.2	6574.5	6575.8	6577.1	6578.3	6579.6	6580.9	1027.50
1027.60	6582.2	6583.5	6584.8	6586.1	6587.4	6588.7	6590.0	6591.3	6592.6	6593.8	1027.60
1027.70	6595.1	6596.4	6597.7	6599.0	6600.3	6601.6	6602.9	6604.2	6605.5	6606.8	1027.70
1027.80	6608.1	6609.4	6610.6	6611.9	6613.2	6614.5	6615.8	6617.1	6618.4	6619.7	1027.80
1027.90	6621.0	6622.3	6623.6	6624.9	6626.1	6627.4	6628.7	6630.0	6631.3	6632.6	1027.90
EVAP.	3.823	3.827	3.831	3.835	3.839	3.843	3.847	3.851	3.855	3.859	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1028.00	6633.9	6635.2	6636.5	6637.9	6639.2	6640.5	6641.8	6643.1	6644.5	6645.8	1028.00
1028.10	6647.1	6648.4	6649.7	6651.1	6652.4	6653.7	6655.0	6656.3	6657.7	6659.0	1028.10
1028.20	6660.3	6661.6	6662.9	6664.2	6665.6	6666.9	6668.2	6669.5	6670.8	6672.2	1028.20
1028.30	6673.5	6674.8	6676.1	6677.4	6678.8	6680.1	6681.4	6682.7	6684.0	6685.4	1028.30
1028.40	6686.7	6688.0	6689.3	6690.6	6692.0	6693.3	6694.6	6695.9	6697.2	6698.6	1028.40
1028.50	6699.9	6701.2	6702.5	6703.8	6705.2	6706.5	6707.8	6709.1	6710.4	6711.8	1028.50
1028.60	6713.1	6714.4	6715.7	6717.0	6718.3	6719.7	6721.0	6722.3	6723.6	6724.9	1028.60
1028.70	6726.3	6727.6	6728.9	6730.2	6731.5	6732.9	6734.2	6735.5	6736.8	6738.1	1028.70
1028.80	6739.5	6740.8	6742.1	6743.4	6744.7	6746.1	6747.4	6748.7	6750.0	6751.3	1028.80
1028.90	6752.7	6754.0	6755.3	6756.6	6757.9	6759.3	6760.6	6761.9	6763.2	6764.5	1028.90
EVAP.	3.863	3.867	3.871	3.875	3.879	3.883	3.887	3.891	3.895	3.899	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1029.00	6765.9	6767.2	6768.5	6769.8	6771.1	6772.4	6773.8	6775.1	6776.4	6777.7	1029.00
1029.10	6779.0	6780.4	6781.7	6783.0	6784.3	6785.6	6787.0	6788.3	6789.6	6790.9	1029.10
1029.20	6792.2	6793.6	6794.9	6796.2	6797.5	6798.8	6800.2	6801.5	6802.8	6804.1	1029.20
1029.30	6805.4	6806.8	6808.1	6809.4	6810.7	6812.0	6813.4	6814.7	6816.0	6817.3	1029.30
1029.40	6818.6	6819.9	6821.3	6822.6	6823.9	6825.2	6826.5	6827.9	6829.2	6830.5	1029.40
1029.50	6831.8	6833.1	6834.5	6835.8	6837.1	6838.4	6839.7	6841.1	6842.4	6843.7	1029.50
1029.60	6845.0	6846.3	6847.7	6849.0	6850.3	6851.6	6852.9	6854.3	6855.6	6856.9	1029.60
1029.70	6858.2	6859.5	6860.9	6862.2	6863.5	6864.8	6866.1	6867.5	6868.8	6870.1	1029.70
1029.80	6871.4	6872.7	6874.0	6875.4	6876.7	6878.0	6879.3	6880.6	6882.0	6883.3	1029.80
1029.90	6884.6	6885.9	6887.2	6888.6	6889.9	6891.2	6892.5	6893.8	6895.2	6896.5	1029.90
EVAP.	3.903	3.907	3.911	3.915	3.919	3.923	3.927	3.931	3.935	3.939	EVAP.

WESTLAKE RESERVOIR VOLUMES

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1030.00	6897.8	6899.1	6900.5	6901.8	6903.2	6904.5	6905.9	6907.2	6908.6	6909.9	1030.00
1030.10	6911.3	6912.6	6914.0	6915.3	6916.7	6918.0	6919.4	6920.7	6922.0	6923.4	1030.10
1030.20	6924.7	6926.1	6927.4	6928.8	6930.1	6931.5	6932.8	6934.2	6935.5	6936.9	1030.20
1030.30	6938.2	6939.6	6940.9	6942.3	6943.6	6944.9	6946.3	6947.6	6949.0	6950.3	1030.30
1030.40	6951.7	6953.0	6954.4	6955.7	6957.1	6958.4	6959.8	6961.1	6962.5	6963.8	1030.40
1030.50	6965.2	6966.5	6967.8	6969.2	6970.5	6971.9	6973.2	6974.6	6975.9	6977.3	1030.50
1030.60	6978.6	6980.0	6981.3	6982.7	6984.0	6985.4	6986.7	6988.0	6989.4	6990.7	1030.60
1030.70	6992.1	6993.4	6994.8	6996.1	6997.5	6998.8	7000.2	7001.5	7002.9	7004.2	1030.70
1030.80	7005.6	7006.9	7008.3	7009.6	7010.9	7012.3	7013.6	7015.0	7016.3	7017.7	1030.80
1030.90	7019.0	7020.4	7021.7	7023.1	7024.4	7025.8	7027.1	7028.5	7029.8	7031.2	1030.90
EVAP.	3.943	3.947	3.951	3.956	3.960	3.964	3.968	3.972	3.977	3.981	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1031.00	7032.5	7033.8	7035.2	7036.5	7037.9	7039.2	7040.6	7041.9	7043.3	7044.6	1031.00
1031.10	7046.0	7047.3	7048.7	7050.0	7051.4	7052.7	7054.1	7055.4	7056.7	7058.1	1031.10
1031.20	7059.4	7060.8	7062.1	7063.5	7064.8	7066.2	7067.5	7068.9	7070.2	7071.6	1031.20
1031.30	7072.9	7074.3	7075.6	7077.0	7078.3	7079.6	7081.0	7082.3	7083.7	7085.0	1031.30
1031.40	7086.4	7087.7	7089.1	7090.4	7091.8	7093.1	7094.5	7095.8	7097.2	7098.5	1031.40
1031.50	7099.9	7101.2	7102.5	7103.9	7105.2	7106.6	7107.9	7109.3	7110.6	7112.0	1031.50
1031.60	7113.3	7114.7	7116.0	7117.4	7118.7	7120.1	7121.4	7122.7	7124.1	7125.4	1031.60
1031.70	7126.8	7128.1	7129.5	7130.8	7132.2	7133.5	7134.9	7136.2	7137.6	7138.9	1031.70
1031.80	7140.3	7141.6	7143.0	7144.3	7145.6	7147.0	7148.3	7149.7	7151.0	7152.4	1031.80
1031.90	7153.7	7155.1	7156.4	7157.8	7159.1	7160.5	7161.8	7163.2	7164.5	7165.9	1031.90
EVAP.	3.985	3.989	3.993	3.998	4.002	4.006	4.010	4.014	4.019	4.023	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1032.00	7167.2	7168.6	7170.0	7171.3	7172.7	7174.1	7175.5	7176.8	7178.2	7179.6	1032.00
1032.10	7181.0	7182.3	7183.7	7185.1	7186.5	7187.8	7189.2	7190.6	7192.0	7193.3	1032.10
1032.20	7194.7	7196.1	7197.5	7198.8	7200.2	7201.6	7203.0	7204.3	7205.7	7207.1	1032.20
1032.30	7208.5	7209.8	7211.2	7212.6	7214.0	7215.3	7216.7	7218.1	7219.5	7220.8	1032.30
1032.40	7222.2	7223.6	7225.0	7226.3	7227.7	7229.1	7230.5	7231.8	7233.2	7234.6	1032.40
1032.50	7236.0	7237.4	7238.7	7240.1	7241.5	7242.9	7244.2	7245.6	7247.0	7248.4	1032.50
1032.60	7249.7	7251.1	7252.5	7253.9	7255.2	7256.6	7258.0	7259.4	7260.7	7262.1	1032.60
1032.70	7263.5	7264.9	7266.2	7267.6	7269.0	7270.4	7271.7	7273.1	7274.5	7275.9	1032.70
1032.80	7277.2	7278.6	7280.0	7281.4	7282.7	7284.1	7285.5	7286.9	7288.2	7289.6	1032.80
1032.90	7291.0	7292.4	7293.7	7295.1	7296.5	7297.9	7299.2	7300.6	7302.0	7303.4	1032.90
EVAP.	4.027	4.031	4.036	4.040	4.044	4.048	4.053	4.057	4.061	4.065	EVAP.

WESTLAKE RESERVOIR VOLUMES

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1033.00	7304.8	7306.1	7307.5	7308.9	7310.3	7311.6	7313.0	7314.4	7315.8	7317.1	1033.00
1033.10	7318.5	7319.9	7321.3	7322.6	7324.0	7325.4	7326.8	7328.1	7329.5	7330.9	1033.10
1033.20	7332.3	7333.6	7335.0	7336.4	7337.8	7339.1	7340.5	7341.9	7343.3	7344.6	1033.20
1033.30	7346.0	7347.4	7348.8	7350.1	7351.5	7352.9	7354.3	7355.6	7357.0	7358.4	1033.30
1033.40	7359.8	7361.1	7362.5	7363.9	7365.3	7366.6	7368.0	7369.4	7370.8	7372.1	1033.40
1033.50	7373.5	7374.9	7376.3	7377.7	7379.0	7380.4	7381.8	7383.2	7384.5	7385.9	1033.50
1033.60	7387.3	7388.7	7390.0	7391.4	7392.8	7394.2	7395.5	7396.9	7398.3	7399.7	1033.60
1033.70	7401.0	7402.4	7403.8	7405.2	7406.5	7407.9	7409.3	7410.7	7412.0	7413.4	1033.70
1033.80	7414.8	7416.2	7417.5	7418.9	7420.3	7421.7	7423.0	7424.4	7425.8	7427.2	1033.80
1033.90	7428.5	7429.9	7431.3	7432.7	7434.0	7435.4	7436.8	7438.2	7439.5	7440.9	1033.90
EVAP.	4.070	4.074	4.078	4.082	4.087	4.091	4.095	4.099	4.104	4.108	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1034.00	7442.3	7443.7	7445.1	7446.5	7447.9	7449.3	7450.7	7452.1	7453.5	7454.9	1034.00
1034.10	7456.3	7457.7	7459.1	7460.5	7461.9	7463.4	7464.8	7466.2	7467.6	7469.0	1034.10
1034.20	7470.4	7471.8	7473.2	7474.6	7476.0	7477.4	7478.8	7480.2	7481.6	7483.0	1034.20
1034.30	7484.4	7485.8	7487.2	7488.6	7490.0	7491.4	7492.8	7494.2	7495.6	7497.0	1034.30
1034.40	7498.4	7499.8	7501.2	7502.7	7504.1	7505.5	7506.9	7508.3	7509.7	7511.1	1034.40
1034.50	7512.5	7513.9	7515.3	7516.7	7518.1	7519.5	7520.9	7522.3	7523.7	7525.1	1034.50
1034.60	7526.5	7527.9	7529.3	7530.7	7532.1	7533.5	7534.9	7536.3	7537.7	7539.1	1034.60
1034.70	7540.5	7541.9	7543.4	7544.8	7546.2	7547.6	7549.0	7550.4	7551.8	7553.2	1034.70
1034.80	7554.6	7556.0	7557.4	7558.8	7560.2	7561.6	7563.0	7564.4	7565.8	7567.2	1034.80
1034.90	7568.6	7570.0	7571.4	7572.8	7574.2	7575.6	7577.0	7578.4	7579.8	7581.2	1034.90
EVAP.	4.112	4.116	4.120	4.124	4.128	4.132	4.136	4.140	4.144	4.148	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1035.00	7582.7	7584.1	7585.5	7586.9	7588.3	7589.7	7591.1	7592.5	7593.9	7595.3	1035.00
1035.10	7596.7	7598.1	7599.5	7600.9	7602.3	7603.7	7605.1	7606.5	7607.9	7609.3	1035.10
1035.20	7610.7	7612.1	7613.5	7614.9	7616.3	7617.7	7619.1	7620.5	7621.9	7623.4	1035.20
1035.30	7624.8	7626.2	7627.6	7629.0	7630.4	7631.8	7633.2	7634.6	7636.0	7637.4	1035.30
1035.40	7638.8	7640.2	7641.6	7643.0	7644.4	7645.8	7647.2	7648.6	7650.0	7651.4	1035.40
1035.50	7652.8	7654.2	7655.6	7657.0	7658.4	7659.8	7661.2	7662.6	7664.1	7665.5	1035.50
1035.60	7666.9	7668.3	7669.7	7671.1	7672.5	7673.9	7675.3	7676.7	7678.1	7679.5	1035.60
1035.70	7680.9	7682.3	7683.7	7685.1	7686.5	7687.9	7689.3	7690.7	7692.1	7693.5	1035.70
1035.80	7694.9	7696.3	7697.7	7699.1	7700.5	7701.9	7703.4	7704.8	7706.2	7707.6	1035.80
1035.90	7709.0	7710.4	7711.8	7713.2	7714.6	7716.0	7717.4	7718.8	7720.2	7721.6	1035.90
EVAP.	4.152	4.155	4.159	4.163	4.167	4.171	4.175	4.179	4.183	4.187	EVAP.

WESTLAKE RESERVOIR VOLUMES

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1036.00	7723.0	7724.4	7725.9	7727.3	7728.7	7730.1	7731.6	7733.0	7734.4	7735.9	1036.00
1036.10	7737.3	7738.7	7740.1	7741.6	7743.0	7744.4	7745.9	7747.3	7748.7	7750.2	1036.10
1036.20	7751.6	7753.0	7754.4	7755.9	7757.3	7758.7	7760.2	7761.6	7763.0	7764.4	1036.20
1036.30	7765.9	7767.3	7768.7	7770.2	7771.6	7773.0	7774.4	7775.9	7777.3	7778.7	1036.30
1036.40	7780.2	7781.6	7783.0	7784.4	7785.9	7787.3	7788.7	7790.2	7791.6	7793.0	1036.40
1036.50	7794.5	7795.9	7797.3	7798.7	7800.2	7801.6	7803.0	7804.5	7805.9	7807.3	1036.50
1036.60	7808.7	7810.2	7811.6	7813.0	7814.5	7815.9	7817.3	7818.7	7820.2	7821.6	1036.60
1036.70	7823.0	7824.5	7825.9	7827.3	7828.7	7830.2	7831.6	7833.0	7834.5	7835.9	1036.70
1036.80	7837.3	7838.7	7840.2	7841.6	7843.0	7844.5	7845.9	7847.3	7848.8	7850.2	1036.80
1036.90	7851.6	7853.0	7854.5	7855.9	7857.3	7858.8	7860.2	7861.6	7863.0	7864.5	1036.90
EVAP.	4.191	4.195	4.198	4.202	4.206	4.209	4.213	4.217	4.220	4.224	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1037.00	7865.9	7867.3	7868.8	7870.2	7871.6	7873.0	7874.5	7875.9	7877.3	7878.8	1037.00
1037.10	7880.2	7881.6	7883.0	7884.5	7885.9	7887.3	7888.8	7890.2	7891.6	7893.1	1037.10
1037.20	7894.5	7895.9	7897.3	7898.8	7900.2	7901.6	7903.1	7904.5	7905.9	7907.3	1037.20
1037.30	7908.8	7910.2	7911.6	7913.1	7914.5	7915.9	7917.3	7918.8	7920.2	7921.6	1037.30
1037.40	7923.1	7924.5	7925.9	7927.3	7928.8	7930.2	7931.6	7933.1	7934.5	7935.9	1037.40
1037.50	7937.4	7938.8	7940.2	7941.6	7943.1	7944.5	7945.9	7947.4	7948.8	7950.2	1037.50
1037.60	7951.6	7953.1	7954.5	7955.9	7957.4	7958.8	7960.2	7961.6	7963.1	7964.5	1037.60
1037.70	7965.9	7967.4	7968.8	7970.2	7971.6	7973.1	7974.5	7975.9	7977.4	7978.8	1037.70
1037.80	7980.2	7981.6	7983.1	7984.5	7985.9	7987.4	7988.8	7990.2	7991.7	7993.1	1037.80
1037.90	7994.5	7995.9	7997.4	7998.8	8000.2	8001.7	8003.1	8004.5	8005.9	8007.4	1037.90
EVAP.	4.228	4.231	4.235	4.238	4.242	4.246	4.249	4.253	4.257	4.260	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1038.00	8008.8	8010.3	8011.7	8013.2	8014.6	8016.1	8017.5	8019.0	8020.4	8021.9	1038.00
1038.10	8023.4	8024.8	8026.3	8027.7	8029.2	8030.6	8032.1	8033.6	8035.0	8036.5	1038.10
1038.20	8037.9	8039.4	8040.8	8042.3	8043.7	8045.2	8046.7	8048.1	8049.6	8051.0	1038.20
1038.30	8052.5	8053.9	8055.4	8056.8	8058.3	8059.8	8061.2	8062.7	8064.1	8065.6	1038.30
1038.40	8067.0	8068.5	8070.0	8071.4	8072.9	8074.3	8075.8	8077.2	8078.7	8080.1	1038.40
1038.50	8081.6	8083.1	8084.5	8086.0	8087.4	8088.9	8090.3	8091.8	8093.2	8094.7	1038.50
1038.60	8096.2	8097.6	8099.1	8100.5	8102.0	8103.4	8104.9	8106.4	8107.8	8109.3	1038.60
1038.70	8110.7	8112.2	8113.6	8115.1	8116.5	8118.0	8119.5	8120.9	8122.4	8123.8	1038.70
1038.80	8125.3	8126.7	8128.2	8129.6	8131.1	8132.6	8134.0	8135.5	8136.9	8138.4	1038.80
1038.90	8139.8	8141.3	8142.8	8144.2	8145.7	8147.1	8148.6	8150.0	8151.5	8152.9	1038.90
EVAP.	4.264	4.268	4.273	4.277	4.281	4.286	4.290	4.294	4.299	4.303	EVAP.

WESTLAKE RESERVOIR VOLUMES

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1039.00	8154.4	8155.9	8157.3	8158.8	8160.2	8161.7	8163.1	8164.6	8166.0	8167.5	1039.00
1039.10	8169.0	8170.4	8171.9	8173.3	8174.8	8176.2	8177.7	8179.2	8180.6	8182.1	1039.10
1039.20	8183.5	8185.0	8186.4	8187.9	8189.3	8190.8	8192.3	8193.7	8195.2	8196.6	1039.20
1039.30	8198.1	8199.5	8201.0	8202.4	8203.9	8205.4	8206.8	8208.3	8209.7	8211.2	1039.30
1039.40	8212.6	8214.1	8215.6	8217.0	8218.5	8219.9	8221.4	8222.8	8224.3	8225.7	1039.40
1039.50	8227.2	8228.7	8230.1	8231.6	8233.0	8234.5	8235.9	8237.4	8238.8	8240.3	1039.50
1039.60	8241.8	8243.2	8244.7	8246.1	8247.6	8249.0	8250.5	8252.0	8253.4	8254.9	1039.60
1039.70	8256.3	8257.8	8259.2	8260.7	8262.1	8263.6	8265.1	8266.5	8268.0	8269.4	1039.70
1039.80	8270.9	8272.3	8273.8	8275.2	8276.7	8278.2	8279.6	8281.1	8282.5	8284.0	1039.80
1039.90	8285.4	8286.9	8288.4	8289.8	8291.3	8292.7	8294.2	8295.6	8297.1	8298.5	1039.90
EVAP.	4.308	4.312	4.316	4.321	4.325	4.329	4.334	4.338	4.342	4.347	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1040.00	8300.0	8301.5	8303.0	8304.5	8305.9	8307.4	8308.9	8310.4	8311.9	8313.4	1040.00
1040.10	8314.9	8316.4	8317.8	8319.3	8320.8	8322.3	8323.8	8325.3	8326.8	8328.2	1040.10
1040.20	8329.7	8331.2	8332.7	8334.2	8335.7	8337.2	8338.6	8340.1	8341.6	8343.1	1040.20
1040.30	8344.6	8346.1	8347.6	8349.1	8350.5	8352.0	8353.5	8355.0	8356.5	8358.0	1040.30
1040.40	8359.5	8360.9	8362.4	8363.9	8365.4	8366.9	8368.4	8369.9	8371.4	8372.8	1040.40
1040.50	8374.3	8375.8	8377.3	8378.8	8380.3	8381.8	8383.2	8384.7	8386.2	8387.7	1040.50
1040.60	8389.2	8390.7	8392.2	8393.6	8395.1	8396.6	8398.1	8399.6	8401.1	8402.6	1040.60
1040.70	8404.1	8405.5	8407.0	8408.5	8410.0	8411.5	8413.0	8414.5	8415.9	8417.4	1040.70
1040.80	8418.9	8420.4	8421.9	8423.4	8424.9	8426.4	8427.8	8429.3	8430.8	8432.3	1040.80
1040.90	8433.8	8435.3	8436.8	8438.2	8439.7	8441.2	8442.7	8444.2	8445.7	8447.2	1040.90
EVAP.	4.351	4.356	4.360	4.365	4.369	4.374	4.379	4.383	4.388	4.392	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1041.00	8448.7	8450.1	8451.6	8453.1	8454.6	8456.1	8457.6	8459.1	8460.5	8462.0	1041.00
1041.10	8463.5	8465.0	8466.5	8468.0	8469.5	8470.9	8472.4	8473.9	8475.4	8476.9	1041.10
1041.20	8478.4	8479.9	8481.4	8482.8	8484.3	8485.8	8487.3	8488.8	8490.3	8491.8	1041.20
1041.30	8493.2	8494.7	8496.2	8497.7	8499.2	8500.7	8502.2	8503.7	8505.1	8506.6	1041.30
1041.40	8508.1	8509.6	8511.1	8512.6	8514.1	8515.5	8517.0	8518.5	8520.0	8521.5	1041.40
1041.50	8523.0	8524.5	8525.9	8527.4	8528.9	8530.4	8531.9	8533.4	8534.9	8536.4	1041.50
1041.60	8537.8	8539.3	8540.8	8542.3	8543.8	8545.3	8546.8	8548.2	8549.7	8551.2	1041.60
1041.70	8552.7	8554.2	8555.7	8557.2	8558.7	8560.1	8561.6	8563.1	8564.6	8566.1	1041.70
1041.80	8567.6	8569.1	8570.5	8572.0	8573.5	8575.0	8576.5	8578.0	8579.5	8580.9	1041.80
1041.90	8582.4	8583.9	8585.4	8586.9	8588.4	8589.9	8591.4	8592.8	8594.3	8595.8	1041.90
EVAP.	4.397	4.402	4.406	4.411	4.415	4.420	4.425	4.429	4.434	4.438	EVAP.

WESTLAKE RESERVOIR VOLUMES

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1042.00	8597.3	8598.8	8600.3	8601.8	8603.4	8604.9	8606.4	8607.9	8609.4	8610.9	1042.00
1042.10	8612.5	8614.0	8615.5	8617.0	8618.5	8620.0	8621.6	8623.1	8624.6	8626.1	1042.10
1042.20	8627.6	8629.1	8630.7	8632.2	8633.7	8635.2	8636.7	8638.2	8639.7	8641.3	1042.20
1042.30	8642.8	8644.3	8645.8	8647.3	8648.8	8650.4	8651.9	8653.4	8654.9	8656.4	1042.30
1042.40	8657.9	8659.5	8661.0	8662.5	8664.0	8665.5	8667.0	8668.6	8670.1	8671.6	1042.40
1042.50	8673.1	8674.6	8676.1	8677.6	8679.2	8680.7	8682.2	8683.7	8685.2	8686.7	1042.50
1042.60	8688.3	8689.8	8691.3	8692.8	8694.3	8695.8	8697.4	8698.9	8700.4	8701.9	1042.60
1042.70	8703.4	8704.9	8706.5	8708.0	8709.5	8711.0	8712.5	8714.0	8715.5	8717.1	1042.70
1042.80	8718.6	8720.1	8721.6	8723.1	8724.6	8726.2	8727.7	8729.2	8730.7	8732.2	1042.80
1042.90	8733.7	8735.3	8736.8	8738.3	8739.8	8741.3	8742.8	8744.4	8745.9	8747.4	1042.90
EVAP.	4.443	4.447	4.451	4.456	4.460	4.464	4.468	4.472	4.477	4.481	EVAP.
ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1043.00	8748.9	8750.4	8751.9	8753.4	8755.0	8756.5	8758.0	8759.5	8761.0	8762.5	1043.00
1043.10	8764.1	8765.6	8767.1	8768.6	8770.1	8771.6	8773.2	8774.7	8776.2	8777.7	1043.10
1043.20	8779.2	8780.7	8782.3	8783.8	8785.3	8786.8	8788.3	8789.8	8791.3	8792.9	1043.20
1043.30	8794.4	8795.9	8797.4	8798.9	8800.4	8802.0	8903.5	8805.0	8806.5	8808.0	1043.30
1043.40	8809.5	8811.1	8812.6	8814.1	8815.6	8817.1	8818.6	8820.2	8821.7	8823.2	1043.40
1043.50	8824.7	8826.2	8827.7	8829.2	8830.8	8832.3	8933.8	8835.3	8836.8	8838.3	1043.50
1043.60	8839.9	8841.4	8842.9	8844.4	8845.9	8847.4	8849.0	8850.5	8852.0	8853.5	1043.60
1043.70	8855.0	8856.5	8858.1	8859.6	8861.1	8862.6	8864.1	8865.6	8867.1	8868.7	1043.70
1043.80	8870.2	8871.7	8873.2	8874.7	8876.2	8877.8	8879.3	8880.8	8882.3	8883.8	1043.80
1043.90	8885.3	8886.9	8888.4	8889.9	8891.4	8892.9	8894.4	8896.0	8897.5	8899.0	1043.90
EVAP.	4.485	4.489	4.493	4.498	4.502	4.506	4.510	4.514	4.519	4.523	EVAP.
ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1044.00	8900.5	8902.0	8903.6	8905.1	8906.7	8908.2	8909.8	8911.3	8912.8	8914.4	1044.00
1044.10	8915.9	8917.5	8919.0	8920.5	9922.1	8923.6	8925.2	8926.7	8928.3	8929.8	1044.10
1044.20	8931.3	8932.9	8934.4	8936.0	8937.5	8939.1	8940.6	8942.1	8943.7	8945.2	1044.20
1044.30	8946.8	8948.3	8949.8	8951.4	8952.9	8954.5	9956.0	8957.6	8959.1	8960.6	1044.30
1044.40	8962.2	8963.7	8965.3	8966.8	8968.3	8969.9	8971.4	8973.0	8974.5	8976.1	1044.40
1044.50	8977.6	8979.1	8980.7	8982.2	8983.8	8985.3	8986.9	8988.4	8989.9	8991.5	1044.50
1044.60	8993.0	8994.6	8996.1	8997.6	8999.2	9000.7	9002.3	9003.8	9005.4	9006.9	1044.60
1044.70	9008.4	9010.0	9011.5	9013.1	9014.6	9016.2	9017.7	9019.2	9020.8	9022.3	1044.70
1044.80	9023.9	9025.4	9026.9	9028.5	9030.0	9031.6	9033.1	9034.7	9036.2	9037.7	1044.80
1044.90	9039.3	9040.8	9042.4	9043.9	9045.4	9047.0	9048.5	9050.1	9051.6	9053.2	1044.90
EVAP.	4.527	4.531	4.534	4.538	4.541	4.545	4.548	4.552	4.555	4.559	EVAP.

WESTLAKE RESERVOIR VOLUMES

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1045.00	9054.7	9056.2	9057.8	9059.3	9060.9	9062.4	9064.0	9065.5	9067.0	9068.6	1045.00
1045.10	9070.1	9071.7	9073.2	9074.7	9076.3	9077.8	9079.4	9080.9	9082.5	9084.0	1045.10
1045.20	9085.5	9087.1	9088.6	9090.2	9091.7	9093.3	9094.8	9096.3	9097.9	9099.4	1045.20
1045.30	9101.0	9102.5	9104.0	9105.6	9107.1	9108.7	9110.2	9111.8	9113.3	9114.8	1045.30
1045.40	9116.4	9117.9	9119.5	9121.0	9122.5	9124.1	9125.6	9127.2	9128.7	9130.3	1045.40
1045.50	9131.8	9133.3	9134.9	9136.4	9138.0	9139.5	9141.1	9142.6	9144.1	9145.7	1045.50
1045.60	9147.2	9148.8	9150.3	9151.8	9153.4	9154.9	9156.5	9158.0	9159.6	9161.1	1045.60
1045.70	9162.6	9164.2	9165.7	9167.3	9168.8	9170.4	9171.9	9173.4	9175.0	9176.5	1045.70
1045.80	9178.1	9179.6	9181.1	9182.7	9184.2	9185.8	9187.3	9188.9	9190.4	9191.9	1045.80
1045.90	9193.5	9195.0	9196.6	9198.1	9199.6	9201.2	9202.7	9204.3	9205.8	9207.4	1045.90
EVAP.	4.562	4.566	4.569	4.573	4.576	4.580	4.583	4.587	4.590	4.594	EVAP.

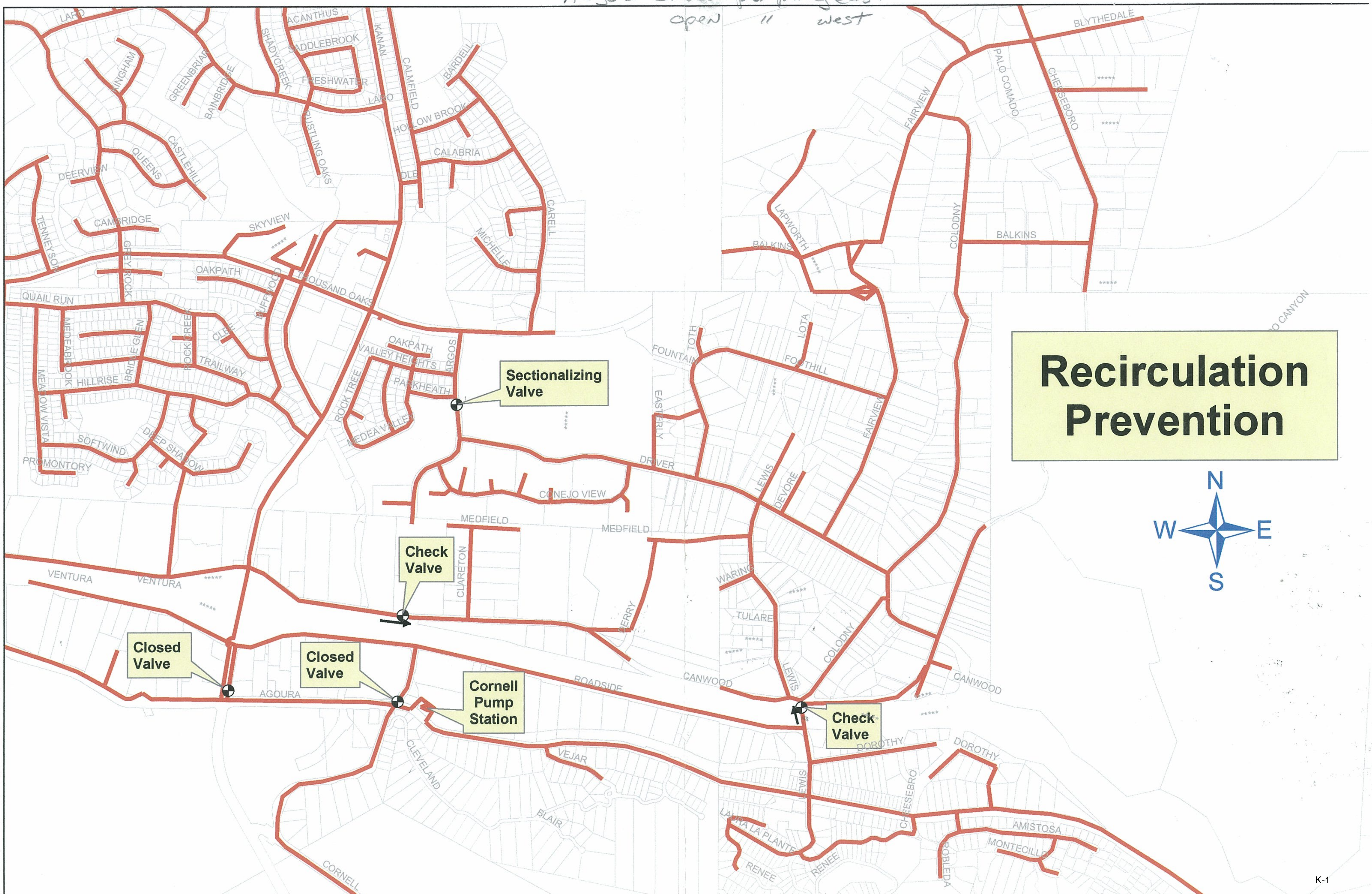
ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1046.00	9208.9	9210.5	9212.0	9213.6	9215.2	9216.7	9218.3	9219.9	9221.4	9223.0	1046.00
1046.10	9224.6	9226.2	9227.7	9229.3	9230.9	9232.4	9234.0	9235.6	9237.1	9238.7	1046.10
1046.20	9240.3	9241.8	9243.4	9245.0	9246.5	9248.1	9249.7	9251.2	9252.8	9254.4	1046.20
1046.30	9256.0	9257.5	9259.1	9260.7	9262.2	9263.8	9265.4	9266.9	9268.5	9270.1	1046.30
1046.40	9271.6	9273.2	9274.8	9276.3	9277.9	9279.5	9281.1	9282.6	9284.2	9285.8	1046.40
1046.50	9287.3	9288.9	9290.5	9292.0	9293.6	9295.2	9296.7	9298.3	9299.9	9301.4	1046.50
1046.60	9303.0	9304.6	9306.1	9307.7	9309.3	9310.9	9312.4	9314.0	9315.6	9317.1	1046.60
1046.70	9318.7	9320.3	9321.8	9323.4	9325.0	9326.5	9328.1	9329.7	9331.2	9332.8	1046.70
1046.80	9334.4	9335.9	9337.5	9339.1	9340.7	9342.2	9343.8	9345.4	9346.9	9348.5	1046.80
1046.90	9350.1	9351.6	9353.2	9354.8	9356.3	9357.9	9359.5	9361.0	9362.6	9364.2	1046.90
EVAP.	4.597	4.601	4.606	4.610	4.615	4.619	4.623	4.628	4.632	4.637	EVAP.

ELEV.	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	ELEV.
1047.00	9365.8	9367.3	9368.9	9370.5	9372.0	9373.6	9375.2	9376.7	9378.3	9379.9	1047.00
1047.10	9381.4	9383.0	9384.6	9386.1	9387.7	9389.3	9390.8	9392.4	9394.0	9395.6	1047.10
1047.20	9397.1	9398.7	9400.3	9401.8	9403.4	9405.0	9406.5	9408.1	9409.7	9411.2	1047.20
1047.30	9412.8	9414.4	9415.9	9417.5	9419.1	9420.6	9422.2	9423.8	9425.4	9426.9	1047.30
1047.40	9428.5	9430.1	9431.6	9433.2	9434.8	9436.3	9437.9	9439.5	9441.0	9442.6	1047.40
1047.50	9444.2	9445.7	9447.3	9448.9	9450.4	9452.0	9453.6	9455.2	9456.7	9458.3	1047.50
1047.60	9459.9	9461.4	9463.0	9464.6	9466.1	9467.7	9469.3	9470.8	9472.4	9474.0	1047.60
1047.70	9475.5	9477.1	9478.7	9480.3	9481.8	9483.4	9485.0	9486.5	9488.1	9489.7	1047.70
1047.80	9491.2	9492.8	9494.4	9495.9	9497.5	9499.1	9500.6	9502.2	9503.8	9505.3	1047.80
1047.90	9506.9	9508.5	9510.1	9511.6	9513.2	9514.8	9516.3	9517.9	9519.5	9521.0	1047.90
EVAP.	4.641	4.645	4.650	4.654	4.659	4.663	4.667	4.672	4.676	4.681	EVAP.

Appendix K

Cornell Pump Station Recirculation Prevention Program

Argos closed pumping east
open " west



Appendix L

Landuse Duty Factors

Las Virgenes Municipal Water District Potable Water Master Plan Demand Factors by Land Use							
			Demographics		Demand Factors for Existing ADD		
City/Area	Landuse	Description	Density for Analysis	Pop/du	gpd/capita	gpd/acre	Estimated gpm/acre
Agoura Hills	RR	Rural Residential	0.2	3.15	325	204.75	0.14
Agoura Hills	RV	Very low density	0.5	3.15	325	511.88	0.36
Agoura Hills	RL	Low density residential	0.5	3.15	325	511.88	0.36
Agoura Hills	RL	Single family residential	3.7	3.15	190	2214.45	1.54
Agoura Hills	RS-k	Single family residential-Kimberly (added by Boyle)	3	3.15	325	3071.25	2.13
Agoura Hills	RM	Medium density residential	8	3.15	190	4788	3.33
Agoura Hills	RH	High density residential	13	3.15	190	7780.5	5.4
Agoura Hills	CD	Shopping center commercial	-	-	-	870	0.6
Agoura Hills	CV	Commercial – Visitor serving	-	-	-	870	0.6
Agoura Hills	CG	Retail service commercial	-	-	-	870	0.6
Agoura Hills	BP-O/R	Business park office retail	-	-	-	870	0.6
Agoura Hills	BP-M	Business Park Manufacturing	-	-	-	870	0.6
Agoura Hills	OS=R	Open Space-Restricted	0.2	3.15	325	204.75	0.14
Agoura Hills	OS-R/DR	Open Space-Resricted/Deed Restricted	0.2	3.15	325	204.75	0.14
Agoura Hills	P	Local Park	-	-	-	50	0.03
Agoura Hills	PR	Regional Park/Recreation	-	-	-	50	0.03
Agoura Hills	CR	Recreation Commercial	-	-	-	50	0.03
Agoura Hills	OW	Open Water	-	-	-	-	-
Agoura Hills	PF	Public Facility	-	-	-	275	0.19
Agoura Hills	SP	Specific Plan	-	-	-	-	-
Agoura Hills	T	Transportation	-	-	-	-	-
Calabasas	R-SF	Residential-Single Family	2.8	2.8	250	1960	1.36
Calabasas	R-SF-NM	Residential-Single Family-New Millennium Development (added by Boyle)	0.9	2.8	300	756	0.53
Calabasas	R-SF-Mc	Residential-Single Family-McCoy (added by Boyle)	2.8	2.8	325	2548	1.77
Calabasas	R-DF-CCW	Residential-Single Family-Cold Cyn/Warner (added by Boyle)	2.8	2.8	175	1372	0.95
Calabasas	R-MF	Residential-Multiple Family	7	2.8	200	3920	2.72
Calabasas	R-MH	Residential-Mobile Home	5	2.8	150	2100	1.46
Calabasas	B-LI	Business-Limited Intensity	-	-	-	2000	1.39
Calabasas	B-R	Business-Retail	-	-	-	2000	1.39
Calabasas	B-PO	Business-Professional Office	-	-	-	2000	1.39
Calabasas	B-BP	Business Park	-	-	-	2000	1.39
Calabasas	B-OT	Old Town	-	-	-	2000	1.39
Calabasas	MU	Mixed Use	-	-	-	2000	1.39
Calabasas	PF-1	Public Facilities-Institutional	-	-	-	450	0.31
Calabasas	PF-R	Public Facilities-Recreational	-	-	-	40	0.03
Calabasas	HM	Hillside-Mountainous	0.1	2.8	300	84	0.06
Calabasas	RR	Rural Residential	0.8	2.8	300	630	0.44
Calabasas	RC	Rural Community	1.5	2.8	200	840	0.58
Calabasas	OS-R	Open Space-Recreational	-	-	-	40	0.03
Calabasas	OS-RP	Open Space-Resource Protection	0	2.8	300	5.25	0
Calabasas	RR-UH	Rural Residential-Urban Hillside	0.8	2.8	300	1624	1.13
Calabasas	T	Transportation	-	-	-	-	-
Hidden Hills	R-A-S	Residential-Agricultural, Suburban	0.6	3.5	660	1339.8	0.93
Hidden Hills	R-A-S2	Residential-Agricultural, Suburban	0.6	3.5	660	1339.8	0.93
Hidden Hills	C-U	Community Use				900	0.64
Hidden Hills	R-1	Single Family Residential	2	3.5	660	4620	3.21

Las Virgenes Municipal Water District Potable Water Master Plan Demand Factors by Land Use							
			Demographics		Demand Factors for Existing ADD		
City/Area	Landuse	Description	Density for Analysis	Pop/du	gpd/capita	gpd/acre	Estimated gpm/acre
Hidden Hills	C-R	Commercial Restricted	-	-	-	2000	1.39
Hidden Hills	T	Transportation	-	-	-	-	-
LA County	1	Low Density Residential	4	2.95	100	1180	0.82
LA County	2	Low/Medium Density Residential	3	2.95	100	885	0.61
LA County	3	Medium Density Residential	15	2.95	100	4425	3.07
LA County	4	High Density Residential	15	2.95	100	4425	3.07
LA County	C	Major Commercial	-	-	-	1275	0.89
LA County	I	Major Industrial	-	-	-	1275	0.89
LA County	P	Public and Semi-Public Facilities	-	-	-	1500	1.04
LA County	R	Non-Urban	2	2.95	100	590	0.41
LA County	O	Open Space	-	-	-	-	-
LA County	SEA	Significant Ecological Areas	-	-	-	-	-
LA County	SP	Specific Plan	-	-	-	-	-
LA County-101 Corridor	OS	Open Space	-	-	-	-	-
LA County-101 Corridor	OS-P	Open Space Parks	-	-	-	-	-
LA County-101 Corridor	OS-DR	Open Space Deed Restricted	-	-	-	-	-
LA County-101 Corridor	OS-W	Open Space Water	-	-	-	-	-
LA County-101 Corridor	N20	Mountain Lands 20	0.1	2.95	250	36.88	0.03
LA County-101 Corridor	N10	Mountain Lands 10	0.1	2.95	250	73.75	0.05
LA County-101 Corridor	N5	Mountain Lands 5	0.2	2.95	250	147.5	0.1
LA County-101 Corridor	N2	Mountain Lands 2	0.5	2.95	250	368.75	0.26
LA County-101 Corridor	N1	Mountain Lands 1	1	2.95	250	737.5	0.51
LA County-101 Corridor	U2	Residential 2	2	2.95	250	1475	1.02
LA County-101 Corridor	US-MG	Residential 2-Mountain Gate Development (added by Boyle)	1.5	2.95	463	2076	1.44
LA County-101 Corridor	U4	Residential 4	4	2.95	250	2950	2.05
LA County-101 Corridor	U8	Residential 8	9	2.95	150	3982.5	2.77
LA County-101 Corridor	C	Commercial	-	-	-	1275	0.89
LA County-101 Corridor	CR	Commercial Recreation-Limited Intensity	-	-	-	1275	0.89
LA County-101 Corridor	P	Public and Semi-Public Facilities	-	-	-	-	-
LA County-101 Corridor	T	Trancportation Corridor	-	-	-	-	-
LA County-101 Corridor	SP	Specific Plan	-	-	-	-	-
LA County-Malibu	M-2	Mountain Land	0.1	2.95	400	59	0.04
LA County-Malibu	3	Rural Land I	0.1	2.95	400	118	0.08
LA County-Malibu	4	Rural Land II	0.2	2.95	400	236	0.16
LA County-Malibu	5	Rural Land III	0.5	2.95	400	590	0.41
LA County-Malibu	3 4	Added by Boyle for Consolidation	0.2	2.95	400	177	0.12
LA County-Malibu	3 4 5	Added by Boyle for Consolidation	0.3	2.95	400	315	0.22
LA County-Malibu	3 5	Added by Boyle for Consolidation	0.3	2.95	400	354	0.25
LA County-Malibu	4 5	Added by Boyle for Consolidation	0.4	2.95	400	413	0.29
LA County-Malibu	6	Residential I	1	2.95	400	1180	0.82
LA County-Malibu	M-2-S	Mountain Land-Seminole & Latigo	0.1	2.95	550	81.13	0.06
LA County-Malibu	3-S	Rural Land I-Seminole and Latigo	0.1	2.95	550	162.25	0.11
LA County-Malibu	4-S	Rural Land II-Seminole and Latigo	0.2	2.95	550	324.5	0.23
LA County-Malibu	5-S	Rural Land III-Seminole and Latigo	0.5	2.95	550	811.25	0.56
LA County-Malibu	3 4-S	Added by Boyle-Seminole & Latigo	0.2	2.95	550	243.38	0.17
LA County-Malibu	3 4 5-S	Added by Boyle-Seminole & Latigo	0.3	2.95	550	433.21	0.3

Las Virgenes Municipal Water District Potable Water Master Plan Demand Factors by Land Use							
			Demographics		Demand Factors for Existing ADD		
City/Area	Landuse	Description	Density for Analysis	Pop/du	gpd/capita	gpd/acre	Estimated gpm/acre
LA County-Malibu	3 5-S	Added by Boyle-Seminole & Latigo	0.3	2.95	550	486.75	0.34
LA County-Malibu	4 5-S	Added by Boyle-Seminole & Latigo	0.4	2.95	550	567.88	0.39
LA County-Malibu	6-S	Residential I-Seminole & Latigo	1	2.95	550	1622.5	1.13
LA County-Malibu	7	Residential II	2	2.95	250	1475	1.02
LA County-Malibu	8A	Residential IIIA	5	2.95	250	3687.5	2.56
LA County-Malibu	8B	Residential IIIB	5	2.95	250	3687.5	2.56
LA County-Malibu	9A	Residential IVA	5	2.95	250	3687.5	2.56
LA County-Malibu	9B	Residential IVB	14	2.95	250	10325	7.17
LA County-Malibu	9C	Residential IVC	14	2.95	250	10325	7.17
LA County-Malibu	11	Institution and Public Facilities	-	-	-	-	-
LA County-Malibu	12	Rural Commercial				1275	0.89
LA County-Malibu	13	General Commercial	-	-	-	1275	0.89
LA County-Malibu	14	Office/Commercial Services	-	-	-	-	-
LA County-Malibu	16	Low-Intensity Visitor Serving Commercial Recreation	-	-	-	123.76	0.09
LA County-Malibu	17	Recreation-Serving Commercial	-	-	-	-	-
LA County-Malibu	18	Parks	-	-	-	-	-
LA County-Malibu		Significant Watersheds and Resource Management Areas	-	-	-	-	-
LA County-Malibu	MU	Mixed Use-Specific Plan Required	-	-	-	-	-
Westlake Vlg	R-LD	Low Density	1.5	-	-	2310	1.6
Westlake Vlg	R-LDH	Low Density Hillside	1.5	2.8	550	2310	1.6
Westlake Vlg	R-LD-3S	Low Density	0.8	2.8	600	1260	0.88
Westlake Vlg	R-LDH-3S	Low Density Hillside	0.8	2.8	600	1260	0.88
Westlake Vlg	R-MD	Medium Density	4.5	2.8	220	2772	1.93
Westlake Vlg	R-ID	Intermediate Density	7	2.8	220	4312	2.99
Westlake Vlg	R-HD	High Density	12	2.8	220	7392	5.13
Westlake Vlg	R-VHD	Very High Density	20	2.8	220	12320	8.56
Westlake Vlg	R-MH	Mobile Home Residential	3	2.8	220	1848	1.28
Westlake Vlg	GC	General Commercial	-	-	-	950	0.66
Westlake Vlg	CR	Commercial Recreation	-	-	-	35	0.02
Westlake Vlg	OC	Office Commercial	-	-	-	950	0.66
Westlake Vlg	BP	Business Park	-	-	-	950	0.66
Westlake Vlg	PU	Public	-	-	-	1300	0.9
Westlake Vlg	SC	Schools	-	-	-	1300	0.9
Westlake Vlg	P	Park	-	-	-	1450	1.01
Westlake Vlg	IN	Institutional	-	-	-	1300	0.9
Westlake Vlg	OS	Open Space	-	-	-	-	-
Westlake Vlg	C	Cemetery	-	-	-	762.85	0.53
Westlake Vlg	T	Transportation	-	-	-	-	-

Appendix M

Priority 4 Pipeline Capacity Improvement Projects

Appendix M - Priority 4 Pipeline Capacity Improvement Projects

Diameter	Pipe Length	Pipe IDs	Zone	Streets	Criteria Trigger	Original Diameter (in)
8	1188.5	P-0600-0020	Three Springs (1425)	Country Ranch Road	MD + FF Pressure < 20 psi	6
10	1085.2	P-0117-0172	Main Zone (1090)	Jim Bowie Road	MD + FF Pressure < 20 psi	8
10	467.9	P-1724-0015	Latigo (1250)	Latigo Canyon Road	MD + FF Pressure < 20 psi	8
6	350.4	P-0400-0090	Mountain Gate (1310)	Enderby Court	MD + FF Pressure < 20 psi	4
8	740.1	P-0800-0770	McCoy	Prado de las Uvas	MD + FF Pressure < 20 psi	6
6	412.5	P-0800-0395	McCoy	Senda Pajaro	MD + FF Pressure < 20 psi	4
6	416.8	P-0100-7414	Main Zone (1200')	Lake Crest Court	MD + FF Pressure < 20 psi	4
6	488.5	P-0157-0128	Main Zone (1200')	Peachwood Pl	MD + FF Pressure < 20 psi	4
6	347.8	P-0157-0148	Main Zone (1200')	Bigstone Pl	MD + FF Pressure < 20 psi	4
6	176.9	P-0100-6766	Main Zone (1200')	Lexington Way	MD + FF Pressure < 20 psi	4
6	444.9	P-0100-5098	Main Zone (1200')	Captains Pl	MD + FF Pressure < 20 psi	4
6	339.4	P-0100-4418	Main Zone (1200')	Promontory Pl	MD + FF Pressure < 20 psi	4
8	382.5	P-0100-0308	Main Zone (1200')	Round Meadow Rd	MD + FF Pressure < 20 psi	6
6	497.3	P-0114-0073	Main Zone (1060')	Kenrose Cir	MD + FF Pressure < 20 psi	4
8	264.5	P-0100-4178	Main Zone (1200')	Careybrook Drive	MD + FF Pressure < 20 psi	6
10	116.5	P-0100-4254	Main Zone (1200')	Twin Oaks Shopping Center	MD + FF Pressure < 20 psi	8
10	489.6	P-0100-4258	Main Zone (1200')	Twin Oaks Shopping Center	MD + FF Pressure < 20 psi	8
14	2119.2	P-0100-4702	Main Zone (1200')	Roadside Drive	MD + FF Pressure < 20 psi	10
14	1779.1	P-0100-3302	Main Zone (1200')	Roadside Drive	MD + FF Pressure < 20 psi	10
14	3870.9	P-0100-2350	Main Zone (1200')	Roadside Drive	MD + FF Pressure < 20 psi	10
12	876.1	P-0100-2242	Main Zone (1200')	Dorothy Drive	MD + FF Pressure < 20 psi	10
10	283.5	P-0100-6326	Main Zone (1200')	Near Via Colinas	MD + FF Pressure < 20 psi	6
10	712.7	P-0100-6278	Main Zone (1200')	Westlake Village Industrial Park	MD + FF Pressure < 20 psi	8
14	347.8	P-0100-6274	Main Zone (1200')	Westlake Village Industrial Park	MD + FF Pressure < 20 psi	8
10	265.6	P-0100-6266	Main Zone (1200')	Westlake Village Industrial Park	MD + FF Pressure < 20 psi	8
10	390.8	P-0100-6406	Main Zone (1200')	Cedar Valley Drive	MD + FF Pressure < 20 psi	8
14	513.2	P-0100-6230	Main Zone (1200')	Corsa Avenue	MD + FF Pressure < 20 psi	10
12	58.0	P-0100-6238	Main Zone (1200')	Corsa Avenue	MD + FF Pressure < 20 psi	10
10	70.2	P-0100-4008	Main Zone (1200')	Oak Crest Drive	MD + FF Pressure < 20 psi	6
10	1091.5	P-0100-4004	Main Zone (1200')	Oak Crest Drive	MD + FF Pressure < 20 psi	6
10	116.2	P-0100-4742	Main Zone (1200')	Sheraton Agoura Hills	MD + FF Pressure < 20 psi	8
10	329.1	P-0100-4746	Main Zone (1200')	Sheraton Agoura Hills	MD + FF Pressure < 20 psi	8
10	502.2	P-0100-4750	Main Zone (1200')	Sheraton Agoura Hills	MD + FF Pressure < 20 psi	8
10	334.0	P-0112-0056	Main Zone (1200')	Crater Oak Drive	MD + FF Pressure < 20 psi	8
12	329.2	P-0706-0675	Mulwood (1415')	Liberty Bell Road	MD + FF Pressure < 20 psi	10
12	298.4	P-0706-0680	Mulwood (1415')	Liberty Bell Road	MD + FF Pressure < 20 psi	10
10	196.3	P-0706-0690	Mulwood (1415')	Freedom Drive	MD + FF Pressure < 20 psi	8
10	1284.0	P-1300-0565	Warner (1640')	Canyon Drive	MD + FF Pressure < 20 psi	8
10	290.0	P-1300-0515	Warner (1640')	Summit Drive	MD + FF Pressure < 20 psi	8
10	689.0	P-1100-0535	Twin Lakes (1585')	Cherokee Trail	MD + FF Pressure < 20 psi	8
10	548.0	P-1100-0545	Twin Lakes (1585')	Cherokee Trail	MD + FF Pressure < 20 psi	8
10	1024.0	P-1100-0550	Twin Lakes (1585')	Cherokee Trail	MD + FF Pressure < 20 psi	8

Appendix N

Information Clarification Request

Kennedy/Jenks Consultants
Engineers & Scientists
3210 El Camino Real, Suite 150
Irvine, CA 92602-1365
949-261-1577
FAX: 949-261-2134

19 March 2014

Mr. David Lippman
Director, Facilities and Operations
Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, California 91302

Subject: Information Clarification Request
Las Virgenes MWD Potable Water Master Plan
K/J 1389005*00

Dear Mr. Lippman:

Per your request, please find a brief clarification on two items that surfaced during our presentation of the Potable Water Master Plan to the Board on March 11, 2014.

- Please clarify what are legacy systems as noted in the pipeline CIP? Legacy systems are mutual water companies that become a part of the water district at formation. These systems were designed and constructed to meet the fire flow requirements in place at that time which are lower standards than what is typically required today.

- Was the water system modeled with the Backbone Improvements included, and is the district in violation of any fire standards? The potable water system was modeled with the Backbone Improvements completed including the 5 million gallon tank. When asked if the district was in violation of any fire standards I answered no based on the model results. If the 5 million gallon tank had not been in the model, the existing system would have been deficient in fire storage in the west end of the system. This facility and other Backbone Improvements eliminated that deficiency.

Please contact me if you have any additional questions or need any additional information.

Very truly yours,

KENNEDY/JENKS CONSULTANTS

Roger D. Null,
Project Manager and Vice President

Appendix 0

Local Agency Growth Estimates – Supporting Documentation

Appendix 0

Local Agency Growth Estimates – Supporting Documentation

LVMWD - Water Master Plan Growth Documentation

Excerpt from Population Projection Technical Memorandum

Table 1: Housing and Population Projections

Agency/Growth Description	Projected New Dwelling Units	Applicable Persons per Household (PPH)	Projected Additional Population
Agoura Hills (1)			
Agoura Village	293	3.345	980
N Agoura Rd	73	3.345	244
Calabasas (2)	746	3.045	2,272
Hidden Hills (3)			
Per HH note from SCAG	34	3.23	110
Westlake Village	84	3.01	253
Westlake Village Business	401	3.01	1,207
Unincorporated LA County (4)			
Additional Population from Land Use Calculations	2,746	3.15	8,773
Vacant HSE Units (5)			
Additional Population from Vacant units	936	3.03	2,816
Totals	**5,314**		**16,655**
Population 2010 (SCAG reconciled with Census)			**70,138**
Population 2010 (Census Blocks(6))			**67,628**
Population Projection 2035			**86,793**

1) May 2013 Housing Element, Agoura Village SP increased by 100 units per A. Cook, PPH from average of tracts 800323 & 800324
2) June 2013 Housing Element, pph from average of tracts 800101 and 800202
3) March 2013 Housing element, pph from tract 800201
4) Based on land use acreage and density, pph from TAZ specific values, averages used in Table 1
5) Vacant Units coverage based on 2010 census data, TAZ specific
6) District estimate based on 2010 Census track and block level data

CITY OF AGOURA HILLS

City of Agoura Hills
2013-2021 Housing Element

May 1, 2013

City of Agoura Hills
Planning and Community Development Department
30001 Ladyface Court
Agoura Hills, CA 91301
Contact: Allison Cook, Principal Planner

Consultant to the City:

KWA
KAREN WARNER ASSOCIATES

include: a housing needs assessment with population and household characteristics; identification of constraints to providing housing; an inventory of available sites for the provision of housing for all economic segments of the community; and a statement of goals, policies and programs for meeting the City's housing needs. The goals of the Housing Element concern:

1. Conserving and improving the condition of the existing housing stock;
2. Assisting in the development of affordable housing;
3. Providing adequate sites to achieve a diversity of housing;
4. Removing governmental constraints to housing, as necessary; and
5. Promoting equal housing opportunities.

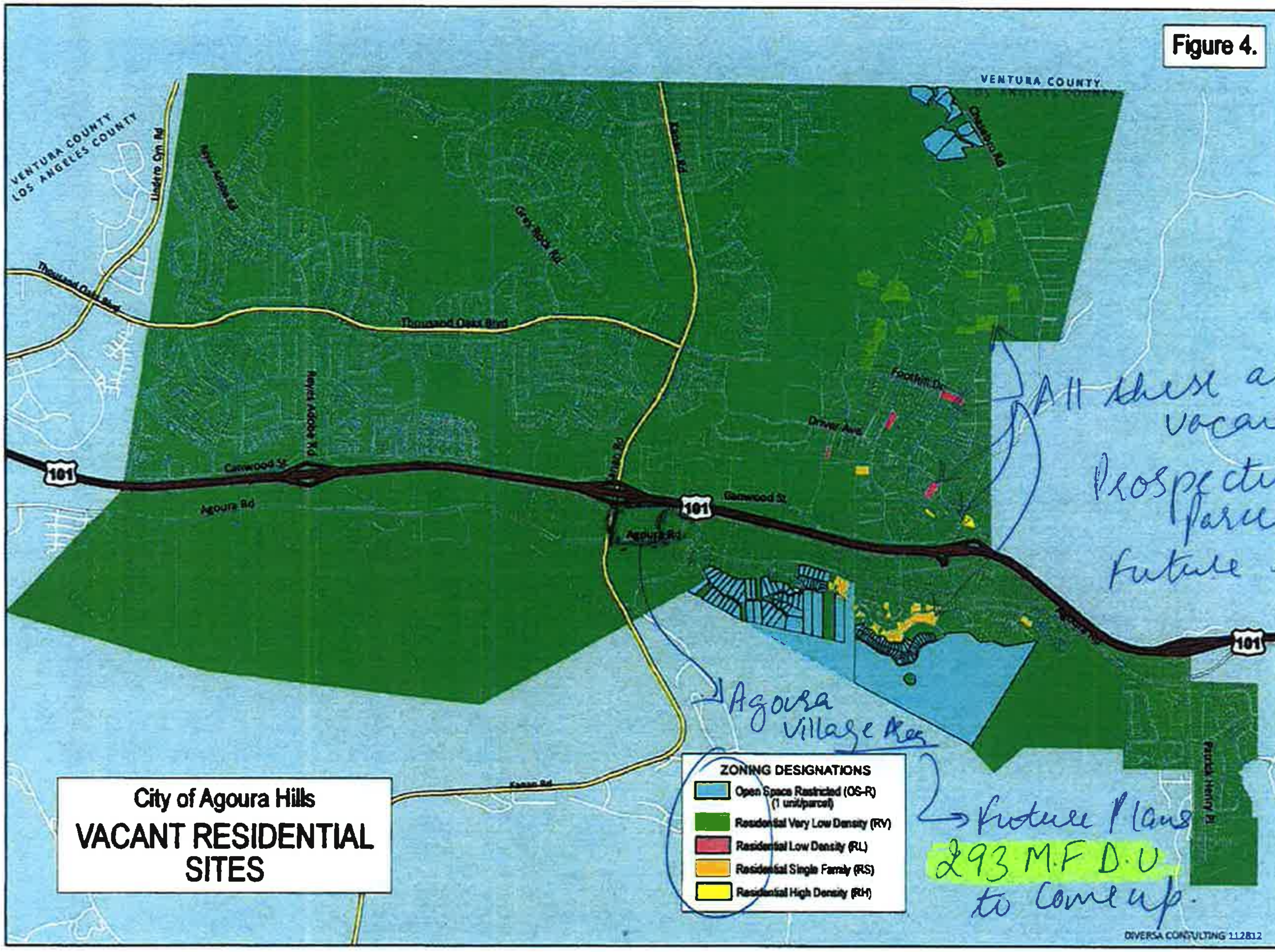
Based on data from the Southern California Association of Governments (SCAG), Agoura Hills has an identified regional housing growth need, or Regional Housing Needs Assessment (RHNA), of 115 units for the 2013-2021 planning period (2014-2021 Housing Element cycle). The Housing Element illustrates that under the current General Plan land use designations and zoning districts, the City has an estimated additional capacity for 300 new residential units on vacant and underutilized parcels that allow residential uses (193 of these within the Agoura Village Specific Plan (AVSP) area and the remaining 107 on vacant residential parcels throughout the City), as shown in the table below.

Comparison of RHNA and Available Residential Sites in Agoura Hills

Income Level	2014-2021 Regional Housing Needs (RHNA)	Default Density Thresholds	Vacant Residential Parcels	Agoura Village Specific Plan
Extremely Low	15	20 units/acre		193
Very Low	16			
Low	19			
Moderate	20	16 du/acre	**23**	
Above Moderate	45	<16 du/acre	**84**	
Total	115		**107**	**193**

TOTAL = 300
USED 293
(ATTACHED)

Therefore, Agoura Hills has sufficient capacity to accommodate the overall RHNA allocation, and there is no need to change any General Plan land use designations or zoning designations on parcels to accommodate the City's housing growth needs. Future residential development is expected to occur on currently vacant residentially zoned sites (see Figure 2, Vacant Residential Sites), and on vacant and under-developed mixed-use sites within the AVSP, located along Agoura Road generally between Kanan Road and Cornell Road.



2010/2011 Plan
Housing element Plan

North side of Agoura Road/West of Kanan Road

This area is currently developed with a fragmented mixture of industrial, auto service, storage, building supply, and retail uses and is designated as Business Park—Manufacturing by the existing General Plan (1993). Properties within this area are challenged by a continued lack of proper maintenance, vacant parcels, awkward lot configurations, and nonconforming uses. However, opportunities for redevelopment exist due to high freeway visibility and large lot sizes.

The General Plan Update goals and policies encourage cohesive and integrated redevelopment of this area supporting the re-use and transformation of the existing fragmented uses and buildings into a well-planned and designed center. New land uses permitted as part of the General Plan Update would include a mix of retail, office, commercial recreation, entertainment, and residential land uses to revitalize the area and also complement nearby areas, such as Agoura Village. Housing units would be permitted upon the adoption of a specific plan or similar document in the future.

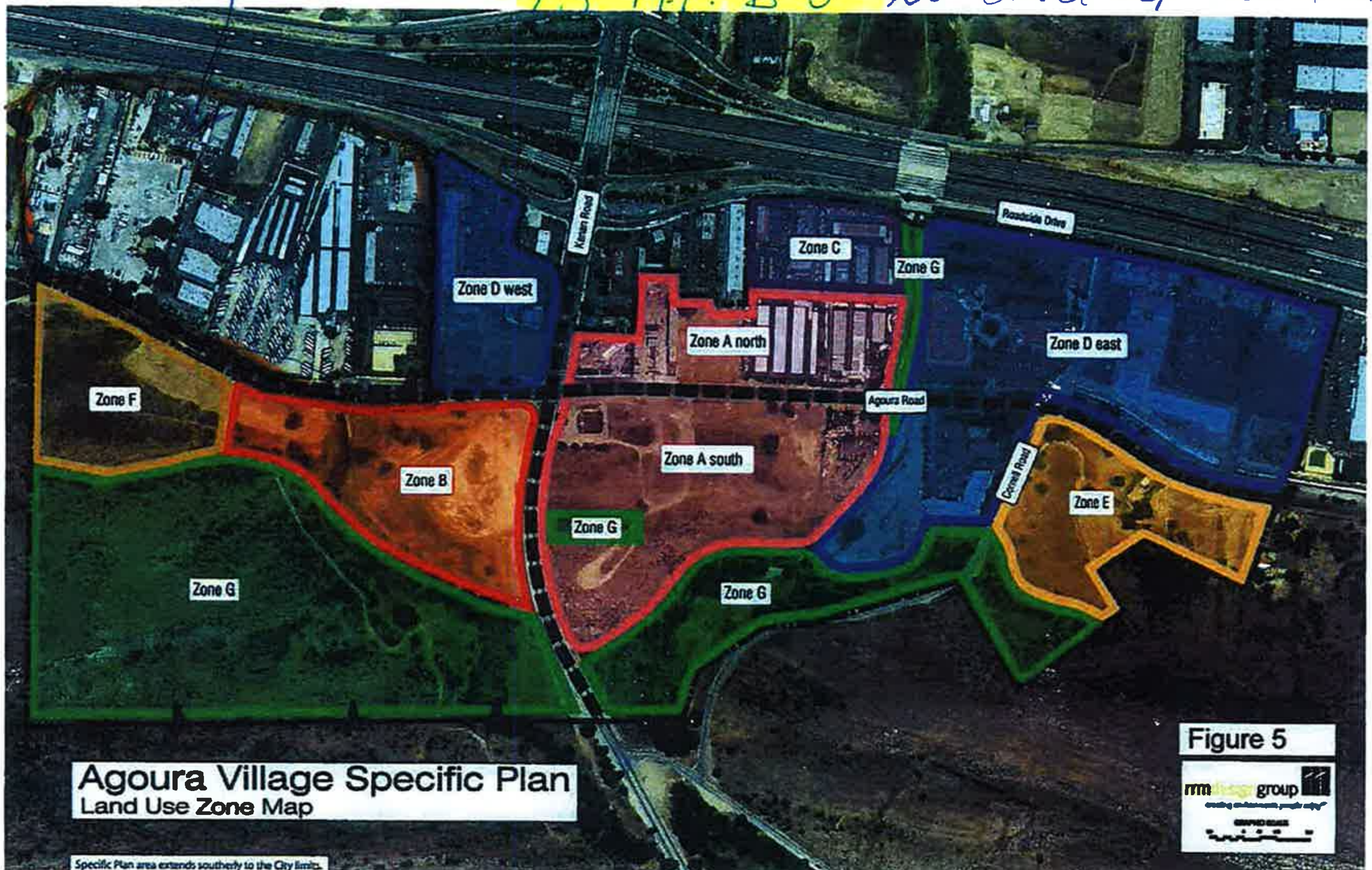
The General Plan Land Use designation would change from Business Park—Manufacturing to Planned Development.

TAZ				Residential		Non-Residential						
				Single-Family Units	Multi-Family Units	Retail/ Service Sq Ft	Office/ Business Park Sq Ft	Business Park/ Manufacturing Sq Ft	School Enroll	Hotel Rooms	Open Space Acres	Parks Acres
8	Incl. SA 5 (North side of Agoura Rd, West of Kanan)	Existing GP	Existing Use	0	0	224,1[illegible]	544,926	174,[illegible]	0	0	0	0
			Buildout	0	0	314,501	977,161	615,7[illegible]	0	0	0	0
			Difference	0	0	90,3[illegible]	432,235	441,141	0	0	0	0
		Proposed GP Buildout	Study Area	0	76	87,812	105,143	105,143	0	0	0	0
			Outside Study Area	0	0	188,2[illegible]	592,811	91,313	0	0	0	0
			Total	0	76	[illegible]	697,954	196,456	0	0	0	0
			Diff Prop GP Bldout - Ex Use	0	76	51,[illegible]	153,028	21,[illegible]	0	0	0	0

76

USED 73
(Attached)

North Agoura Road Planning Area.
future tentative Plan
73 M.F.D.U to come up in the area



Housing Element Plan.

CITY *of* CALABASAS

2030 General Plan

2014-2021 HOUSING ELEMENT

PUBLIC REVIEW DRAFT

AUGUST 2013

7/22/13. Per Karen Warner: The State approved the City's plan last summer.

CITY OF CALABASAS
COMMUNITY DEVELOPMENT DEPARTMENT
100 CIVIC CENTER WAY
CALABASAS, CA 91302

KAREN WARNER ASSOCIATES
Housing Policy Consultants

V.B Residential Sites Analysis

California Housing Element law requires that each jurisdiction develop local housing programs to meet their "fair share" of existing and future housing needs for all income groups. This "fair share" allocation concept seeks to ensure that each jurisdiction accepts responsibility for the housing needs of not only its resident population, but also for the jurisdiction's projected share of regional housing growth across all income categories. Regional growth needs are defined as the number of units needed to accommodate forecasted household growth, as well as units needed to compensate for anticipated demolitions and changes to achieve an "ideal" vacancy rate.

In the Southern California region, the agency responsible for assigning these regional housing needs to each jurisdiction is the Southern California Association of Governments (SCAG). The regional growth allocation process begins with the State Department of Finance's projection of Statewide housing demand, which is then apportioned by the State Department of Housing and Community Development (HCD) among each of the State's official regions. For 2014-2021, SCAG was allocated a total housing need range of 409,060 to 438,030 units.

SCAG has determined the projected housing needs throughout its region for the 2014-2021 Housing Element cycle, and has allocated this housing need to each jurisdiction by income category. This Regional Housing Needs Assessment (RHNA) represents the minimum number of housing units each community must plan for by providing "adequate sites" through general plan and zoning. An important component of the Housing Element is the identification of adequate sites for future housing development to address the City's RHNA. Calabasas' 2014-2021 RHNA allocation is 330 units distributed among the following income groups: 44 extremely low income; 44 very low income; 54 low income; 57 moderate income; and 131 above moderate income units.

The City plans to fulfill its share of regional housing needs using a combination of the following methods:

- Residential projects with development entitlements;
- Vacant residential sites;
- Underutilized residential and mixed-use sites; and
- Second residential units.

Calabasas' residential sites capacity from the above sources provides for 747 additional units, including sites suitable for development of 331 lower income, 171 moderate

Development Potential Compared with Calabasas' Regional Housing Needs

Table V-4 compares Calabasas' residential unit potential described in the sections above (and quantified in Tables V-1, V-2 and V-3), and provides a comparison with the City's 2014-2021 Regional Housing Needs (RHNA) for 330 units.

Table V-4
Comparison of Sites Inventory with Regional Housing Growth Need (RHNA)

Income Group	Entitled Projects *(post 2013 occupancy)*	Minimum Density Guidelines	Vacant Residential Sites	Underutilized Residential Sites	Second Units	Total Unit Potential	Total RHNA
Very Low	12	≥20 du/acre	147	172		331	88
Low							54
Moderate		≥12 du/acre	60	99	12	171	57
Above Moderate	146	≤12 du/acre	99			245	131
Total	**158**		**306**	**271**	**12**	**747**	**330**

In terms of evaluating the adequacy of sites to address the affordability targets established by the RHNA, Housing Element statutes provide for use of "default densities" to assess affordability. Based on its population, Calabasas falls within the default density of 20 units per acre for providing sites affordable to very low and low income households; sites suitable for moderate income households can be provided at 12 units per acre. Allocating Calabasas' residential sites inventory based on these density thresholds, combined with the 12 very low income units known in entitled projects, results in the provision of sites suitable for development of 331 units affordable to lower income households, 171 units affordable to moderate income households, and 245 units for above moderate income households. A comparison of this income distribution with the City's RHNA identifies sufficient sites at appropriate densities to accommodate Calabasas' regional housing needs.

It is to Calabasas' benefit that its residential site capacity exceeds the minimum RHNA required within each income category to help offset any sites that may be developed with fewer units than assumed in the Housing Element sites inventory. A healthy buffer above the required RHNA therefore provides a "margin of safety" from having to rezone additional sites during the 2014-2021 planning period of the element.

CITY OF HIDDEN HILLS

2008-2014 HOUSING ELEMENT

March 2013

Due to the rural, guard-gated nature of Hidden Hills, it is unlikely that any homeless persons are in the city. While there are no known homeless persons in the city, Program 7b in the Housing Plan (Chapter V) has been included to comply with the new planning requirements for emergency shelters under SB 2.

F. Assisted Housing at Risk of Conversion

There are no residential units within the City of Hidden Hills that participate in a federal, state or local program that provide some form of assistance, either through financial subsidy or a control measure. Therefore, there are no units at risk of conversion[12].

G. Housing Growth Needs

1. Overview of the Regional Housing Needs Assessment

The Regional Housing Needs Assessment (RHNA) is a key tool for local governments to plan for anticipated growth. The RHNA quantifies the anticipated need for housing within each jurisdiction for the 8½-year period from January 2006 to July 2014. Communities then determine how they will address this need through the process of updating the Housing Elements of their General Plans.

The current RHNA was adopted by the Southern California Association of Governments (SCAG) in July 2007. The future need for housing is determined primarily by the forecasted growth in households in a community. Each new household, created by a child moving out of a parent's home, by a family moving to a community for employment, and so forth, creates the need for a housing unit. The housing need for new households is then adjusted to maintain a desirable level of vacancy to promote housing choice and mobility. An adjustment is also made to account for units expected to be lost due to demolition, natural disaster, or conversion to non-housing uses. The sum of these factors – household growth, vacancy need, and replacement need – determines the construction need for a community. Total housing need is then distributed among four income categories on the basis of the county's income distribution, with adjustments to avoid an over-concentration of lower-income households in any community.

2. 2006-2014 Hidden Hills Growth Needs

The Southern California Association of Governments (SCAG) determined the RHNA growth needs for each city within the SCAG region, plus the unincorporated areas. The total housing growth need for the City of Hidden Hills during the 2006-2014 planning period is 34 units. This total is distributed by income category as shown in Table II-23.

12 Sources: SCAG/California Housing Partnership Corp; City of Hidden Hills

Table II-23

Regional Housing Growth Needs

Extremely Low	Very Low	Low	Moderate	Above Moderate	Total
5*	4	6	6	13	34
15%	12%	18%	18%	38%	100.0%

Source: SCAG 2007
Note: The RHNA planning period is 1/1/06-6/30/14
* The RHNA identified the City's Very-Low-Income need as 9 units. Extremely-Low need is assumed to be 50% of the Very-Low need per state law

It should be noted that SCAG did not identify growth needs for the extremely-low-income category in the adopted RHNA. As provided in Assembly Bill (AB) 2634 of 2006, jurisdictions may determine their extremely-low-income need as one-half the need in the very-low category.

All new units built or preserved after January 1, 2006 may be credited in the current RHNA period. A discussion of the city's net remaining growth need is provided in the land inventory section of Chapter III.

CITY OF WESTLAKE VILLAGE

2006-2014
HOUSING ELEMENT

DRAFT

UNDERDEVELOPED AND REDEVELOPABLE AREAS

Underdeveloped sites are defined as properties that are developed at less than their designated maximum densities would permit. While no such properties exist within the City, some intensification of residential development is expected to occur through the construction of second units on lots with existing single-family dwellings. Similarly, there may be future opportunities within aging, functionally obsolete business park areas, for the introduction of mixed use development including residential and non-residential land uses.

SURPLUS LANDS

The City owns five developed park sites, one undeveloped park site, and the civic center site housing the City Hall, library and community rooms. None of these sites are considered to be surplus. Similarly, the City is unaware of any State or Federally controlled land that has been identified as surplus and is available for acquisition.

POTENTIAL HOUSING SITES

Based on the preceding analyses, one site has been identified that is both available and suitable for future residential development (Figure 3). In addition, there are nine (9) individual lots scattered throughout the City's existing neighborhoods that are zoned and available for the development of single-family homes.

Site No. 1 and vacant residential lots could accommodate a wide variety of housing types and densities, ranging from large-lot, custom single-family homes to high-density multi-family units. The number of dwelling units which could be developed on Site No. 1 is shown in Table 4. In addition, in order to demonstrate the development capacity of this site, a prototypical development plan has been prepared and is presented in Appendix A. This exhibit documents that an appropriate density can be accommodated on this site and in compliance with all applicable development standards (e.g., zoning, lot coverage, building height, floor area ratio, setbacks, parking and landscaping requirements, etc.).

Under current zoning, up to 84 units could be added to the City's housing stock through development of these sites. This represents an approximately 2.5 percent increase over the City's 2007 housing stock and exceeds the projected number of new housing units needed within the City by 2014 according to SCAG's Regional Housing Needs Assessment (see Table 8, page 27).

Notice of Preparation of an Environmental Impact Report
and
Notice of Scoping Meeting

TO:	**Interested Parties**
PROJECT TITLE:	**Westlake Village Business Park Specific Plan**
LEAD AGENCY:	**City of Westlake Village** **31200 Oak Crest Drive** **Westlake Village, CA 91361**
SCOPING MEETING:	**December 11, 2012 at 6:00 PM** **Council Chambers** **City of Westlake Village** **31200 Oak Crest Drive** **Westlake Village, CA 91361**

In accordance with the California Environmental Quality Act (CEQA), the City of Westlake Village is serving as the Lead Agency and will be preparing a Program Environmental Impact Report (EIR) for the proposed *Westlake Village Business Park Specific Plan.* In compliance with Section 15082 of the CEQA Guidelines, the City of Westlake Village is sending this Notice of Preparation (NOP) to responsible and trustee agencies, and other interested parties to inform them of the proposed Specific Plan and its environmental review process.

In addition, the City needs to know your agency's views with respect to the scope and content of the environmental information that is germane to your agency's statutory responsibilities in connection with the proposed project, as your agency may need to use the Program Environmental Impact Report (EIR) when considering the issuance of any permits or other approvals for future redevelopment projects allowed under the proposed *Westlake Village Business Park Specific Plan* and public improvements that may be constructed as part of Specific Plan implementation.

Project Location

The City of Westlake Village (City) is located at the northwestern end of Los Angeles County, east of the Los Angeles County-Ventura County line. The City covers 5.62 square miles of land and is bound by the City of Agoura Hills to the east and northeast; the City of Thousand Oaks to the north and west; and unincorporated Los Angeles County land to the southeast and south. Regional access to Westlake Village is provided by the Ventura Freeway (Interstate [I] 101), which bisects the City in an east-west direction, with on- and off-ramps at Lindero Canyon Road. Exhibit 1 is the City's regional location.

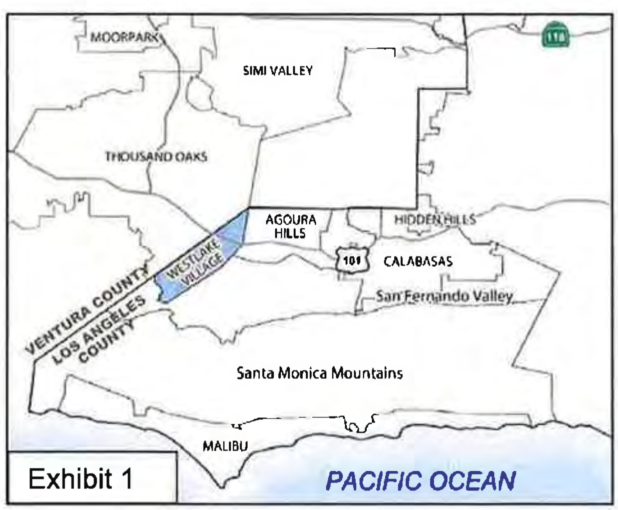


Exhibit 1

ITEM 8D

Table 1 provides an estimate of development that can be accommodated within each Specific Plan district at buildout of the planning area, assuming maximum densities and intensities.

TABLE 1
MAXIMUM DEVELOPMENT CAPACITY

District	Land Area	Residential Development	Non-Residential Development	
			Land Use	Floor Area (sf)
Mixed Use – Corsa District (1a)	15.56 ac	301 du[a]	Specialty Retail Restaurant(s) Office Subtotal	108,473 13,559 13,559 135,591
Mixed Use – Via Colinas District (6)	17.09 ac	100 du[b]	Flex space	267,622
Mixed Commercial District (1b)	10.79 ac	–	Specialty Retail Restaurant(s) Office Subtotal	79,876 7,988 311,516 399,380
Corporate Office District (2)	19.98 ac	–	Office	652,702
Flex Office District[c] (3, 5)	18.55 ac	–	Flex space	507,082
Design District (4a, 4b)	29.73 ac	–	Home Design/Improv Restaurants Subtotal	638,925 8,638 647,563
Public Rights-of-Way	16.93 ac	–		–
Total	**128.63 ac**	**401 du**		**2,609,940 sf**
Existing Development[d]		–		2,021,090 sf
Development Increase		***401 du***		***588,850 sf***

sf: square feet; ac: acres; du: dwelling unit

[a] Assumes residential development on 80% of land area at a density of 18–25 du/ac

[b] Assumes residential development on 40% of land area at a density of 18–25 du/ac

[c] Four parcels on Cedarvalley Drive are developed with buildings that exceed the maximum floor area ratio permitted by the Specific Plan. Thus, these buildings are expected to remain indefinitely without any increase in floor area over time.

[d] Total floor area of existing offices, business parks, and light industrial uses within the Focus Area.

Source: The Arroyo Group, Westlake Village Business Park Specific Plan (Public Review Draft), September 2012

Exhibit 4 shows the conceptual vision plan for the planning area.

Exhibit 4

ITEM 8D

Unincorporated Area GIS land Use Summary Table	
Zoning_Codes Included	R-1, R-2, R-3 (DRP Zoning Codes) LCR110000, LCR112000, LCR16000, LCR175000, LCR2, LCR3,LCRPD1000012U, LCRPD100009.0U-, LCRPD11.2U, LCRPD12U,LCRR1, LCRR10, LCRR1Y, LRRPD40000.9U,LCRPD1-2U,LCRPD250003U,LCRPD600015U,LCRPD11UDP,LCRPD1000071/4,LCRPD100.6U (County Codes)
Zoning Codes Not Included	A-1, A1-1, A-1-10, a-1-10000,A1-1-15000, A1-2, A-1-2.5, A-1-20, A-1-20000, A-1-40000, A-1-5, A-1-5000, A1-6000, A-2-1, A-2-2, A-2-5, B-1, B-2, C-1, C-2, C-3, C-M, C-R, D-2-1, D-2-2, IT, M-1, M-1.5, M2, OS, P-R
Total Unincorporated Acerage within District Boundary*	58,000
Approximate Acerage Used*	9,900
PPH (Range)	2.98 - 3.15
Dwelling Units*	2,746
Estimated Additional Population*	8,773

* Approximate Values. Totals are subject to rounding

ZONING DESIGNATOR

This memorandum details the manner in which the zoning information should be maintained, and explains the composition and meaning of the "zoning designator".

Note: When the method for automating zoning is instituted, a future update of this memo will be issued.

1. ZONING DESIGNATOR COMPOSITION

1.1 The zoning designator includes three to 15 symbols, designed to identify the city in which the property is located, the zoning of the property, and the minimum lot size and/or height limit (when they are expressed as part of the zoning).

A. The *first two symbols* are always letters. They represent zoning jurisdictions.

Examples: GL - Glendale; LB - Long Beach.
(See page 6 of this memo, for the abbreviations of the various cities in Los Angeles County.)

B. The third symbol is always a letter. It represents the basic zoning of the property.

Examples: R = residential; C = commercial; A = Agricultural
M = manufacturing (industrial)

C. When a fourth symbol is used it may be either a letter, a number, or a dash. It generally represents either the intensity or limit of a property's use; or, in the case of a dash, it is used to separate multiple zones or height districts.

Examples: LAR3-1*, LCC2*, LAP-1*

NOTE: M is also used for "Multiple" in several cities. Therefore, use a fourth symbol, the letter R, to distinguish Multiple Residential (MR) from Manufacturing, and similarly, use a fourth symbol, a number, to indicate the *kind* of manufacturing; M1, 2, 3, or 4.

D. When five or more symbols (up to a maximum of 15) are required to describe the zoning, enter all the symbols in the manner prescribed by this memorandum.

NOTE: Refer to paragraph 4.2 for examples of multiple zoned parcels. Refer to paragraphs 4.7, 4.8 and 4.9 for examples of parcels with minimum allowed land area and/or maximum allowed number of units, shown as part of the zoning jurisdiction's designator.

1.2 Use a dash (-) to separate multiple zoning on a parcel (e.g., LCC2-R3-R1*). Also, use a dash to separate the height restriction district in Los Angeles City (e.g., LAR1-1*).

1.3 Place an asterisk at the end of every zoning designator, showing the zone designator is complete. Where a zone extends beyond the maximum 15 spaces allotted the asterisk will not show.

1.4 Where special category zoning is entered, use parenthesis to enclose the symbols that designate the type. Refer to paragraph 5, "Special Category Designators".

Example: LAR3-1(T)-RA-1*

2. HOW TO TRANSMIT A NEW DESIGNATOR

The new zoning designator may be transmitted by a Property Data Record (PDR), or an Administrative Change Form (ASSR 135) at any time. Consult the Optimum Manual for procedures on completing these forms.

3. GENERAL INFORMATION ABOUT DESIGNATOR

3.1 Where more than 15 symbols (including the asterisk, dashes, parentheses, etc.) have been submitted and data entered, only the first 15 will print out. Therefore, if 15 such symbols print out without an asterisk, be aware that additional zoning *may* exist on the parcel.

3.2 It is *not* necessary to fill in all 15 spaces. Fill in only the total number of symbols to describe the zoning accurately. Only the first three spaces are necessary in order to designate the city code, and the basic zone of the property.

4. ENTERING THE DESIGNATOR

4.1 The first three symbols of any given zone (zoning jurisdiction abbreviation plus primary zoning symbols) must be grouped together without a space, a dash, or an ampersand.

Examples: Enter R1-6000 in Los Angeles County as LCR16ØØØ*. *Do not enter* it as
LC-R16ØØØ* nor LCR-16ØØØ*.

4.2 If a parcel has two or more separate zones, enter each zone but separate each by a dash (-). Enter the zoning jurisdiction prefix *only once*. Also, enter the most "significant" zoning immediately after this prefix.

Examples: A. Enter a parcel in Bellflower with C2, R3, and R15000 zonings (assuming R3 is the most "significant" zoning) as BFR3-C2-R15ØØØ*.

B. Enter a parcel in Los Angeles City with C2, R3, and R1 zoning (each with a height limit district) as LAC2-1-R3-1-R1-1*. (Note that in this case there are 17 symbols entered. Only 15 will be printed on printouts.)

4.3 Cities such as Alhambra, Glendale, and Los Angeles permit *two* different *uses* in *one zone* (e.g., commercial and/or parking). When this is the case *do not* place a dash between the zoning symbols.

Example: A. C3P1 is one zoning with two permitted uses in Alhambra. Enter the designator as ALC2P1*.

4.4 In Los Angeles City, height limitation districts (1 through 4) exist as part of the zoning jurisdiction's designators. Separate these limitations from the zoning to which they apply by a dash.

Examples: A. LAR1-1*

B. LAC2-2-R3-2*

4.5 Many cities employ supplemental zones, sometimes called "overlays", which are only used in combination with another zone. This occurs when there are two zones on one property, each covering the entire parcel. The use of the ampersand symbol indicates that both designators apply to the total parcel.

Examples: A. A property in Los Angeles City zoned R1 with one height limit and a supplemental zone H (hillside) is designated LAR1-1&H*.

B. A property in Whittier zoned RA7500 and EQ (Equestrian District overlay) is designated WHRA75ØØ&EQ*.

4.6 "Combining Zones" refers to two zones which must always be used together, although the second zone in the combination may not cover the entire parcel. The designator for such a zone is written without any separation.

Example: TOM2Ø2*

4.7 When a jurisdiction includes *acreage* minimums in its designator, enter these minimums in the zoning designator without any separation.

Examples: A. Enter R1-10 acre zoning in Los Angeles County as LCR11Ø*

B. LCRA1*

C. LCA25*

4.8 Where *square footage* minimums are included, enter these - except the least of them - in the zoning designator.

Examples: A. Los Angeles County zone R110000 is entered as LCR11ØØØØ*

B. Glendale zoning RA-17000 is entered as GLRA17ØØØ*, but R15000 is entered as LCR1*; 5000 being understood to be the least square footage allowed where that zoning exists, i.e., R1 alone indicates the minimum for the jurisdiction.

C. Enter RD3 zoning (restricted density zoning with a minimum of 3000 square feet of land per dwelling unit) in height district number 1 in Los Angeles City as LARD3-1*.

4.9 When minimum lot area and/or maximum dwelling units per lot area is specified by the zoning jurisdiction's designator, enter these in the designator.

Examples: A. An RPD-1(7U) zone in Los Angeles County indicates that it is a Residential Planned Development with a minimum land area of one (1) acre per *single* family dwelling unit or a maximum of 7 units per acre if developed for *multiple* residential dwellings. Enter it as LCRPD17U*.

B. An RPD10000-(4U) in Los Angeles County indicates Residential Planned Development with a minimum land area of 10000 sq. ft. per single family dwelling unit or a maximum four (4) units per acre if developed for multiple residential dwellings. Enter it as LCRPD1ØØØØ4U*.

C. An R3-(20U) zone in Los Angeles County indicates multiple dwelling with a maximum of 20 units per acre. Enter it as LCR32ØU*.

5. SPECIAL CATEGORY DESIGNATORS

5.1 The special category designators will incorporate both the *tentative* higher zoning and the *existing* lower permissive zoning. Immediately after the city abbreviation, enter the tentative higher zoning, *then* the existing zoning. Sales are computer-sorted for Sales Details and Sales Summaries in the order of city, then the first two symbols of the zoning.

Examples: A. Tentative (T) zoning in Los Angeles city; assuming a parcel has a small portion of "tentative" zoned C2-1, and assuming the existing zoning is R3-1, enter the designator LAC2-1(T)-R3-1*.

B. Funded (F) zoning in Los Angeles City; assuming a parcel is "funded" for R3-1, and assuming it is more significant than the existing RA-1 zoning, enter the designator LAR3-1(F)-RA-1*.

Tentatives zoning and Qualified zoning are the most often used special categories in Los Angeles City. If both apply to the same property, include both in one parentheses. If two zones are in the special category, list them both, then the special category, followed by the existing zone. Similarly for three zones, etc.

Example: LACR-1-P-1(TQ)-R3-1*

When the final map is recorded, the "(T)" is removed, as well as the existing zone (R3 in this case). Then the "(Q)" must be decided on its own merits. When all qualifications are met, depending on whether the conditions are temporary or permanent as listed on the ordinance, the Q is either dropped or used without the parentheses.

Example: LACR-1-P-1* or LACR-1-P-1Q*

5.2 When entering a special category designator with fifteen or more symbols (count includes dashes, parenthesis symbols, etc.), confirm the placement of the special category symbol with the appropriate jurisdiction. This will insure that the special symbol is properly located and is within the fifteen symbols which will be computer-printed.

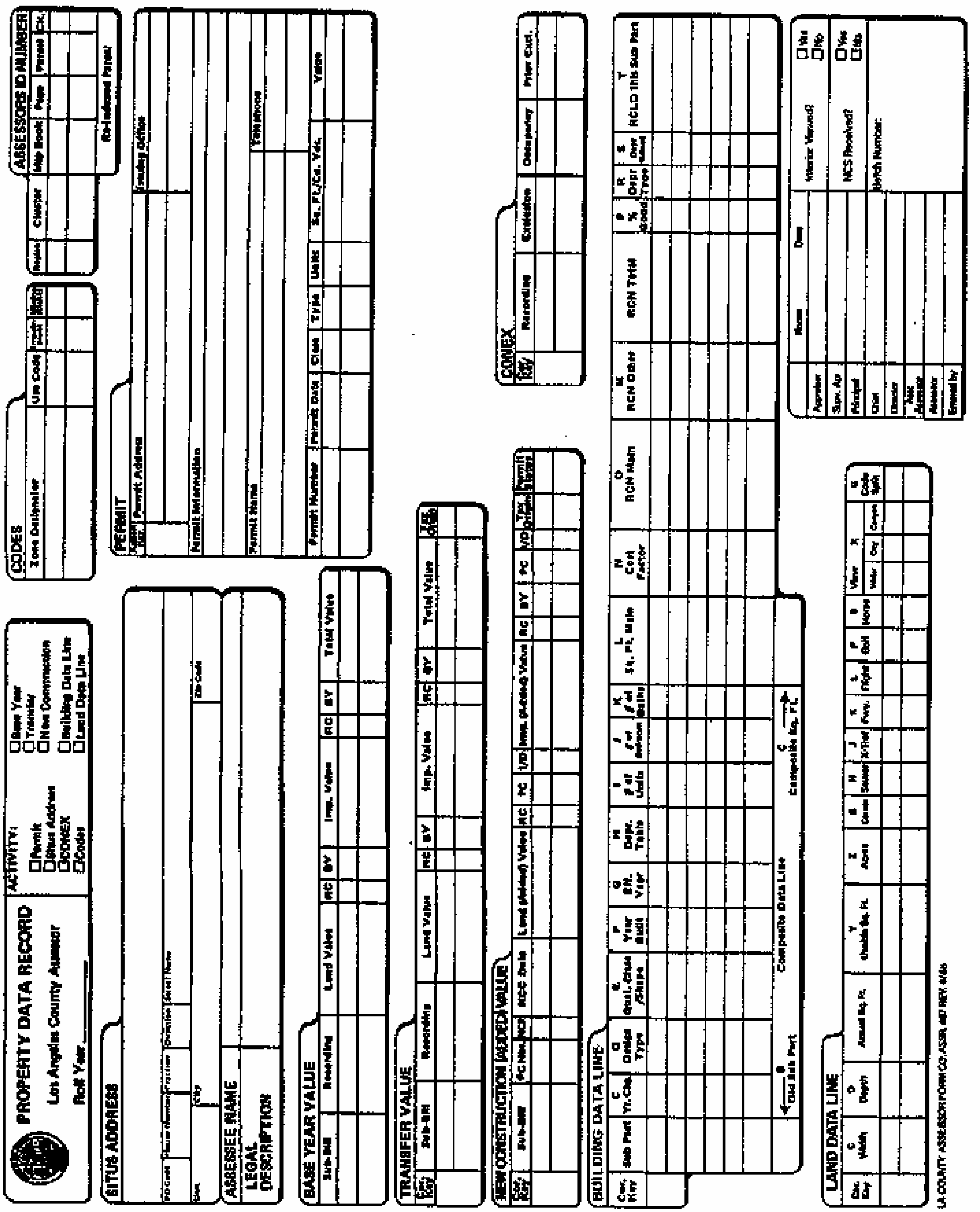
John Crowner, Director
Appraisal/Processing Subdepartment

CITY ABBREVIATION LIST

AH	-	Agoura Hills
AL	-	Alhambra
AR	-	Arcadia
AT	-	Artesia
AV	-	Avalon
AZ	-	Azusa
BP	-	Baldwin Park
BL	-	Bell
BG	-	Bell Gardens
BF	-	Bellflower
BH	-	Beverly Hills
BR	-	Bradbury
BU	-	Burbank
CS	-	Calabasas
CA	-	Carson
CE	-	Cerritos
CL	-	Claremont
CM	-	Commerce
CO	-	Compton
CV	-	Covina
CU	-	Cudahy
CC	-	Culver City
DB	-	Diamond Bar
DO	-	Downey
DU	-	Duarte
EM	-	El Monte
ES	-	El Segundo
GA	-	Gardena
GL	-	Glendale
GD	-	Glendora
HG	-	Hawaiian Gardens
HA	-	Hawthorne
HB	-	Hermosa Beach
HH	-	Hidden Hills
HP	-	Huntington Park
ID	-	Industry
IN	-	Inglewood
IR	-	Irwindale
LF	-	La Canada-Flintridge
LH	-	La Habra Heights
LK	-	Lakewood
LM	-	La Mirada
LR	-	Lancaster
LP	-	La Puente
LV	-	La Verne
LN	-	Lawndale
LO	-	Lomita
LB	-	Long Beach
LA	-	Los Angeles
LC	-	Los Angeles County
LASP	-	Los Angeles San Pedro
LAVN	-	Los Angeles Van Nuys
LAWL	-	Los Angeles West Los Angeles
LAWV	-	Los Angeles West Valley
LY	-	Lynwood
MA	-	Malibu
MB	-	Manhattan Beach
MY	-	Maywood
MO	-	Monrovia
MN	-	Montebello
MP	-	Monterey Park
NC	-	Norwalk
PD	-	Palmdale
PV	-	Palos Verdes Estates
PA	-	Paramount
PS	-	Pasadena
PR	-	Pico Rivera
PO	-	Pomona
RP	-	Rancho Palos Verdes
RB	-	Redondo Beach
RH	-	Rolling Hills
RE	-	Rolling Hills Estate
RM	-	Rosemead
SD	-	San Dimas
SF	-	San Fernando
SL	-	San Gabriel
SO	-	San Marino
SC	-	Santa Clarita
SS	-	Santa Fe Springs
SM	-	Santa Monica
SR	-	Sierra Madre
SH	-	Signal Hill
SE	-	South El Monte
SG	-	South Gate
SP	-	South Pasadena
TC	-	Temple City
TO	-	Torrance
VE	-	Vernon
WA	-	Walnut
WC	-	West Covina
WD	-	West Hollywood
WV	-	Westlake Village
WH	-	Whittier

Rev. 10/93

When completing "ZONE DESIGNATOR" area under "CODES" always check box next to "CODES" in "ACTIVITY" area.



PROPERTY DATA RECORD
Los Angeles County Assessor
Roll Year
ACTIVITY:
Permit
Situs Address
CONEX
Codes
Base Year
Transfer
New Construction
Building Data Line
Land Data Line
CODES
Zone Designator
ASSESSOR'S ID NUMBER
PERMIT
CONEX
SITUS ADDRESS
ASSESSEE NAME
LEGAL DESCRIPTION
BASE YEAR VALUE
TRANSFER VALUE
NEW CONSTRUCTION (ADDED VALUE)
BUILDING DATA LINE
LAND DATA LINE

5231-1-3
Page 8 of 8

Besides the PDR, this form may be used for changing zoning.

COUNTY OF LOS ANGELES • OFFICE OF ASSESSOR • VALUATIONS DIVISION

ASSESSOR

ADMINISTRATIVE CHANGE FORM

REGION

PAGE OF

#	ASSESSOR'S ID NUMBER			C D	ZONE DESIGNATOR	USE CODE	IMPAIR-MENT	MINING RIGHTS	[illegible]	CLUSTER
	MAP BOOK	PAGE	PARCEL							
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
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21										
22										
23										
24										
25										

NOTES	PREPARED BY	DATE	PRINCIPAL APPRAISER (FROM REGION)	DATE
	ENTERED BY	DATE	PRINCIPAL APPRAISER (TO REGION)	DATE
	VERIFIED BY			
	PARCEL COUNT		BATCH NUMBER	

ASSR-136 (1/87)

PROPERTY USE CLASSIFICATION CHART

0000 RESIDENTIAL

00 (OPEN)

010V VACANT LAND

01 SINGLE

3rd Character		*4th Character*	
0	Open	1	Pool
1	High value residence X cost classification	3	Pool and misc.
		4	Therapy pool (spa)
T	Wireless communication tower	5	Tennis court
		8	Guesthouse
		9	Other improvements only
	CONDOMINIUM ONLY	C	Condominium
	3rd Character	D	Planned unit development (PUD)
D	Detached	E	Condo conversion
H	High rise 5 stories or more	F	Cooperative
		G	Mills Act property
2	Townhouse format	H	Own-your-own
		L	Lift (entered by lift desk only.)
		M	Modular
		X	Vacant parcel that has improvement value due to existing non-structural other imps.

02 DOUBLE, DUPLEX OR TWO UNITS
03 THREE UNITS (ANY COMBINATION)
04 FOUR UNITS (ANY COMBINATION)
05 FIVE OR MORE APARTMENTS OR UNITS. COOPERATIVE OR OWN-YOUR-OWN PROJECTS NOT SEPARATELY PARCELED.

3rd Character		*4th Character*	
0	4 stories or less	1	Pool
5	5 stories or more	3	Pools and misc.
T	Wireless communication tower	9	Other improvements only
		A	Cooperative
		B	Own-your-own
		C	Condominium
		G	Mills Act property
		L	Lift (entered by lift desk only.)
		M	Modular
		V	Vacant
		X	Vacant parcel that has improvement value due to existing non-structural other imps.

06 (OPEN)

07 MANUFACTURED HOMES

3rd Character		*4th Character*	
0	Single residence	0	Assessed by RP (Permanent foundation)
1	Multiple residence	P	Assessed by PP (No permanent foundation)

08 ROOMING/BOARDING HOUSE

09 MANUFACTURED HOME PARK

3rd Character		*4th Character*	
0	None	1	Pool
1	Own-your-own lot		
T	Wireless communication tower		

1000 [3]COMMERCIAL

100V VACANT LAND

10 COMMERCIAL

3rd Character
- 0 Open
- 1 Miscellaneous commercial
- 2 Artist in residence

11 STORE

12 STORE COMBINATION (WITH OFFICE OR RESIDENTIAL)

3rd Character
- 0 Store & office combination
- 1 Store & residential combination

13 DEPARTMENT STORE

3rd Character
- 1 Discount department store (Target, etc.)
- 2 Building supplies (Home Depot, etc.)
- 3 Home furnishings (Ethan Allen, etc.)
- 4 Retail-warehouse combo. (Levitz, etc.)
- 5 Warehouse store (Costco, etc.)

14 SUPERMARKET

3rd Character
- 0 Supermarket - 12,000 sf or more
- 1 Supermarket - 6,000 sf through 11,999 sf
- 2 Small food store - less than 6,000 sf

15 SHOPPING CENTER (NEIGHBORHOOD, COMMUNITY)

16 SHOPPING CENTER (REGIONAL)

17 OFFICE BUILDING

3rd Character
- 1 Loft-type buildings
- 2 Office and residential

18 HOTEL AND MOTEL

3rd Character
- 0 Hotel - under 50 rooms
- 1 Hotel - 50 rooms and over
- 2 Motel - under 50 rooms
- 3 Motel - 50 rooms and over
- 4 Motel/hotel and apartment combinations - under 50 units
- 5 Motel/hotel and apartment combinations - 50 units and over

19 PROFESSIONAL BUILDING

3rd Character
- 1 Medical dental building
- 2 Veterinary hospital, clinic

2000 [3]COMMERCIAL

20 (OPEN)

200V VACANT LAND

21 RESTAURANT, COCKTAIL LOUNGE

3rd Character
- 0 Restaurant, cocktail lounge, tavern
- 1 Fast food-walk up
- 2 Fast food-auto oriented

22 WHOLESALE AND MANUFACTURING OUTLET

23 BANK, SAVINGS & LOAN

24 SERVICE SHOP
RADIO & TELEVISION REPAIR
REFRIGERATION SERVICE
PAINT SHOP
ELECTRIC REPAIR
LAUNDRY

25 SERVICE STATION

3rd Character		*4th Character*	
0	Full service	0	No add'l services
1	Self service	1	Convenience store
2	W/ Car wash	2	Fast food
3	Card lock (See note)	3	Service bay
		4	Conv. store, fast food,
		5	Conv.store, service bay
		6	Conv. store, fast food, & service bay

Note: Card lock fuel stations are unmanned, automated fueling stations.

26 AUTO, RECREATION EQUIPMENT, CONSTRUCTION EQUIPMENT SALES AND SERVICE

3rd Character
- 0 Auto body repair shop
- 1 Used car sales
- 2 New car sales and service
- 3 Car wash only
- 4 Car wash only, self-service type
- 5 Recreation equipment sales & service (campers, motor homes & boats)
- 6 Farm and construction equipment sales & service
- 7 Auto service centers (no gasoline)

27 PARKING LOT (COMMERCIAL USE PROPERTY)

3rd Character
- 0 Lots-patron or employee
- 1 Lots-commercial parking
- 2 Parking structures-patron or employee
- 3 Parking structures-commercial parking

28 **ANIMAL KENNEL**

29 NURSERY OR GREENHOUSE

---

[3] For the third and fourth characters.

THIRD CHARACTER

T Describes properties with wireless communication tower.

FOURTH CHARACTER

For improved properties, the 4th character describes the number of stories in the main structure (with the exception of lifts, condominiums or Mills Act.) (See Section 2.4C.)

0	One story	9	Other improvements only
2-5	To indicate the # of stories from 2 through 5	L	Lift (entered by Lift Desk Section ONLY)
6	To indicate 6 through 13 stories	G	Mills Act property
7	To indicate 14 through 20 stories	X	Vacant parcel that has improvement value due to existing non-structural other improvements (e.g., fences, block walls, light fixtures, spur track, paving that is not used for parking, service station canopies, etc.). This is used for Measure B purposes.
8	To indicate over 20 stories		

PROPERTY USE CLASSIFICATION CHART

3000 [4]INDUSTRIAL	4000 [4]IRRIGATED FARM	5000 [4]DRY FARM
300V VACANT LAND	40 (OPEN)	50 (OPEN)
30 INDUSTRIAL *3rd Character* 0 Open 1 Miscellaneous industrial 2 Artist-in-residence	**4010 PRIVATE RURAL PUMPING PLANT**	**51 FRUITS & NUTS**
	41 FRUITS & NUTS	**52 VINEYARD**
	42 VINEYARD	**53 FIELD CROPS**
31 LIGHT MANUFACTURING **SMALL EQUIPMENT MANUFACTURING** **SMALL MACHINE SHOP** **INSTRUMENT MANUFACTURING** **PRINTING PLANT**	**43 VINE & BUSH FRUITS**	**54 PASTURE**
	44 TRUCK CROPS	**55 TIMBER - PINE**
32 HEAVY MANUFACTURING	**45 FIELD CROPS**	**56 TIMBER - FIR**
33 WAREHOUSING, DISTRIBUTION, STORAGE *3rd Character* 0 Warehousing, distribution, under 10,000 sf 1 Warehousing, distribution, 10,000 to 24,999 sf 2 Warehousing, distribution, 25,000 to 50,000 sf 3 Warehousing, distribution, over 50,000 sf 4 Public storage (Bekins, Lyons) 5 Public storage - mini warehouse	**46 PASTURE**	**57 TIMBER- REDWOOD**
	47 DAIRY	**58 DESERT**
	48 POULTRY, ETC.	**59 WASTE**
	49 FEED LOT	
34 FOOD PROCESSING PLANT *3rd Character* 0 Meat 1 Beverage 2 Other		
35 MOTION PICTURE, RADIO AND TELEVISION INDUSTRY *3rd Character* 0 Studio 1 Transmission facility 2 Microwave relay tower		
36 LUMBER YARD		
37 MINERAL PROCESSING *3rd Character* 1 Cement, rock & gravel plant 2 Petroleum refinery, chemical plant		
38 PARKING LOT (INDUSTRIAL USE PROPERTY)		
39 OPEN STORAGE *3rd Character* 1 Trucking company, terminal 2 Contractor storage yard		

[4] For the third and fourth characters.

THIRD CHARACTER

T Describes properties with wireless communication tower.

FOURTH CHARACTER

For improved properties, the 4th character describes the number of stories in the main structure (with the exception of lifts, condominiums or Mills Act.) (See Section 2.4C.)

0	One story
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8	To indicate over 20 stories
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G	Mills Act property
X	Vacant parcel that has improvement value due to existing non-structural other improvements (e.g., fences, block walls, light fixtures, spur track, paving that is not used for parking, service station canopies, etc.). This is used for Measure B purposes.

PROPERTY USE CLASSIFICATION CHART

6000 [5]RECREATIONAL
60 (OPEN)
61 THEATER *3rd Character* 0 Movie - indoor 1 Movie - drive-in 2 Legitimate (stage) theater
62 WATER RECREATION *3rd Character* 1 Fee owned boat slip
63 BOWLING ALLEY
64 CLUB, LODGE HALL, FRATERNAL ORGANIZATION
65 ATHLETIC AND AMUSEMENT FACILITY *3rd Character* 0 Auditorium, stadium, amphitheater 1 Amusement facility 2 Commercial swimming pools, school 3 Gymnasium, health spa 4 Dance hall 5 Tennis court, club, pro shop
66 GOLF COURSE *3rd Character* 1 Non profit 2 Three par 3 Miniature
67 RACE TRACK *3rd Character* 1 Horse stable - private
68 CAMP *3rd Character* 1 Trailer and camper park (overnight)
69 SKATING RINK *3rd Character* 0 Ice 1 Roller

7000 [5]INSTITUIONAL
70 CHILDREN'S DAY CARE CENTER
71 CHURCH *3rd Character* 1 Church parking lot
72 SCHOOL (PRIVATE)
73 COLLEGE, UNIVERSITY (PRIVATE)
74 HOSPITAL *3rd Character* 1 Convalescent hospital, nursing home
75 HOMES FOR AGED & OTHERS
76 SENIOR DAY CARE CENTER *3rd Character* 0 Adult care facility - social and recreational services 1 Adult day services - skilled care services offered
77 CEMETERY, MAUSOLEUM, MORTUARY *3rd Character* 0 Cemetery, mausoleum 1 Mortuary, funeral home
78 (OPEN)
79 (OPEN)

8000 MISCELLANEOUS
80 PRIVATELY OWNED *3rd Character* 1 Misc. privately owned properties that do not fall into any other classification. (e.g. fire stations, reservoirs, or airports.)
81 UTILITY COMMERCIAL & MUTUAL: PUMPING PLANT STATE ASSESSED PROPERTY
82 MINING
83 PETROLEUM & GAS
84 PIPELINE, CANAL
85 RIGHTS OF WAY
86 WATER RIGHTS
87 RIVERS & LAKES
8800 GOVERNMENT OWNED PROPERTY (“900” Parcels)
8800 (OPEN)
880V VACANT LAND
8810 Rights of way, general
8811 Street, road, highway
8812 Future street, alley, etc.
8813 Power transmission lines
8814 Sewers, utilities
8820 Government services, general
8821 City hall, administration center

[5] For the third and fourth characters.

THIRD CHARACTER

T Describes properties with wireless communication tower.

FOURTH CHARACTER

For improved properties, the 4th character describes the number of stories in the main structure (with the exception of lifts, condominiums or Mills Act.) (See Section 2.4C.)

0	One story
2-5	To indicate the # of stories from 2 through 5
6	To indicate 6 through 13 stories
7	To indicate 14 through 20 stories
8	To indicate over 20 stories
9	Other improvements only
L	Lift (entered by Lift Desk Section ONLY)
G	Mills Act property
X	Vacant parcel that has improvement value due to existing non-structural other improvements (e.g., fences, block walls, light fixtures, spur track, paving that is not used for parking, service station canopies, etc.). This is used for Measure B purposes.

PROPERTY USE CLASSIFICATION CHART

8800 GOVERNMENT OWNED PROPERTY ("900" Parcels)	8800 GOVERNMENT OWNED PROPERTY (CONT.) ("900" Parcels)	8800 GOVERNMENT OWNED PROPERTY (CONT.) ("900" Parcels)
8822 Auxiliary and regional center	8850 Water related facilities, general	8899 Government property and possessory interest not classified in any of above
8823 Police and fire station	8851 Small boat marina	8900 Dump site
8824 Utilities office, (power, water, etc.)	8852 Boat slip	
8825 Welfare and social services	8853 Boat mooring	
8826 Postal facility	8854 Pier, wharf	
8827 Library	8855 Flood control drainage	
8828 Court building, jail	8856 Irrigation - related	
8829 Military post	8857 Dam	
8830 Public school, general	8858 Reservoir, tank underground storage	
8831 College	8859 Watershed	
8832 High school	8860 Transportation, general	
8833 Elementary school	8861 Harbor & related	
8834 School administration center	8862 Airport, general	
8835 School service center	8863 Airport, t-hanger	
8840 Recreation, general	8864 Airport, tie-down	
8841 Public park	8865 Airport, fixed - base operator	
8842 Art center, museum	8866 Rapid transit, bus, etc.	
8843 Public swimming pool	8870 Concession on public property	
8844 Sports stadium	8871 Food concession	
8845 Beach	8872 Souvenir shop	
8846 Horse stable	8873 Parking lot lease	
8847 Amusement ride	8874 Office space lease	
8848 Ball field (Little League, etc.)	8890 Community redevelopment	
8849 Youth facility (Scouts, etc.)	8891 Public housing	

TABLE 1: VACANT HOUSING UNIT ESTIMATE

ObjectID	STATE_FIPS	CNTY_FIPS	FIPS	PROPORTIONAL VACANT UNITS #	ADDITIONAL PROPORTIONAL POP. FROM VACANT UNITS
4031	06	037	06037108200	1	2
4050	06	037	06037113202	8	25
4051	06	037	06037113211	8	22
4054	06	037	06037113231	0	1
4208	06	037	06037134401	6	20
4223	06	037	06037135203	12	39
4224	06	037	06037137000	13	40
4228	06	037	06037137302	2	7
4229	06	037	06037137401	8	21
4230	06	037	06037137402	12	35
5884	06	037	06037800101	14	44
5885	06	037	06037800102	72	209
5886	06	037	06037800201	93	301
5887	06	037	06037800202	49	158
5888	06	037	06037800302	119	370
5889	06	037	06037800303	110	344
5890	06	037	06037800323	20	69
5891	06	037	06037800324	26	84
5892	06	037	06037800325	47	129
5893	06	037	06037800326	59	178
5894	06	037	06037800401	36	102
5896	06	037	06037800404	76	219
5897	06	037	06037800501	47	127
5898	06	037	06037800502	87	238
6012	06	037	06037920303	11	32
			Totals	**936**	**2816**

Source: 2010 Census data