TRIUNFO SANITATION DISTRICT
A PUBLIC AGENCY

LAS VIRGENES MUNICIPAL WATER DISTRICT
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LVMWD Project No. 2560.00
June 2014

FINAL REPORT

Sanitation Master Plan Update 2014

for the

Joint Powers Authority of:

Las Virgenes Municipal Water District &
Triunfo Sanitation District

KJ Project No. 1389005*00

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Sanitation Master Plan Update 2014

20 June 2014

Prepared for:

Joint Powers Authority Of:

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LVMWD Project No. 2560.00

K/J Project No. 1389005*00

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Executive Summary

Background

The JPA of the Las Virgenes Municipal Water District (LVMWD, District) and Triunfo Sanitation District (TSD) operate and maintain a sewer system and wastewater treatment facilities that serve the Malibu Creek Watershed within Los Angeles and Ventura Counties. The TWRF provides tertiary treatment and disinfection to the wastewater prior to beneficial reuse for irrigation of golf courses, green belts, parks, schools, and HOA common areas. Surplus recycled water that is not used in the recycled water system is released to Malibu Creek after it is dechlorinated. Wastewater solids generated during wastewater treatment are pumped to the Rancho Las Virgenes composting Facility (Rancho) using a 4-mile long buried pipeline. These solids undergo anaerobic digestion, dewatering, composting and then are distributed to the public as Class A Exceptional Quality compost.

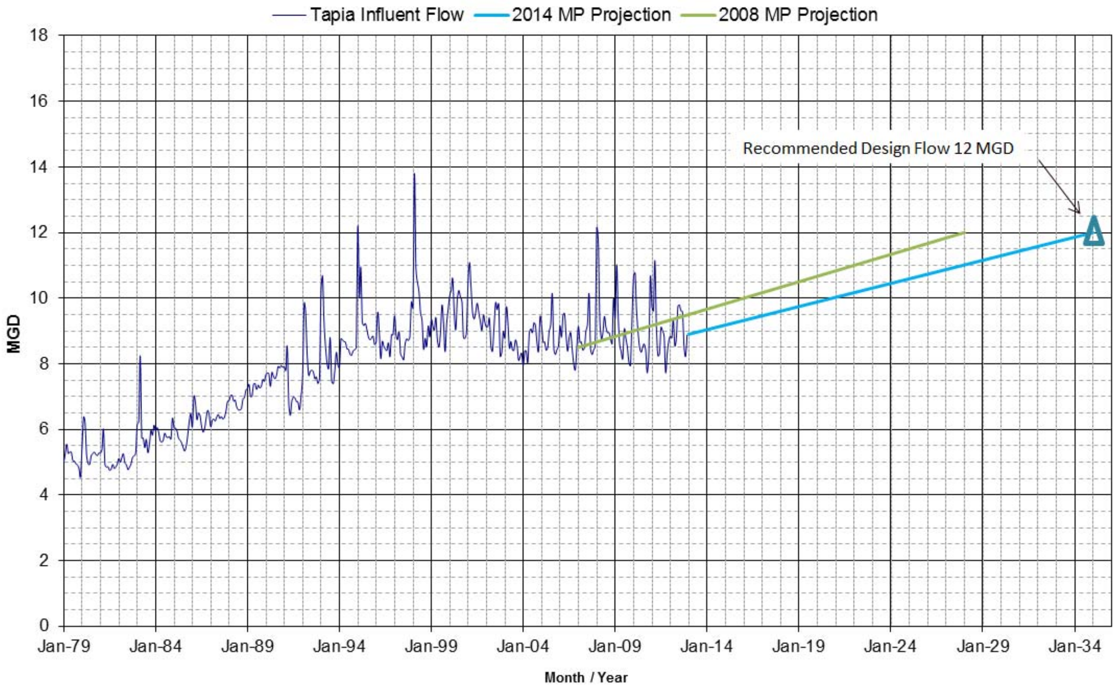
The focus of the 2014 Sanitation Master Plan is to support the following objectives:

1. Establish the system and facility requirements to meet the needs of the Joint Powers Authority (JPA) for providing sanitation services through the year 2035 under the conditions of the current permit
2. Provide a schedule for the construction of sanitation facilities at both the Tapia Water Reclamation Facility (TWRF) and the Rancho Las Virgenes Composting Facility (Rancho) to adequately serve growth projections within the service area and meet the requirements of the current permit
3. Integrate this sanitation plan with the updated plans for water and recycled water.
4. Develop a CIP that identifies needed projects along with the scheduling and estimated construction cost.
5. Serve as a basis for financial planning.
6. Integrate with other studies.

Current and Projected Wastewater Flows

There was a generally steady increase in wastewater flows from the late 1970's to mid 1990's. Since that time, wastewater flows to Tapia have remained relatively constant, even though overall population in the JPA's service area has increased. To ascertain the projected level of future flows, a comprehensive evaluation of changes in both population and unit wastewater flow factors was performed. The results of the analyses suggest that projected flows could increase to approximately 12 MGD. As shown in Figure ES-1, this value is comparable to the findings of the 2008 Sanitation Master Plan, and is therefore recommended as the basis of the TWRP design flow.

ES-1: Comparison of Wastewater Flow Projections



Process Evaluation Findings and Recommendations

Given a 12 MGD basis of design, an evaluation of the liquid and solids processing were performed. Below is a listing of the key design criteria followed by a description of the methodology used to evaluate both of the wastewater treatment process streams.
The updated biological process simulator was used to:

- Project biological nitrogen removal at 12 mgd under steady state conditions,
- Assist in identification of process bottlenecks, and
- Validate process bottlenecks previously identified by other consultants.

The results of the biological process simulations, identified the key deficiencies in the liquid treatment and biosolids management systems. These deficiencies are as follows:

- At Tapia, the aerobic treatment volume seems to be marginal with regard to nitrogen removal.
- At Tapia, there may be insufficient carbon to satisfactorily drive the de-nitrification process.

- At Tapia, the existing oxygen transfer is inefficient.
- The percent solids in the feed sludge to the digesters is limited by the capabilities of the transfer line from Tapia to Rancho. The dilute concentration of the feed sludge impacts the hydraulic capacity of the digesters. Considering the cost of a new line, it is more cost effective to thicken the sludge on the Rancho site prior to digestion.
- With the two existing operational digesters, there is insufficient redundancy to perform required maintenance. A third digester is currently under construction.
- The existing composting operation, while effective, is potentially more energy and operationally intensive than needed, as compared to some new composting technologies.
- Small plastic pieces continue to show up in the compost compromising the quality of the final product.
- The centrate treatment system is an essential part of the overall strategy to meet nutrient limits for nitrate and nitrite. Another Equalization Tank is needed to provide an adequate level of redundancy for reliable compliance and redundancy.

The improvements recommended to mitigate these items are included in Section 5: Proposed Capital Improvement Program. The total cost of these improvements is approximately $19.7 Million. To support their implementation and prioritization, the identified improvements are generally derived to address the following key considerations for the District’s Sanitation facilities:

- Improved reliability and capacity for nutrient removal
- Reduced energy consumption for liquid treatment at Tapia
- Enhanced digestion capacity and efficiency at Rancho
- Reduced energy consumption for biosolids treatment at Rancho
- Improved compost product quality at Rancho

Section 1 – Introduction

Section 1: Introduction

Following is an introduction to this Master Plan Update for the sanitation facilities and system owned and operated jointly by the Las Virgenes Municipal Water District and The Triunfo Sanitation District. This is part of an integrated plan that also encompasses the water and recycled water systems.

1.1 Goals and Purpose (Objectives of the Plan)

The Plan has the following objectives:

1. Establish the system and facility requirements to meet the needs of the Joint Powers Authority (JPA) for providing sanitation services through the year 2035.
2. Provide a schedule for the construction of sanitation facilities at both the Tapia Water Reclamation Facility (TWRF) and the Rancho Las Virgenes Composting Facility (Rancho) to adequately serve growth projections within the service area and meet current regulatory constraints. The water quality objectives for the effluent from Tapia reflect the conditions in the current discharge permit.
3. Integrate this sanitation plan with the updated plans for water and recycled water.
4. Develop a CIP that identifies needed projects along with the scheduling and estimated construction cost.
5. Serve as a basis for financial planning.
6. Integrate with other studies

A review of the Master Plan is necessary whenever:

- A change in Board policy or direction affects project implementation.
- New or upcoming regulations impact existing or planned projects.
- New processes and technologies provide an opportunity to reduce capital and O&M costs.
- Uncertainties arise where project deferral or scope reduction may be necessary.

1.2 Background

The JPA of the Las Virgenes Municipal Water District (LVMWD, District) and Triunfo Sanitation District (TSD) operate and maintain a sewer system and wastewater treatment facilities that serve the Malibu Creek Watershed within Los Angeles and Ventura Counties. The TWRF provides tertiary treatment and disinfection to the wastewater prior to beneficial reuse for irrigation of golf courses and green belts. Surplus recycled water that is not used in the recycled water system is released to Malibu Creek or the Los Angeles River after it is dechlorinated. Wastewater solids generated during wastewater treatment are pumped to Rancho using a 4-mile long buried pipeline. These solids undergo anaerobic digestion, dewatering, composting and then are distributed to the public as Class A Exceptional Quality compost. Prior to completion of Rancho in 1994, the biosolids were disposed by land injection at the Rancho Las Virgenes Farm (Farm). Crops grown at the Farm removed the nitrogen from the soil after the injection.

1.3 Service Area Tributary to Tapia

LVMWD's wastewater service area comprises approximately 70 square miles (45,715 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 includes the incorporated cities of Agoura Hills, Calabasas, Hidden Hills, and Westlake Village as well as unincorporated portions of Los Angeles County. LVMWD's wastewater service area is smaller than that of its water service area. Adjacent to LVMWD's service area, TSD's wastewater service area comprises approximately 50-square miles (32,000 acres) in eastern Ventura County, including Oak Park, Lake Sherwood, Bell Canyon, and the Westlake Village and North Ranch portions of Thousand Oaks.

There is approximately 60 miles of sewer trunk in the LVMWD service area. Of these facilities, approximately 49 miles are owned by the JPA and 11 miles are owned by the LVMWD. LVMWD also owns and operates two sewer lift stations and approximately 1/2 mile of sewer force main. The basic collection systems are owned and operated by others. Within its service area, TSD operates 120 miles of pipelines for wastewater collection.

Together, the two service areas, LVMWD and TSD, comprise the complete service area of the JPA. As illustrated in Figure 1-2, the current sewer collection system throughout the JPA tends to be established in pocket areas, rather than a full network of collection facilities. The east side of the TSD service area, including the Bell Canyon area, and LVMWD's Westhills and Chatsworth service areas drain easterly to the City of Los Angeles, rather than to the TWRF, for wastewater treatment and disposal. There is a significant amount of undeveloped land around and east of the Oak Park service area. While much of the 19,000 acres is likely not be developable, TSD considers a small amount, approximately 1,200 acres and other potential infill areas that may be developable with potential future TSD wastewater flows to TWRF.

1.4 Topography and Climate

There are several unique aspects of the JPA's geography which must be considered when discussing regional sanitation infrastructure. The change in elevation within the 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. In addition, because of the JPA's rural location within the Santa Monica Mountains, the collection system is large.

The climate in the 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.

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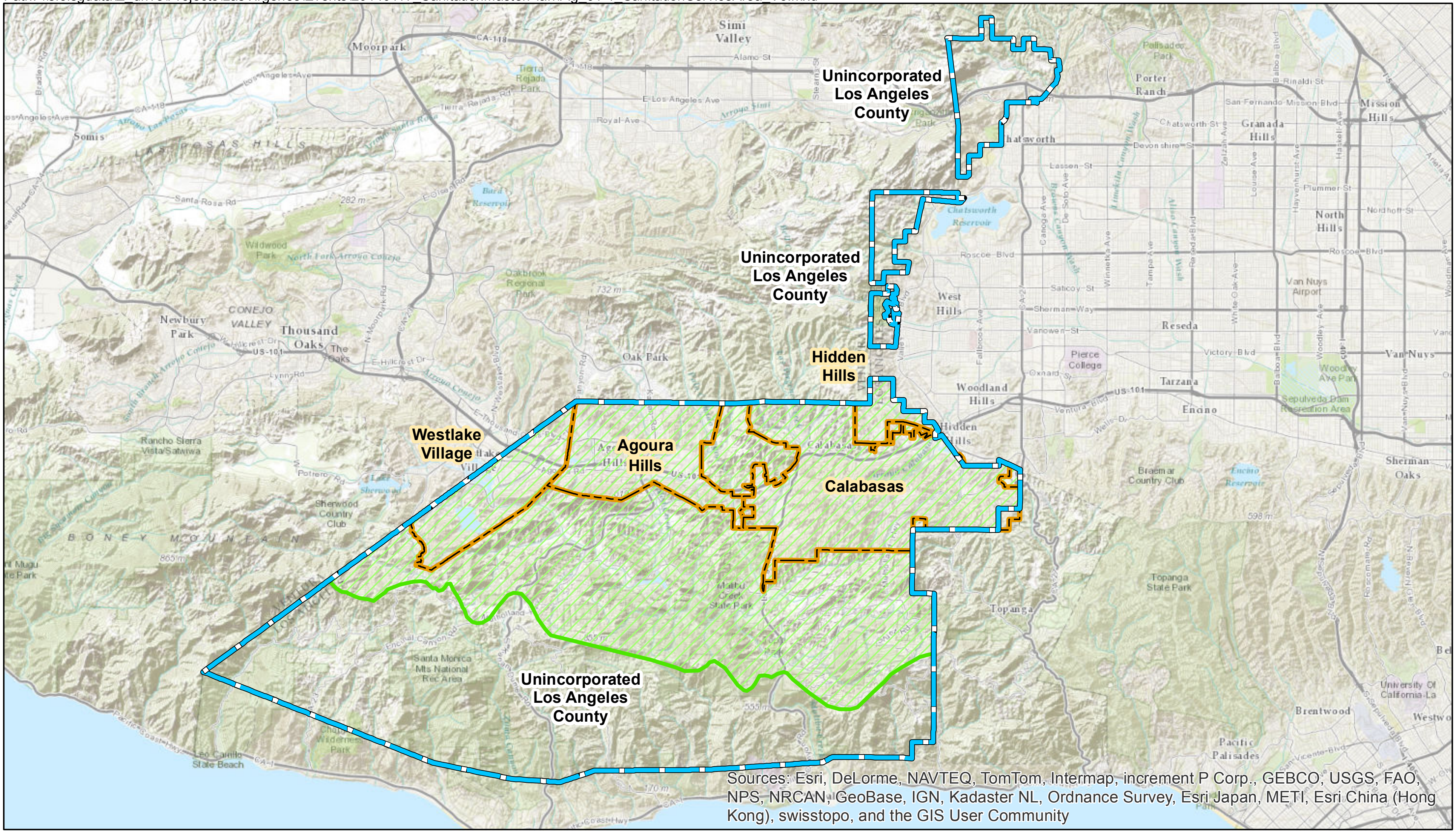
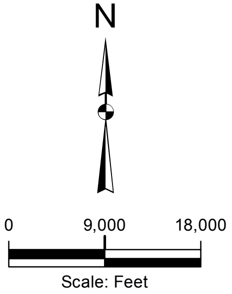


Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

Legend

- ▭ LVMWD Potable Water Service Area
- ▨ LVWMD Sewer Service Area
- ▭ City Limits



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LVMWD Existing Sewer Service Area

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Figure 1-1

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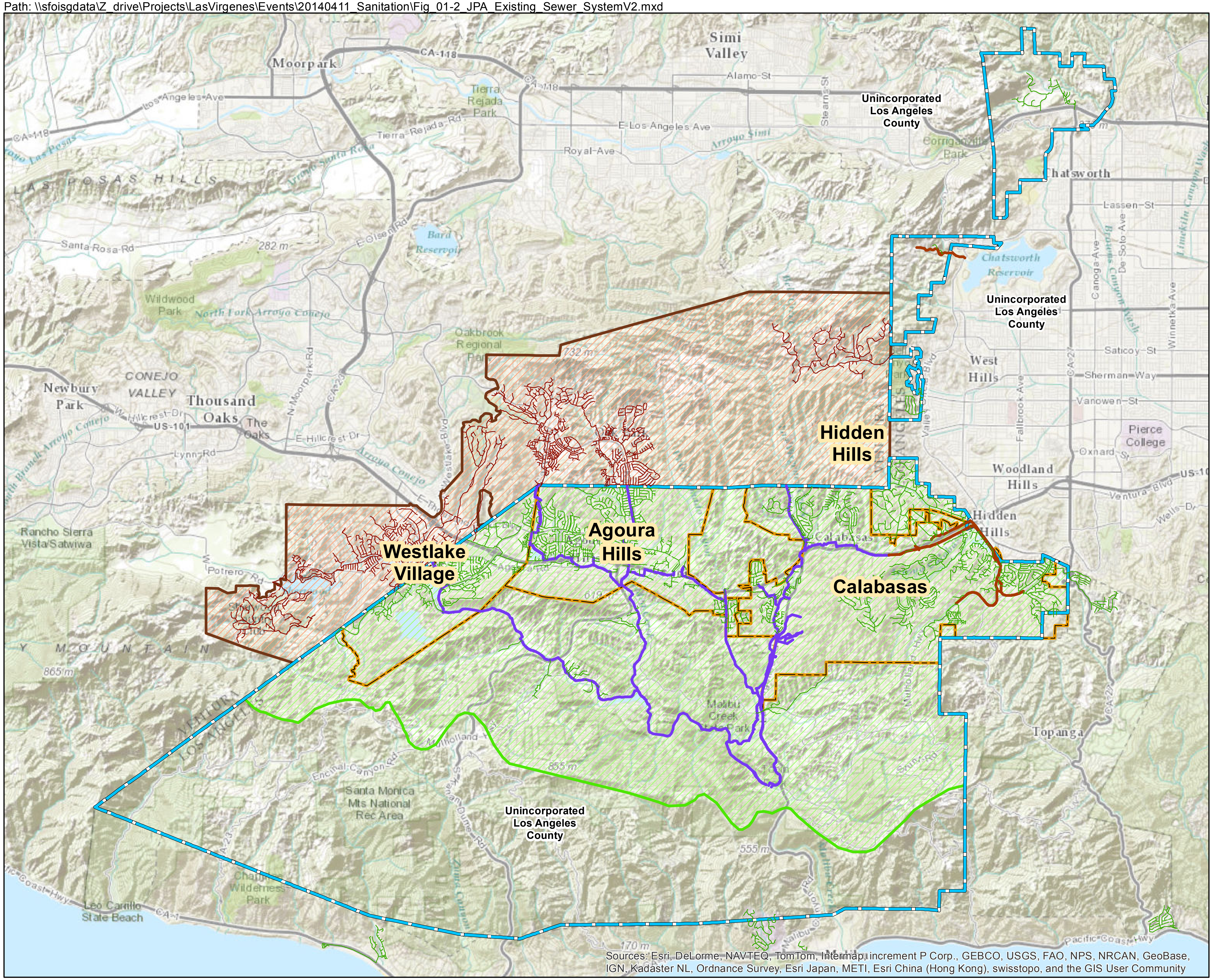

Legend

- TSD Mains
- LA County Pipelines
- JPA Sewers
- LVMWD Sewers
- ☐ LVMWD Potable Water Service Area
- ▨ LVWMD Sewer Service Area
- ▨ Triunfo Sanitation District
- ☐ City Limits

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Scale: Feet

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Los Angeles, County, CA

JPA Existing Sewer System

KJ/ 1389005.00

Figure 1-2

The average annual rainfall in the JPA's service area is approximately 12 inches. The rainy season is from December through March. There is very little rain during the rest of the year.

Table 1-1: Local Climate Data

	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

1.5 Previous Efforts and Studies

The JPA prepared the first Sanitation Master Plan (2003 Plan) in July 2003. The 2003 Plan consolidated all past planning efforts and studies relative to expansion and upgrades for the sanitation facilities. A list of projects, including a timeline for implementation, was developed to adequately provide sanitation service consistent with population growth over a 20-year period. An important element in the 2003 Plan was lower population projections at the service area's build-out. The reduced population scaled back the required treatment capacity from 16.1 million gallons per day (mgd) to 12 mgd.

Several changes in permit requirements, regulations and operational conditions in the last five years warranted an update of the 2003 Plan. In 2008 the Sanitation Master Plan (2008 Plan) was updated by the District. The 2008 Plan included assumptions relative to type and level of treatment, recycled water and air regulations, and permit conditions.

Since completion of the 2008 Sanitation Master Plan Update, the District complete two additional studies. These included:

- Report on the Biological Nutrient Removal Project
- Study of the Current Air Demand and Supply at Tapia

- Preliminary and Final Design for the Third Anaerobic Digester at Rancho

The recommendations found in these studies have generally been designed and implemented. The impacts of those facility improvements are considered in this Sanitation Master Plan Update 2014.

1.6 List of Acronyms

The following abbreviations and acronyms are used in this report.

2003 Plan	July 2003 Sanitation Master Plan
2008 Plan	Sanitation Master Plan Update 2008
ADWF	Average Dry Weather Flow
BHMP	Biosolids Handling Master Plan
BNR	biological nutrient removal
CIMIS	California Irrigation Management Information System
CIP	Capital Improvement Program
District	Las Virgenes Municipal Water District
DU	dwelling unit
EPA	Environmental Protection Agency
ETo	evapotranspiration
Farm	Rancho Las Virgenes Farm
gal/day	gallons per day
HCF	hundred cubic feet
I&I	inflow and infiltration
JPA	Joint Powers Authority
LA RWQCB	Los Angeles Regional Water Quality Control Board
LVMWD	Las Virgenes Municipal Water District
MCL	maximum contaminant level

mgd	million gallons per day
mg/L	milligrams per liter
mMLE	modified Ludzack-Ettinger
MLSS	mixed liquor suspended solids
msl	mean sea level
NPDES	National Pollutant Discharge Elimination System
NRMP	Nutrient Reduction Master Plan
PWWF	peak wet weather flow
Rancho	Rancho Las Virgenes Composting Facility
RAS	return activated sludge
RFE IV	Regional Facilities Expansion IV
RPA	Reasonable Potential Analysis
SCAG	Southern California Association of Governments
SRT	solids retention time
TAZ	Transportation Analysis Zones
TMDL	total maximum daily load
TSD	Triunfo Sanitation District
TSO	Time Schedule Order
TWRF	Tapia Water Reclamation Facility
WAS	waste activated sludge
WW	wastewater
WWTP	wastewater treatment plant
µg/L	micrograms per liter

Section 2 – Historical and Future Wastewater Flows

Section 2: Historical and Future Wastewater Flows

This section presents the 20-year projections for wastewater flows and the rational for the projections. Per capita wastewater flows for service areas in California similar to the one served by the JPA have decreased rather notably since the dry weather period experienced in the late 1980’s and early 1990s. It is likely that most of that decrease has been fully realized and further decreases in per capita wastewater generation will be small. Considering the anticipated steady unit rate of wastewater generation, the projections reflect population growth from infill. A comprehensive analysis of current and projected wastewater flows is provided in Appendix A, and summarized in the following sections.

2.1 Historical Wastewater Flows

Historical TWRF wastewater flows from 1980 to 2013 are shown in Figure 2-1. A breakdown of the origin of wastewater flows between the District, TSD, and other non-potable sources is provided in Table 2-1. As shown, flows to the TWRF have tended to be relatively constant since the late 1990’s, even though overall population in the District’s service area has increased. It is believed that a portion of the continuity in wastewater flows can be attributed to a decline in the economy, the drought and mandatory conservation implemented in the JPA service area.

Figure 2-1: Historical TWRF Wastewater Flows

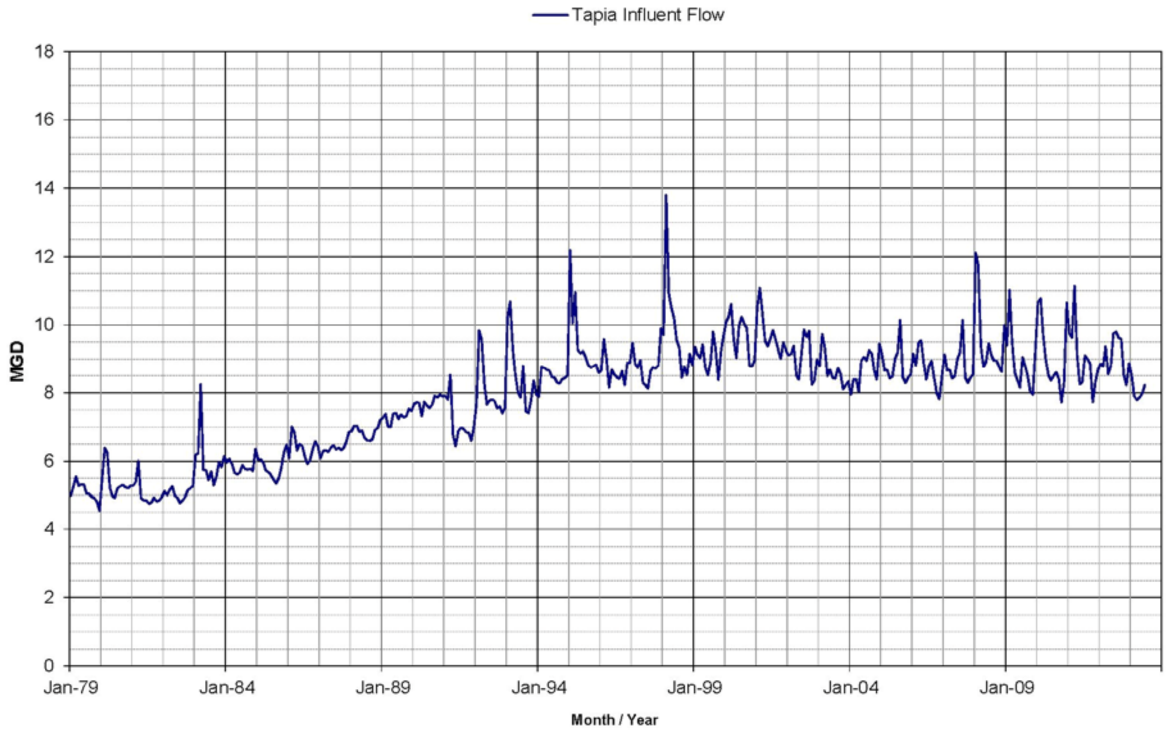

Table 2-1: 2012 Wastewater Flows by Agency

Month	WW Influent (MGD)	Westlake Wells Supplement (MGD)	Net WW Influent (MGD)	LV WW Flows (MGD)	TSD WW Flows (MGD)
Jan	8.85	0.00	8.85	6.20	2.65
Feb	8.79	0.00	8.79	6.14	2.65
Mar	9.37	0.00	9.37	6.68	2.69
Apr	8.54	0.00	8.54	5.76	2.78
May	8.79	0.15	8.63	6.00	2.63
June	9.43	0.69	8.74	6.14	2.60
July	9.80	0.78	9.02	6.48	2.54
Aug	9.62	0.74	8.88	6.29	2.59
Sept	9.58	0.74	8.84	6.24	2.60
Oct	8.52	0.23	8.28	5.73	2.55
Nov	8.22	0.00	8.22	5.67	2.55
Dec	8.87	0.00	8.87	6.33	2.54
Averages	**9.03**	**0.28**	**8.75**	**6.14**	**2.61**

Notes:
Source: 2012 Wastewater data, JPA/LVMWD

2.2 Future Wastewater Flows

The focus of this section is to present the historical wastewater flows to the TWRF, briefly summarize prior water demand analysis, and transition from projecting LVMWD's population and water demands to forecasting projected wastewater discharges to TWRF.

2.2.1 Land Use and Growth Conditions

As previously shown in Figure 1-2, only a portion of the overall service area for both LVMWD and TSD is tributary to the JPA's TWRF. In fact, much of the undeveloped area resides in the southern slopes of LVMWD's service area, and is largely projected to remain on septic in the future. To project future flows, estimated growth opportunities was derived for each agency.

2.2.1.1 LVMWD Growth

The comprehensive population projection developed for LVMWD in support of its water demand projection (Appendix A) was used to ascertain the additional dwelling units projected from vacant land and intensified parcels. This analysis determined that the population in LVMWD's water 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.

An important element of the water population projection analysis revealed the need to "clip" various regional planning data sets to LVMWD's water service area boundary. A similar "clipping" was also required to refine the regional planning data to LVMWD's sewer service area boundary. Based on this analysis, it is estimated that approximately 50 percent of the projected growth resides within LVMWD's service area and is tributary to the TWRF. The projected increase in additional dwelling units within the sewer service area is shown in Table 2-2.

Table 2-2: Housing Projections for LVMWD's Sewer Service Area

Agency/Growth Description	Projected New Dwelling Units
Agoura Hills[a]	
Agoura Village	293
N Agoura Rd	73
Calabasas[a]	746
Hidden Hills[a]	
Per HH note from SCAG	34
Westlake Village[a]	84
Westlake Village Business	401
Potential Septic Tank Conversions[b]	
Calabasas Highlands	36
Old Topanga	27
Malibu Lake	339
Monte Nido	63
Vacant HSE Units [c]	
Vacant Units	548
Totals	**2,644**

Notes:
(a) Agency specific 2013 Housing Elements.
(b) Detailed aerial review of existing dwellings not on sewer per area.
(c) Vacant Units coverage based on 2010 census data, TAZ specific

2.2.1.2 TSD Growth

The TSD's estimate of projected growth was derived from several sources. These included a complete list of parcels that TSD currently serves (both active and inactive), the existing sewer collection system coverage within its services area, Ventura County parcel data, Ventura County Planning Division's area plans, and discussions with TSD staff. During this process, it was difficult to determine how much of the vacant land, especially on the east side of TSD, would develop and if the area tributary to the City of Los Angeles would continue to be discharged easterly to Los Angeles.

As discussed with TSD staff, for the purposes of this planning effort, it was assumed that current septic accounts will ultimately convert to the sewer system, wastewater generated in the eastern service area will continue to be treated by Los Angeles, a small amount of vacant infill parcels may develop and approximately 1,200 acres may potentially develop in the 2035 horizon as low density residential parcels (1 dwelling unit (DU) per 2 acres). It should be noted that while this potential rezoning growth element is uncertain, the increase in future wastewater flows does not affect the capacity findings at the Tapia WRF. The large area of "vacant" land in TSD's service area is graphically depicted in Figure 2-2.

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Figure 2-2: Vacant Land within the TSD Service Area

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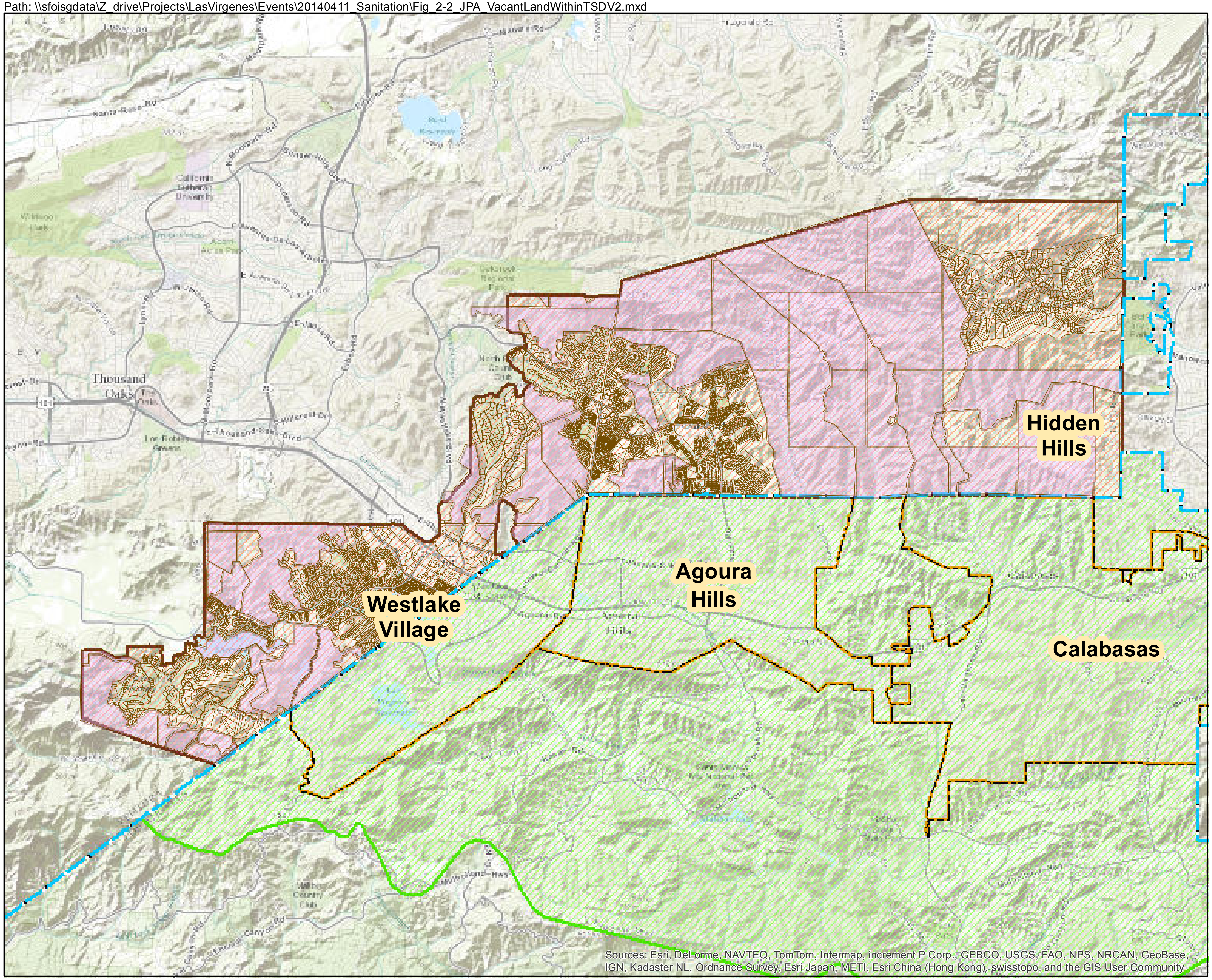

Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

Legend

- ▭ TSD Parcels
- 🟪 TSD Vacant Land
- ▭ LVMWD Potable Water Service Area
- ▨ LVMWD Sewer Service Area
- ▨ Triunfo Sanitation District
- ▭ City Limits

N

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Scale: Feet

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JPA Vacant Land Within the Triunfo Sanitation Service Area

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Figure 2-2

In finalizing the Sanitation Master Plan, growth potential in the TSD service area was further discussed at the June 2, 2014 JPA Board Meeting. Based on the additional uncertainty surrounding potential rezoning, it was decided that a range of potential growth may better reflect potential TSD growth. For the lower range, no growth from potential rezoning would be included. A summary of the range of potential additional dwelling units in the TSD service area is shown Table 2-3. The upper limit was used in this master plan analysis because including the upper limit does not trigger additional capacity at Tapia and is more conservative.

Table 2-3: Housing Projections for TSD's Sewer Service Area

Growth Description	Maximum Projected New Dwelling Units	Minimum Projected New Dwelling Units
Infill Vacant	540	540
Septic	125	125
Non-Taxed Parcels	126	126
Future Rezoning	600[(a)]	0
Totals	**1,400**	**780**

Notes: Totals are rounded

Source data provided by TSD for infill, septic and non-taxed parcels.

(a) Future potential rezoning estimate based on area of 1200 acres in close proximity to existing collection systems, and 1 DU per 2 acres for density.

2.2.2 Economic Analysis of Water Demands and Wastewater Discharge

To assess the potential impact of the weather and economic conditions on water demands and potential wastewater discharges, a regression analysis of LVMWD'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, evapotranspiration (ETo)) and economic (unemployment rate) factors for LVMWD's customers over this same time period. Although it was found that there wasn't a high correlation with ETo or rainfall (for water and not applicable for wastewater), the results of a demand analyses indicate that both water demands and wastewater discharges correlated with the changing economic conditions within LVMWD'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 and wastewater discharges are predicted to increase under good economic conditions for various customer categories (commercial, residential, irrigations, etc.). Since sewage is not metered at the account level, the account-level water usage during the winter billing period was used to represent wastewater for each account. Based on this analysis, it is suggested an economic factor of 13 percent be applied to the 2012 winter water data in the projection of future wastewater discharges for LVMWD. A comprehensive Technical Memorandum of this statistical analysis is provided in Appendix A and A-1. Although account-level water data was not evaluated for TSD, it is believed that the service area characteristics are similar enough to apply this factor to both service areas of the JPA for the purposes of projecting wastewater flows to TWRF.

2.2.3 Drought Implications

Dr. Randal Orton, Resource Conservation Manager, studied the impacts of drought on water demands and submitted a Technical Memorandum of findings in April 2012. The objective of the study was to estimate the pace and magnitude of post drought response on water demands. Based on the 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 the annual demand following the end of the recent drought will continue to rise, attaining its pre-drought level in approximately five to 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 to 4 years, while winter time levels returning in six to seven years.

Based on this study, a drought recovery factor of 31 percent was applied to the 2010 water usage data, and 18 percent to the 2012 water usage data in the development of a future demand projection that would be used to represent an "upper limit" of a full drought recovery. Since it is logical to assume that the influence of the economy and the drought are not mutually exclusive, a partial drought recovery factor was also developed. To this end, an additional water demand scenario was derived based on a 50 percent level of drought recovery (equal to 9 percent for the 2010 usage data).

Since winter water demands (used to represent wastewater) were not found to be as sensitive to the economy or drought as overall annual water demands, applying a full drought recovery factor in addition to the economic adjustment factor appears inappropriate. If we assume that the drought response is split equally for interior and exterior water usage, then 50 percent of the drought recovery factor (9 percent) would be appropriate for inclusion in projecting wastewater flows to TWRF. The District's Technical Memorandum addressing the drought response is provided in Appendix A and A-2.

2.2.4 Projected JPA Wastewater Flows

A projection of future wastewater flows was derived by combining the current average wastewater discharges shown in Table 2-1 with applicable adjustment factors for the economy, drought and other system conditions and then applying this information to current account information and projected growth values derived in Table 2-2 and Table 2-3. The results of the process are provided in Table 2-4.

Table 2-4: JPA Wastewater Flow Projections

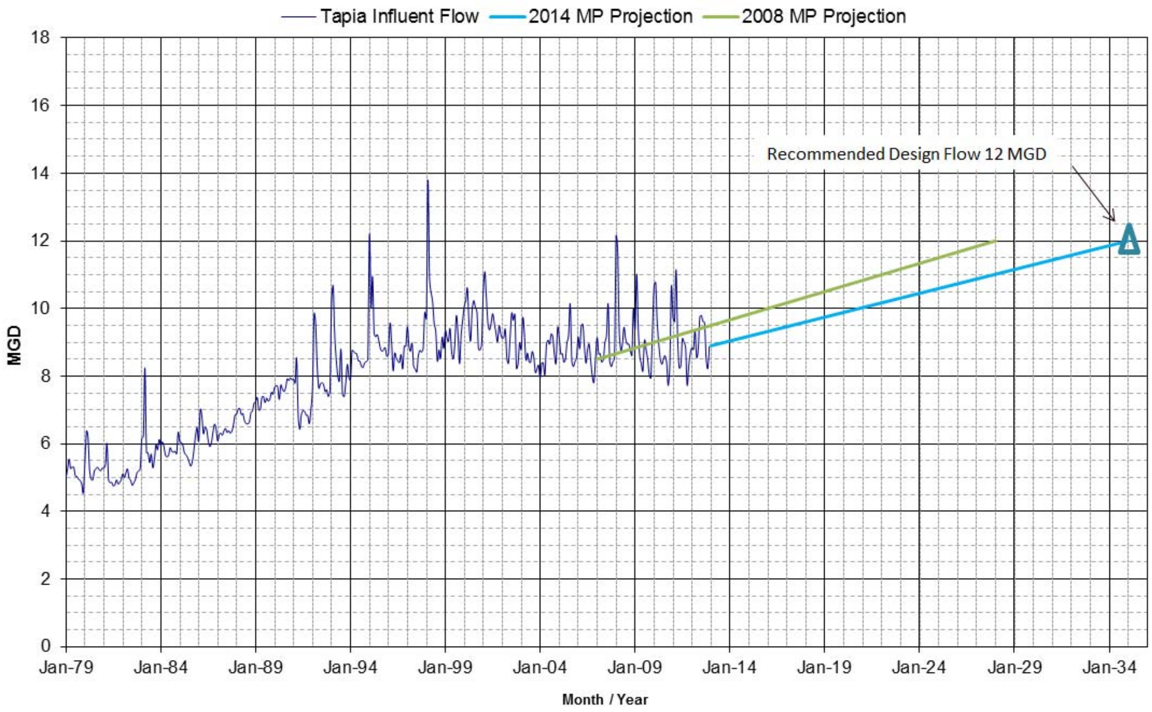
JPA Wastewater Projection

Description	LVMWD	TSD
Total Water Usage (HCF)	7,059,749	N/A
Total Water Usage (MGD)	14.47	N/A
March/April Water Usage (MGD)	11.21	N/A
Current Annual WW Generation (MGD)	6.14	2.61
Ratio of WW/Winter Water	0.55	N/A
WW Generation/Account (Gal/Day)	376	244
WW Generation/DU (Gal/Day)[a]	280	244
Approximate Number of DU 2012[a]	21,913	10,712
Projected New DU by 2035[a]	2,644	1,391
Additional WW Generation by 2035 (MGD)	0.74	0.34
Current Annual WW Generation (MGD)	6.14	2.61
Total WW Generation by 2035 (MGD)	6.88	2.95
JPA Total WW Generation (MGD)	**9.83**	
2035 WW Generation w/ Economic Factor (MGD)[b]	**11.11**	
2035 WW Generation w/ Drought Recovery (MGD)[c]	**12.11**	
2035 WW Generation w/ Provision for I&I[d]	**12.59**	

Notes:
Water and Wastewater values shown are for calendar year 2012.
(a) TSD # of Accounts assumed identical to TSD # of Units; maximum range used herein.
(b) Economic Factor of 13 percent
(c) Drought Recovery Factor of 9 percent
(d) Infiltration and Inflow Factor of 4 percent

To further demonstrate this finding, the flow projection trends developed in the 2008 Sanitation Master Plan, along with current trend lines and the new 2013 long-range wastewater flow projections are shown graphically on Figure 2-3. Consistent with the work performed for the LVMWD's water system demand projection, Figure 2-3 demonstrates that the projections derived herein are comparable to the previous long-range planning values for the JPA.

Figure 2-3: Comparison of Wastewater Flow Projections



2.2.5 Recommended Design Flows

Based on the wastewater projection analysis described above, a design flow of 12 mgd is recommended. This value provides for projected growth as well as treatment capacity for groundwater supplement. Considering these projections, the wastewater flows will not reach the capacity of TWRF for at least 20 years, assuming the current permit requirements. Regulators typically ask wastewater agencies to begin the planning process for increasing capacity once the wastewater flows reach 85 percent of design maximum. If the growth in wastewater flows match the projection shown in Figure 2-3, above. The District would need to initiate the expansion planning process in about 2025.

Section 3 – Existing Facilities

Section 3: Existing Facilities

3.1 Sewer Collection System

The JPA owns and operates sixty miles of trunk sewers within its service area. Tributary flows to trunk sewers are owned and operated by the local cities, County of Los Angeles or Triunfo Sanitation District. The JPA's existing conveyance system has the demonstrated capacity to transport up to 32 mgd of peak wet weather flow (PWWF) to the TWRF. No expansion of the conveyance system is anticipated at this time. However, in the influent lift station only two of the four pumps are equipped with variable pumping capacity (variable frequency drives). Also, equipping the remaining two pumps with variable frequency drives will provide an enhanced level of reliability for handling peak storm flows.

LVMWD owns and operates two sewage lift stations that transport sewage from the U-2 area within the LA River watershed to the U-1 area in the Malibu Creek watershed. The balance of the sewage flows to the TWRF by gravity through the JPA collection system.

Triunfo Sanitation District (TSD) owns and operates 120 miles of sewer collection system pipelines. These facilities are also supported by four lift stations and ½ mile of pressure force mains to pump sewage from low areas in the collection system into the trunk system. Together, the TSD collection and pumping system annually conveys approximately 2.6 MGD of wastewater to the TWRF.

3.2 Tapia Water Reclamation Facility

In 1990, the Regional Facilities Expansion IV (RFE IV) Project – Phase I, expanded the TWRF's liquid treatment capacity to the ultimate anticipated flow of 16.1 mgd. The National Pollutant Discharge Elimination System (NPDES) permit in place during RFE IV required full nitrification only (no nitrogen removal) during secondary treatment so that the effluent would not be toxic to aquatic life in Malibu Creek.

In 1997, a new NPDES permit was issued with a nitrate limit of 10 milligrams per liter (mg/L) and a Malibu Creek discharge prohibition from April 15 to November 15. An associated Time Schedule Order (TSO) revised the nutrient requirement to 13 mg/L as an annual average and 17 mg/L as a daily maximum, until the Los Angeles Regional Water Quality Control Board (LA RWQCB) determined the appropriate limit. Permit compliance was achieved by reducing the air flow to two aeration basins, thus creating anoxic zones for denitrification.

To provide an outlet for surplus recycled water during the discharge prohibition, a new and separate discharge permit was issued in 1999. This allowed discharge to the LA River at outfall 005 as long as the nitrate+nitrite was below 8 mg/L. This more stringent limit required the installation of submersible mixers in the aeration basins. Each of these treatment configurations used capacity intended for a 16.1 mgd flow. In 2003, the Environmental Protection Agency (EPA) established a total maximum daily load (TMDL) for nutrients to Malibu Creek. However, the LA RWQCB did not approve the EPA TMDL or make their own determination, so the TSO nutrient limits remained in effect.

In January 2002, while the EPA TMDL was under development, a Nutrient Reduction Master Plan (NRMP, LVMWD Report No. 2181.00) was completed. The plan identified the necessary facilities to achieve compliance with the near-term as well as projected future nutrient limits. However, with the nutrient TDML pending approval by the LA RWQCB, it appeared prudent to defer construction of these facilities until the final limits were established. To meet near-term compliance with nitrate limits at a moderate cost, the interim Biological Nutrient Removal Improvements and Electrical Upgrades Project was implemented in December 2002. The project created two modified Ludzack-Ettinger (mMLE) flow trains in the existing aeration tanks. Each flow train had an anoxic and an aerobic tank with an internal recycle pump.

To meet short-term compliance with effluent discharge prohibition during the seven summer months, a combination of programs were implemented. These included: sewage diversion to the City of Los Angeles, discharge of treated effluent to the LA River, waste spraying on JPA/leased lands, expansion of the recycled water systems, and new cost incentive programs to encourage additional recycled water customers and usage in the spring and fall periods.

In November 2005, the LA RWQCB issued a new NPDES permit for the TWRF. The new permit consolidated the Malibu Creek and Los Angeles River discharge and monitoring requirements under a single permit. A nitrogen requirement of 8 mg/L nitrate, based on the EPA TMDL, was specified. An associated TSO provides less stringent, interim limits until the final compliance date of May 18, 2010. Facilities needed to comply with the nitrogen requirement have been constructed and have been in operation since late 2009. Components of this construction include:

1. Aeration Basin Modifications
2. Centrate Storage and Treatment
3. Return Activated Sludge (RAS) Treatment

In addition to the nitrogen requirement described above, the permit also includes requirements for other constituents. A 3 mg/L total phosphorus limit as a monthly average, based on historical plant performance, is unchanged in the new permit from the previous 1997 permit. However, the daily maximum value is more restrictive, changing from 6 mg/L to 4 mg/L. Compliance has generally been achieved since the end of 2011.

It should be noted that discharge limitations for some of the mineral-based constituents, like total dissolved solids and chlorides, are actually more stringent to the LA River than to Malibu Creek. Since mineral removal at Tapia WRF would be a high cost addition to the plant, it is recommended that the JPA continue to monitor mineral constituents for trends in increased loadings. Moreover, given the potential significant cost of mineral removal for LA River discharges emphasizes the long-term benefit of maintaining the ability to discharge to Malibu Creek. While there are limits for other toxic materials, these are not anticipated to pose compliance problems based on recent plant performance.

The current permit also includes a provision for an annual Reasonable Potential Analysis (RPA) that may trigger new limits for priority pollutants that have a reasonable potential to cause, or contribute to an excursion above any State Water Quality Standard. Some of these pollutants include those discussed previously. In the first RPA conducted under the new permit, seven pesticide chemicals triggered reasonable potential. A reopener provision in the permit allows the LA RWQCB to reopen the permit to allow inclusion of new numeric limitations for constituents that exhibit reasonable potential. No treatment facilities are planned to remove these constituents.

The current permit also retained the Malibu Creek discharge prohibition from April 15 to November 15 except during treatment plant upsets and operational emergencies, qualifying storm events, and creek flow augmentation. A qualifying storm event was changed from 0.1 to 0.4 inches of rain. Permission to discharge is required during rain events less than 0.4 inches. In contrast to the 1997 permit, discharge to the LA River is neither flow nor time limitedThe JPA anticipates that the next discharge permit will be issued in the fall of 2015.

3.3 Rancho Las Virgenes Farm

The Farm is a permitted facility for disposal of Class B biosolids by subsurface land injection. Class B biosolids can be produced by aerobic digestion at the TWRF or anaerobic digestion at Rancho. The Farm consists of two centrate treatment tanks, a pumping station and a piping system extending to the injection fields. A tractor fitted with subsurface injectors, connects with a hose to the piping outlets in the fields. The EPA Standards for the Use or Disposal of Sewage Sludge (Title 40 of the Code of Federal Regulations) Part 503, or simply the Part 503 Rule, limit biosolids application at the agronomic nutrient uptake rate of the crops that are planted and harvested. Operation of Rancho in 1994 resulted in a substantial reduction in Farm injection. With the restriction on Malibu Creek discharge in 1997, the Farm became the primary disposal area for surplus recycled water.

In May 2002, the LA RWQCB issued a directive to prepare a Fate and Transport Study, including a Groundwater Remediation Plan to mitigate the elevated nitrates in the groundwater. A 2-phase work plan was presented to the LA RWQCB to complete the Study. The Phase I Groundwater Study was completed in March 2005. It concluded that natural attenuation and minimal biosolids injection have reduced nitrates in the groundwater. Further, while legacy nitrates remain, the data does not provide their precise movement and location. It was estimated that about 55 percent of the nitrates remained bound in the soil and groundwater beneath the Farm. The Study recommended further subsurface work within the Farm and sampling in Las Virgenes Creek be performed in the Phase II study to validate this finding. Recommendations were also made to discontinue deep ripping in the fields and minimize south canyon operation.

Biosolids injection was only conducted once in the last five years. In the summer of 2003, 1.2 million gallons of anaerobically digested biosolids were injected to accommodate modifications to the cake metering bin and distribution conveyors at the facility.

Since the flowing water in Las Virgenes Creek meets the current EPA nutrient TDML requirement of 8 mg/L for nitrate and nitrite as well as the maximum contaminant level (MCL) for drinking water, it was concluded that a groundwater remediation project is not necessary. In addition, operation of the Farm for effluent disposal and emergency biosolids application can continue as long as best management practices are observed. Since the Phase II Groundwater Study recommends the continuation of the current nitrate monitoring program, no additional groundwater remediation or management projects are considered at this time.

In 2011, the District initiated the process for planning, designing and constructing the expansion of the digestion capacity at the Rancho site (see Section 3.3). The District's intention is to handle all the biosolids at the Rancho site with the Farm serving only as an emergency backup for biosolids disposal.

3.4 Rancho Las Virgenes Composting Facility

The Rancho Las Virgenes Composting Facility was constructed as part of the RFE IV Project to provide biosolids treatment due to lack of space at the TWRF site. Originally sized for 16.1 mgd, the project was scaled back during “value engineering” for an 8 mgd TWRF flow. All major processes at Rancho, including anaerobic digestion, dewatering and composting, are currently designed to and operating at half of the capacity of the original design. The intent was to continue to use the Farm for disposal of aerobically digested waste activated sludge (WAS). Construction of several treatment components was deferred until capacity was needed. As discussed earlier, use of the Farm for the disposal of effluent has resulted in the diversion of biosolids to Rancho.

In January 2002, a Biosolids Handling Master Plan (BHMP, LVMWD Report No. 2182.00) was completed to identify facilities necessary to manage biosolids production from the TWRF. Instead of constructing a new Compost Reactor Building, the BHMP specified larger equipment-related capacity improvements to meet the additional capacity needs. .

As noted above, in 2011 the District started the process of adding a third digester on the Rancho site to fulfill redundancy needs and add capacity. The third digester, also a 1.1 million gallon facility, was identified as a CIP item in the JPA's 2008 Master Plan Update. The planning for that digester is included in the Third Digester Pre-design Report. This facility is currently under construction with startup scheduled for late 2014.

In 2011 the District initiated the planning for a cogeneration project to utilize the digester gas for power production, combined with provision for using the waste heat to heat the digesters. The cogeneration system is operated under a power purchase agreement with a private firm.

3.5 Final Disposal and Discharge

After demands for recycled water are met, excess tertiary-treated effluent is disposed of in one of several ways. The primary disposal method is discharge into Malibu Creek via Discharge Point 001 during the November 16th to April 14th timeframe. Excess effluent may also be pumped over the Calabasas grade and discharged into the Arroyo Calabasas via Discharge Point 005. Arroyo Calabasas is a tributary to the Los Angeles River. There are two other discharge points, which are rarely used. Discharge Point 003, located above the County gauging station (R-13 in Order No. 2005-0075) on Malibu Creek, is only used as an additional outlet during extremely high flow conditions. LVMWD's recycled water reservoir overflow (Discharge Point 002) is located behind LVMWD headquarter building . Additionally, excess effluent may be used for irrigation in the farm fields at the Rancho Las Virgenes Composting facility.

Section 4 – Process Evaluations

Section 4: Process Evaluations

The liquid and solids processing needs for the sanitation services were evaluated for a 25-year planning horizon. Following is a listing of the key design criteria followed by a description of the methodology used to evaluate both of the wastewater treatment process streams.

4.1 Regulatory Trends

Nationally, the EPA has been pushing for nutrient limits to be included in future discharge permits. This trend has expanded beyond the needs of inland dischargers to also include ocean discharge systems. Given that the EPA has been conducting studies on Malibu Creek for several years, it is likely that future nutrient limits will become more stringent. As discussed with staff, this Master Plan Update is conducted under the assumption that the nutrient limits will remain at their current limits for the next few years.

4.2 Liquid Processes

A biological process simulator was used to evaluate the capabilities of the existing secondary treatment process at the TWRF. A discussion of the treatment system model and modeling evaluations is provided in the following subsections.

4.2.1 Design Criteria

The key design criteria for the liquid process that were considered as part of this planning update are listed in Table 1 of Figure 4-1. The assumed maximum ADWF is 12 mgd.

4.2.2 Purpose and Methodology

The purpose of this work was to update the Las Virgenes biological process simulator, developed by AECOM in 2011, to reflect current operational strategies and process loading. The updated simulator was then used to:

- Project biological nitrogen removal at 12 mgd under steady state conditions,
- Assist in identification of process bottlenecks, and
- Validate process bottlenecks previously identified by other consultants.

The following sections present the results of the biological process simulation, with regards to compliance with anticipated effluent quality goals limitations. The simulator used in this analysis was developed by others, and was updated only to reflect an increase in influent waste strength since the time the simulator was initially developed. Similarly, while biological phosphorus removal is also estimated by the model, these estimates should be considered “rough” estimates as operational data related to phosphorus was not provided to review or adjust modeling results in this study.

Las Virgenes Municipal Water District - Tapia WRF Biological Process Modeling Results

Table 1: Model Inputs for Primary Effluent Characteristics

Used In Simulation #	Primary Effluent Characteristics	Characteristics from Operating Data				Assumed Characteristics						
		COD	TSS	NH3-N	TP[1]	CBOD5[2]	VSS[3]	TKN[4]	NO3-N[5]	PO4-P[5]	Alkalinity[5]	pH[5]
		mg/L	mg/L	mg N/L	mg P/L	mg/L	mg/L	mg N/L	mg N/L	mg P/L	mg CaCO3/L	-
1, 3	Average Concentrations 2011-2012	275.2	93.5	25.7	6.6	138	83.2	37.1	0	4.9	300	7.3
2	Average Concentrations 2012	288.6	98.3	26.4	7.8	144	87.4	38.0	0	4.9	300	7.3
4, 5, 6, 7	Maximum Month Concentrations 2012 (Highest 30-Day Average)	356.7	147.0	30.0	6.6	178	130.8	43	0	4.9	300	7.3

1) TP - Avg of 7 measurements (2009 to 2012) from raw influent
2) COD/CBOD5 = 2.0 (typical range = 1.8 to 2.0 per Influent Specifier)
3) ISS of primary effluent = 10 to 20 mg/L per Influent Specifier
4) NH3-N/TKN = 0.69 based on data from 6/16/2010 (0.6-0.85 per Influent Specifier)
5) Values from 2007 MWH Report

Table 2: Model Inputs and Targets for Flows, Recycle Ratios, Temperature, and DO and Process Loading Summary

Used In Simulation #	Operating Conditions	Given						Assumed
		PE Flow	IR ratio	RAS ratio	Target MLSS	Temp.	RAS Flow	DO in Oxic
		MGD	% of PE	% of PE	mg/L	°F	MGD	mg/L
1	Average Concentrations 2011-2012	8	300%	90%	2400	70-72	7.2	2
2	Average Concentrations 2012	8	300%	90%	3000	70-73	7.2	2
3	Average Concentrations 2011 2012	12	300%	90%	3000 3200	70 72	10.8	2
4, 5, 6, 7	Maximum Month Concentrations 2012 (Highest 30-Day Average)	12	300%	90%	3000+	70-72	10.8	2

Calculated Primary Effluent Loads			
COD	TSS	NH3-N	TP
lbs/d	lbs/d	lbs/d	lbs/d
18361	6236	1717	438
19253	6556	1763	520
27542	9354	2576	657
35695	14712	3001	657

Table 3: Model Inputs for Process Volumes and Calculated HRTs - Main Stream Biological Tanks

Used In Simulation #	Main Stream Process Volumes and HRTs	Anx 3 / Anx 4	Ox 2-2 / Ox 5-2	Anx 2-1 / Anx 5-1	Anx 1-1 / Anx 6-1	Ox 1-2 / Ox 6-2	Total per train	# of Trains	Total	Total Anoxic	Total Oxic	Total HRT	Anoxic HRT	Ox HRT
		MG	MG	MG	MG	MG	MG	Ea	MG	MG	MG	hrs	hrs	hrs
1, 2, 3	At 8 MGD Flow	0.54	0.405	0.135	0.135	0.405	1.62	2	3.24	1.62	1.62	9.72	4.86	4.86
4, 5, 6, 7	At 12 MGD Flow	0.54	0.405	0.135	0.135	0.405	1.62	2	3.24	1.62	1.62	6.48	3.24	3.24

Table 4: Model Inputs for Process Volumes and Calculated HRTs - RAS Tanks

Used In Simulation #	RAS Stream Process Volumes and HRTs	RAS Ox1	RAS Anx-2	RAS Anx-3	Total	Total Anoxic	Total Oxic	Total HRT	Anoxic HRT	Ox HRT
		MG	MG	MG	MG	MG	MG	hrs	hrs	hrs
1, 2, 3	At 8 MGD Flow	0.25	0.25	0.25	0.75	0.5	0.25	0.104	0.069	0.035
4, 5, 6, 7	At 12 MGD Flow	0.25	0.25	0.25	0.75	0.5	0.25	0.069	0.046	0.023

Table 5: Simulation Outputs - Estimates of Steady State Biological Process Performance

Simulation #	Process Model Outputs	Total Process				Main Stream		Secondary Effluent											RAS Anx-3		PE	SE	WAS	Process
		SRT[1]	RAS TSS	WAS Flow	WAS TSS	SRT[2]	MLSS	COD	CBOD5	TSS	NH3-N	NO3-N	NO2-N	TKN	TP	PO4-P	Alkalinity	pH	NH3-N	NO3-N	TN	TN	TN	TN Removal
		days	mg/L	MGD	lbs/day	days	mg/L	mg/L	mg/L	mg/L	mg N/L	mg N/L	mg N/L	mg N/L	mg P/L	mg P/L	mg CaCO3/L	-	mg N/L	mg N/L	lbs/d	lbs/d	lbs/d	%
1	Average Primary Effluent Concentrations 2011-2012, 8 MGD Flow	15	5017	0.15	6410	10.1	2406	35	4	9	0.3	5.2	0.3	2.5	1.8	1.3	192.5	6.9	2.3	0	2470	530	435	61%
	2011-2012, AVG		5432				2366				0.9	8.9												
	2011-2012, Range		3120-8360				1431-3811				0.2-4.3	1.5-15.7												
2	Average Primary Effluent Concentrations 2012, 8 MGD Flow	19	6298	0.12	6335	12.8	3014	40	4	12	0.2	4.9	0.2	2.7	2	1.4	190.5	6.9	2.8	0	2540	511	425	63%
	2012, AVG		6419				3000				0.3	7.5												
	2012, Range		4530-7470				1431-3811				0.3	3.6-10.5												
3	Average Concentrations, 12 MGD Flow	13.3	6660	0.17	9600	8.9	3200	39	5	12	0.4	5.2	0.8	2.8	1.9	1.3	192	6.9	1.3	0.2	3705	864	655	59%
4	Maximum Month Concentrations, 12 MGD Flow - 3200 MLSS	9	6660	0.26	14200	6	3200	45	6	12	1.0	2.2	4.6	3.6	0.8	0.3	178	6.9	4.8	0	4306	1008	954	54%
5	Maximum Month Concentrations, 12 MGD Flow - Higher SRT	14	9360	0.16	12800	9.5	4480	51	7	17	0.4	5.2	0.7	3.3	1.2	0.5	178	6.9	6	0	4306	906	836	60%
6	Maximum Month Concentrations, 12 MGD Flow - Higher SRT + 480 GPD Sup. Carbon	14	9850	0.16	13400	9.4	4719	53	8	18	0.4	3.3	0.8	3.4	1.0	0.3	185	6.9	6.1	0	4306	745	891	62%
	Current NPDES Nitrogen Limits										**<2.3**	**< 8**												

1) MLSS in the RAS reactors includedin SRT calculation
2) MLSS in the RAS reactors excluded from SRT calculation

Calculations and Proces Modeling By: Eun Kim
Reviewed By: David Seymour
Date: 10/23/2013

Preface:

The purpose of this work is to update the Las Virgines biological process model (developed by AECOM in 2011) to reflect current operational strategies and process loading. The updated model will then be used to project biological nitrogen removal at 12 MGD flow under steady state conditions. Biological phosphorus removal is also estimated by the model, but these estimates should be considered "rough" estimates as operational data related to phosphorus was not provided to review or adjust modeled results.

Approach to Model Input Parameters:

Primary effluent, operating parameters, and process volumes were generated from review of 2011-2012 historical operating data, review of previous modeling and report by AECOM and MWH, and interviews with Brett Dingman. Model input parameters are shown on Tables 1, 2, 3, and 4 to the left. A simplifying assumption was made that primary effluent concentrations at 8 MGD will be similar to primary effluent concentrations at 12 MGD. This should be cross-checked against predicted influent loadings prior to finalizing the model.

Simulations Conducted:

Six simiulations were conducted and are summarized in Table 5 below:
Simulation 1: 2011/2012 Average Performance - to check modeled predictions
Simulation 2: 2012 Aveerage Performance - to check modeled predictions
Simulation 3: Estimate average process performance at 12 MGD
Simulation 4: Estimate maximum month process performance at 12 MGD maintaining current operational strategies
Simulation 5: Estimate maximum month process performance at 12 MGD, higher SRT/MLSS
Simulation 6: Estimate maximum month process performance at 12 MGD, higher SRT/MLSS + sup. carbon

Summary:

The model appears to be overpredicting nitrification and denitrification performance in Simulations 1 and 2; this should be considered when reviewing predictions of future performance. Model calibration with adjustment of kinetic and stoichiometric parameters could be achieved with additional data, but such effort is beyond the scope of this work.

With respect to future scenarios, the model is predicting that incomplete nitrification will occur at 12 MGD if the current operating MLSS is maintained (as evidenced by ammonia and nitrite present in the secondary effluent). Adjustment of SRT/MLSS and supplemental carbon did not result in complete nitrification, although an increase in SRT improved the nitrification performance and supplemental carbon improved denitrification performance. The model is predicting that the biological process will be limited in aerobic SRT. Increasing SRT by raising MLSS alone may result in other issues, such as deteriorating performance of the secondary clarifiers due to high solids loading rates. Consideration should be given to additional aerobic basin volume or conversion of anoxic basin volume to aerobic volume and also provisions for supplemental carbon.

Path: Z:\Projects\LasVirgenes\Events\20140117_SanitationMasterPlan\Fig_05-1_TapiaWRF.pptx

Abbreviations/Acronyms:

ANX - Anoxic
CBOD5 – 5-day Carbonaceous Biochemical Oxygen Demand
COD – Chemical Oxygen Demand
DO – Dissolved Oxygen
HRS - Hours
HRT – Hydraulic Retention Time
IR – Internal Recycle
MG – Millions of Gallons
MGD – Millions of Gallons Per Day
MLSS – Mixed Liquor Suspended Solids
NH3-N – Ammonia Nitrogen
NO3-N – Nitrate Nitrogen
OX - Oxic
PE – Primary Effluent
PO4-P – Phosphate Phosphorus
RAS – Return Activated Sludge
SRT – Solids Retention Time
TEMP - Temperature
TKN – Total Kjeldahl Nitrogen
TN – Total Nitrogen
TP – Total Phosphorus
TSS – Total Suspended Solids
VSS – Volatile Suspended Solids

Kennedy/Jenks Consultants

Sanitation Master Plan Update 2014
Los Angeles, County, CA

Tapia WRF Biological Process
Modeling Inputs & Results

KJ/ 1389005.00

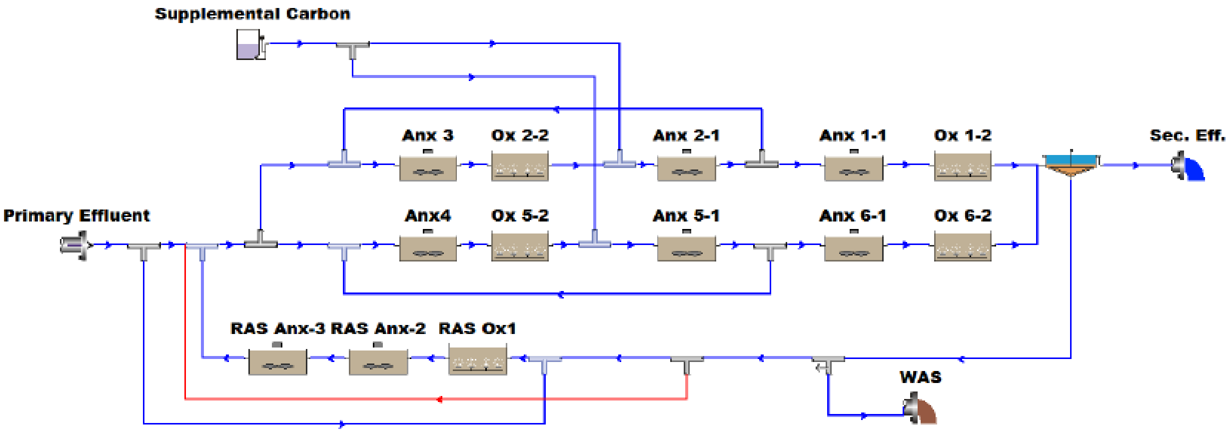
Figure 4-1

4.2.3 BioWin Model Validation

Biological process modeling of the secondary treatment process was carried out using the BioWin 3.1 simulator, developed by Envirosim of Ontario, Canada. The BioWin model uses complex biological interactions to predict material transformations and pollutant removals in different processes at a wastewater treatment plant (WWTP). The model enables the user to simulate carbonaceous oxidation, nitrification, denitrification, and biomass production, among other things.

A flow schematic in the BioWin simulator was set up to resemble the WWTP configuration shown in Figure 4-2. For the purposes of this study, the biological basins were modeled as two parallel treatment trains as shown in the layout below. Each pass of each treatment train was simulated as an anoxic or aerobic zone, based on feedback from plant staff on operational strategies. The RAS re-aeration basins were also included in the simulation, as well as the secondary clarifiers. To simplify the model, primary treatment was excluded from the simulation. Effluent quality improvement through supplemental carbon addition is estimated by simulating carbon addition to the anoxic portions of basins 2 and 5.

Figure 4-2: Tapia WRF Biological Process Model Schematic



4.2.3.1 Process Model Inputs

Inputs to the simulator included the dimensions and volumes of tanks, RAS flow, internal recycle flow, solids retention time (SRT), primary effluent wastewater parameters, dissolved oxygen concentrations, supplemental carbon dosage, and temperature.

Primary effluent, operating parameters, and process volumes were generated from review of 2011-2012 historical operating data, review of previous modeling and report by AECOM and MWH, and interviews with plant staff. Primary effluent parameters, operational parameters, and other process model inputs are shown in Tables 1, 2, 3, and 4 of Figure 4-1.

4.2.3.2 Secondary Effluent Quality Objectives

The effluent quality objectives for the secondary treatment process are summarized in Table 4-1.

Table 4-1: Effluent Quality Objectives

Measured Parameter	Effluent Quality Objective
BOD_5, monthly average	<10 mg/L
TSS, monthly average	<10 mg/L
Total Ammonia, monthly average	<1 mg/L
Total Nitrogen, monthly average	
pH, monthly average	6.5-7.5

4.2.3.3 Simulation Scenarios

BioWin was used to assist in the evaluation of process bottlenecks by simulating process operation under different operating scenarios. A summary of the six operating scenarios considered in this study is presented below, along with the rationale for the selection of each scenario.

- **Scenario 1**: 2011/2012 Average (Steady State) Performance
    - To compare simulator predictions of performance against actual operation.

- **Scenario 2**: 2012 Steady State Performance
    - To compare simulator predictions of performance against actual operation.

- **Scenario 3**: Typical Influent Concentrations, 12 mgd Flow
    - Estimate process performance at 12 mgd ADWF with influent concentrations similar to those currently observed on a typical basis.

- **Scenario 4**: Maximum Month Influent Concentrations, 12 mgd Flow, Maintain Current Mixed Liquor suspended solids (MLSS) Concentration
    - Estimate process performance at 12 mgd ADWF with influent concentrations similar to those currently observed on a maximum month basis. This scenario assumes that the current MLSS concentration is maintained.

- **Scenario 5**: Maximum Month Influent Concentrations, 12 mgd Flow, Maintain Current Solids Retention Time (SRT) and Allow MLSS to Increase
    - Estimate process performance at 12 mgd ADWF with influent concentrations similar SRTs to those currently observed on a maximum month basis. This scenario assumes that the current MLSS concentration is increased.

- **Scenario 6**: Maximum Month Influent Concentrations, 12 mgd Flow, Maintain Current Solids Retention Time (SRT) and Allow MLSS to Increase, Add Supplemental Carbon
    - Purpose is similar to Scenario 5, except that the impact of supplemental carbon is estimated.

For each simulation, effluent quality (CBOD5, TSS, Ammonia, Nitrite, Nitrate, TP, TN, and pH), WAS production, SRT, MLSS, and alkalinity consumption were estimated. A summary of results from the simulations is presented in Table 5 of Figure 4-1.

4.2.4 BioWin Model Findings

The model appears to be over-predicting nitrification and denitrification performance in Simulations 1 and 2; this should be considered when reviewing predictions of future performance. Model calibration with adjustment of kinetic and stoichiometric parameters could be achieved in the future with additional data. With respect to future scenarios at 12 mgd flow, the model is predicting that incomplete nitrification will occur at 12 mgd if the current operating MLSS is maintained (as evidenced by ammonia and nitrite present in the secondary effluent). Adjustment of SRT/MLSS and supplemental carbon did not result in complete nitrification, although an increase in SRT improved the nitrification performance and supplemental carbon improved denitrification performance. The model is predicting that the biological process will be limited in aerobic SRT. Increasing SRT by raising MLSS alone may result in other issues, such as deteriorating performance of the secondary clarifiers due to high solids loading rates. Consideration should be given to additional aerobic basin volume or conversion of anoxic basin volume to aerobic volume and also provisions for supplemental carbon to improve the efficiency of the anoxic basins. These results are generally consistent with the conclusions and recommendations derived from previous evaluations.

It should be noted that this evaluation and the process simulations may not account for some complex chemical and biological interactions that may occur in a full-scale system. Foaming, solids bulking, membrane fouling, mixing limitations, tank geometry, short circuiting, poor solids distribution, chemical interactions, and impacts to microbiology by inhibitors are not accounted for and are beyond the scope of this evaluation.

4.3 Solids Processes

The District's basic approach to biosolids management consists of anaerobic digestion of combined primary and secondary sludges to meet the requirements of the Part 503 regulations for Class B biosolids. The fully digested sludge is then composted with wood chips at the Rancho Facility and the compost product is hauled off as a soil amendment.

4.3.1 Sludge transfer from Tapia to Rancho Site

Combined waste activated sludge and primary sludge is pumped to the Rancho site from Tapia through an 8-inch line about 4 miles long. Pressure constraints limit the solids concentration to about 2.5 to 3 percent.

4.3.2 Digestion System

The digestion system currently consists of two 1.1 million gallon mesophillic digesters. Both of these digesters are required for providing the minimum 15 – day detention time, considering the concentration of the feed sludge. As previously mentioned, a new, third 1.1 million gallon digester is under construction and slated for operation in 2014. The existing digesters are currently heated with steam. The steam heating system will be replaced by a hot water system utilizing water from the cogeneration engine.

4.3.3 Biosolids Dewatering

The digested sludge is dewatered in one of two centrifuges to a concentration of about 20-25 percent before combination with the woodchip bulking agent for composting. The centrifuges are generally operated one shift per day, 6 days per week.

4.3.4 Biosolids composting

While the existing biosolids composting process at Rancho produces a very good Class A product, there are operational challenges that impact the overall efficiency of the program. These challenges include the relatively high energy and labor requirements to run the facility, equipment maintenance and bulking agent costs, and high level of odor management. An evaluation of the Rancho composting process would include evaluating these challenges as well as composting technologies that may prove to be more effective for Rancho.

For example, there may be benefits gained from piloting the use of covers on the existing composting process (Figure 4-3) to evaluate reducing carbon dioxide and other gases impacting equipment within the compost buildings. The pilot would also include the use of a different aeration system that has a significantly less energy demand and labor cost than the current process. If the pilot proves successful, and the JPA wanted to implement a full scale demonstration, the modifications required to the existing facilities would be fairly nominal and would not negatively impact the existing production of biosolids compost at Rancho.

Figure 4-3: Example Static Pile Installation for Potential Piloting at Rancho

4.4 Identified Deficiencies

Following are key deficiencies in the liquid treatment and biosolids management systems that have been identified in the conduct of the 2014 Sanitation Master Plan:

- At Tapia, the aerobic treatment volume seems to be marginal with regard to nitrogen removal.
- At Tapia, there may be insufficient carbon to satisfactorily drive the de-nitrification process.
- At Tapia, the existing oxygen transfer is inefficient.
- The percent solids in the feed sludge to the digesters is limited by the capabilities of the transfer line from Tapia to Rancho. The dilute concentration of the feed sludge impacts the hydraulic capacity of the digesters. Considering the cost of a new line, it is more cost effective to thicken the sludge on the Rancho site prior to digestion.

- With the two existing operational digesters, there is insufficient redundancy to perform required maintenance. A third digester is currently under construction.

- The existing composting operation, while effective, is potentially more energy and operationally intensive than needed, as compared to some new composting technologies.

- Small plastic pieces continue to show up in the compost compromising the quality of the final product.

- The centrate treatment system is an essential part of the overall strategy to meet nutrient limits for nitrate and nitrite. Another Equalization Tank is needed to provide an adequate level of redundancy for reliable compliance and redundancy.

The improvements recommended to mitigate these items are included in Section 5: Proposed Capital Improvement Program.

Section 5 – Proposed Capital Improvement Program

Section 5: Proposed Capital Improvement Program

5.1 Introduction

An important element of this Sanitation 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 sanitation facilities and is based on 2013 dollar values.

5.2 Tapia Water Reclamation Facility

The TWRF is located at 731 Malibu Canyon Road, Calabasas, CA 91302 in Malibu Canyon and provides wastewater treatment and recycled water production for the Las Virgenes/Triunfo JPA. Future expansion on this site due to open space and topographical restrictions. The TWRF has permitted discharges to two highly regulated water bodies - Malibu Creek, and the Los Angeles River. Additionally, the effluent is used to produce Title 22 quality recycled water for “unrestricted use”.

Several measures were used to evaluate the needs for the TWRF considering a 25-year planning horizon:

- Process Modeling - The existing Biowin process model was updated and calibrated with recent operating data. The model was used to evaluate plant performance up to the projected maximum dry weather flow of 12 mgd, estimated to occur around 2035.
- Site visits - Personnel toured the facilities with District staff to observe the general condition of structures and equipment and note deficiencies as discussed with staff.
- Discussions with Management and Operations staff - Discussions were held with the District’s management and operations staff to ascertain key challenges associated with operating the TWRF under all conditions while maintaining compliance.

As a result of employing these various evaluation measures, several needed improvements were identified. The improvements are categorized by the reasons they are needed: capacity/reliability, operations/efficiency, aging/failing facilities, and regulatory/compliance. Following is a brief discussion of the special considerations related to these four parameters.

5.2.1 Capacity/Reliability

The dry weather capacity of TWRF was confirmed to be 12 mgd. That dry weather flow is not projected to be reached until approximately 2035. However, some bottlenecks related to nutrient treatment are projected to be reached as the flow increases and approaches 12 mgd. Measures related to enhanced reliability of the secondary process, particularly related to nutrient removal, are included in this CIP.

Additionally, the TWRF does experience hydraulic issues during very high flow storm events. Measures for addressing both variable and high influent flows have been included in this CIP in the form of two projects, one for flow equalization of primary effluent and the other to install variable frequency drives on the two submersible influent pumps.

5.2.2 Operations/Efficiency

Some of the major process equipment at TWRF does not reflect modern technology. Potentially cost-effective improvements that will enhance plant operations and reduce energy consumption are included in this CIP.

5.2.3 Aging/Failing Facilities

The TWRF is a 24/7 facility and, considering the age, some of the equipment may be approaching or have exceeded its normal useful life. Additionally, the main structures are not pile supported and are located on alluvial soils. The District staff has pointed out a few structures that have settled relative to adjacent structures. Some projects have been included in this CIP to address important issues associated with aging or failing facilities.

5.2.4 Regulations/Compliance

This CIP is prepared to reflect compliance with the existing permit. If the next permit includes more stringent requirements, additional improvements may need to be added to the CIP to provide for compliance. Projects are included in this CIP to provide for more reliable compliance with the existing permit.

One of the most challenging requirements of the existing, and likely future, permits is the limit nitrogen (nitrate plus nitrite). The current biological nutrient removal (BNR) strategy involves three separate processes for meeting the nitrogen limit:

- BNR in the secondary treatment process using a combination of aerobic, anoxic and anaerobic zones in the aeration tanks.

- BNR of the RAS in existing tank to reduce the nitrogen in the sludge recycled back to the aeration tanks of the secondary treatment process.

- BNR of the centrate to reduce the load of resoluble nitrogen compounds (mostly ammonia) returned from the digestion process to the headworks of the plant.

Improvements to each of these nitrogen removal processes are indicated to provide more reliable compliance. The improvements are described in the CIP table.

5.3 Rancho Las Virgenes Composting Facility

The Rancho facility is also located at 3700 Las Virgenes Road, Calabasas, CA 91302 in Malibu Canyon and provides for digestion of the wastewater solids from the TWRF and production of a compost product for disposal. The facilities, which include two anaerobic digesters, were constructed in 1991. The 2008 Sanitation Master Plan Update included construction of a third digester at the Rancho site. That third digester is under construction and scheduled to be operational in 2014. The third digester is required for redundancy - to allow for each of the original digesters to be taken off line for maintenance, one at a time. Cogeneration facilities were constructed in 2012 under a Power Purchase Agreement to utilize digester gas to produce power.

Several measures were used to evaluate the needs for the Rancho solids management facilities considering a 20-year planning horizon:

- Process Planning - Planning for the digestion facilities at Rancho was documented in the pre-design report for the Third Digester.

- Site Visits - Personnel toured the facilities with District staff to observe the operations and general condition of structures and equipment and note deficiencies as pointed out by the staff.

- Discussions with Management and Operations staff - Discussions were held with the District's management and operations staff to learn about the operational challenges of operating Rancho site while providing for major maintenance activities that may take facilities off line for several months, with limited redundancy.

As a result of employing these various evaluation measures some needed improvements were identified. The improvements are categorized by the reasons they are needed: capacity/reliability, operations/efficiency, aging/failing facilities, and regulatory/compliance. Following is a brief discussion of the special considerations related to these four parameters.

5.3.1 Capacity/Reliability

The combined primary and waste activated sludge solids are pumped from Tapia to Rancho at a dilute consistency due to the hydraulic limitations of the sludge transfer line. The dilute sludge compromises the hydraulic capacity of the anaerobic digesters. Thickening the sludge at the Rancho site could increase the hydraulic capacity of the digestion system.

5.3.2 Operations/Efficiency

The existing heating system for the two original digesters is very inefficient and in need of major repairs or replacement. The heat for the digesters is either recovered from the cogeneration engine or produced from digester gas in the boiler. A more efficient digester heating system will provide for more gas to produce power.

The marketability of the compost product is partly dependent on its quality. Small individual fruit labels and other small plastic pieces find their way through the liquid process and are currently present in the sludge sent to Rancho.

5.3.3 Aging/Failing Facilities

As noted above, the digester heating system has failed and is in need of replacement. The compost building is subject to highly corrosive conditions due to the gases liberated during the composting process. Most of the remaining facilities are in relatively good condition. Typically, digesters are taken down about every 10 years for maintenance. The existing two digesters have been continuously in operation for nearly 20 years.

5.3.4 Regulations/Compliance

The Part 503 regulations for Class B biosolids require a minimum of 15 days detention time at 95 degrees. In order to remain in compliance with this regulation, the existing digesters cannot be taken off line for maintenance until the new Third digester is operational.

The centrate treatment system is composed of two reactor tanks, which are used to treat centrate generated by the centrifuge dewatering of anaerobically digested solids. Currently, one centrate treatment tank is used to store centrate, while the other is used to treat in a batch process. To allow for better permit compliance and provide redundancy, a centrate equalization/storage tank needs to be constructed.

5.4 Conveyance System

The District owns the sewer trunk lines and does not own or operate the collection systems. The main pump station to TWRF pumps a wide range of flows from dry weather nighttime minimums to peak flows during storm events.

5.5 Potential Innovative Improvements

New technologies have been developed in recent years that have the potential to directly address some of the wastewater management issues at the District and provide long term financial benefits. Following are three evaluations that could lead the way to considerable cost savings as well as performance improvements.

5.5.1 Evaluation of Supplemental Carbon Options

Nitrogen/nutrient removal in the TWRF secondary process is required for compliance with the discharge permit. Carbon addition in the anoxic zones at TWRF will enhance nitrogen removal, particularly during periods of higher flow (mornings) and in the future as growth occurs and flow increase. Typically, methanol is used to supplement carbon, or possibly acetate.

Another source of carbon is the organic material contained in the cell walls of bacteria. Generally, this carbon does not go into solution or become available to aqueous biological activity. However, there are some processes that rupture the cell membranes and render the cell contents accessible to biological activity. Once treated or conditioned, waste activated sludge is more digestible. A portion of the treated waste activated sludge can be recycled to the anoxic zone as a carbon supplement. This has been demonstrated full scale at the Tempe

Arizona WWTP. The benefits include a low cost carbon source for nutrient removal, increased digester gas production and reduced residual solids following digestion.

5.5.2 Evaluation of Potential Composting Process Improvements

While the existing composting process at Rancho produces a good product, it is fairly energy and operation intensive and requires a high level of odor management. Static pile composting is less energy intensive and can be covered to contain odors and moisture. A pilot evaluation of a static pile composting operation could be quite conveniently be conducted at the Rancho site over a two month period. If the pilot proves successful, and the District wanted to implement a static pile approach, the modifications required to the existing facilities are fairly nominal.

5.5.3 Market Study of Local High Carbon Wastes for Co-digestion

Most of the digester gas at Rancho is used to generate electrical power on site. The more gas available the more power that can be generated. Certain high strength, high carbon wastes have been demonstrated to co-digest effectively with wastewater solids. Recent studies as well as full scale demonstrations have shown the following benefits to co-digestion:

- Enhanced gas production
- Reduced residual solids
- Improved dewaterability of the digested solids
- Reduced Odor potential

The purpose of a market study would be to identify possible local sources of high-carbon wastes, assess their digestibility and volume and determine long term availability.

5.6 Planning Level Unit Costs

Unit cost estimates are derived to support the development of the Sanitation Master Plan CIP. These unit costs were derived based on cost information from industry manufacturers, data provided by LVMWD, Kennedy/Jenks experience on similar sanitation system improvements, and discussions with staff. The costs derived herein should be considered as representative costs for future improvements and are for budgetary and planning purposes. More accurate estimates should be derived during the design phase of capital improvement implementation. In addition to the base planning unit cost, a 35 percent allowance has been included for the design, environmental, construction management, legal, and administrative costs.

5.7 Capital Improvement Program Summary

The recommended projects to be included in the JPA's Capital Improvement Program are shown in Table 5-1. These projects generally address the following key considerations for the JPA's Sanitation facilities:

- Improved reliability and capacity for nutrient removal
- Reduced energy consumption for liquid treatment at Tapia
- Enhanced digestion capacity and efficiency at Rancho
- Reduced energy consumption for biosolids treatment at Rancho
- Improved compost product quality at Rancho

Table 5-1: Sanitation Master Plan - Capital Improvement Program

PROJECT NO.	PROJECT LOCATION	CIP PROJECTS	TIMEFRAME		PROJECT COST	PRIORITY			TREATMENT THEMES				NOTES
			Short Term (0-10 years)	Long Term (11+ years)	Estimated Cost ($1,000)	High	Medium	Low	Capacity/ Reliability Improvements	Operations/ Efficiency Improvements	Aging/Failing Facility Improvements	Regulatory/ Compliance Improvements	
1	TWRF	Increase Aerobic basin volume by converting anoxic volume, baffled zone separation, RAS drop and provision for supplemental carbon	X		$1,200	X			X	X		X	The process modeling indicated that as the flows approach 12 mgd there is insufficient aerobic volume in the aeration tanks to secure complete nitrification. One option is to increase the aerobic volume at the expense of the anoxic volume and enhance the effectiveness of denitrification in the remaining anoxic zone. While there are other options for improving BNR this alternative will likely provide the most beneficial impact per dollar and provide improved operational stability.
2	TWRF	Increase Aeration Efficiency (Install Fine Bubble Diffusers and New Blowers)		X	$4,000			X		X			Current aeration is energy inefficient. Fine bubble aeration combined with new, more efficient blowers will likely save considerable energy and cost. However, payback period will likely exceed 10 years
3	TWRF	Flow Equalization on Primary Effluent (also need additional pump station)		X	$12,000		X		X	X		X	Primary Effluent equalization. This would buffer out peaks for improved performance from secondary process. Additionally, would serve dual function by also providing the equivalent of Recycled Water storage by increasing TWRF's ability to supply RW during the night when influent flows are typically low and recycled water demands are high. Assume 4 million gallons of storage.
4	TWRF	Sludge Screening Before Pumping to Rancho	X		$100		X			X			To remove plastic fruit stickers, small pieces of plastic, hair from sludge to improve quality of compost, prevent accumulation in digesters and protect equipment .
5	Rancho Composting Facility	Thickening of Sludge from Tapia Prior to Digestion	X		$500		X		X	X			Thickening centrifuge or rotary drum thickener would fit in space available. Implementation of thickening would Increased capacity of digesters.
6	Conveyance	Install Variable Speed on Two Submersible Influent Pumps		X	$80		X		X				Two existing submersibles are fixed speed. Variable speed would provide for more efficient influent pumping.
7	TWRF	Address Issues of Infrastructure Settling	X		$30	X			X	X	X	X	Considering differential settling of discharge piping from RAS Pumps, flex couplings should be installed to relieve apparent stress in pipe.
8	TWRF	Divert Primary Flow to RAS Re-aeration Basins for Nitrification/Denitrification	X		$400			X	X	X		X	This would likely be an option if Item 1 is not implemented. Implementation of Item 1 would likely produce better and more reliable results.
9	CIP STUDY	Evaluation of Supplemental Carbon Options - WAS cell lysing, methanol, acetate, etc.	X		$80	X			X	X		X	Study to evaluate best strategy for supplying additional carbon to drive denitrification in anoxic zones.
10	CIP Study	Pilot; Gore Covered Aerated Static Pile for Biosolids Composting	X		$60	X				X			Gore static pile composting process could substantially reduce energy consumption, equipment needs and odor potential with limited modifications to existing facilities.
11	CIP STUDY	Market Study and Digestibility Evaluation for Possible Local Carbon Sources	X		$50		X			X			Once the third digester is operational the District's digestion system will have substantial capacity to digest an external source of high strength waster. The potential benefits are: increased gas production, decreased residual solids for compost, improved dewaterability and reduced odor potential. Once viable sources are identified the digestibility and gas production potential will be evaluated using respirometry techniques
12	Rancho Composting Facility	Construction of Centrate Equalization Tank	X		$1,200	X			X	X		X	The centrate digester is composed of two reactor tanks, which are used to treat centrate generated by the centrifuge dewatering of anaerobically digested solids. Currently, one centrate treatment tank is used to store centrate, while the other is used to treat in a batch process. To allow for better permit compliance and provide redundancy, a centrate equalization/storage tank needs to be constructed.
				Totals	$19,700	$2,570	$12,730	$4,400					

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Appendix A

Current and Projected Wastewater Generation Technical Memorandum

Kennedy/Jenks Consultants

17 January 2014

Technical Memorandum

To: John Zhao & David Lippman (LVMWD), Mark Norris (TSD)

From: Roger Null, VP; Dakota Corey

Subject: Current and Projected Wastewater Generation - Revised
K/J 1389005*00

During the conduct of the Las Virgenes Municipal Water District's (District's) Potable Water, Recycled Water and Sanitation Master Plans, Kennedy/Jenks Consultants has prepared two previous Technical Memorandums (TMs) related to the analysis of current and historical water demands and projected increases in population and water usage in the District's service area. The focus of this TM is to present the historical wastewater flows to the Tapia Water Reclamation Facility (TWRF or Tapia), briefly summarize this prior analysis, and transition from projecting the District's population and water demands to forecasting projected wastewater discharges to TWRF.

Background of Local Wastewater Services

In 1964, the Las Virgenes Municipal Water District and the Triunfo Sanitation District (TSD) formed a Joint Powers Authority (JPA) to treat wastewater in its service area. TWRP has evolved from its original capacity of 0.5 million gallons per day (mgd) to a capacity of 16 mgd. In approximately 2005, TWRF completed the construction of necessary facility improvements to meet more stringent nutrient discharge requirements, resulting in a de-rated the wastewater plant capacity to its current level of 12 mgd. The service area boundaries of the District, TSD, and the JPA along with an overlay of census tracts used for planning are shown in Figure 1.

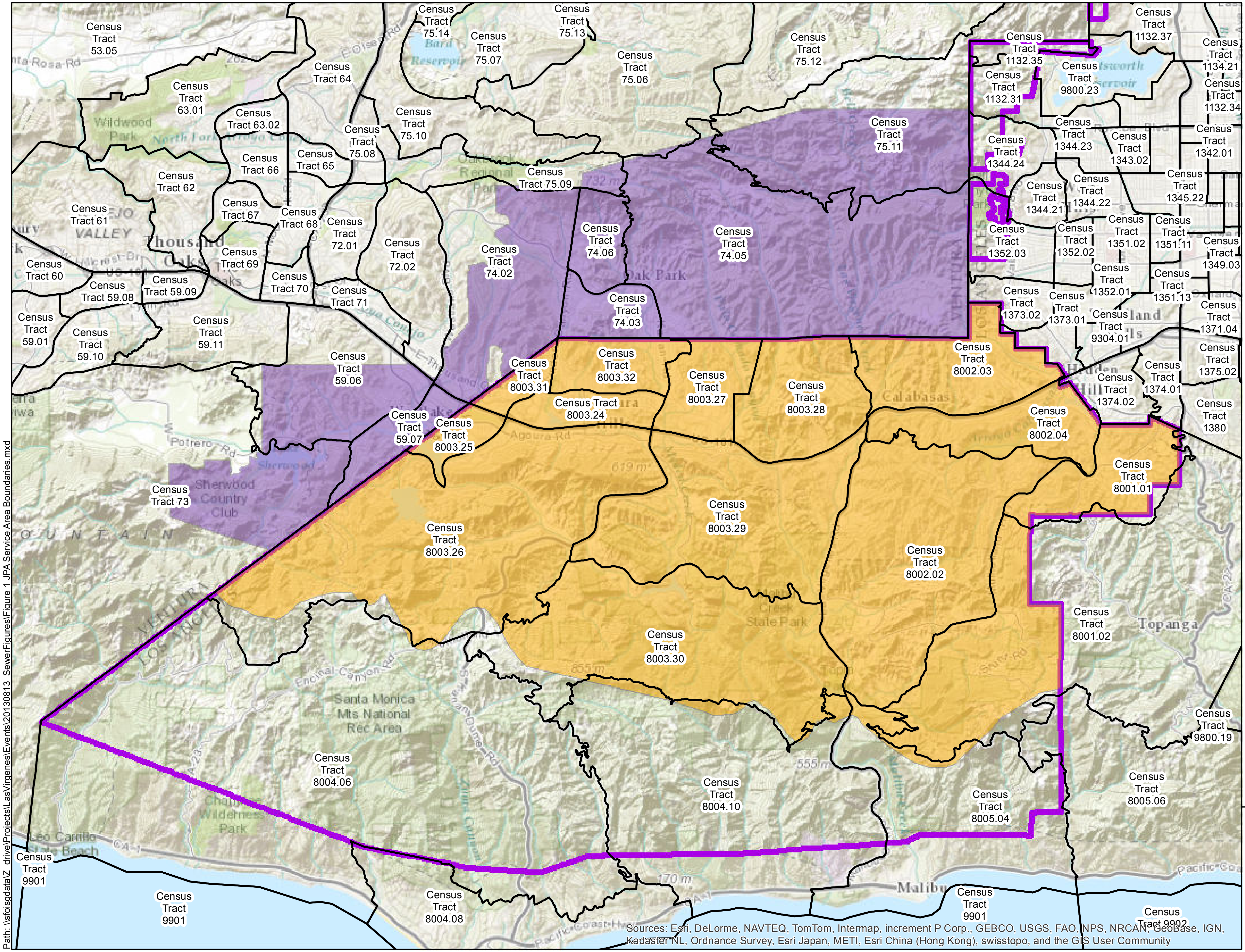
To fully interpret the long-range development opportunities within the JPA, the current wastewater collection pipeline system pipeline network should be considered in conjunction with any known potential development areas. This additional information is reflected in Figure 2.

There are several key findings associated with these two figures. These are:

- Much of the District's water service area resides outside its wastewater service area. As such, the recent population and water demand projections derived for the District will need to be adjusted to account for these service area differences and the inclusion of TSD service area considerations,

- The current sewer collection system throughout the JPA tends to be established in pocket areas, rather than a full network of collection facilities.

- The east side of the TSD service area, including the Bell Canyon area, and the District's Westhills and Chatsworth service areas drain easterly to the City of Los Angeles for wastewater treatment and disposal. These areas are therefore excluded from the projection of JPA wastewater flows to TWRF, and



Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

Path: \\sfoisgdata\Z drive\Projects\LasVirgenes\Events\20130813 SewerFigures\Figure 1 JPA Service Area Boundaries.mxd

Legend

- ☐ LVMWD Boundary
- ☐ Tract 2010 Census
- 🟧 Las Virgenes WMD Sewer Boundary
- 🟪 Triunfo Sanitation District

Note: LVMWD Boundary extends beyond map extent.

N

0 5,000 10,000

Scale: Feet

Kennedy/Jenks Consultants

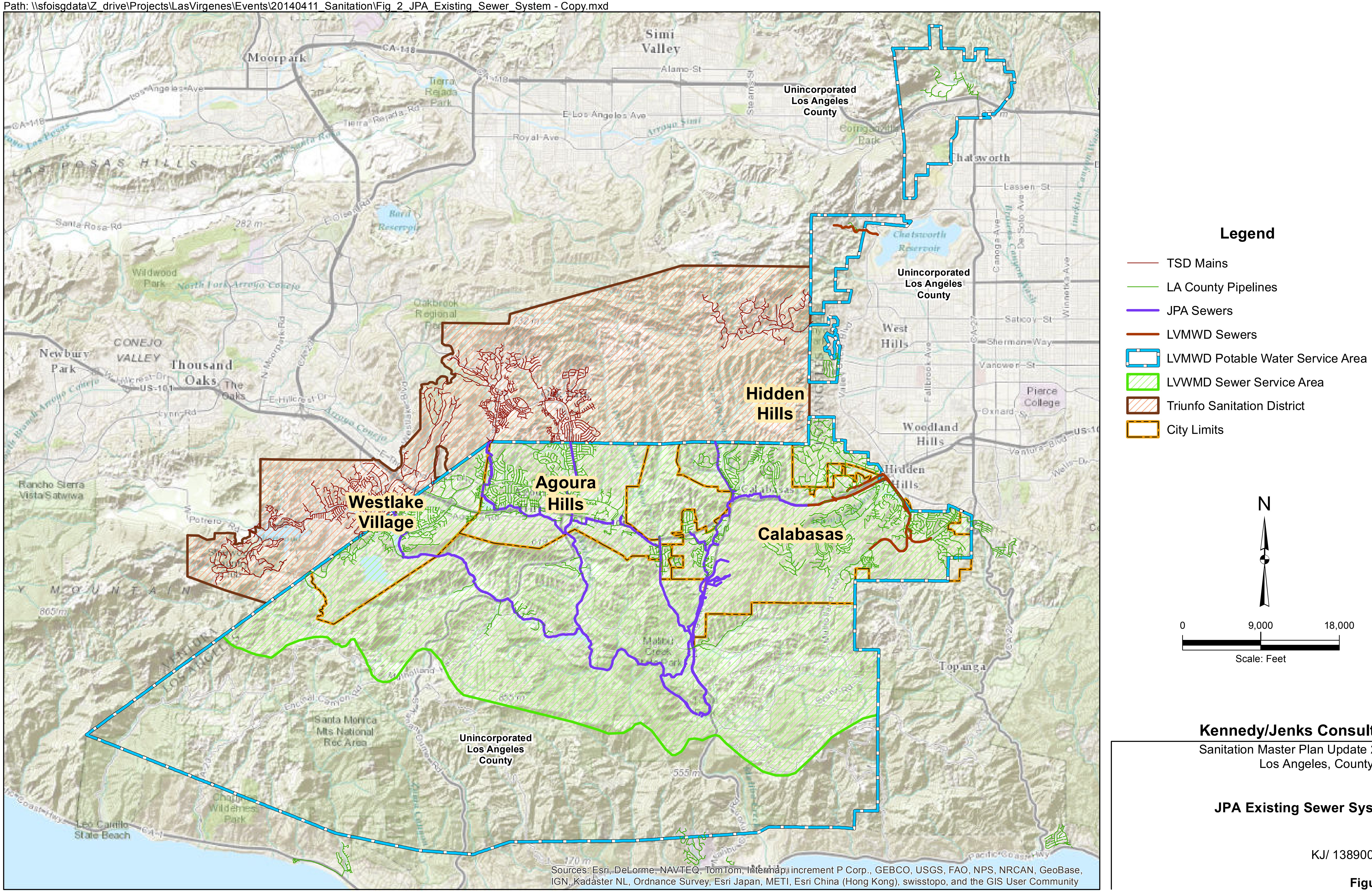
Las Virgenes MWD - W/RW/WW Master Plan
Los Angeles, CA

JPA Service Area Boundaries

August, 2013

Figure 1

Path: \\sfoisgdata\Z_drive\Projects\LasVirgenes\Events\20140411_Sanitation\Fig_2_JPA_Existing_Sewer_System - Copy.mxd



Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

Kennedy/Jenks Consultants

Sanitation Master Plan Update 2014
Los Angeles, County, CA

JPA Existing Sewer System

KJ/ 1389005.00

Figure 2

- Their appears to be a significant amount of undeveloped land around and east of the Oak Park service area. While much of the 19,000 acres may not be developable, a small amount, only 1,200 acres around Oak Park, is conservatively incorporated in the projection of future TSD wastewater flows to TWRF.

Historical and Current Wastewater Flows

Historical TWRF wastewater flows from 1980 to 2012 are shown in Figure 3. A breakdown of the origin of wastewater flows between the District, TSD, and other non-potable sources is provided in Table 1. As shown, flows to Tapia have tended to be relatively constant since the late 1990's, even though overall population in the District's service area has increased. It is believed that a portion of the continuity in wastewater flows can be attributed to a decline in the economy, the drought and mandatory conservation implemented in the JPA service area. Each of these factors is discussed in the following sections.

Figure 3: JPA Influent

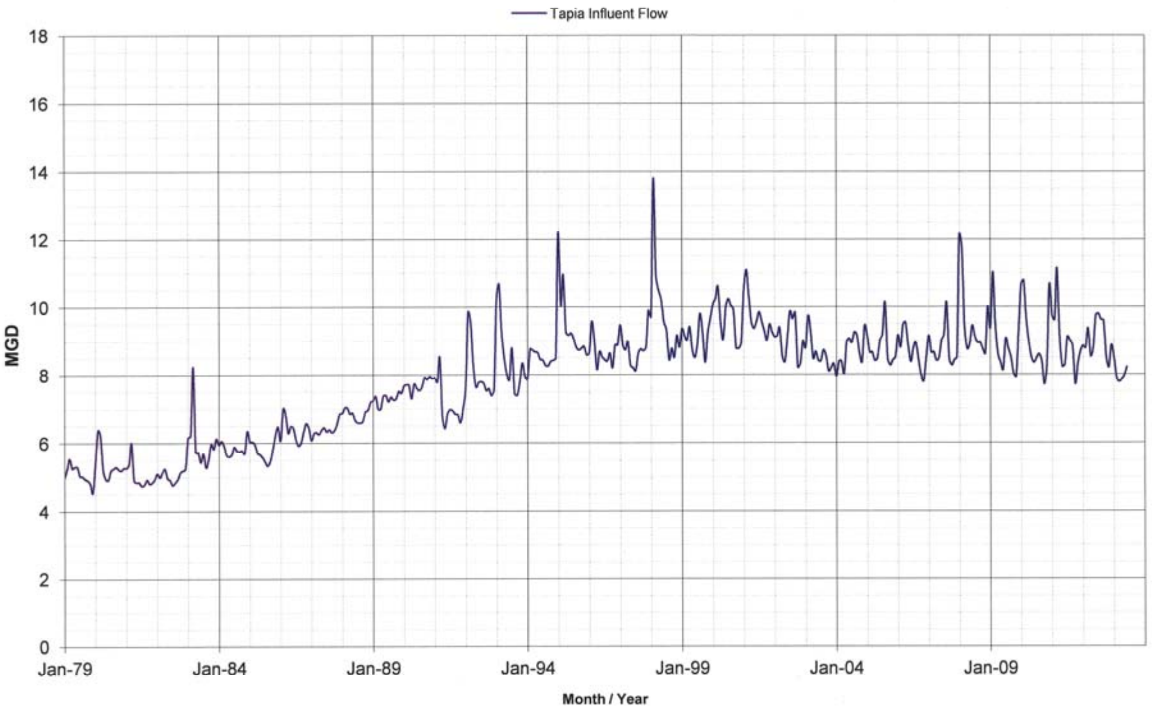


Table 1: 2012 Wastewater Flows by Agency

Month	WW Influent (MGD)	Westlake Wells Supplement (MGD)	Net WW Influent (MGD)	LV WW Flows (MGD)	TSD WW Flows (MGD)
Jan	8.85	0.00	8.85	6.20	2.65
Feb	8.79	0.00	8.79	6.14	2.65
Mar	9.37	0.00	9.37	6.68	2.69
Apr	8.54	0.00	8.54	5.76	2.78
May	8.79	0.15	8.63	6.00	2.63
June	9.43	0.69	8.74	6.14	2.60
July	9.80	0.78	9.02	6.48	2.54
Aug	9.62	0.74	8.88	6.29	2.59
Sept	9.58	0.74	8.84	6.24	2.60
Oct	8.52	0.23	8.28	5.73	2.55
Nov	8.22	0.00	8.22	5.67	2.55
Dec	8.87	0.00	8.87	6.33	2.54
Averages	**9.03**	**0.28**	**8.75**	**6.14**	**2.61**

Source: 2012 Wastewater data, JPA/LVMWD

Economic Analysis of Water Demands and Wastewater Discharges

To assess the potential impact of the weather and economic conditions on water demands and potential wastewater discharges, 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 (for water and not applicable for wastewater), 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 and wastewater discharges are predicted to increase under good economic conditions for various customer types. Since sewage is not metered at the account level, the account-level water usage during the winter billing period was used to represent wastewater for each account. Based on this analysis, it is suggested an economic factor of 13 % be applied to the 2012 winter water data in the projection of future wastewater discharges for the District. A comprehensive Technical Memorandum of this statistical analysis is provided in Appendix A-1. Although account-level water data was not evaluated for TSD, it is believed that the service area characteristics are similar enough to apply this factor to both service areas of the JPA for the purposes of projecting wastewater flows to TWRF.

Drought Analysis of Water Demands and Wastewater Discharges

Dr. Randal Orton, Resource Conservation Manager, studied the impacts of drought on water demands and submitted a Technical Memorandum of findings in April 2012.. 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 five to 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, while winter time levels returning in six to seven years.

Based on this study, a drought recovery factor of 31% was applied to the 2010 usage data, and 18% to the 2012 usage data in the development of a future demand project that would be used to represent an "upper limit" of a full drought recovery. Since it is logical to assume that influence of the economy and the drought are not mutually exclusive, a partial drought recovery factor was also developed. To this end, an additional water demand scenario was derived based on a 50% level of drought recovery (equal to 9% for the 2010 usage data).

Since winter water demands (used to represent wastewater) were not found to be as sensitive to the economy or drought as overall annual water demands, applying a full drought recovery factor in addition to the economic adjustment factor appears inappropriate. If we assume that the drought response is split equally for interior and exterior water usage, then 50% of the drought recovery factor (9%) would be appropriate for inclusion in projecting wastewater flows to TWRF. The District's Technical Memorandum addressing the drought response is provided in Appendix A-2.

Projected Growth

As previously shown in Figures 1 and 2, only a portion of the overall service area for both the District and TSD are tributary to the JPA's TWRF. In fact, much of the undeveloped area in the water service area resides in the southern slopes of the District, and is largely projected to remain on septic in the future. To project future wastewater flows, an estimate of new growth opportunities was derived for each agency. The discussion of growth in the sewer service area opportunities and assumptions follows.

LVMWD Growth Projection

The comprehensive population projection developed for the District in support of its water demand projection was incorporated herein to ascertain the additional dwelling units projected from vacant land/intensified parcels in the growth projection. This analysis determined that the population in the District's water 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.

An important element of that evaluation revealed the need to “clip” various regional planning data sets to the District’s water service area boundary. A similar “clipping” is now required to refine the regional planning data to the District’s sewer service area boundary. Based on this review, it is estimated that approximately 50% of the projected growth is estimated to reside within the District and is tributary to the TWRF. The projected increase in additional dwelling units in the sewer service area is shown in Table 2.

Table 2: Housing Projections - LV Sewer Area

Agency/Growth Description	Projected New Dwelling Units
Agoura Hills[a]	
Agoura Village	293
N Agoura Rd	73
Calabasas[a]	746
Hidden Hills[a]	
Per HH note from SCAG	34
Westlake Village[a]	84
Westlake Village Business	401
Potential Septic Tank Conversions[b]	
Calabasas Highlands	36
Old Topanga	27
Malibu Lake	339
Monte Nido	63
Vacant HSE Units [c]	
Vacant Units	548
Totals	**2,644**

Notes:
(a) Agency specific 2013 Housing Elements.
(b) Detailed aerial review of existing dwellings not on sewer per area.
(c) Vacant Units coverage based on 2010 census data, TAZ specific

TSD Growth Projection

The TSD's estimate of projected growth was derived from several sources. These included the complete list of parcels that TSD currently serves (both active and inactive), the existing sewer collection system coverage in its services area, Ventura County's parcel data, Ventura County Planning Division's area plans, and discussions with TSD staff. During this process, it was difficult to determine how much of the vacant land (especially on the east side of TSD would develop and if the area tributary to the City of Los Angeles would continue to be discharged easterly to Los Angeles.

Memorandum

As discussed with TSD staff, for the purposes of this planning effort, it was assumed that current septic accounts will ultimately convert to the sewer system, wastewater generated in the eastern service area will continue to be treated by Los Angeles, a small amount of vacant infill parcels may develop and approximately 1,200 acres may potentially develop in the 2035 horizon as low density residential parcels (1 dwelling unit (DU) per 2 acres). The large area of "vacant" land in TSD's service area is graphically depicted in Figure 4. A summary of the number of potential additional units in the TSD service area is shown Table 3.

Figure 4: TSD Selected Vacant Parcel Coverage

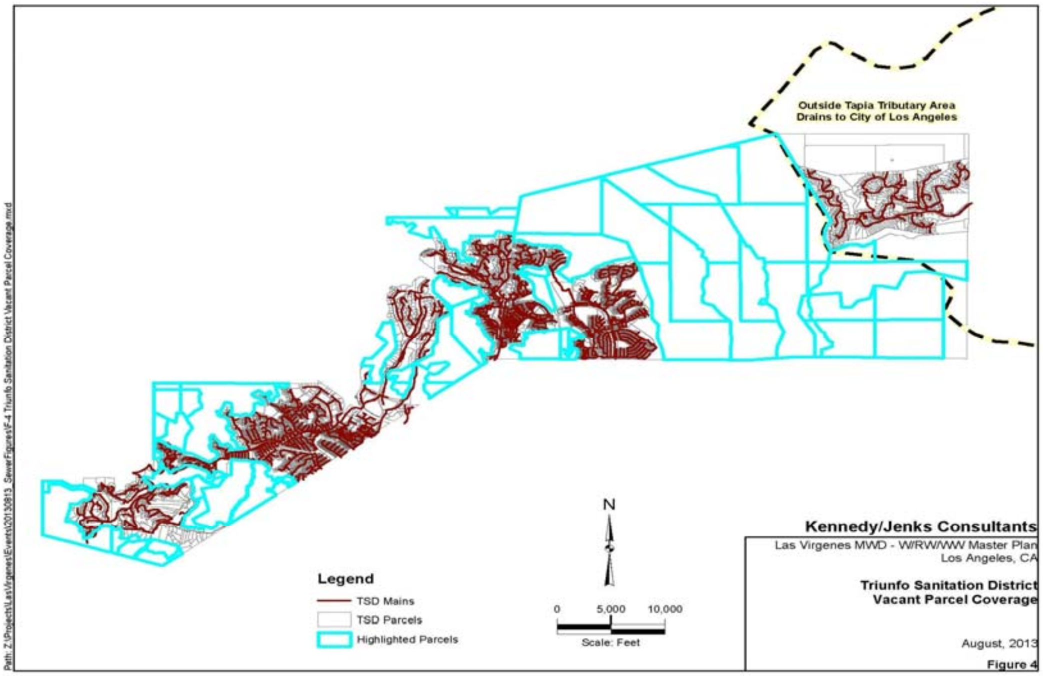


Table 3: Housing Projections - TSD Sewer Area

Growth Description	Projected New Dwelling Units
Infill Vacant	540
Septic	125
Non-Taxed Parcels	126
Future Rezoning [(a)]	600
Totals	**1,400**

Notes: Totals are rounded. Source data provided by TSD for infill, septic, and non-taxed parcels

(a) Future rezoning estimate based on area 1200 acres in close proximity to existing collection systems, and 1 DU per 2 acres for density.

Projected JPA Wastewater Flows

A projection of future wastewater flows is derived by combining the current average wastewater discharges shown in Table 1 with applicable adjustment factors for the economy, drought or other system conditions, and apply this information to current account information and projected growth values derived in Tables 2 and 3. The results of the process are summarized in Table 4.

Table 4: Wastewater Flow Projection

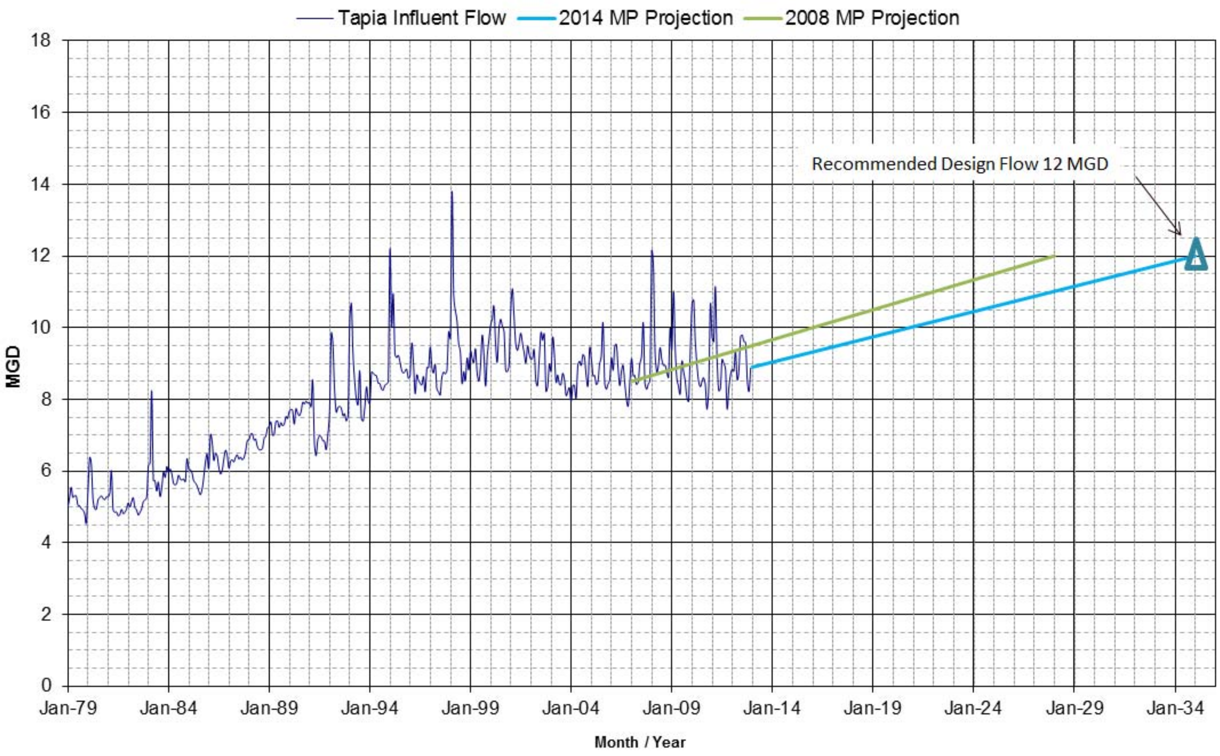
JPA Wastewater Projection		
Description	**LVMWD**	**TSD**
Total Water Usage (HCF)	7,059,749	N/A
Total Water Usage (MGD)	14.47	N/A
March/April Water Usage (MGD)	11.21	N/A
Current Annual WW Generation (MGD)	6.14	2.61
Ratio of WW/Winter Water	0.55	N/A
WW Generation/Account (Gal/Day)	376	244
WW Generation/DU (Gal/Day)[1]	280	244
Approximate Number of DU 2012[1]	21,913	10,712
Projected New DU by 2035[1]	2,644	1,391
Additional WW Generation by 2035 (MGD)	0.74	0.34
Current Annual WW Generation (MGD)	6.14	2.61
Total WW Generation by 2035 (MGD)	6.88	2.95
JPA Total WW Generation (MGD)	**9.83**	
2035 WW Generation w/ Economic Factor (MGD)[2]	**11.11**	
2035 WW Generation w/ Drought Recovery (MGD)[3]	**12.11**	
2035 WW Generation w/ Provision for I&I[4]	**12.59**	

Note: Water and Wastewater values shown are for CY 2012

1. TSD # of Accounts assumed identical to TSD # of Units
2. Economic Factor of 13%
3. Drought Recovery Factor of 9%
4. I&I Factor of 4%

To further demonstrate this finding, the flow projection trends developed in the 2008 Sanitation Master Plan, along with current trend lines and the new 2013 long-range wastewater flow projections are shown graphically on Figure 5. Consistent with the work performed for the District's water system demand projection, Figure 5 demonstrates that the projection derived herein are comparable to the previous long-range planning values for the JPA. Based on this analysis, the continuation of a 12 mgd design flow is recommended. This value provides for projected growth as well as a capacity for the treatment of supplemental groundwater.

Figure 5: Wastewater Flow Projections



Water Demand and Wastewater Generation Projection - Appendix A-1

Economic Analysis Technical Memorandum

Kennedy/Jenks Consultants

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

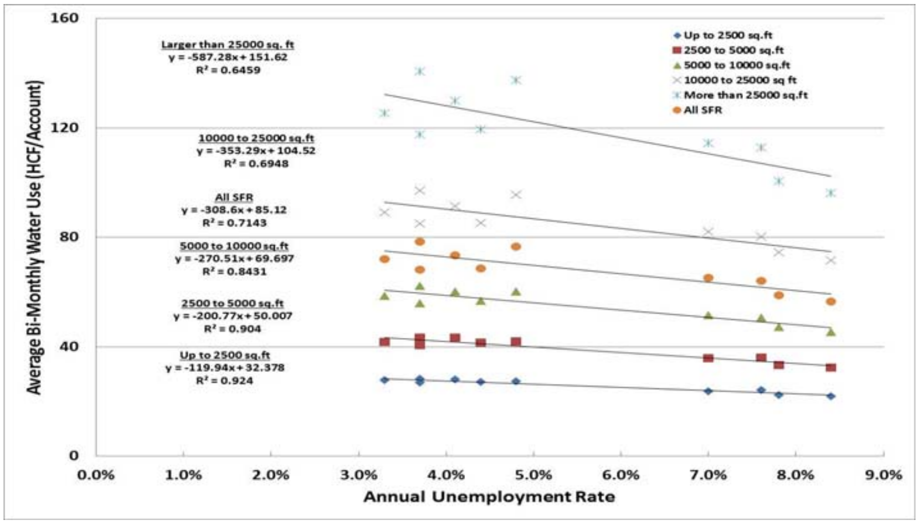
Results of the demand analyses indicate that both water and wastewater demand are correlated with economic conditions within LVWMD's service area. When the economy is "good" with a low unemployment rate, both water usage and wastewater generation increase. Water usage is predicted to increase as much 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.

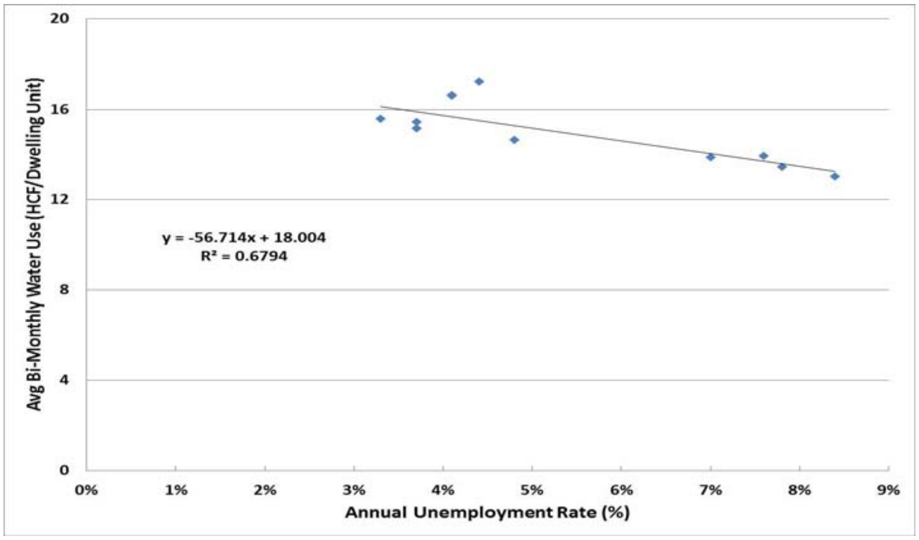
Water Demand and Wastewater Generation Projection Appendix A-1.1

Water Use Figures

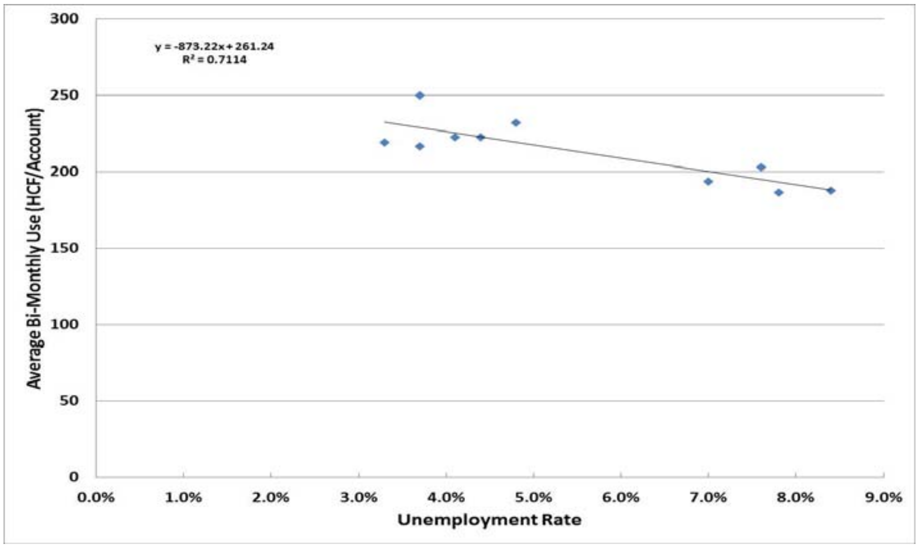
Effect of Economy (Unemployment Rate) on SFR Water Use



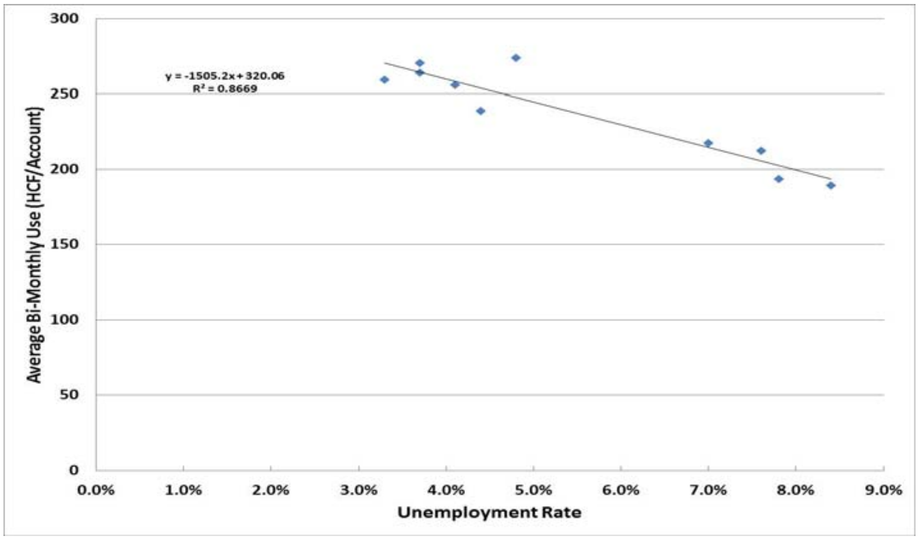
Effect of Economy (Unemployment Rate) on MFR Water Use



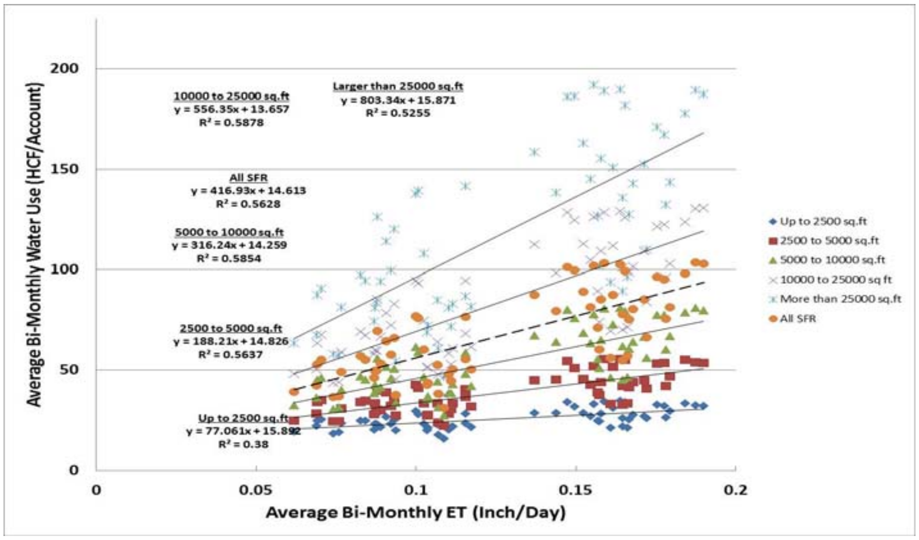
Effect of Economy (Unemployment Rate) on Commercial Water Use



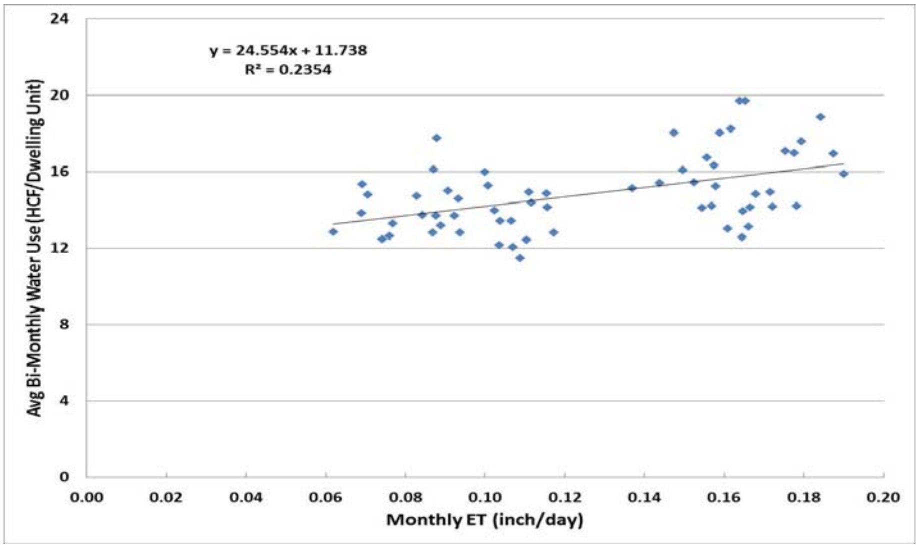
Effect of Economy (Unemployment Rate) on Irrigation Water Use



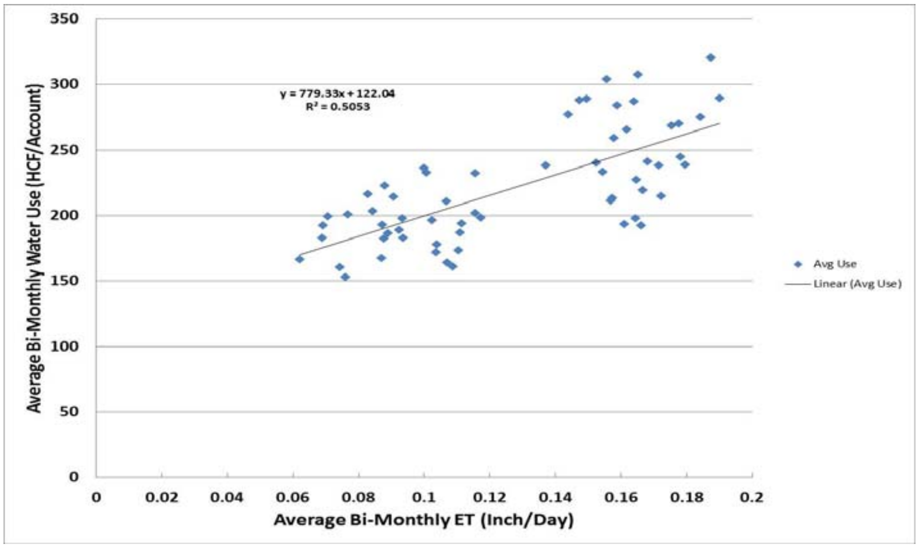
Effect of Weather (ET) on SFR Water Use



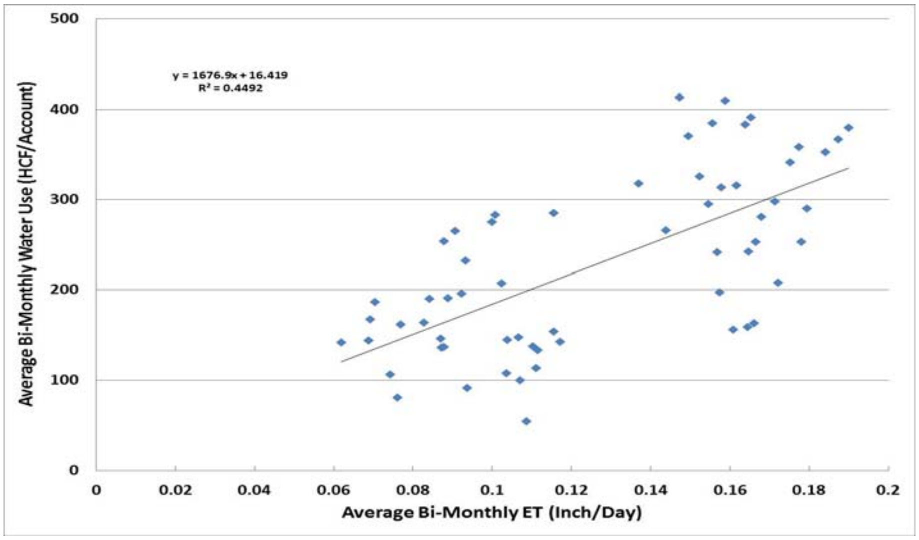
Effect of Weather (ET) on MFR Water Use



Effect of Weather (ET) on Commercial Water Use



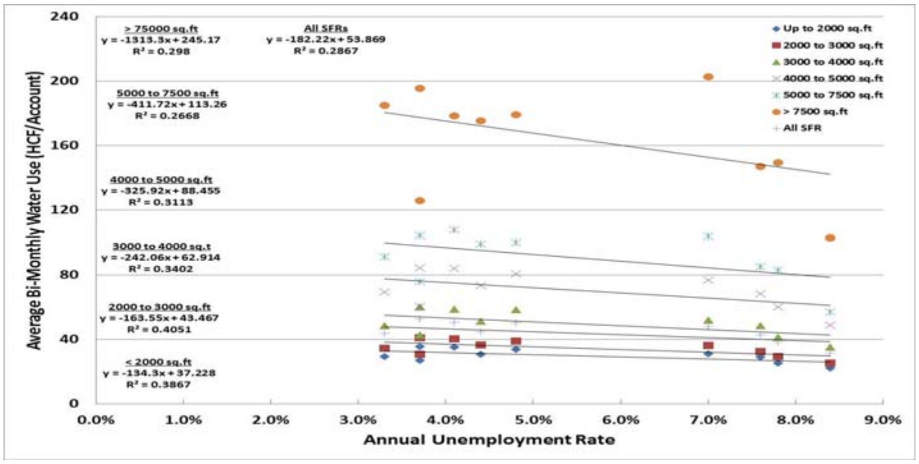
Effect of Weather (ET) on Irrigation Water Use



Water Demand and Wastewater Generation Projection Appendix A-1.2

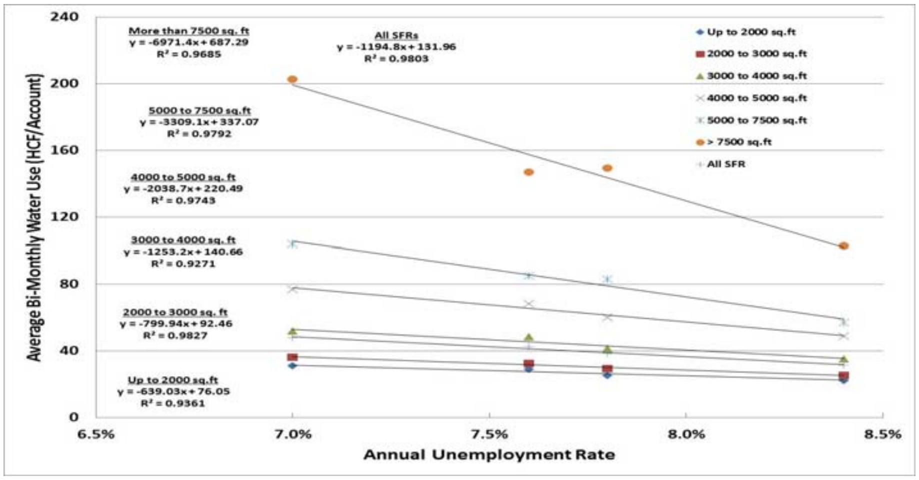
Winter Water Use (Wastewater) Figures

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



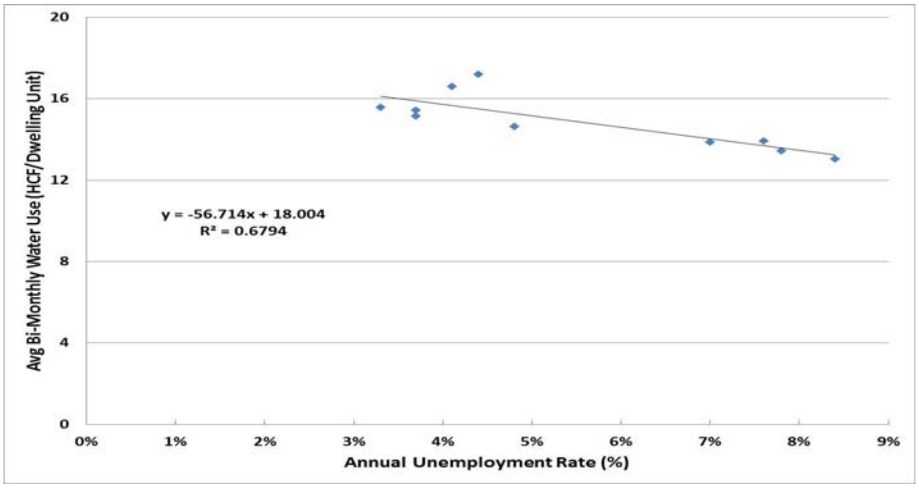
Poor correlation ($R^2 < 0.5$) obtained when unemployment rates throughout the project period were considered

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

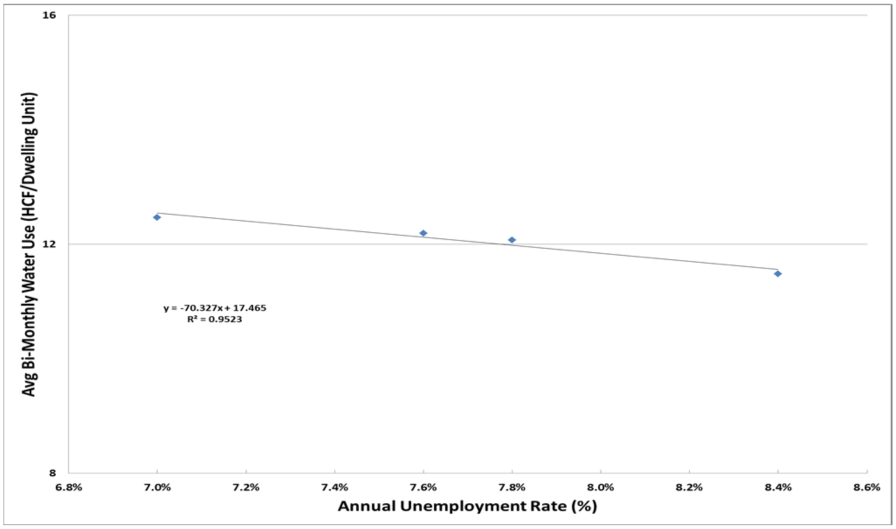


Good correlation ($R^2 < 0.9$) obtained when unemployment rates greater than 6.5% were considered.

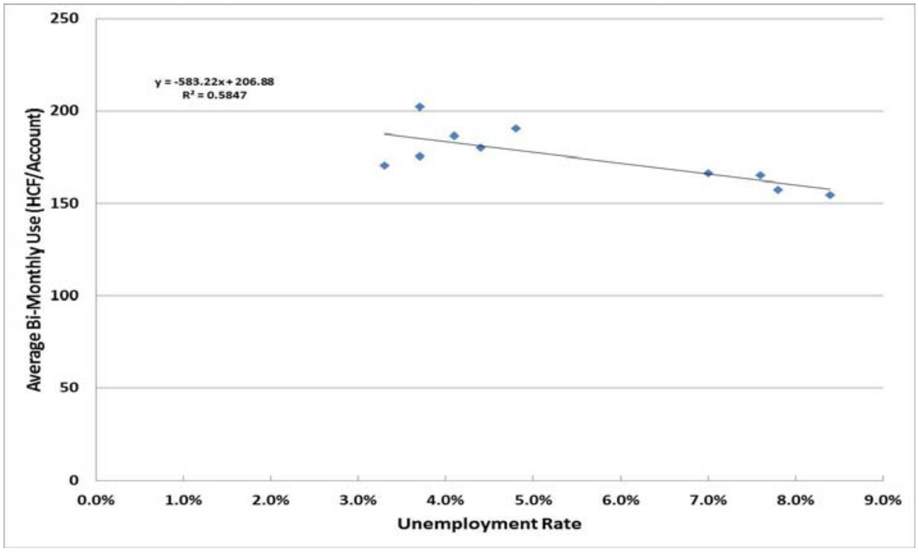
Effect of Economy on MFR Winter Water Use (Using Unemployment Rates Throughout the Project Period)



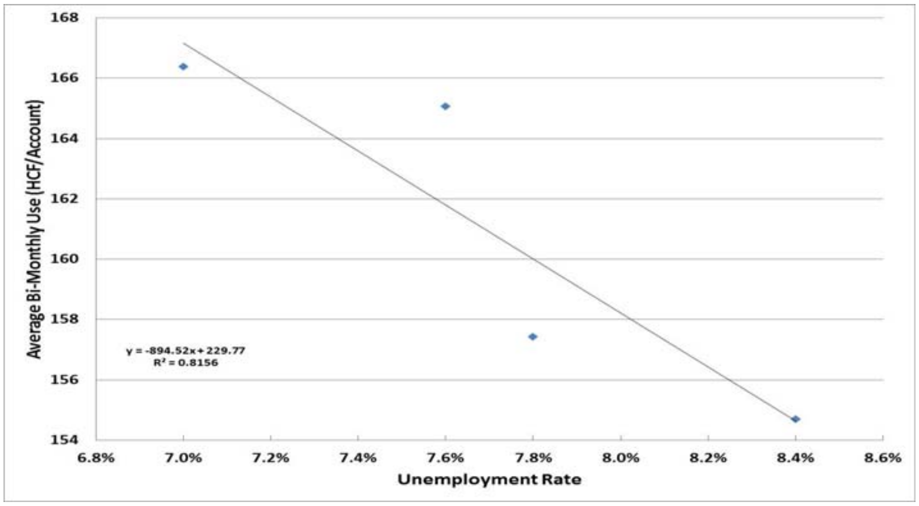
Effect of Economy on MFR Winter Water Use (Using Unemployment Rates Higher than 6.5% Only)



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

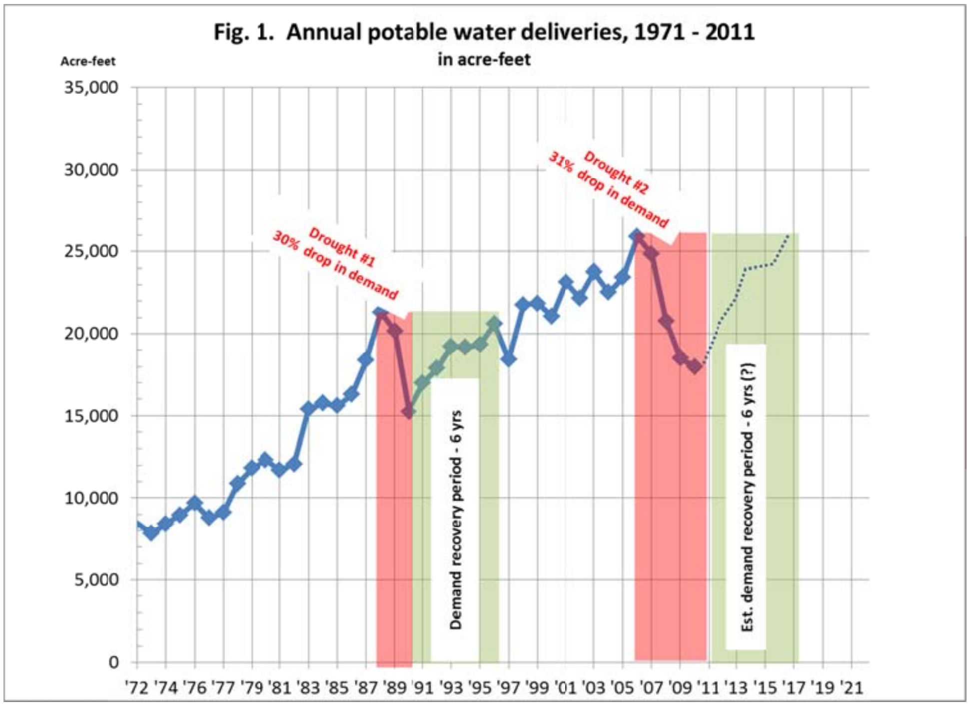


Fig. 1. Annual potable water deliveries, 1971 - 2011
in acre-feet

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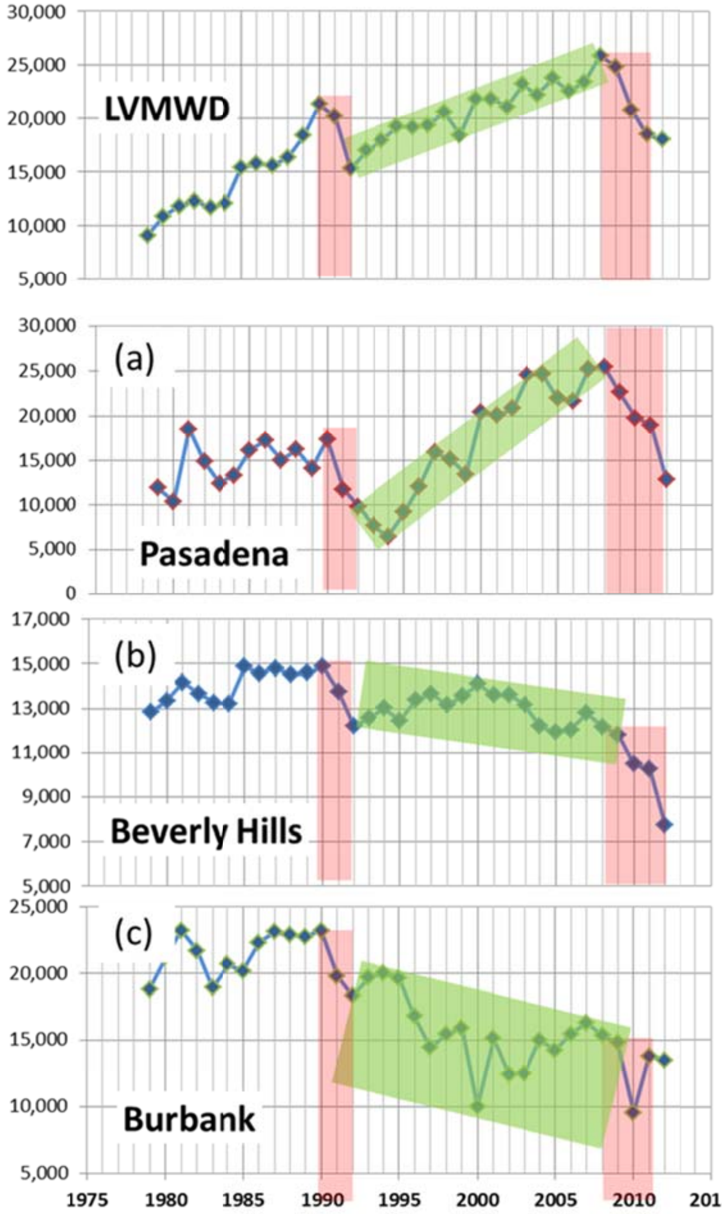
[1] D. Holliday (IS), M. Hamilton (F&A), G. Weston (CS), S. Harris (RC) and J. Dougall (RC) assisted in data compilation and analysis.

[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).

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.



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

New Connections

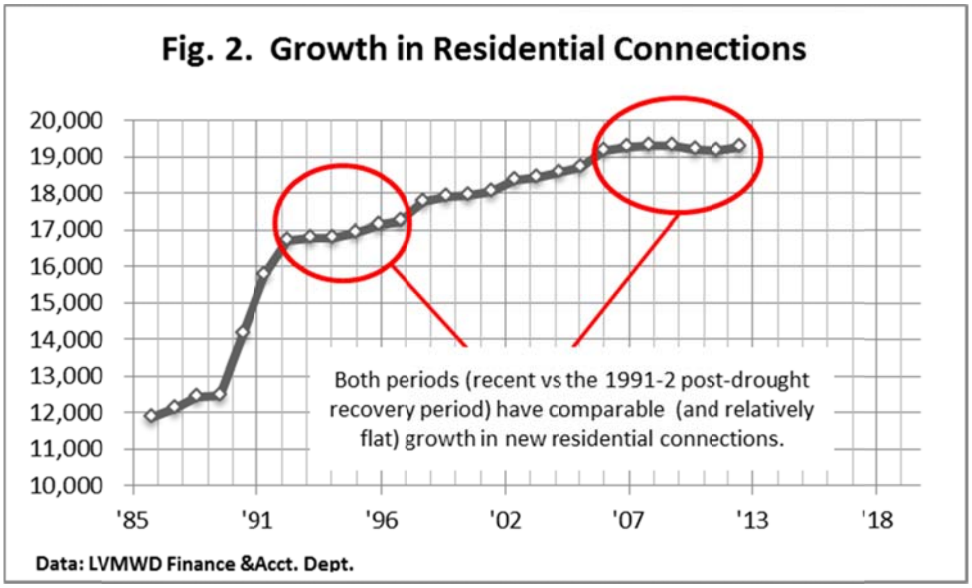


Fig. 2. Growth in Residential Connections

Data: LVMWD Finance &Acct. Dept.

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

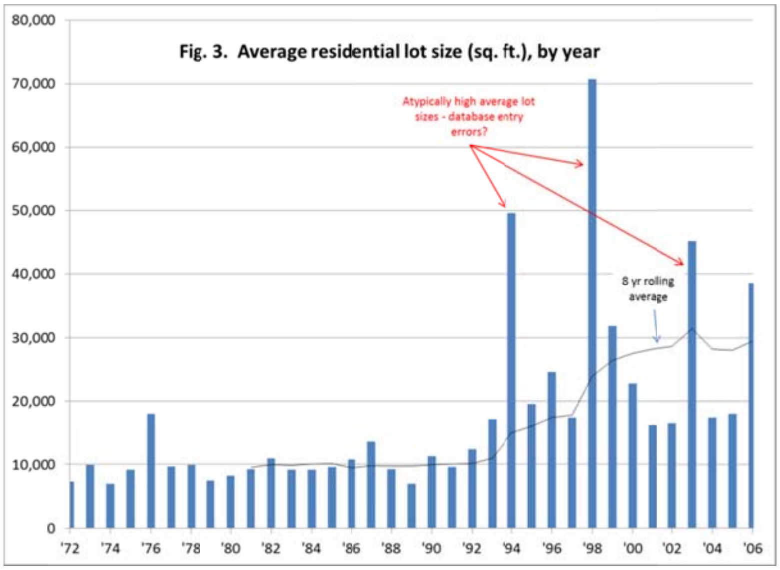


Fig. 3. Average residential lot size (sq. ft.), by year

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

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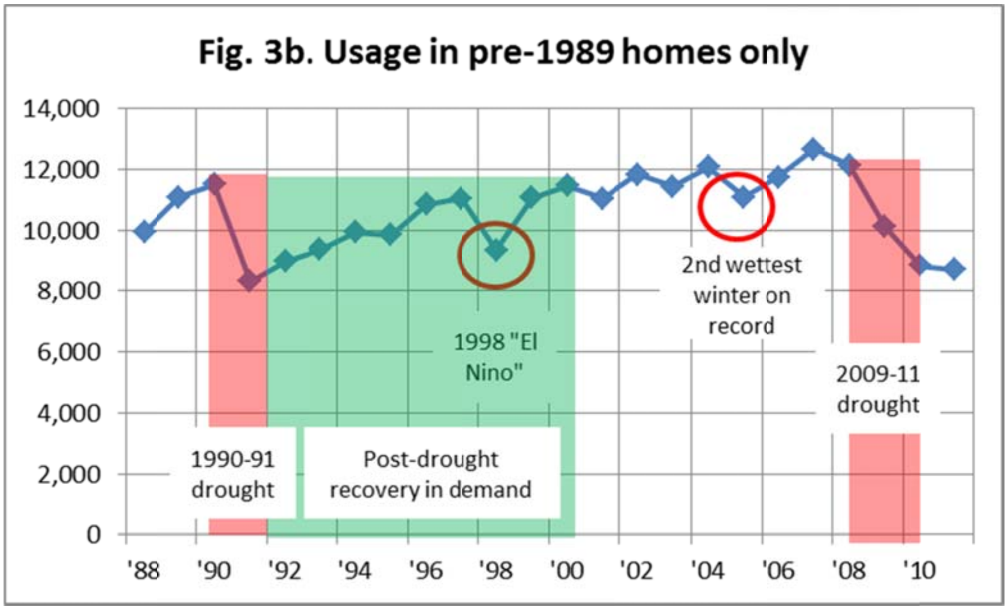
[4] As a measure of central tendency, the median is less sensitive than the average to extreme values and outliers.

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.

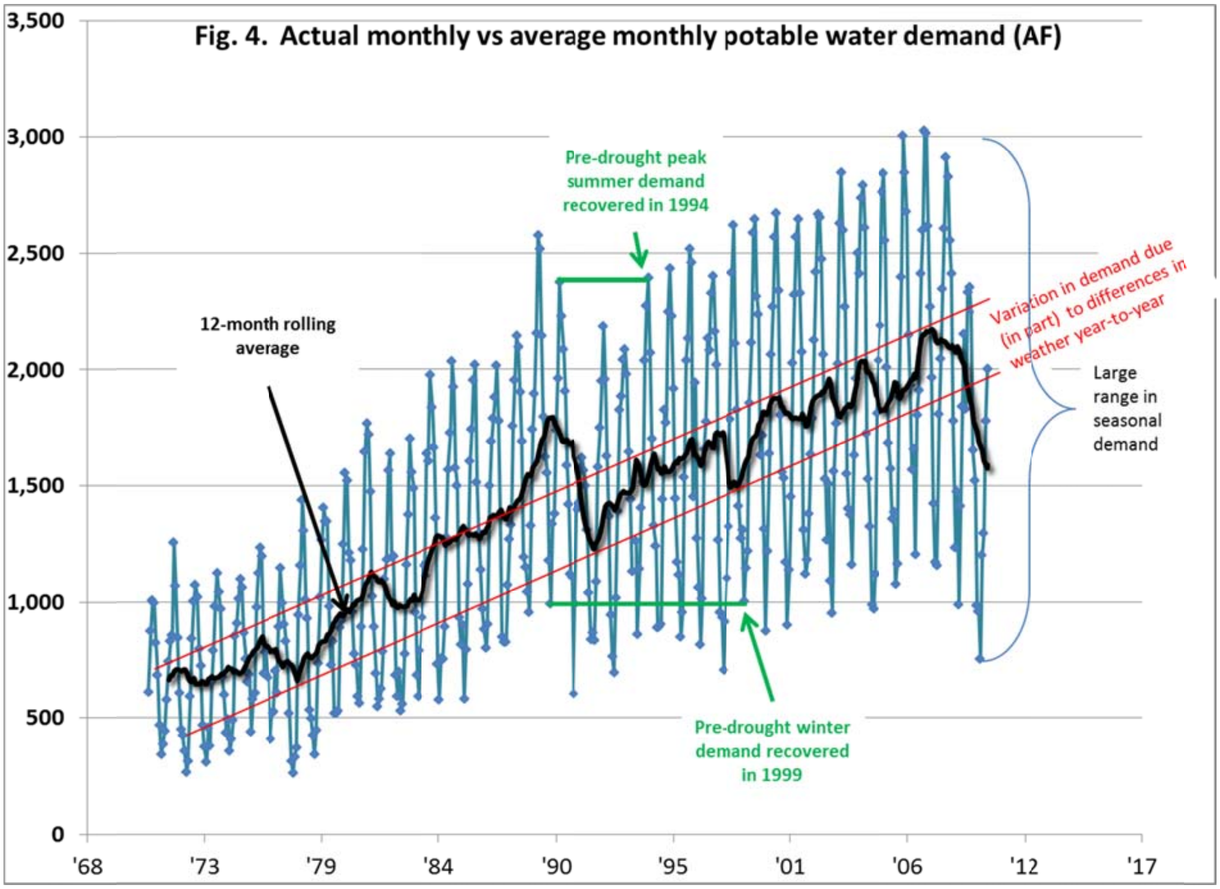

Fig. 4. Actual monthly vs average monthly potable water demand (AF)

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[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).

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 ($R^2 = 0.42$).

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"**

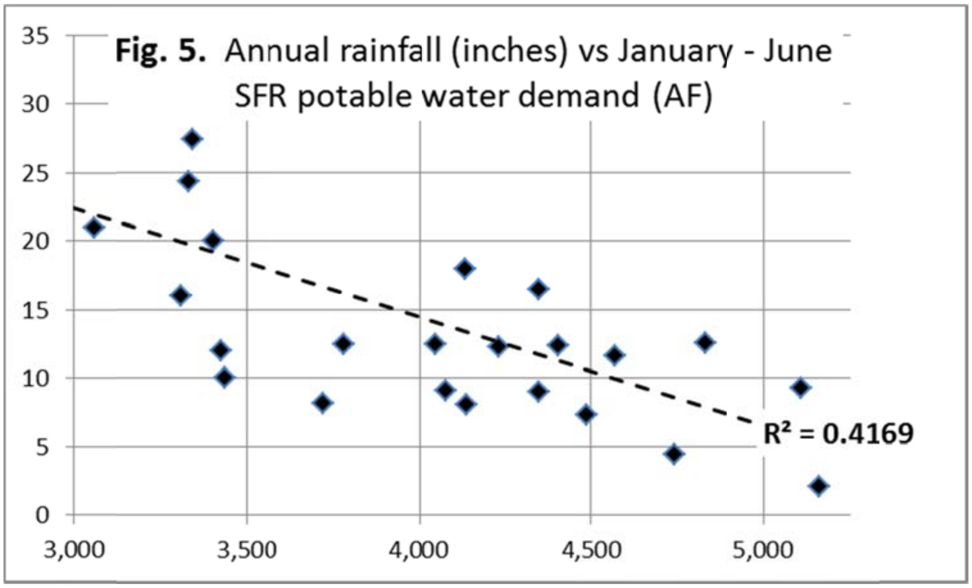
Fig. 5. Annual rainfall (inches) vs January - June SFR potable water demand (AF)

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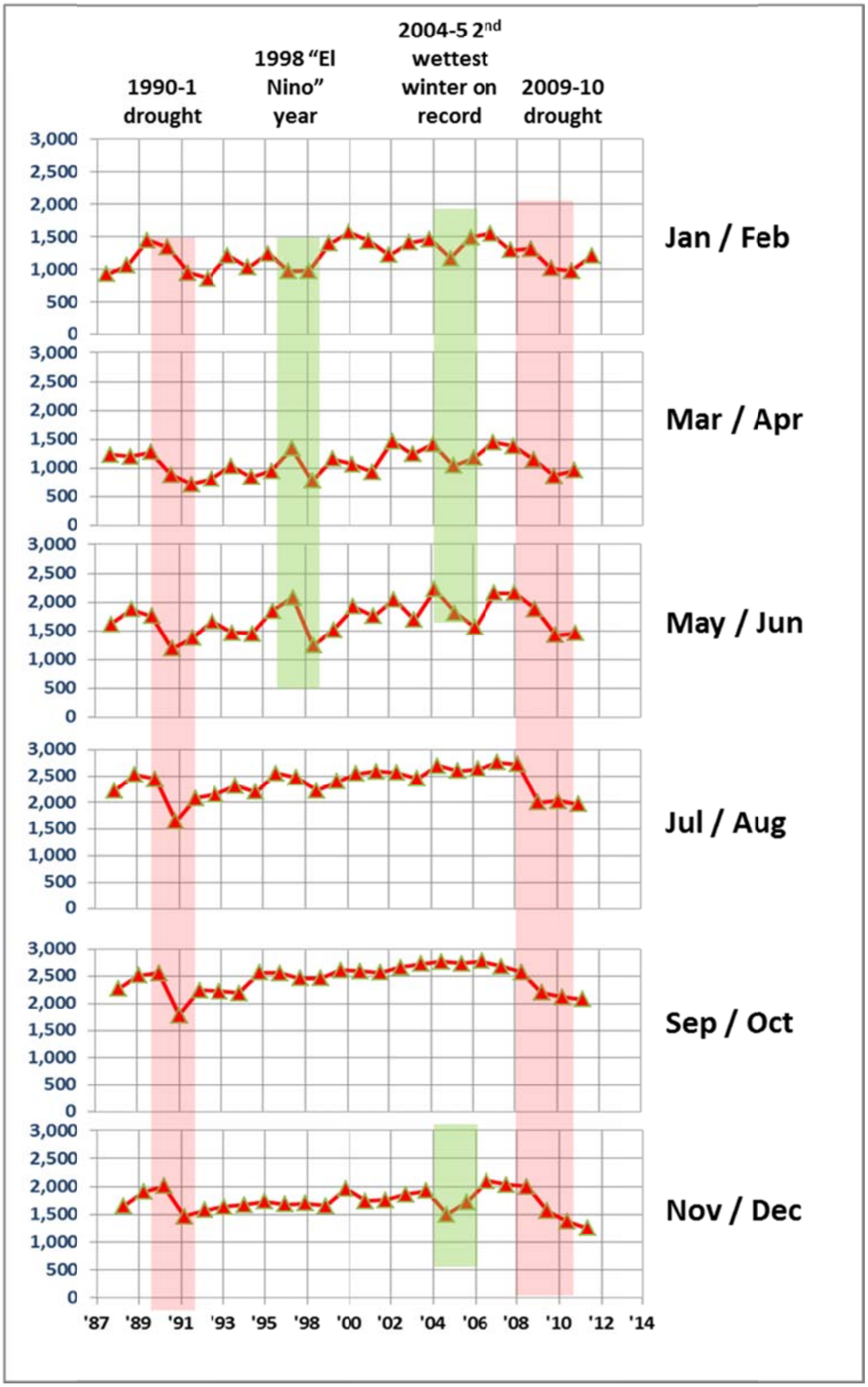
[8] Where a wet year is defined as year where the amount of rain received is greater than one standard deviation from the long term mean

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.



<u>Differences in water conserving fixture installation rates (demand hardening)</u>

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

<u>Economic factors.</u>

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).

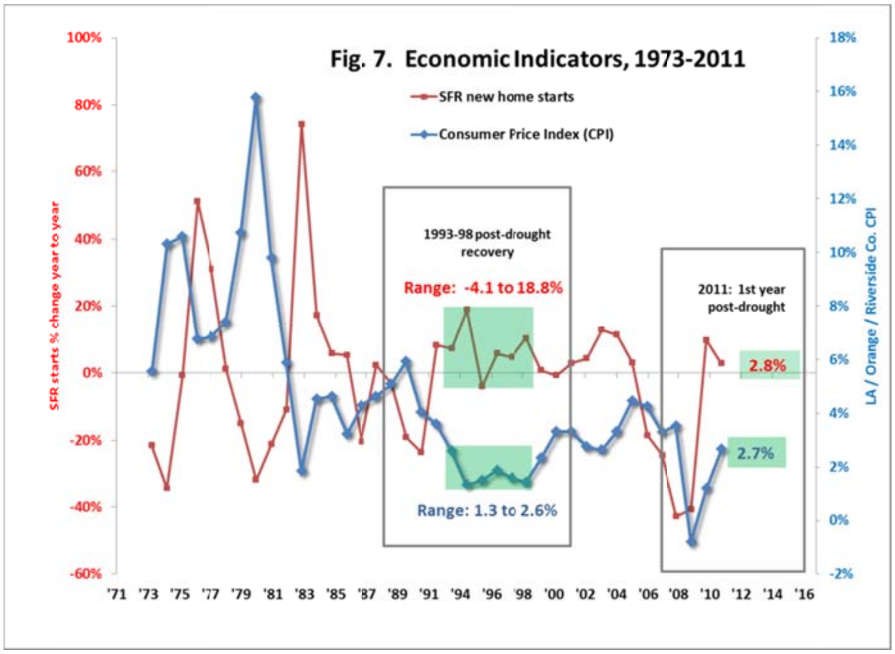


Fig. 7. Economic Indicators, 1973-2011

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.