SEWER SYSTEM

11. Existing Sewer Collection System

The District's sewer collection system consists of the RRWWTP, eight (8) lift stations, 40.3 miles of gravity pipelines, 8.7 miles of force mains and 914 manholes. The sewer collection system is composed of three (3) separate outfall basins. The District's service area is geographically divided into three (3) portions: the West, Central, and East portions of the system. The central portion of the sewer service area consists primarily of individual septic systems and was not included in this analysis. A sewer facilities map is provided as Exhibit 11-1 and a hydraulic schematic is provided as Exhibit 11-2. A summary of the collection system characteristics is presented in the following sub-sections.

11.1 Wastewater Treatment Facilities

The District owns and operates the RRWWTP, which has a current design capacity of 0.85 MGD and provides treatment for developments on the east side of the service area. A condition assessment of the RRWWTP was performed and described in Section 15. A review of the treatment process at RRWWTP is included as Appendix G.

The wastewater from the west side of the District's service area is conveyed to SMWD's Chiquita Wastewater Reclamation Plant (CWWRP) located in the City of San Juan Capistrano for treatment and disposal. The CWWRP has a capacity of 9 MGD, of which the District owns 125,000 GPD.

11.2 Lift Stations

The District owns and operates eight (8) sewage lift stations, with the pump properties of each lift station described in Table 11-1.

Table 11-1: Lift Stations

Lift Stations	Pump	Design Flow (gpm)	Design Head (ft)	Start Level (ft)	Stop Level (ft)	Pump Configuration	Pump Curve Source
				From bottom of Wet Well			
Heritage	Pump 1	-	-	3.5	2	Parallel	Testing
	Pump 2	820	125				
	Pump 3 (Not in Service)	-	-				
Barneburg	Pump 1	185	125	3.33	2	Parallel	Manufacturer
	Pump 2						
El Toro	Pump 1 & 2	1280 (Same for both Stages)	175 (Same for both Stages)	8	3	Pumps in Series (&) Parallel to each pair (row)	Testing
	Pump 3 & 4						
	Pump 5 & 6						
	Pump 7 & 8						
Plano Trabuco	Pump 1	600	140	5	3	Parallel	Testing
	Pump 2						
	Pump 3 (Not in Service)						
Santiago	Pump 1	30	60	3	1	Parallel	Manufacturer
	Pump 2			4			
Bell Canyon	Pump 1	100	200	4.5	3.5	Parallel	Manufacturer
	Pump 2						
Golf Club	Pump 1 & 2	600 (Same for both Stages)	175 (1st Stage) 185 (2nd Stage)	4	2	Pumps in Series (&) Parallel to each pair (row)	Testing
	Pump 3 & 4						
Via Allegre	Pump 1	300	120	2	1.5	Parallel	Design Point
	Pump 2						

The corresponding wet well information for the District's lift stations are listed in Table 11-2.

Table 11-2: Wet Well Summary

Lift Stations	WW Bottom Elevation (ft)	WW Top Elevation (ft)	Wet Well Depth (ft)	Wet Well Diameter/ Size (ft)
Heritage	1229.2	1242.2	13	10 x 23
Barneburg	982.67	995.19	12.52	6
El Toro *	719	740.5	21.5	10 x 18
Plano Trabuco	1154.66	1167.66	13	10 x 23
Santiago	1354	1365	11	5
Bell Canyon	963.1	976.65	13.55	8
Golf Club	1008	1108.15	29.5	8
Via Allegre	1079	1097	18	6

***El Toro Lift Station is composed of two (2) identical and interconnected wet wells**

11.3 Pipelines

11.3.1 Gravity Mains

The following table and figure show the distribution of gravity mains by diameter, with the majority of the system being 8-inches in diameter.

Table 11-3: Existing Gravity Mains by Diameter

Pipe Diameter (in)	Length (ft)	Length (mi)	Percentage (%)
6	769	0.15	0.36%
8	190,417	36.06	89.45%
10	5,610	1.06	2.64%
12	3,543	0.67	1.66%
15	8,524	1.61	4.00%
18	4,015	0.76	1.89%
TOTAL	**212,877**	**40.32**	**100.00%**

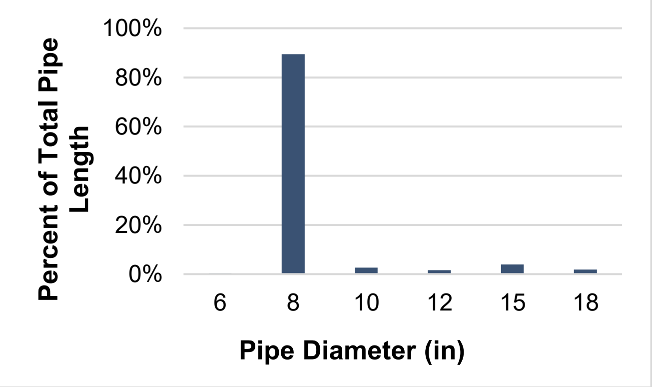


Figure 11-1: Existing Gravity Mains by Diameter

The following table and figure show the distribution of gravity mains by material, with the majority of pipes made of PVC.

Table 11-4: Existing Gravity Mains by Material

Material	Length (ft)	Length (mi)	Percentage (%)
PVC	186,056	35.24	87.40%
VCP	26,297	4.98	12.35%
DI	523	0.10	0.25%
TOTAL	**212,877**	**40.32**	**100.00%**

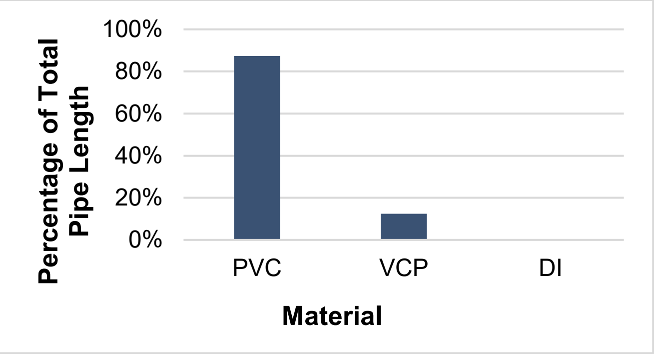


Figure 11-2: Existing Gravity Mains by Material

The following table and figure show the distribution of gravity mains by ownership.

Table 11-5: Existing Gravity Mains by Ownership

Ownership	Length (ft)	Length (mi)	Percentage (%)
TCWD	193,394	36.63	90.85%
IRWD	18,102	3.43	8.50%
SMWD	1,380	0.26	0.65%
TOTAL	**212,877**	**40.32**	**100.00%**

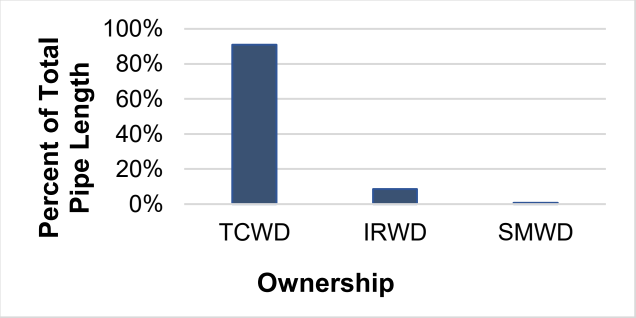


Figure 11-3: Existing Gravity Mains by Ownership

11.3.2 Force Mains

The following table and figure show the distribution of force mains by diameter.

Table 11-6: Existing Force Mains by Diameter

Pipe Diameter (in)	Length (ft)	Length (mi)	Percentage (%)
2	1,579	0.30	3.42%
4	4,516	0.86	9.79%
6	4,738	0.90	10.27%
8	22,276	4.22	48.28%
10	3,222	0.61	6.98%
12	9,673	1.83	20.97%
14	134	0.03	0.29%
TOTAL	**46,138**	**8.74**	**100.00%**

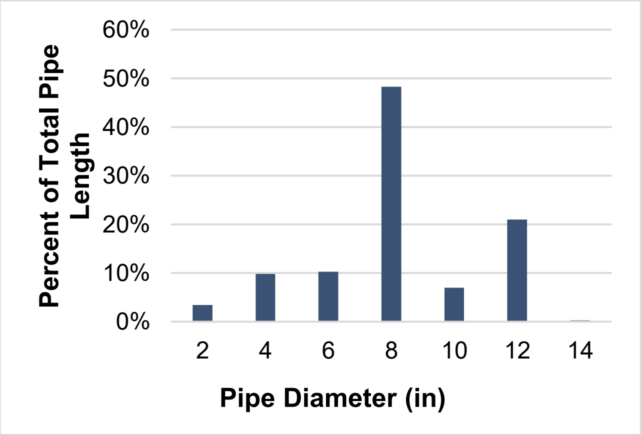


Figure 11-4: Existing Force Mains by Diameter

The following table and figure show the distribution of force mains by material.

Table 11-7: Existing Force Mains by Material

Material	Length (ft)	Length (mi)	Percentage (%)
DI	5,724	1.08	12.41%
PVC	40,414	7.65	87.59%
TOTAL	**46,138**	**8.74**	**100.00%**

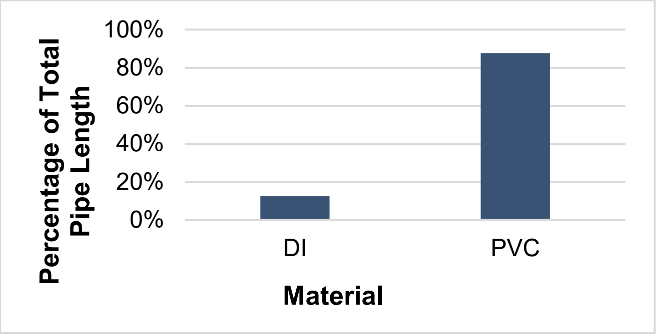


Figure 11-5: Existing Force Mains by Material

11.4 Manholes

The District owns 88.3% of the manholes in the modeled system, with some manholes owned by adjacent water districts as shown in the following table and figure. Non-TCWD-owned manholes were included where necessary for system connectivity.

Table 11-8: Existing Manholes by Ownership

Ownership	Quantity	Percentage (%)
TCWD	807	88.29%
IRWD	99	10.83%
SMWD	8	0.88%
TOTAL	**914**	**100.00%**

Figure 11-6: Existing Manholes by Ownership

The following table and figure show the data sources used to determine manhole rim and invert elevations. The properties and incorporation of data for the three (3) data sources used are further explained in section 13.2.

Table 11-9: Existing Manholes by Data Source

Source	Quantity	Percentage (%)
As-Built	669	73.19%
GIS	86	9.41%
DEM*	159	17.40%
TOTAL	**914**	**100.00%**

***DEM: Digital Elevation Model**

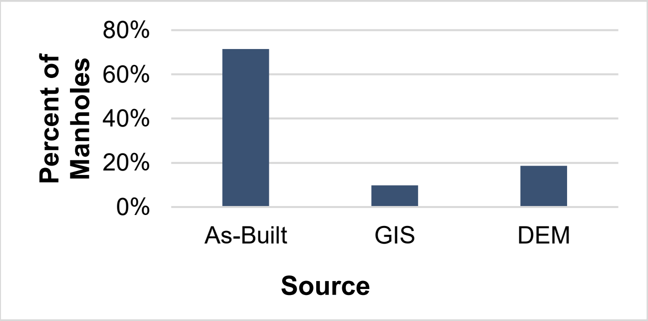


Figure 11-7: Existing Manholes by Data Source

The following table and figure show the distribution of manhole invert depths used in the model. The depths shown in the table and figure below were sourced from As-builts or GIS only. Most manhole inverts in the system are 7-9 feet below grade.

Table 11-10: Existing Manholes by Depth

Depth	Quantity	Percentage (%)
3-6	14	1.85%
6-7	23	3.05%
7-8	180	23.84%
8-9	336	44.50%
9-10	90	11.92%
10-11	39	5.17%
11-12	32	4.24%
12-15	25	3.31%
15-18	10	1.32%
18-21	3	0.40%
21-24	1	0.13%
24-25	2	0.26%
TOTAL	**755***	**100.00%**

***Manholes with invert information from As-Builts or GIS**

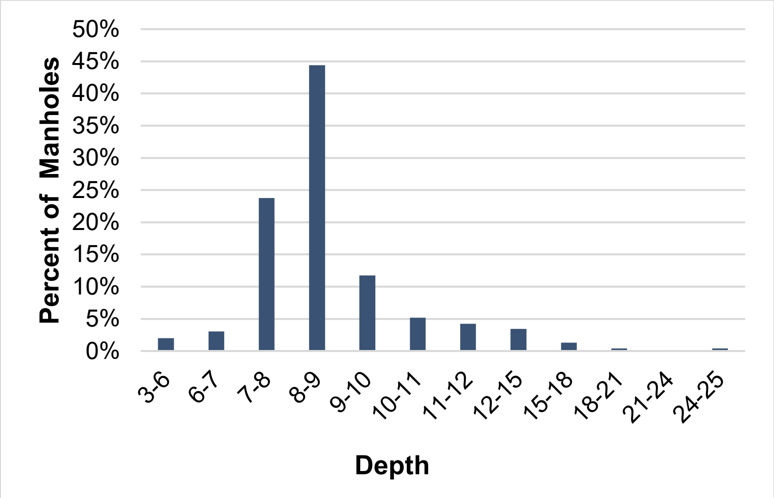
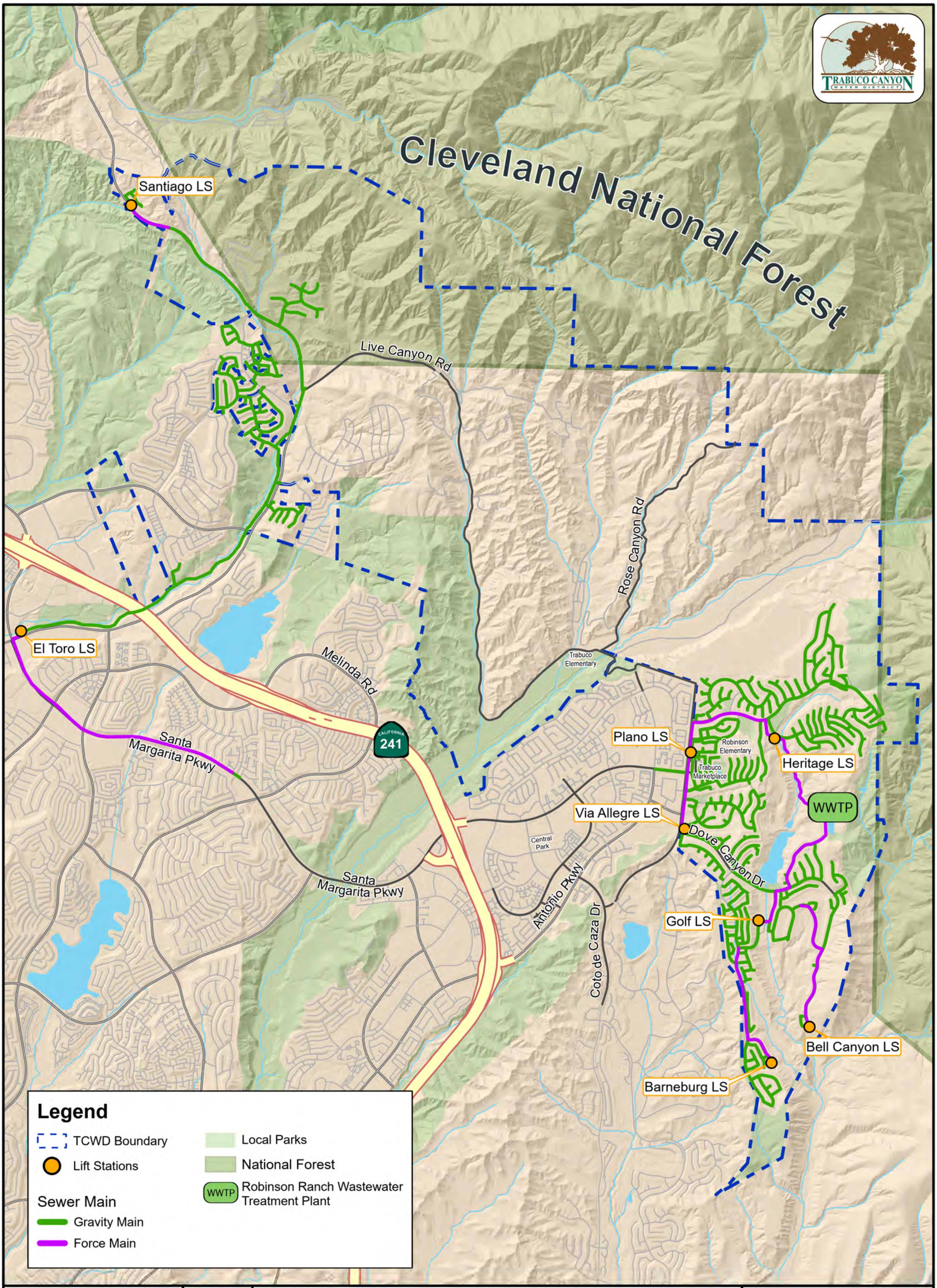


Figure 11-8: Existing Manholes by Depth

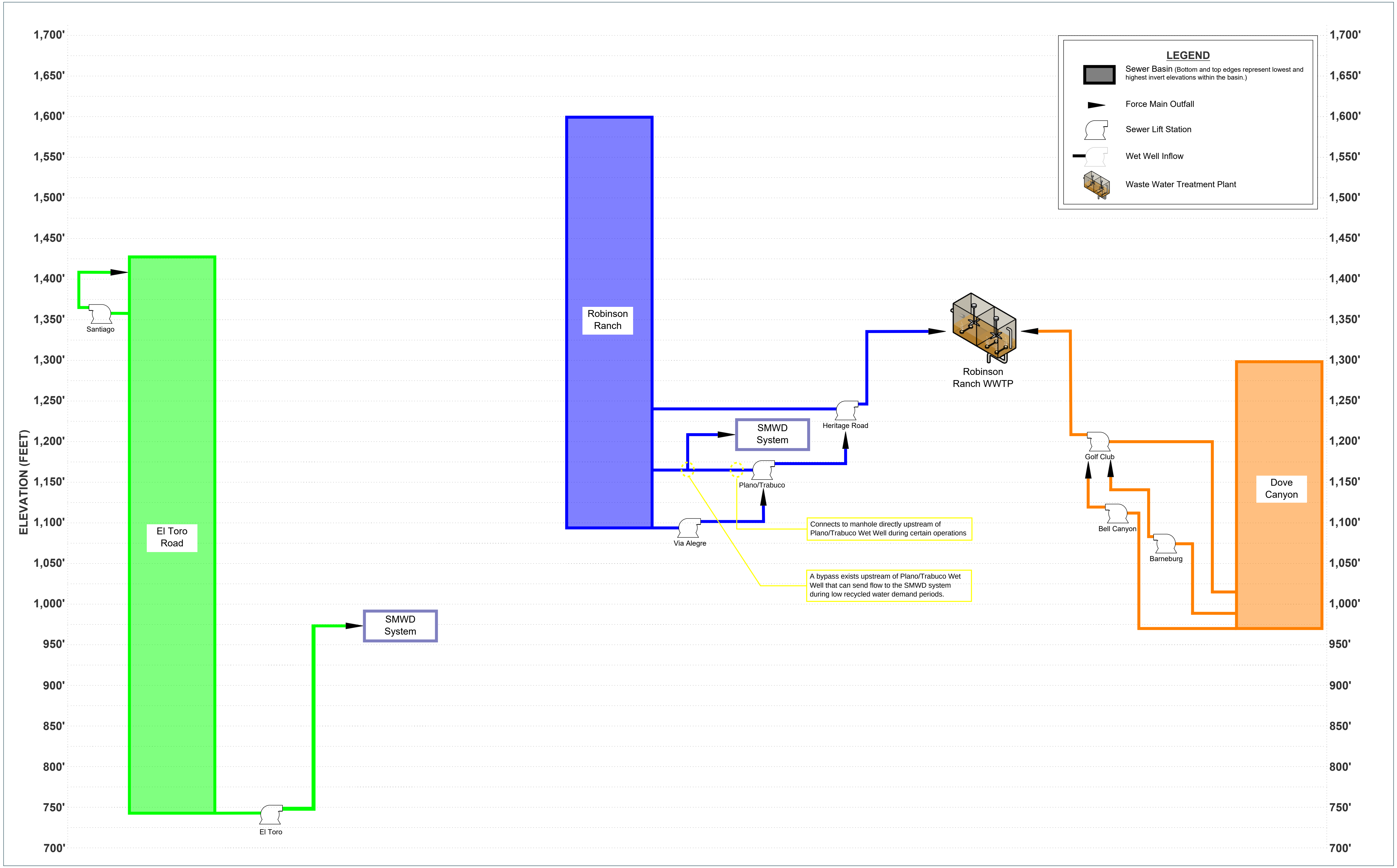


Existing Sewer System Facilities

Exhibit 11-1

Hazen

Trabuco Canyon Water District
Master Plan



Connects to manhole directly upstream of Plano/Trabuco Wet Well during certain operations

A bypass exists upstream of Plano/Trabuco Wet Well that can send flow to the SMWD system during low recycled water demand periods.

EXHIBIT 11-2

EXISTING SEWER SYSTEM FLOW SCHEMATIC

12. Planning, Design, and Evaluation Criteria

The purpose of this section is to provide a summary of the sewer planning, design, and evaluation criteria to analyze the District's sewer collection system. Standards and criteria are included for the analysis, design, installation, rehabilitation, and repair of the sewer collection system. The standards and criteria are intended to ensure that new construction, replacement, and rehabilitation of the sewer collection system uses the most recent and relevant standards.

The standards and criteria identified herein will be used as the basis to determine if the existing sewer collection system is adequately serving the District's customers, both today and in the future. The standards and criteria herein will be used as the basis for determining the existing deficiencies and system improvement requirements.

12.1 Design Criteria

Design criteria were established drawing upon several references including industry accepted standards. Design criteria for the sewer system address gravity pipelines, force mains, and lift stations. These are the criteria used to evaluate the performance of the existing system and serve as the basis for new project recommendations.

12.1.1 New Gravity Pipelines

Table 12-1 identifies the minimum design criteria to be used for all new pipeline designs.

Table 12-1: Design Criteria for New Gravity Pipelines

Pipe Dia. (in)	Min. Slope	Max. d/D	Min. Velocity (ft/s)	Max. Velocity (ft/s)
8	0.0040	0.50	2.0	10
10	0.0028	0.50		
12	0.0022	0.50		
≥ 15	0.0015	0.75		

The maximum allowable slope shall be the slope which generates a maximum flow velocity of 10 ft/s at the peak flow rate. The minimum slope shall be set such that the pipe can be constructed at normal depths and achieve a minimum scouring velocity of 2.0 ft/s during peak dry weather conditions. The minimum slope shall also be set to avoid exceeding the maxium depth over diameter (Max. d/D) under peak dry weather conditions.

12.1.1.1 Pipe Material

For new construction, gravity pipeline materials shall be PVC (SDR35), or as approved by the District.

12.1.1.2 Minimum Depth

Minimum depth from finish street grade to top of sewer main pipe shall be 7 feet. If 7 feet of cover is not feasible due to the depth of the existing main connection point, the District may consider lesser depths on a case-by-case basis and may require appropriate protective cover such as slurry backfill or extra strength pipe material.

12.1.1.3 Elevation Drop Across Manholes

When as-built data is not available, it is assumed that pipes have a straight run through a manhole. When designing new pipelines, all manholes shall have 0.10-foot drop across a manhole when flowing through straight, and 0.20-foot drop for angles.

12.1.1.4 Horizontal and Vertical Separation

The District, in accordance with requirements of the State of California, Department of Health Services and the Division of Drinking Water, requires minimum horizontal and vertical separation between sewer and potable water mains and other nearby utilities. The regulations in place at the time of construction shall apply to the work.

12.1.2 Existing Gravity Pipelines

Table 12-2 identifies the criteria used to evaluate the capacity of the existing gravity pipelines to determine if they need to be improved (upsized).

Table 12-2: Capacity Analysis Criteria for Existing Pipelines

Pipe Dia. (in)	d/D Ratio		
	0.50 to 0.75	0.75 to 0.90	≥ 0.90
All	Watch[1]	Schedule[2]	Improve[3]

Notes:

1. “Watch” indicates that special attention needs to be paid to increased flows that are tributary to this pipe. A proposed development may create a situation where the performance criteria is exceeded.
2. “Schedule” indicates that a capacity improvement project needs to be considered but can be scheduled at some point in the future.
3. “Improve” indicates that project funding and design should begin to increase capacity.

Minimum and maximum velocity criteria used to evaluate existing gravity pipelines are the same as for new pipelines: 2.0 to 10 ft/sec.

For the purposes of hydraulic calculations and system analyses of the existing collection system, an industry standard value of 0.014 shall be used for the Manning’s Roughness Coefficient (“n”) for all existing non-lined vitrified clay pipelines and a value of 0.010 shall be used for PVC pipelines. These coefficients are listed below in Table 12-3. Vitrified clay pipe and PVC pipe represent a majority of the sewer system pipeline materials.

Table 12-3: Manning Roughness Coefficient Used by Material

Material	Manning's
PVC	0.010
VCP	0.014
DI	0.012

12.1.3 Force Mains

All force mains and pressure sewers shall be ductile iron pipe (AWWA C150 and C151, fusion bonded epoxy lined), PVC (AWWA C900 or C905), or HDPE (AWWA C906, minimum DR of 17) unless otherwise approved by the District. Table 12-4 lists the Hazen-Williams coefficients that were used for PVC and DI force mains in the model.

Table 12-4: Hazen-Williams Coefficient Used by Material

Material	Hazen-Williams
PVC	139
DI	130

Force main velocity should be between a minimum of 3 ft/sec and a maximum of 8 ft/sec.

12.1.4 Lift Stations

Wet well overflows and the creation of backwater effects in the collection system pipelines upstream of the wet wells in the model were used to identify potential lift station capacity deficiencies. Note that backwater effects can also be caused by specific operational patterns at lift stations rather than true capacity deficiencies.

12.1.5 Treatment Facilities

Flow data for influent to the RRWWTP and SMWD system was not available at the time this report was written. Therefore, the treatment plant was modeled as a free outfall which reflects a lack of flow restriction.

13. Model Development and Calibration

As-built data, flow monitoring data, and the District's existing GIS database were used to construct the sewer model's physical network components. In locations where detailed information about existing system conditions was unavailable, engineering judgement was applied to infer or interpolate missing data. Throughout the data collection and assessment process, engineering judgment was used for appropriate assumptions as documented in the following sections.

The developed model network extent includes all active and TCWD-owned sewer lines and facilities within the eastern and western portions of the District as well as non-TCWD-owned sewer lines necessary for connectivity.

Once developed, the hydraulic model was calibrated to ensure model accuracy with respect to actual system conditions. Dry weather flow calibration was achieved by iteratively adjusting model parameters (e.g., diurnal curves) to match model results with flow monitoring data that was collected within the sewer collection system. A wet weather flow estimation was developed by considering a conservative 10-year 24-hour design storm with estimated Rainfall-Derived Infiltration and Inflow (RDII) values.

13.1 Model Overview

A hydrologic/hydraulic model of a sewer system is a mathematical representation of an actual physical collection system. Data describing the physical characteristics of the system as well as input data and boundary information are supplied to the modeling program, which simulates the response of the collection system to dry and wet weather flows. Physical data describing the collection system infrastructure includes pipe diameter, invert elevation, length, roughness, manhole rim elevation, connectivity, and geometry. Other model input data includes dry weather flow characteristics and boundary information.

An essential step in ensuring model accuracy is calibration, which is the process of adjusting data describing the mathematical model of the system until model predictions are in reasonable agreement with flow monitoring data.

13.1.1 Model Extents

The model developed for the analysis includes all sewers, including:

- all active and TCWD-owned sewer lines and facilities within the eastern and western portions of the District
- non-TCWD-owned sewer lines necessary for connectivity.

The model includes gravity lines, manholes, force mains, and lift stations to represent the collection system.

13.1.2 Software

InfoSWMM® was selected for use in modeling the District's sewer system because of its flexible data format and consistency with the Autodesk software platforms used for the District's water and recycled water models. InfoSWMM utilizes a user-friendly, GIS-based, graphical object-oriented interface from which to develop and execute the model's functions. InfoSWMM is a wastewater and stormwater modeling and management software application that performs fast, accurate, reliable simulations to represent the hydraulic behavior of sewer systems. InfoSWMM uses a system of integrated relational databases to store and apply data describing the collection system and can handle non-uniform, non-steady flow behavior, including surcharged pipes, looped networks, bidirectional flow, bifurcations, and backwater impacts. InfoSWMM also contains self-diagnosis and debugging features, as well as an array of options for simulating the hydrologic cycle, such that rainfall is converted into inflow into the modeled sewer system. InfoSWMM version 14.7 was used for all simulations conducted during this study.

13.2 Model Input Data Sources

The sewer model includes physical system data and hydrologic flow data. The physical system network was developed using the sanitary pipes and manholes in the District's GIS database and as-built data. Manholes and pipes were imported into InfoSWMM, and error-checking tools were used to validate the network database and identify missing values or data discrepancies, such as inaccurate pipe profiles. The process of integrating, identifying, and resolving data discrepancies for the physical system will be discussed in this section.

The InfoSWMM model network consists of three (3) major physical system components - nodes, links, and subcatchments. Nodes represent a specific point in the network and are classified as a manhole, outfall, or storage. Links are structures connecting nodes. Subcatchments are assigned to specific nodes and define the event characteristics (e.g., rainfall, sanitary flow, and infiltration) associated with the specified node.

13.2.1 Nodes

13.2.1.1 Manholes

Manholes make up 80.5% of the nodes in the model. Within the InfoSWMM software, manhole nodes indicate a pipe direction or slope change and provide shaft and chamber storage. Crucially, the manhole records (both GIS and As-Built) for the District contain the invert elevation and depth data required to calculate the hydraulic characteristics of the District's gravity conveyance network. The unique ID, rim elevation, minimum invert elevation, and GIS coordinates are the principal records extracted from the GIS data to develop the hydraulic model network for manhole nodes. The District's elevation data in the existing GIS has a precision to one foot. For higher accuracy to support sewer system modeling, the District supplemented the existing GIS elevation data with as-built information, which has a precision of 0.01 feet, where available. The GIS "Manhole ID" field was used as the unique ID field to establish a one-to-one mapping relationship between GIS and the model database.

Missing elevations were populated with the aid of a Digital Elevation Model (DEM) developed by the Orange County Department of Public Works (OCDPW). Manholes that lacked any known elevation data (as-built or existing GIS data) were assigned the overlaying ground elevation identified by the DEM with a statistically based elevation adjustment as the rim elevation. Figure 13-1 shows the depth distributions of manholes with known elevation data.

Invert elevations were validated to ensure declining slope was achieved in the connecting links where known elevation data did not confirm an inclining slope. If invert elevations failed the validation criteria, engineering judgment was used to adjust invert elevations as long as no known elevation data was available or contradicted. Figure 11-7 shows the distribution of manholes by elevation data source (As-Built, GIS, or DEM).

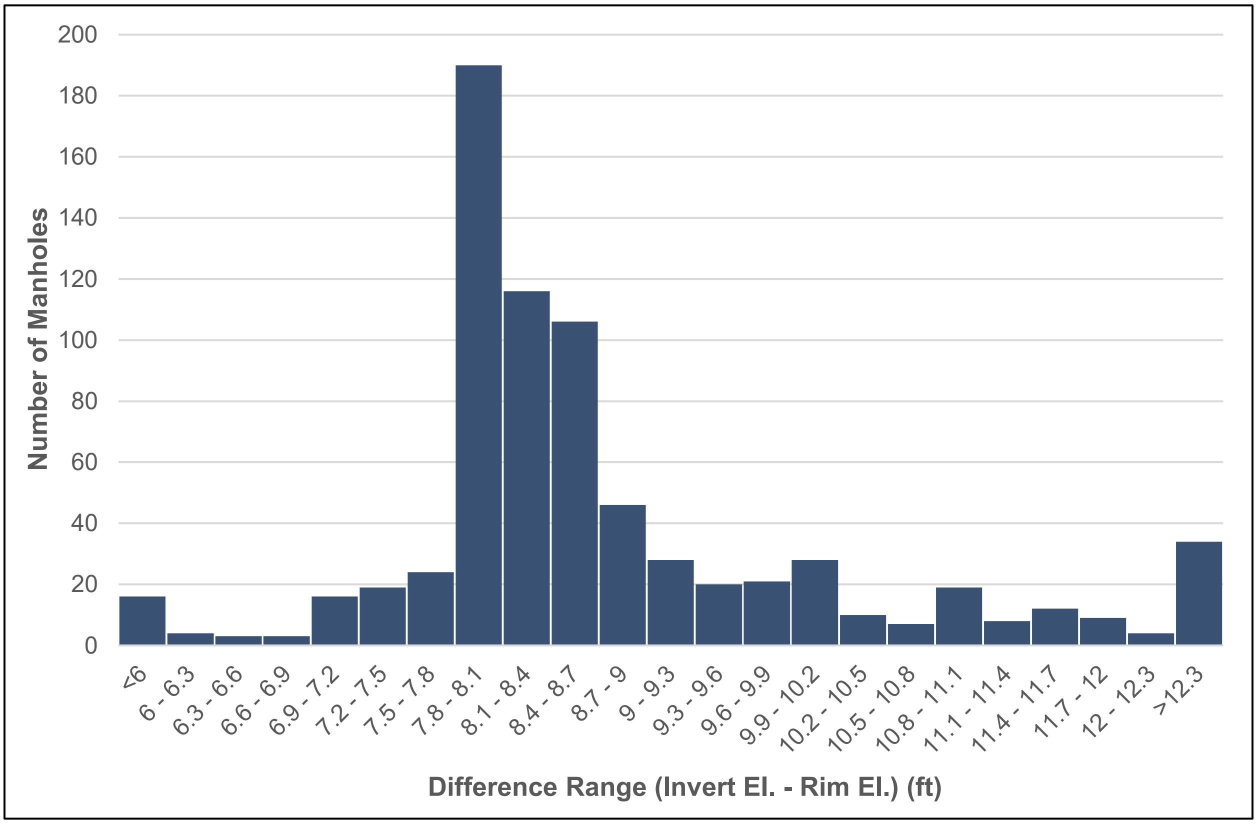


Figure 13-1: Depth Distribution of Manholes with Known Elevation Data

13.2.1.2 Dummy Nodes

"Dummy nodes" are classified as manholes in the InfoSWMM model but represent non-manhole infrastructure elements within the District's infrastructure. The creation of "dummy nodes" within the InfoSWMM model is made necessary by the software requirement that every link start and terminate with a node for connectivity. Dummy nodes were distinguished from manholes by a prefix attached to the "ID" field in the model. Table 13-1 identifies the ID prefix and includes a description of all the modeled manhole node categories.

Table 13-1: Modeled Manhole Node Categories

Manhole Node Categories	ID Prefix	Quantity	Percentage (%)	Description
Manholes	**M**	914	80.53%	Existing manholes in the District's GIS.
Force Main Nodes	**F**	188	16.56%	Dummy nodes connecting force main links to one another or pump links.
Pipe-to-Pipe connections	**PIPE**	13	1.15%	Dummy nodes placed on gravity link connections when gravity links connect to one another without a manhole.
Property Connections	**PC**	11	0.97%	Dummy nodes that represent property connections in the District's GIS.
Cleanouts	**CLN**	7	0.62%	Dummy nodes that represent cleanouts in the District's GIS.
Supplemental Manholes	**DM**	1	0.09%	Dummy nodes that represent a manhole identified in as-builts but not in the District's GIS.
Unknown Manholes	**UNK**	1	0.09%	Dummy nodes that represent a manhole identified through satellite imagery but not in the District's GIS.
	TOTAL	**1,135**	**100.00%**	

Dummy nodes were given depth and invert elevations based on as-built data, GIS data, interpolation of known elevations, or using estimates based on the OCDPW DEM.

13.2.1.3 Wet Wells

The model contains nine (9) nodes to represent wet wells. Modeled wet well characteristics can be seen in Table 11-2. It should be noted that no wet well in the model had a constant cross-sectional area. The cross-sectional area of every wet well was tapered near the bottom, which is common in wet well design. The cross-sectional area of each wet well was represented by an area-over-depth curve which will provide higher accuracy than a constant cross-sectional area assumption.

13.2.1.4 Outfalls

The model contains four (4) outfall nodes. An outfall is located at the most downstream points in the model network. Two (2) outfalls are located at the RRWWTP capturing the flow at the downstream ends of Heritage Lift Station and Golf Club Lift Station force mains. The third outfall is located at the intersection of Antonio Parkway and Santa Margarita Parkway. It captures any modeled bypassed flow entering SMWD's sewer system based on flow conditions seen at Plano Trabuco Lift Station. Currently, incoming flow to the Plano Trabuco Lift Station will only be bypassed if it exceeds 1.354 MGD, which is the maximum flow capacity of a single pump running continuously at Plano Trabuco Lift Station. The fourth outfall is located near the intersection of Santa Margarita Parkway and Promenade. It captures flow entering SMWD's sewer system at the downstream end of the El Toro Lift Station force main. The outfalls were given a "free outfall" designation in the model with assumption that no hydraulic restriction exists. As no backwater was observed at the most downstream flow monitors, this "free outfall" assumption has no impact on model calibration.

13.2.2 Links

13.2.2.1 Gravity Mains

Gravity mains make up 82.2% of the modeled and existing link length. The cross-section geometry (height/width/diameter), length, and material were the principal attributes extracted from the GIS data to develop the hydraulic model network for links. All invert elevations were tied to manhole elements. As a result, internode link connectivity was established using X and Y coordinate values with the link start coordinate representing the upstream link end and the end coordinate representing the downstream end. Link elements in the District's GIS are almost entirely drawn from upstream to downstream. Engineering judgment was used to identify the few links that were not drawn using this convention and were corrected in the InfoSWMM model. Once connectivity was established, invert elevations (in the form of offset elevations) were assigned from the manhole with the same X and Y coordinate data. Assigning offset elevations were handled by the following criteria:

- If a manhole has zero link connections, it was considered an orphaned manhole and was not modeled.
- If a manhole only has one connected link it is a terminating upstream element. Thus, the upstream end of the connected link was assigned an offset of zero.
- If a manhole has two connected links:
    - The link that is connected to the manhole by its upstream end was given an offset elevation of zero.
    - The link connected on the downstream end of the manhole was given the offset elevation equal to the maximum invert elevation minus the minimum invert elevation found in the manhole data.
- If a manhole has three connected links:
    - The link that is connected to the manhole by its upstream end was given an offset elevation of zero.
    - The link connected on the downstream end of the manhole with the closest direction of flow orientation to the outgoing link was given the offset elevation equal to the second lowest invert elevation minus the minimum invert elevation found in the manhole data.
    - The remaining connected link was given the offset elevation equal to the maximum invert elevation minus the minimum invert elevation found in the manhole data.
    - If only two invert elevations were present in the manhole data, then:
        - The link that is connected to the manhole by its upstream end was given an offset elevation of zero.
        - The two remaining links were given the offset elevation equal to the maximum invert elevation minus the minimum invert elevation found in the manhole data.

- If a manhole has four connected links or more than one outgoing link its offsets were assigned using engineering judgment.
- If a manhole only has one invert elevation associated with it all connected link ends were given an offset elevation of zero.

Table 13-2 shows the distribution of connection quantities for each manhole. Section 11.3.1 categorizes some of the existing characteristics of the District's gravity mains. These same characteristics are present in the model. It should be noted that Table 13-2 lists 922 manholes not 914 (as identified in section 11.4). The difference was caused by including dummy manholes representing property connections and pipe-to-pipe connections in this analysis.

Table 13-2: Distribution of Connection Quantities on Manholes

Number of Connections on Each Manhole	Quantity	Percentage (%)
0	3	0.33%
1	156	16.92%
2	532	57.70%
3	225	24.40%
4	6	0.65%
TOTAL	**922**	**100.00%**

After being imported into the model, pipe profiles were checked for negative slope or other data inconsistencies. If GIS data contained unrealistic values, engineering judgment was used to replace these values based on surrounding pipe inverts and manhole data.

All modeled pipes in the system are assumed to be circular in shape. To model gravity flow within the system, Manning's roughness coefficients (n) were assumed based on available pipe material data and adjusted as necessary during the dry-weather calibration. Modeled Manning's coefficients for various pipe materials are presented in Table 12-3.

13.2.2.2 Force Mains

Force mains make up 17.8% of the modeled and existing link length. The extracted GIS data and data gaps for the force mains were similar to the gravity mains, with unique IDs and elevations assigned in a similar manner. Upstream/downstream end selection was established in the same manner as in the gravity mains. Force main nodes were created from X and Y coordinates of the force main link ends. In the case of force mains, no elevation data was present in the GIS. All force main links and associated force main nodes were assigned elevation data from as-builts except for the Plano Trabuco Lift Station force main links (which had no available as-built data). Plano Trabuco Lift Station force main links were given invert elevations using the OCDPW DEM, the associated elevation adjustment described in section 13.2.1.1, and the minimum force main cover depth seen in most as-builts (5 ft). Force main links were further segmented in the model based on as-built-identified changes in link slope. Section 0 categorizes some of the existing characteristic of the District's force mains. These same characteristics are present in the model. Table 12-4 lists the Hazen-Williams coefficients by pipe material that were assumed for force mains in the model.

13.2.2.3 Pumps

Pumps are considered non-length link elements within InfoSWMM. Pump links connect a wet well node to a surcharged node (force main node). Table 11-1 list the existing characteristics of the District's pumps, which were used in the model.

Pumps "on and off" settings are controlled by wet well levels. In InfoSWMM, pumps can be either ideal or non-ideal. An ideal pump takes the inflow rate seen at the wet well and applies it to the end of the force main node. A non-ideal pump uses a pump curve to determine the flowrate at the force main node. All pumps in the model are non-ideal and use head vs. flow curves. Table 11-1 shows the data source of the pump curves. Three data sources were used to determine the pump curves:

1. Testing: these are pump curves determined through lift station testing and are the preferred pump curve data source.
2. Manufacturer: these are pump curves provided by the pump manufacturer or found on the pump manufacture's website.
3. Design Point: these are pump curves developed by InfoSWMM using the lift stations design head and flow.

13.2.3 Subcatchments

Subcatchments represent physical areas contributing flow to the modeled sewer network and define the inflow characteristics for a specific node. The subcatchments were generated by the Thiessen polygon method considering only the manhole location distribution. The subcatchments are presented in Exhibit 13-1 and Exhibit 13-2.

In InfoSWMM, the dry weather flow is input directly into the loading manholes, not through subcatchments. However, the subcatchment boundaries were used to distribute the flow within the flow monitoring basins.

13.3 Dry Weather Flows

13.3.1 Flow Monitoring Data

To determine the dry weather flows within the District, a temporary flow monitoring program was implemented. The flow monitoring program consisted of installing temporary flow meters at eight (8) locations within the District's collection system. The flow monitoring occurred over a three-week period from April 6, 2022, through April 26, 2022. The flow meters captured flow data at five-minute intervals over the flow monitoring period. The eight (8) sites were selected to capture flow data at locations in the downstream parts of the system, where a majority of the District's flows could be measured. The temporary flow monitoring program was performed by ADS Environmental Services, Inc. The flow monitoring report is provided in Appendix J. Exhibit 13-3 and Exhibit 13-4 show the locations of the eight (8) flow monitoring locations and the tributary basins of each flow monitor.

Utilizing the temporary flow monitoring data, two (2) separate average dry-weather flow (ADWF) diurnal curves were developed for each flow meter basin. ADWF diurnal curves were developed by averaging all weekdays and weekend days in the 3-week monitoring period. Certain flow meter data was not included in the ADWF diurnal curves such as:

- Days that had rain events. A small 3-hour rain event occurred on 4/22/2022 from 1:00 am to 3:40 am. The rainfall intensity over time pattern had a triangular shape with a peak value of 0.15 inches. A small rainfall response was observed in some flow meters. As a result, no data from 4/22/2022 was considered in the dry weather flow analysis.
- Data with flow inconsistencies. All flow monitors had flow consistent data except flow monitor 7. The flow data from flow monitor 7 from 04/06/2022 – 04/21/2022 was uncharacteristically flat. With only a less than 10% difference between flow peaks and flow average. As well as a less than 10% difference between flow valley and flow average. As a result, only data from 04/23/2022 – 04/26/2022 was considered for flow meter 7.

The following Figure 13-2 shows the diurnal weekday curve for flow monitoring basin 4. The diurnal curves for the other flow monitoring basins are provided in Appendix H labeled as "Calibration Curves" in the Model Calibration Results figures.

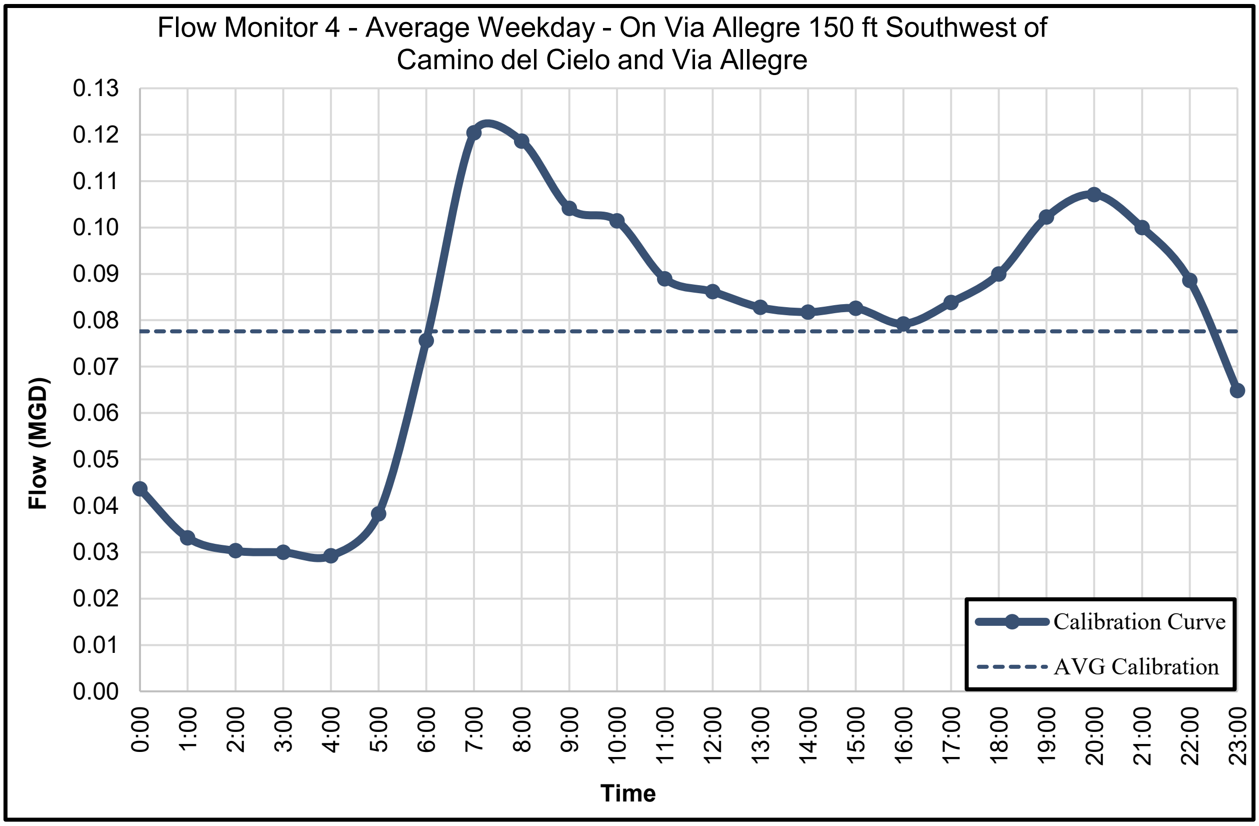


Figure 13-2: Flow Monitoring Basin 4 Weekday ADWF Curve

The following table shows the diurnal ADWF weekday peaking factors (flow for that time divided by average flow for that day) for flow monitoring Basin 4. The peak factor tables for other flow monitoring basins are provided in Appendix H.

Table 13-3: Flow Monitoring Basin 4 Weekday ADWF Peak Factors

Time	Weekday Peaking Factors
12:00 AM	0.427
1:00 AM	0.390
2:00 AM	0.386
3:00 AM	0.376
4:00 AM	0.503
5:00 AM	1.024
6:00 AM	1.692
7:00 AM	1.539
8:00 AM	1.341
9:00 AM	1.307
10:00 AM	1.146
11:00 AM	1.110
12:00 PM	1.066
1:00 PM	1.053
2:00 PM	1.064
3:00 PM	1.021
4:00 PM	1.090
5:00 PM	1.169
6:00 PM	1.327
7:00 PM	1.400
8:00 PM	1.289
9:00 PM	1.102
10:00 PM	0.726
11:00 PM	0.452
Average	**1.000**

13.3.2 Distribution of Dry Weather Flow

Dry weather flow distribution was achieved by using the District's potable water service meter data assuming wastewater usage is proportional to the water usage. All the District's sewer service accounts also have an associated water service account but only water service accounts are metered.

The address of every sewer service account was geocoded to determine which flow monitoring basin captured flow from the service account. The historical average April water use was calculated for each sewer service account throughout entire available service history through 2021 (volumetric water use is recorded monthly). Once the historical average April water use was calculated, it was divided by the total water use per flow monitoring basin to obtain a contributing water use percentage in each service account. The representative daily average weekday flows per basin were then multiplied to each service account's contributing percentage. Each service account was also assigned the encompassing flow monitoring basin's weekday and weekend diurnal curve. The daily average flow difference between weekday and weekend flows was corrected by multiplying each weekend peak flow value by the weekday-to-weekend daily average flow ratio. Dry weather sewer inflows into the sewer were then assigned to the nearest manhole, cleanout, or property connection node.

Unmonitored areas were grouped into contributing area basins and their contributing water use percentage per service account was calculated in the same manner as the monitored basins. Each unmonitored service account's contributing percentage was multiplied by the nearest meter basin's wastewater-to-water ratio to estimate its sewer inflow. Unmonitored areas were assigned the same dry weather diurnal curves as the nearest flow monitored basin.

Exhibit 13-5 below shows the location at which a portion of flow monitoring basin 6's flow diverts to flow monitoring basin 5.

Because of the partial flow diversion, calculating the daily average flows in flow monitoring basins 5 and 6 differed from the other basins. Calculating the daily average flows in flow monitoring basins 5 and 6 was accomplished using the following equations:

$$WW_5 = FM_5 - WW_{6\rightarrow 5}$$

$$WW_6 = FM_6 + WW_{6\rightarrow 5}$$

WW_x: Wastewater Flow Generated in Flow Monitoring Basin X

FM_x: Average Daily Flow Seen at Flow Monitor X

$WW_{6\rightarrow 5}$: Flow that Diverts from Flow Monitoring Basin 6 to 5

Equation 1: Flow Generation in Flow Monitoring Basins 5 and 6

$WW_{6\rightarrow 5}$ was found using the following method and assumptions:

- Adding FM_5 to FM_6 then dividing by the total number of service accounts in both basins.
- The above result was distributed into the nearest manhole node for every contributing service account in both basins and the model then routed the flows.
- It was found that the diverting manhole diverted 26.3% of the flow into basin 5 and 73.7% of the flow into basin 6
- The quantity of historical average April water usage in the contributing basin upstream of the diverter manhole was compared to the contributing basin that only flows to flow monitor 6. This yielded a 4.78 ratio between the two (with the flow of the contributing basin upstream of the diverter manhole being larger). Similarly, a comparison of service account quantities yielded a 5.38 ratio. These results indicate similar water usage rates between the two. It was assumed that

the water usage ratio could be applied to the sewage generation within basin 6. Leading to the following relationship:

$$WW_{6\rightarrow 5} = 0.263 \times \left[\frac{FM_6 \times \left(1 - \frac{1}{4.78}\right)}{.737} \right]$$

Equation 2: Diverted Flow from Basin 6 to 5

13.4 Dry Weather Flow Model Calibration

Model calibration is a crucial step in determining that the model accurately simulates the collection system response to dry and wet weather flow. The hydraulic model was calibrated to represent dry weather flow based on the three-week monitoring period.

Dry weather flow calibration was accomplished by simulating an average dry weather weekday and an average dry weather weekend day and comparing the modeled versus calculated peak flows and volumes at each metering location.

Based on generally accepted practice, model accuracy and robustness are achieved by setting the model calibration parameters (within an acceptable range) such that the model's predicted response matches that of an observed or measured response (e.g., monitored field conditions). The following paragraphs summarize the model Dry Weather Flow calibration criteria for flow comparison.

Generally, the comparison of predicted and observed responses were quantified in a statistical framework and visually depicted through observed versus model-predicted plots for each location in the model (i.e., meter locations) where the respective data is compared.

The following calibration criteria were used in this study as a guideline:

- Modeled peak flows should be within 10 percent of the observed peak flows
- Modeled 24-hour volumes should be within 10 percent of the observed volumes
- Matching as closely as possible the ratio of the time to peak for the modeled and observed events indicating that the shapes of the modeled and observed hydrographs are similar

Table 13-4 compares model-predicted volumes and peak flows relative to observed values for a dry weather weekday and weekend day. The model is calibrated well to dry weather conditions observed during the monitoring period at all eight (8) sites.

Table 13-4: Dry Weather Flow Calibration Summary by Flow Monitoring Basin

Flow Monitoring Basin	Metered Average (MGD)	Modeled Average Difference (%)	Metered 1st Peak (MGD)	Modeled 1st Peak Difference (%)	Metered 2nd Peak (MGD)	Modeled 2nd Peak Difference (%)
FM1 Weekday	0.146	1.5%	0.222	1.9%	0.216	0.9%
FM2 Weekday	0.080	1.5%	0.107	0.6%	0.092	4.9%
FM3 Weekday	0.040	0.5%	0.052	0.8%	0.050	0.2%
FM4 Weekday	0.078	0.4%	0.120	3.7%	0.107	1.5%
FM5 Weekday	0.109	2.5%	0.152	2.1%	0.155	0.2%
FM6 Weekday	0.132	0.9%	0.188	1.6%	0.186	1.8%
FM7 Weekday	0.068	3.2%	0.095	2.3%	0.101	0.8%
FM8 Weekday	0.267	1.4%	0.403	1.1%	0.396	0.5%
FM1 Weekend	0.158	0.7%	0.245	2.4%	0.214	0.6%
FM2 Weekend	0.081	2.5%	0.110	2.6%	0.096	2.5%
FM3 Weekend	0.041	0.5%	0.056	0.7%	0.056	3.4%
FM4 Weekend	0.083	2.4%	0.131	2.7%	0.106	1.9%
FM5 Weekend	0.116	0.1%	0.160	2.4%	0.150	0.8%
FM6 Weekend	0.138	1.6%	0.208	1.6%	0.177	1.0%
FM7 Weekend	0.076	1.2%	0.110	2.2%	0.083	1.7%
FM8 Weekend	0.290	0.5%	0.447	1.3%	0.398	0.7%

Exhibit 13-6 shows the calibration results graphically for flow monitoring Basin 4 as an example. Figures for every flow meter basin are provided in Appendix H.

13.5 Wet Weather Flow Estimation

Wet weather calibration is typically accomplished by simulating observed wet weather events and adjusting model parameters in an iterative fashion until the modeled hydrograph's shape and timing, as well as values for flow, volume, and depth match with measured values (within specified tolerances).

Due to the lack of significant rainfall events during the monitoring period, wet weather calibration was not performed. Instead, a design storm simulation was performed to estimate the system's wet weather response. As this estimation is not based on actual wet weather flow data and RDII characteristics can vary significantly between monitored basins, this section provides a conceptual approach to evaluate the system capacity under wet weather conditions and results should not be used for decision-making without first calibrating the model with actual wet weather flow data.

13.5.1 Design Storm

The 10-year 24-hr design storm was used to simulate the system's wet weather response. The storm duration was based on recommendations from the Orange County Hydrology Manual. The cumulative rainfall of 3.68 inches for the design storm was also stated in Orange County Hydrology Manual. The temporal rainfall distribution was determined by Type I 24-hour SCS Standard Rainfall Distribution. Note that this is a large design storm and its use for sewer system evaluation is considered very conservative. The design storm is represented graphically in Figure 13-3.

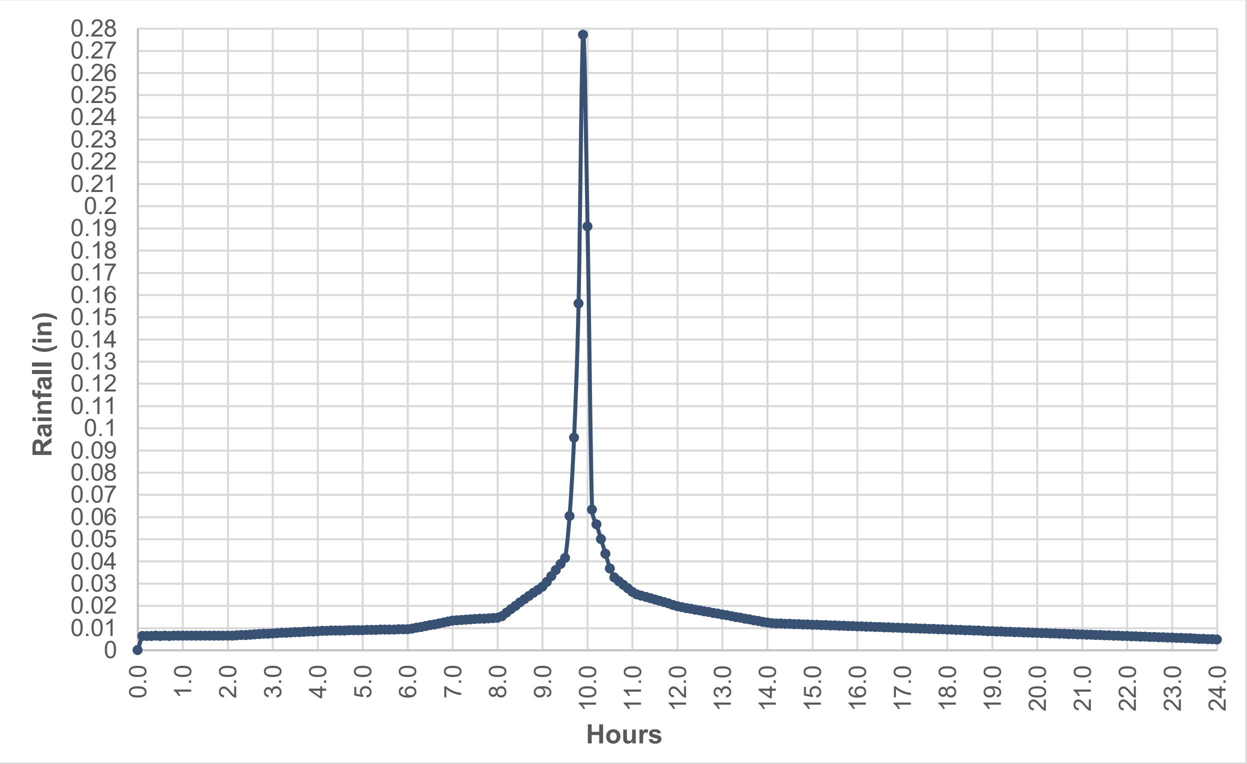


Figure 13-3: Type I 10-year 24-hr 6-min Increment Design Storm (3.68 in)

13.5.2 RTK Values

Wet weather flows were developed from an RTK estimate. Since this sewer system is a separated sanitary system, wet weather flow enters the sewers via RDII into the sewers rather than through direct connections from the storm drainage system.

The RTK unit hydrograph method was used as the hydrologic routine for representing the wet weather response in the sewer system model due to RDII. This method uses three triangular-shaped unit hydrographs to represent the RDII flow. Three parameters define each triangular unit hydrograph: R (ratio of RDII volume to rainfall volume), T (time to peak), and K (ratio of “time to recession” to “time to peak”). The R-Value, or capture coefficient, represents the relative fraction of rainfall that ends up in the sewer system. Higher R-values indicate a greater number, or severity, of sewer system defects that allow greater entry of wet weather flows into the sewer system. A high R-value can also indicate illegal drain connections into the sewer system.

The first set of parameters (R1, T1, K1) represents the fast response of the sewer system to inflow. The second set (R2, T2, K2) represents the delayed response of the system to infiltration and the third set (R3, T3, K3) represents the much longer and slower response of the sewer system to infiltration that could last days and weeks. Figure 13-4 illustrates this methodology as it relates to the wet weather RDII sewer system response.

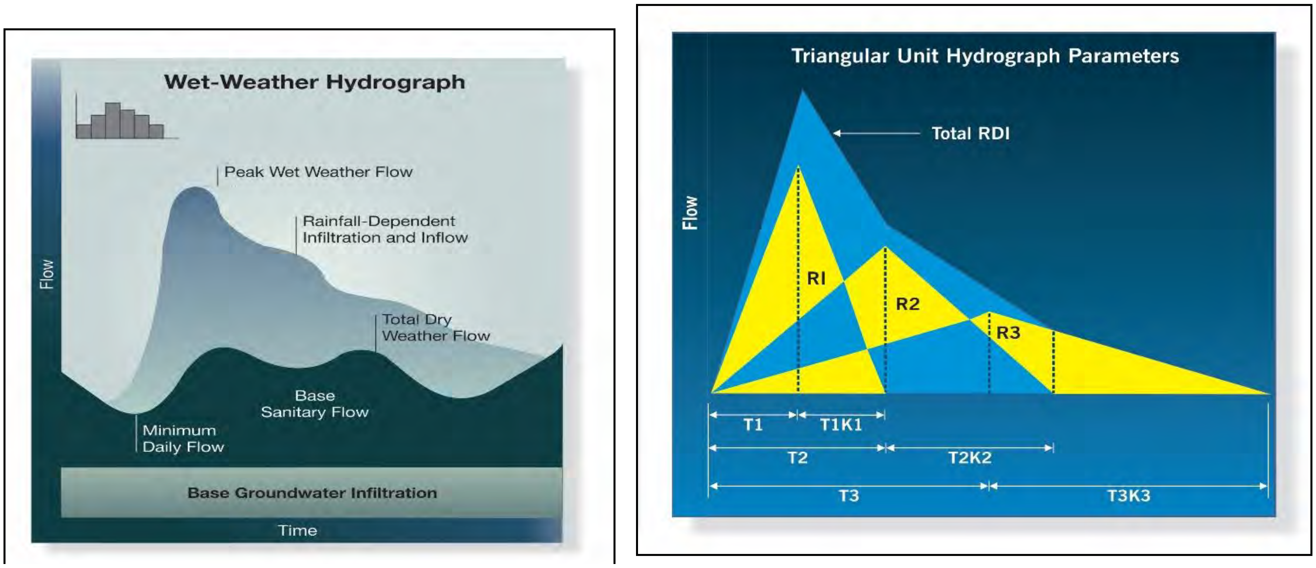


Figure 13-4: Wet Weather Hydrograph and Triangular Hydrograph Parameters

Because no significant rainfall occurred during the modeling period, low RTK values within standard ranges were used to estimate a unit hydrograph for the system. Table 13-5 shows the RTK values that were used in the model. These RTK values were based on engineering judgment and were intended to demonstrate the process of developing wet weather flow in the model. Representative system-specific RTK values can only be developed from wet weather flow monitoring data.

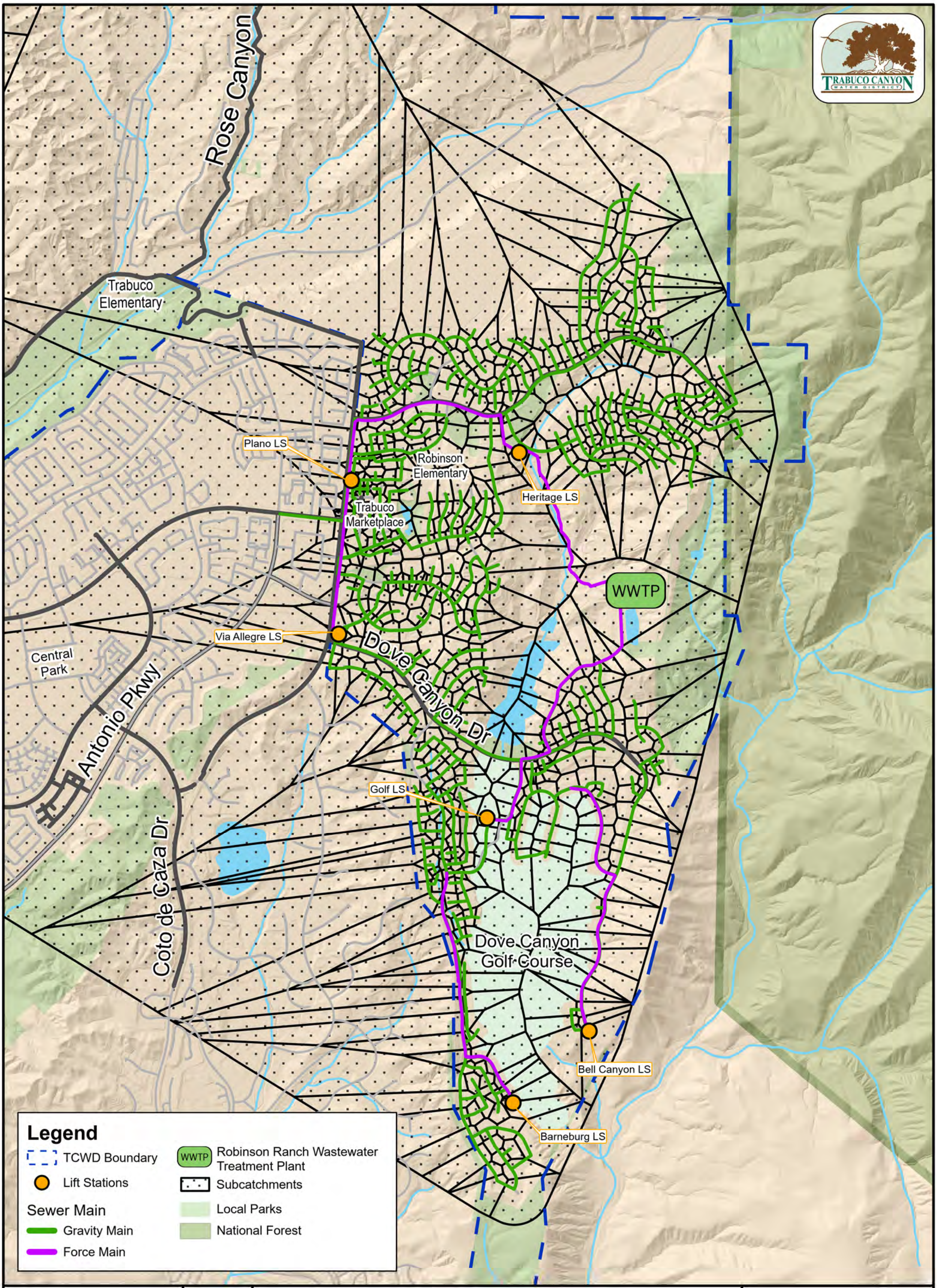
Table 13-5: RTK Values Used in Model

Response Type	R	T	K
Short-Term	0.005	1	1.5
Medium-Term	0.005	4	2.5
Long-Term	0	7.5	5

This global set of RTK values was attributed to every node underlying a Thiessen Polygon. The area of the polygon was used as the contributing area of the unit hydrograph.

13.5.3 Wet Weather Estimation Effects on the System

The design storm's chosen start date and time was at 10:00 pm during the simulation of the weekday period. This was done so that the peak of the storm could coincide with the dry weather peak of the system, during the following simulation weekend day. Exhibit 13-7 compares the calibrated dry weather flow and the estimated wet weather response over the weekend simulation period for Basin 4 as an example basin. Figures comparing the calibrated dry weather flow and the estimated wet weather response for every flow meter basin are provided in Appendix I.



0.00 0.13 0.25
Miles

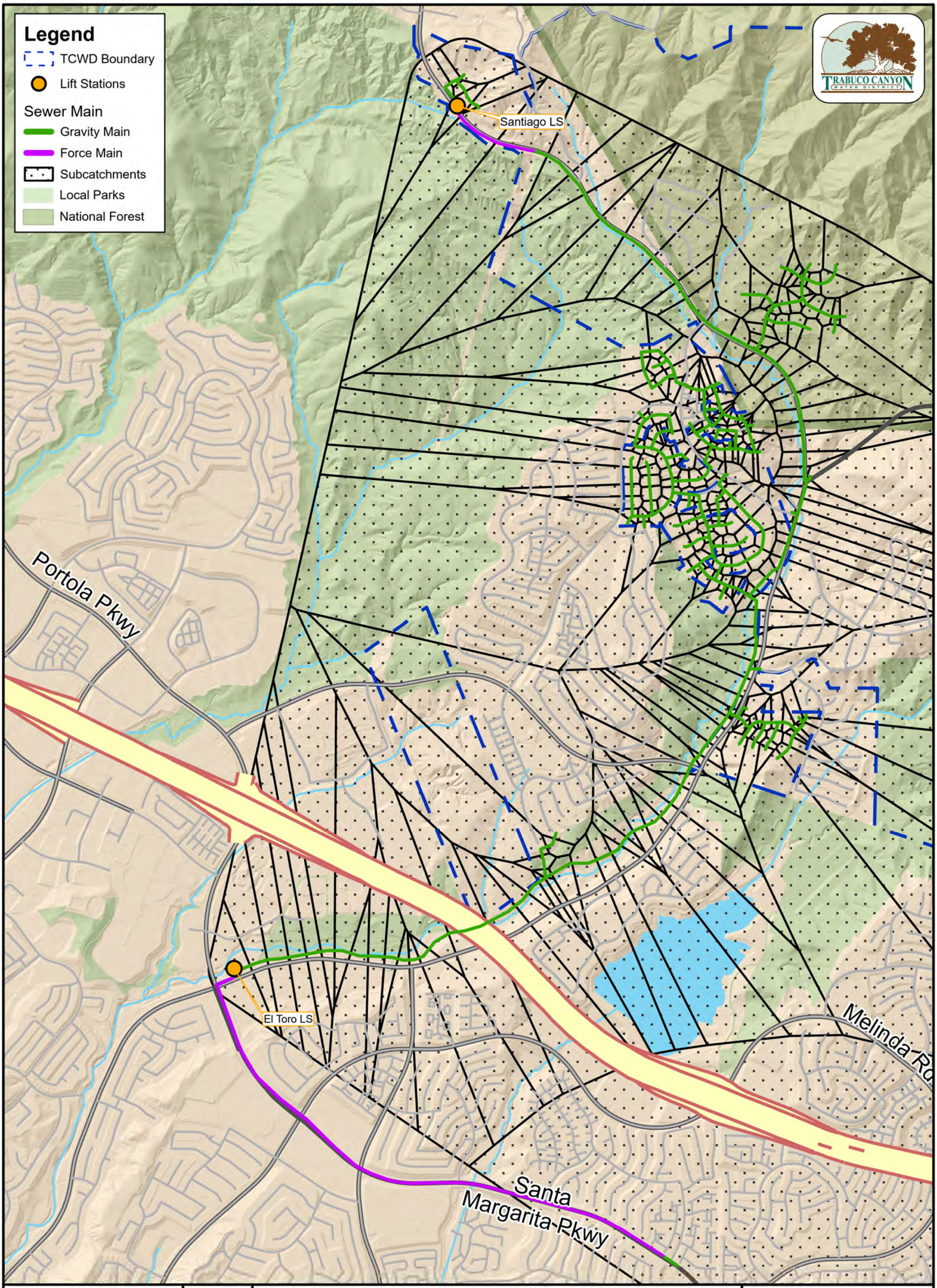
N

Existing Sewer System Facilities and Subcatchments for Dove Canyon and Robinson Ranch

Exhibit 13-1

Hazen

Trabuco Canyon Water District
Master Plan



0.00 0.13 0.25 Miles

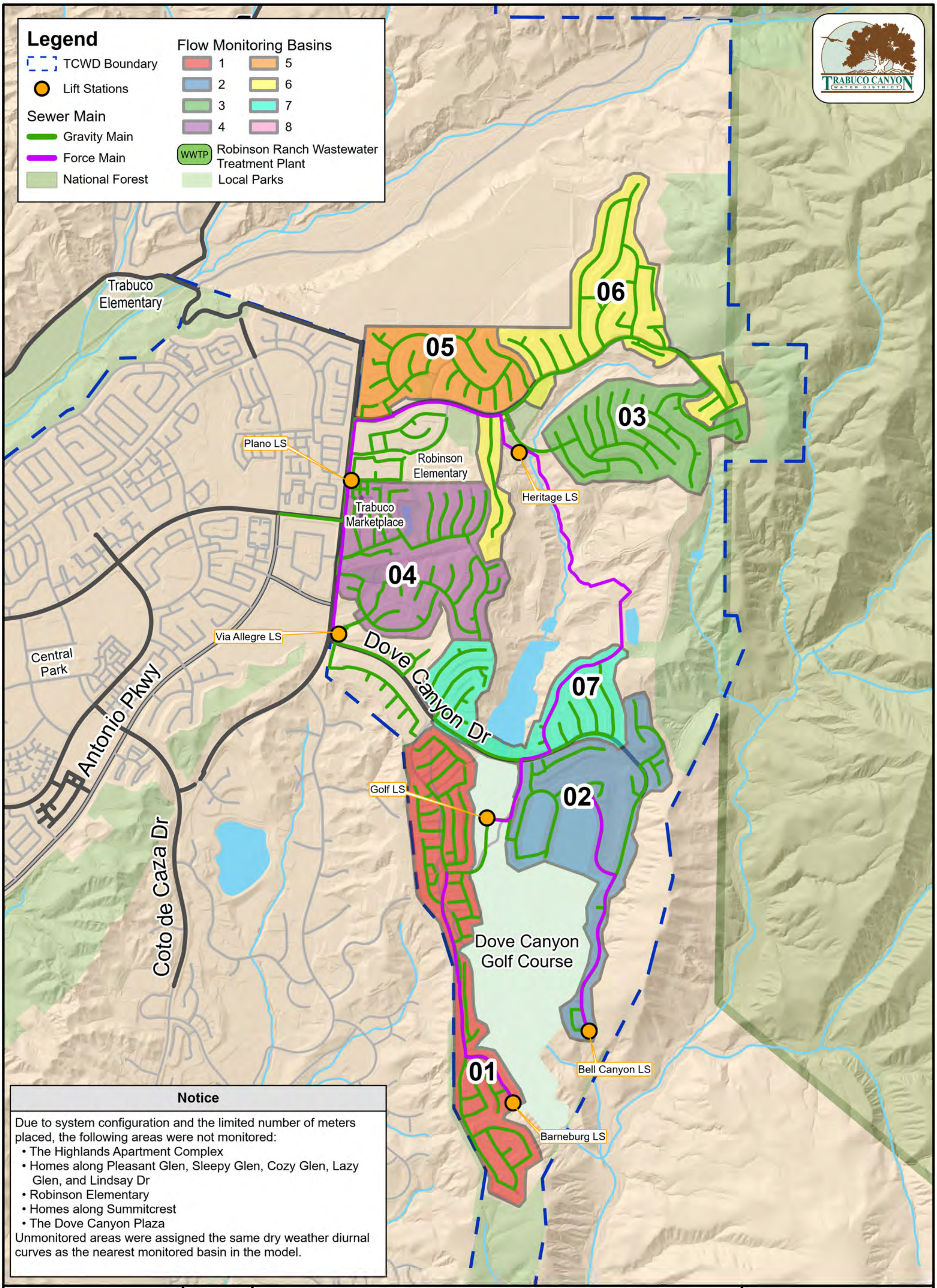
N

Existing Sewer System Facilities and Subcatchments for El Toro

Exhibit 13-2

Hazen

Trabuco Canyon Water District
Master Plan



Notice

Due to system configuration and the limited number of meters placed, the following areas were not monitored:

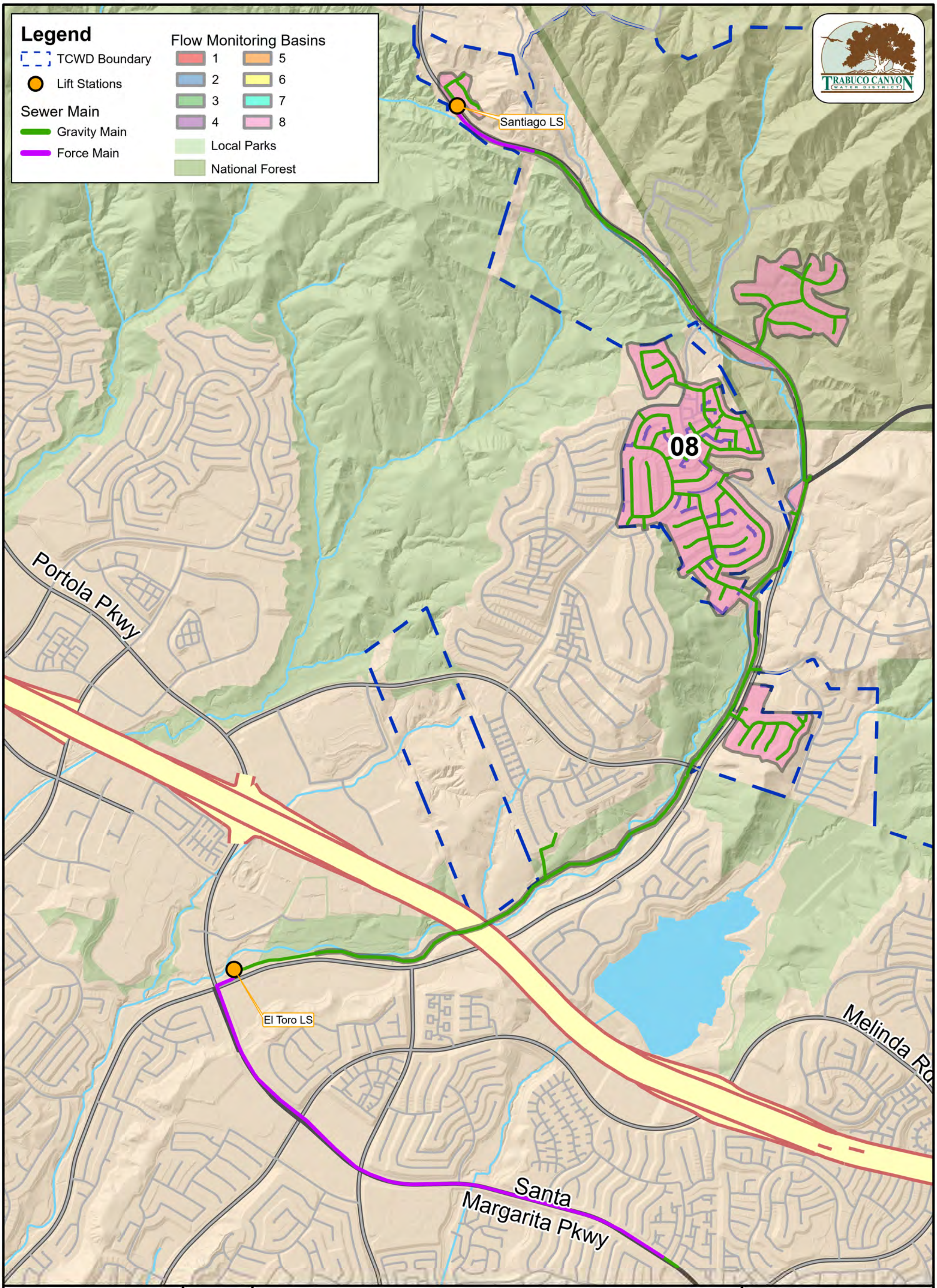
- The Highlands Apartment Complex
- Homes along Pleasant Glen, Sleepy Glen, Cozy Glen, Lazy Glen, and Lindsay Dr
- Robinson Elementary
- Homes along Summitcrest
- The Dove Canyon Plaza

Unmonitored areas were assigned the same dry weather diurnal curves as the nearest monitored basin in the model.

Existing Sewer System Facilities and Flow Monitoring Basins for Dove Canyon and Robinson Ranch

Exhibit 13-3

Trabuco Canyon Water District
Master Plan



0.00 0.13 0.25 Miles

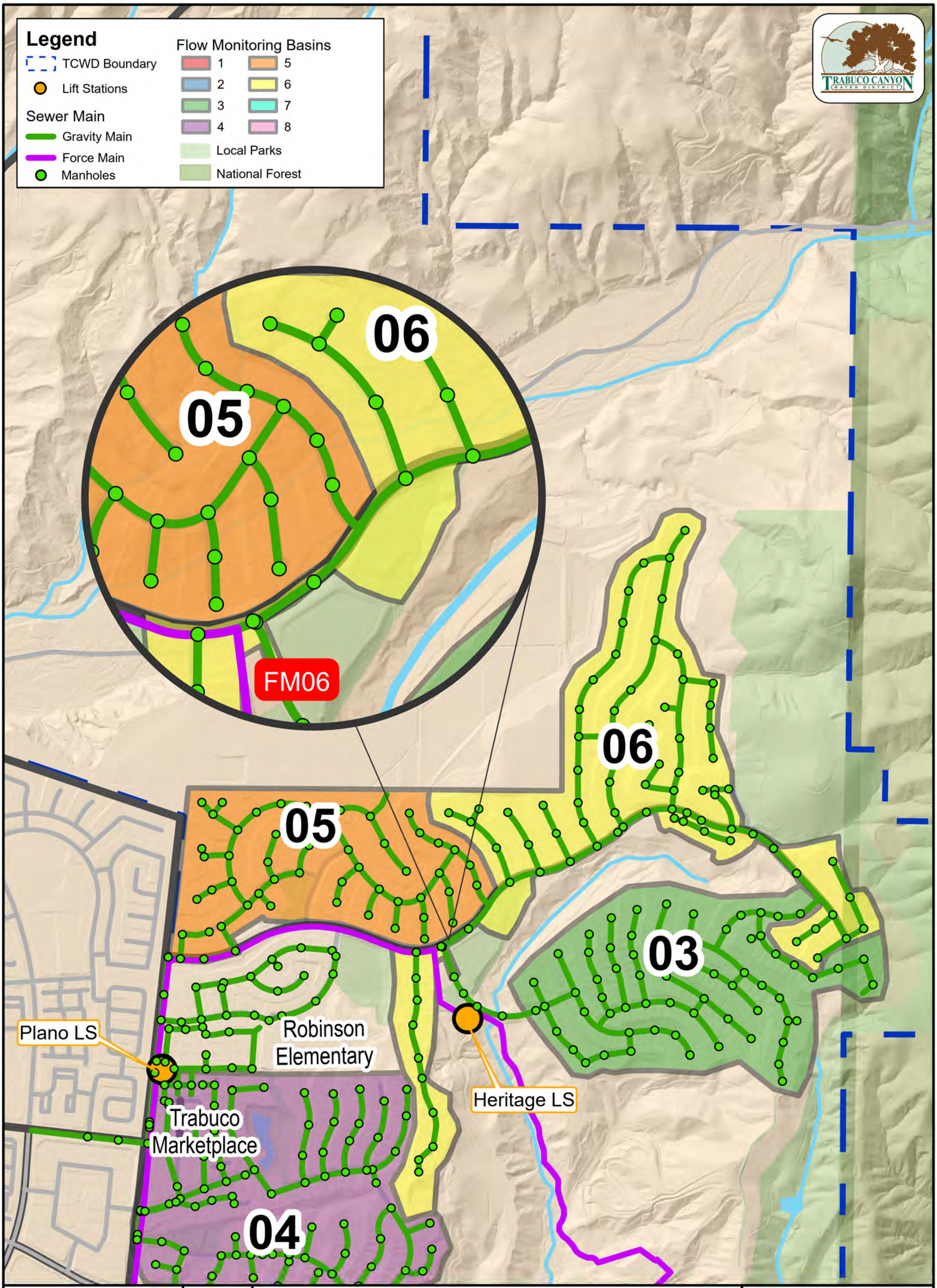
N

Existing Sewer System Facilities and Flow Monitoring Basins for El Toro

Exhibit 13-4

Hazen

Trabuco Canyon Water District
Master Plan



Partial Flow Diversion from Flow Monitoring Basin 6 to 5

Exhibit 13-5

Hazen

Trabuco Canyon Water District
Master Plan

14. Sewer System Evaluation

The assessment of the existing and future capacity of the collection system and its ability to convey predicted peak flows is summarized in the following section. The overall capacity evaluation approach was to simulate dry and wet weather conditions in the collection system using the hydrologic/hydraulic model and evaluate the system based on the established performance criteria. The capacity evaluation approach and results are summarized in this section.

14.1 Flow Projections

Flow projections for the future (year 2045) condition are based on the 2020 UWMP and information from the District regarding details of new developments. In total, 0.007 MGD of flow was added to the Eastern portion of the system and 0.402 MGD of flow was added to the Western portion of the system to account for new developments in the future scenario. Refer to Exhibit 14-9 for a map of the future developments.

14.2 Capacity Analysis

Model simulation results for baseline and future (year 2045) conditions are presented in this section. Table 14-1 and Table 14-2 show capacity deficiencies in the sewer system during dry weather and estimated wet weather. The figures illustrate the d/D ratio of all modeled pipe segments as well as locations of any model-predicted sanitary sewer overflows (SSOs).

It should be noted that model-predicted SSOs and areas with reduced capacity do not necessarily correlate to actual occurrences; rather, they represent the model-predicted potential for surcharging under the estimated design storm conditions.

14.2.1 Baseline (2022) Conditions Scenario

Table 14-1, Exhibit 14-1, and Exhibit 14-2 show peak d/D ratios in the gravity sewer system under baseline (2022) dry weather flow conditions. No nodes were reported as flooded during the dry weather simulation and no surcharging occurred directly upstream of a lift station, indicating that there were no capacity constraints at the lift stations. The gravity sewer capacity analysis shows that, under baseline dry weather conditions, eight (8) sewer segments are categorized to watch because they have a flow depth-to-diameter (d/D) value between 0.50 and 0.75. Note that segment G948 in Table 14-1 is directly downstream of the District’s force main discharge into SMWD’s system. No capacity improvement projects are recommended for the baseline conditions scenario.

Table 14-1: Baseline Dry Weather Flow Conduit Capacity Analysis

Model ID	d/D	Watch (0.5 - 0.75)	Schedule (0.75 - 0.9)	Improve (≥ 0.9)
G470	0.511	X		
G811	0.516	X		
G1112	0.523	X		
G156	0.529	X		
G398	0.531	X		
G493	0.532	X		
G835	0.584	X		
G948	0.683	X		
	TOTAL	**8**	**0**	**0**
Average d/D throughout all Gravity Mains: 0.093				

Table 14-2, Exhibit 14-3, and Exhibit 14-4 show peak d/D ratios in the gravity sewer system under baseline (2022) estimated wet weather flow conditions. The gravity sewer capacity analysis shows that, under baseline simulated wet weather conditions, thirty-two (32) sewer segments are categorized to watch because they have a flow depth-to-diameter (d/D) value between 0.50 and 0.75. One (1) segment is categorized for scheduled improvements based on a d/D value between 0.75 and 0.90. Sixteen (16) segments are categorized for improvements based on a d/D value above 0.90.

Five (5) nodes were reported as flooded (SSO) during the wet weather simulation and surcharging with d/D in the 0.5 – 0.75 range occurred directly upstream of Plano Trabuco and Heritage Lift Stations. Surcharging with d/D equal to or greater than 0.90 occurred directly upstream of the following lift stations: Barneburg, Bell Canyon, Golf Club, Via Allegre. The flooding seen at these manholes can be attributed to deficit capacity at the lift stations during the design storm.

As previously described in Section 13.5, the RTK values used in the model for wet weather flow estimation were based on engineering judgment and were intended to demonstrate the process of developing wet weather flow in the model but are not based on system-specific rainfall data. This wet weather flow analysis identifies portions of the system to watch and prioritize for inspection work in the future, but it is not recommended to proceed with specific improvement projects based on the wet weather flow estimation results.

Table 14-2: Baseline Wet Weather Flow Conduit Capacity Analysis

Model ID	d/D	Watch (0.5 - 0.75)	Schedule (0.75 - 0.9)	Improve (≥ 0.9)
G872	0.504	X		
G346	0.513	X		
G811	0.529	X		
G729	0.534	X		
G155	0.544	X		
G261	0.547	X		
G156	0.548	X		
G404	0.553	X		
G398	0.557	X		
G724	0.559	X		
G640	0.562	X		
G493	0.565	X		
G163	0.58	X		
G907	0.584	X		
G400	0.589	X		
G728	0.591	X		
G137	0.601	X		
G726	0.603	X		
G627	0.606	X		
G597	0.614	X		
G262	0.615	X		
G401	0.615	X		
G260	0.621	X		
G835	0.633	X		
G801	0.648	X		
G470	0.649	X		
G723	0.657	X		
G948	0.685	X		
G511	0.696	X		
G213	0.699	X		
G1164	0.718	X		
G727	0.738	X		
G206	0.856		X	
G508	0.935			X
G703	0.955			X
G154	1			X

Model ID	d/D	Watch (0.5 - 0.75)	Schedule (0.75 - 0.9)	Improve (≥ 0.9)
G205	1			X
G216	1			X
G509	1			X
G510	1			X
G512	1			X
G598	1			X
G599	1			X
G626	1			X
G628	1			X
G629	1			X
G630	1			X
G1112	1			X
G1114	1			X
	TOTAL	**32**	**1**	**16**
Average d/D throughout all Gravity Mains: 0.180				

14.2.2 Future (2045) Conditions Scenario

Table 14-3, Exhibit 14-5, and Exhibit 14-6 show peak d/D ratios in the gravity sewer system under future (2045) dry weather flow conditions. No nodes were reported as flooded during the dry weather simulation and no surcharging occurred directly upstream of a lift station, indicating that there were no capacity restrictions at the lift stations. The gravity sewer capacity analysis shows that, under future dry weather conditions, ten (10) sewer segments are categorized to watch because they have a flow depth-to-diameter (d/D) value between 0.50 and 0.75. Note that segment G948 is directly downstream of the District's force main discharge into SMWD's system. No capacity improvement projects are recommended based on the future dry weather conditions scenario.

Table 14-3: Future Dry Weather Flow Conduit Capacity Analysis

Model ID	d/D	Watch (0.5 - 0.75)	Schedule (0.75 - 0.9)	Improve (≥ 0.9)
G262	0.502	X		
G260	0.505	X		
G470	0.511	X		
G811	0.516	X		
G1112	0.518	X		
G156	0.529	X		
G398	0.531	X		
G493	0.532	X		
G835	0.584	X		
G948	0.684	X		
	TOTAL	**10**	**0**	**0**
Average d/D throughout all Gravity Mains: 0.103				

Table 14-4, Exhibit 14-7, and Exhibit 14-8 show peak d/D ratios in the gravity sewer system under future (2045) estimated wet weather flow conditions. The gravity sewer capacity analysis shows that, under 2045 simulated wet weather conditions, thirty-nine (39) sewer segments are categorized to watch because they have a flow depth-to-diameter (d/D) value between 0.50 and 0.75. Three (3) segments are categorized for scheduled improvements based on a d/D value between 0.75 and 0.90. Sixteen (16) segments are categorized for improvements based on a d/D value above 0.90.

No additional nodes were reported as flooded (SSO) during the 2045 wet weather simulation when compared to the baseline wet weather simulation, in which five (5) nodes were reported as flooded (SSO) during the wet weather simulation and surcharging with d/D in the 0.5 – 0.75 range occurred directly upstream of Plano and Heritage lift stations. Surcharging with d/D equal to or greater than 0.90 occurred directly upstream of the following lift stations: Barneburg, Bell Canyon, Golf Club, Via Allegre. The flooding seen at these manholes can be attributed to deficit capacity at the lift stations during the design storm.

As previously described in Section 13.5, the RTK values used in the model for wet weather flow estimation were based on engineering judgment and were intended to demonstrate the process of developing wet weather flow in the model, but do not represent system-specific rainfall data. This wet weather flow analysis identifies portions of the system to watch and prioritize for inspection work in the future, but it is not recommended to proceed with specific improvement projects based on the wet weather flow estimation results.

Table 14-4: Future Wet Weather Flow Conduit Capacity Analysis

Model ID	d/D	Watch (0.5 - 0.75)	Schedule (0.75 - 0.9)	Improve (≥ 0.9)
G264	0.5	X		
G300	0.502	X		
G929	0.502	X		
G257	0.503	X		
G872	0.504	X		
G225	0.506	X		
G346	0.513	X		
G258	0.518	X		
G220	0.52	X		
G811	0.529	X		
G729	0.54	X		
G155	0.544	X		
G156	0.548	X		
G640	0.555	X		
G398	0.557	X		
G404	0.561	X		
G904	0.562	X		
G493	0.565	X		
G724	0.566	X		
G163	0.58	X		
G217	0.583	X		
G627	0.585	X		
G907	0.588	X		
G728	0.596	X		
G400	0.597	X		
G137	0.601	X		
G726	0.603	X		
G597	0.614	X		
G401	0.623	X		
G835	0.633	X		
G470	0.649	X		
G801	0.649	X		
G723	0.665	X		
G261	0.683	X		

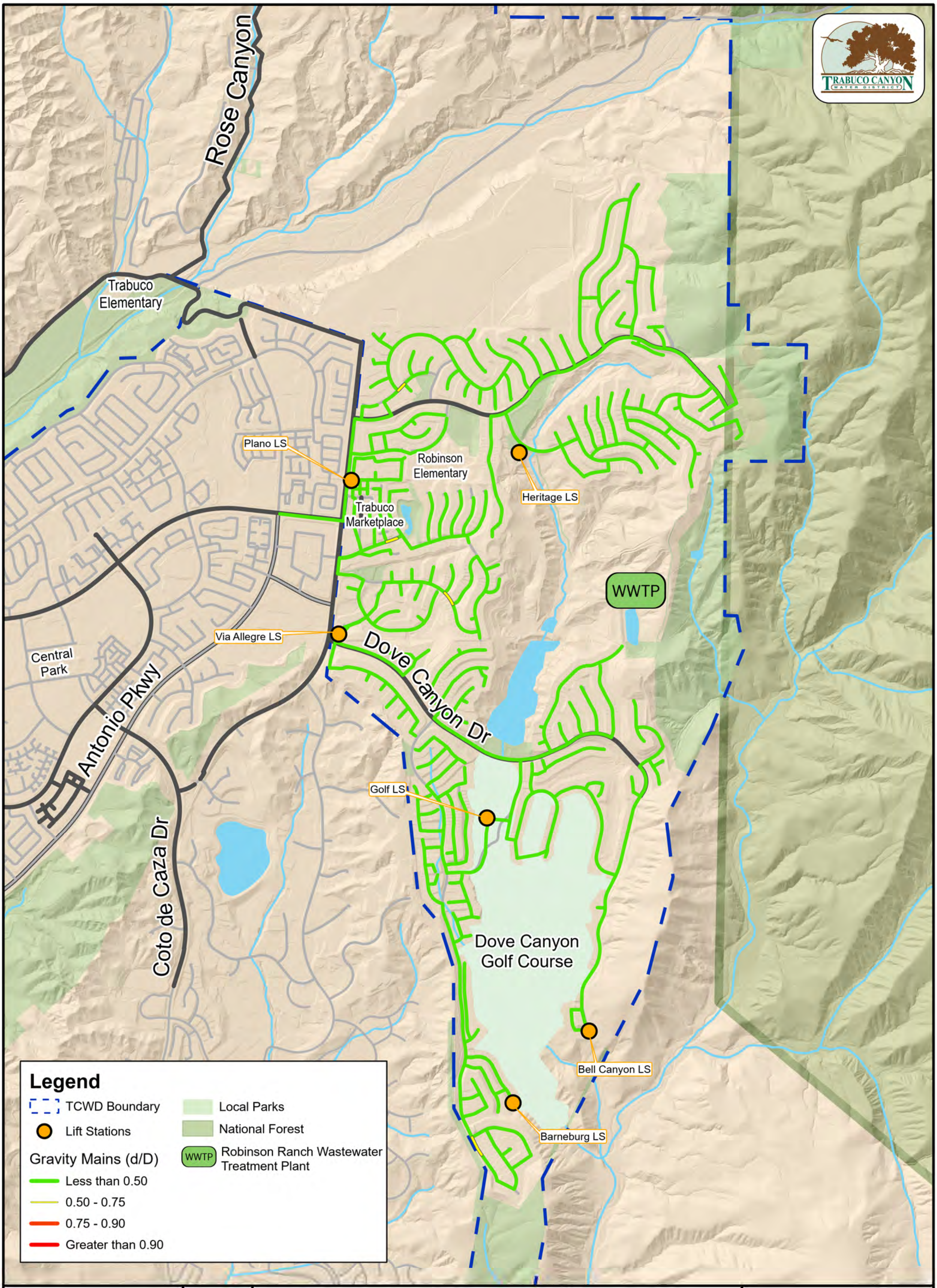
Model ID	d/D	Watch (0.5 - 0.75)	Schedule (0.75 - 0.9)	Improve (≥ 0.9)
G948	0.686	X		
G511	0.696	X		
G213	0.699	X		
G1164	0.723	X		
G727	0.743	X		
G262	0.775		X	
G260	0.782		X	
G206	0.848		X	
G508	0.935			X
G703	0.957			X
G154	1			X
G205	1			X
G216	1			X
G509	1			X
G510	1			X
G512	1			X
G598	1			X
G599	1			X
G626	1			X
G628	1			X
G629	1			X
G630	1			X
G1112	1			X
G1114	1			X
	TOTAL	**39**	**3**	**16**
Average d/D throughout all Gravity Mains: 0.188				

14.2.3 Capacity Analysis Summary and Recommendations

In summary, the model results indicate that the District's sewer system has sufficient capacity to convey dry weather flow without deficiencies (defined as flow d/D greater than 0.75) for both baseline (2022) and future (2045) dry weather flow scenarios, with very few pipelines on the watch list (defined as flow d/D between 0.50 and 0.75). No capacity improvement projects are recommended to convey dry weather flow.

While the model results suggest isolated capacity restrictions in some parts of the system for both baseline and future wet weather flow scenarios, these results are not considered actionable because they are not based on system-specific wet weather flow monitoring results. Additionally, data provided by the District and conversations with District staff do not indicate wet weather capacity issues in the system at this time. It is therefore recommended that the District consider the wet weather scenario results to highlight areas likely to be the first to experience capacity restrictions during large storm events and prioritize these in regular inspection and maintenance programs rather than initiate any capital improvement projects based on the results. The District could elect to perform wet weather flow monitoring if there are future indications of wet weather capacity restrictions such as backups, surcharging, or overflows or as part of a subsequent master plan update.

While capacity-related capital improvement projects are not recommended based on the modeling results, it is recommended that the District implement a recurring 5-year Closed-Circuit Television (CCTV) sewer inspection program as identified described in Section 17. The program objective would be to complete inspection of approximately 20% of the sewer pipelines per year such that all sewers are inspected approximately every five (5) years. Hazen has provided recommendations for sewer segments to be prioritized based on the District's known maintenance "hot spots" as well as locations where model results indicate sewers are flowing more than 50% full during dry weather. CCTV inspection of the sewer system is the first line of defense in the early identification of existing or potential problem areas that could otherwise lead to reduced level of service or failures. The CCTV inspection program data can be used to inform asset management, rehabilitation and replacement activities, and (combined with capacity-related information) inform the CIP on an ongoing basis.



0.00 0.13 0.25
Miles

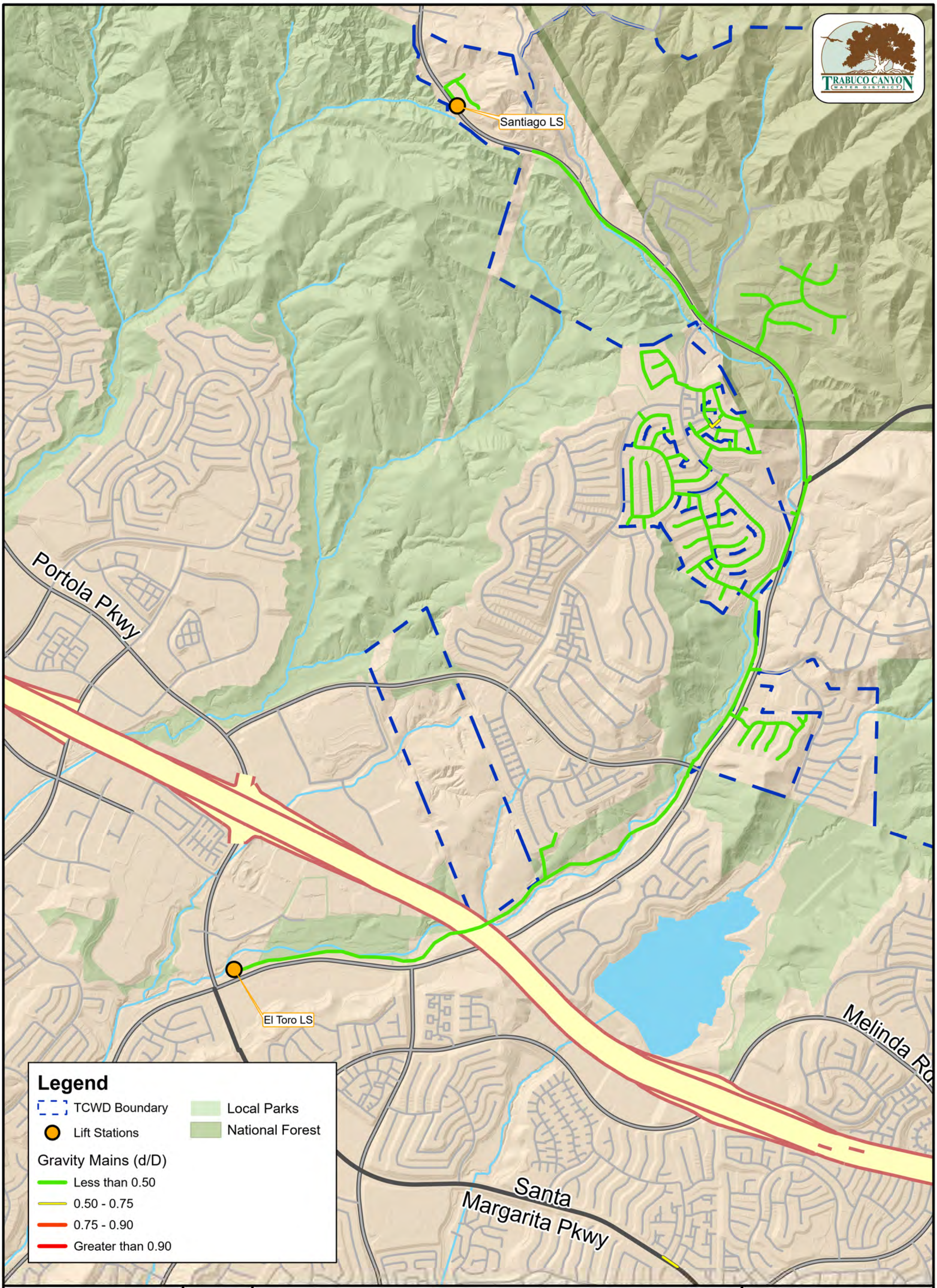
N

Existing Sewer System Facilities and Flow Monitoring Basins for Dove Canyon and Robinson Ranch Under Dry Weather Flow

Exhibit 14-1

Hazen

Trabuco Canyon Water District
Master Plan



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Miles

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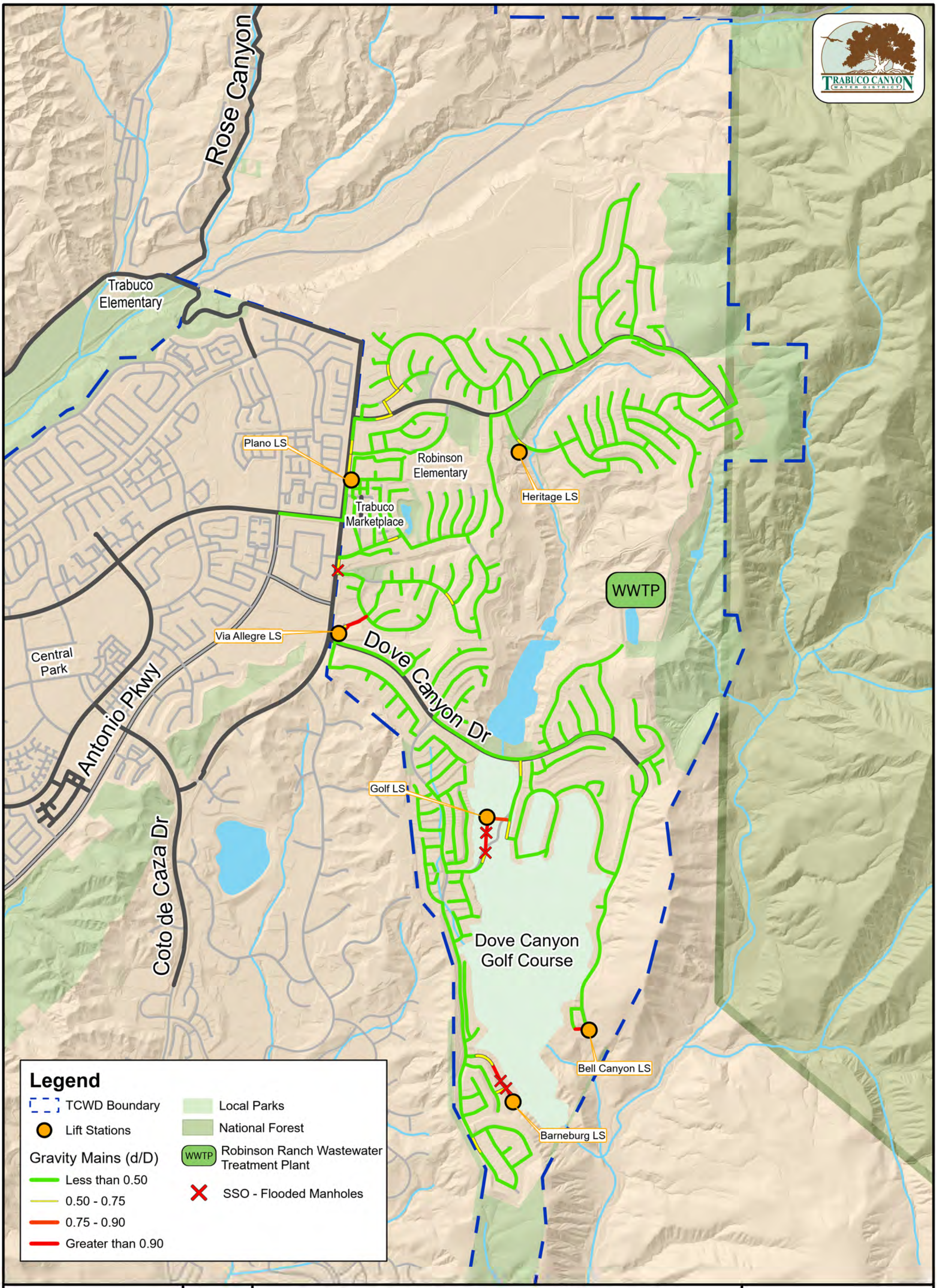
Existing Sewer System Facilities and Flow Monitoring Basins for El Toro Under Dry Weather Flow

Exhibit 14-2

Hazen

Trabuco Canyon Water District
Master Plan



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Miles

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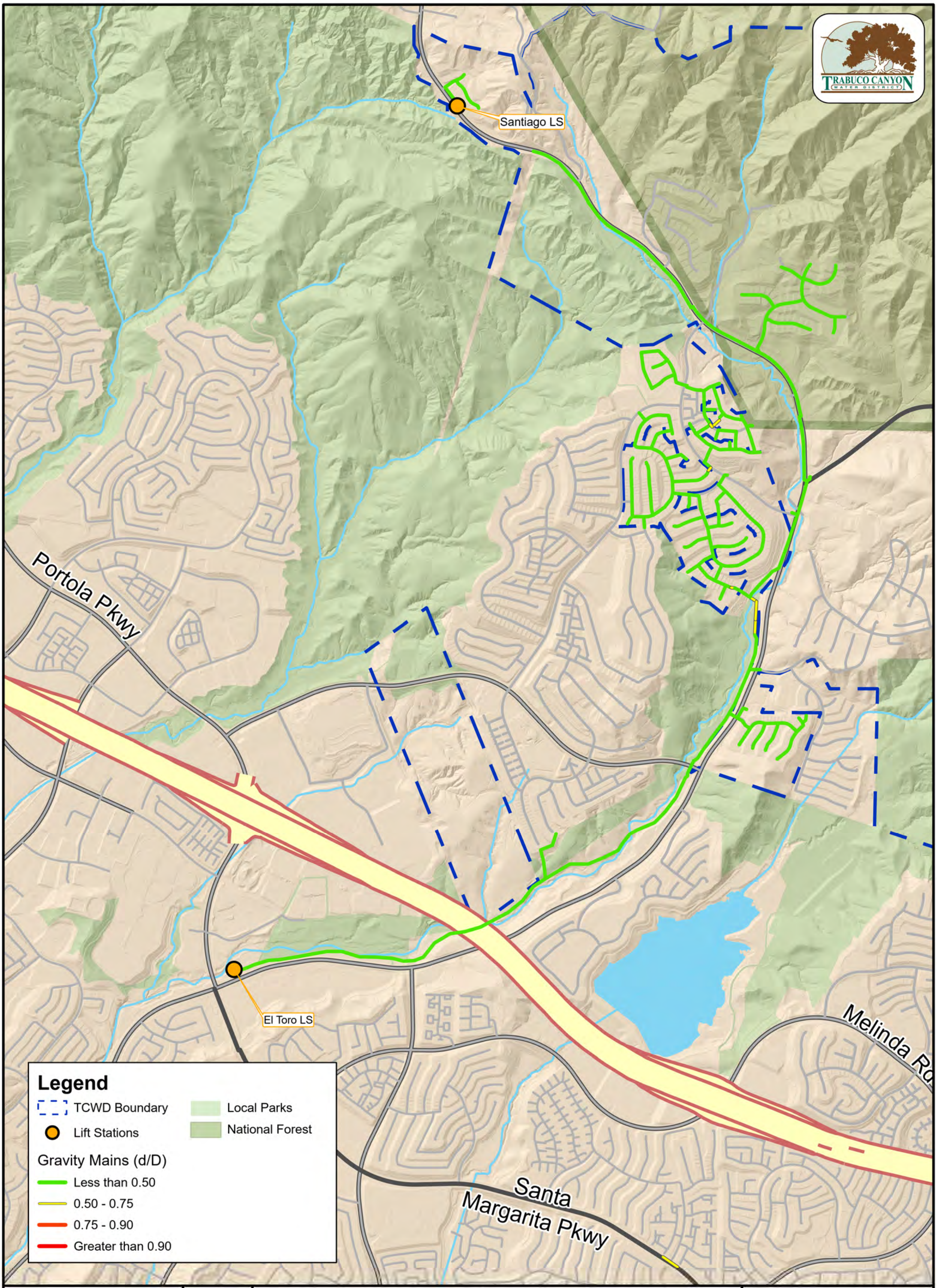
Existing Sewer System Facilities and Flow Monitoring Basins for Dove Canyon and Robinson Ranch Under Wet Weather Flow

Exhibit 14-3

Hazen

Trabuco Canyon Water District
Master Plan



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Miles

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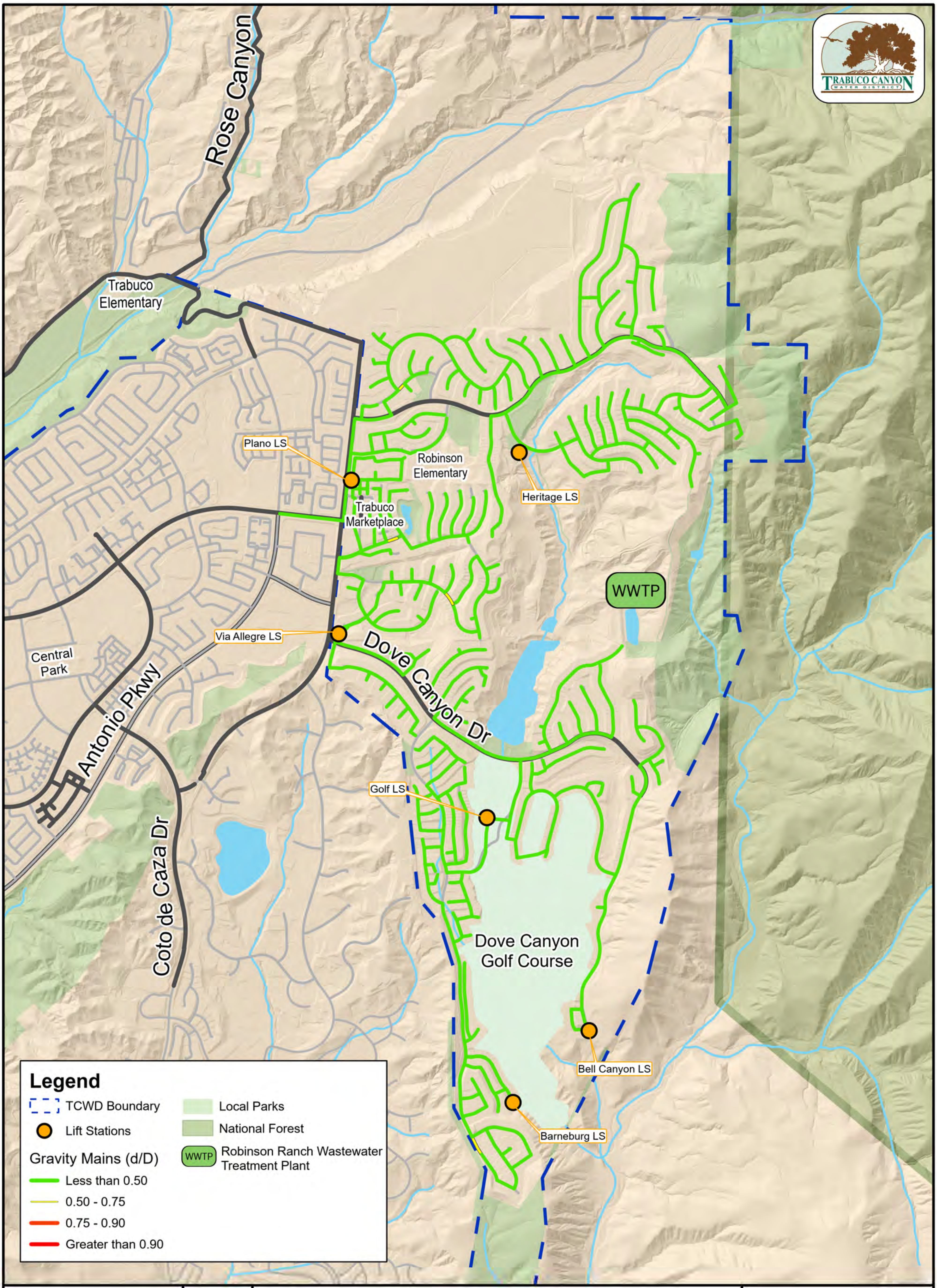
Existing Sewer System Facilities and Flow Monitoring Basins for El Toro Under Wet Weather Flow

Exhibit 14-4

Trabuco Canyon Water District
Master Plan



0.00 0.13 0.25
Miles

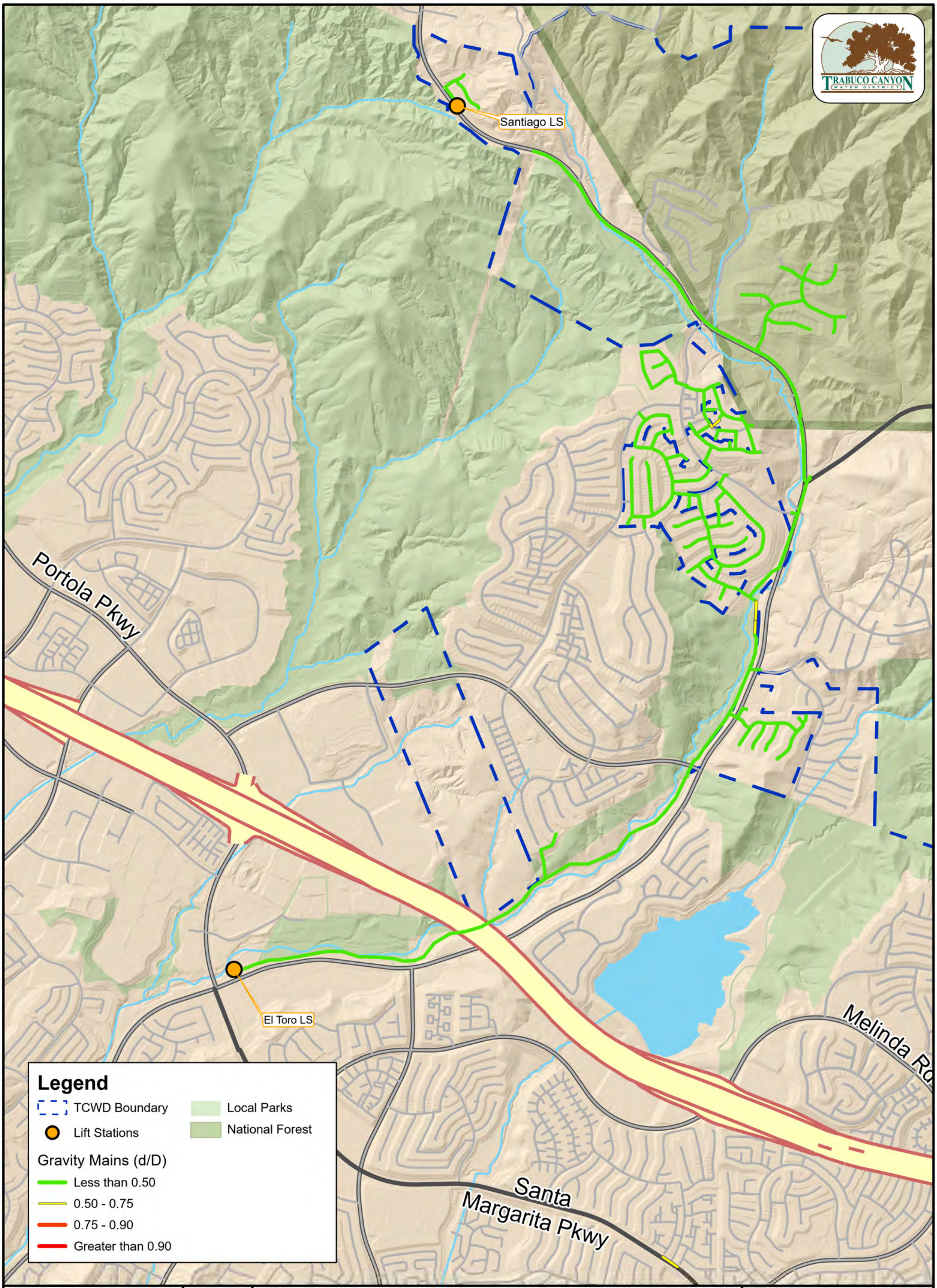
N

Future 2045 Sewer System Facilities and Flow Monitoring Basins for Dove Canyon and Robinson Ranch Under Dry Weather Flow

Exhibit 14-5

Hazen

Trabuco Canyon Water District
Master Plan



0.00 0.13 0.25
Miles

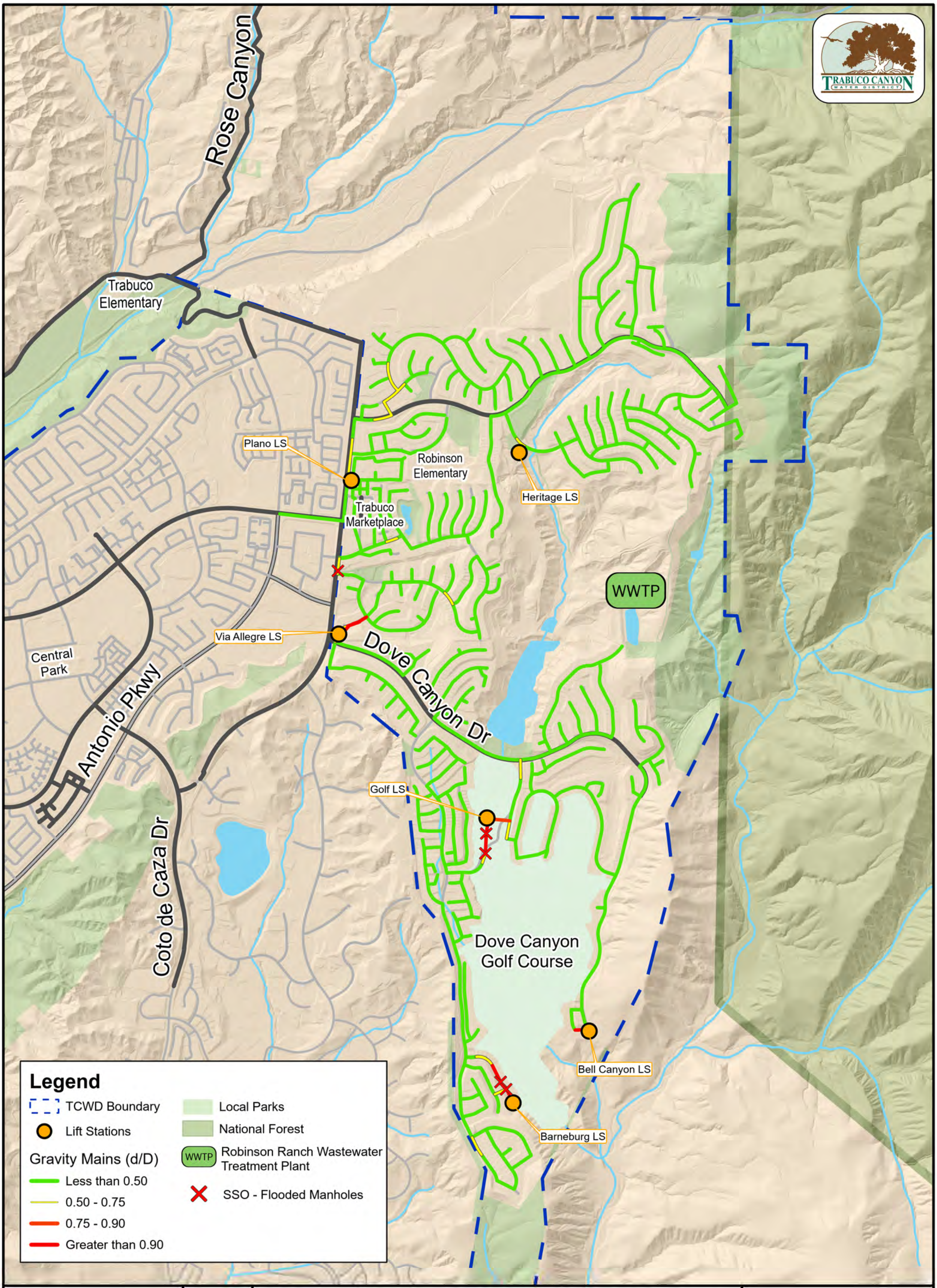
N

Future 2045 Sewer System Facilities and Flow Monitoring Basins for El Toro Under Dry Weather Flow

Exhibit 14-6

Hazen

Trabuco Canyon Water District
Master Plan



0.00 0.13 0.25
Miles

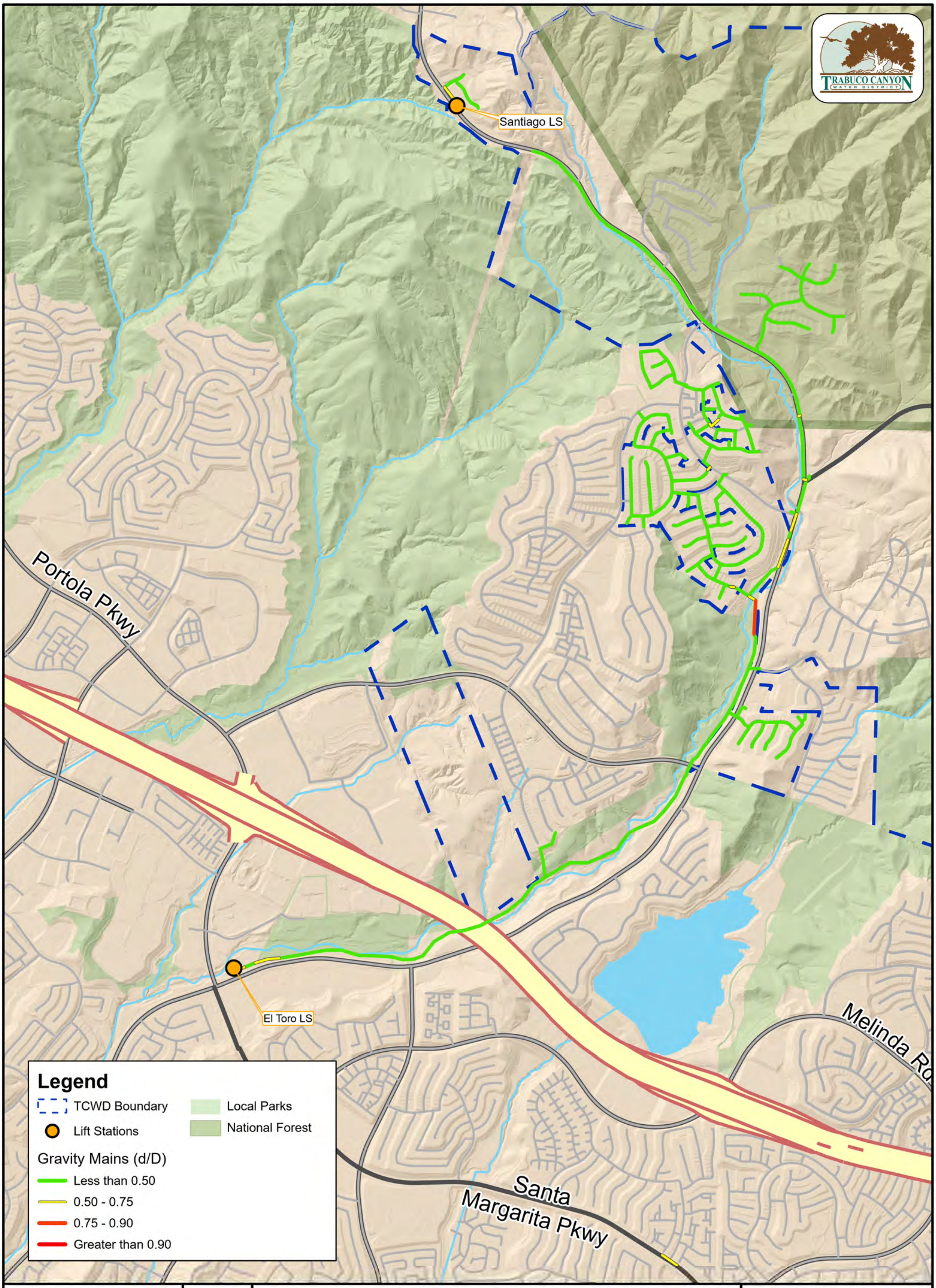
N

Future 2045 Sewer System Facilities and Flow Monitoring Basins for Dove Canyon and Robinson Ranch Under Wet Weather Flow

Exhibit 14-7

Hazen

Trabuco Canyon Water District
Master Plan



Legend

- TCWD Boundary
- ● Lift Stations
- Local Parks
- National Forest

Gravity Mains (d/D)

- Less than 0.50
- 0.50 - 0.75
- 0.75 - 0.90
- Greater than 0.90

0.00 0.13 0.25 Miles

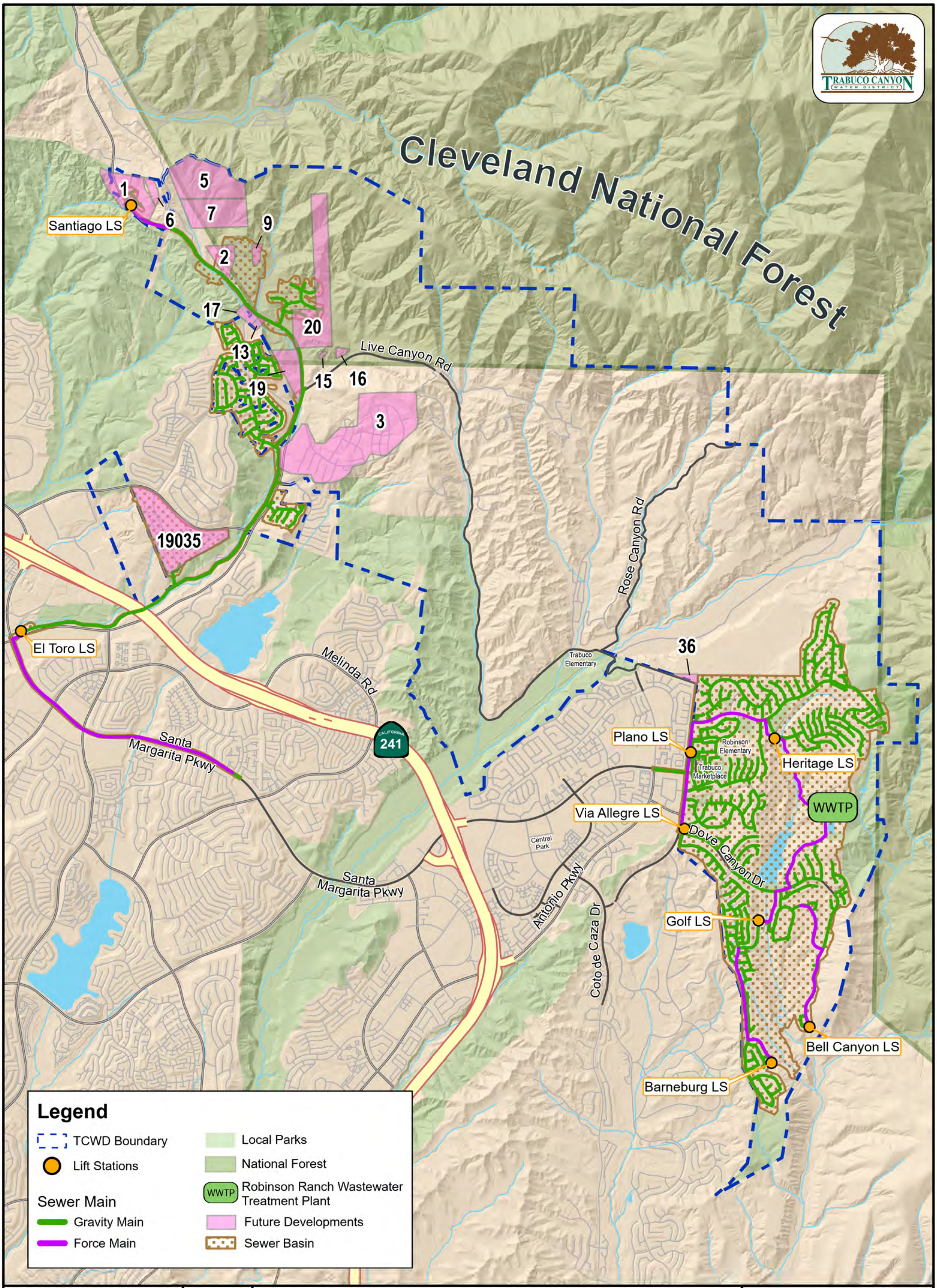
N

Future 2045 Sewer System Facilities and Flow Monitoring Basins for El Toro Under Wet Weather Flow

Exhibit 14-8

Hazen

Trabuco Canyon Water District
Master Plan



0.00 0.38 0.75 Miles

N

Existing Sewer System Facilities and Future Developments with Sewer Demands

Exhibit 14-9

Hazen

Trabuco Canyon Water District
Master Plan