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INTRODUCTION

BACKGROUND AND PURPOSE OF STUDY

The most recent Collection System Master Plan (CSMP) for Valley Sanitary District (VSD) was prepared in 2013 by MWH, now part of Stantec. Since 2013, economic factors have led to less growth than anticipated in the 2013 CSMP, and effective conservation measures have also contributed to lower than anticipated increase in sewerage flow. This Technical Memorandum (TM) presents the Collection System Master Plan Review (CSMP Review) completed by Stantec. This CSMP Review was initiated to refine earlier population projections, update the model with current observed flows from the Water Reclamation Facility (WRF) and recently added infrastructure improvements, and verify project recommendations from the CSMP. The CSMP Review is not intended to serve as a full update to the 2013 CSMP but is intended to help guide VSD in the implementation of the remaining CIP recommendations. Tasks not included in the CSMP Review include flow monitoring or recalibration of the model.

The purpose of this CSMP Review is to review and revise the sewer system capital improvements projections from the 2013 CSMP. The main objectives of the CSMP Review include:

- 1) Updating the Bentley SewerGEMS model with current infrastructure and sewage generation;
- 2) Identifying Areas of Concern for the existing, planning and build-out planning horizons
- 3) Reviewing the recommendations from the 2013 master plan;
- 4) Revising the capital improvement program based on new model results.

DATA SOURCES

In preparation of this CSMP review, VSD staff provided several reports, maps, electronic files, and other sources of information. Pertinent material included historical flows for the WRF, as built drawings of recently upgraded infrastructure, and updated GIS files for the sewer collection system. In addition, multiple telephone meetings with VSD staff were conducted throughout the project to obtain a thorough understanding of changes that have occurred in the District since 2013.

ACKNOWLEDGEMENTS

Stantec would like to acknowledge and thank all VSD staff for their time and support in completing this project. Special thanks to Joseph Glowitz (General Manager), Ron Buchwald (District Engineer), Steve Shepard, Tito Moreno, and Adrian Contreras.

PROJECT STAFF

The following Stantec staff was principally involved in the preparation of CSMP Review:

Project Manager:	Oliver Slosser
Project Engineer:	Muralikrishna Chelupati
Project Engineer:	Areeba Syed
Technical Review:	Carl Chan

OVERVIEW OF 2013 COLLECTION SYSTEM MASTER PLAN

VSD primarily serves the city of Indio, California. The city of Indio encompasses 96 percent of VSD's service area, while the remaining 4 percent consists of portions of City of La Quinta, City of Coachella, and unincorporated area in Riverside County.

VSD maintains and operates approximately 254 miles of sanitary sewer line and in 2017 delivered approximately 5.6 million gallons per day (MGD) of wastewater to its water reclamation facility (WRF), located at Van Buren Street and Enterprise Way. The WRF is rated for a capacity of 12.5 MGD, but economic and environmental conditions have led to a decrease in average flow since 2013. Pipes in VSD's collection system range from 4 to 54 inches, with 8-inch pipes or smaller comprising 75% of the gravity sewer system. The collection system contains approximately 649 feet of force main ranging from 4 inches to 8 inches in diameter. The collection system also has eight inverted siphons, most of which are single barrel pipes. There are four lift stations within VSD's collection system that are currently operational.

The model developed as part of the CSMP contained approximately 4,800 manholes and 5,000 pipe segments. The database included all collection system pipelines 10-inches in diameter and greater. Additional pipes with diameters smaller than 10-inches were added to capture flow from a network of small pipes.

After developing and allocating current and future wastewater flows, calibrating the model, and evaluating the sewer system capacity, a list of recommended improvements were developed for the 2013 CSMP. The outstanding recommended improvements were evaluated in this CSMP Review to determine if these improvements are still required.

MODEL UPDATE AND VERIFICATION

The first task in the CSMP Review consisted of data collection. Information obtained from VSD was used to review, update, and verify the model. This subsection discusses these tasks in greater detail.

DATA COLLECTION

Table 1 presents the information requested as part of the data collection process. The information requested was used for specific tasks as listed in the table.

Table 1 – Data Collection

Item	Category	Description	Use
1	SCADA	Daily Pump Performance Data for Barrymore/Calhoun/Carver/Vandenberg PS	Model Calibration
2	Demand Projection	City of Indio General Plan	Flow Projection
3	Information	VSD WRF No Discharge Technical Report	
4	Model	SewerGEMS Model: 20130818VSDModel_Final	Model Update
5	GIS	Manholes/Pipes/Pump Stations/Septic Tanks	Model Update
6	Demand Projection	Flow Data for WRF (January 2014 through July 2018)	Flow Projection
7	Demand Projection	Permit Log	Flow Projection
8	Record Drawings	Requa Interceptor	Model Update
9	Record Drawings	Lift Station Controls	Model Update

MODEL REVIEW

VSD's Bentley SewerGEMS model was reviewed and compared to the GIS provided by VSD on August 20, 2018. Conduit parameters that were reviewed include conduit IDs (labels), upstream inverts, downstream inverts, diameters, and slope. Negatively sloped conduits, manhole rim elevations, and depths were also reviewed and compared to the GIS. Lift stations were compared to the new information provided by VSD.

Table 2 shows a summary of data conflicts found during the model review.

Table 2 – Summary of Data Conflicts

Description	Count
Conduits in the model	5,024
Conduits in the model but not in GIS	227
Conduits with difference in upstream invert between model and GIS is less than 1 inch	14
Conduits with difference in upstream invert between model and GIS is between 1 inch and 6 inches	49
Conduits with difference in upstream invert between model and GIS is greater than 6 inch	122
Conduits with difference in downstream invert between model and GIS is less than 1 inch	79
Conduits with difference in downstream invert between model and GIS is between 1 inch and 6 inches	142
Conduits with difference in downstream invert between model and GIS is greater than 6 inch	151
Conduits with difference in diameter between model and GIS	8

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Conduits with difference in lengths between model and GIS is greater than 1 ft	1,008
Manholes containing no depth information	1,032
Manholes containing no rim elevations	760

Figure 1 through **Figure 3** graphically depict the results of the conduit parameter comparison. **Figure 1** shows a comparison of the pipe IDs in VSD's GIS system versus the model, while **Figure 2** and **Figure 3** compare the upstream and downstream invert elevations, respectively. **Figure 4** shows an overview of the conduits identified having negative slopes. Data conflicts were resolved through discussion with VSD staff and review of as-built drawings and is further detailed in the Model Update section.

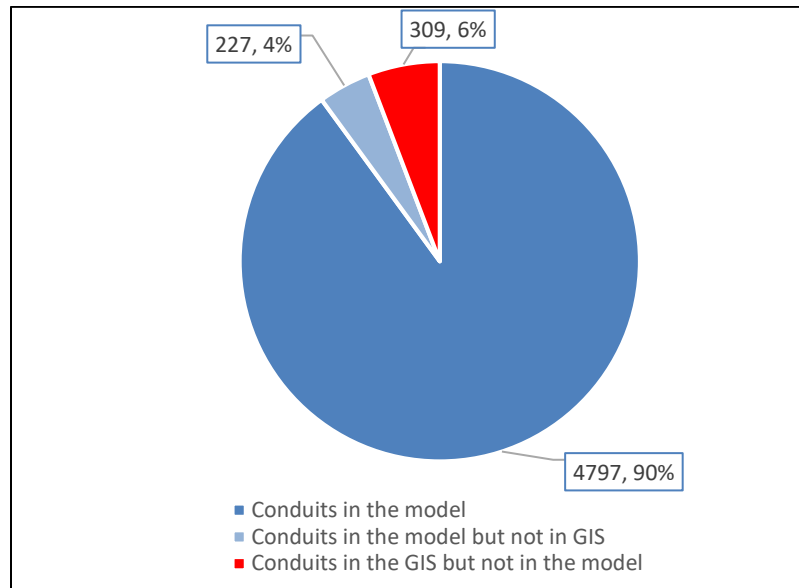


Figure 1 – Conduit Comparison for Diameters 8 inches or Larger

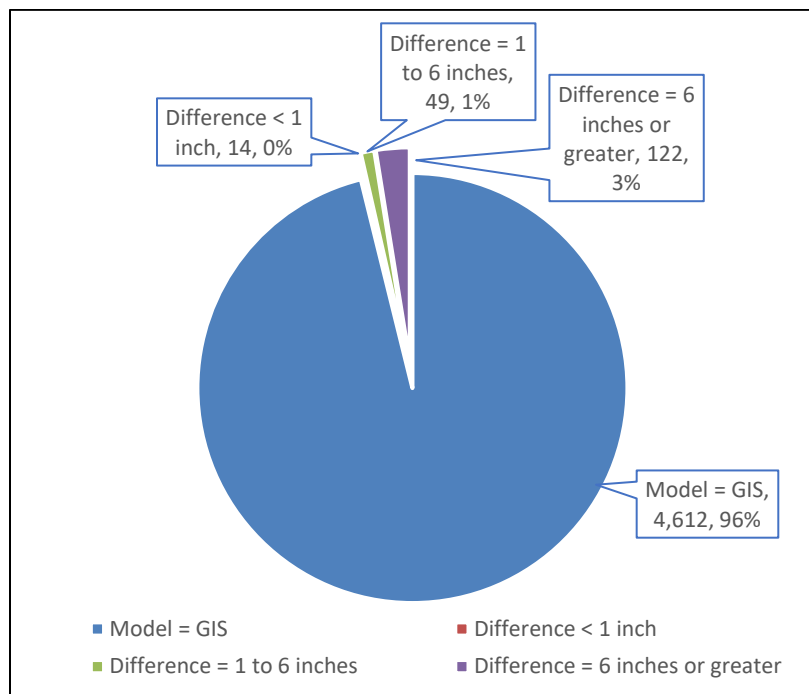


Figure 2 – Upstream Invert Comparison

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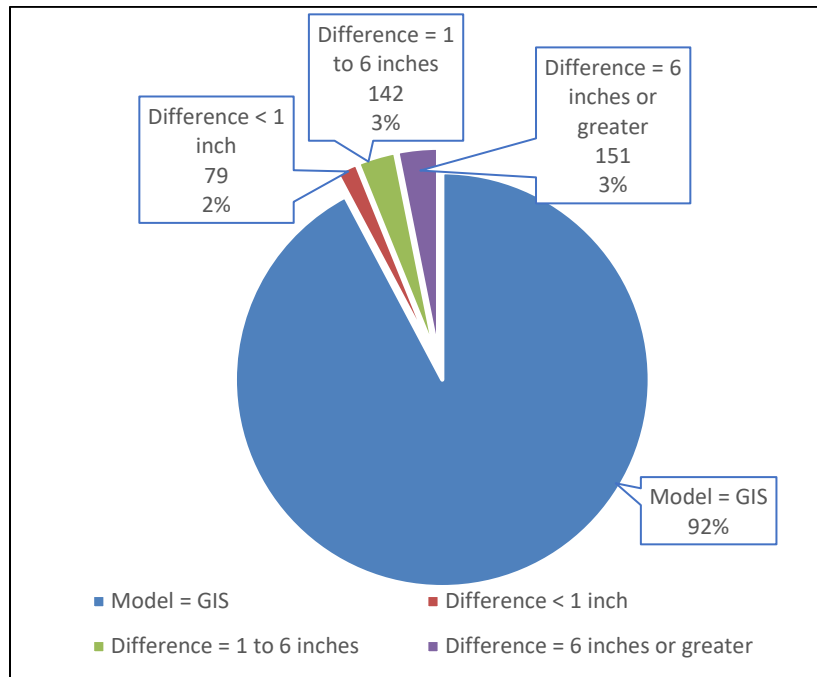


Figure 3 – Downstream Invert Comparison

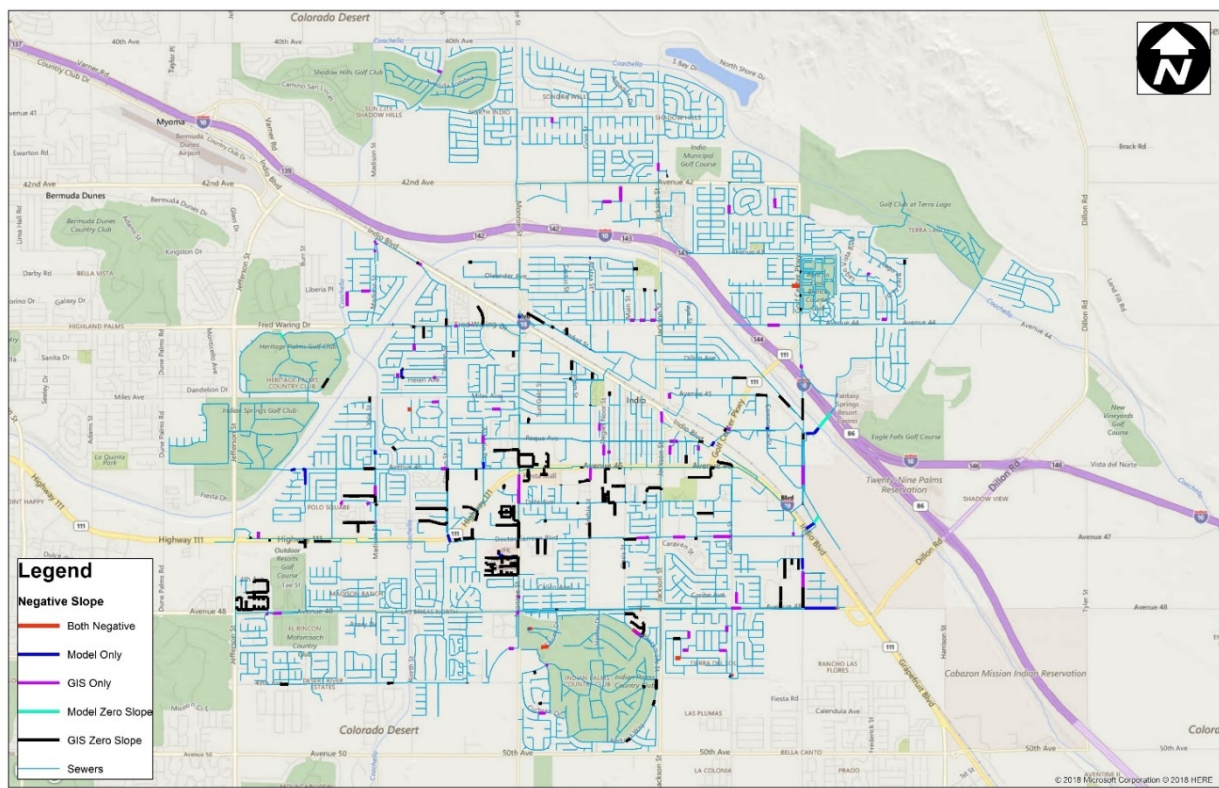


Figure 4 – Negative Slopes

Lift Station Review

VSD lift stations were reviewed with VSD staff to determine if any changes to lift station operation, control, or infrastructure had occurred since the 2013 CSMP. VSD staff informed Stantec that the Shields lift station had been removed from service since the 2013 CSMP, and as such the model was updated with that change. VSD further communicated that no other changes to the lift stations had been made since the previous CSMP. **Table 3** and **Table 4** present the wet well and pump characteristic used for the active lift stations in the VSD system (Barrymore, Calhoun, and Carver lift stations) for this model review.

Table 3 - VSD Wet Well Characteristics

Model ID	Description	Invert Elevation (ft.)	Maximum Depth ¹ (ft.)	Wet Well Area (sq. ft.)
BarrymoreWW	VSD Wet Well at Barrymore Lift Station	456.56	16.50	28.3
CalhounWW	VSD Wet Well at Calhoun Lift Station	435.75	34.65	113.1
CarverWW	VSD Wet Well at Carver Lift Station	447.60	7.30	38.5
Vandenberg LS	VSD Wet Well at Vandenberg Lift Station	484.75	15.25	28.3

Table 4 - VSD Pump Station Characteristics

Model ID	Description	Year of Pump Curve	Model Pump ID Curve	Startup Depth (ft.)	Shutoff Depth (ft.)
BarrymorePMP-1	Lead Pump for Barrymore Lift Station	Not provided (Pump Installed 1967)	Barrymore Curve	461.56	459.56
BarrymorePMP-2	Lag Pump for Barrymore Lift Station	Not provided (Pump Installed 1967)	Barrymore Curve	461.56	459.56
CalhounPMP-1	Lead Pump for Calhoun Lift Station	2005	Calhoun Curve	445.75	443.75
CalhounPMP-2	Lag Pump for Calhoun Lift Station	2005	Calhoun Curve	445.75	443.75
CarverPMP-1	Lead Pump for Carver Lift Station	Not provided (Pump Installed 1979)	Carver Curve	451.6	449.1
CarverPMP-2	Lag Pump for Carver Lift Station	Not provided (Pump Installed 1979)	Carver Curve	451.6	449.1
VandPMP-1	Lead Pump for Vandenberg Lift Station	Not provided	Vandenberg curve	488.75	486.75

Model ID	Description	Year of Pump Curve	Model Pump ID Curve	Startup Depth (ft.)	Shutoff Depth (ft.)
VandPMP-2	Lag Pump for Vandenberg Lift Station	Not provided	Vandenberg curve	488.75	486.75

MODEL UPDATE

The model was updated based on recent GIS data and new improvements to VSD's system since the 2013 CSMP. Conduits that were built on or after January 1, 2013 were added to the hydraulic model using GIS. The Requa Interceptor, an improvement identified in the 2013 CSMP, was one of the major improvements that has been implemented by VSD since the previous CSMP. The Requa Interceptor was updated using November 2017 as-built drawings provided by VSD. Lift station controls were updated using operational information provided by VSD. During the model review, negative sloped pipes were identified and were updated using the following methodology:

- If GIS had a positive slope, then model inverts were updated to GIS.
- If GIS had no inverts for a pipe, the model inverts were interpolated using upstream conduits to maintain positive slope.
- If GIS inverts were causing negative slopes upstream or downstream, inverts were interpolated to maintain positive slope.
- As-builts were referenced for any pipe showing a negative slope, where available, and information was confirmed with VSD.

A list of conduits with negative or flat slopes were sent to VSD for verification and are included as Appendix A to this TM. Per VSD's inputs, inverts were interpolated for 42 of the 76 conduits identified to maintain a positive slope. Some of the negative sloped pipes were private laterals and were removed from the model. The remaining negative slope pipes remain unchanged as either there was insufficient data for invert interpolation or the negative slopes were confirmed (often these negative slopes occurred near lift stations).

One of the major improvements included in the model as part of the CSMP Review was construction of the Requa Interceptor. The Requa Interceptor consists of approximately 20,900 feet of pipe ranging from 18-inch to 30-inch in diameter. The plan and profile of the Requa Interceptor between Madison Street and the WRF, as included within the model, are shown in **Figure 5** and **Figure 6** and are based on the as-built drawings provided by VSD on August 27, 2018.

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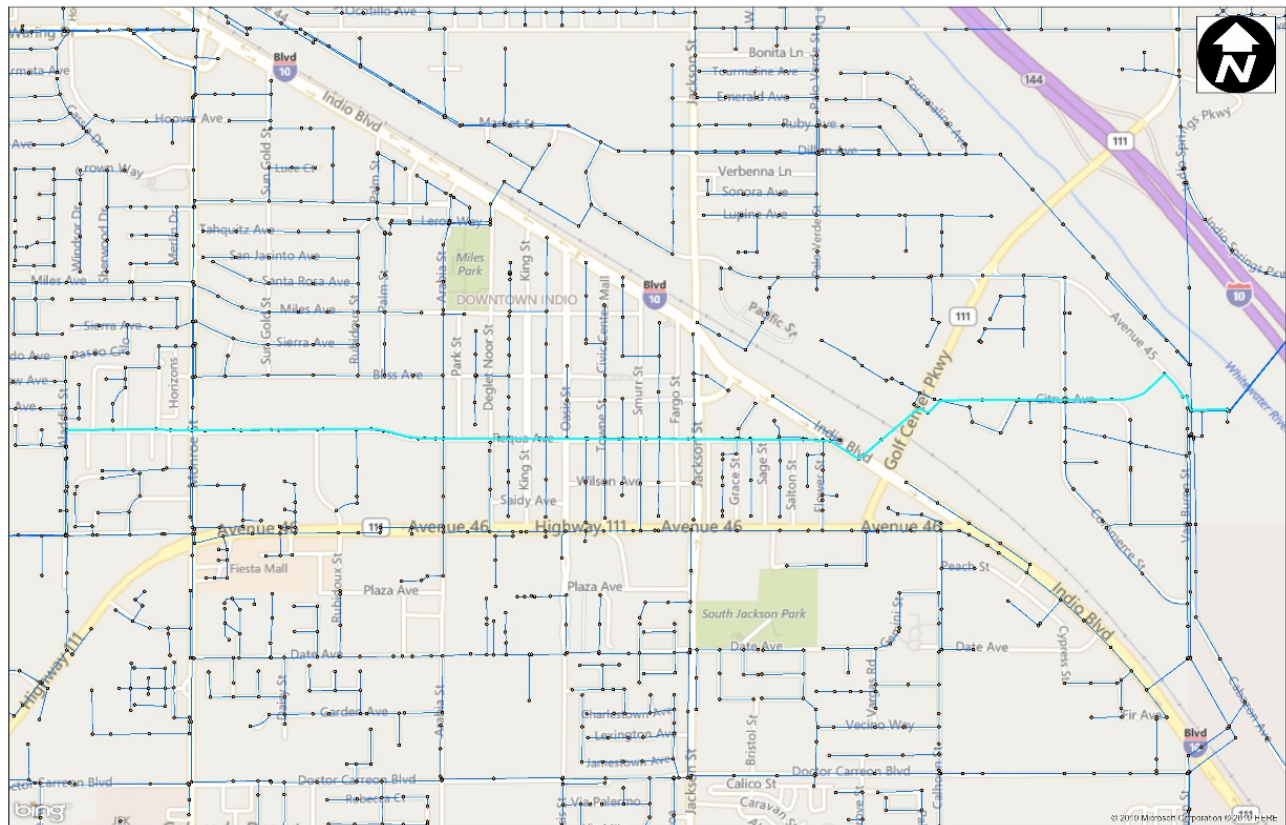


Figure 5 – Plan of Requa Interceptor between Jackson St and WRF per Model Update

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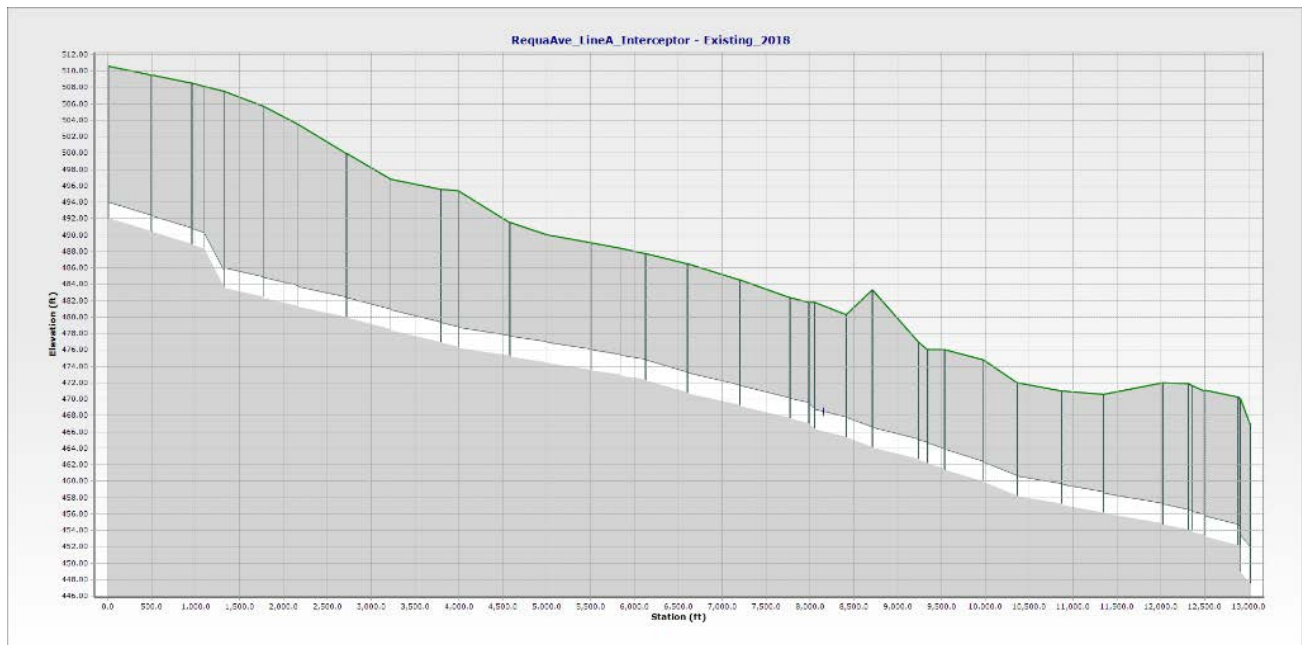


Figure 6 – Profile of Requa Interceptor between Jackson St and WRF per Model Update

The following discrepancies were identified during model update:

- Some model conduits were inactive, but GIS showed them as active.
- Record drawings conduit size did not match with GIS
- Record drawing inter-connections not shown in GIS.
- Record drawing lengths not matching in GIS.
- GIS missing inverts at few key inter-connections.

Discrepancies between GIS and record drawings were discussed with VSD staff to determine the most reliable source of data. These issues were identified and resolved prior to model run. The identified issues were sent to VSD on September 28, 2018. VSD maintains the GIS layer and have since updated any identified data errors. It is recommended that the GIS be regularly updated in conjunction with any changes in the system, or discrepancies with the record drawings that are identified.

SEWER DEMAND UPDATE

The CSMP Review included an update to sewer flow allocation to reflect existing conditions. Sewage flow coefficients in the model were reviewed as were the total baseflows from the 2013 CSMP (8.0 MGD). Plant inflows were analyzed to identify maximum daily flow not influenced by rainfall. The period from November 25th, 2017 to December 1st, 2017 was identified as representative of typical maximum daily flow through analysis of the data and conversations with VSD staff. This period is shown on **Figure 7**. While higher quantities of daily flow occurred in April and May of 2018, that period was not representative of typical daily flows. The average daily flow from November 25th to December 1st, 2017 is 5.7 MGD and was used to

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represent existing conditions in the updated model. Baseflows from the previous model were scaled globally in order to achieve a total system flow of 5.7 MGD. It is noted that this scaling assumes homogenous changes in conservation from 2013 and 2017, and is a generalization used to analyze the system. It is recommended that prior to the next model update and master plan that VSD conduct flow monitoring in order to verify where flows have changed in the system and more accurately represent existing conditions.

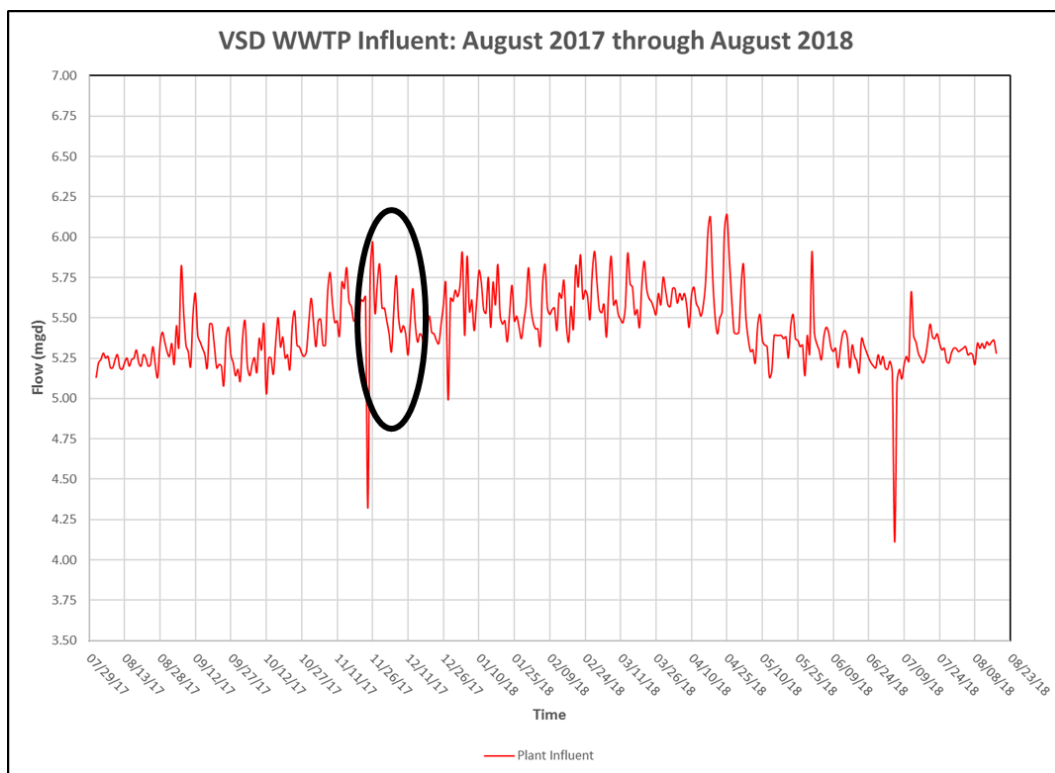


Figure 7 – Typical Maximum Daily Flow Not Influenced by Rainfall

FUTURE SEWER DEMAND PROJECTIONS AND MODEL SCENARIOS

The CSMP Review also included an update to sewer projections for the interim (2035) and build-out scenarios. VSD provided updated zoning for the City of Indio, a shapefile of septic parcels, and a list of known developments among other data sources. These data sources were reviewed for reference against the original loadings built into the 2013 model. The information provided confirmed similar future conditions as were analyzed in the previous master plan. Based on this updated information and analysis, as well as conversations with VSD staff, the build-out scenario was defined to be equal to that calculated in the 2013 CSMP, 19.9 MGD. This level of flow would represent a 355% increase from current conditions. This upper limit is based on the potential for the VSD service area given the available land and planned zoning. As such, recommendations for this planning horizon should be used as a guide for monitoring specific areas in the system. As the service area approaches build-out, the specific areas of growth will determine which of the areas of concern start having capacity deficiencies first.

An interim planning horizon was not defined in the previous CSMP but given the large difference between future and existing flows, it was decided to define an interim scenario in order to plan for near term growth. Given the relatively slow rate of population growth and the effects of conservation, this interim scenario was defined as occurring in 2035. Stantec looked at the population for the service area in 2013 and 2017 in order

to analyze changes in per capita usage since the CSMP. The population for the VSD service area in 2013 was estimated to be 76,063. Updated U.S. Census information estimates the population in 2017 was 89,793. These population projections were applied to the 2013 and 2017 plant flows and used to calculate a per capita usage for 2013 and 2017. The results are shown in **Table 5**.

This analysis shows the per capita usage rate has declined by 41% since the previous CSMP. This high rate of conservation suggests that further conservation and decline in per capita usage will be difficult to achieve, and as such no further conservation was assumed for the interim scenario. The 2017 per capita usage rate was applied to the 2035 population projection established in the 2013 CSMP of 120,767, which yielded a total demand of 5238.7 gpm, or 7.5 MGD. This was applied to the model as the interim planning scenario and represents an increase in the current population of 34% with no change in the current per capita usage. The model scenario was built by taking the build-out demand in the system and scaling it down globally to 7.5 MGD.

It is noted that actual growth in the system will occur in different areas at different rates, and the interim scenario is defined to represent a possible distribution of demand that is based on the future zoning for the service area. It is also noted that the distribution of demand is based on ultimate zoning and not on the calibrated existing demands established in the 2013 CSMP. Therefore, certain areas of the model may show less demand in a pipe in the interim scenario than is represented in the existing scenario. This assumption for the interim scenario allows for analysis of a near term system that is developing in accordance to the future zoning.

Table 6 shows a summary of the dry weather flow allocation for the existing and future scenarios.

Table 5 - Per Capita Usage Comparison for 2013 and 2017

Year	flow (gpm)	Population (from US Census)	Per Capita Usage (gpm/person)	Per Capita Usage (gpd/capita)	Flow based on 2013 per capita (gpm)	Flow Based on 2017 Per Capita (gpm)
2017	3,898	89,793	0.0434	62.5		
2013	5,569	76,036	0.0732	105.4		
2035 Population Projection		120,676			8,838	5,238

Table 6 - Dry Weather Flow Allocation

Scenario	Baseflows (gpm)	Baseflows (MGD)
Existing Conditions (2013 MP)	5,645	8.1
Existing Conditions (2018 CSMP Review)	3,898	5.6
Interim Planning Horizon 2035	5,238	7.5
Ultimate Build Out Conditions (2035)	13,723	19.9

MODEL VERIFICATION

Model calibration was not completed as part of the CSMP Review as flow monitoring data was not available or collected. However, the model simulated flows for the November 25th through December 1st, 2017 period were compared with the available plant influent flow data as a verification. VSD provided seven-minute interval WRF flow data for a diurnal pattern analysis. The model was run with the original CSMP (2013) dry weather flows and compared with the observed WRF flow data within the November 25th to December 1st period. As shown in **Figure 8**, the 2013 CSMP demand projections (shown in blue) were significantly higher than the observed daily flows (shown in red). The CSMP demand projections were adjusted by reducing the flows in the model by 30%. The adjusted demands are shown on **Figure 8** in green and more closely match the observed flow at the end of 2017. The model was further verified by ensuring connectivity, checking for negative or flat slopes, and confirming areas where there were issues not originally identified in the CSMP.

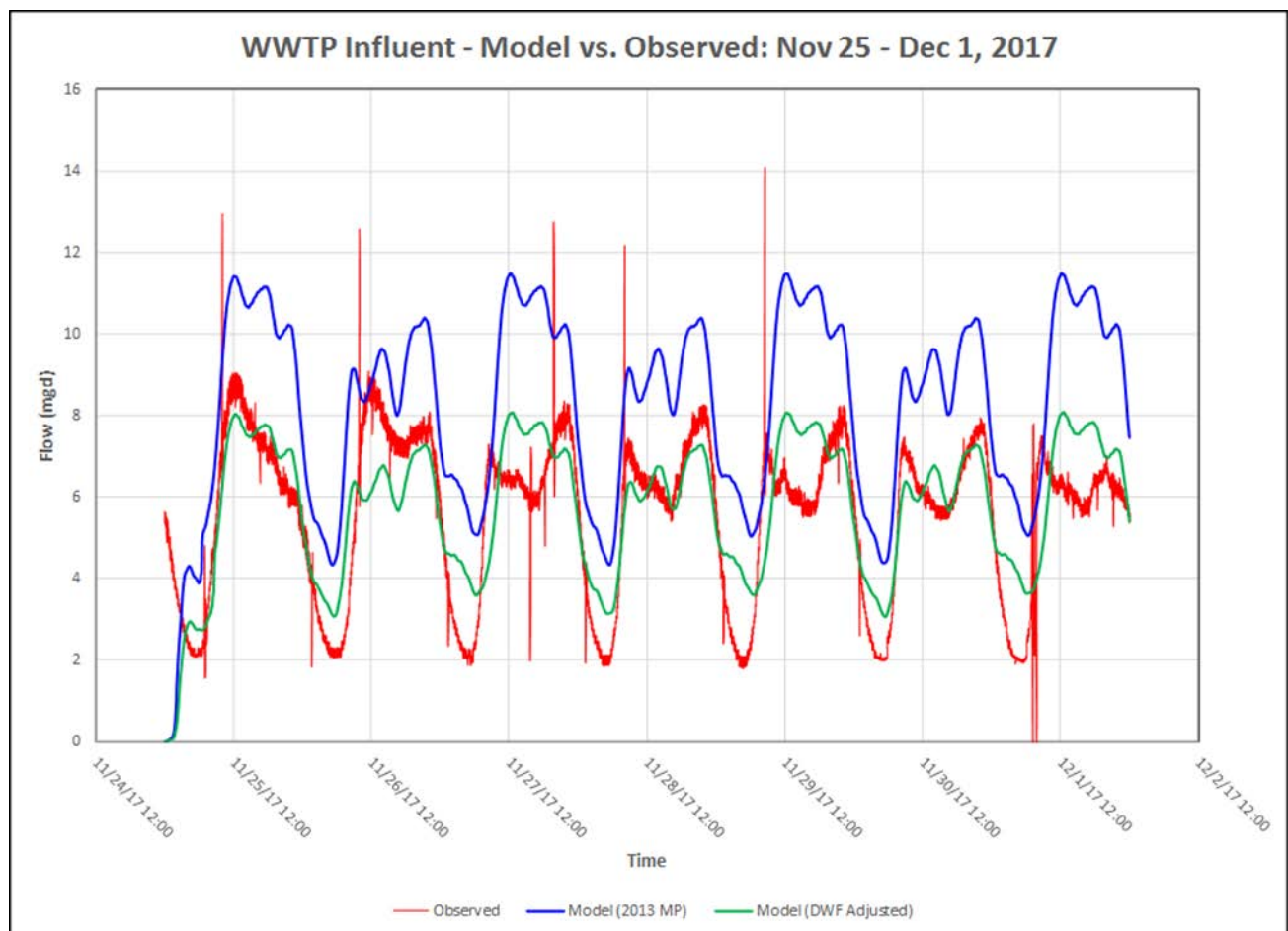


Figure 8 – Demand Projections Comparison

MODEL ANALYSIS

After model verification, the model was used to analyze the following objectives: 1) Identifying Areas of Concern 2) Verifying the requirements of previously identified capital improvement projects (CIPs).

SYSTEM EVALUATION CRITERIA

The system capacity evaluation criteria established during CSMP (2013) was used for the CSMP Review. A more comprehensive discussion of the criteria is shown in the Sewer System Planning and Design Criteria Technical Memorandum (TM) shown in Appendix F of the CSMP. Potential areas of concern were evaluated at existing conditions (2017), interim planning horizon (2035), and build-out conditions.

Per the CSMP, the criteria used to evaluate dry weather flow for all the flow conditions include:

- All modeled pipes in the existing and interim scenario with a d/D ratio (depth of flow in pipe divided by the pipe diameter) greater than the design criteria (d/D ratio of 0.5 or less for pipes smaller than 18 in. in diameter, ratio of 0.75 or less for pipes 18-in. or greater in diameter) are identified as an area of concern.
- All modeled pipes in the build-out scenario with a d/D ratio equal to or greater than 0.9 are identified as an area of concern.

It is important to note that the CSMP Review used a different computational engine compared to CSMP (2013). The original SewerGEMS model from the CSMP (2013) used SewerGEMS Implicit Solver in computations. For the current CSMP Review, the analysis used the SWMM Solver engine, which offers a more conservative estimate of flows in the system. As a result, additional areas of concern were identified in build-out scenario that were not highlighted in the previous CSMP. Using the SWMM Solver engine as a more conservative approach captures any areas where future capacity deficiency may occur and can be monitored as-needed by VSD.

MODEL RESULTS

The model was run for existing (2017), interim (2035), and buildout conditions. Pipes in the model were color coded based on the maximum d/D ratio and categorized according to the evaluation criteria. The results of this analysis are shown on **Figure 9** through **Figure 11**. The results of the capacity analysis are used to identify areas of concern (AOCs) in the subsequent section.

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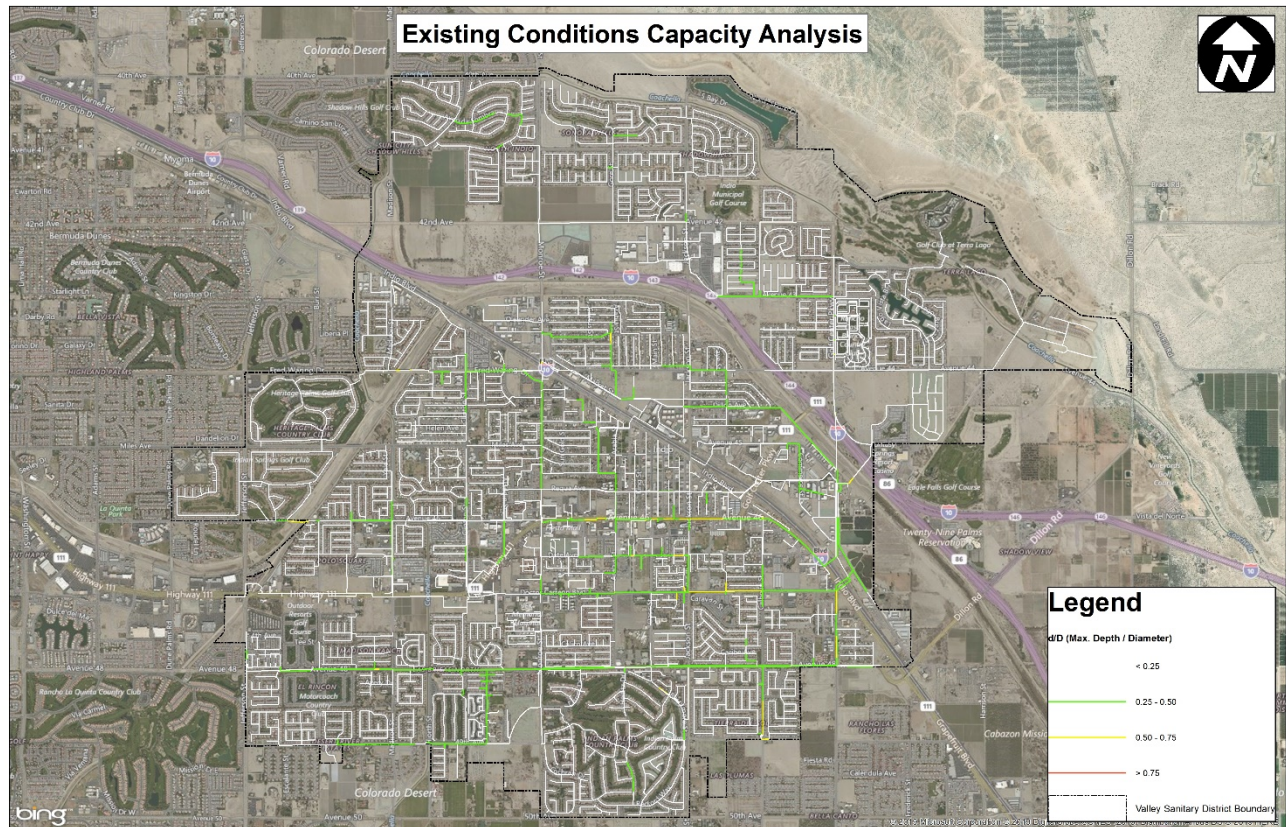


Figure 9: Existing Conditions Capacity Analysis

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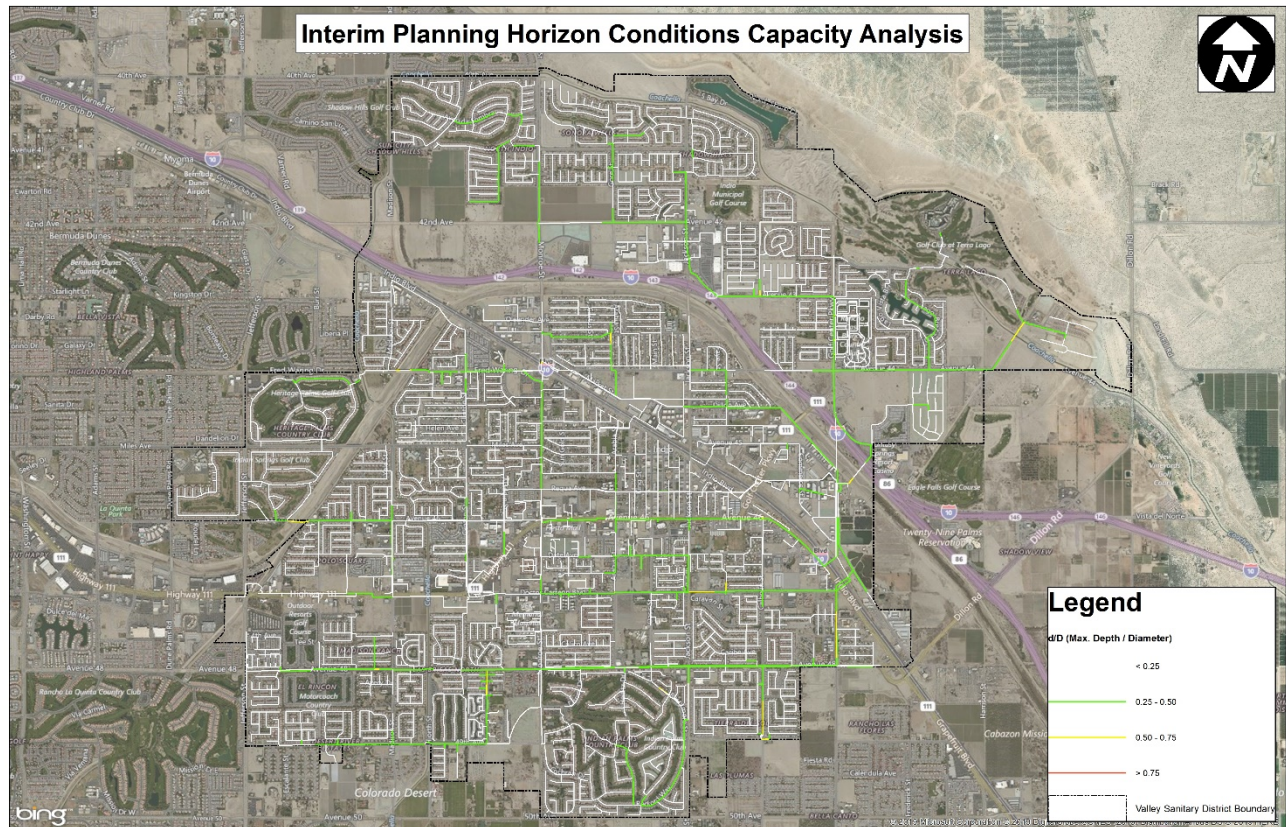


Figure 10: Interim (2035) Conditions Capacity Analysis

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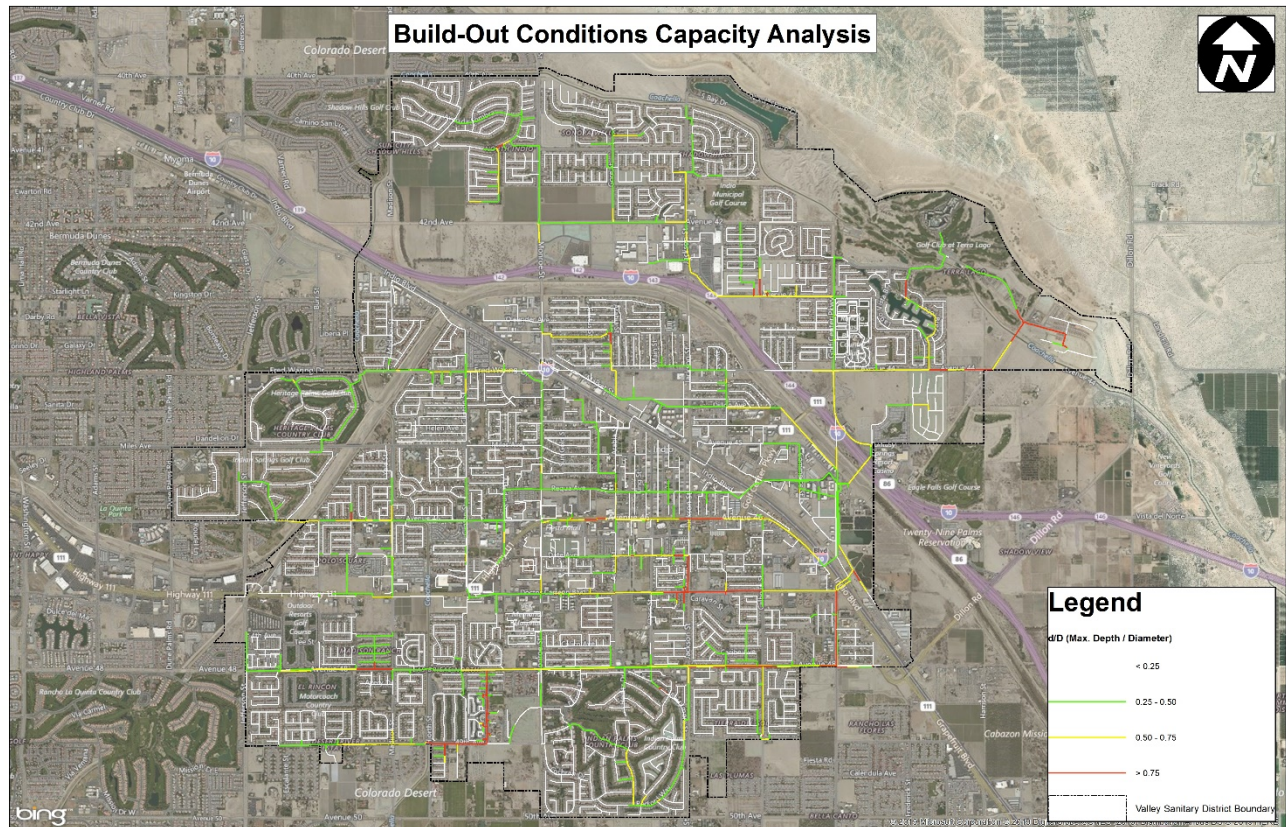


Figure 11: Buildout Conditions Capacity Analysis

AREAS OF CONCERN

AOCs were identified using the model results and sewer system capacity criteria discussed in the previous section. Areas of concern previously identified in the CSMP (2013) are verified by the CSMP Review and have been associated with a capital improvement project. New areas of concern identified in the CSMP Review do not have a capital improvement projects associated and should be monitored by VSD. **Table 7** and **Figure 12** shows a summary of areas of concern by planning horizon i.e. existing conditions (2017), interim planning horizon conditions (2035), build-out conditions.

Table 7 – Areas of Concern (AOCs)

AOC Number	Location	Cross Street
1	Avenue 48	Avenue 48 between Shields Rd and Madison St
2	Dr. Carreon Blvd	Dr. Carreon Blvd between Oasis St and Mangrove St
3	Date Ave	Date Ave between Arabia St and Jackson St
4	Highway 111/Arabia St	Highway 111 between Monroe St and Arabia St
5	Highway 111/Flower St	Highway 111 between Arabia St and Flower St
6	Sola St	Sola St between Oleander Ave and Avenue 44
7	Avenue 49	Avenue 49 between Hjorth St and Desert Grove Dr
8	Desert Grove Dr	Desert Grove Dr between Avenue 49 and Avenue 48
9	Van Buren St	Van Buren St between Avenue 48 and Highway 111
10	Calhoun St	Calhoun St at Avenue 43

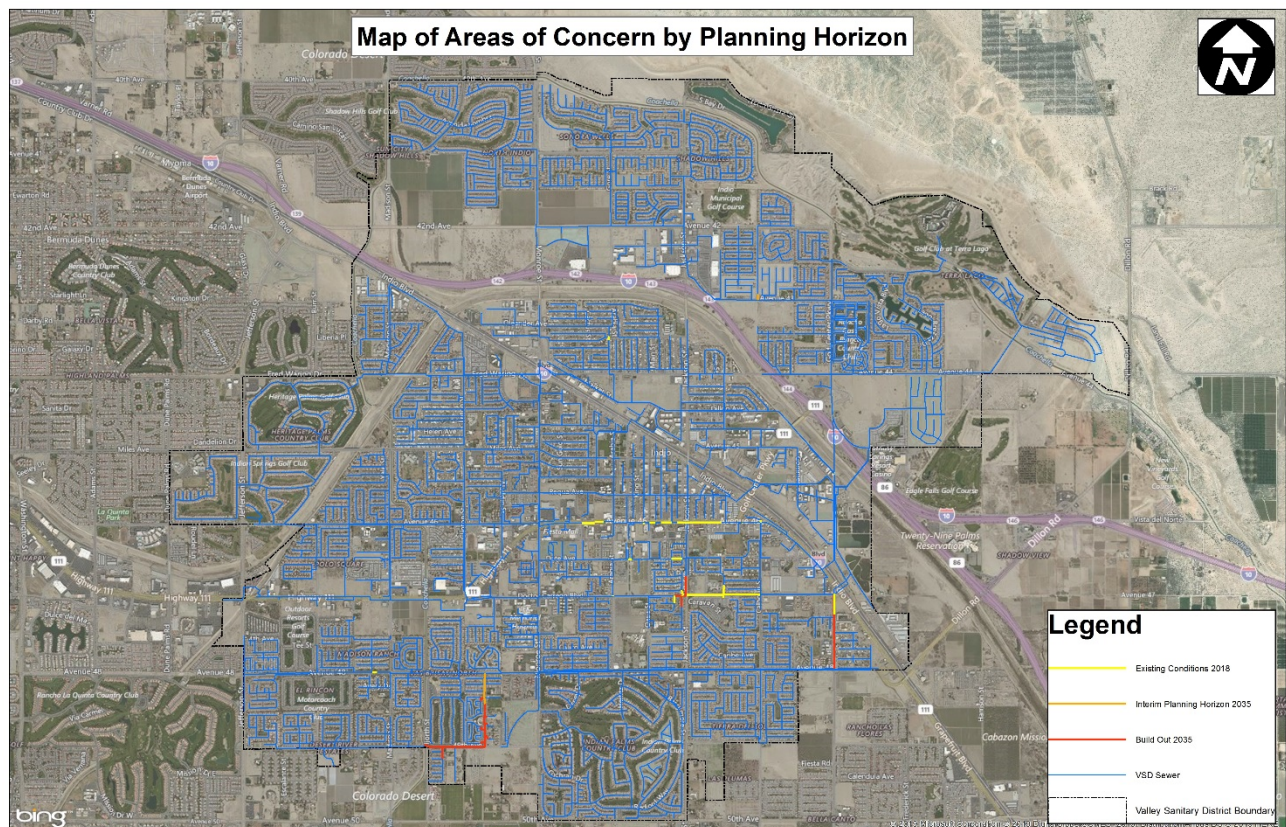


Figure 12 – Areas of Concern by Planning Horizon

The conduits that exceeded the design criteria (d/D) for existing conditions, interim planning horizon and build-out conditions along with CIPs required for each area of concern are discussed below.

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1. **Avenue 48 between Shields Rd and Madison St** – The conduit that exceeded the d/D criteria for existing conditions, interim planning horizon and build-out conditions on Avenue 48 is listed below. The hydraulic profile for this area of concern is shown in **Figure 13** through **Figure 15**, and the model results are shown in **Table 8**. Avenue 48 West Upgrade project is recommended for this area of concern which will provide relief for current and projected capacity issues.

Table 8 - Avenue 48 between Shields Rd and Madison St

Conduit ID	Diameter (inches)	Existing Conditions d/D	Interim Planning Horizon d/D	Build-Out Conditions d/D
12D-M150_12D-M340	10	0.55	0.55	1.00

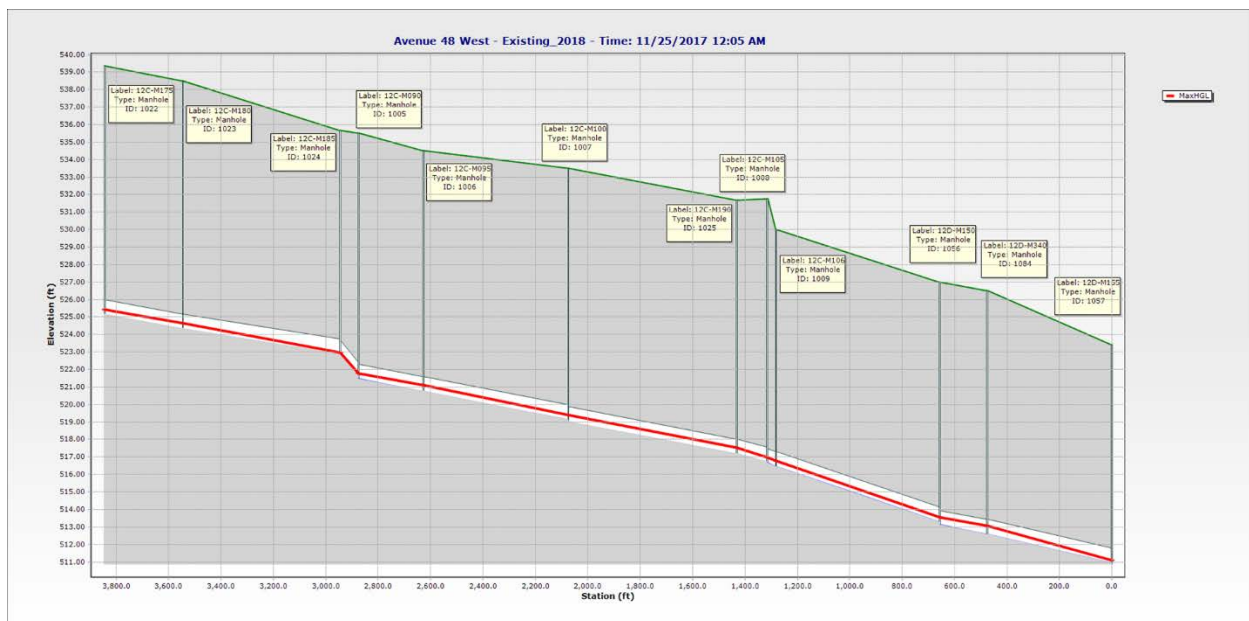


Figure 13 – Avenue 48 under Existing Conditions

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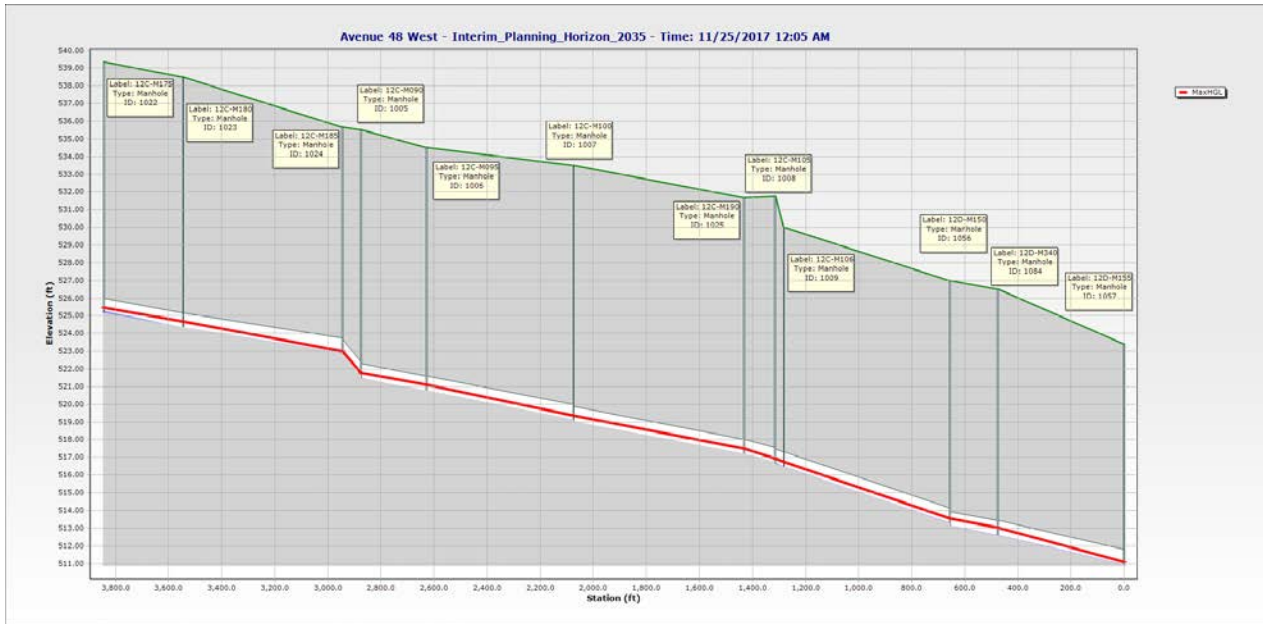


Figure 14 – Avenue 48 under Interim Planning Horizon Conditions

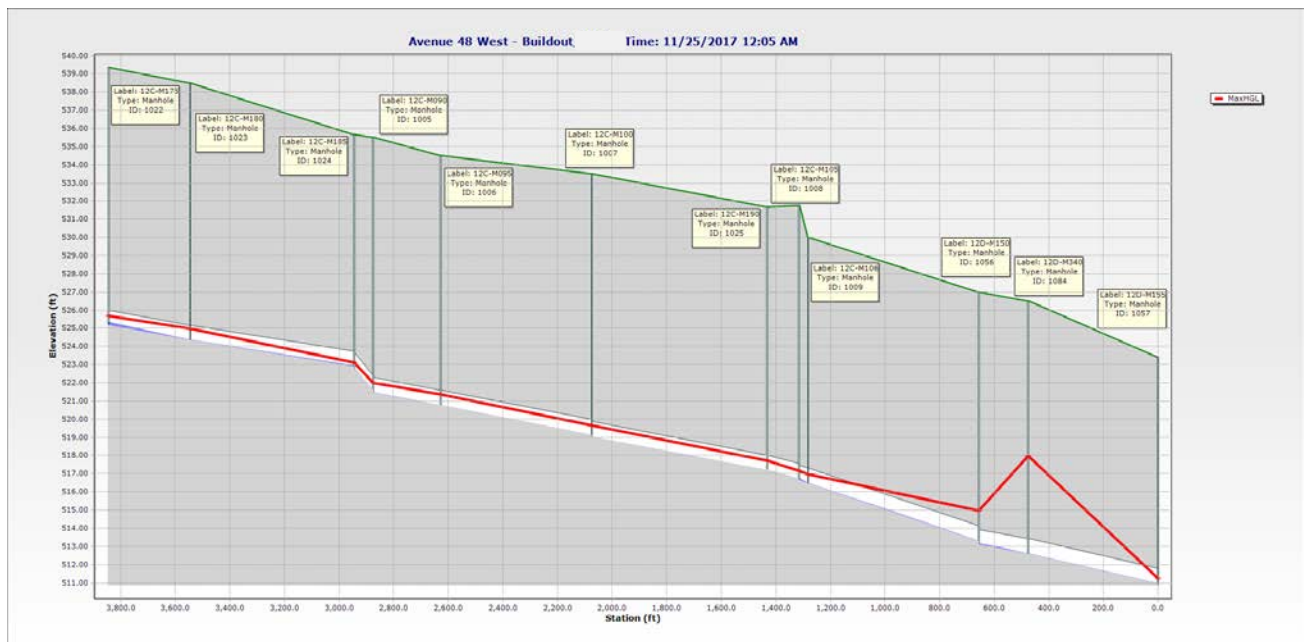


Figure 15 – Avenue 48 under Build-Out Conditions

- 2. Dr. Carreon Blvd. between Oasis St. and Mangrove St.** – The conduits that exceeded the d/D criteria for existing conditions, interim planning horizon and build-out conditions on Dr. Carreon Blvd are listed below. Some conduits listed below exceed d/D criteria only for build-out conditions. The hydraulic profile for this area of concern is shown in **Figure 16** through **Figure 18**, and the model results are shown in **Table 9**. Clinton St Operational Change, Arabia Interceptor/ Jackson Street Operational Change and Highway 111 Interceptor projects are recommended for this area of concern which will provide relief for current and projected capacity issues.

Table 9 - Dr. Carreon Blvd. between Oasis St. and Mangrove St. Model Results

Conduit ID	Diameter (inches)	Existing Conditions d/D	Interim Planning Horizon d/D	Build-Out Conditions d/D
10H-M005_10H-M010	8	0.56	0.56	1.00
10H-M046_10H-M275	8	0.54	0.54	0.73
10H-M120_10H-M240	8	0.52	0.52	0.94
10H-M210_10H-M235	8	0.55	0.55	1.00
10H-M305_10H-M265	8	0.50	0.50	0.99
11H-M150_10H-M005	8	0.29	0.23	1.00
10H-M010_10H-M240	15	0.40	0.37	1.00
10H-M235_10H-M010	15	0.47	0.43	1.00
10H-M240_10H-M245	15	0.45	0.39	1.00
10H-M245_10H-M250	15	0.47	0.41	1.00
10H-M250_10H-M255	15	0.48	0.41	1.00
10H-M255_10H-M257	15	0.58	0.58	1.00
10H-M257_10H-M260	15	0.60	0.60	1.00
10H-M260_10H-M265	15	0.51	0.51	0.88
10H-M275_10H-M277	15	0.51	0.51	0.94
10H-M277_10I-M130	15	0.53	0.53	0.91

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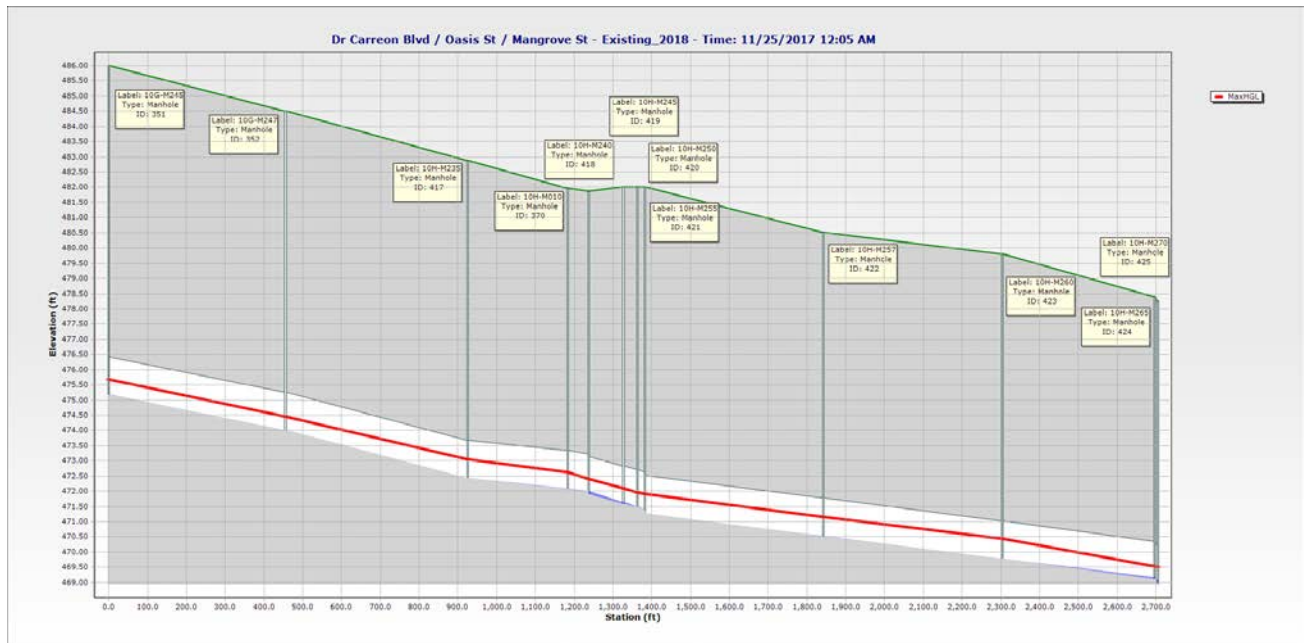


Figure 16 – Dr. Carreon Blvd under Existing Conditions

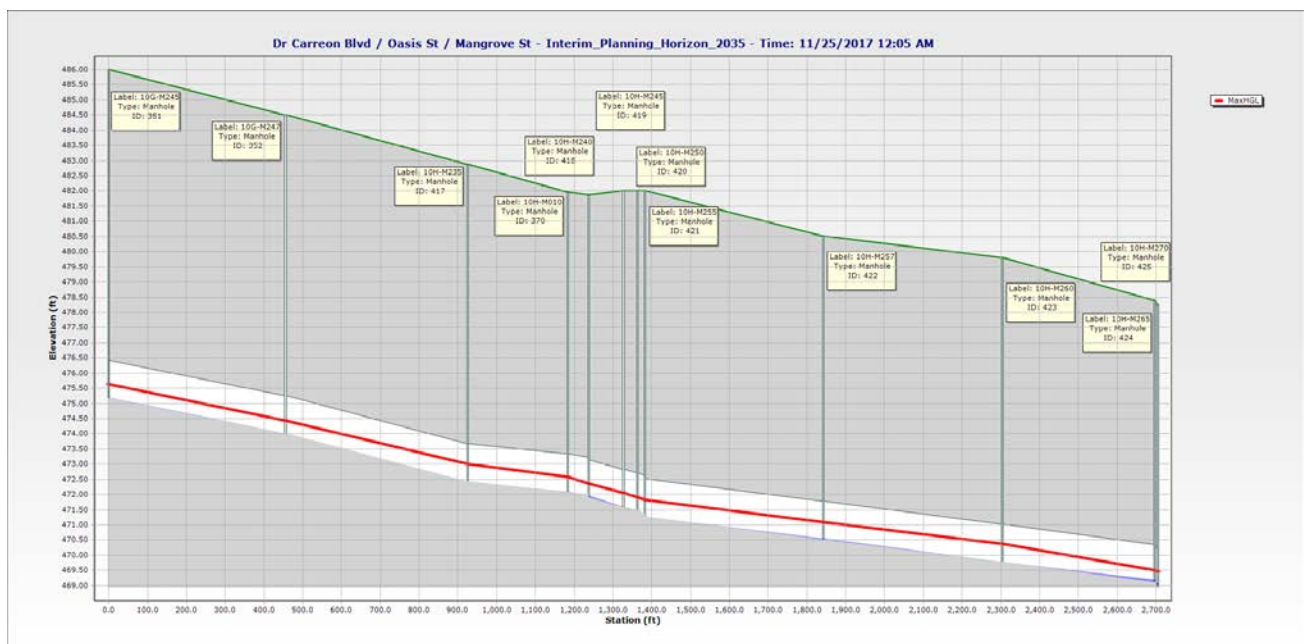


Figure 17 - Dr. Carreon Blvd under Interim Planning Horizon Conditions

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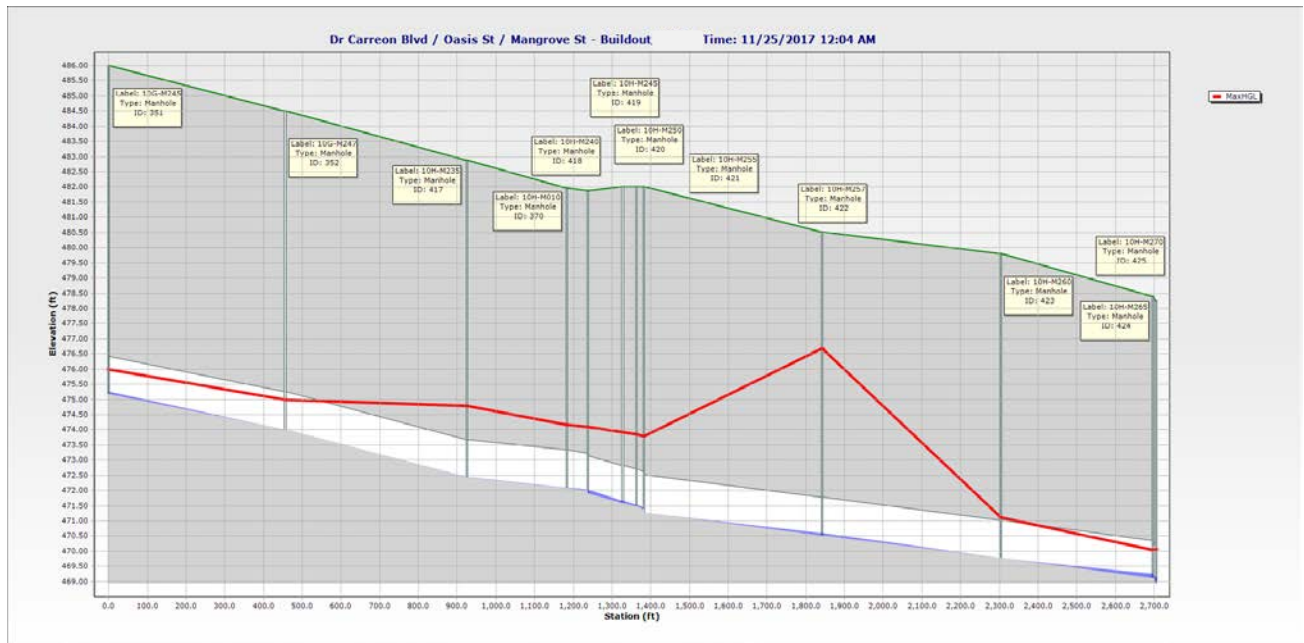


Figure 18 - Dr. Carreon Blvd under Build-Out Conditions

- 3. Date Ave between Arabia St and Jackson St** – The conduits that exceeded the d/D criteria for existing conditions and interim planning horizon conditions on Date Ave between Arabia St and Jackson St are listed below. However, these conduits do not exceed the d/D criteria for build-out conditions. The hydraulic profiles for this area of concern is shown in **Figure 19** through **Figure 21**, and the model results are shown in **Table 10**. A CIP is not recommended for this AOC as d/D doesn't exceed the design criteria of 0.90. However, based on conversations with VSD and review of the hydraulic profile and model, there does appear to be capacity concerns in this line that warrant further monitoring and study. The model calculates max d/D based on an average depth over the length of the pipe; review of the hydraulic profile shows that even though the max d/D for 10H-M215_10H-M325 during build-out is 0.81, there may be full pipe conditions at the downstream end of the pipeline. It is recommended that VSD monitor this location and conduct further study if capacity deficiency is observed.

Table 10 - Date Ave between Arabia St and Jackson St. Model Results

Conduit ID	Diameter (inches)	Existing Conditions d/D	Interim Planning Horizon d/D	Build-Out Conditions d/D
10G-M205_10G-M206	8	0.52	0.45	0.75
10H-M215_10H-M325	8	0.50	0.44	0.81

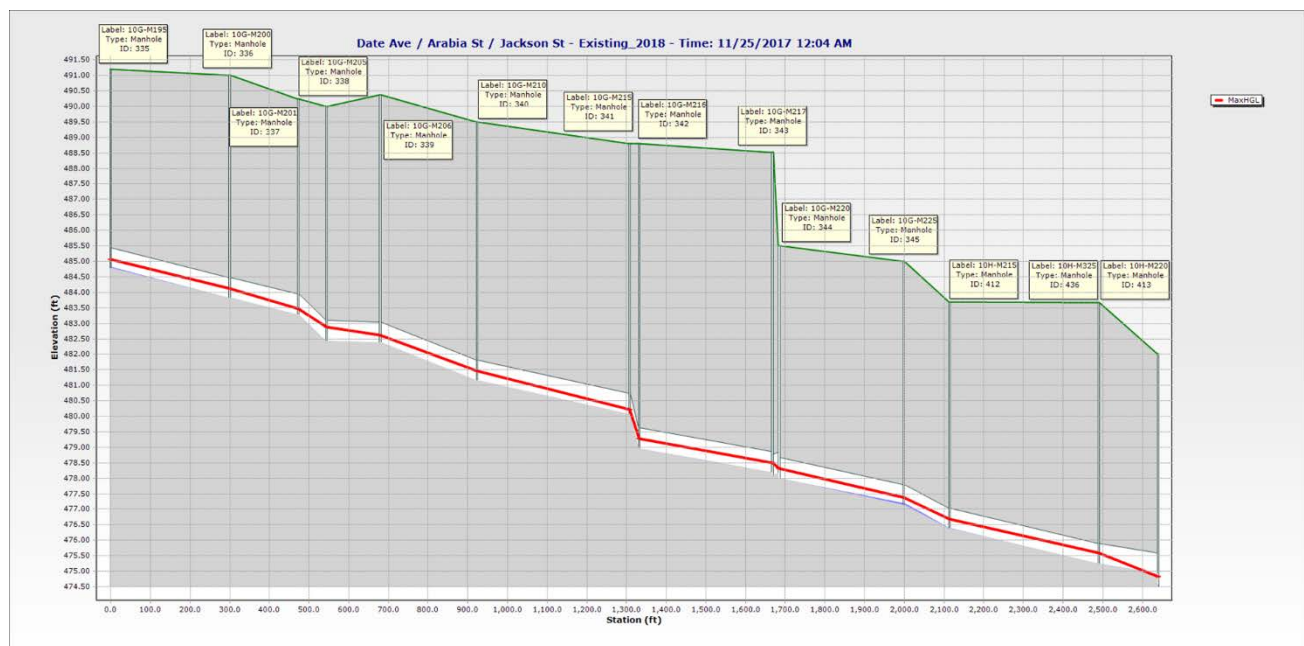


Figure 19 – Date Ave between Arabia St and Jackson St under Existing Conditions

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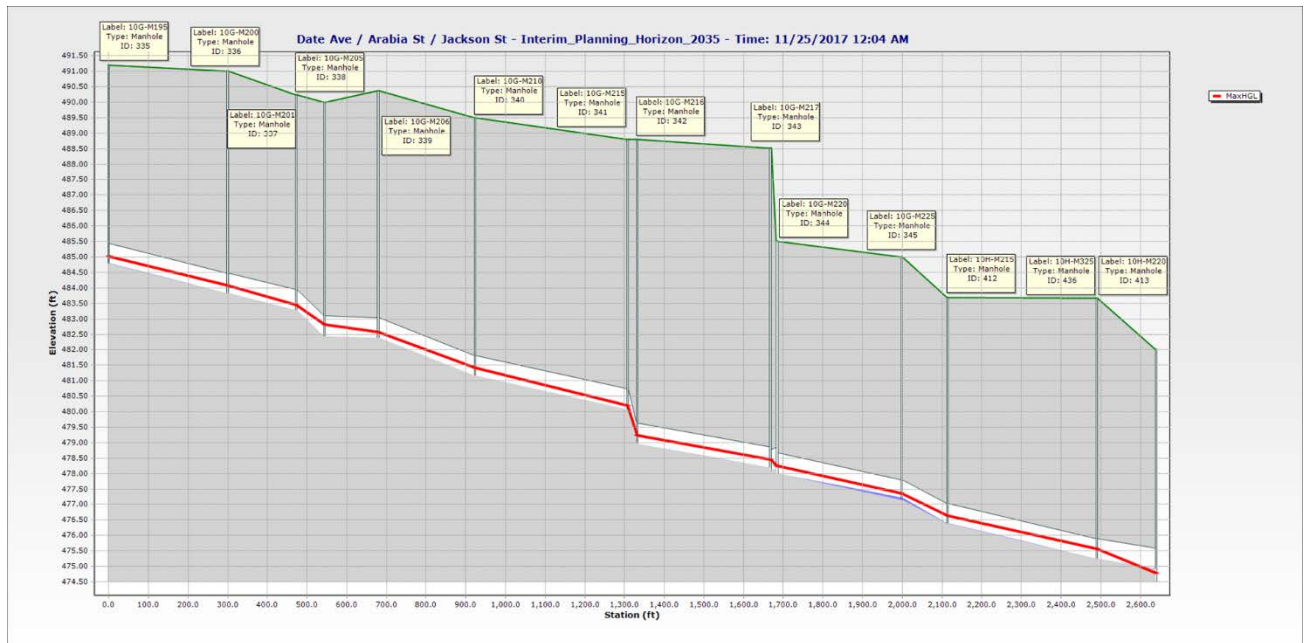


Figure 20 – Date Ave between Arabia St and Jackson St under Interim Planning Horizon Conditions

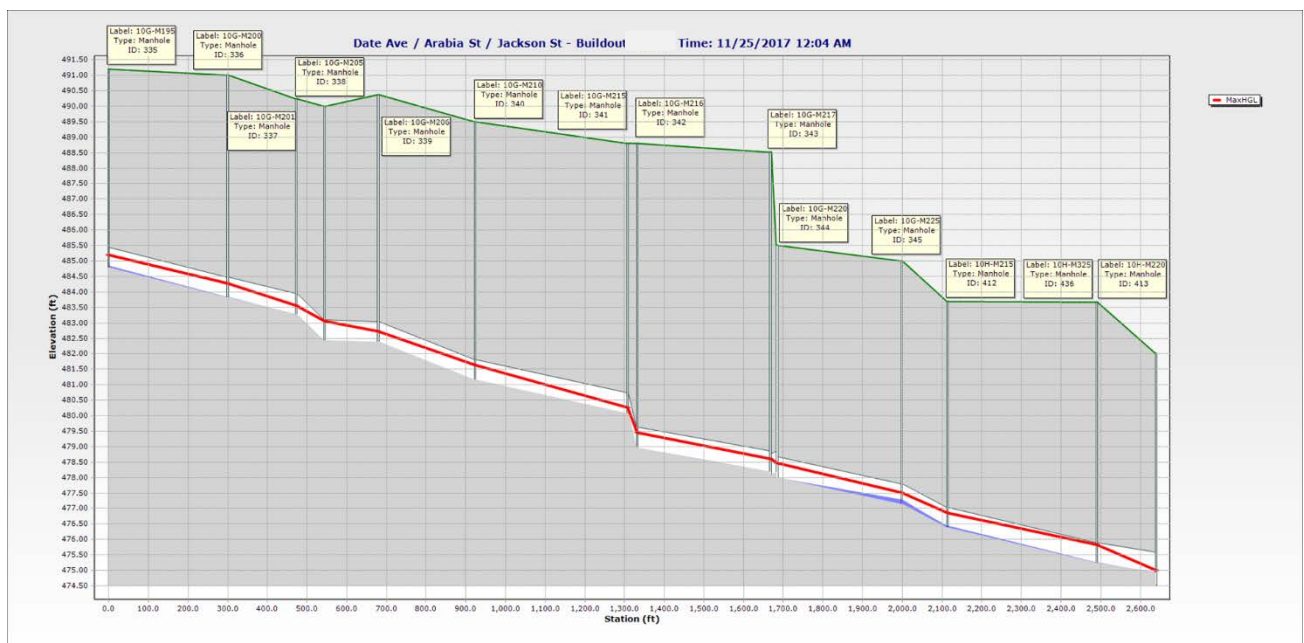


Figure 21 – Date Ave between Arabia St and Jackson St under Build-Out Conditions

4. **Highway 111 between Monroe St and Arabia St** – The conduits that exceeded the d/D criteria for existing conditions on Highway 111 between Monroe St and Arabia St are listed below. However, these conduits do not exceed the d/D criteria for interim planning horizon and build-out conditions. The hydraulic profiles for this area of concern is shown in **Figure 22** through **Figure 24** and the model results are shown in **Table 11**. A CIP is not recommended for this AOC as d/D doesn't exceed the design criteria of 0.90. However, Highway 111 Interceptor project recommended for the Dr. Carreon Blvd AOC will increase the capacity of this line.

Table 11 - Highway 111 between Monroe St and Arabia St Model Results

Conduit ID	Diameter (inches)	Existing Conditions d/D	Interim Planning Horizon d/D	Build-Out Conditions d/D
9F-M045_9F-M047	8	0.54	0.45	0.82
9F-M047_9F-M050	8	0.52	0.44	0.77
9F-M055_9G-M100	8	0.50	0.42	0.78

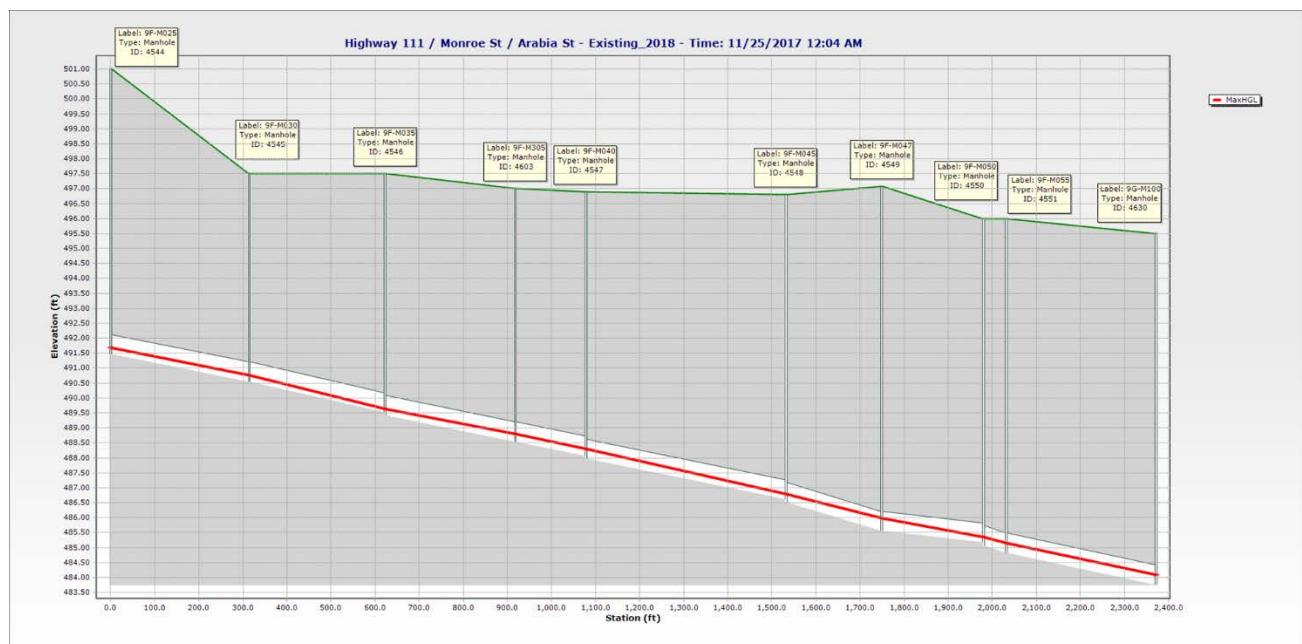


Figure 22 – Highway 111 between Monroe St and Arabia St under Existing Conditions

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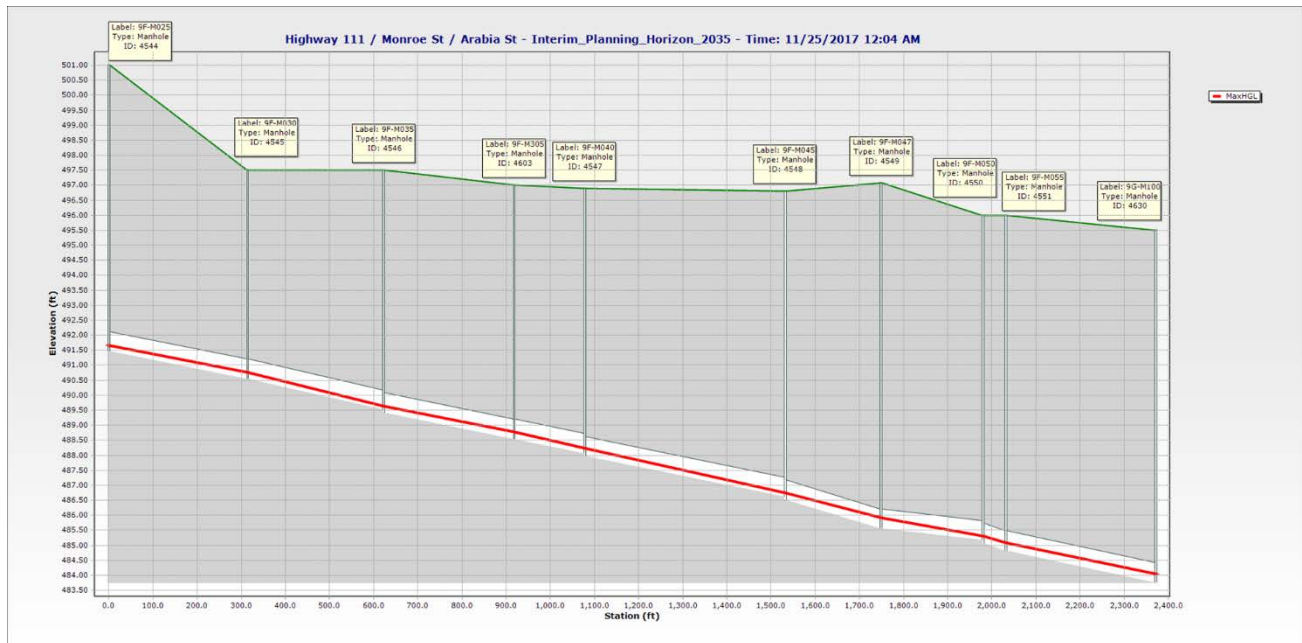


Figure 23 – Highway 111 between Monroe St and Arabia St under Interim Planning Horizon Conditions

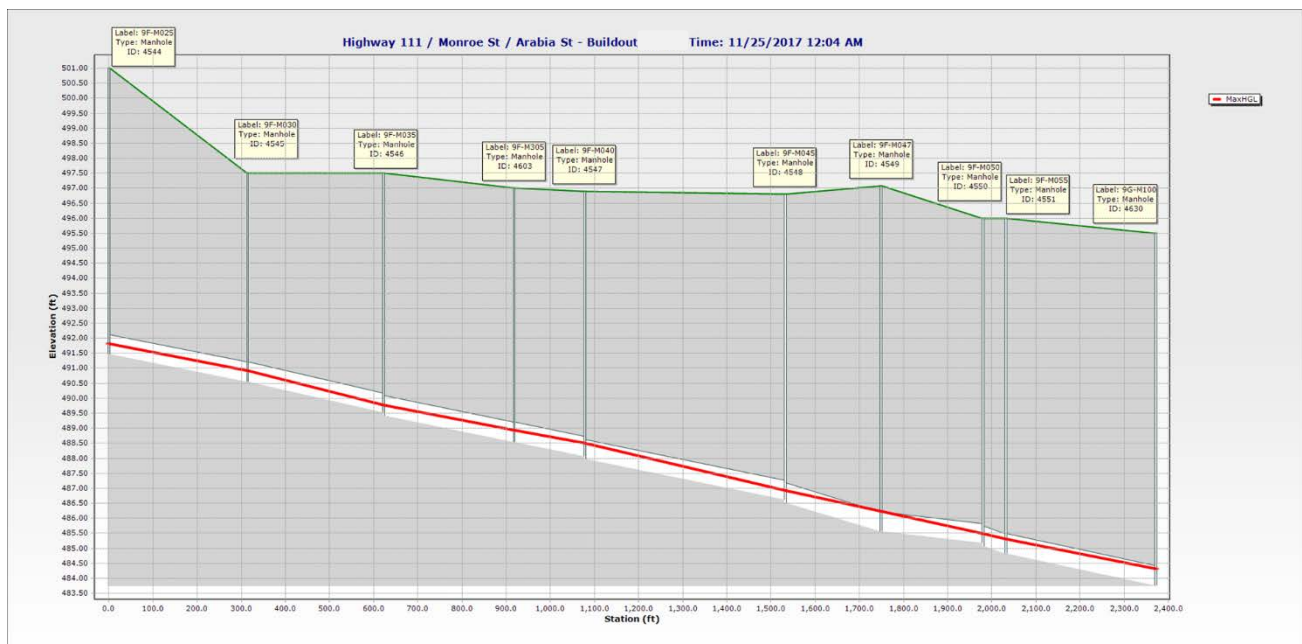


Figure 24 – Highway 111 between Monroe St and Arabia St under Build-Out Conditions

- 5. Highway 111 between Arabia St and Flower St** – The conduits that exceeded the d/D criteria for existing conditions on Highway 111 between Arabia St and Flower St are listed below. However, these conduits do not exceed the d/D criteria for interim planning horizon and build-out conditions. The hydraulic profiles for this area of concern is shown in **Figure 25** through **Figure 27**, and the model results are shown in **Table 12**. A CIP is not recommended for this AOC as d/D doesn't exceed the design criteria of 0.90.

Table 12 - Highway 111 between Arabia St and Flower St Model Results

Conduit ID	Diameter (inches)	Existing Conditions d/D	Interim Planning Horizon d/D	Build-Out Conditions d/D
9G-M245_9G-M170	8	0.60	0.48	0.89
9G-M175_9G-M180	12	0.53	0.41	0.73
9G-M185_9G-M190	12	0.52	0.40	0.73
9G-M190_9G-M195	12	0.55	0.42	0.75
9H-M120_9H-M135	12	0.51	0.48	0.84
9H-M135_9H-M140	12	0.52	0.49	0.86
9H-M140_9H-M145	12	0.51	0.48	0.84
9H-M145_9H-M150	12	0.51	0.48	0.81

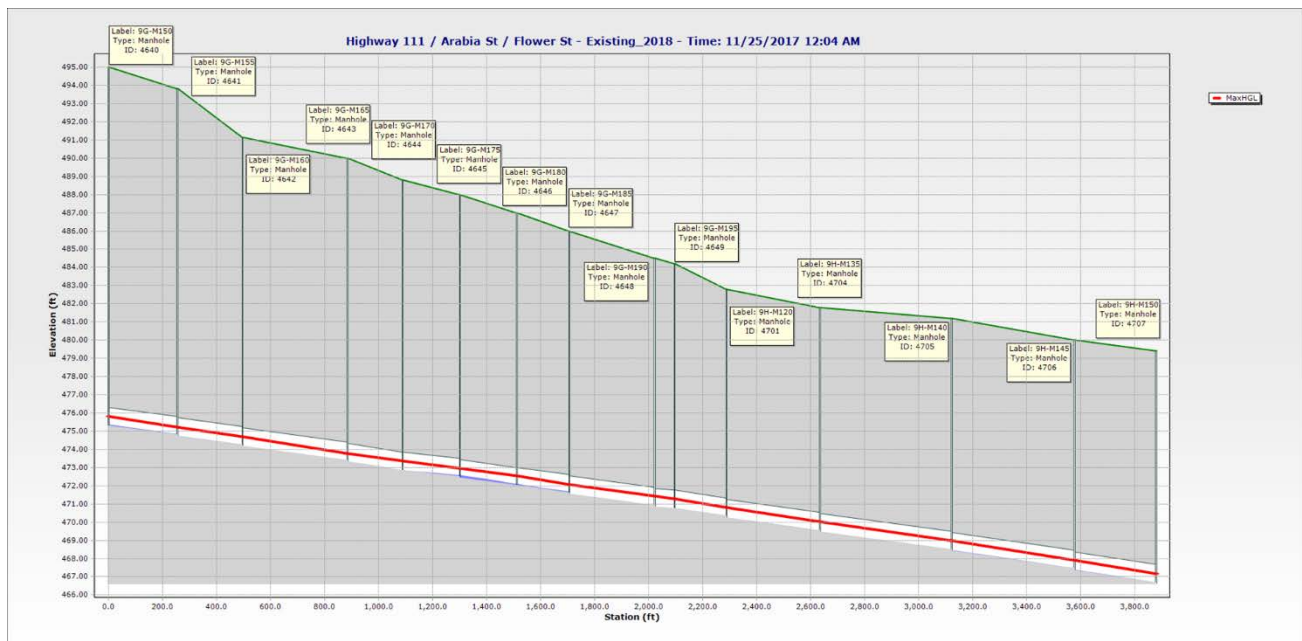
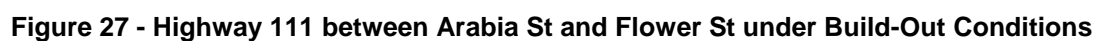


Figure 25 – Highway 111 between Arabia St and Flower St under Existing Conditions

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- 6. Sola St between Oleander Ave and Avenue 44** – The conduits that exceeded the d/D criteria for existing conditions, interim planning horizon and build-out conditions on Sola St are listed below. The hydraulic profile for this area of concern is shown in **Figure 28** through **Figure 30**, and the model results are shown in **Table 13**. Industrial PI/Market Interceptor project is recommended for this area of concern which will provide relief for current and projected capacity issues.

Table 13 - Sola St between Oleander Ave and Avenue 44 Model Results

Conduit ID	Diameter (inches)	Existing Conditions d/D	Interim Planning Horizon d/D	Build-Out Conditions d/D
6G-M195_6G-M200	8	0.65	0.60	1.00
6G-M200_6G-M205	8	0.71	0.66	1.00

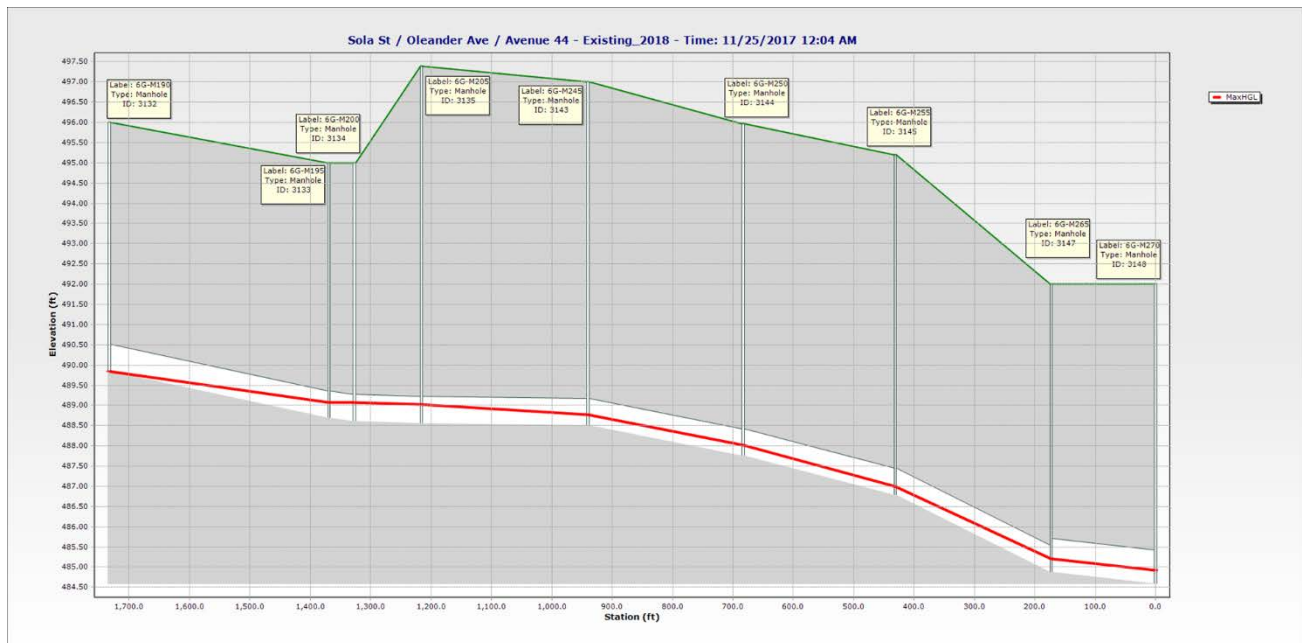


Figure 28 – Sola St between Oleander Ave and Avenue 44 under Existing Conditions

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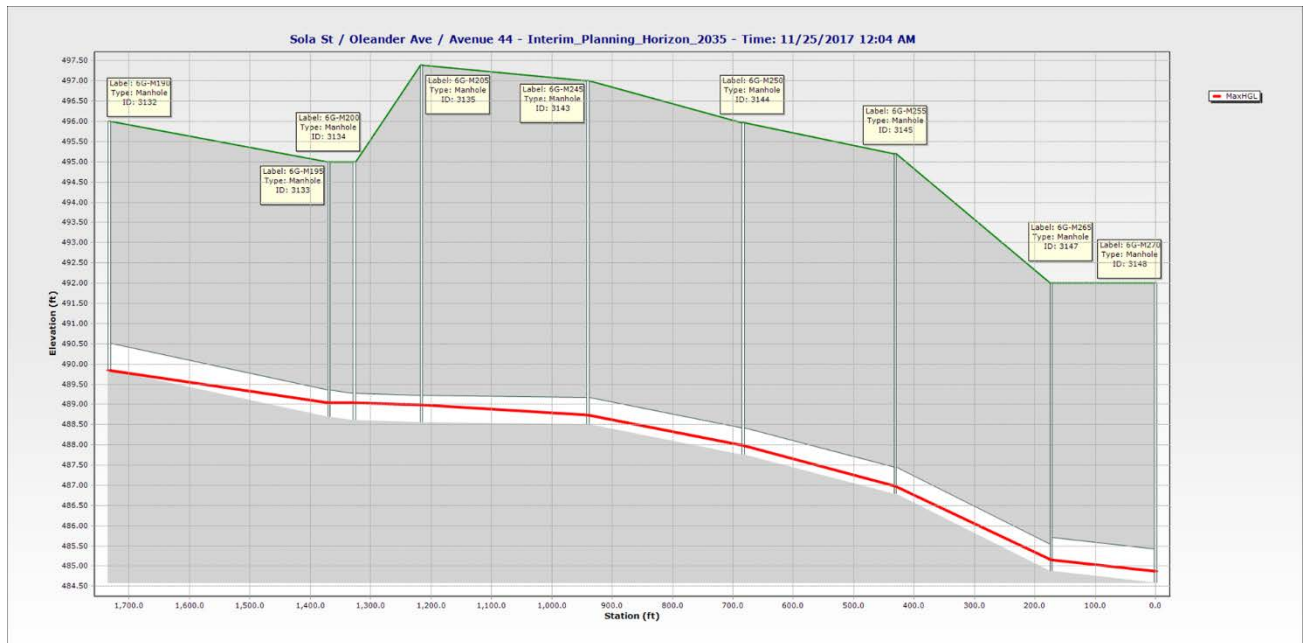


Figure 29 – Sola St between Oleander Ave and Avenue 44 under Interim Planning Horizon Conditions

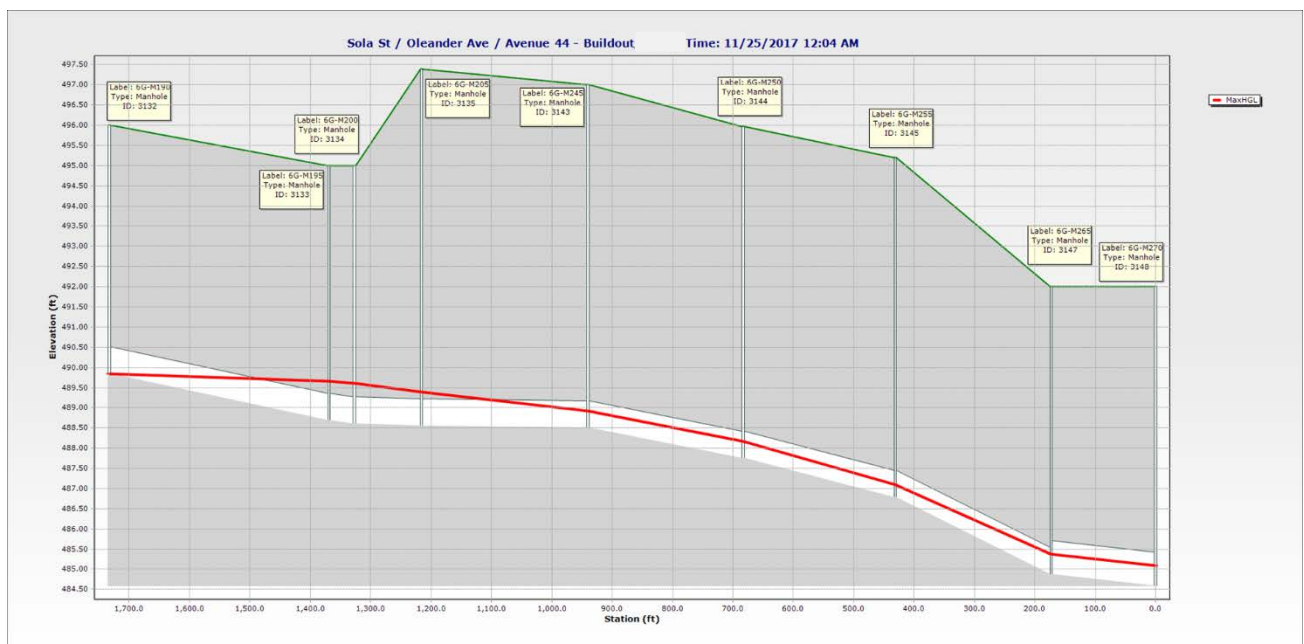


Figure 30 – Sola St between Oleander Ave and Avenue 44 under Build-Out Conditions

- 7. Avenue 49 between Hjorth St and Desert Grove Dr** – This area of concern is applicable for build-out conditions only. The conduits that exceeded the d/D criteria for build-out conditions on Avenue 49 are listed below. The hydraulic profile for this area of concern is shown in **Figure 31**, and the model results are shown in **Table 14**. Avenue 49 Interceptor project was previously recommended for this area of concern and provides partial relief for projected capacity issues. It is recommended that VSD continues to monitor this line for future capacity issues and include this area in future flow monitoring efforts.

Table 14 - Avenue 49 between Hjorth St and Desert Grove Dr Model Results

Conduit ID	Diameter (inches)	Existing Conditions d/D	Interim Planning Horizon d/D	Build-Out Conditions d/D
13E-M130_13E-M135	8	0.06	0.07	1.00
13E-M135_13E-M210	8	0.28	0.33	1.00
13D-M070_13D-M075	10	0.27	0.31	1.00
13D-M075_13D-M080	10	0.35	0.41	1.00
13D-M080_13E-M210	10	0.40	0.47	1.00
13E-M210_13E-M215	10	0.36	0.43	1.00
13E-M215_13E-M220	10	0.36	0.44	1.00
13E-M220_13E-M225	10	0.36	0.45	1.00
13E-M225_13E-M230	10	0.39	0.49	1.00
13E-M230_13E-M235	10	0.35	0.43	1.00

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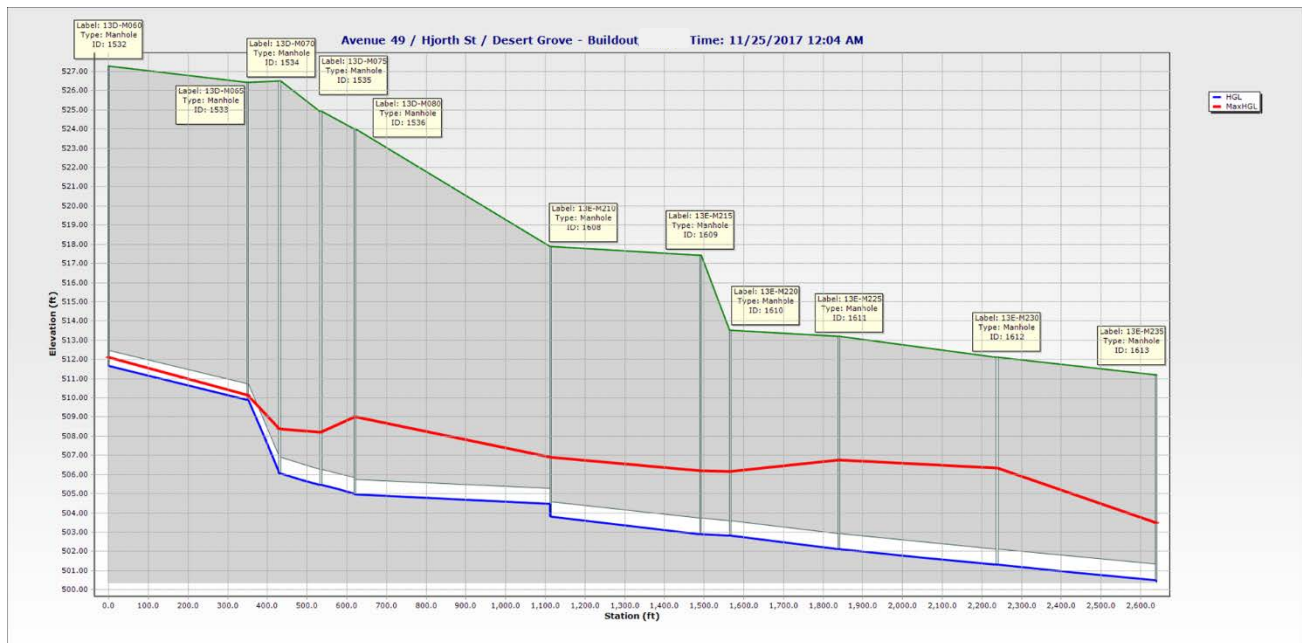


Figure 31 – Avenue 49 between Hjorth St and Desert Grove Dr under Build-Out Conditions

8. **Desert Grove Dr between Avenue 49 and Avenue 48** – This area of concern is applicable for build-out conditions only. The conduits that exceeded the d/D criteria for build-out conditions on Desert Grove Dr are listed below. There are few conduits on the trunk line which exceeded the d/D criteria for interim planning horizon conditions. The hydraulic profile for this area of concern is shown in **Figure 32** through **Figure 34**, and the model results are shown in **Table 15**. It is recommended that VSD monitor this area and include it as part of future flow monitoring efforts. It is noted that project P-3 may provide relief to this area as well.

Table 15 - Desert Grove Dr between Avenue 49 and Avenue 48 Model Results

Conduit ID	Diameter (inches)	Existing Conditions d/D	Interim Planning Horizon d/D	Build-Out Conditions d/D
12E-M315_12E-M320	10	0.39	0.49	1.00
12E-M320_12E-M325	10	0.40	0.50	1.00
12E-M325_12E-M330	10	0.41	0.53	1.00
12E-M330_12E-M335	10	0.40	0.52	1.00
12E-M335_12E-M340	10	0.43	0.54	1.00
13E-M235_13E-M240	10	0.33	0.44	1.00
13E-M240_13E-M245	10	0.35	0.46	1.00
13E-M245_13E-M250	10	0.34	0.45	1.00

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Conduit ID	Diameter (inches)	Existing Conditions d/D	Interim Planning Horizon d/D	Build-Out Conditions d/D
13E-M250_13E-M255	10	0.36	0.47	1.00
13E-M255_13E-M260	10	0.39	0.49	1.00
13E-M260_12E-M315	10	0.39	0.49	1.00
13E-M295_13E-M235	10	0.19	0.24	1.00
12E-M340_12E-M385	10	0.45	0.53	0.83

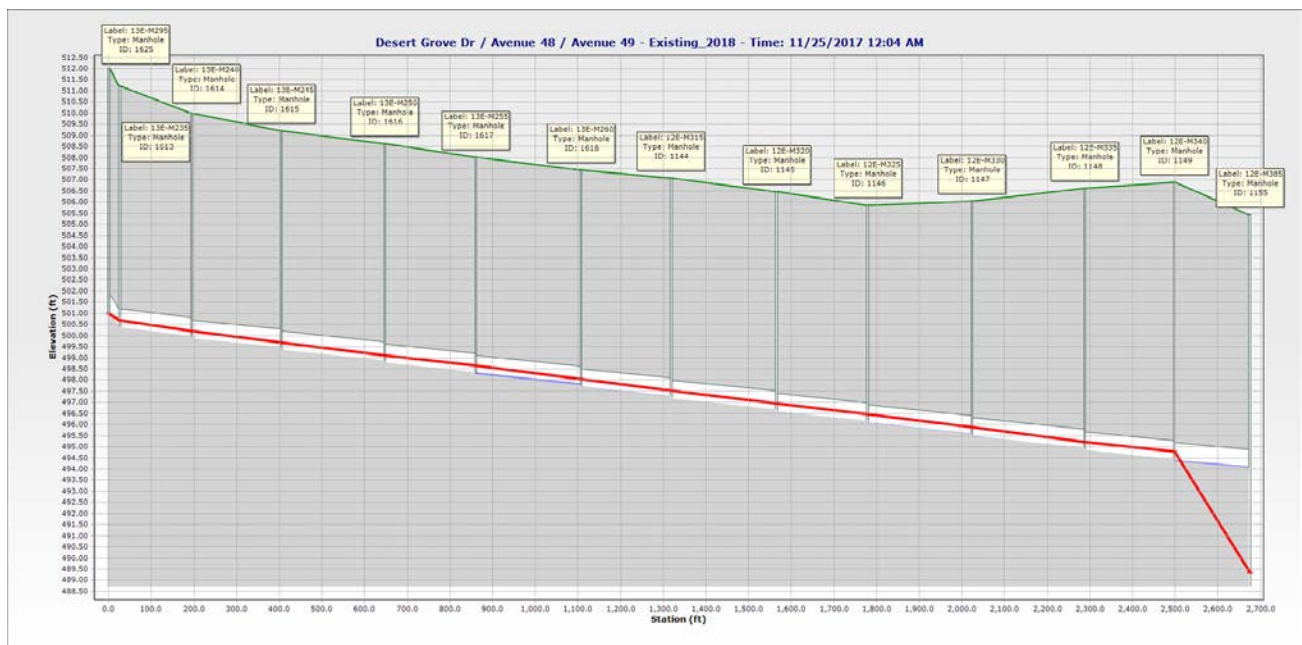


Figure 32 – Desert Grove Dr between Avenue 49 and Avenue 48 under Existing Conditions

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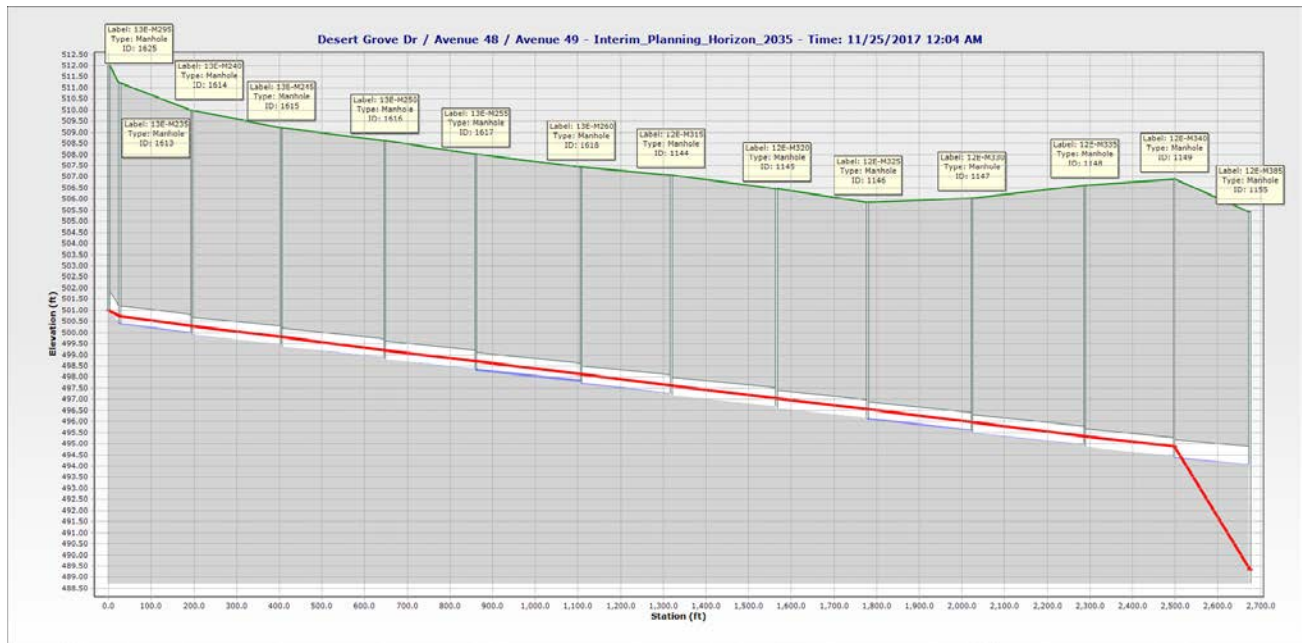


Figure 33 – Desert Grove Dr between Avenue 49 and Avenue 48 under Interim Planning Horizon Conditions

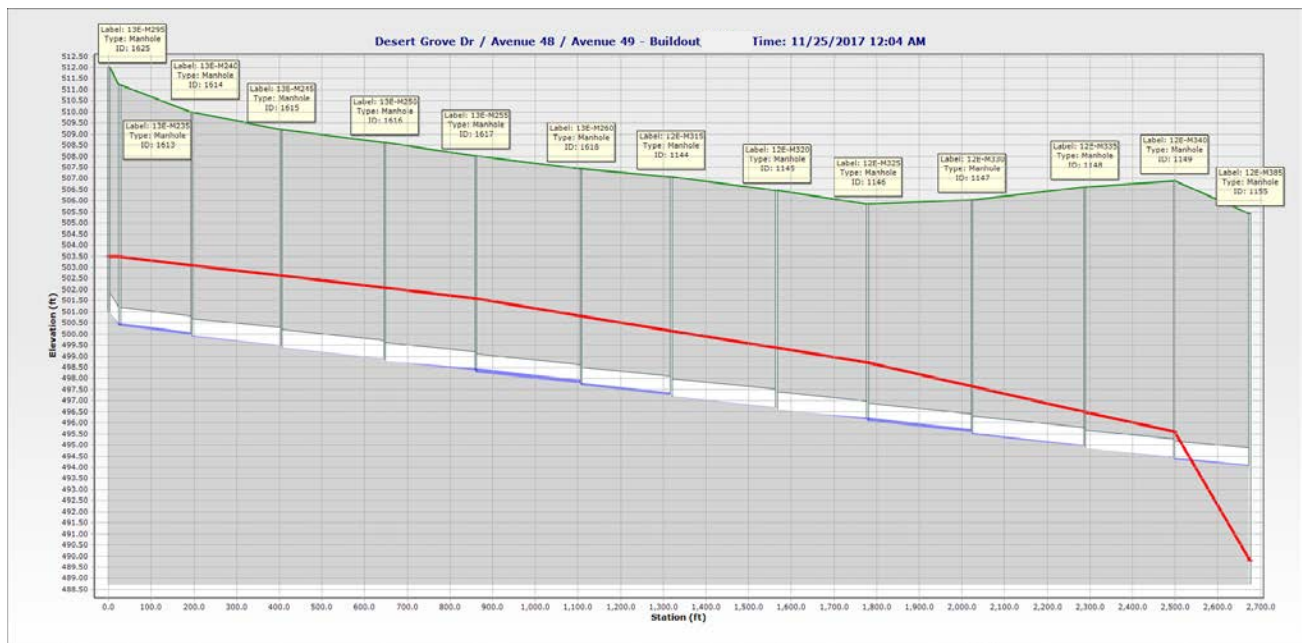


Figure 34 – Desert Grove Dr between Avenue 49 and Avenue 48 under Build-Out Conditions

- 9. Van Buren St between Avenue 48 and Highway 111** – This area of concern is applicable for build-out conditions only. The conduits that exceeded the d/D criteria for build-out conditions on Van Buren street are listed below. The model results are shown in **Table 16**. There was no CIP project from the 2013 CSMP that addressed this areas and as such it is recommended that VSD monitor this area and include it as part of future flow monitoring efforts.

Table 16 - Van Buren St between Avenue 48 and Highway 111 Model Results

Conduit ID	Diameter (inches)	Existing Conditions d/D	Interim Planning Horizon d/D	Build-Out Conditions d/D
12J-M075_12J-M080	30	0.46	0.50	0.99
12J-M080_11J-M085	30	0.53	0.56	1.00
11J-M085_11J-M090	30	0.52	0.55	0.98
11J-M090_11J-M145	30	0.48	0.51	0.95
11J-M145_11J-M095	30	0.48	0.51	0.94
11J-M095_11J-M100	30	0.49	0.51	0.93
11J-M100_11J-M105	30	0.53	0.55	0.94
11J-M105_10J-M045	30	0.57	0.58	0.93

- 10. Calhoun St** – The conduit that exceeded the d/D criteria for interim planning horizon and build-out conditions on Calhoun St at Avenue 43 between South Fork Ct is listed below. The hydraulic profile for this area of concern is shown in **Figure 35**, and the model results are shown in **Table 17**. There was no CIP project from the 2013 CSMP that addressed this areas and as such it is recommended that VSD monitor this area and include it as part of future flow monitoring efforts.

Table 17 - Calhoun St Model Results

Conduit ID	Diameter (inches)	Existing Conditions d/D	Interim Planning Horizon d/D	Build-Out Conditions d/D
5I-M075_5I-M080	15	0.40	0.59	1.00

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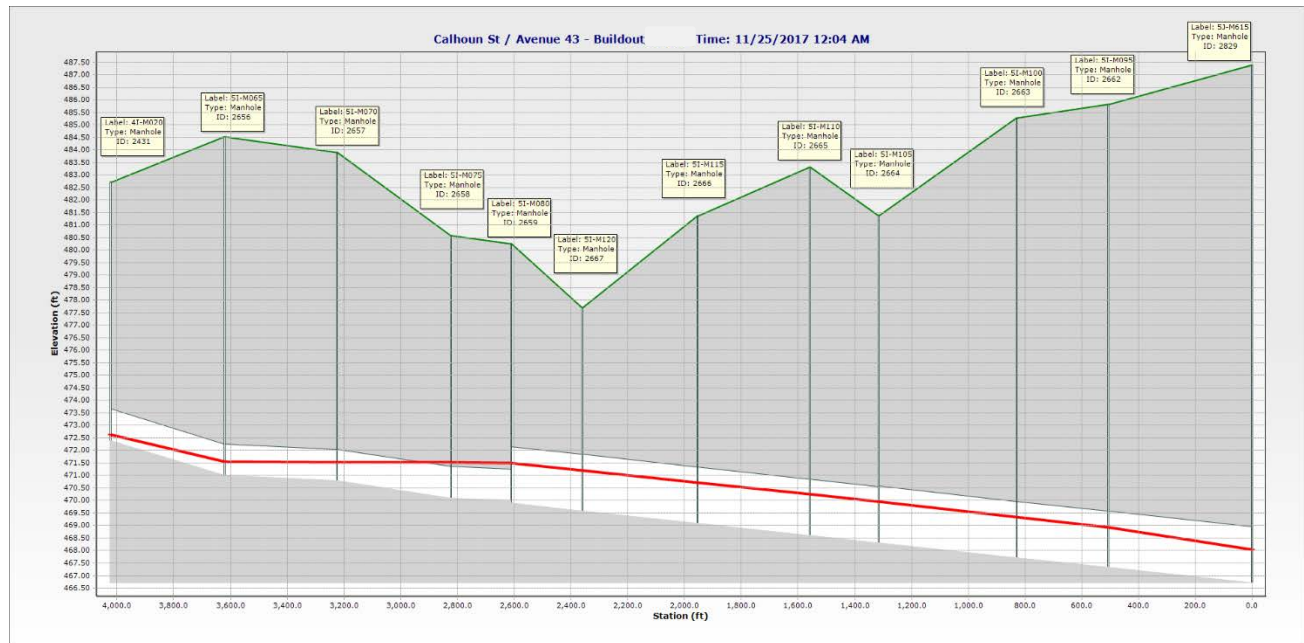


Figure 35 – Calhoun St at Avenue 43 Under Build-Out Conditions

Updated Recommended Improvements

The model results indicate that no improvements are needed for the existing conditions (2017) and interim planning horizon conditions (2035). However, projects E-4, E-6, P-1, P-2 and P-3 from the CSMP (2013) are still required to address the capacity deficiencies predicted by the model for build-out conditions. These projects are recommended no sooner than the planning horizon according to the results of this CSMP Review; however new development, changes in zoning and population, and changes in usage trends could cause areas to exceed design capacity sooner which would necessitate a project earlier than the interim horizon (2035). It is recommended that VSD initiate a new Master Plan Update and flow monitoring effort prior to 2035, ideally in the next four to eight years, in order to confirm these results and update model flows with field data. AOCs identified in this review should be prioritized for flow monitoring and should be monitored by operations staff in the meantime to ensure no capacity issues develop. A summary of updated recommended improvements is shown in **Table 18**.

Table 18 – Updated Recommended Improvements Summary

Project Number	Project Name	Description	Purpose	AOC Addressed	Phase ¹	New or Upgrade	Operational Change	Size of Pipe (in)	Length of Pipe (ft.)	Total Length of Pipe (ft.)
E-4	Clinton Street Operational Change	Operational change to send flows north on Clinton Street to the Requa Interceptor.	Relieve Dr. Carreon Blvd	2	Build-Out	N/A	Yes	N/A	N/A	N/A
E-6	Avenue 48 West Upgrade	Upsizing of 10-inch line extending west from along Avenue 48 from Madison St.	Relieve current and projected capacity issues for Avenue 48 West	1	Build-Out	Upgrade	No	15/18	670/ 2,875	3,545
P-1	Arabia Interceptor/ Jackson Street Operational Change	Bulkheading change and pipe improvements to divert flow from Dr. Carreon Blvd north to Highway 111	Relieve Dr. Carreon Blvd and Date St	2	Build-Out	New	Yes	8	850	850
P-2	Highway 111 Interceptor	Pipe connecting N. Hwy 111 to the Requa Interceptor	Relieve Dr. Carreon and increase Hwy 111 capacity in order to accommodate jail expansion	2, 4, 5	Build-Out	Both	No	12	2,979	2,979
P-3	Avenue 49 Interceptor	Interceptor to convey flows from Avenue 49 to Monroe Street and then north to Avenue 48	Relieve Avenue 49 and Desert Grove Street	7, 8	Build-Out	New	No	12	565	565
P-4	Industrial Pl./Market Interceptor	12-inch interceptor along Fred Waring Dr. from Industrial Pl. to Monroe St., sending flows down Market street	Relieve Sola Street, Palo Verde Street, Avenue 44, and Avenue 45	6	Build-Out	New	No	12	967	967

¹: These areas should be monitored, reviewed and modeled in the next 4-8 years, but are currently not recommended until after the interim planning scenario.

REMAINING AREAS OF CONCERN

The model is run with the updated CIP recommendations shown in **Table 5**, and the results were analyzed to verify if any projects are further required to address capacity issues. The model results show the following areas of concern with conduits exceeding the design criteria ($d/D > 0.90$) for build-out conditions. **Figure 36** shows the locations of these AOCs. It is recommended that these areas be monitored in the future.

- Calhoun St at Avenue 43
- Highway 111 between Oasis St and Calhoun St
- Van Buren St between Avenue 48 and Dr. Carreon Blvd
- Avenue 49 between Hjorth St and Desert Grove Dr.

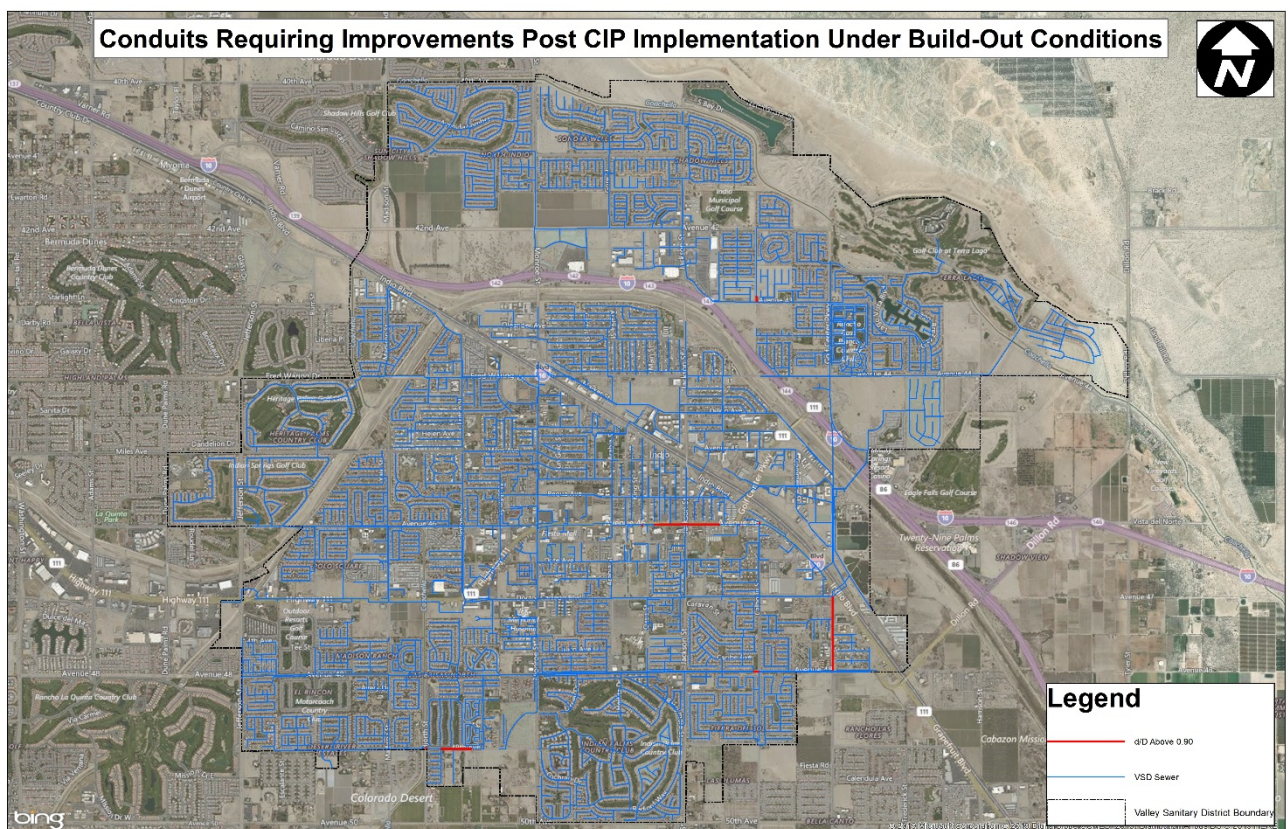


Figure 36 – Conduits Exceeding Design Criteria ($d/D > 0.90$) Post CIP Implementation

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APPENDIX A – NEGATIVE AND FLAT SLOPE VERIFICATION

Review of Negative and Flat Slopes in 2018 Model				
Conduit_ID (2013 Model)	Conduit_ID (2018 Model)	Slope (ft/ft)		VSD Comment
		2013	2018	
10E-M153_10E-M180	10E-M153_10E-M180	-0.0213967	-0.0213967	Not Negative See 2-133, 2-193, & 2-105
10E-M170_10E-M180	10E-M170_10E-M180	-0.0007725	-0.0007725	Not Negative See 2-105
10G-M217_10G-M220	10G-M217_10G-M220	-0.0035473	0.0065034	Negative See 10-051
10G-M240_10G-M245	10G-M240_10G-M245	0	0.0338447	Not negative See 2-050
10J-M045_10J-M050	10J-M045_10J-M050	-0.0069798	0.0008725	Negative See 2-325.03
10J-M060_10J-M065	10J-M060_10J-M065	-0.0006064	0.0001155	See 2-325.03
10J-M065_10J-M070	10J-M065_10J-M070	-0.0139472	0.0004102	See 2-325.03
10J-M070_10J-M075	10J-M070_10J-M075	0	0.0001323	See 2-325.03
10J-M100_10J-M025	10J-M100_10J-M025	0	0	Dry Over flow line 2-003
11F-M230_11F-M235	11F-M230_11F-M235	-0.0018301	0.0030719	Private. Remove from model
11F-M245_11F-M250	11F-M245_11F-M250	-0.0029295	0.000651	Private. Remove from model
11J-M095_11J-M100	11J-M095_11J-M100	-0.000172	0.0003194	See 2-325.03
12C-C010_12C-M175	12C-C010_12C-M175	-0.0441951	-0.0168182	Private. Remove from model
12F-M135_12F-M140	12F-M135_12F-M140	-0.0739672	-0.0739672	Force Main
12F-M240_12F-M245	12F-M240_12F-M245	-0.0013621	0.0012995	No as-builts. Interpolate
12F-M315_12F-M316	12F-M315_12F-M316	0	0.0045455	Accept as interpolated.
12G-M215_12G-M340	12G-M215_12G-M340	-0.0037145	-0.0037145	See 2-110
12G-M225_12G-M230	12G-M225_12G-M230	-0.0286786	-0.0286786	Force Main
12H-M355_12H-M360	12H-M355_12H-M360	0	0.0003924	See 15-310.05
12J-M045_12J-M025	12J-M025_12J-M045	0	0	Pump Station Overflow
12J-M050_12J-M055	12J-M050_12J-M055	-0.0036826	-0.0036826	Old Force Main Out of Service
12J-M070_12J-M085	12J-M070_12J-M085	0	0.000343	See 2-325.03
12J-M085_12J-M075	12J-M085_12J-M075	-0.0056288	0.0009381	See 2-325.03
13H-C005_13H-M130	13H-C005_13H-M130	-0.0433492	0.0031628	Accept as interpolated.
4H-M008_4H-C020	4H-M008_4H-C020	-0.0045454	0.4795449	4H-C020 is US Stub for Tie ON
6D-M005_6D-M105	6D-M005_6D-M105	0	0.0020284	See 2-124
6F-M335_6F-M340	6F-M335_6F-M340	-0.0350253	0.0033457	See 2-182 Siphon Dry due to Monroe interceptor
6I-M120_6J-M780	6I-M120_6J-M780	-0.0001319	0.0031658	Accept as interpolated.
7C-M075_7C-M080	7C-M075_7C-M080	0	0.0006312	See 5-095
7D-M024_7D-M077	7D-M024_7D-M077	-0.012569	0.0010079	See 5-002
7G-M325_7G-M200	7G-M325_7G-M200	-0.0470117	0.0315939	Over Flow
8D-M290_8D-M175	8D-M290_8D-M175	-0.0000758	0.0014407	See 5-029
8G-C005_8G-M035	8G-C005_8G-M035	0	0.0123904	No as-builts. Interpolate

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Conduit_ID (2013 Model)	Conduit_ID (2018 Model)	Slope (ft/ft)		VSD Comment
		2013	2018	
8J-M065_8J-M070	8J-M065_8J-M070	-0.0030403	0.0041897	Accept as interpolated.
9C-M145_9C-M150	9C-M145_9C-M150	-0.0099129	-0.0099129	Force Main Out of Service
9D-M330_9D-M335	9D-M330_9D-M335	-0.0005756	0.001535	Trouble spot may have grade bust
9E-M146_9E-M147	9E-M146_9E-M147	0	0.0033956	Private. Remove from model
9H-M255_9H-M250	9H-M255_9H-M250	-0.0011233	-0.0011233	No longer in GIS. Remove from model
CALHOUN_13I-M010_1	CALHOUN_13I-M010_1	-0.0325781	-0.0325781	Force Main
CALHOUN_13I-M015	CALHOUN_13I-M015	0	0.0094595	13I-M015 upstream See 15-324.04
CDT-11	9C-M265_9C-M270_2	-0.068	0.0019405	Siphon See 2-122
CDT-15	Crest Ave Siphon 1_5G-M085	-0.0175	-0.0175	Siphon See 4-057
CDT-19	6F-M030_6F-M205	0	0.0025794	Siphon See 4-172
CDT-25	6D-M115_6D-M120	-0.4141208	0.0021286	Siphon See 2-123
CDT-29	8J-M125_8J-M130_7	-0.1412805	0.0036897	Siphon See 2-306.05
CDT-31	8J-M125_8J-M130_8	-0.1412805	0.0037009	Siphon See 2-306.05
CDT-33	8J-M125_8J-M130_9	-0.1412805	0.0037009	Siphon See 2-306.05
CDT-35	8J-M125_8J-M130_4	0	0.0037006	Siphon See 2-306.05
CDT-37	8J-M125_8J-M130_5	0	0.0037006	Siphon See 2-306.05
CDT-45	8J-M125_8J-M130_6	0	0.0037006	Siphon See 2-306.05
CO-10	BarrymorePMP-1_12G-M225	-0.5975233	-0.5975233	Force Main
CO-149	9E-M280_9E-M345	-0.0144509	0.0460999	See 2-385.38
CO-15	12G-M290_BarrymorePMP-2	0	0	Force Main
CO-150	9E-M245_9E-M330	-0.0554394	0.0633333	See 2-385.37
CO-16	BarrymorePMP-2_12G-M225	-0.2909552	-0.2909552	Force Main
CO-19	9C-M145_ShieldsWW	0	0	Pump Station
CO-24	ShieldsWW_ShieldsPMP-1	0	0	Pump Station
CO-25	ShieldsPMP-1_MH-5	-7.4686564	-7.4686564	Pump Station
CO-26	ShieldsPMP-2_MH-5	-8.3163369	-8.3163369	Pump Station
CO-27	ShieldsWW_ShieldsPMP-2	0	0	Pump Station
CO-31	VandPMP-1_12F-M135	-0.1747081	-0.1747081	Force Main
CO-32	Vand WW_VandPMP-1	0	0	Pump Station
CO-33	Vand WW_VandPMP-2	0	0	Pump Station
CO-34	VandPMP-2_12F-M135	-0.1579684	-0.1579684	Force Main
CO-37	12J-M050_12J-M030	-0.0057436	-0.0057436	Force Main
CO-44	CalhounWW_CalhounPMP-1	0	0	Pump Station
CO-45	CalhounPMP-1_CALHOUN	-1.0968326	-1.0968326	Pump Station

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Conduit_ID (2013 Model)	Conduit_ID (2018 Model)	Slope (ft/ft)		VSD Comment
		2013	2018	
CO-46	CarverPMP-1_12J-M050	-0.5333333	-0.5333333	Pump Station
CO-47	12J-M-045_CarverPMP-1	0	0	Pump Station
CO-48	CarverPMP-2_12J-M050	-0.5333333	-0.5333333	Pump Station
CO-49	12J-M-045_CarverPMP-2	0	0	Pump Station
CO-5	CalhounWW_CalhounPMP-2	-0.3728618	-0.3728618	Pump Station
CO-6	CalhounPMP-2_CALHOUN	-0.3622374	-0.3622374	Pump Station
CO-73	8I-M098_8I-M200	-0.0096268	0.174	See 2-385.34
CO-9	12G-M290_BarrymorePMP-1	0	0	Pump Station
CO-91	9G-M130_9G-M330	-0.1534076	0.00625	See 2-385.36