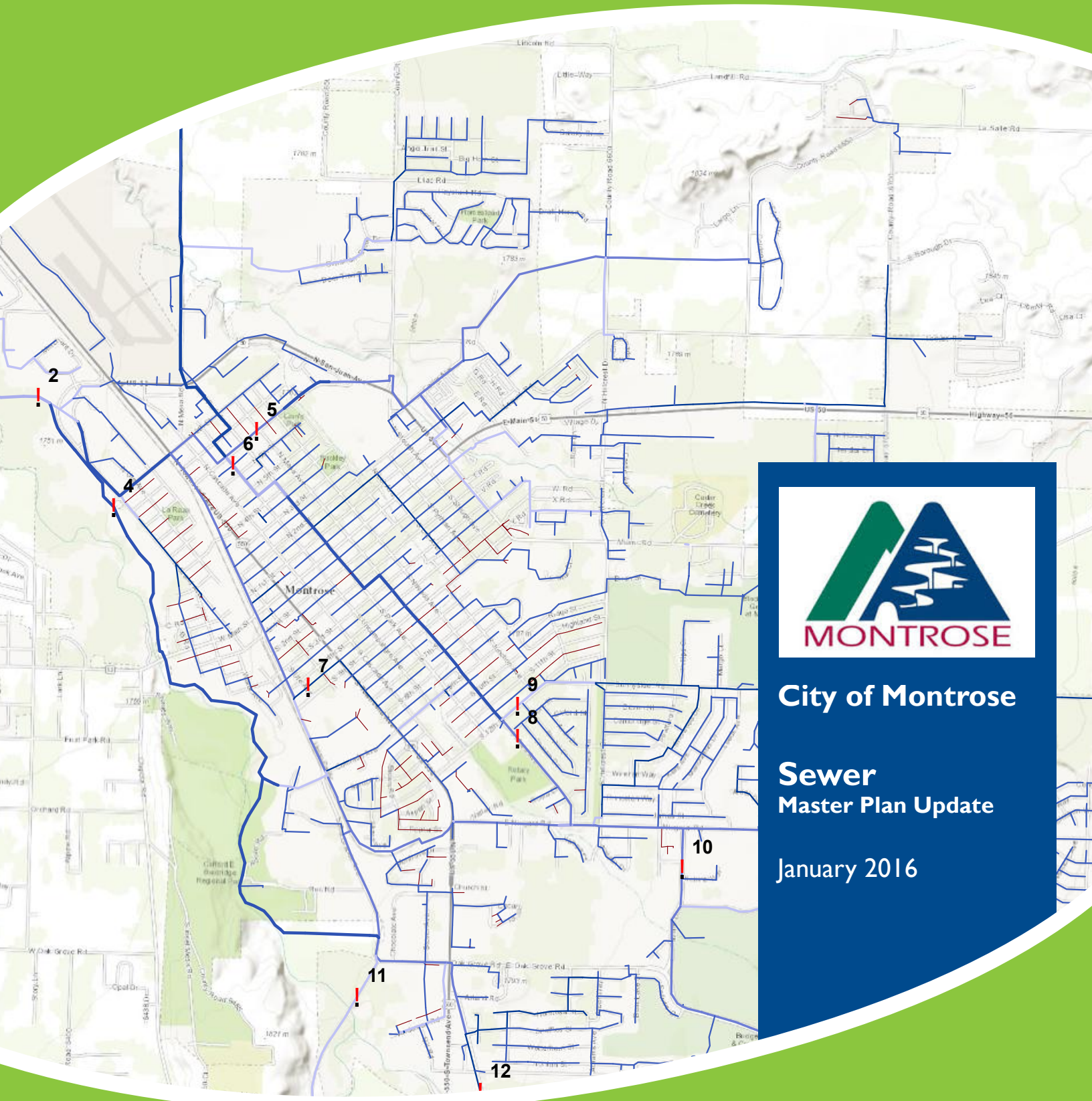
Farnsworth GROUP



MONTROSE

City of Montrose

Sewer
Master Plan Update

January 2016

Final Report

Table of Contents

I. Executive Summary 2
A. Purpose 2
B. Scope 2
C. Projected Growth and Sewage Flows 2
D. Capital Improvement Recommendations 3
II. Existing System Evaluation 4
A. Introduction 4
B. City GIS Data 5
C. Trunk Sewer System 5
D. Field Survey 5
E. Existing Sewer System 5
F. Flow Monitoring 6
1. Objectives of Flow Monitoring 6
2. Flow Meter Locations 6
3. Flow Monitor Results & Analysis 8
4. Commercial and Industrial Users 12
G. Model Calibration - Recommended Unit Flow Rates and Peaking Factors 12
H. Hydraulic Model of Existing System 16
Field Validations of the Model 17
III. Future System Evaluation 20
A. Future Land Use – Location and Rate of Growth 20
B. Population and Sewer Flows 20
IV. CCTV Inspection Data Review 21
A. Pipeline Maintenance History Review 21
B. Inspection Data Review and Assessment 21
C. Pipeline Rehabilitation Plan 22
V. Capital Improvement Recommendations 22
A. CIPP and Replacement Improvement Recommendations 22
B. Large Scale Capital Improvement Projects 25
C. Potential Permanent Flow Monitoring Locations 30
D. Considerations for the proposed Chipeta Park Addition (CIP – A) 30
Appendix A – Calibration Results 32
Appendix B – Sewer Flows per Basin Spreadsheets 38
Appendix C – Additional Information 39

I. Executive Summary

A. Purpose

The purpose of this report is to examine the City's existing wastewater collection system and update the 2008 Sewer Master Plan (MP) for the City of Montrose. Several projections from the 2008 MP needed to be revised. For example, in the 2008 the growth rate was assumed to be 4% which is what the City was experiencing at the time of the previous master plan. Actual growth rates have been much lower since, closer to 1.5%. The master plan also needs to be updated because the City has faithfully followed the 2008 Master Plan Capital Improvement Project (CIP) recommendations. Therefore, this master plan update evaluates the current 2015 collection system and provides the City with an up to date CIP list for the future based on sewer flow increases.

B. Scope

Specific tasks involved in the preparation of the Sewer Master Plan Update for the City include:

1. Revise the Population and Growth Projections based on WWTP influent flows and historic population trends.
2. Sewer Data collection and input – Including twelve (12) simultaneous flow monitor locations, field survey in certain areas, and field inspecting manholes that have two outlets.
3. Update and calibrate the sewer model using InfoSewer, City GIS data, new survey information, and the new flow monitoring data.
4. Develop a list of problem areas using both modelling results and CCTV inspection data, and determine cause of problem (pipe size, slope, deteriorated conditions, etc).
5. Develop list of CIP needs for the collection system, with special attention given to the 10-year plan. A longer term plan is also included.
6. This master plan considers the impact to sewer flow for service area populations up to approximately 56,000. (Note: This is different from the Water Master Plan because the water and sanitary services boundaries are not identical.)

C. Projected Growth and Sewage Flows

The 2008 Master Plan estimated population growth to occur at 4% annually. Since 2008, actual growth has been around 1.5% per annum growth according to the Colorado Department of Local Affairs (DOLA). It is possible the recent recession is responsible for the lower growth rate because between 2010 and 2013 the population of the City declined each year. Population declines are not expected long term, nor is the trend in 2014 and 2015. For the purpose of this master plan, we assume growth at 2% per annum.

Sewage flows were calculated using the "Sewer Flows per Basin Spreadsheet", see Tables 1A, 1B, 1C, and 1D located in the Appendix. Influent sewage flows as recorded at the WWTP have generally trended with the population, slightly declining between 2010 and 2013, and increasing over the past two years. Peaking factor, contributions per capita, and people per tap have been revised for this study, but are generally similar to the previous master plan.

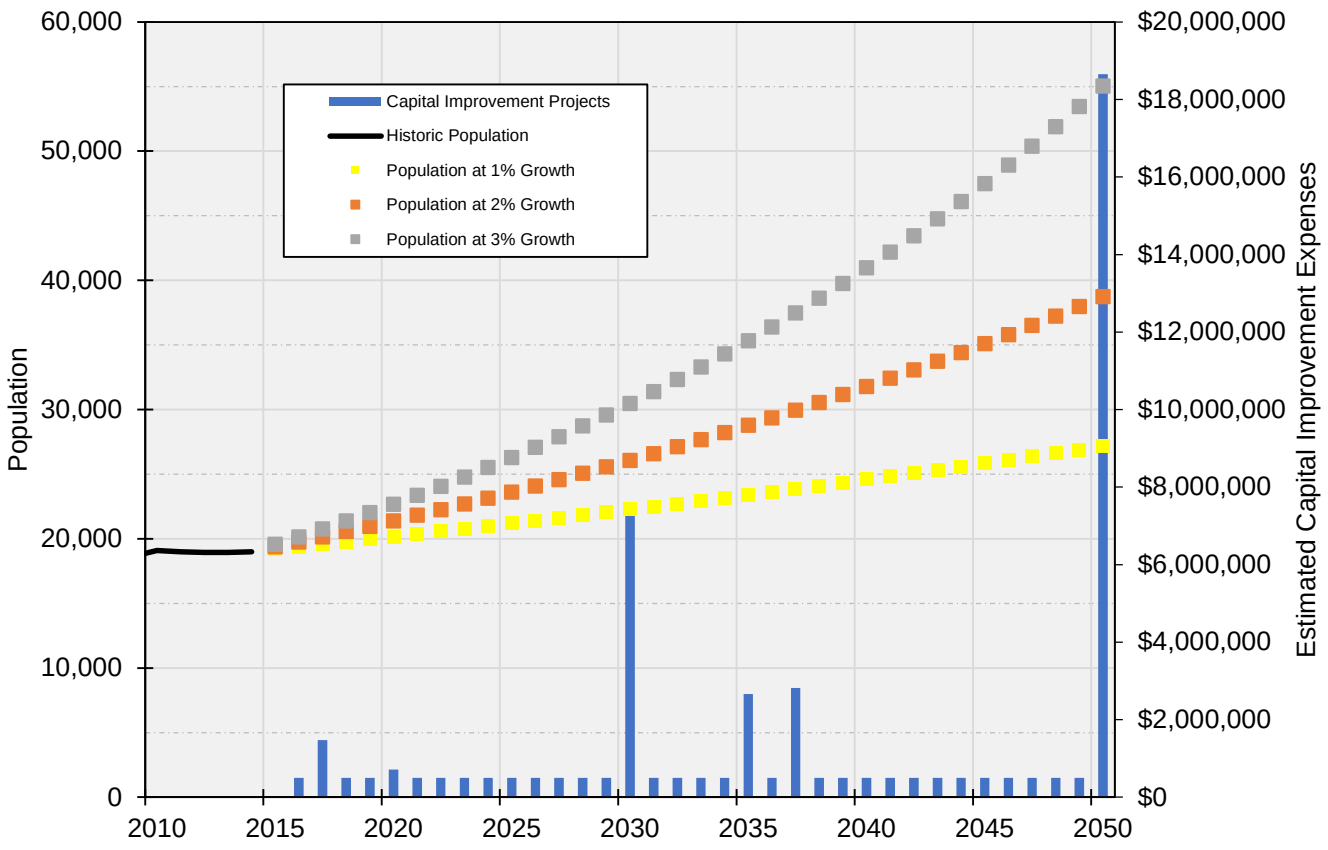


Figure 1 – Population Projections and Estimated CIP Expenses

Figure 1 shows three different curves, representing sewer service area population growth rates of 1%, 2%, and 3% per year. For the purposes of scheduling when improvements may need to be made, we have selected the 2% growth rate. The blue columns represent approximate dates and dollars for implementing the CIP's defined in this master plan. The costs are based on year 2015 estimates plus inflation of 3.5 % annual, costs can also be found in
Table 1.

Notice that the populations associated with each model output refers to the sewer service area equivalent population, which is larger than the population within the City limits. The various Design Years are consistent with the approach developed in the 2008 Master Plan, where by flows are expressed as a function of growth rather than calendar year.

This study has assumed four future scenarios referred to in this report as design years:

- Design Year 0.5 is equivalent to a Population of 25,400 and year 2027.
- Design Year 1 is equivalent to a Population of 31,600 and year 2037.
- Design Year 2 is equivalent to a Population of 44,000 and a year beyond 2050.
- Design Year 3 is equivalent to a Population of 56,000 and a year beyond 2050.

The population numbers assume at a 2% growth rate.

D. Capital Improvement Recommendations

City CCTV records were used to develop CIPP and replacement priority lists. The 50 most defective pipes according to CCTV data make up the CIPP list, and the 50 pipes with the worst sag conditions make up the replacement list. Some pipes rank high on both the CIPP list and replacement list, these pipes ought to be replaced rather than lined. We recommend the City improve the listed pipes by implementing an annual

budget in the order of $500K. Improvements recommended are listed on Table 1, and are shown on Exhibit 1.

Table 1 – Recommended Capital Improvement Projects

CIP#	Year	Est. Cost		Project
		(2016 $'s)	(Inflated $'s)	
1	2017	$ 938,000	$ 971,000	Stone Bridge Drive New Trunk Sewer
2	2020	$ 188,000	$ 216,000	Niagara Rd. to Hillcrest Improvement
3	2030	$4,358,000	$7,055,000	Upsize Eastern Highway 50 Interceptor Trunk Sewer & 7th Street Parallel Sewer
4	2035	$1,125,000	$2,163,000	Improve Segment of River Trunk Line near Recla Metal.
5	2037	$1,125,000	$2,317,000	Improve River Trunk Sewer Downstream of Airport Interceptor
6	2050	$2,407,000	$7,753,000	Improve River Trunk Sewer Between CIP 4 and Grande Ave. Sewer
7	2050	$1,554,000	$5,006,000	Improve River Trunk and Colorado Ave Sewer
8	2050	$ 985,000	$3,173,000	Improve Upstream Section of River Trunk Sewer
9	2050	$ 688,000	$2,216,000	Improve River Trunk Sewer upstream of Airport Interceptor *(Unless future survey shows not needed)*
A	2016	TBD	-	Highway 550/Townsend Southern Gateway Interceptor West of River Interceptor
B	2016	TBD	-	Highway 550/Townsend Southern Interceptor East of River

Inflated dollars represents actual costs in the predicted year of the CIP. It is difficult to estimate the actual valve of inflation due to changing construction costs, we have assumed inflation at 3.5%.

In general, Capital Improvement Projects 1 thru 5 need to be implemented by Design Year 1, which is equivalent to a population of about 32,000; Projects 6 thru 9 need to be implemented by Design Year 2, or 44, 000. The actual years recommended in Table 1 are based on the 2% growth rate, and a prioritization/sequencing that is preferable. CIP's 1 and 2 are recommended sooner than may be absolutely necessary as these will reduce maintenance issues with slow-flowing partially surcharged flat sections of sewer. Also, CIP 1 is recommended soon as this will help secure the easement and alignment for this new sewer before development densifies too much and complicates the sewer installation. Projects A and B are development trunk lines that the City has plans to construct in the near future. We have included the developer projects because they will serve as trunk sewers vital to the growth of the system.

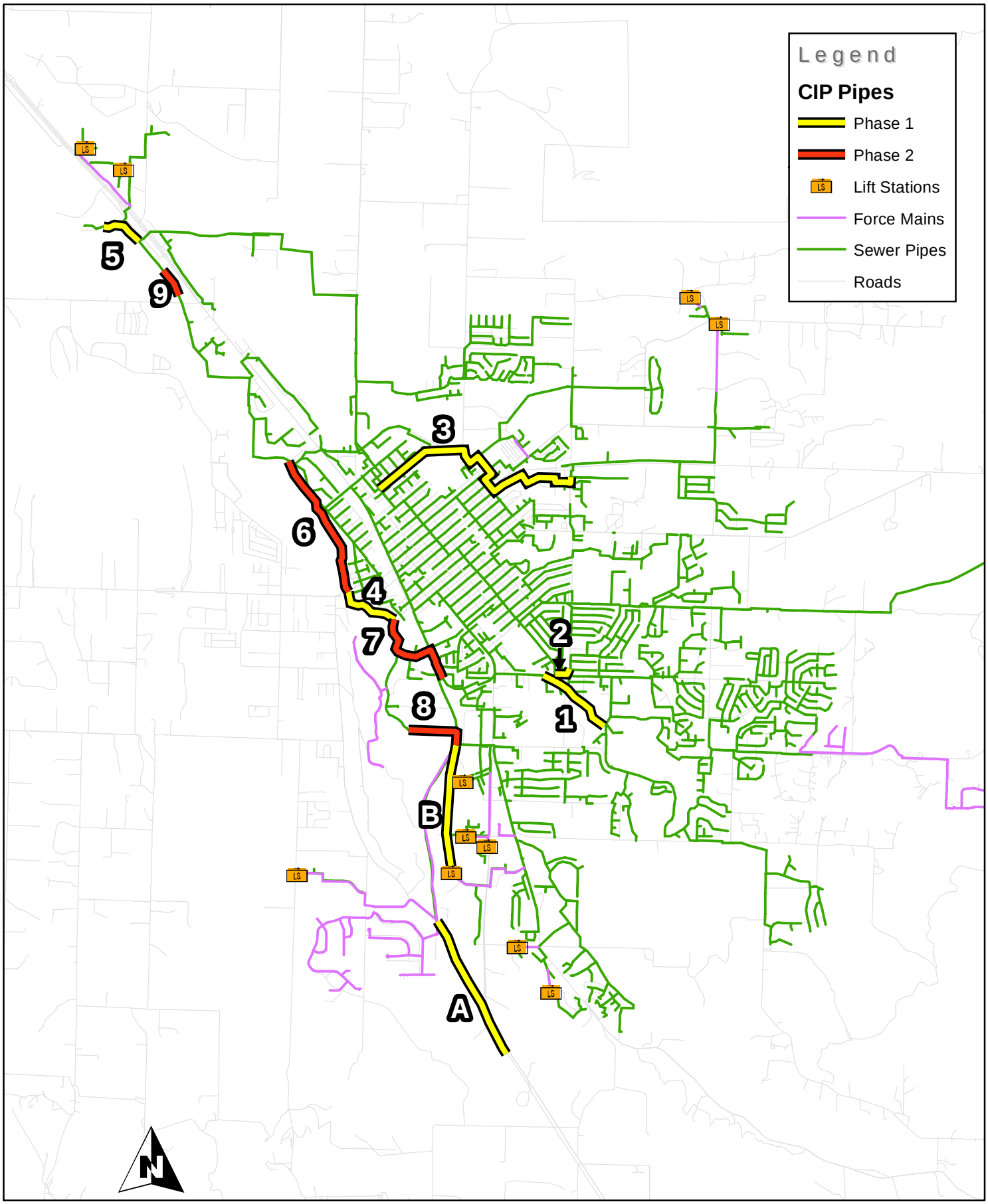
Refer to the CIP Map in Exhibit 1 for the locations of the capital improvement projects. Refer to the descriptions of the CIP's in Section V for an explanation of the need and schedule for each project.

Note: For additional detail and map of the system, refer to the large map that is in the back pocket of this report.

II. Existing System Evaluation

A. Introduction

The existing collection system was evaluated using CCTV data, flow monitoring and modeling analysis, and discussion with City staff. CCTV records provided data primarily associated with branch sewer pipes. Flow monitor data and modeling analysis provided information used to evaluate current and future trunk



0 1 2 Miles

1/16/2016

Montrose Sewer System
CIP Map

Exhibit 1

line issues. Discussions with City personnel provided additional insight to problems throughout the system, and foresight concerning the possible directions for correction. Farnsworth Group engineers also inspected the critical manholes around the City to verify actual conditions.

Peaking factors (PF), Inflow and Infiltration (I&I) distributions, flow paths, critical pipe slopes, and flow distributions were among the more crucial data parameters needed and analyzed for calibrating the updated model and evaluating future scenarios. Unit hydrographs (UH) from each basin have been confirmed analyzing the 2015 flow monitoring data, so the UHs remain as developed in the 2008 Master Plan. I&I distributions were altered slightly based upon the higher quality 2015 flow monitoring data. Calibration results are excellent.

B. City GIS Data

Sewer model input data for pipes and manholes were provided by the City. Pipe GIS data included pipe length, diameter, material, and Manning's N. Manhole GIS data included invert elevations, pipe outlet size, and location. Manhole and pipe data were processed to relate each pipe with the appropriate manhole up and downstream, and followed by a calculation of pipe slope.

Some manhole inverts and pipe networking needed to be adjusted to make the model functional. Exhibit 2 highlights the edits that were made to the input dataset. See the "Hydraulic Model of Existing System" section for details. Model accuracy can be improved by performing additional survey work at the manholes listed in Exhibit 2 as "Adjusted" or "Not surveyed". Pipe networking adjustments included assuming sewage passes in only one direction at spilt flow manholes. These assumptions are categorized in the "Hydraulic Model of Existing System" section as well.

C. Trunk Sewer System

The Trunk sewer system was delineated in the previous model based on pipe size and relationship to the system. The 2015 model basically matches the previous model's trunk delineation, but includes additions made to the system since 2008, most notably the airport interceptor. An overview of the modelled trunk lines and pipe sizes can be found in Exhibit 3. This exhibit also shows which manholes are used to receive sub-basin influent in the model. This is general consistent with the 2008 Sewer Master Plan.

D. Field Survey

In this study 60 manholes were surveyed. These manholes were selected based on flow monitoring locations, checking the three (3) flow-split manholes, and key manhole invert data that was missing. Not all manholes in the City's GIS had invert data, so a handful of these manholes were selected to fill in the missing data, but many manholes remain un-surveyed. Surveying these manholes is a good further study item. Exhibit 2 graphically presents the quality of invert data for each manhole on the trunk lines, a list with manhole IDs can be found in Appendix C.

E. Existing Lift Stations

The sewer system has nine lift stations. Previous Farnsworth Group work reviewed the condition of the lift stations and made recommendations for improvements and replacements. Many of the lift stations have poor electric and controls conditions and do not comply with NEC regulations. Corrosion is also a significant issue with many of the lift stations, like LaSalle Rd, because existing flows are not enough to regularly cycle the pumps on and off. Therefore, anaerobic conditions build up in the force mains and release sulfides in the downstream manholes and pipes. Exhibit 4 shows the location of the lift stations, force mains, grinder pump force mains and the sewer diameters.

Lift stations were not included in our model, but maximum flows were modelled by including sewage contributions in pumped basins as if there were no pump. This affects flow monitor data, and the calibration

process, as the monitors will experience spikes in flow as the pumps turn on and off, whereas the model experiences flow as the contributions are made. Given that many lift stations are planned to be eliminated by future interceptor sewers, this approach is reasonable.

The city is planning to extend the river trunk line south to intercept flows that are currently served by the Sears and Home Depot lift stations. The existing conditions model does not include the extension, but does include the extension in the future scenarios. It is worth noting that throughout the system some of the force mains pump sewage into a lateral basin which may contribute to a different trunk sewer. In our model we have assumed all flow originating in a given basin flows by gravity from that basin. So the existing system model flows will vary slightly from actual flows for Basins 13 and 44.

F. Flow Monitoring

1. Objectives of Flow Monitoring

Twelve Sigma 910 flow monitors were installed at key locations throughout the collection system. The objective of the monitors is to provide field data to calibrate the model. Certain locations also have specific goals such as quantifying I&I flows, characterizing flow and pattern, or characterizing a specific sewer capacity.

Flow monitoring throughout the system is vital to develop appropriate diurnal curves throughout the system and in the differing use areas. Without flow monitors properly placed at key locations in the system calibrating the model is not possible. Ultimately, the goal was to develop a realistic model that can be used to confidently predict the system's behavior under different scenarios and future conditions.

2. Flow Meter Locations

Three monitors were placed on the 18-inch interceptor along the Uncompahgre River, one on the downstream segment of the 30-inch Airport interceptor, two monitors at the main trunk lines feeding the 30-inch Airport trunk line, one in Mesa Ave. near Rotary Park, one in S 12th St. where it runs into Mesa Ave., one in the gravity line crossing the river that serves the Cobble Creek area, one in Woodgate Rd. downstream of the proposed recreation center, and one in Pavilion Dr. upstream of the event center. Exhibit 5 shows all the flow monitoring locations. Additional detail is shown on the large map included in the back pocket of this report.

Monitor 1

Flow monitor 1 is located in Manhole E3-I7-39 and has a pipe diameter of 24 inches. This location was chosen because it is the main interceptor collecting from the City and is located near the end of the collection system just upstream of the 30-inch airport interceptor. Comparing flows at this location to the WWTP influent flows, and Monitor's 2 and 3 flows give us a good indication I/I flow conditions in the original 18" interceptor.

Monitor 2

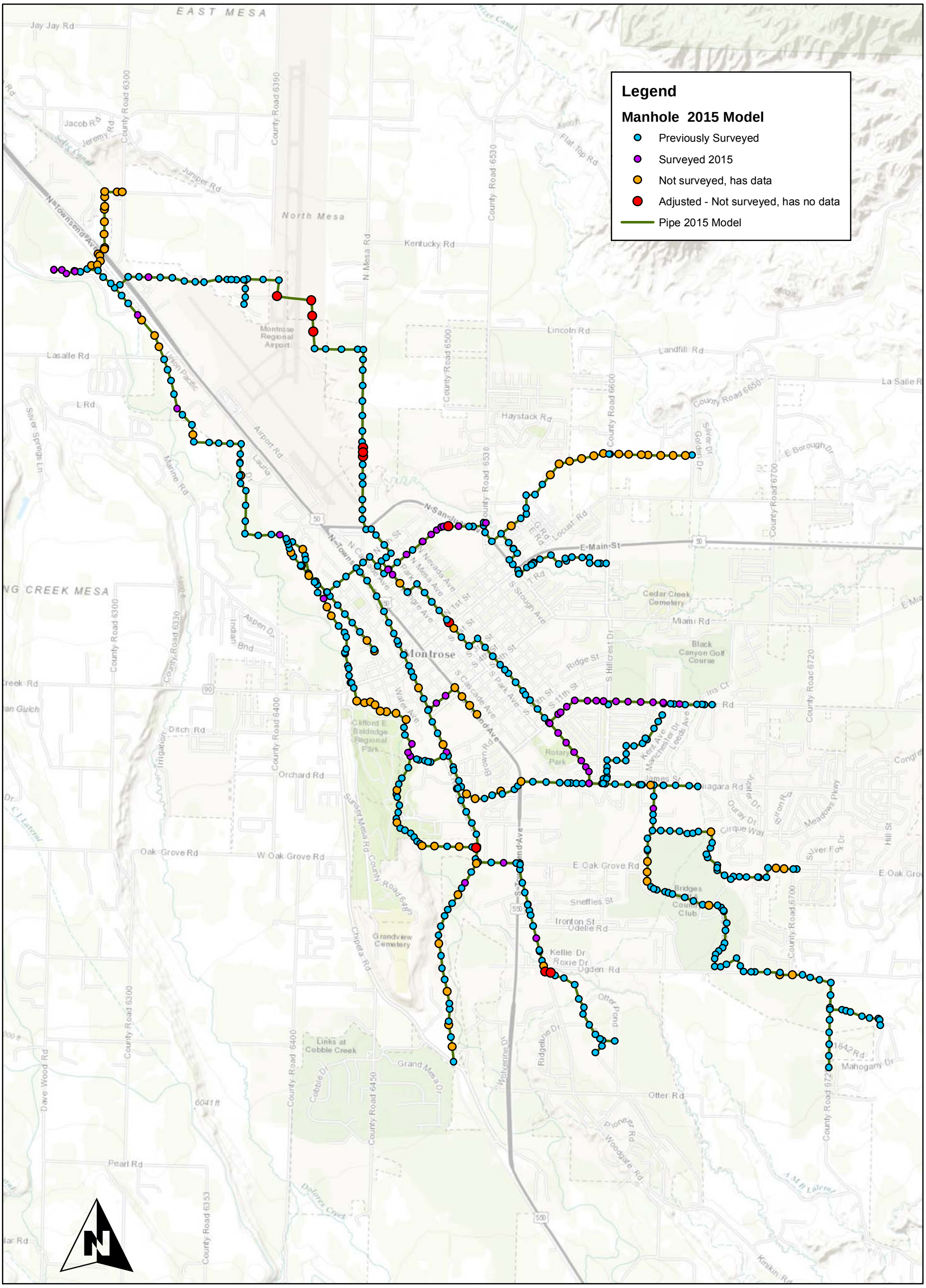
Monitor 2 is located in manhole F4-L8-6, on the 18" interceptor following the river, just downstream of Grand Ave. near the Justice Center. This site was chosen because very few sewer services exist between this monitor and Monitor 1, and because this is the furthest upstream site that is also downstream of the downtown area.

Monitor 3

Monitor 3 is located in manhole E3-I7-53 located at the downstream end of the 30" airport trunk line. This monitor provides necessary information to record the quantity of flow contributed from the 30" airport line versus the 18-inch (old) river interceptor.

Monitor 4

Monitor 4 is the third and most upstream monitor in the 18" (old) river trunk line, the Manhole ID is F4-L8-3. The site is located at the intersection of Grand Ave. and N 9th St. Data from this monitor help to define where flows in the final reach of the 18" trunk line are originating, either from upstream

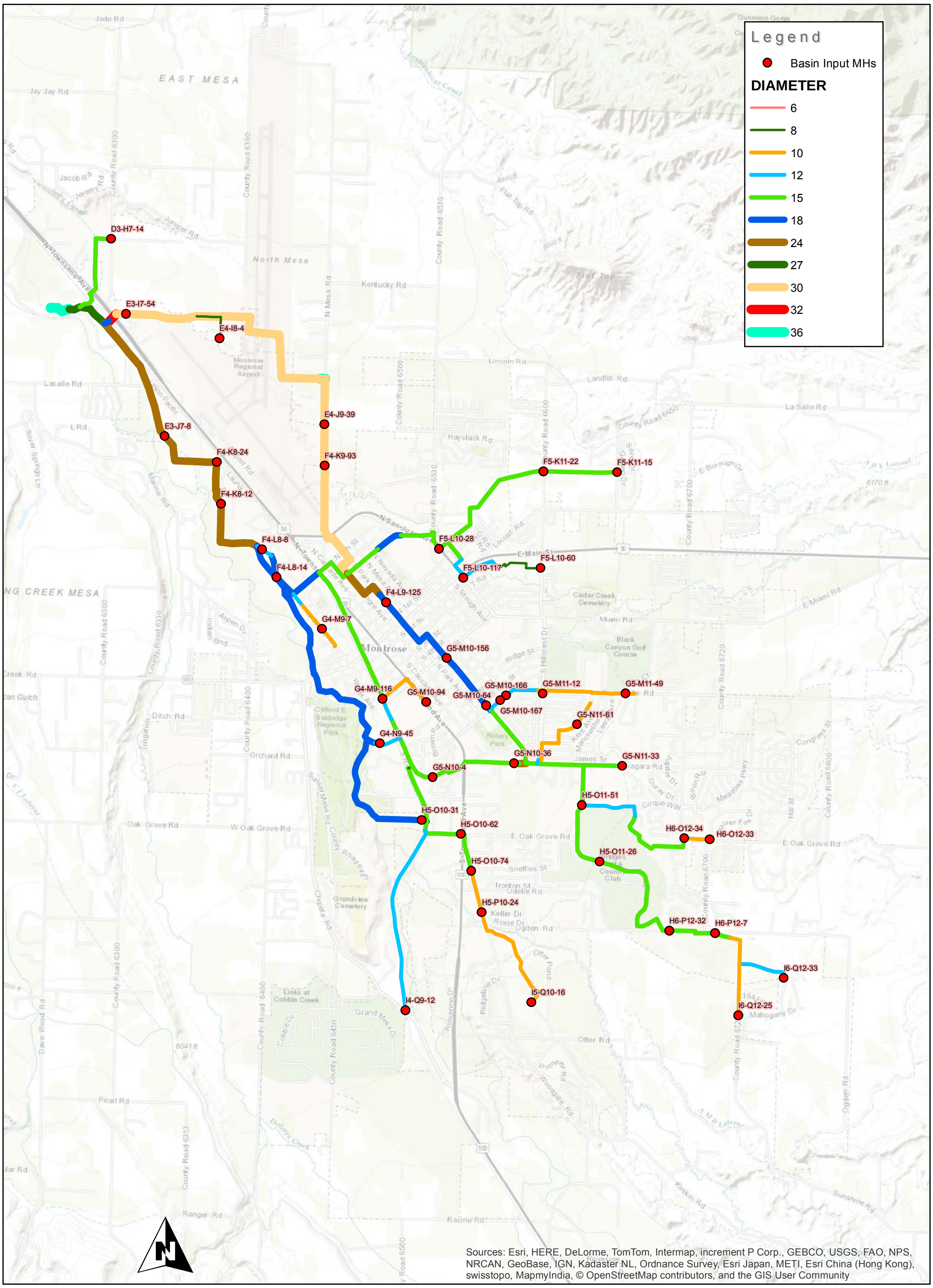


Montrose Sewer System

Farnsworth GROUP

MH Invert Quality

Exhibit 2



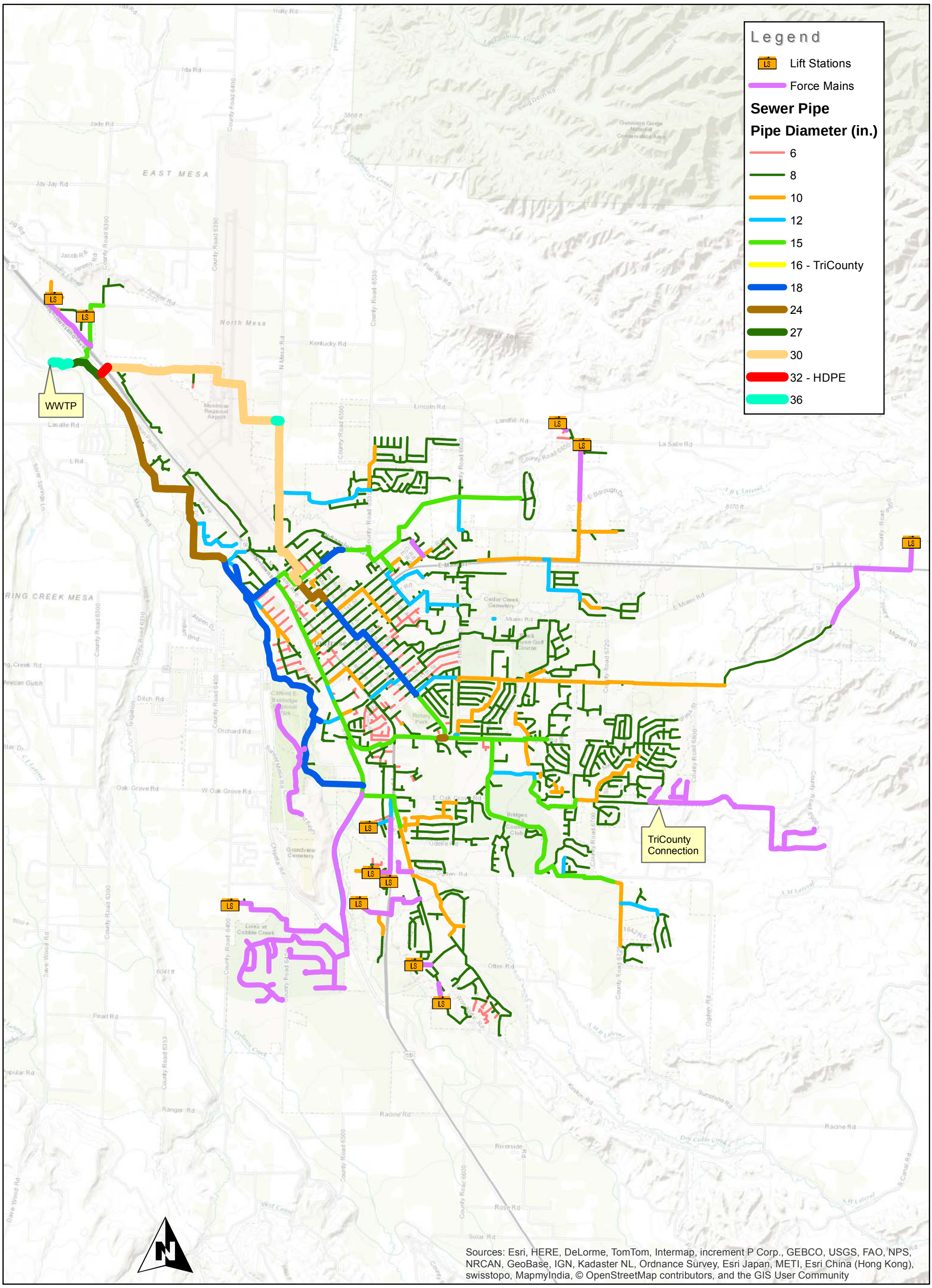
0 1 2 Miles

12/7/2015

Farnsworth GROUP

Montrose Sewer Model

Exhibit 3



0 1 2 Miles

12/7/2015

Farnsworth GROUP

Montrose Existing Sewer System

Exhibit 4

of Colorado Ave. or contributions from downtown. Since the Airport Interceptor is a new feature from the previous Master Plan flows contributed by the downtown area to the 18" interceptor need to be determined.

Monitor 5

Monitor 5 was placed in Manhole F4-L9-84, which is located in 7th St. near Mesa Ave. Flows at this location represent contributions from Basin Areas 11, 12, 13, 14, and a small portion of 18. Flows from this monitor and Monitor 6 generally account for the contributions to the airport interceptor from the City. Contributions after these monitors are along Highway 50 and services around the airport.

Monitor 6

Monitor 6 is located in Uncompahgre Ave. between N 6th St. and N 7th St. in Manhole F4-L9-120. This site represents all contributions collected by the airport interceptor, which follows Mesa Ave. through the City, upstream of N 7th St. The previous Master Plan did not quantify with monitor how much flow would be contributed to the airport interceptor, so Monitor 6 was used to record current flows in the interceptor. As mentioned before Monitor 6 and Monitor 5 will together generally account for all the contributing flows being made to the airport interceptor from the City.

Monitor 7

Monitor 7 is located in Manhole G4-M9-76 in the S 4th / 5th St. alley at Ute Ave., and generally recorded all contributing flows between Townsend Ave. and flows intercepted by the airport / Mesa Ave. interceptor. This area is relatively small, but the flows recorded here represent mixed-use medium density flows which are vital data for properly calibrating the model.

Monitor 8

Monitor 8 was placed in Manhole G5-N10-169, located on the Mesa Ave. trunk line upstream of S 12th St. This site quantifies the contributing flows to the airport interceptor from Basin Areas 25, 31, 32, 33, 34, 35, 40, 41, 42, and part of 23 and 30.

Monitor 9

Manhole G5-M10-168 located in S 12th St. just upstream of Mesa Ave. was selected for Monitor 9 because S 12th St. serves as a major trunk line along Sunnyside Rd. receiving contributions from Basins 27, 26, 24, and a SE portion of 23. The Sunnyside Rd. trunk line is also new as of 2014 when a series of disconnected pipes in Basins 24, 25, and 26 were redirected to flow through the now continuous interceptor in Sunnyside Rd. eventually contributing to the Mesa Ave. interceptor at S 12th St.

Monitor 10

Monitor 10 is located in Manhole G5-N11-16 in Pavilion Dr. just downstream of the intersection with Robins Way. The sewer in this area is relatively shallow and so recording flows in this segment of the system was important for available capacity estimates and analyzing the need for a potential additional sewer line starting upstream of Monitor 10 in Pavilion Dr. following Dry Cedar Creek to the Mesa Ave. Interceptor. The contributing Basins to Monitor 10 are 31, 32, 34, 40, 41, 42, and potential future development in Basins 35, 36, and 39.

Monitor 11

Monitor 11 is located in Manhole H4-O9-15, which is on the gravity portion of the sewer serving the Cobble Creek development. Cobble Creek is served by an E1 pressure system which turns to gravity at Chipeta Rd. and follows the Uncompahgre River. Monitor 10 was installed just downstream of the river crossing before flows combine with Oak Grove Rd. This site was specifically chosen to quantify non-I/I conditions (since the area is all pressure) and to help develop a strong correlation between AMI water use data and sewer contributions.

Monitor 12

Manhole H5-P10-26 was selected for Monitor 12 because it is downstream of the proposed site for the new Montrose County Recreation Center facility, which is going to have a multiple pool filters and backwash systems. The site is located in Woodgate Rd. near the City Market. Capacity calculations at this monitor will help justify the filter backwash flow limitations the City is enforcing on the recreation center.

3. Flow Monitor Results & Analysis

The Sigma 910 flow monitors report results in a text file that is easily converted into a comma-delimited file and processed by Microsoft Excel. The monitor records contain date, time, depth of flow in inches, flow in gallons per minute, and velocity in feet per second. Using these parameters a number of analysis can be performed, including; percent capacity (depth/diameter), peaking factor (average/peak flow), diurnal patterns (average/hourly flow), and I&I (downstream flow minus upstream flow).

Flows are also recorded at the WWTP influent using a Parshall flume. Influent flow records represent the total system flow, and are considered to be more reliable than the Sigma 910 monitors. The flow monitors performed well over all, but some inconsistencies and errors were encountered. Noteworthy inconsistencies and errors include;

- FM 3 recorded significantly higher flows for a period of 2 weeks
- FM 7 recorded a flow rate of zero consistently, even during peak use hours.
- FM 2 periodically recorded higher flow rates than FM 1 (loss of flow)
- The sum of FM 1 and 3 sometimes was greater than the WWTP influent flow (loss of flow)
- FM 3 recorded flow significantly higher than the sum of FM 5 and 6.

Each of these issues are discussed below in further detail.

June 28th and 29th were selected as the most representative days to calibrate the model, because all the flow monitors during that time appear to have recorded reasonable data. Two days were used for calibration to account for variation, particularly regarding lift station on/off cycles. Further discussion is provided below.

Figure 2 shows the WWTP influent flows and flows at Monitors 1 and 3. The combined flow of Monitors 1 and 3 should approximately equal flows at the WWTP with the addition of a small section of contributions downstream of 6300 Rd. Assuming the WWTP record is accurate one or both of flow Monitors 1 and 3 are over measuring actual flows. The overall error appears to be 0.5 MGD (350 gpm) or less on average.

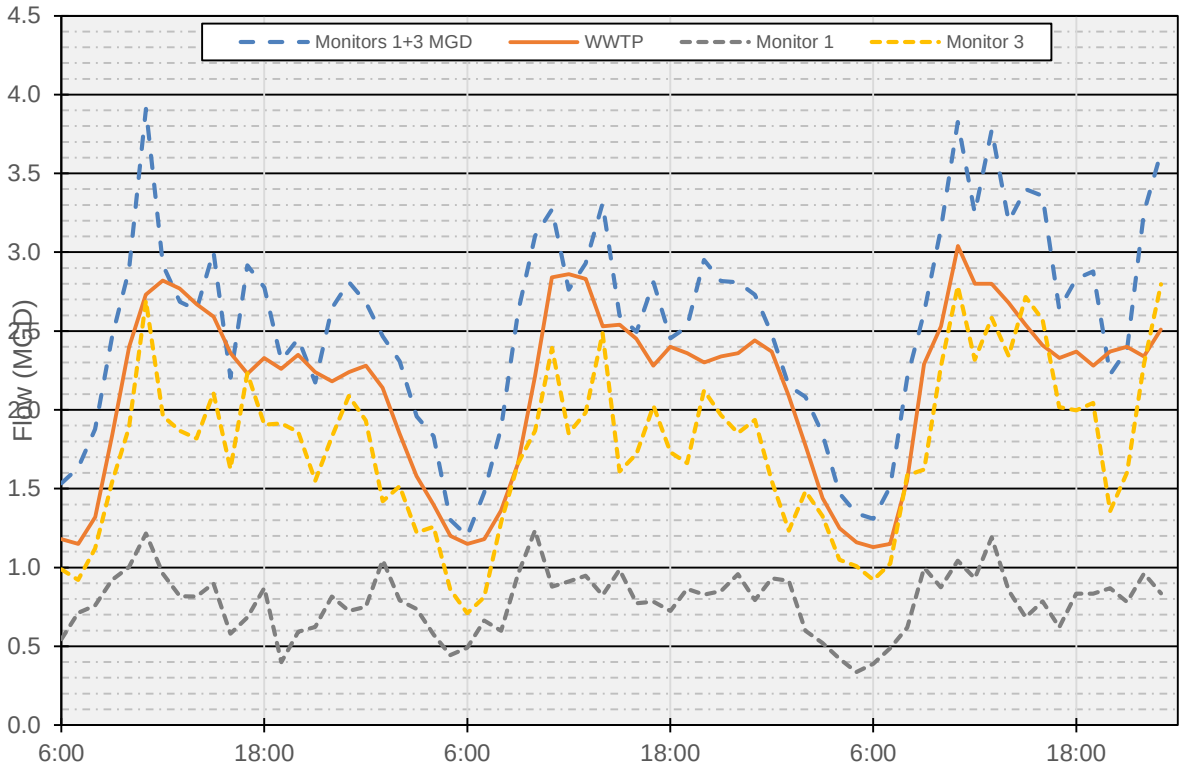


Figure 2 – WWTP influent and Flow Monitor 1 and 3 flows from June 27th to June

Figure 3 shows the daily average flows at Flow Monitor 1 and 2 over the duration of the monitoring period. Monitor 2 is upstream of Monitor 1 on the river trunk sewer northeast of town. Few sanitary contributions exist between the monitor locations, so the difference in flow between 1 and 2 can be mostly attributed to I&I and/or a systematic inconsistency in the flow monitoring accuracy. Flow monitoring data is not considered to be completely accurate as many conditions can cause the monitor to fowl or read turbulent flows. The first couple weeks of data (June 16 – 30) record flows we would expected to see. Flows later in the monitoring period experienced flows upstream that are higher than flows downstream. This does not represent reality, but is not unexpected. The monitor is laying in the flow path and over time collects dirt, grime, and other debris disrupting the flow. When calibrating the sewer model June 28 and 29 were chosen since these days appeared to have the best flow monitoring data throughout the system.

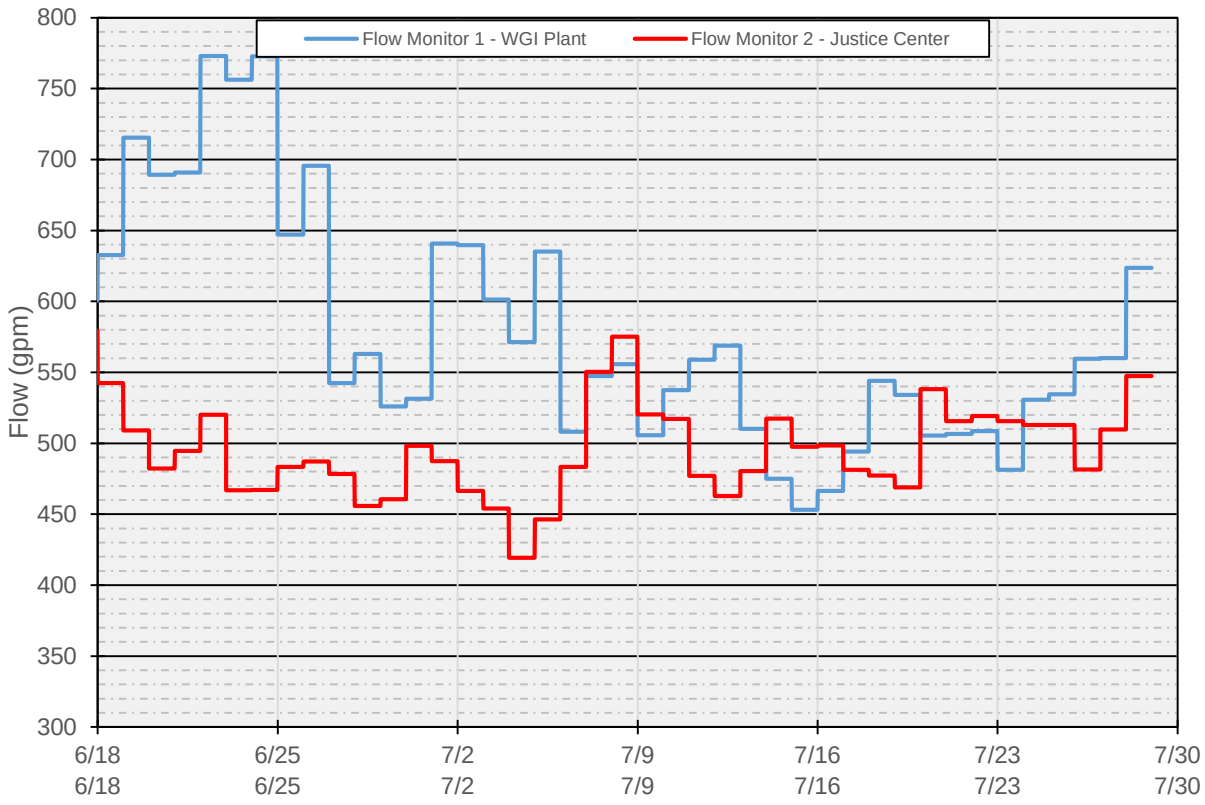


Figure 3 – Flow Monitor 1 and 2 recorded average day flows.

Figure 4 shows the comparison of average day flows from Monitors 3, 5, 6, and also graphs the combined flows for Monitors 5 and 6. As expected flows at Monitor 3 are consistently higher than the combined flows of Monitors 5 and 6. However, Monitor 3 is located on the airport trunk line, and all the pipe and manholes between flow Monitors 5/6 and Monitor 3 are less than ten years old. There are additional customers contributing to this segment of pipe, but not enough to account for 600 gpm. It is possible there is I&I occurring due to the depth of the airport sewer line, or an unknown large user is located in the area.

Also note in that Monitor 3 has a large bump between June 30th and July 16th. We are not certain that flows at Monitor 3 really increased this much for that period and suspect that the monitor was somehow fouled. When allocating flows and calibrating the model this bump was ignored. However, given that we did not observe the fouling that may have caused the high readings, and that the monitor was consistently reading 600 plus gpm more than Monitors 5 and 6 combined we suggest the City investigate the airport trunk line to ensure there is not significant infiltration, and investigate customers' usage in the area.

Given that Monitor 1 + 3 flows are higher than WWTP influent flows, and Monitor 3 flows are 600 gpm higher than Monitor 5 + 6 flows may suggest that Monitor 3 was systematically measuring higher than actual flows. However, 350 gpm does not fully account for the 600 gpm increase between Monitor 5/6 and Monitor 3.

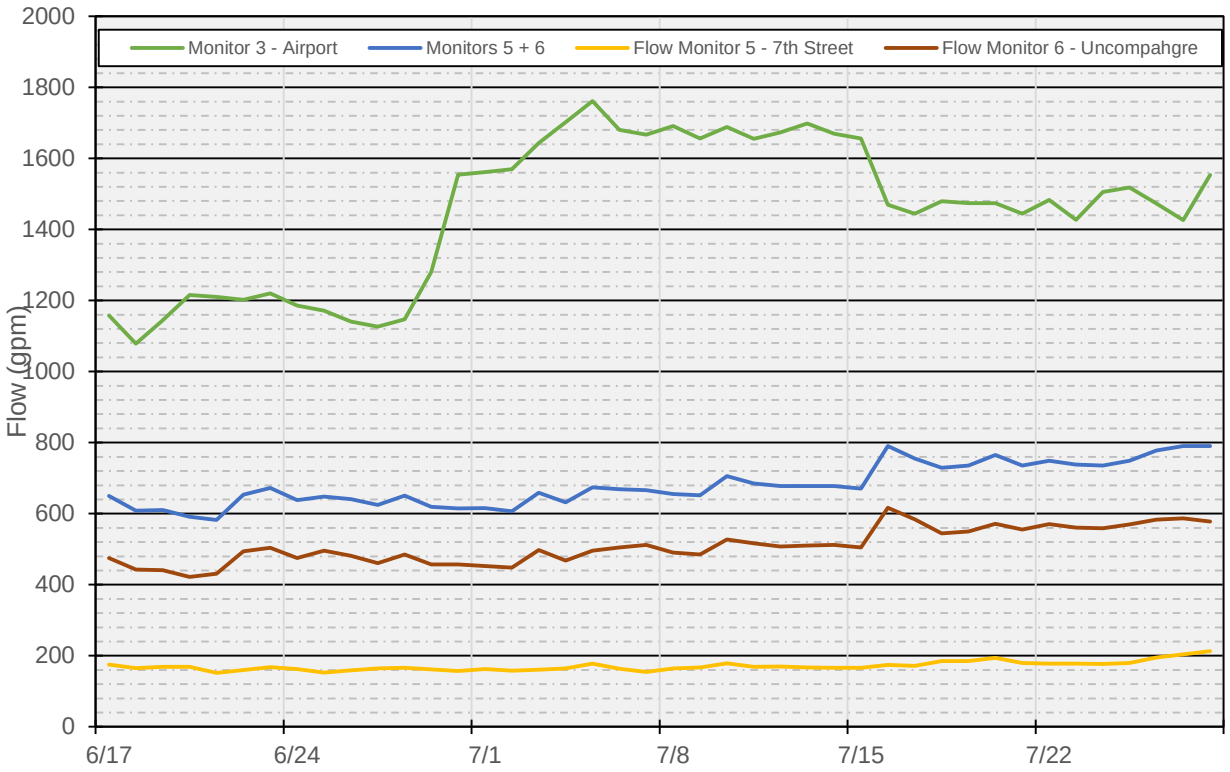


Figure 4 – Flow Monitor 3, 5, and 6 recorded average day flows. Light blue line

Figure 5 graphs the average day flow recordings from Monitors 6, 8, and 9, as well as the combined flow of Monitors 8 and 9. Monitor 6 is located on the Mesa Ave. interceptor downstream of Monitor 8 which is also located on the Mesa Ave. interceptor. Monitor 9 is located on the 12th St. sewer line just upstream of the confluence with Mesa Ave. The total flow at Monitors 8 and 9 should equal the flow at Monitor 6 plus the additional contributions from basin 17 and part of basin 18. The results suggest less than 100 gpm is contributed to the Mesa Ave. interceptor between S. 12th St. and N. 6th St. 100 gpm seems to be a little low given the density of basin 17. In the Sewer Flows per Basin Spreadsheet about 200 gpm is contributed from basin 17 during a max month. 75% of this flow is considered to be equivalent to a late June average day flow, which means we have estimated that flow Monitor 6 is under recording flows by about 50. Monitor 6 reading low could account for some of the difference in flows between Monitor 3 and Monitor 5/6. Consider that in our model we have estimated a sanitary contribution from basin 2, 7, and 45 to be 103 gpm. Add the 350 gpm which is the amount flow Monitor 1 + 3 is over the WWTP influent flows by we get 453 gpm. 150 gpm remains unaccounted for of the 600 gpm difference, so we have included these flows in the model as I&I in Basins 2, 7, and 45. It is possible the flows can be attributed to a large discharger.

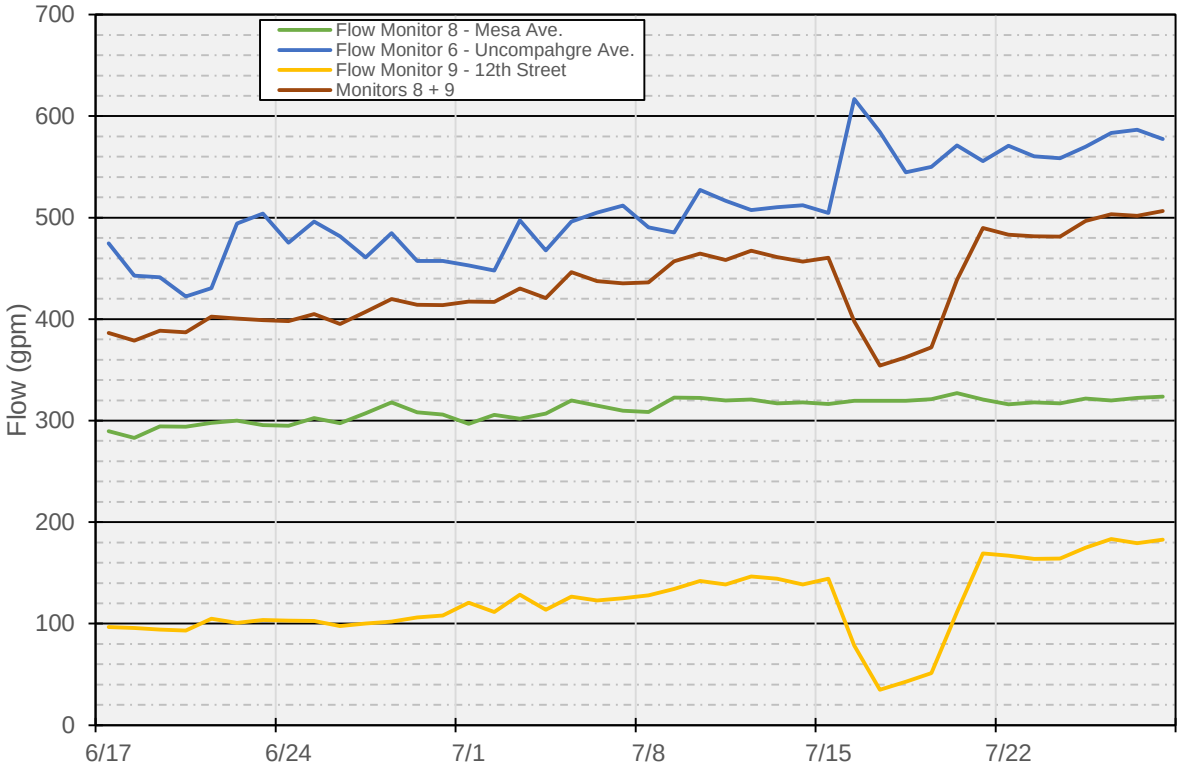


Figure 5 – Flow Monitor 6, 8, and 9 recorded average day flows. Red line shows total of flow monitors 8 and 9.

Flow Monitor 7 consistently recorded flow rates of zero, which is unexpected given that the sewer FM 7 was installed in serves about half a mile's worth of Townsend Rd. with both residential and commercial contributors. The sewer line at this location had plenty of flow depth, but velocities are extremely small, so this likely explains the data. It also shows there is a localized concern with sewer blockage, and/or flat slopes downstream. Therefore, we have omitted Flow Monitor 7 from our calibration procedures. The other eleven Flow Monitors were used for calibration after accounting for the known discrepancies listed at the beginning of this section. Flow Monitor recordings from June 28th and 29th can be found in the Appendix.

4. Commercial and Industrial Users

High discharge flows from the 2008 Master Plan model were carried over in the 2015 model with the addition of a 10,000 gpd discharge in Basin 5 and a 15,000 gpd discharge in Basin 22. These additional flows were added to account for hotels in the area and other industries that may be contributing higher than normal sewage flows.

G. Model Calibration - Recommended Unit Flow Rates and Peaking Factors

Wastewater treatment plant influent flows were provided by the City. All WWTP influent passes through a Parshall flume, which we have assumed are reliable data for the purposes of modelling. Inflow and Infiltration flows are calculated based on basin tap count, and basin area in the Sewer Flows per Basin Spreadsheet. Distribution of I&I flows in the spreadsheet were estimated from pipe age, pipe material, and flow monitoring data.

Figure 6 shows the monthly average and maximum day WWTP influent flow records. The figure also shows average and maximum day flows for the months of July, August, and September. These months on average

represent the peak seasonal influent flows, so trending these month's flows best captures the historic peak influent flows, which is of higher relevance when analyzing collection system capacity limitations.

Sanitary, industrial, and I&I sewer contribution flows were developed using the Sewer Flows per Basin Spreadsheet. Column "Existing Customer Sanitary Flow (gpd)" represents the average monthly contribution for the month of August. On average monthly June flows are 80% of August flows, which we account for when calibrating the model. The best flow monitoring data was from June 28th and 29th, so these days were used to calibrate the model. The "Existing Customer Sanitary Flows" needed to be adjusted down in order to calibrate the model to the 28th and 29th flow data. WWTP flow for those days was about 2.05 MGD, and average August flows are 2.5 MGD. I&I is estimated to be the same in June and August at 0.66 MGD so a factor of 0.75 was applied to the August sanitary flows [(2.05-0.66)/(2.52/0.66)=0.75]. The model calibrated well using these flow estimations.

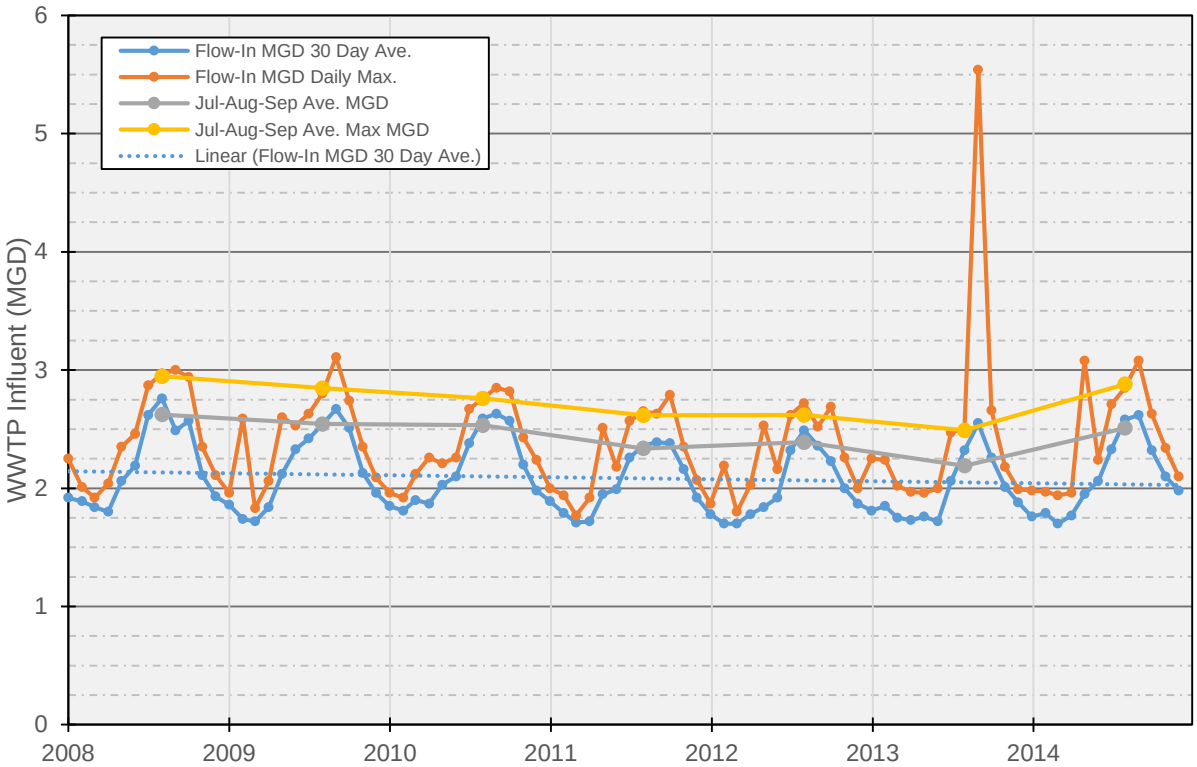


Figure 6 – Monthly Average and Maximum Day WWTP Influent flows. (DMR Data)

Model Input Flows

Model flow inputs originated from the previous master plan's Sewer Flows per Basin Spreadsheet. The location of flow input nodes per basin is shown on Exhibit 5. The City has used this spreadsheet for planning purposes since 2008, and desired to continue its use for ease of continuity. Updates to the spreadsheet are highlighted in red and include:

- <u>Peaking Factor</u> (for maximum day estimates)
  A peaking factor of 1.3 was selected by comparing the average monthly flows of July, August, and September to maximum day flows from the same months at the WWTP. Figure 6 shows the comparison of max. day (yellow line) and monthly average (gray line) flows at the WWTP. On average the max day is 1.3 times larger than the average monthly flow, so 1.3 was used as the peaking factor. This is slightly lower than the 1.4 factor used in 2008.

- <u>People per Tap and Basin Taps count</u>
  Estimated tap additions were added to the Sewer Flows per Basin Spreadsheet by reviewing building permits since 2013 and comparing satellite photographs from 2008 and 2014. Basins with

growth since 2008 were estimated to have between 10 and 30 additional taps, see column labelled "2008-2015 New Eqiv. Taps" highlighted in red. The people/tap number slightly increased from 2.0 to 2.1 as an estimation of general population increase not represented by new tap construction.

- Gallons per Capita per Day Usage
  The model-calibrated gallons used per capita per day decreased to 95 gpcd from 100 gpcd in the previous master plan. The CDPHE Design Criteria for Domestic Wastewater Treatment Works Section 3.2.2 Part c. requires Maximum Month Average Daily Gallons per Capita per Day Usage to be between 75 to 100 gpcd, unless otherwise justified. National standards vary between 54 gpcd and 130 gpcd.[1]This number was primarily changed as a calibration to the model. The number is expected to decrease over time as efficient fixtures and higher density housing units are constructed, so the revised number is reasonable.

- Basin Area Delineation
  Basin areas for 28, 37, 43, and 44 were modified to better reflect the City's plans to intercept basin contributions in trunk lines either east or west of the Uncompahgre River. The previous Master Plan had divided basins along Highway 550. This modification was performed at the City's request as they would rather make sewer connections across the highway than the river. Contributions originating west of the Uncompahgre will flow to the existing 12" river crossing and contributions originating east of the Uncompahgre will flow into a proposed interceptor following the Uncompahgre on the east.

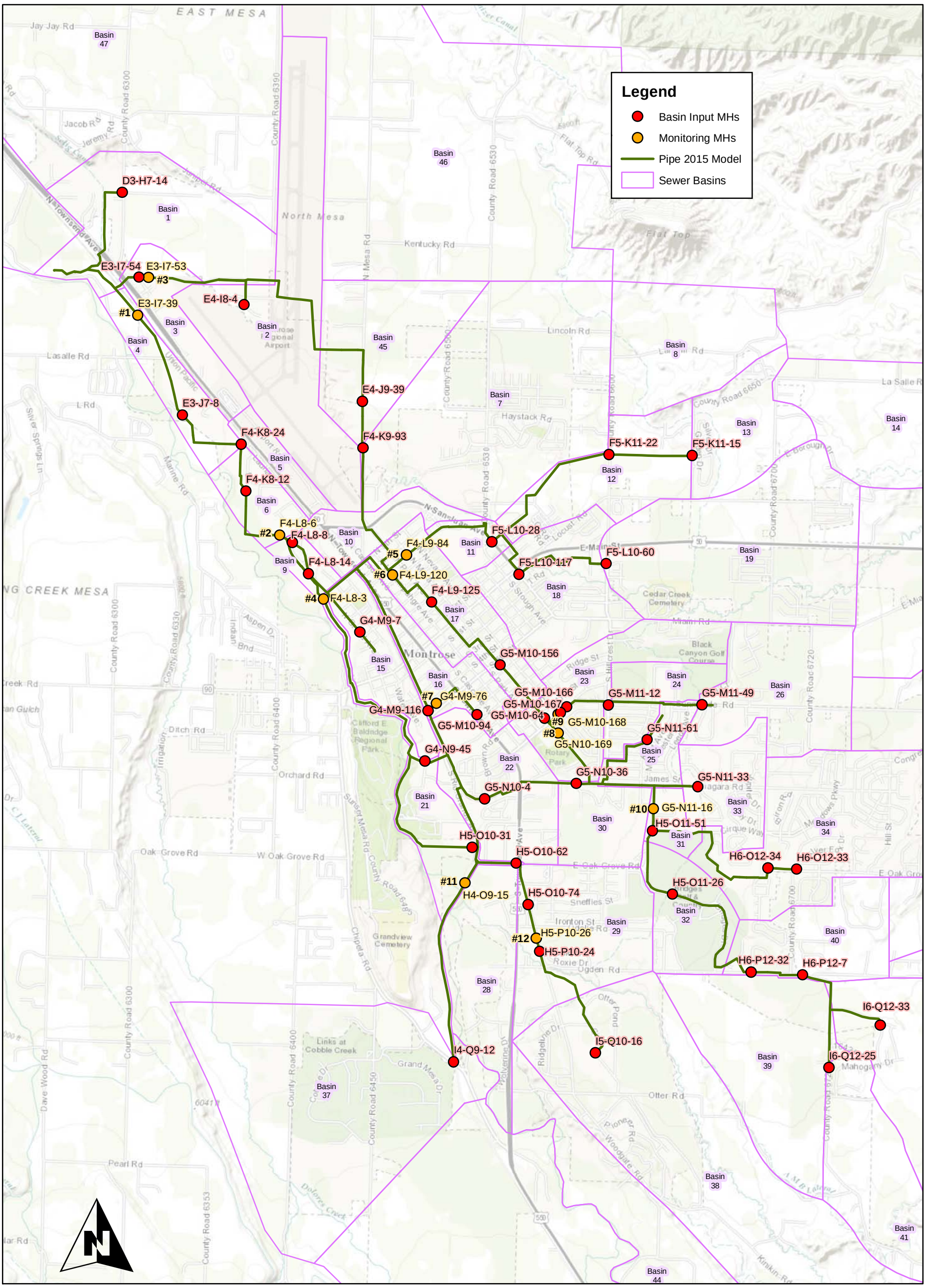
- Basin Contribution Manhole Locations
  Sewer flows originating from each basin is introduced into the model at "input manholes". These manholes represent idealized locations on the sewer trunk lines where most of the flow from a particular basin is introduced. The Sewer Flows per Basin Spreadsheet lists the manholes that the model contributes the basin flows to. Some of these manholes needed to be revised for one of the following reasons; 1 – the manhole was demolished and/or replaced with a new manhole, 2 – Input locations needed to be divided into multiple manholes, or 3 – input locations were too close to a monitoring location disrupting the calibration process. Often the input manholes are located upstream of where we expect the basin to truly be contributing, this is a conservative approach because more flow occurs in more pipe.

- Basin I&I Relative Factors
  The 2008 sewer model introduced I&I by broadly adding additional flows in the sewer system based on approximate sewer age to represent I&I. During the calibration process it became evident that the broad application of I&I throughout the system could be refined. To address the issue I&I Factors were adjusted to increase I&I contributions near the north and river sections of town, and reduce I&I across the rest of the system. The I&I relative factor in the Sewer Flows per Basin Spreadsheet is a unitless arbitrary number that is used to distribute I&I flows in different amounts to each basin. In other words, basins that we know have higher I&I flows get a higher relative factor, and basins with less I&I get a smaller relative factor.

- High Discharge Contributions
  A few high user discharge numbers were added to the spreadsheet to represent hotel contributions in Basin 5 and Basin 22.

The 2008 Sewer Master Plan estimated the number of sewer services by counting rooftops from an aerial map and adding equivalent taps to duplexes and apartments. Sewer service count has been updated to 2015 conditions by adding the number of sewer service tap sales since 2008 and dividing them appropriately among the sewer basins.

[1] Metcalf & Eddy, *Wastewater Engineering, Treatment and Reuse 4th Edition*, New York City, McGraw-Hill 2003



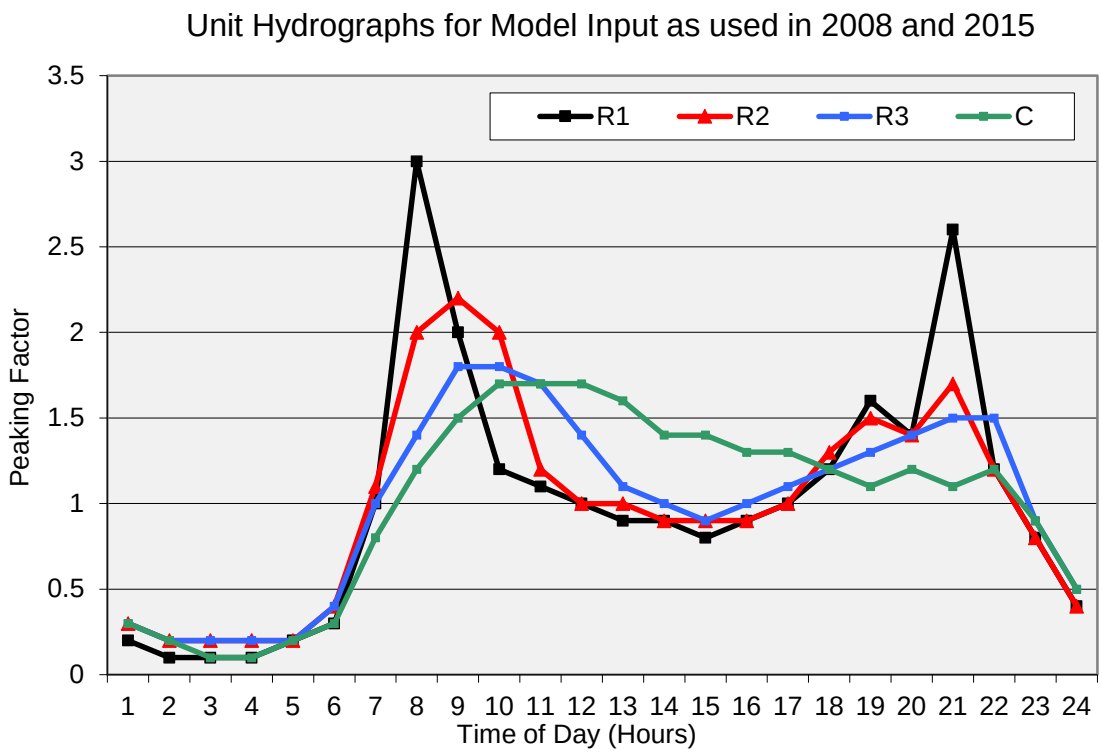
Farnsworth GROUP

Montrose Sewer System

Basin Input MHs & Monitoring MHs

Exhibit 5

The figure below shows the sewer contribution multiplier patterns used in the model. These are the same as the patterns in the 2008 model because they generally correlate well with the water demand patterns developed using AMI data in the 2015 Water Master Plan Report.



Calibration graphs showing flow monitoring data with model output results for each monitoring location can be found in Appendix A. These graphs generally show good correlation between the model and flow monitoring data. Where deviations exist remember that the flow monitors are not especially accurate given the variability of field conditions. The WWTP uses a Parshall flume which is considerably more accurate than the flow monitors. So the plant flows are the most reliable calibration point. Figure 7 shows the comparison between the recorded WWTP influent data on June 28th, the day the model was calibrated to, and the red line showing the model output flows; this is an excellent model calibration, and provides a high level of confidence in moving forward with projections for future improvements to accommodate future growth.

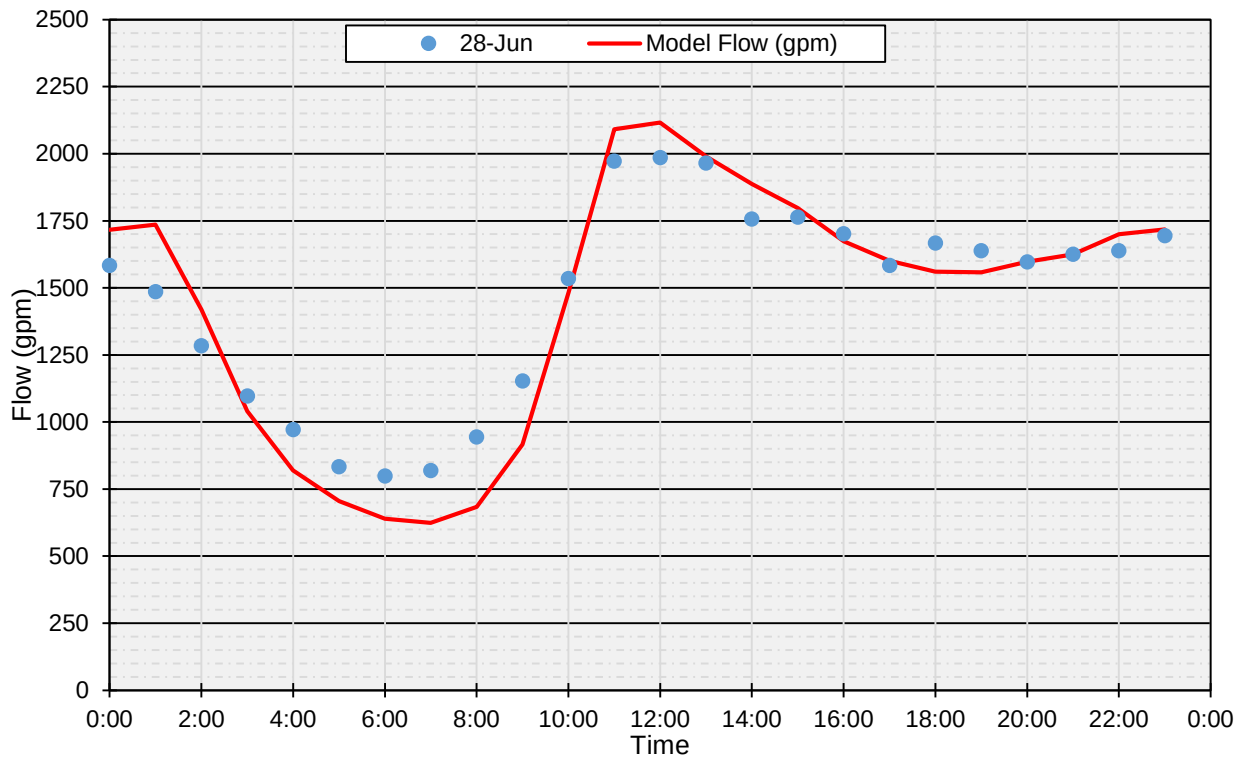


Figure 7 – 28th of June WWTP Influent Flows and Model Flow

H. Hydraulic Model of Existing System

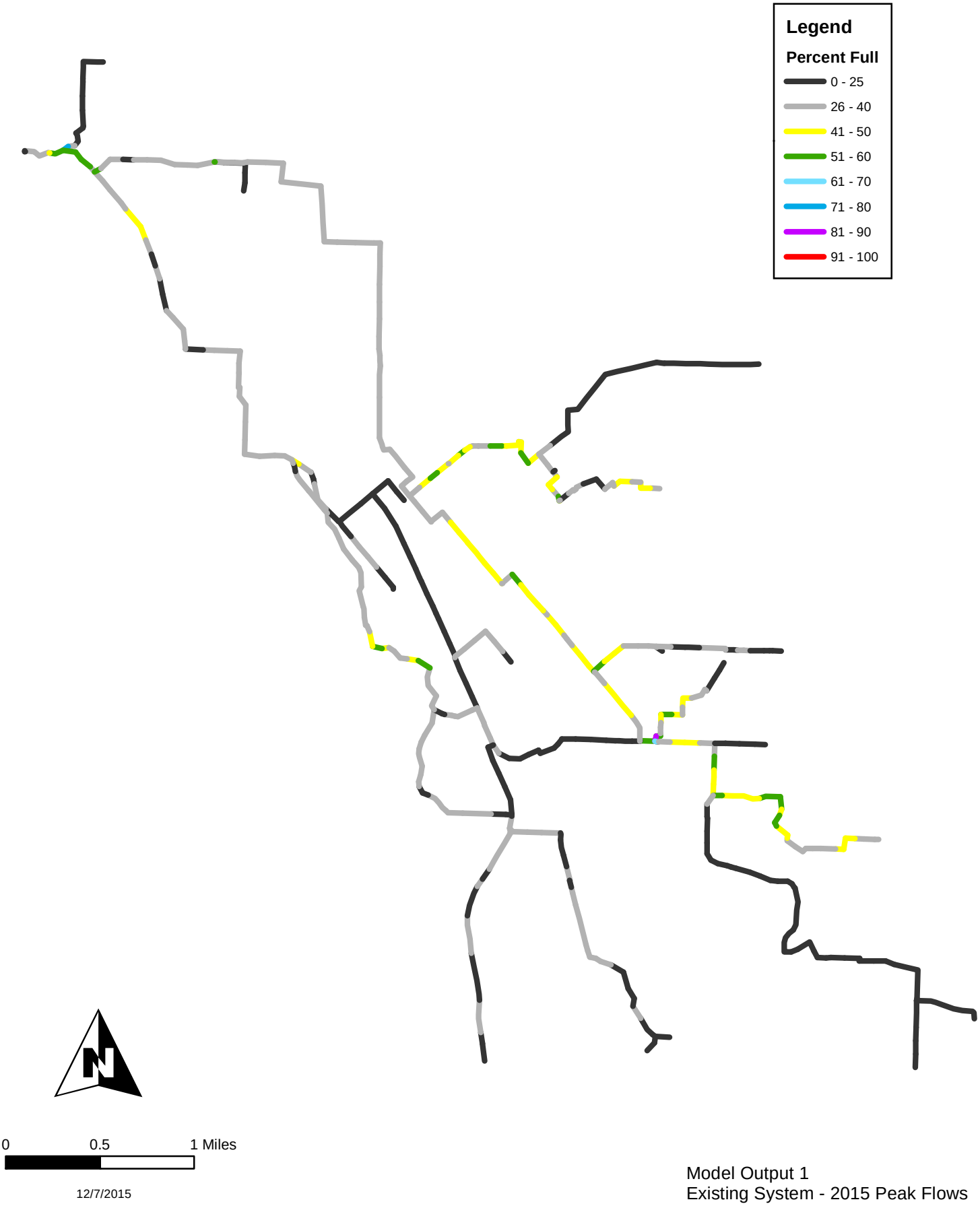
This section describes the step-by-step approach taken to identify the sewer capacity deficiencies in the modeled trunk sewer system as growth leads to increases in sewer flows. Flows are examined at five (5) different levels, as identified below.

The model output graphics display the highest value of d/D (depth of flow "d" over pipe diameter "D") that occurred during the peak day for that year. In other words, it looks for the maximum depth of flow throughout the day, which is important as the peak flow times vary depending which part of the collection system is being considered. This results from the four diurnal shapes used, R1, R2, R3, C and the travel times for the flows within the sewer.

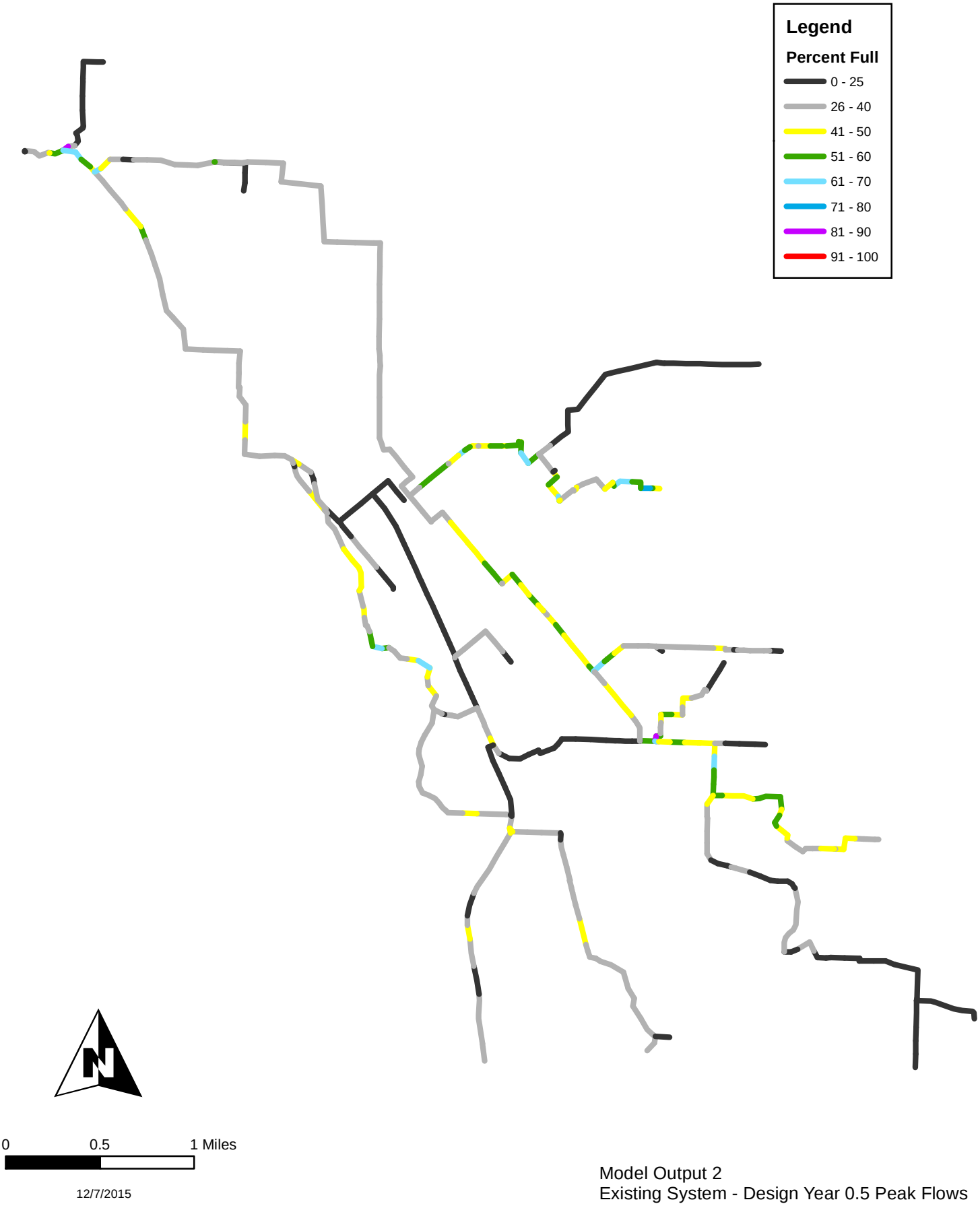
Refer to the seven (7) model output graphics that follow. The color coding is bracketed as shown in the legend. In order to prevent air-locks, sewers are generally designed to flow at no more than 70-75% full by depth. A sewer at this depth is conveying most of what a full pipe can carry. This means that any pipe segment shown in dark blue, purple or red is in need of attention.

There are three (3) manholes that have two outlets, meaning that flow can split and go in two directions. These are shown on the large sewer map. While this can be modeled, it is valuable to have a certain flow path, making predictions more accurate and eliminating the chance for "more sewerage than desired" to "go down the wrong pipe". Accordingly, the following flow direction are imposed, in keeping with where the flows generally go at present:

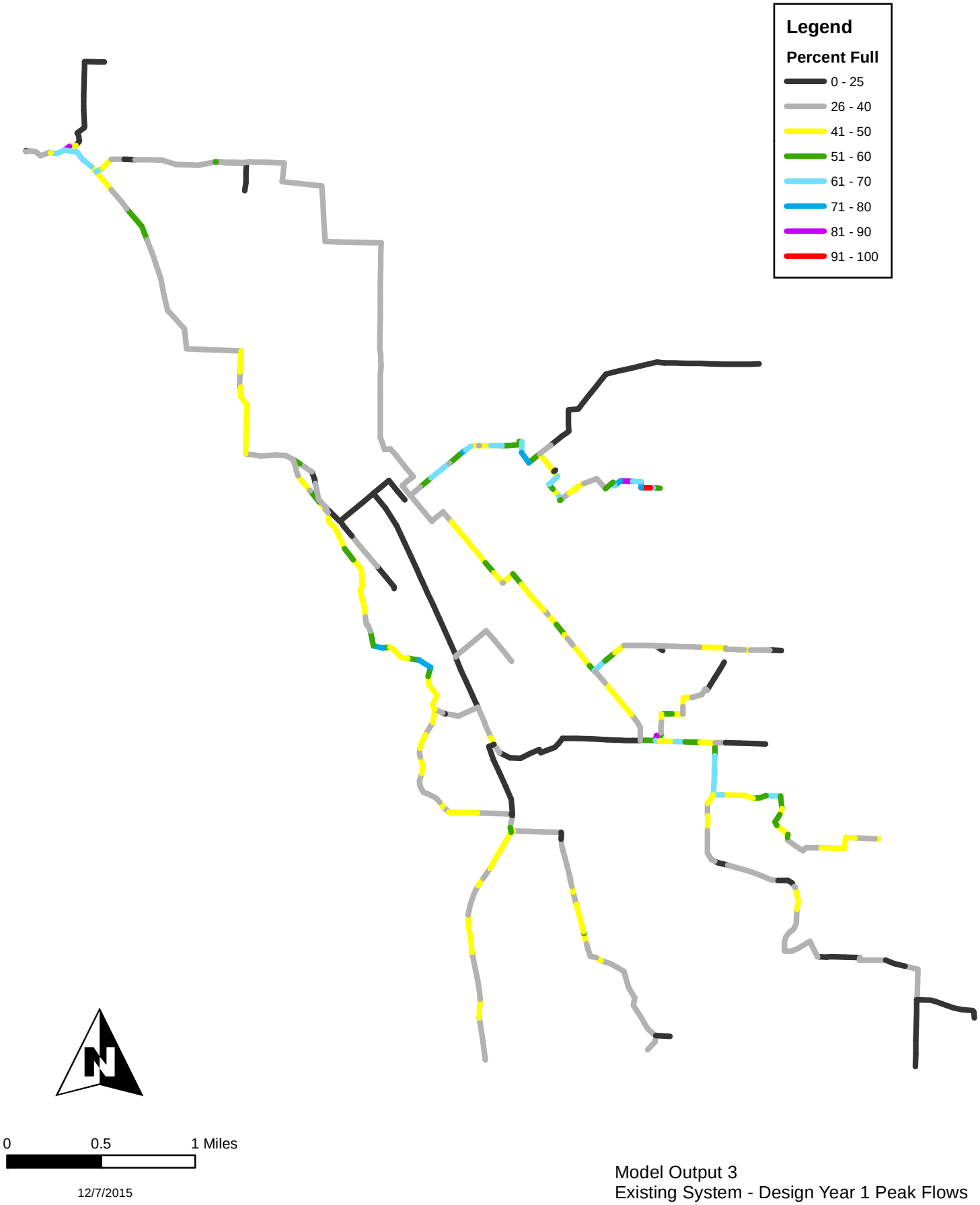
1. On Niagara, the flow from the east is all directed northwards into the new Mesa sewer.
2. At Rio Grande Ave. just north of Oak Grove Rd. the flow is all directed westward to the river trunk sewer.
3. At Rio Grande Ave. and Colorado Ave. the flow is all directed westward to the river trunk sewer.



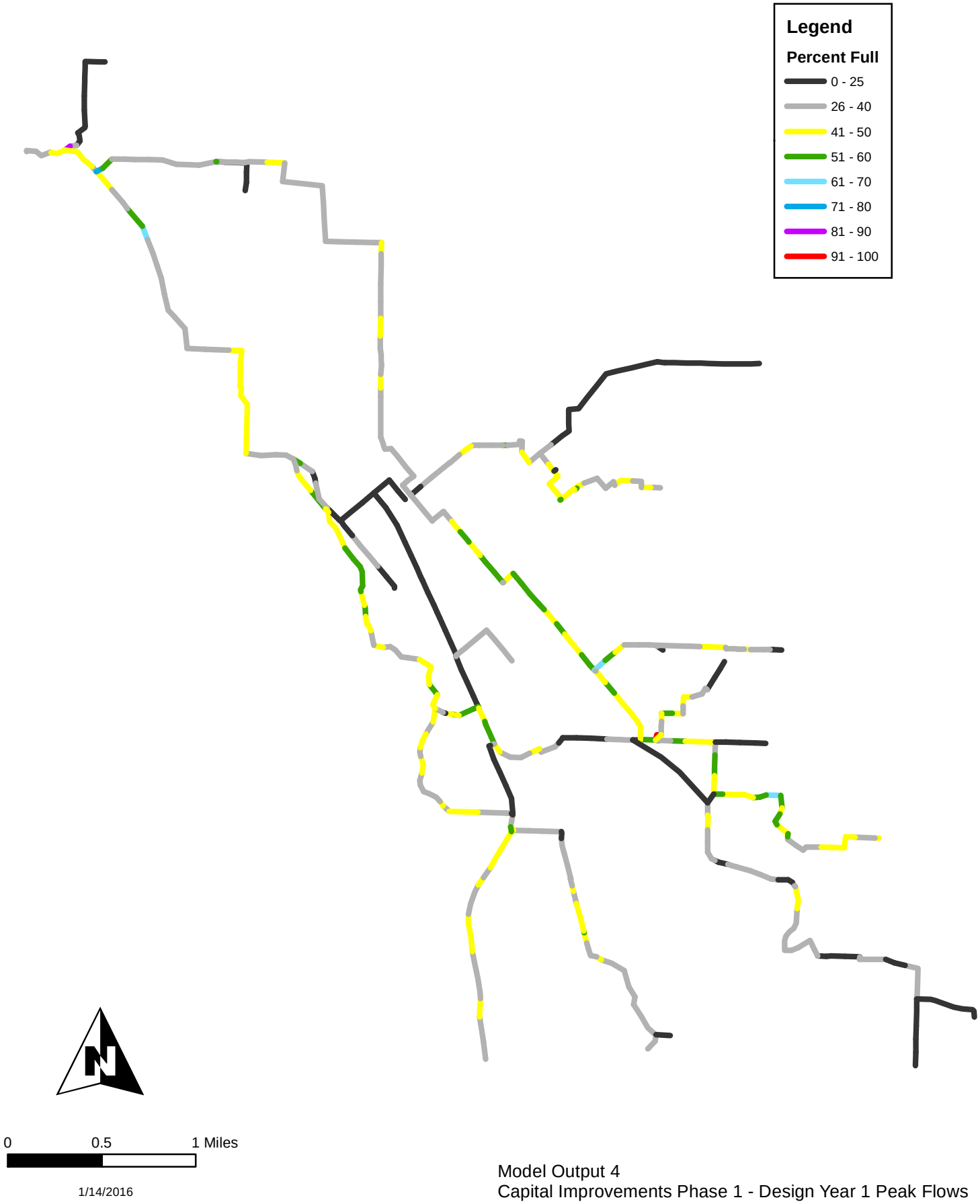
Model Output 1
Existing System - 2015 Peak Flows



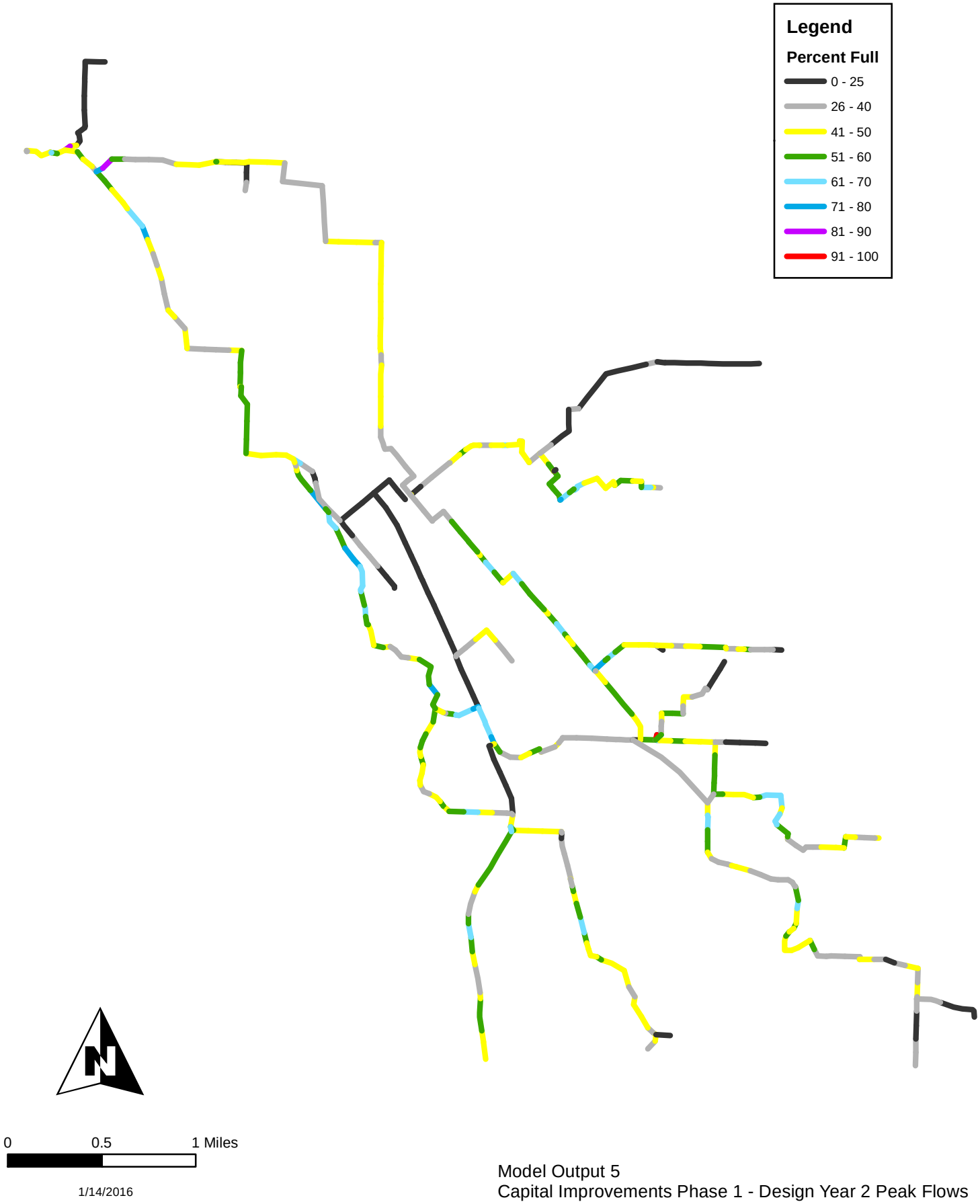
Model Output 2
Existing System - Design Year 0.5 Peak Flows



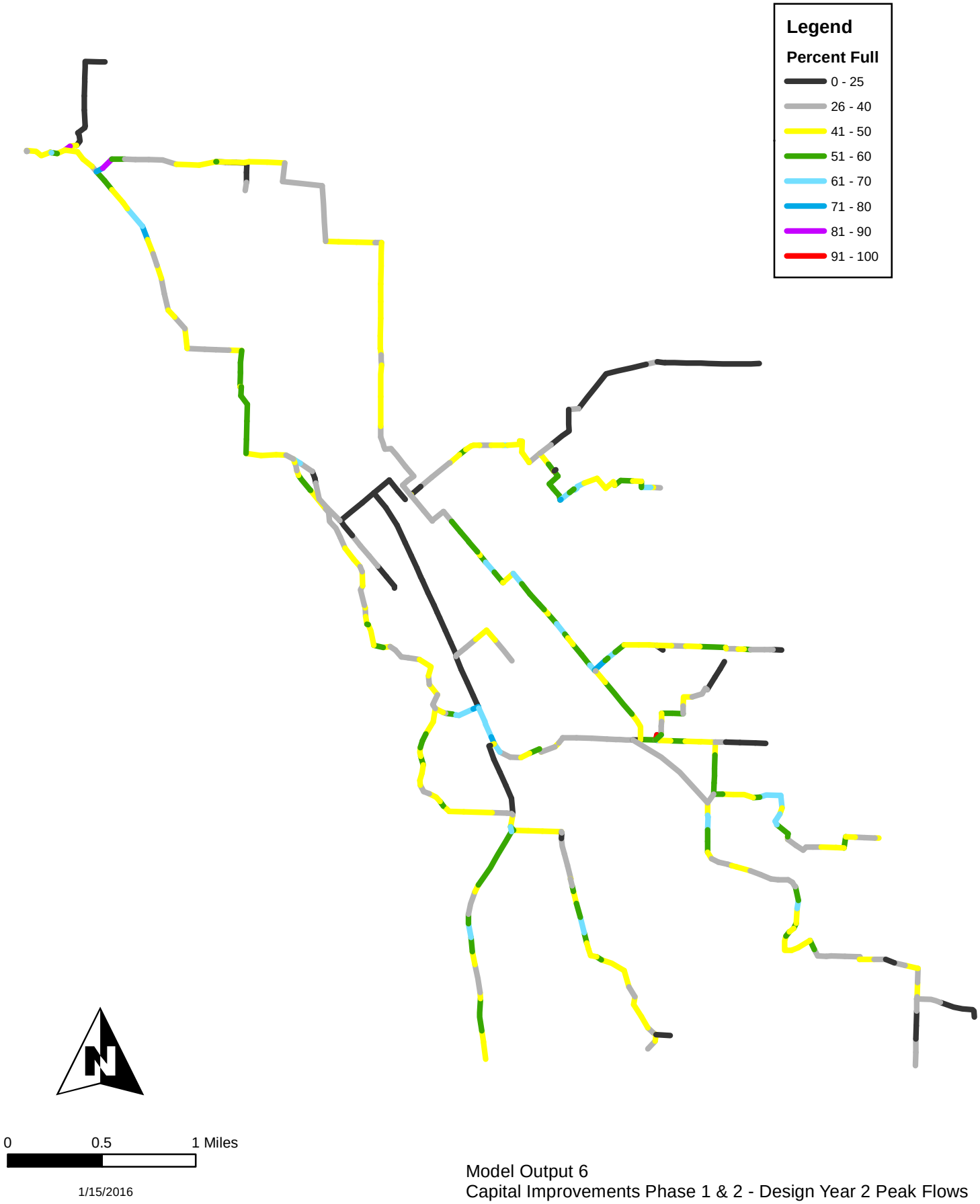
Model Output 3
Existing System - Design Year 1 Peak Flows



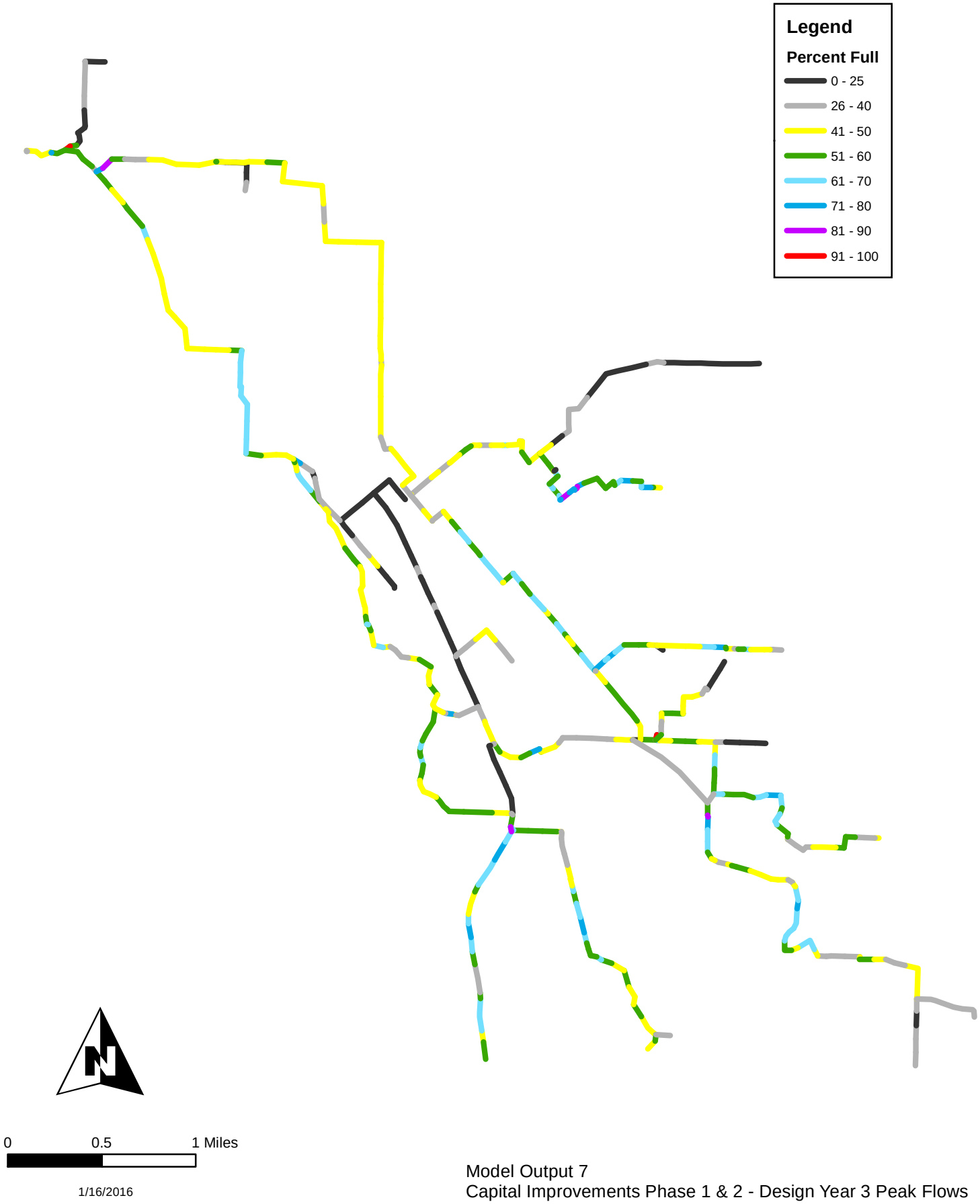
Model Output 4
Capital Improvements Phase 1 - Design Year 1 Peak Flows



Model Output 5
Capital Improvements Phase 1 - Design Year 2 Peak Flows



Model Output 6
Capital Improvements Phase 1 & 2 - Design Year 2 Peak Flows



Model Output 7
Capital Improvements Phase 1 & 2 - Design Year 3 Peak Flows

A general observation from the model is that in many cases, especially for the main trunk river sewer, capacity problems are limited to certain segments where the survey data indicates sewers were installed flatter than most of the other segments. This highlights the importance of verifying survey data for these areas. While efforts have been made to verify the areas of most concern, certain manhole segments should be verified using survey-grade accuracy – this is particularly important through the scrap metals yard where we were unable to locate the manholes and visually inspect them.

Model Output 1: Existing System – 2015 Peak Flows (Existing population approx. 19,000)
Using the input flows established by the calibration process, this graphic shows the existing highest percentage full by depth for every sewer segment, manhole-manhole, in the model. As can be seen from the small segment of purple at the intersection of Hillcrest and Niagara, the model accurately predicts the surcharging that is occurring at this location.

Model Output 2: Existing System – Design Year 0.5 Peak Flows (Population approx. 25,400)
This intermediate year was added to examine the impacts of growth in the near future if no significant changes are made to the existing sewer system. It shows that there are capacity problems emerging as a blue coloration in a number of areas.

Model Output 3: Existing System – Design Year 1 Peak Flows (Population approx. 31,600)
This reflects the situation expected by Design Year 1, which is associated with a service area effective population of approximately 31,600 people if no significant changes are made to the existing sewer system. This shows the progression of capacity challenges, generally at the same locations as noted in Design Year 0.5. This results in the capital improvement projects (CIP's) recommended to be done by Design Year 1, shown later in this report. (These are shown as CIP's 1, 2, 3, 4 and 5 on Exhibit 1)

Model Output 4: Phase 1 Capital Improvements – Design Year 1 Peak Flows (Population approx. 31,600)
Model Output 4 shows how the system improves once the Design Year 1 improvements have been implemented. Note that when sizing improvements for Design Year 1 we are anticipating the flows that may result if the Design Year 3 (ultimate) flows are realized one day.

Model Output 5: Phase 1 Capital Improvements – Design Year 2 Peak Flows (Population approx. 44,000)
This graphic shows that more portions of the trunk sewer along the river are likely to have capacity challenges by the time we reach this design year. This leads to the recommended CIP's 6 and 7.

Model Output 6: Phase 1&2 Capital Improvements – Design Year 2 Peak Flows (Pop. approx. 44,000)
Implementation of the Phase 2 CIP's improves the system performance as indicated here. (This includes completion of CIP's 6, 7, 8 and 9). Notice that the need for CIP 9 is indicated by a few sections of relatively flat existing sewer. Exhibit 2 shows that the invert data in the location of CIP 9 is not logged in the City's GIS as being survey-grade accuracy. Accordingly, we recommend that this be located and surveyed in the near future; if it is steeper than presently modeled, this distant CIP 9 may not be needed.

Model Output 7: Phase 1&2 Capital Improvements – Design Year 2 Peak Flows (Pop. approx. 56,000)
This final output graphic from the model shows how the system may look if the distant-future Design Year 3 growth occurs. The key here is that the improvements made in Phase 1 and 2 are sufficient to handle these high flow rates.

1. Field Validations of the Model

After the model of the existing system was calibrated to the flow monitor data field investigations of suspect model results were conducted. Three sewer segments were visually inspected on November 3rd for depth and flow conditions because flows in these segments were considerably high, or low.

Rio Grande Ave.

The 15” sewer running down Rio Grande Avenue was reporting less than 35% full during peak flow conditions in the model. Our field investigation found the pipe had evidence of flowing fuller than the model was reporting, but was not more than 50% full at the time of the investigation. The area serves a number of industrial and commercial buildings, as well as a number of abandoned and empty lots, so this area is not considered built out and needs to have capacity to grow. The upstream portion of the Rio Grande sewer, near 7th St., had a very small depth of flow, and the flow was very clean water for a sanitary sewer. Flows in this area are likely either from the recreation center pool, or infiltration. Based on field investigation the sewer in Rio Grande Ave. from 9th St. down should not be expected to pick up any additional flows other than from infill additions. This means flows currently diverted west at the intersection of Rio Grande Ave. and Colorado Ave. should continue to do so.

Figure 8 – Manhole F4-L9-78, in Rio Grande Ave.

Hillcrest Drive & Niagra

The 10” sewer in Hillcrest Dr. was modelled at over 75% full in the existing model, so a site visit was also made at this location just upstream of the confluence with Niagara Rd. Visual inspections were made at both the confluence manhole in Niagara Rd. and the upstream manhole on the Hillcrest Dr. 10” pipe. Both manholes had deep flows. The 10” Hillcrest Dr. manhole was filled to about 1 inch below the crown of the pipe, and the flow in the Niagara Rd. manhole was filled to about an inch or two above the crown of the 10” pipe. Pipes in this manhole were matched to invert rather than to crown. Thus, the 10” between Niagara and the first manhole toward Hillcrest Dr. is surcharged.

Figure 9 – Manhole G5-N10-11, in Hillcrest Dr. sewer line just upstream of the Niagara Rd. confluence

.

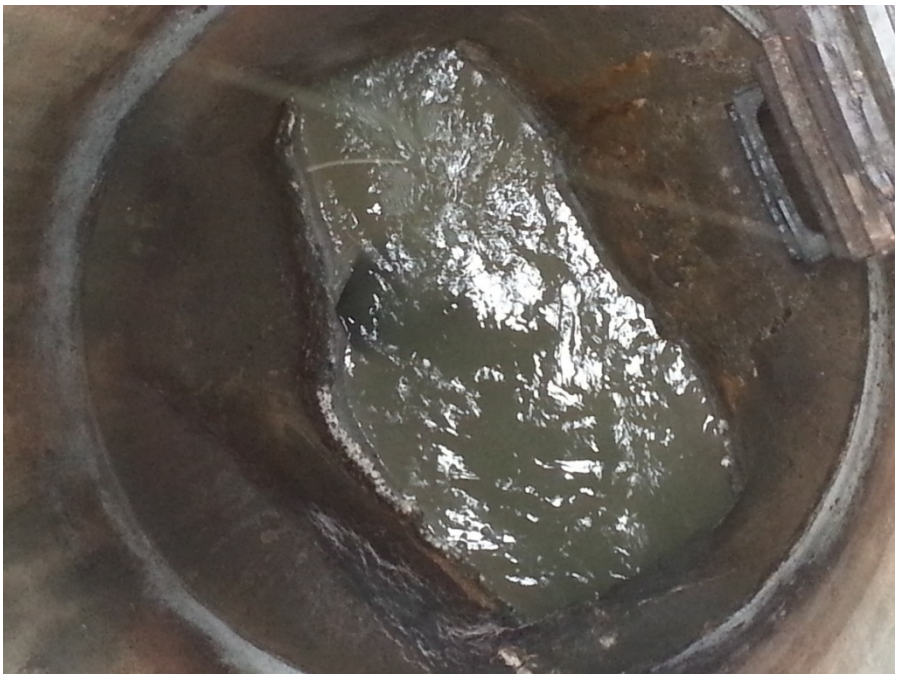


Figure 10 – Manhole G5-N10-49, Confluence of Hillcrest Dr. and Niagara Rd. Notice submerged 10" on the left

Alley Way
The third field investigation was made at Alley Way. The sewer at this location serves all of the Highway 50 corridor east of Hillcrest Dr., and a number of the residential growth areas north of Miami Rd. The model reports high flows and 75% plus flow depth in the Alley Way segment of the sewer. Visual inspection confirmed this finding, and may even suggest larger flows than we originally expected. The Highway 50 corridor in this area has many hotels, and restaurants so higher sewer flows would not be surprising.

Figure 11 – Manhole F4-L10-54, drop manhole located in Alley Way, debris around the bottom of the manhole suggests surcharging.

III. Future System Evaluation

A. Future Land Use – Location and Rate of Growth

Future growth rates are based on an average of 2%. The location and density of that growth is based on the 2008 City of Montrose Comprehensive Plan. Edits have been made according to more recent population counts, documented growth areas, and the latest meter and GIS data. Changes since the 2008 Master Plan are shown in red text in Tables 1A-1D in the Appendix.

Future land use and growth rate are based on the 2008 Comprehensive Plan as described in the 2008 Sewer Master Plan. Planned land uses have not changed since 2008, however growth rates have been revised down since growth between 2009 and 2014 was well below the 2008 Comprehensive Plan projection. It is important to note that Design Years are based on number of taps in the system, not calendar years.

B. Population and Sewer Flows

Peaking factors, tap counts, and flow monitoring data are located in Section G Model Calibration - Recommended Unit Flow Rates and Peaking Factors.

IV. CCTV Inspection Data Review

A. Pipeline Maintenance History Review

Exhibit 6 shows which sewers have been lined, according to the City's GIS.

B. Inspection Data Review and Assessment

CCTV data has been recorded by the City for many years. These data were processed and reviewed to develop a pipe replacement priority list based on pipe sags, and a CIPP priority list based on defects such as roots, bad service connections, displaced gaskets, infiltration, etc.

The City's CCTV data was challenging to process due to a lack of continuity in note taking procedures. For example, a joint that is displaced may be logged as a separation, deformation, or off-set joint. Farnsworth Group developed a customized approach to get the best results from the available data, as explained below.

Table 2 lists the general key words used to search the database for defects. Each defect listed is given a base score of 1, if an adjective key word was used the adjustment score would be added to the base score of 1. So a "Crack" note would have a score of 1, but if the note included the word "bad" a score of 2 would be assigned. The key words in the table were developed by manually reviewing a number of the CCTV logs. We do not believe this list to be completely exhaustive, but should cover the majority of the defects, particularly pipes that have many defects. The top 50 pipes listed have been manually reviewed.

Sag defects were scored differently than the other defects because the severity of the sag is not known other than the length of the sag. Fortunately, sag defects appear to be uniformly recorded in the CCTV data and included beginning and ending locations of the sag. Therefore, the sag scores are based on the distance the pipe is sagging. Each linear foot of sag was scored as 0.3, so a pipe with a 10 foot sag would have a score of 3. As mentioned before, we did not review all CCTV entries, so it is possible not all the sag defects were recorded uniformly. The top 50 pipes listed have been manually reviewed. Refer to Exhibit 7 for a map of where the pipes with the worst sags are located.

Using MS Excel and VBA programming scores for each pipe were totaled and ranked in order of severity. This process included hours of manually reviewing the ranking because many of the video logs included multiple pipe inspections, and/or the video log data was repeated with each pipe ID in the file. Manual review of a pipe total score was only performed on the top 50 scores in both the CIPP recommendation list and the Replacement list. Note that the CIP Improvement section of this report includes recommendations based upon capacity and growth needs, and CCTV data. This section of the report makes improvement recommendations based on CCTV data alone. The CIPP and Replacement lists include a "Notes" column which documents any modifications we made to the data to arrive at the score listed Exhibit 8 summarizes the pipes that need to be replaced and pipes that need to be lined based on the above criteria.

Table 2 – List of defects queried in the CCTV database, and associated severity adjectives and score adjustment

Abandoned-Offset	Exposed	Adjective	Score Adjustment
Abandoned-Protruding	Gasket	Light	-0.5
abandoned-Root	Hole	Medium	0
Break-In-Connection	Infiltration	BAD	1
Broken	Intruding	Defective	0
Corrosion	Offset	HEAVY	0.75
Crack	Rock	Severe	1
Deformed	Root	MASS	0
Encrustation	Separated		

C. Pipeline Rehabilitation Plan

The City currently has a large collection of videoed sewer lines, however, no uniform naming conventions are in place to easily filter through the video database. We have performed rudimentary queries seeking out the pipes with the most documented defects, but some deficient pipes may have gone unnoticed due to the lack of uniform naming conventions. As part of an ongoing rehabilitation plan we recommend continuing videoing practices and implement a standard naming convention such as PACP (Pipeline Assessment and Certification Program). PACP is a nationally recognized sewer format for recording CCTV data.

We also recommend setting aside an annual budget to line and replace pipes listed in
Table 3 and Table 3. All of the pipes that have been videoed are smaller pipes off the main trunk lines, so flows are manageable from a construction point of view, but maybe located in difficult to work in areas like alley ways. We suggest setting an annual budget of $500,000 to perform this type of work, and re-inspect each line before performing the work to verify the need for improvement.

V. Capital Improvement Project Recommendations

Capital improvement project recommendations were derived from sewer system model analysis, future growth estimates, and CCTV data reviews. Improvement recommendations based on system analysis comprises projects that need to be construction to address current or future growth. Improvements recommendations based upon CCTV data are projects that can be performed over time as the City has funding, or as the assets deteriorate further and require immediate attention.

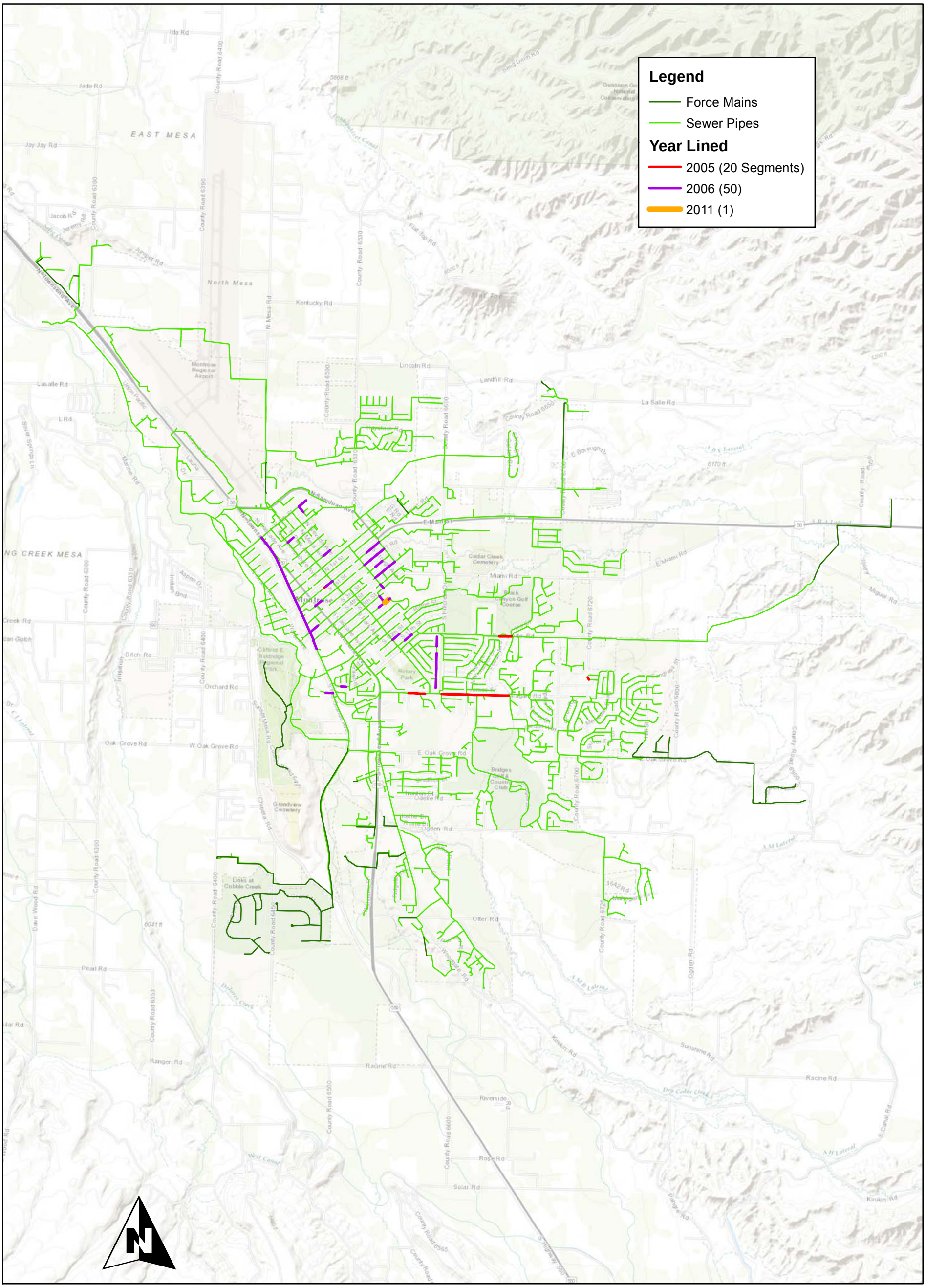
A. CIPP and Replacement Improvement Recommendations

As mentioned in the previous section, two groups of improvements were developed from the CCTV data review. One group lists pipes identified as candidates from CIPP lining, the other group lists pipes identified as candidates for replacement due to pipe sags.

Table 3 lists the top 50 pipes recommended for lining, and Table 3 lists the top 50 pipes recommended for replacement. Pipes highlighted in red are pipes that appear in both lists suggesting that pipe has a high number of defects, and should probably be replaced not lined. Refer also to Exhibit 8 for the general locations. Notice that the pipes are not on the trunk sewer lines that form the basis of the sewer model. It is noteworthy that condition data from CCTV does not exist for most of the trunk sewer system, likely as flows are too high.

Table 3 – List of top 50 pipes with defects that may be suited best for lining treatment. List reads top left to bottom right, left column first. Highlighted pipe IDs are pipes that appear in both lining and replacement lists, which suggest a high number of defects.

Pipe ID	Upstream MH	Downstream MH	Street Location
1735	F4-L9-65	F4-L9-101	Between N 4th St and N 3rd St
1827	F5-L10-33	F5-L10-121	N Cedar Ave
1424	F5-L10-82	F5-L10-89	Between N 2nd St and N 1st St
2180	G5-M10-151	G5-M10-100	Between S 4th St and S 5th St
2491	G5-N10-137	G5-N10-102	Behind Brown Rd
2179	G5-M10-99	G5-M10-100	Between S 4th St and S 5th St
2219	G5-N10-158	G5-M10-4	Dover Rd
1365	F5-L10-59	F5-L10-67	Between E Main St and S 1st St



0 1 2 Miles

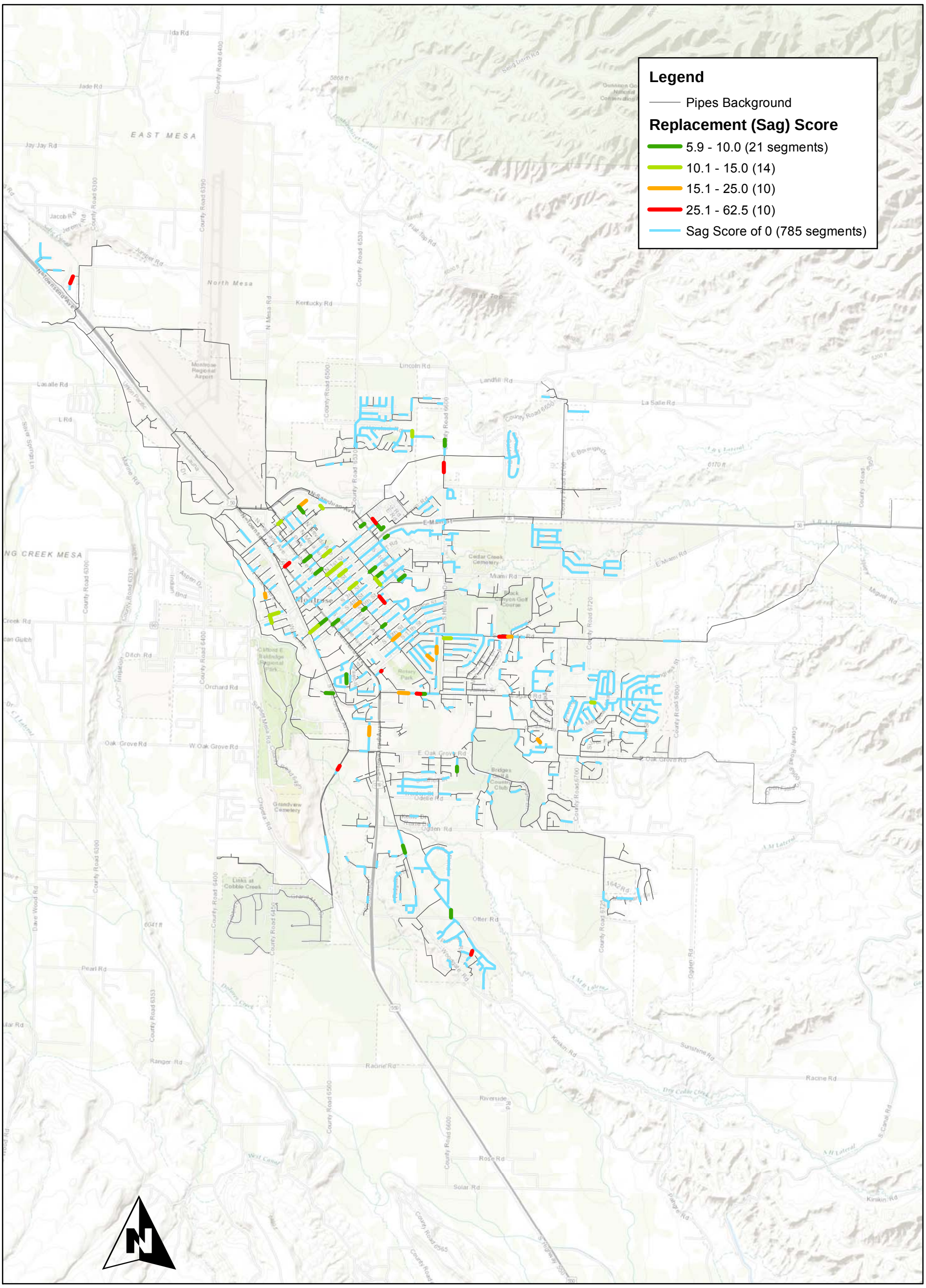
12/4/2015

Farnsworth GROUP

Montrose Sewer System

Lined Pipes

Exhibit 6



0 1 2 Miles

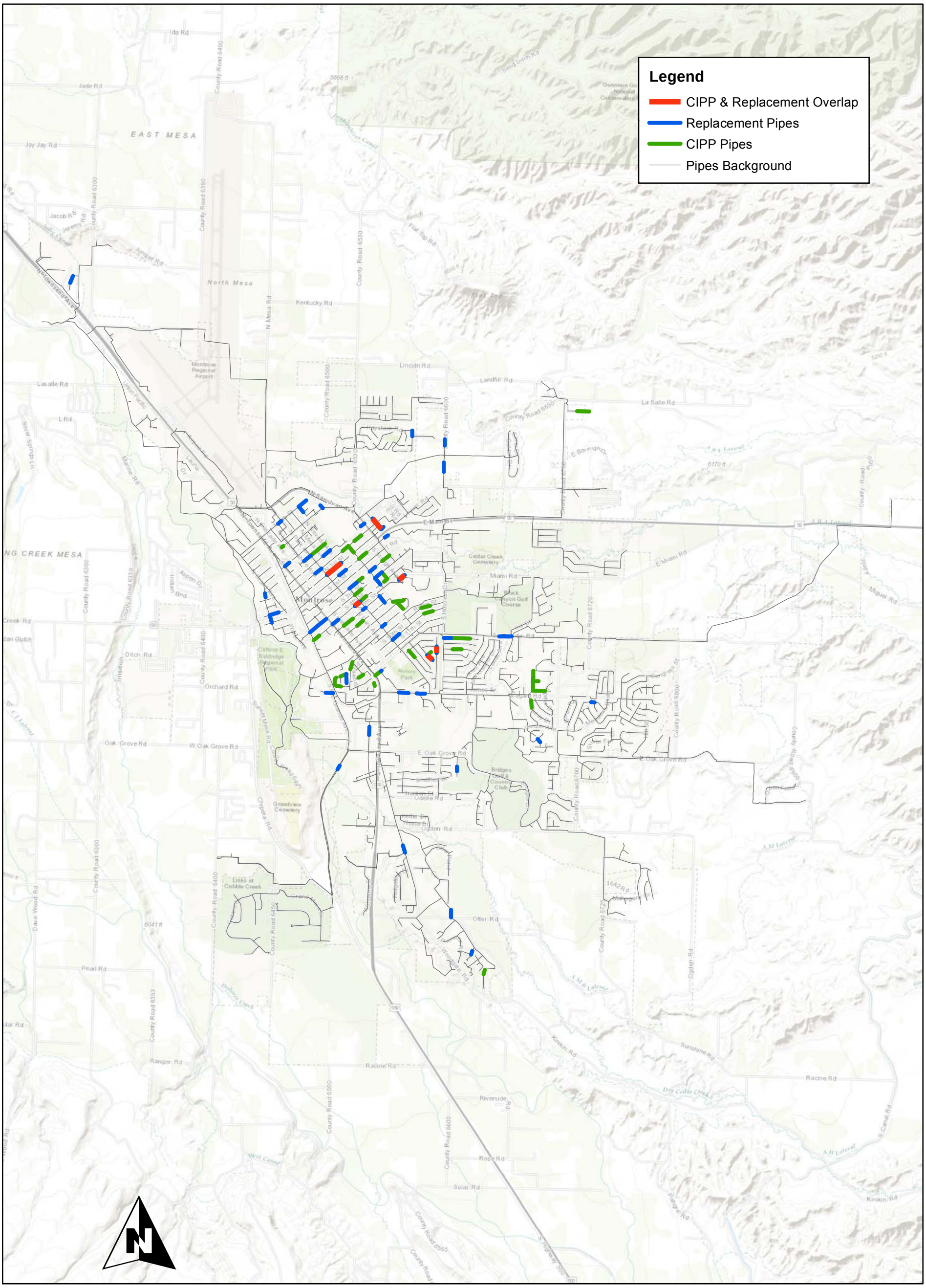
12/7/2015

Farnsworth GROUP

Montrose Sewer System

Sewer Sag Replacement Scores

Exhibit 7



0 1 2 Miles

12/7/2015

Farnsworth GROUP

Montrose Sewer System

CIPP and Replacement Overview

Exhibit 8

Pipe ID	Upstream MH	Downstream MH	Street Location
2218	F4-L9-101	F4-L9-124	Between N 4th St and N 3rd St
1356	F5-L10-88	F4-L9-59	Between N 2nd St and N 1st St
1579	F4-L9-112	F4-L9-60	Between N 1st St and E Main St
1338	F4-L9-60	F4-L9-128	Between N 1st St and E Main St
1409	F5-L10-111	F5-L10-76	Between S 2nd St and S 3rd St
988		F5-L10-20	Behind S 5th St
1418	G5-N11-57	G5-N11-58	Cambridge St
2914	G5-M10-130	G5-M10-132	Centennial Dr
2287	G5-N10-85	G5-N10-82	Eton Ct
3545	E6-J12-15	E6-J12-1	Las Vegas Dr
1570	G5-M11-5	G5-M11-7	Essex St
2239	G5-M10-125	G5-M10-129	Between Highland Dr and S 11th St
1696	G4-N9-49	G4-N9-58	Spruce Dr
1814	G5-N10-91	G4-N9-59	Spruce Dr
1987	G5-N10-75	G5-N10-81	Behind Aspen St
1750	G5-M10-135	G5-M10-71	Centennial Dr
1937	G4-M9-76	G4-M9-75	S 4th St
1978	G5-N10-78	G5-N10-107	Between Spruce Dr and Columbia Way
2990		F5-L10-121	N Cedar Ave
1337	G5-N11-72	G5-N11-96	Stellar Ct
1552	G5-M11-7	G5-M11-10	Essex St
1623	G5-N11-95	G5-N11-96	Stellar Pl
2142	G5-N11-98	G5-N11-95	Stellar Pl
2226	F5-L10-72	F5-L10-34	Between S 2nd St and S 3rd St
309	G5-N11-96	G5-N11-26	Stellar Pl
621	G5-N11-15	G5-N11-26	Star Ridge Dr
734	G6-N12-59	G5-N11-15	Star Ridge Dr
1549	G5-M10-40	G5-M10-82	Between S 5th St and S 6th St
2200	G5-M10-7	G5-M10-127	Between Ridge St and Highland St
2232	G5-M10-132	G5-M10-133	S 7th St
1405	F5-L10-22	F5-L10-65	S Pythian Ave
2171	G5-N10-132	G5-N10-66	Chatam Dr
1007	G5-N10-74	G5-N10-82	Avon St
1089	G4-N9-57	G4-N9-58	Columbia Way
2178	G5-M10-101	G5-M10-102	Between S 3rd St and S 4th St
1407		F5-L10-22	S 4th St
706	G5-N11-32	G5-N11-12	Ouray Dr
1557	G5-M10-60	G5-M10-61	Between S 6th St and S 7th St
2193	F5-L10-34	G5-M10-115	Between S 2nd St and S 3rd St
2922	G5-N10-67	G5-N10-146	Behind S 12th St

Pipe ID	Upstream MH	Downstream MH	Street Location
3087	G5-N10-146	G5-N10-128	Behind S 12th St
1360	F5-L10-87	F5-L10-88	N Lot Ave
2837	I5-R11-55	I5-R11-56	Crestview Dr
3397		F4-L9-48	Between N 7th St and N 6th St

Table 4 – List of top 50 pipes with defects that may be suited best for replacement. List reads top left to bottom right, left column first. Highlighted pipe IDs are pipes that appear in both lining and replacement lists, which suggest a high number of defects.

Pipe ID	Upstream MH	Downstream MH	Street Location
2641	F5-K11-27	F5-K11-26	6600 Rd
132	D3-H7-21	D3-H7-20	Denny Ct
1537	G5-N10-119	G5-N10-67	Behind S 12th St
2391	F4-L9-39	F4-L9-40	Between N 5th St and N 4th St
3255	H4-O9-16	H4-O9-15	Near S Rio Grande Ave
1377	G5-M10-98	G5-M10-118	S Junction Ave
1917	G5-M11-51	G5-M11-17	Sunnyside Rd
455	I5-R11-31	I5-R11-11	Perpendicular Crestview Dr
644	G5-N10-36	G5-N10-35	Niagara Rd
2990		F5-L10-121	N Cedar Ave
2219	G5-N10-158	G5-M10-4	Dover Rd
2180	G5-M10-151	G5-M10-100	Between S 4th St and S 5th St
1946	G5-M11-49	G5-M11-51	Sunnyside Rd
625	G5-N10-37	G5-N10-39	Niagara Rd
1241	G5-M10-41	G5-M10-34	Between S 10th St and S 11th St
1007	G5-N10-74	G5-N10-82	Avon Dr
1047	F4-K9-70	F4-K9-55	N 9th St
815	H5-O10-9	H5-O10-88	Stover Ave
86	G4-M9-121	G4-M9-16	Beach Ln
3058	H5-O11-84	H5-O11-37	Laura Ln
2184	F5-L10-15	F4-L9-61	Between E Main St and S 1st St
1157	F4-L9-96	F4-L9-102	Between N 3rd St and N 2nd St
1766	G4-M9-73	G4-M9-74	Between S 3rd St and S 4th St
2596	G6-N12-74	G6-N12-120	Natalia Way
262	G4-M9-23	G4-M9-13	N Maple Ave
1534	G5-M11-10	G5-M11-11	Essex St
6	G4-M9-106	G4-M9-13	Between W North 1st St and W Main St
1615		F4-L9-94	N 9th St
2170	G5-M10-115	G5-M10-13	Between S 2nd St and S 3rd St
1713	F4-K9-85	F4-K9-89	Cedar Creek Ave
2817	E5-J10-24	E5-J10-25	Barnwood Rd

Pipe ID	Upstream MH	Downstream MH	Street Location
2259	G5-M10-113	F5-L10-64	S Lot Ave
1579	F4-L9-112	F4-L9-60	Between N 1st St and E Main St
1338	F4-L9-60	F4-L9-128	Between N 1st St and E Main St
1195	G5-M10-160	G5-M10-1	Between S 8th St and S 9th St
1708	G4-M9-89	G4-M9-73	Between S 3rd St and S 4th St
1626	F4-K9-47	F4-K9-55	Behind N Nevada Ave
1416	F5-L10-65	F5-L10-64	Between S 3rd St and S 4th St
2426	E5-J11-9	F5-K11-25	6600 Rd
643	G5-N10-47	G5-N10-36	Niagara Rd
1559	G5-M10-16	G5-M10-156	Between S 5th St and S 6th St
1379	F4-L9-55	F4-L9-126	Between N 2nd St and N 1st St
1827	F5-L10-33	F5-L10-121	N Cedar Ave
2213	F5-L10-100	F5-L10-33	Between N 1st St and E Main St
2033	F5-L10-16	F5-L10-21	Behind E Main St
1367	F5-L10-77	F5-L10-66	Between S 2nd St and S 3rd St
988		F5-L10-20	Behind S 5th St
1440	F4-L9-73	F4-L9-124	Between N 4th St and N 3rd St
624	I5-Q11-16	I5-Q11-14	Otter Pond Cir
701	G4-N9-14	G4-N9-8	Apollo Rd
2950	H5-O11-76	H5-O11-75	Bear Lake Dr
1746	G5-N10-90	G5-N10-91	Akard Ave
1790	F5-L10-110	F5-L10-31	Behind N 2nd St
3079	I5-Q10-25	H5-P10-77	Woodgate Rd
2141	G4-M9-77	G4-M9-90	Between S 4th St and S 5th St

The location of the pipes in Table 3 and Table 4 are shown on Exhibit 8. Pipes with significant defects are shown in green, pipes with significant sags are shown in blue. Pipes that are both, shown in red in the tables, are shown in red.

As mentioned in Part C of the IV. CCTV Inspection Data Review section we recommend setting aside an annual budget of $500K to improve the pipes listed in Table 3 and Table 4, and continuing inspection practices and implementing a uniform naming convention such as PACP. Training for PACP is provided by NASSCO (National Association of Sewer Service Companies).

B. Large Scale Capital Improvement Projects

The following capital improvement projects are best implemented by Design Year 1 with the exception of the river trunk line improvements which can wait until Design Year 2. Design Year 3 model simulations with the following improvements included performed acceptably throughout the system, although many existing pipes were reaching capacity. Given that Design Year 3 represents a 250% growth from existing no engineering estimates are provided for mitigation or replacement of pipes for handling.

The focus of these capital improvements is to provide the City with a near term plan to address immediate and near future system deficiencies. However, it is worth noting that no system improvements are needed to maintain performance before Design Year 0.5 (~25,000 pop.). Current issues like Hillcrest Rd. and Alley

Way will remain problems but likely will not significantly disrupt performance until after Design Year 0.5. They will, however, require more routine maintenance if not corrected.

Sewer pipe surcharging appears to be an existing condition near the WWTP. No field investigations were made into this segment of the system to verify. Due to the location surcharging is not expected to affect any customers and due to the size of the sewer blockage is not expected to occur either. Therefore, waiting until after Design Year 1 to improve this segment of sewer along with the rest of the river trunk line is appropriate.

Recommended Capital Improvements are shown in Table 1 in the Executive Summary and Exhibit 1.

CIP A: Highway 550/Townsend Southern Gateway Development West of River Interceptor (2016 +/-)

Multiple development plans are currently under design in the Highway 550 Southern Gateway planning area, and growth is expected to continue into the far future. This area is defined in the model as Basin 43, and is projected to have a peak day sewer contribution of 0.4 MGD in Design Year 3. Future sewer lines extending into this basin should be sized to handle a 1.2 MGD assuming a peak hour factor of 3.0. Assuming a minimum slope of 0.42% can be maintained a 12" diameter pipe would be sufficient. This is also the size of the downstream sewer that crosses the river and collects contributions from Cobble Creek. An 8" pipe may also be used if a minimum slope of 0.28% can be maintained.

CIP B: Highway 550/Townsend Southern Gateway East of River Interceptor (2016 +/-)

As growth continues in the Southern Townsend commercial area flows are expected to increase straining the capacities, and longevity of the lift stations in the area. Three lift stations (Home Depot, Sears, & River Landing) can be removed by extending the river trunk line from Oak Grove Rd. along the east side of the river to Rio Grande Ave. Removing the lift stations will save the city long term in maintenance costs by removing the energy cost of pumping, and reducing the production of corrosive sulfides in the force mains.

Peak day flows are expected to increase to 0.6 MGD by Design Year 3, assuming Basin 28 and 44 are the only contributing basins. Assuming a peak hour factor of 3.0, the interceptor will need capacity to pass 1.8 MGD. A 12" sewer at minimum slope of 0.9% or a 15" sewer at minimum slope of 0.28% will sufficiently pass 1.8 MGD.

Capital Improvement Projects 1 through 5 need to be implemented by Design Year 1, which is equivalent to a population of about 32,000, Projects 6 through 8 need to be implemented by Design Year 2, or 44, 000. Projects A and B are development trunk lines that the City has plans to construct in the near future. We have included the developer projects because they will serve as trunk sewers vital to the growth of the system.

CIP 1: Stone Bridge Drive New 15" Trunk Sewer (2017)

The sewer line in Pavilion Dr. between Niagara and Rd. and Oak Grove Rd. has a very slow and deep flow due a flat slope. By Design Year 1 depth of flow in this pipe segment increases to over 60% full according to our model. Flow monitor 10, which was installed in this manhole, recorded an average flow depth of 5 inches, and a maximum depth of 6 inches during the period from June 16th to July 29th. Field visits to the manhole revealed visibly slow and deep flow, see Figure 12.

Figure 12 – Manhole G5-N11-16 located in Pavilion Dr. Notice the depth of flow in the pipe.

Downstream of the Niagara Rd. and Pavilion Dr. confluence the flow in Niagara backs up flows coming from Hillcrest Dr. This is partly due to the fact that the Hillcrest sewer pipe has a smaller diameter and is matched to the invert of the Niagara pipe, not the crown as it should be, see Figure 12. Also, a storm sewer runs over the Hillcrest sanitary sewer at this location which may be the reason for matching inverts.

CIP 2: Hillcrest Relief (2020)

It is recommended that a 15" interceptor line (assuming a slope of 0.9%) be constructed from upstream of the Pavilion flow backups to Niagara Rd. just west of Mesa Ave. generally following the Dry Cedar Creek channel, CIP #1 in the CIP Map. The Stone Bridge Drive new trunk sewer would help relieve flows in Pavilion Dr. and reduce or eliminate the surcharging in Hillcrest Dr.

It is also recommended that a sewer parallel be installed to intercept Hillcrest flows and divert flows directly to the Mesa Ave. interceptor, CIP #2 in the CIP Map. Assuming a slope of 0.15% can be maintained a 15" pipe would be able to pass Design Year 3 flows at d/D of 0.75. If the Stonebridge Drive interceptor (CIP 1) relieves surcharges in Hillcrest Dr., it will likely be temporary until growth upstream of Pavilion increases. Timing of this alternative is really based on how significantly the Stonebridge interceptor reduces surcharging in Hillcrest Dr. It is recommended the Stonebridge interceptor be constructed first and then reassess the conditions at Niagara and Hillcrest.

CIP 3: Upsize Eastern Highway 50 Gateway Trunk Sewer (2030)

Alley Way Upgrade:
The Eastern Highway 50 gateway area is the corridor along HWY 50 generally between 6700 Rd. to San Juan Ave. This area, and outlying developments east of town, is served by an 8" sewer line which shows signs of surcharging in manhole F4-L10-54. As shown in Figure 11, this manhole does not meet current standards for a drop manhole. The City's 2008 Comprehensive Plan calls this area "The East Center", and states that mixed commercial zones already exist in this area, and growth here is expected in the near future as the Southern Townsend Center approaches build out.

Model projections for Design Year 3 have estimated peak day sewer flows in the area to be 0.92 MGD. This is assuming that the lift station at LaSalle Rd. is replaced with gravity flow and is contributing to the east along County Road 6650 to Basin 12. A 12" sewer would need to be used to serve this size of flow at an estimated slope of 1.13%, or a larger flatter sewer if detailed design conditions so dictate.

Flow in this area is difficult to estimate because the area of potential growth is large, but currently not rapid. The average slope of the existing sewer trunk between 1st St. and Hillcrest Dr. is 1%. The sewer needs to be replaced from the 15" in 1st Street up to Hillcrest Rd. However, that segment of sewer turns back to Highway 50 in Hillcrest Rd. so it may be feasible to install a new trunk line along the highway from 1st Street so that the existing sewer can remain in place and no service connections would need to be made.

7th Street Sewer Main Upgrade

The 7th Street sewer main needs to be upsized or paralleled from Uncompahgre Ave. up to Cedar Ave. This trunk main serves Model Basins 20, 19, 18, 14, 13, 12, and 11. Cumulative Design Year 3 flow for these basins is 1.67 MGD. The model Design Years 2 and 3 were simulated with an upsized trunk line of 24" from Uncompahgre Ave. to Cedar Creek Ave., and 21" from Cedar Creek Ave. to Cedar Ave. If the City desires the sewer could be paralleled with a similar size pipe to reduce the complexity of reinstalling service connections.

Recommended additional work prior to implementing CIP 4 thru 9

Locate and inspect all manholes on the river trunk sewer to confirm invert elevations for manholes that have not been previously measured to survey grade accuracy, and to establish the quantity of manholes that need repair due to corrosion. Verification of inverts will improve the accuracy of determining when to increase capacity with a new sewer. Determination of manhole condition will enable the estimation of manhole lining/rehabilitation cost versus cost of replacing the sewer with a larger line. This will be important in making the decision between paralleling or replacing the existing river trunk sewer.

Figure 13 – Manhole E3-I7-39, showing the extent of corrosion in many of the river trunk line manholes.

The majority of the cost to install a parallel line would be excavation and easement acquisition, so increasing the pipe size to completely replace the sewer is as feasible as a parallel line. Also, fiberglass style manholes on the replacement main could be used to prevent corrosion. Installing a parallel line has the benefit of redundancy, assuming gates or diversion structures are used to isolate each sewer. Doing this would allow for easier maintenance and video inspection, and no by-pass pumping during construction. Relaying to eliminate flat reaches is feasible at a few locations by use of bypass pumping, if the other options are not viable.

Figure 14 – Lift Station at Home Depot, to be replaced with river trunk line extension project.

CIP 4 thru 9: River Trunk Line Improvements (2035-2050)

The existing river trunk line provides adequate capacity for the near future, but as the population approaches 25,000, the section of the sewer near Recla Metal become more than 90% full (depth over diameter). A comparison of Model Outputs 3 and 4 shows the benefits of CIP 4 on the river trunk line near Recla Metal.

There are basically two alternatives to improve the trunk line: 1.) replace the trunk line with a larger diameter pipe, or 2.) install a new parallel sewer to relieve the existing sewer. The goal is to level out adjacent flat and steep reaches to achieve an improved overall slope. In the model pipe diameters were increased from 18” to 27” from Manhole G4-M9-66 to G4-M9-20.

As the population approaches 44,000 more sections of the river trunk line become more than 70% full. Model Output 7 shows that all these improvements are capable of handling Design Year 3 flows which is an estimated population of 56,000. Proposed Phase 2 work plans to improve the river trunk line at various locations as shown in red on Exhibit 1 to address these sections of the river trunk line. The extent of pipe that is replaced under one construction contract is flexible since this report does not go into detail identifying feasible tie-in points and minimum slope restraints. This is something to be explored during detailed design, when other utilities and drainage crossings can be surveyed.

Given that the current river trunk line has not been videoed, it is difficult to know whether the existing sewer is worth maintaining. We noticed in the field that the manhole with Flow Monitor 1 had some infiltration occurring around the joint. The City is also aware that sulfide corrosion in the pipes and manholes is a significant concern likely due to the number of force mains in the system and the detention time in those mains. As such, we expect that option 1, sewer replacement, will be preferable.

Notice that the need for CIP 9 is indicated by a few sections of relatively flat existing sewer. Exhibit 2 shows that the invert data in the location of CIP 9 is not logged in the City’s GIS as being survey-grade accuracy. Accordingly, we recommend that this be located and surveyed in the near future; if it is steeper than presently modeled, this distant CIP 9 may not be needed.

C. Potential Permanent Flow Monitoring Locations

During our discussions at the progress meeting the first week of November City staff expressed interest in installing one or two permanent flow monitors in the collection system. The advantage of a permanent flow monitor is: continuous trending data at a point in the system other than the WWTP, and better quality data than temporary monitors. The additional points of flow data could be used in conjunction with the WWTP flow data to develop a better understanding of contribution origination, and identify unusual flow patterns, including any seasonal variations potentially associated with ground water levels or inflows. There are a variety of locations in the system that would provide useful flow information, example most of the monitoring locations of this study were effective and provide some level of insight. Only choosing one or two locations however means more forethought is required to gain the best benefit.

Probably the best two locations to install a permanent flow monitor are at manholes E3-I7-53 and E3-I7-39, see Exhibit 5. Flow monitors at one or both of these locations allows for easy comparison of monitor data with WWTP data. For example, if only one monitor is used flow data at the other manhole could be deduced relatively accurately by subtracting the WWTP flows from the monitor flow. Only flows in Basin 1 would cause some discrepancy.

Installing a flow monitor on the river trunk line would be preferable to the airport trunk line because the river trunk line is more likely to reach capacity in the near future, particularly as Townsend builds out, and the Stonebridge interceptor is added. Trending flow in the sewer would allow the City to make more informed decisions about when to perform CIPs. Similarly, a flow monitor at F4-L9-84 would better inform the City about capacity availability in 7th Ave. prior to going to construction for CIP 3.

D. Considerations for the proposed Chipeta Park Addition (CIP – A)

In this short section we describe our review of the Chipeta Park Addition proposed development, and calculations provided to the City by Alpine Engineering.

1. Review of peaking factors:

The calculations presented by Alpine Engineering indicate an average day flow of 89,125 gpd. We believe that the peaking factor of 1.2 is too low. We propose that a more conservative value of 3.35 be used given the small size of the development.

This higher factor is supported by similar findings from flow data gathered in the Utility Master Plan, and in general by Figure 3-13 of the 4th Edition of Wastewater Engineering by Metcalf & Eddy which indicates a peaking factor (PF) of 4.0 for primarily domestic flow for populations under 5,000. Using a 4.0 PF for the 70,000 gpd domestic portion of the proposed development alone yields a peak flow of 280,000 gpd, and it is reasonable to expect the restaurant and commercial peak flows to be at other times of day.

Superimposing just average flows for the restaurants and commercial onto the peak domestic gives a peak flow rate of 299,125 gpd. The 3.35 peaking factor results in a peak-hour flow rate of 298,569 gpd, essentially the same as what is derived by looking at the sources separately.

2. Comparison of capacities required for development vs future growth:

The projected peak-hour flow for Basin 43 is 0.65 MGD, based on the 2015 Utility Master Plan with a peaking factor of 1.8 for the classification R3. The 0.30 MGD peak rate from the proposed development is 46% of the minimum capacity that is recommended in the Utility Master Plan. However, we recommend that if this sewer is extended as a trunk main, it would be prudent to size it to be of similar capacity to the existing 12-inch main along the bike path that runs north from Cobble Creek. Accordingly, we recommend that the trunk main be designed with a capacity of not less than 1.2 MGD. This reduces the amount of capacity used by the proposed development to 25%.

3. Comparison of sewer sizes required for development vs future growth:

A suitable sewer sizing to convey just the proposed development, at a typical design maximum depth:diameter ratio of 70% is 8-inch diameter at minimum grade of 0.40% (0.50% minimum slope preferred). In theory, a 6-inch diameter at a 1.0% slope would perform in a similar manner, but it is doubtful that the 1.0% slope is available for the entire alignment.
In order to carry the projected flow rate for Design Year 3 in a sewer that is no more than 70% full by depth, a 12" diameter sewer at 0.42% slope or steeper would be suitable if grades allow. Alternatively, a flatter 15" diameter would carry this flow rate. In order to achieve a reasonable velocity in the sewer during the initial early stages of development when flows are low, the steeper 12" solution is preferable, if grades allow. Moreover, the existing sewer that carries flow by gravity from Cobble Creek northwards along the bike path is a 12-inch diameter line with a slope of approximately 0.3% at the flatter segments, which could convey 1.2 MGD flowing full if necessary. As such, it is reasonable to design the sewer extension to have a similar capacity to the existing downstream main.

4. Comparison of sewer project costs required for development vs future growth:

- The design cost for a sewer project whether 6-in or 15-inch is the same.
- The construction cost for a 6-inch or 8-inch sewer vs a 12-inch or 15-inch is different, but likely not by very much.
    - Mobilization costs, manhole costs, testing and restoration are essentially the same identical;
    - Trench excavation and compaction costs for a 6" sewer is in the order of 80% of the cost for a 15" sewer.
    - Highway boring costs are likely very similar as a sufficiently large diameter steel casing is required to keep the alignment straight regardless of which sewer is installed. Also, it is probable that the sewer across the highway could be smaller than the trunk sewer, as much of the future growth in Basin 43 is expected west of Highway 550.
- Hence, it is likely that it may only cost 10-20% more to design/bid/build/inspect a 6" sewer vs a 15" sewer from the development to the connection at Chipeta and the bike trail.

Appendix A – Calibration Results

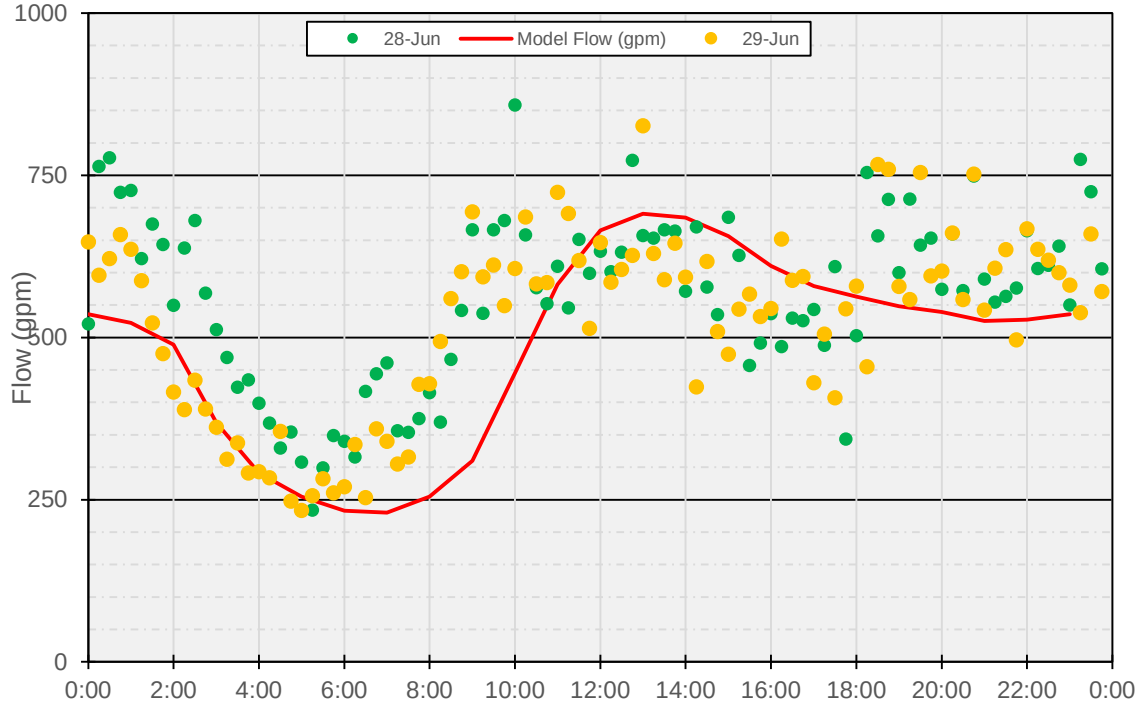


Figure 15 – Model Calibration at Flow Monitor 1 – Manhole E3-I7-39 located on the WGI Plant property.

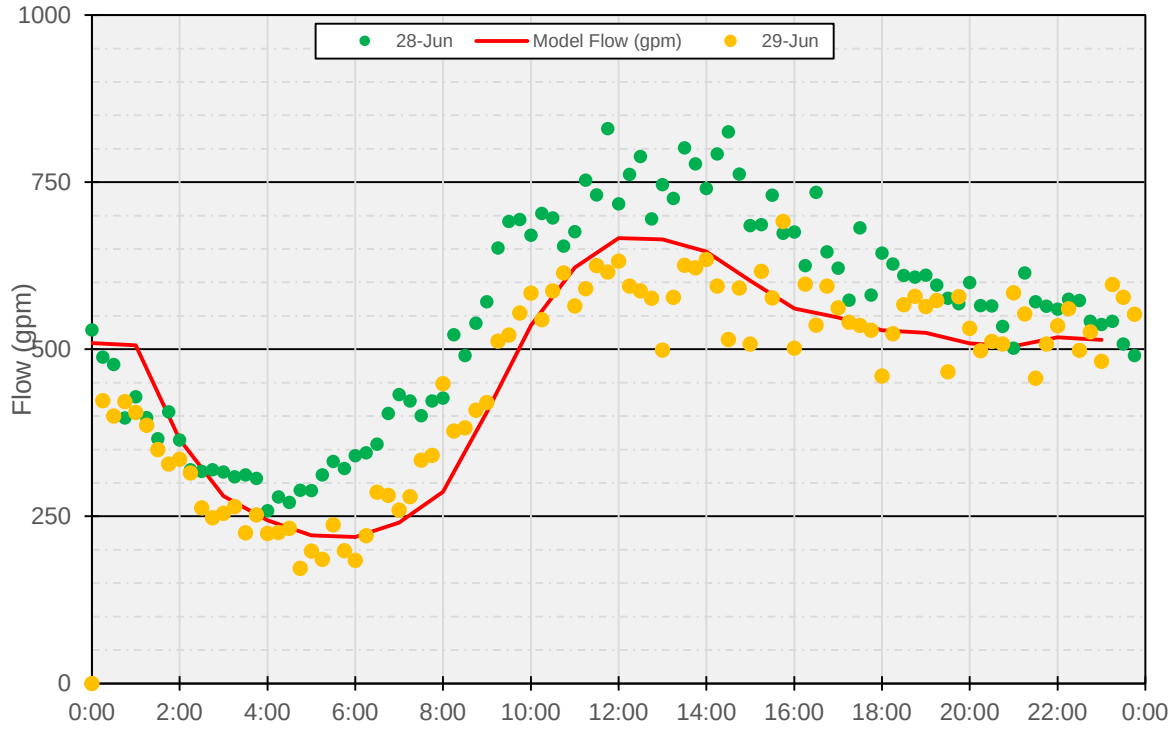


Figure 16 – Model Calibration at Flow Monitor 2 – Manhole F4-L8-6 near the Justice Center

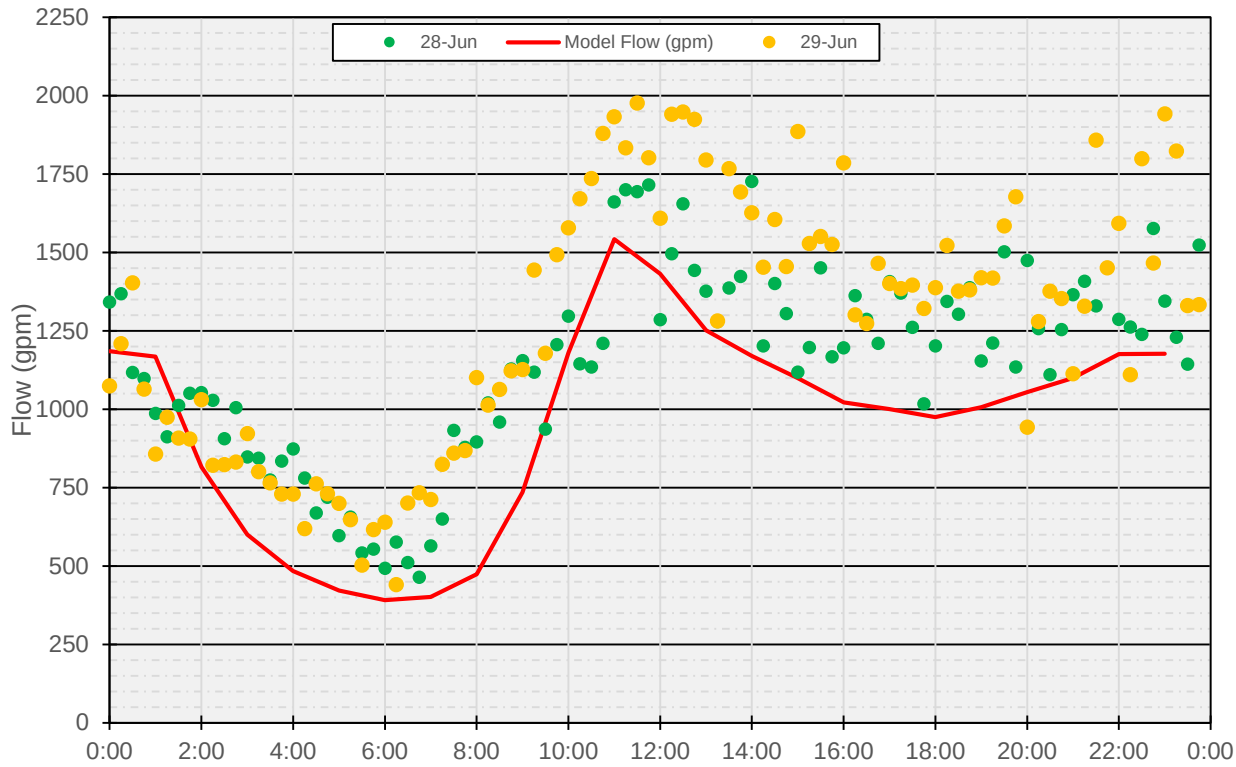


Figure 17 - Model Calibration at Flow Monitor 3 – Manhole E3-I7-53 located on airport trunk line.

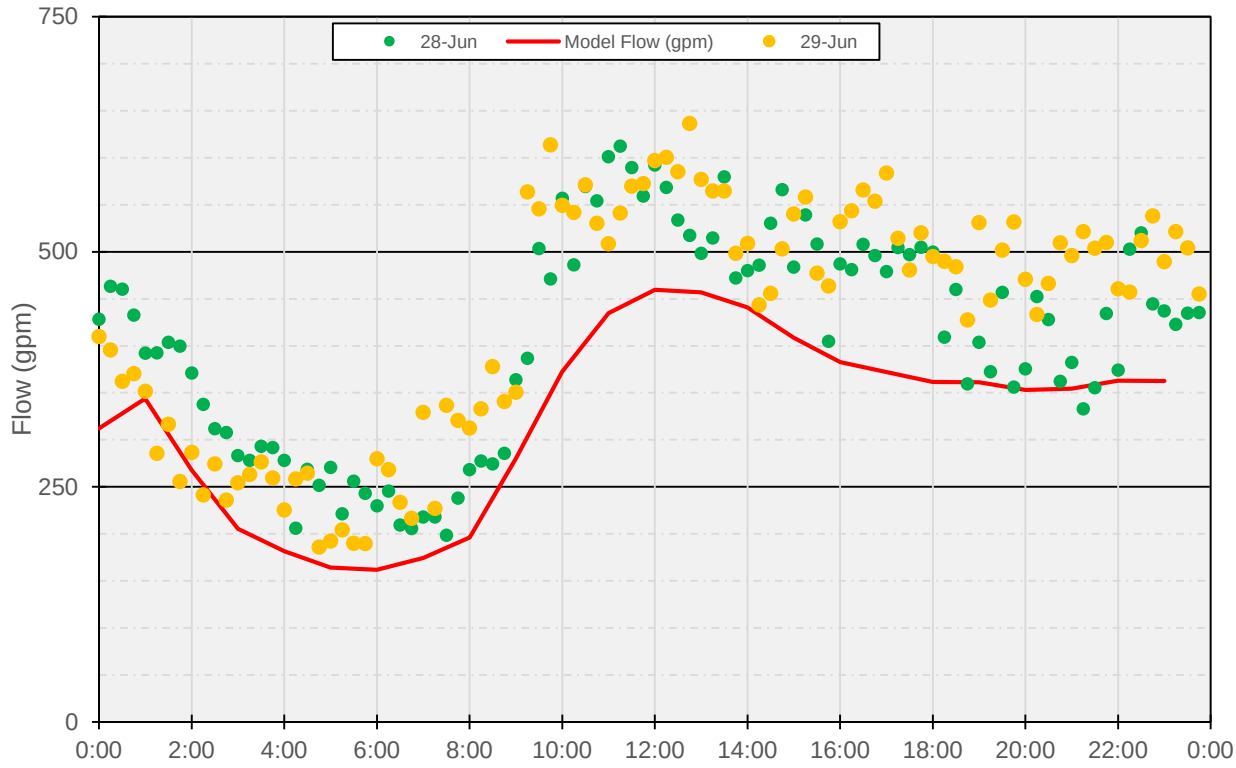


Figure 18 - Model Calibration at Flow Monitor 4 – Manhole F4-L8-3 in N. 9th Street.

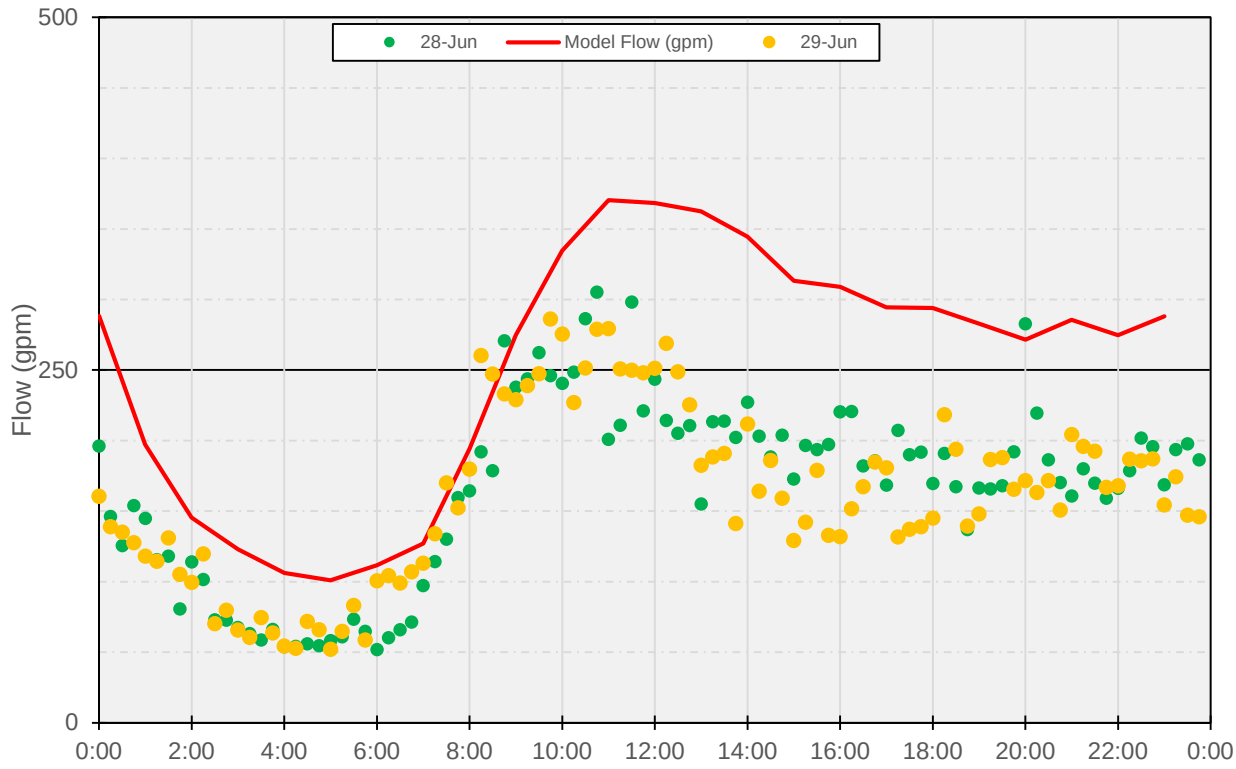


Figure 19 - Model Calibration at Flow Monitor 5 – Manhole F4-L9-84 in N. 7th Street

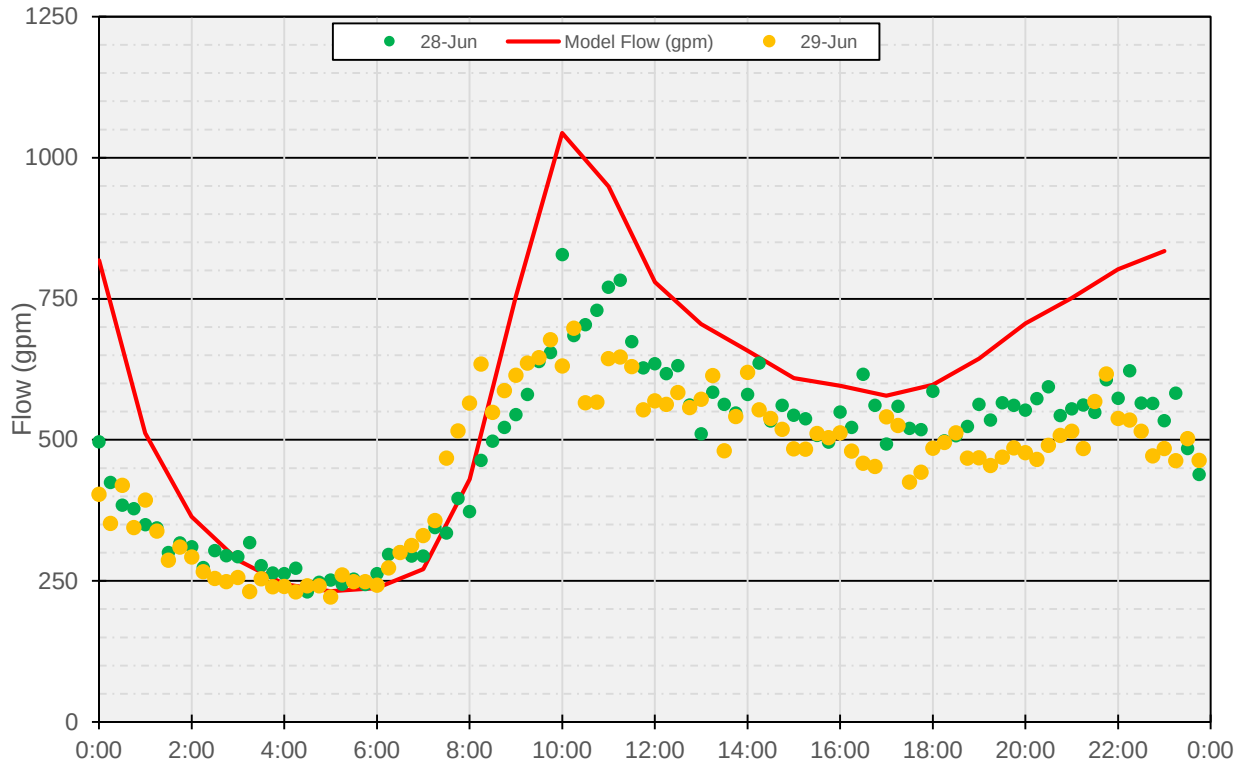


Figure 20 - Model Calibration at Flow Monitor 6 – Manhole F4-L9-120 in Uncompahgre Ave.

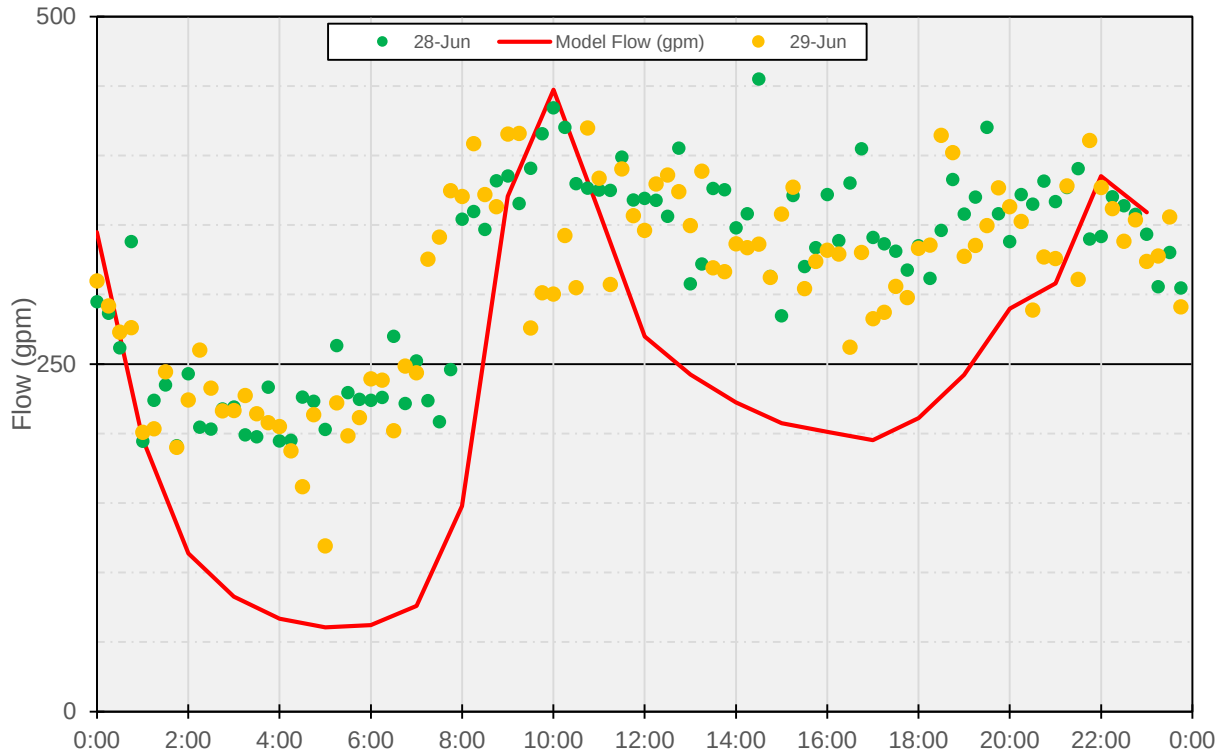


Figure 21 - Model Calibration at Flow Monitor 8 – Manhole G5-N10-169 in Mesa Ave.

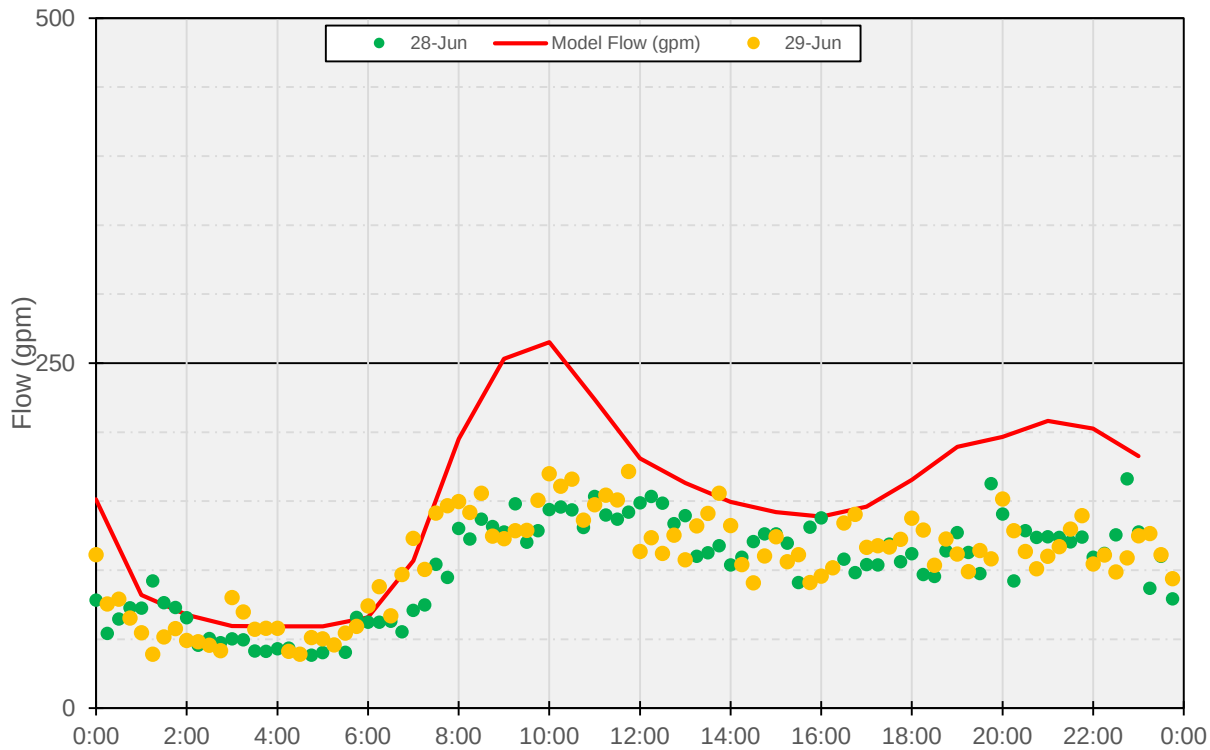


Figure 22 - Model Calibration at Flow Monitor 9 – Manhole G5-M10-168 in S. 12th Street.

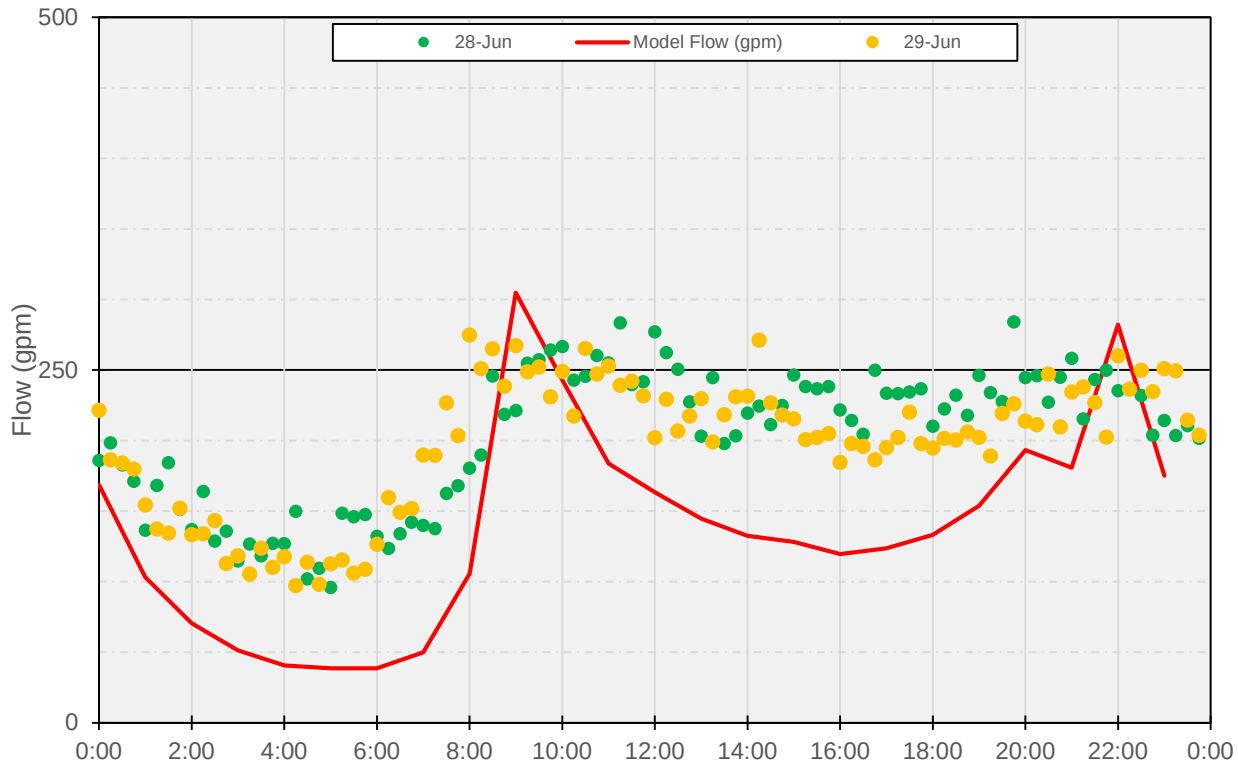


Figure 23 - Model Calibration at Flow Monitor 10 – Manhole G5-N11-16 in Pavilion Dr.

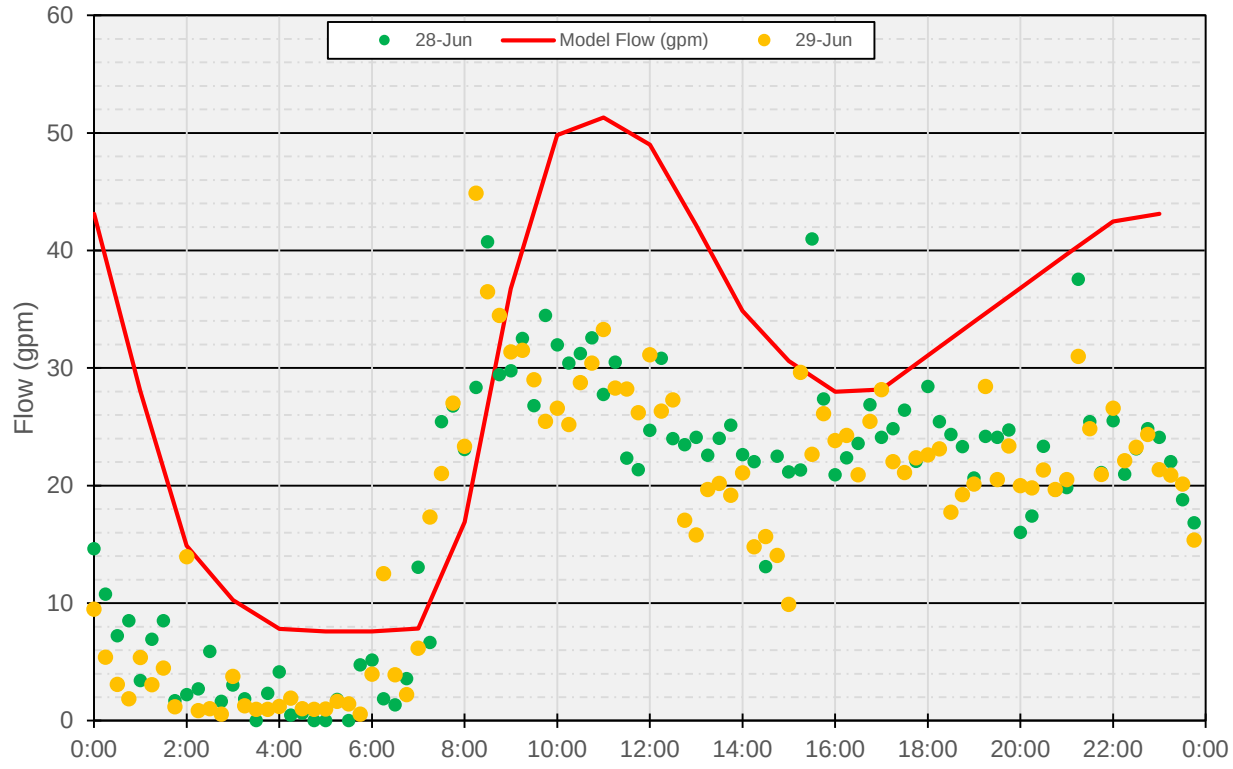


Figure 24 - Model Calibration at Flow Monitor 11 – Manhole H4-O9-15 in Cobble Creek Gravity line by River Crossing

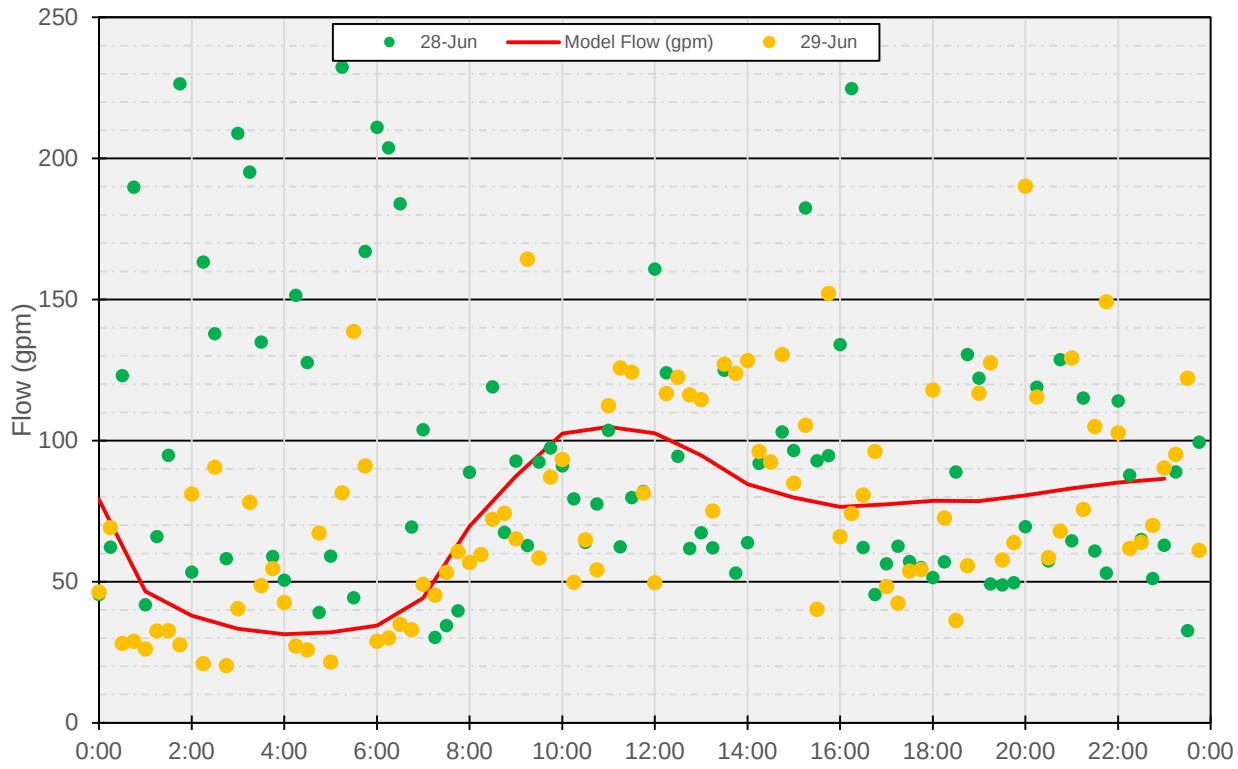


Figure 25 - Model Calibration at Flow Monitor 12 – Manhole H5-P10-26 in Woodgate Rd.

Appendix B – Sewer Flows per Basin Spreadsheets

Table - 1A: Sewer Flows per Basin Spreadsheet

EXISTING WASTEWATER COLLECTION SYSTEM FLOW ANALYSIS - DIVIDED BY BASIN

30	= I&I max month (gpcd) for existing customers	
131	= Max Month flow from all existing sources (gpcd)	
159	= Peak Day flow from all existing sources (gpcd)	
1.22	= Effective Peak Day to Max Month Factor	

					2.1	People/tap									
					95	gpcd									
					19,249	Eff. Exist. Pop.									
					199.5	g/tap/day	1.3			0.1			Max Month	Peak Day
Basin Number	Assigned MH for Model Input	Basin Area (acres)	2015 Existing Customers in Basin (Eqiv. Taps)	2009-2015 New Eqiv. Taps	2008 Existing Customers in Basin (Eqiv. Taps)	Existing Customer Flow Rate (g/tap/day)	Existing Customer Sanitary Flow (gpd)	Existing Sanitary Peak Day Flow	Basin I&I Factor (No. Taps x Basin Area)	I&I Factor Relative to average basin I&I per acre	Existing Summer I&I in basin (gpd)	Existing High Discharger Flow (gpd)	Sub-total Existing Flow in Basin (gpd)	Peak Day Flow = Peak Day Sanitary flows + constant I&I + High Discharger flows (gpd)
1	D3-H7-14	508	40		40	199.5	7,980	10,374	20,320	2	4,064	-	12,044	14,438
2	E4-I8-4	732	12		12	199.5	2,394	3,112	8,786	2	1,757	-	4,151	4,869
3	E3-I7-64	180	33		33	199.5	6,584	8,559	5,925	2	1,185	-	7,768	9,744
4	E3-J7-8	177	15		15	199.5	2,993	3,890	2,650	2	530	-	3,522	4,420
5	F4-K8-24	83	49	20	29	199.5	9,776	12,708	4,083	1	408	10,000	20,184	23,116
6	F4-K8-12	123	28		28	199.5	5,586	7,262	3,441	2	688	-	6,274	7,950
7	F4-K9-93	987	557	20	537	199.5	111,122	144,458	550,035	1	55,004	-	166,125	199,461
8	F4-K9-93	427	12		12	199.5	2,394	3,112	5,124	1	512	-	2,906	3,625
9	F4-L8-14	54	21		21	199.5	4,190	5,446	1,144	2	229	-	4,418	5,675
10	F4-L8-8	145	107		107	199.5	21,347	27,750	15,565	2	3,113	-	24,460	30,863
11	F5-L10-28	73	70	10	60	199.5	13,965	18,155	5,130	2	1,024	-	14,989	19,178
12	F5-K11-22	320	88	10	78	199.5	17,556	22,823	28,201	1	2,820	-	20,376	25,643
13	F5-K11-15	264	82		82	199.5	16,359	21,267	21,681	1	2,168	-	18,527	23,435
14	F5-K11-15	558	9		9	199.5	1,796	2,334	5,018	1	502	-	2,297	2,836
15	G4-M9-7	179	310		310	199.5	61,845	80,399	55,638	4	22,255	-	84,100	102,654
16	G4-M9-116	181	493		493	199.5	98,354	127,860	89,101	4	35,640	-	133,994	163,500
16A	G5-M10-94													
17	G5-M10-156	296	928		928	199.5	185,136	240,677	274,937	4	109,975	10,000	305,111	360,652
17A	F4-L9-125													
18	F5-L10-117	374	1,055		1,055	199.5	210,473	273,614	394,570	2	78,914	10,000	299,387	362,528
19	F5-L10-60	807	261	20	241	199.5	52,070	67,690	210,716	1	21,072	-	73,141	88,762
20	F5-L10-60	1345	50		50	199.5	9,975	12,968	67,263	0.3	2,018	-	11,993	14,985
21	G4-N9-45	214	15		15	199.5	2,993	3,890	3,216	2	643	-	3,636	4,533
21A	H5-O10-31		-											
22	G5-N10-4	325	684		684	199.5	136,459	177,396	222,139	2	44,428	15,000	195,886	236,823
23	G5-M10-167	321	713		713	199.5	142,244	184,917	228,689	2	45,738	-	187,981	230,654
23A	G5-M10-64													
23B	G5-M10-168													
24	G5-M11-12	154	309		309	199.5	61,646	80,139	47,502	2	9,500	-	71,146	89,640
25	G5-N11-61	112	368		368	199.5	73,416	95,441	41,247	2	8,249	-	81,665	103,690
26	G5-M11-49	409	310	20	290	199.5	61,845	80,399	126,880	1	12,688	-	74,533	93,087
27	G5-M11-45	663	-			199.5	-	-	-	1	-	-	-	-
28	H5-O10-62	318	110	30	80	199.5	21,945	28,529	34,972	2	6,994	70,000	98,939	105,523
29	H5-O10-74	422	448		448	199.5	89,376	116,189	189,175	2	37,835	-	127,211	154,024
29A	H5-P10-24		-											
30	G5-N10-36	171	31		31	199.5	6,185	8,040	5,298	2	1,060	-	7,244	9,099
31	H5-O11-51	63	88		88	199.5	17,556	22,823	5,578	1	558	-	18,114	23,381
32	H5-O11-26	215	32		32	199.5	6,384	8,299	6,865	1	687	-	7,071	8,986
33	G5-N11-33	197	365	20	345	199.5	72,818	94,663	71,952	0.7	5,037	-	77,854	99,699
34	H6-O12-33	636	792	20	772	199.5	158,004	205,405	503,733	0.5	25,187	-	183,191	230,592
34A	H6-O12-34		-											
35	H6-P12-7	979	-			199.5	-	-	-	1	-	-	-	-
36	H6-P12-7	340	22		22	199.5	4,389	5,706	7,474	0.3	224	-	4,613	5,930
37	I4-Q9-12	1168	263	20	243	199.5	52,469	68,209	307,139	0.1	3,071	-	55,540	71,280
38	I5-Q10-16	1506	218		218	199.5	43,491	56,538	328,320	0.5	16,416	-	59,907	72,954
39	H5-P11-13	549	-		-	199.5	-	-	-	1	-	-	-	-
40	H6-P12-32	294	102		102	199.5	20,349	26,454	29,937	0.7	2,096	-	22,445	28,549
40A	H6-P12-7		-											
41	I6-Q12-25	560	25		25	199.5	4,988	6,484	13,993	1	1,399	-	6,387	7,883
42	I6-Q12-33	1063	20	10	10	199.5	3,990	5,187	21,265	1	2,126	-	6,116	7,313
43	I4-Q9-12	2314	-			199.5	-	-	-	1	-	-	-	-
44	I5-Q10-62	736	29		29	199.5	5,786	7,521	21,346	1	2,135	-	7,920	9,656
45	E4-J9-39	396	2		2	199.5	399	519	792	1	79	-	478	598
46	E3-I7-46	1.908	-		-	199.5	-	-	-	1	-	-	-	-
47	E3-I7-46	2.081	-		-	199.5	-	-	-	1	-	-	-	-
48	E3-I7-46	659	-		-	199.5	-	-	-	1	-	-	-	-
49						199.5	-	-	-	1	-	-	-	-
50					-	199.5	-	-	-	1	-	-	-	-
Totals		**26,588**	**9,166**	**200**	**8,966**	**--**	**1,828,617**	**2,377,202**			**570,028**	**115,000**	**2,513,645**	**3,062,230**

Notes: = Input cells that may be edited

ADDITIONAL WASTEWATER FLOWS PER BASIN - FROM FUTURE (NEW) CUSTOMERS ONLY

35	= I&I max month (gpcd) for new customers	
129	= Max Month flow from all new sources (gpcd)	
159	= Peak Day flow from all existing sources (gpcd)	
1.20	= Effective Peak Day to Max Month Factor	

													2	People/tap							
													85	gpcd							
													6,165	Eff. New Pop.							
		0	0.5	1	2	3	0.5						170	g/tap/day	1.3			0.08		Max Month	1.3
Basin Number	Comp Plan Ultimate Total Dwelling Units (Taps)	Existing Flows Only	Basin Percentage Build-out from Existing to Design Year 0.5	Basin Percentage Build-out from Existing to Design Year 1	Basin Percentage Build-out from Existing to Design Year 2	Basin Percentage Build-out from Existing to Design Year 3	New Taps at design year	New Customer Flow Rate (g/tap/day)	New Customer Sanitary Flow (gpd)	New Sanitary Peak Day Flow	Basin I&I Factor (No. New Taps x Basin Area)	I&I Factor Relative to average new taps in basin I&I per acre	New Summer I&I in basin (gpd)	New High Discharger Flow (gpd)	Sub-total New Flow in Basin (gpd)	Peak Day Flow = Peak Day Sanitary flows + constant I&I + High Discharger flows (gpd)
1	2,943	0%	2.5%	5.0%	10.0%	15.0%	73	170	12,339	16,039	36,868	1	2,949	-	15,287	18,989
2	4,393	0%	0.5%	1.0%	2.0%	3.0%	22	170	3,724	4,841	16,038	1	1,283	-	5,007	6,124
3	1,077	0%	2.5%	5.0%	10.0%	15.0%	26	170	4,438	5,770	4,687	1	375	-	4,813	6,145
4	900	0%	1.3%	2.5%	5.0%	7.5%	11	170	1,881	2,445	1,955	1	156	-	2,037	2,602
5	500	0%	2.5%	5.0%	10.0%	15.0%	11	170	1,916	2,491	939	1	75	5,000	6,992	7,567
6	605	0%	2.5%	5.0%	10.0%	15.0%	14	170	2,453	3,188	1,773	1	142	-	2,595	3,330
7	4,526	0%	3.8%	7.5%	15.0%	22.5%	149	170	25,314	32,908	147,041	1	11,763	-	37,077	44,671
8	1,776	0%	1.3%	2.5%	5.0%	7.5%	22	170	3,748	4,872	9,413	1	753	-	4,501	5,625
9	305	0%	5.0%	10.0%	20.0%	30.0%	14	170	2,413	3,137	773	1	62	-	2,475	3,199
10	723	0%	5.0%	10.0%	20.0%	30.0%	31	170	5,232	6,802	4,477	1	358	-	5,591	7,160
11	487	0%	5.0%	10.0%	20.0%	30.0%	21	170	3,548	4,612	1,526	1	122	-	3,670	4,734
12	1,718	0%	3.8%	7.5%	15.0%	22.5%	61	170	10,389	13,506	19,585	1	1,567	-	11,956	15,073
13	1,220	0%	2.5%	5.0%	10.0%	15.0%	28	170	4,828	6,290	7,525	1	602	-	5,440	6,892
14	2,492	0%	1.3%	2.5%	5.0%	7.5%	31	170	5,277	6,860	17,309	1	1,385	-	6,662	8,245
15	1,103	0%	5.0%	10.0%	20.0%	30.0%	40	170	6,741	8,763	7,117	1	569	-	7,310	9,333
16	1,189	0%	5.0%	10.0%	20.0%	30.0%	35	170	5,917	7,692	6,291	1	503	-	6,421	8,196
17	2,129	0%	5.0%	10.0%	20.0%	30.0%	60	170	10,210	13,272	17,793	1	1,423	5,000	16,633	19,696
18	2,098	0%	5.0%	10.0%	20.0%	30.0%	52	170	8,868	11,529	19,510	1	1,561	5,000	15,429	18,090
19	4,048	0%	5.0%	10.0%	20.0%	30.0%	189	170	32,190	41,846	152,870	1	12,230	-	44,419	54,076
20	6,654	0%	3.8%	7.5%	15.0%	22.5%	248	170	42,102	54,733	333,167	1	26,653	-	68,755	81,386
21	635	0%	5.0%	10.0%	20.0%	30.0%	31	170	5,266	6,846	6,641	1	531	-	5,798	7,378
21A			0.0%													
22	1,812	0%	5.0%	10.0%	20.0%	30.0%	56	170	9,589	12,466	18,319	1	1,466	7,500	18,555	21,432
23	1,471	0%	5.0%	10.0%	20.0%	30.0%	38	170	6,446	8,380	12,161	1	973	-	7,419	9,352
24	615	0%	5.0%	10.0%	20.0%	30.0%	15	170	2,600	3,380	2,351	1	188	-	2,788	3,568
25	448	0%	5.0%	10.0%	20.0%	30.0%	4	170	683	888	450	1	36	-	719	924
26	1,702	0%	5.0%	10.0%	20.0%	30.0%	70	170	11,833	15,383	28,490	1	2,279	-	14,112	17,662
27	3,266	0%	3.8%	7.5%	15.0%	22.5%	122	170	20,823	27,069	81,250	1	6,500	-	27,323	33,570
28	1,065	0%	5.0%	10.0%	20.0%	30.0%	47	170	8,034	10,444	15,026	1	1,202	35,000	44,236	46,646
29	1,773	0%	5.0%	10.0%	20.0%	30.0%	66	170	11,260	14,637	27,968	1	2,237	-	13,497	16,875
29A																
30	684	0%	5.0%	10.0%	20.0%	30.0%	33	170	5,547	7,211	5,577	1	446	-	5,993	7,657
31	254	0%	5.0%	10.0%	20.0%	30.0%	8	170	1,407	1,829	525	1	42	-	1,449	1,871
32	858	0%	5.0%	10.0%	20.0%	30.0%	41	170	7,022	9,129	8,862	1	709	-	7,731	9,838
33	789	0%	5.0%	10.0%	20.0%	30.0%	21	170	3,600	4,680	4,174	1	334	-	3,934	5,014
34	2,522	0%	5.0%	10.0%	20.0%	30.0%	86	170	14,703	19,114	55,009	1	4,401	-	19,104	23,515
35	3,892	0%	2.5%	5.0%	10.0%	15.0%	97	170	16,540	21,502	95,263	1	7,621	-	24,161	29,123
36	1,465	0%	1.3%	2.5%	5.0%	7.5%	18	170	3,066	3,985	6,126	1	490	-	3,556	4,475
37	4,276	0%	3.8%	7.5%	15.0%	22.5%	150	170	25,584	33,260	175,753	1	14,060	-	39,644	47,320
38	7,433	0%	2.5%	5.0%	10.0%	15.0%	180	170	30,665	39,864	271,663	1	21,733	-	52,398	61,597
39	2,932	0%	2.5%	5.0%	10.0%	15.0%	73	170	12,463	16,202	40,225	1	3,218	-	15,681	19,420
40	1,172	0%	3.8%	7.5%	15.0%	22.5%	40	170	6,823	8,870	11,780	1	942	-	7,765	9,812
40A																
41	3,242	0%	2.5%	5.0%	10.0%	15.0%	80	170	13,672	17,773	45,013	1	3,601	-	17,273	21,374
42	6,101	0%	2.5%	5.0%	10.0%	15.0%	152	170	25,844	33,597	161,635	1	12,931	-	38,775	46,528
43	5,956	0%	2.5%	5.0%	10.0%	15.0%	149	170	25,312	32,906	344,570	1	27,566	-	52,878	60,472
44	4,875	0%	2.5%	5.0%	10.0%	15.0%	121	170	20,595	26,774	89,172	1	7,134	-	27,729	33,907
45	1,923	0%	2.5%	5.0%	10.0%	15.0%	48	170	8,163	10,611	19,014	1	1,521	-	9,684	12,132
46	9,716	0%	0.5%	1.0%	2.0%	3.0%	49	170	8,259	10,736	92,691	1	7,415	-	15,674	18,151
47	8,574	0%	1.3%	2.5%	5.0%	7.5%	107	170	18,220	23,686	223,031	1	17,842	-	36,062	41,528
48	3,054	0%	1.3%	2.5%	5.0%	7.5%	38	170	6,490	8,437	25,157	1	2,013	-	8,502	10,449
49	-	0%	0.0%	0.0%	0.0%	0.0%	-	170	-	-	-	1	-	-	-	-
50	-	0%	0.0%	0.0%	0.0%	0.0%	-	170	-	-	-	1	-	-	-	-
Totals	**123,383**						**3,083**		**524,044**	**681,257**			**213,964**	**57,500**	**795,508**	**952,721**

TOTAL WASTEWATER FLOWS PER BASIN (EXISTING + FUTURE)

25,414	= Effective total population in Design Year
130	= Max Month flow from all new and existing sources
159	= Peak Day flow from all existing sources (gpcd)
1.21	= Effective Peak Day to Max Month Factor

			1.3			Max Month	1.3
Basin Number	Total Taps in Basin	Total Sanitary Flow (gpd)	Total Sanitary Peak Day Flow (gpd)	Total Summer I&I in basin (gpd)	Total High Discharger Flow (gpd)	Total Average Summer Flow in Basin (MGD)	Peak Day Flow = Peak Day Sanitary flows + constant I&I + High Discharger flows (gpd)
1	113	20,318	26,413.08	7,013	0	27,331	33,427
2	34	6,118	7,953	3,040	0	9,158	10,993
3	59	11,022	14,329	1,560	0	12,582	15,888
4	26	4,874	6,336	686	0	5,560	7,022
5	60	11,692	15,200	483	15,000	27,175	30,683
6	42	8,039	10,450	830	0	8,869	11,280
7	706	136,435	177,366	66,767	0	203,202	244,132
8	34	6,142	7,984	1,265	0	7,407	9,250
9	35	6,602	8,583	291	0	6,893	8,874
10	138	26,579	34,553	3,471	0	30,050	38,024
11	91	17,513	22,766	1,146	0	18,659	23,912
12	149	27,945	36,329	4,387	0	32,332	40,716
13	110	21,197	27,556	2,770	0	23,967	30,326
14	40	7,073	9,195	1,887	0	8,959	11,081
15	350	68,586	89,162	22,825	0	91,411	111,986
16	528	104,271	135,552	36,144	0	140,414	171,696
17	988	195,346	253,949	111,398	15000	321,744	380,347
18	1,107	219,341	285,143	80,475	15000	314,816	380,618
19	450	84,259	109,537	33,301	0	117,560	142,838
20	298	52,077	67,700	28,671	0	80,748	96,371
21	46	8,259	10,737	1,174	0	9,433	11,911
21A							-
22	740	146,047	189,862	45,893	22500	214,441	258,255
23	751	148,689	193,296	46,711	0	195,400	240,007
24	324	64,246	83,519	9,688	0	73,934	93,208
25	372	74,099	96,329	8,285	0	82,384	104,614
26	380	73,678	95,782	14,967	0	88,645	110,749
27	122	20,823	27,069	6,500	0	27,323	33,570
28	157	29,979	38,972	8,196	105000	143,175	152,169
29	514	100,636	130,826	40,072	0	140,708	170,899
29A							-
30	64	11,732	15,251	1,506	0	13,237	16,757
31	96	18,963	24,652	600	0	19,563	25,252
32	73	13,406	17,428	1,395	0	14,802	18,823
33	386	76,417	99,343	5,371	0	81,788	104,713
34	878	172,707	224,519	29,587	0	202,294	254,107
35	97	16,540	21,502	7,621	0	24,161	29,123
36	40	7,455	9,691	714	0	8,169	10,405
37	413	78,053	101,469	17,132	0	95,184	118,600
38	398	74,156	96,402	38,149	0	112,305	134,551
39	73	12,463	16,202	3,218	0	15,681	19,420
40	142	27,172	35,324	3,038	0	30,210	38,362
40A							
41	105	18,659	24,257	5,000	0	23,659	29,257
42	172	29,834	38,784	15,057	0	44,891	53,841
43	149	25,312	32,906	27,566	0	52,878	60,472
44	150	26,381	34,295	9,268	0	35,649	43,563
45	50	8,562	11,130	1,600	0	10,162	12,730
46	49	8,259	10,736	7,415	0	15,674	18,151
47	107	18,220	23,686	17,842	0	36,062	41,528
48	38	6,490	8,437	2,013	0	8,502	10,449
49	-	-	-	-	0	-	-
50	-	-	-	-	0	-	-
Totals	**12,249**	**2,352,661**	**3,058,459**	**783,992**	**172,500**	**3,309,153**	**4,014,951**

Table - 1B: Sewer Flows per Basin Spreadsheet

EXISTING WASTEWATER COLLECTION SYSTEM FLOW ANALYSIS - DIVIDED BY BASIN

30	= I&I max month (gpcd) for existing customers	
131	= Max Month flow from all existing sources (gpcd)	
159	= Peak Day flow from all existing sources (gpcd)	
1.22	= Effective Peak Day to Max Month Factor	

2.1	People/tap	
95	gpcd	
19,249	Eff. Exist. Pop.	
199.5	g/tap/day	

Basin Number	Assigned MH for Model Input	Basin Area (acres)	2015 Existing Customers in Basin (Equiv. Taps)	2009-2015 New Equiv. Taps	2008 Existing Customers in Basin (Equiv. Taps)	Existing Customer Flow Rate (g/tap/day)	Existing Customer Sanitary Flow (gpd)	Existing Sanitary Peak Day Flow (1.3)	Basin I&I Factor (No. Taps x Basin Area)	I&I Factor Relative to average basin I&I per acre (0.1)	Existing Summer I&I in basin (gpd)	Existing High Discharger Flow (gpd)	Sub-total Existing Flow in Basin (gpd) (Max Month)	Peak Day Flow = Peak Day Sanitary flows + constant I&I + High Discharger flows (gpd) (Peak Day)
1	D3-H7-14	508	40		40	199.5	7,980	10,374	20,320	2	4,064	-	12,044	14,438
2	E4-I8-4	732	12		12	199.5	2,394	3,112	8,786	2	1,757	-	4,151	4,869
3	E3-I7-64	180	33		33	199.5	6,584	8,559	5,925	2	1,185	-	7,768	9,744
4	E3-J7-8	177	15		15	199.5	2,993	3,890	2,650	2	530	-	3,522	4,420
5	F4-K8-24	83	49	20	29	199.5	9,776	12,708	4,083	1	408	10,000	20,184	23,116
6	F4-K8-12	123	28		28	199.5	5,586	7,262	3,441	2	688	-	6,274	7,950
7	F4-K9-93	987	557	20	537	199.5	111,122	144,458	550,035	1	55,004	-	166,125	199,461
8	F4-K9-93	427	12		12	199.5	2,394	3,112	5,124	1	512	-	2,906	3,625
9	F4-L8-14	54	21		21	199.5	4,190	5,446	1,144	2	229	-	4,418	5,675
10	F4-L8-8	145	107		107	199.5	21,347	27,750	15,565	2	3,113	-	24,460	30,863
11	F5-L10-28	73	70	10	60	199.5	13,965	18,155	5,130	2	1,024	-	14,989	19,178
12	F5-K11-22	320	88	10	78	199.5	17,556	22,823	28,201	1	2,820	-	20,376	25,643
13	F5-K11-15	264	82		82	199.5	16,359	21,267	21,681	1	2,168	-	18,527	23,435
14	F5-K11-15	558	9		9	199.5	1,796	2,334	5,018	1	502	-	2,297	2,836
15	G4-M9-7	179	310		310	199.5	61,845	80,399	55,638	4	22,255	-	84,100	102,654
16	G4-M9-116	181	493		493	199.5	98,354	127,860	89,101	4	35,640	-	133,994	163,500
16A	G5-M10-94													
17	G5-M10-156	296	928		928	199.5	185,136	240,677	274,937	4	109,975	10,000	305,111	360,652
17A	F4-L9-125													
18	F5-L10-117	374	1,055		1,055	199.5	210,473	273,614	394,570	2	78,914	10,000	299,387	362,528
19	F5-L10-60	807	261	20	241	199.5	52,070	67,690	210,716	1	21,072	-	73,141	88,762
20	F5-L10-60	1345	50		50	199.5	9,975	12,968	67,263	0.3	2,018	-	11,993	14,985
21	G4-N9-45	214	15		15	199.5	2,993	3,890	3,216	2	643	-	3,636	4,533
21A	H5-O10-31		-											
22	G5-N10-4	325	684		684	199.5	136,459	177,396	222,139	2	44,428	15,000	195,886	236,823
23	G5-M10-167	321	713		713	199.5	142,244	184,917	228,689	2	45,738	-	187,981	230,654
23A	G5-M10-64													
23B	G5-M10-168													
24	G5-M11-12	154	309		309	199.5	61,646	80,139	47,502	2	9,500	-	71,146	89,640
25	G5-N11-61	112	368		368	199.5	73,416	95,441	41,247	2	8,249	-	81,665	103,690
26	G5-M11-49	409	310	20	290	199.5	61,845	80,399	126,880	1	12,688	-	74,533	93,087
27	G5-M11-45	663	-			199.5	-	-	-	1	-	-	-	-
28	H5-O10-62	318	110	30	80	199.5	21,945	28,529	34,972	2	6,994	70,000	98,939	105,523
29	H5-O10-74	422	448		448	199.5	89,376	116,189	189,175	2	37,835	-	127,211	154,024
29A	H5-P10-24		-											
30	G5-N10-36	171	31		31	199.5	6,185	8,040	5,298	2	1,060	-	7,244	9,099
31	H5-O11-51	63	88		88	199.5	17,556	22,823	5,578	1	558	-	18,114	23,381
32	H5-O11-26	215	32		32	199.5	6,384	8,299	6,865	1	687	-	7,071	8,986
33	G5-N11-33	197	365	20	345	199.5	72,818	94,663	71,952	0.7	5,037	-	77,854	99,699
34	H6-O12-33	636	792	20	772	199.5	158,004	205,405	503,733	0.5	25,187	-	183,191	230,592
34A	H6-O12-34		-											
35	H6-P12-7	979	-			199.5				1	-	-		
36	H6-P12-7	340	22		22	199.5	4,389	5,706	7,474	0.3	224	-	4,613	5,930
37	I4-Q9-12	1168	263	20	243	199.5	52,469	68,209	307,139	0.1	3,071	-	55,540	71,280
38	I5-Q10-16	1506	218		218	199.5	43,491	56,538	328,320	0.5	16,416	-	59,907	72,954
39	H5-P11-13	549	-			199.5	-	-	-	1	-	-	-	-
40	H6-P12-32	294	102		102	199.5	20,349	26,454	29,937	0.7	2,096	-	22,445	28,549
40A	H6-P12-7		-											
41	I6-Q12-25	560	25		25	199.5	4,988	6,484	13,993	1	1,399	-	6,387	7,883
42	I6-Q12-33	1063	20	10	10	199.5	3,990	5,187	21,265	1	2,126	-	6,116	7,313
43	I4-Q9-12	2314	-			199.5	-	-	-	1	-	-	-	-
44	I5-Q10-62	736	29		29	199.5	5,786	7,521	21,346	1	2,135	-	7,920	9,656
45	E4-J9-39	396	2		2	199.5	399	519	792	1	79	-	478	598
46	E3-I7-46	1.908	-		-	199.5	-	-	-	1	-	-	-	-
47	E3-I7-46	2,081	-		-	199.5	-	-	-	1	-	-	-	-
48	E3-I7-46	659	-		-	199.5	-	-	-	1	-	-	-	-
49					-	199.5	-	-	-	1	-	-	-	-
50					-	199.5	-	-	-	1	-	-	-	-
Totals		**26,588**	**9,166**	**200**	**8,966**	**--**	**1,828,617**	**2,377,202**			**570,028**	**115,000**	**2,513,645**	**3,062,230**

Notes: = Input cells that may be edited

ADDITIONAL WASTEWATER FLOWS PER BASIN - FROM FUTURE (NEW) CUSTOMERS ONLY

35	= I&I max month (gpcd) for new customers	
129	= Max Month flow from all new sources (gpcd)	
158	= Peak Day flow from all existing sources (gpcd)	
1.20	= Effective Peak Day to Max Month Factor	

2	People/tap	
85	gpcd	
12,330	Eff. New Pop.	
170	g/tap/day	

Basin Number	Comp Plan Ultimate Total Dwelling Units (Taps)	Existing Flows Only (0)	Basin Percentage Build-out from Existing to Design Year 0.5 (0.5)	Basin Percentage Build-out from Existing to Design Year 1 (1)	Basin Percentage Build-out from Existing to Design Year 2 (2)	Basin Percentage Build-out from Existing to Design Year 3 (3)	New Taps at design year (1)	New Customer Flow Rate (g/tap/day)	New Customer Sanitary Flow (gpd)	New Sanitary Peak Day Flow (1.3)	Basin I&I Factor (No. New Taps x Basin Area)	I&I Factor Relative to average new taps in basin I&I per acre	New Summer I&I in basin (gpd) (0.08)	New High Discharger Flow (gpd)	Sub-total New Flow in Basin (gpd) (Max Month)	Peak Day Flow = Peak Day Sanitary flows + constant I&I + High Discharger flows (gpd) (1.3)
1	2,943	0%	2.5%	5.0%	10.0%	15.0%	145	170	24,676	32,078	73,736	1	5,899	-	30,574	37,977
2	4,393	0%	0.5%	1.0%	2.0%	3.0%	44	170	7,448	9,682	32,076	1	2,566	-	10,014	12,248
3	1,077	0%	2.5%	5.0%	10.0%	15.0%	52	170	8,876	11,539	9,375	1	750	-	9,626	12,289
4	900	0%	1.3%	2.5%	5.0%	7.5%	22	170	3,762	4,891	3,909	1	313	-	4,075	5,204
5	500	0%	2.5%	5.0%	10.0%	15.0%	23	170	3,833	4,983	1,879	1	150	10,000	13,983	15,133
6	605	0%	2.5%	5.0%	10.0%	15.0%	29	170	4,905	6,377	3,546	1	284	-	5,189	6,661
7	4,526	0%	3.8%	7.5%	15.0%	22.5%	298	170	50,627	65,815	294,082	1	23,527	-	74,154	89,342
8	1,776	0%	1.3%	2.5%	5.0%	7.5%	44	170	7,495	9,744	18,826	1	1,506	-	9,001	11,250
9	305	0%	5.0%	10.0%	20.0%	30.0%	28	170	4,826	6,273	1,546	1	124	-	4,949	6,397
10	723	0%	5.0%	10.0%	20.0%	30.0%	62	170	10,465	13,604	8,955	1	716	-	11,181	14,321
11	487	0%	5.0%	10.0%	20.0%	30.0%	42	170	7,095	9,224	3,052	1	244	-	7,339	9,468
12	1,718	0%	3.8%	7.5%	15.0%	22.5%	122	170	20,779	27,012	39,169	1	3,134	-	23,912	30,146
13	1,220	0%	2.5%	5.0%	10.0%	15.0%	57	170	9,676	12,579	15,050	1	1,204	-	10,880	13,783
14	2,482	0%	1.3%	2.5%	5.0%	7.5%	62	170	10,554	13,721	34,618	1	2,769	-	13,324	16,490
15	1,103	0%	5.0%	10.0%	20.0%	30.0%	79	170	13,482	17,527	14,234	1	1,139	-	14,621	18,665
16	1,189	0%	5.0%	10.0%	20.0%	30.0%	70	170	11,835	15,385	12,582	1	1,007	-	12,841	16,391
17	2,129	0%	5.0%	10.0%	20.0%	30.0%	120	170	20,419	26,545	35,585	1	2,847	10,000	33,266	39,392
18	2,098	0%	5.0%	10.0%	20.0%	30.0%	104	170	17,737	23,058	39,021	1	3,122	10,000	30,858	36,179
19	4,048	0%	5.0%	10.0%	20.0%	30.0%	379	170	64,379	83,693	305,741	1	24,459	-	88,838	108,152
20	6,654	0%	3.8%	7.5%	15.0%	22.5%	495	170	84,204	109,465	666,333	1	53,307	-	137,511	162,772
21	635	0%	5.0%	10.0%	20.0%	30.0%	62	170	10,533	13,693	13,283	1	1,063	-	11,596	14,755
21A			0.0%													
22	1,812	0%	5.0%	10.0%	20.0%	30.0%	113	170	19,179	24,933	36,639	1	2,931	15,000	37,110	42,864
23	1,471	0%	5.0%	10.0%	20.0%	30.0%	76	170	12,892	16,759	24,323	1	1,946	-	14,837	18,705
24	615	0%	5.0%	10.0%	20.0%	30.0%	31	170	5,200	6,761	4,703	1	376	-	5,577	7,137
25	448	0%	5.0%	10.0%	20.0%	30.0%	8	170	1,366	1,775	900	1	72	-	1,438	1,847
26	1,702	0%	5.0%	10.0%	20.0%	30.0%	139	170	23,666	30,766	56,979	1	4,558	-	28,225	35,325
27	3,266	0%	3.8%	7.5%	15.0%	22.5%	245	170	41,645	54,139	162,501	1	13,000	-	54,645	67,139
28	1,065	0%	5.0%	10.0%	20.0%	30.0%	95	170	16,068	20,888	30,048	1	2,404	70,000	88,472	93,292
29	1,773	0%	5.0%	10.0%	20.0%	30.0%	132	170	22,519	29,275	55,936	1	4,475	-	26,994	33,750
29A																
30	684	0%	5.0%	10.0%	20.0%	30.0%	65	170	11,094	14,423	11,153	1	892	-	11,986	15,315
31	254	0%	5.0%	10.0%	20.0%	30.0%	17	170	2,814	3,658	1,049	1	84	-	2,898	3,742
32	858	0%	5.0%	10.0%	20.0%	30.0%	83	170	14,044	18,257	17,723	1	1,418	-	15,462	19,675
33	789	0%	5.0%	10.0%	20.0%	30.0%	42	170	7,200	9,360	8,349	1	668	-	7,868	10,028
34	2,522	0%	5.0%	10.0%	20.0%	30.0%	173	170	29,406	38,228	110,018	1	8,801	-	38,208	47,030
35	3,892	0%	2.5%	5.0%	10.0%	15.0%	195	170	33,080	43,004	190,525	1	15,242	-	48,322	58,246
36	1,465	0%	1.3%	2.5%	5.0%	7.5%	36	170	6,131	7,970	12,253	1	980	-	7,111	8,951
37	4,276	0%	3.8%	7.5%	15.0%	22.5%	301	170	51,168	66,519	351,506	1	28,121	-	79,289	94,640
38	7,433	0%	2.5%	5.0%	10.0%	15.0%	361	170	61,329	79,728	543,326	1	43,466	-	104,796	123,194
39	2,932	0%	2.5%	5.0%	10.0%	15.0%	147	170	24,926	32,403	80,450	1	6,436	-	31,362	38,839
40	1,172	0%	3.8%	7.5%	15.0%	22.5%	80	170	13,646	17,740	23,560	1	1,885	-	15,531	19,625
40A																
41	3,242	0%	2.5%	5.0%	10.0%	15.0%	161	170	27,343	35,546	90,027	1	7,202	-	34,545	42,748
42	6,101	0%	2.5%	5.0%	10.0%	15.0%	304	170	51,688	67,194	323,270	1	25,862	-	77,549	93,056
43	5,956	0%	2.5%	5.0%	10.0%	15.0%	298	170	50,625	65,812	689,141	1	55,131	-	105,756	120,944
44	4,875	0%	2.5%	5.0%	10.0%	15.0%	242	170	41,190	53,547	178,344	1	14,268	-	55,458	67,815
45	1,523	0%	2.5%	5.0%	10.0%	15.0%	96	170	16,325	21,223	38,028	1	3,042	-	19,367	24,265
46	9,716	0%	0.5%	1.0%	2.0%	3.0%	97	170	16,517	21,472	185,381	1	14,831	-	31,348	36,303
47	8,574	0%	1.3%	2.5%	5.0%	7.5%	214	170	36,440	47,371	446,062	1	35,685	-	72,124	83,056
48	3,054	0%	1.3%	2.5%	5.0%	7.5%	76	170	12,980	16,873	50,315	1	4,025	-	17,005	20,899
49	-	0%	0.0%	0.0%	0.0%	0.0%	-	170	-	-	-	1	-	-	-	-
50	-	0%	0.0%	0.0%	0.0%	0.0%	-	170	-	-	-	1	-	-	-	-
Totals	**123,383**						**6,165**		**1,048,087**	**1,362,514**			**427,929**	**115,000**	**1,591,016**	**1,905,442**

TOTAL WASTEWATER FLOWS PER BASIN (EXISTING + FUTURE)

31,579	= Effective total population in Design Year	
130	= Max Month flow from all new and existing sources	
167	= Peak Day flow from all existing sources (gpcd)	
1.21	= Effective Peak Day to Max Month Factor	

Basin Number	Total Taps in Basin	Total Sanitary Flow (gpd)	Total Sanitary Peak Day Flow (gpd) (1.3)	Total Summer I&I in basin (gpd)	Total High Discharger Flow (gpd)	Total Average Summer Flow in Basin (MGD) (Max Month)	Peak Day Flow = Peak Day Sanitary flows + constant I&I + High Discharger flows (gpd) (1.3) (Peak Day)
1	185	32,656	42,452.15	9,963	0	42,618	52,415
2	56	9,842	12,794	4,323	0	14,165	17,118
3	85	15,460	20,098	1,935	0	17,395	22,033
4	37	6,755	8,781	843	0	7,597	9,624
5	72	13,608	17,691	559	20,000	34,167	38,250
6	57	10,491	13,639	972	0	11,463	14,611
7	855	161,749	210,273	78,530	0	240,279	288,803
8	56	9,889	12,856	2,018	0	11,908	14,874
9	49	9,015	11,720	353	0	9,368	12,072
10	169	31,811	41,355	3,829	0	35,641	45,184
11	112	21,060	27,378	1,298	0	22,358	28,646
12	210	38,335	49,835	5,954	0	44,288	55,789
13	139	26,035	33,846	3,372	0	29,407	37,218
14	71	12,350	16,055	3,271	0	15,621	19,326
15	389	75,327	97,925	23,394	0	98,721	121,319
16	563	110,188	143,244	36,647	0	146,835	179,891
17	1,048	205,555	267,222	112,822	20000	338,377	400,043
18	1,159	228,209	296,672	82,036	20000	330,245	398,708
19	640	116,449	151,383	45,531	0	161,979	196,914
20	545	94,179	122,433	55,325	0	149,504	177,757
21	77	13,525	17,583	1,706	0	15,231	19,289
21A						-	-
22	797	155,637	202,329	47,359	30000	232,996	279,687
23	789	155,135	201,676	47,684	0	202,819	249,359
24	340	66,846	86,900	9,877	0	76,723	96,776
25	376	74,782	97,216	8,321	0	83,103	105,538
26	449	85,511	111,165	17,246	0	102,758	128,411
27	245	41,645	54,139	13,000	0	54,645	67,139
28	205	38,013	49,416	9,398	140000	187,411	198,815
29	580	111,895	145,464	42,310	0	154,205	187,774
29A							-
30	96	17,279	22,462	1,952	0	19,231	24,414
31	105	20,370	26,481	642	0	21,012	27,123
32	115	20,428	26,557	2,104	0	22,533	28,661
33	407	80,017	104,022	5,705	0	85,722	109,727
34	965	187,410	243,633	33,988	0	221,398	277,621
34A							-
35	195	33,080	43,004	15,242	0	48,322	58,246
36	58	10,520	13,676	1,204	0	11,725	14,881
37	564	103,637	134,728	31,192	0	134,829	165,920
38	579	104,820	136,267	59,882	0	164,703	196,149
39	147	24,926	32,403	6,436	0	31,362	38,839
40	182	33,995	44,194	3,980	0	37,975	48,174
40A							-
41	186	32,331	42,030	8,601	0	40,932	50,631
42	324	55,678	72,381	27,988	0	83,666	100,369
43	298	50,625	65,812	55,131	0	105,756	120,944
44	271	46,976	61,069	16,402	0	63,378	77,471
45	98	16,724	21,741	3,121	0	19,846	24,863
46	97	16,517	21,472	14,831	0	31,348	36,303
47	214	36,440	47,371	35,685	0	72,124	83,056
48	76	12,980	16,873	4,025	0	17,005	20,899
49	-		-	-	0	-	-
50	-		-	-	0	-	-
Totals	**15,331**	**2,876,704**	**3,739,716**	**997,957**	**230,000**	**4,104,661**	**4,967,672**

Table - 1C: Sewer Flows per Basin Spreadsheet

EXISTING WASTEWATER COLLECTION SYSTEM FLOW ANALYSIS - DIVIDED BY BASIN

30	= I&I max month (gpcd) for existing customers	
131	= Max Month flow from all existing sources (gpcd)	
159	= Peak Day flow from all existing sources (gpcd)	
1.22	= Effective Peak Day to Max Month Factor	

2.1	People/tap	
95	gpcd	
19,249	Eff. Exist. Pop.	
199.5	g/tap/day	1.3

Basin Number	Assigned MH for Model Input	Basin Area (acres)	2015 Existing Customers in Basin (Eqiv. Taps)	2009-2015 New Eqiv. Taps	2008 Existing Customers in Basin (Eqiv. Taps)	Existing Customer Flow Rate (g/tap/day)	Existing Customer Sanitary Flow (gpd)	Existing Sanitary Peak Day Flow	Basin I&I Factor (No. Taps x Basin Area)	I&I Factor Relative to average basin I&I per acre	Existing Summer I&I in basin (gpd)	Existing High Discharger Flow (gpd)	Sub-total Existing Flow in Basin (gpd)	Peak Day Flow = Peak Day Sanitary flows + constant I&I + High Discharger flows (gpd)
										0.1			Max Month	Peak Day
1	D3-H7-14	508	40		40	199.5	7,980	10,374	20,320	2	4,064	-	12,044	14,438
2	E4-B-4	732	12		12	199.5	2,394	3,112	8,786	2	1,757	-	4,151	4,869
3	E3-I7-64	180	33		33	199.5	6,584	8,559	5,925	2	1,185	-	7,768	9,744
4	E3-J7-8	177	15		15	199.5	2,993	3,890	2,650	2	530	-	3,522	4,420
5	F4-K8-24	83	49	20	29	199.5	9,776	12,708	4,083	1	408	10,000	20,184	23,116
6	F4-K8-12	123	28		28	199.5	5,586	7,262	3,441	2	688	-	6,274	7,950
7	F4-K9-93	987	557	20	537	199.5	111,122	144,458	550,035	1	55,004	-	166,125	199,461
8	F4-K9-93	427	12		12	199.5	2,394	3,112	5,124	1	512	-	2,906	3,625
9	F4-L8-14	54	21		21	199.5	4,190	5,446	1,144	2	229	-	4,418	5,675
10	F4-L8-8	145	107		107	199.5	21,347	27,750	15,565	2	3,113	-	24,460	30,863
11	F5-L10-28	73	70	10	60	199.5	13,965	18,155	5,130	2	1,024	-	14,989	19,178
12	F5-K11-22	320	88	10	78	199.5	17,556	22,823	28,201	1	2,820	-	20,376	25,643
13	F5-K11-15	264	82		82	199.5	16,359	21,267	21,681	1	2,168	-	18,527	23,435
14	F5-K11-15	558	9		9	199.5	1,796	2,334	5,018	1	502	-	2,297	2,836
15	G4-M9-7	179	310		310	199.5	61,845	80,399	55,638	4	22,255	-	84,100	102,654
16	G4-M9-116	181	493		493	199.5	98,354	127,860	89,101	4	35,640	-	133,994	163,500
16A	G5-M10-94													
17	G5-M10-156	296	928		928	199.5	185,136	240,677	274,937	4	109,975	10,000	305,111	360,652
17A	F4-L9-125													
18	F5-L10-117	374	1,055		1,055	199.5	210,473	273,614	394,570	2	78,914	10,000	299,387	362,528
19	F5-L10-60	807	261	20	241	199.5	52,070	67,690	210,716	1	21,072	-	73,141	88,762
20	F5-L10-60	1345	50		50	199.5	9,975	12,968	67,263	0.3	2,018	-	11,993	14,985
21	G4-N9-45	214	15		15	199.5	2,993	3,890	3,216	2	643	-	3,636	4,533
21A	H5-O10-31		-					-			0.0%			
22	G5-N10-4	325	684		684	199.5	136,459	177,395	222,139	2	44,428	15,000	195,886	236,823
23	G5-M10-167	321	713		713	199.5	142,244	184,917	228,689	2	45,738	-	187,981	230,654
23A	G5-M10-64													
23B	G5-M10-166													
24	G5-M11-12	154	309		309	199.5	61,646	80,139	47,502	2	9,500	-	71,146	89,640
25	G5-N11-61	112	368		368	199.5	73,416	95,441	41,247	2	8,249	-	81,665	103,690
26	G5-M11-49	409	310	20	290	199.5	61,845	80,399	126,880	1	12,688	-	74,533	93,087
27	G5-M11-45	663	-			199.5	-	-	-	1	-	-	-	-
28	H5-O10-62	318	110	30	80	199.5	21,945	28,529	34,972	2	6,994	70,000	98,939	105,523
29	H5-O10-74	422	448		448	199.5	89,376	116,189	189,175	2	37,835	-	127,211	154,024
29A	H5-P10-24		-											
30	G5-N10-36	171	31		31	199.5	6,185	8,040	5,298	2	1,060	-	7,244	9,099
31	H5-O11-51	63	88		88	199.5	17,556	22,823	5,578	1	558	-	18,114	23,381
32	H5-O11-26	215	32		32	199.5	6,384	8,299	6,865	1	687	-	7,071	8,986
33	G5-N11-33	197	365	20	345	199.5	72,818	94,663	71,952	0.7	5,037	-	77,854	99,699
34	H6-O12-33	636	792	20	772	199.5	158,004	205,405	503,733	0.5	25,187	-	183,191	230,592
34A	H6-O12-34		-											
35	H6-P12-7	979	-			199.5		-		1	-	-		
36	H6-P12-7	340	22		22	199.5	4,389	5,706	7,474	0.3	224	-	4,613	5,930
37	I4-Q9-12	1168	263	20	243	199.5	52,469	68,209	307,139	0.1	3,071	-	55,540	71,280
38	I5-Q10-16	1506	218		218	199.5	43,491	56,538	328,320	0.5	16,416	-	59,907	72,954
39	H5-P11-13	549	-			199.5	-	-	-	1	-	-	-	-
40	H6-P12-32	294	102		102	199.5	20,349	26,454	29,937	0.7	2,096	-	22,445	28,549
40A	H6-P12-7		-											
41	I6-Q12-25	560	25		25	199.5	4,988	6,484	13,993	1	1,399	-	6,387	7,883
42	I6-Q12-33	1063	20	10	10	199.5	3,990	5,187	21,265	1	2,126	-	6,116	7,313
43	I4-Q9-12	2314	-			199.5	-	-	-	1	-	-	-	-
44	I5-Q10-62	736	29		29	199.5	5,786	7,521	21,346	1	2,135	-	7,920	9,656
45	E4-J9-39	396	2		2	199.5	399	519	792	1	79	-	478	598
46	E3-I7-46	1.908	-		-	199.5	-	-	-	1	-	-	-	-
47	E3-I7-46	2.081	-		-	199.5	-	-	-	1	-	-	-	-
48	E3-I7-46	659	-		-	199.5	-	-	-	1	-	-	-	-
49					-	199.5	-	-	-	1	-	-	-	-
50					-	199.5	-	-	-	1	-	-	-	-
Totals		**26,588**	**9,166**	**200**	**8,966**	**--**	**1,828,617**	**2,377,202**			**570,028**	**115,000**	**2,513,645**	**3,062,230**

Notes: = Input cells that may be edited

ADDITIONAL WASTEWATER FLOWS PER BASIN - FROM FUTURE (NEW) CUSTOMERS ONLY

35	= I&I max month (gpcd) for new customers	
129	= Max Month flow from all new sources (gpcd)	
159	= Peak Day flow from all existing sources (gpcd)	
1.20	= Effective Peak Day to Max Month Factor	

2	People/tap	
85	gpcd	
24,661	Eff. New Pop.	
170	g/tap/day	1.3

Basin Number	Comp Plan Ultimate Total Dwelling Units (Taps)	Existing Flows Only	Basin Percentage Build-out from Existing to Design Year 0.5	Basin Percentage Build-out from Existing to Design Year 1	Basin Percentage Build-out from Existing to Design Year 2	Basin Percentage Build-out from Existing to Design Year 3	New Taps at design year	New Customer Flow Rate (g/tap/day)	New Customer Sanitary Flow (gpd)	New Sanitary Peak Day Flow	Basin I&I Factor (No. New Taps x Basin Area)	I&I Factor Relative to average new taps in basin I&I per acre	New Summer I&I in basin (gpd)	New High Discharger Flow (gpd)	Sub-total New Flow in Basin (gpd)	Peak Day Flow = Peak Day Sanitary flows + constant I&I + High Discharger flows (gpd)
		0	0.5	1	2	3	2			1.3			0.08		Max Month	1.3 Peak Day
1	2,943	0%	2.5%	5.0%	10.0%	15.0%	290	170	49,351	64,156	147,472	1	11,798	-	61,149	75,954
2	4,393	0%	0.5%	1.0%	2.0%	3.0%	88	170	14,895	19,364	64,153	1	5,132	-	20,028	24,496
3	1,077	0%	2.5%	5.0%	10.0%	15.0%	104	170	17,753	23,078	18,749	1	1,500	-	19,253	24,578
4	900	0%	1.3%	2.5%	5.0%	7.5%	44	170	7,524	9,782	7,819	1	626	-	8,150	10,407
5	500	0%	2.5%	5.0%	10.0%	15.0%	45	170	7,666	9,966	3,757	1	301	20,000	27,966	30,266
6	605	0%	2.5%	5.0%	10.0%	15.0%	58	170	9,811	12,754	7,092	1	567	-	10,378	13,321
7	4,526	0%	3.8%	7.5%	15.0%	22.5%	596	170	101,254	131,630	588,165	1	47,053	-	148,307	178,683
8	1,776	0%	1.3%	2.5%	5.0%	7.5%	88	170	14,950	19,488	37,652	1	3,012	-	18,003	22,500
9	305	0%	5.0%	10.0%	20.0%	30.0%	57	170	9,651	12,547	3,093	1	247	-	9,899	12,794
10	723	0%	5.0%	10.0%	20.0%	30.0%	123	170	20,930	27,209	17,909	1	1,433	-	22,362	28,641
11	487	0%	5.0%	10.0%	20.0%	30.0%	83	170	14,190	18,447	6,105	1	488	-	14,679	18,936
12	1,718	0%	3.8%	7.5%	15.0%	22.5%	244	170	41,557	54,024	78,339	1	6,267	-	47,824	60,291
13	1,220	0%	2.5%	5.0%	10.0%	15.0%	114	170	19,353	25,158	30,099	1	2,408	-	21,760	27,566
14	2,492	0%	1.3%	2.5%	5.0%	7.5%	124	170	21,109	27,441	69,236	1	5,539	-	26,648	32,980
15	1,103	0%	5.0%	10.0%	20.0%	30.0%	159	170	26,964	35,054	28,467	1	2,277	-	29,242	37,331
16	1,189	0%	5.0%	10.0%	20.0%	30.0%	139	170	23,669	30,770	25,163	1	2,013	-	25,682	32,783
17	2,129	0%	5.0%	10.0%	20.0%	30.0%	240	170	40,838	53,090	71,171	1	5,694	20,000	66,532	78,783
18	2,098	0%	5.0%	10.0%	20.0%	30.0%	209	170	35,473	46,115	78,042	1	6,243	20,000	61,717	72,359
19	4,048	0%	5.0%	10.0%	20.0%	30.0%	757	170	128,758	167,386	611,481	1	48,918	-	177,677	216,304
20	6,654	0%	3.8%	7.5%	15.0%	22.5%	991	170	168,408	218,931	1,332,666	1	106,613	-	275,022	325,544
21	635	0%	5.0%	10.0%	20.0%	30.0%	124	170	21,066	27,386	26,566	1	2,125	-	23,191	29,511
21A			0.0%													
22	1,812	0%	5.0%	10.0%	20.0%	30.0%	226	170	38,358	49,865	73,278	1	5,862	30,000	74,220	85,727
23	1,471	0%	5.0%	10.0%	20.0%	30.0%	152	170	25,783	33,518	48,646	1	3,892	-	29,675	37,410
24	615	0%	5.0%	10.0%	20.0%	30.0%	61	170	10,401	13,521	9,405	1	752	-	11,153	14,274
25	448	0%	5.0%	10.0%	20.0%	30.0%	16	170	2,731	3,551	1,801	1	144	-	2,875	3,695
26	1,702	0%	5.0%	10.0%	20.0%	30.0%	278	170	47,333	61,533	113,959	1	9,117	-	56,450	70,649
27	3,266	0%	3.8%	7.5%	15.0%	22.5%	490	170	83,291	108,278	325,002	1	26,000	-	109,291	134,278
28	1,065	0%	5.0%	10.0%	20.0%	30.0%	189	170	32,135	41,776	60,098	1	4,808	140,000	176,943	186,584
29	1,773	0%	5.0%	10.0%	20.0%	30.0%	265	170	45,038	58,550	111,872	1	8,950	-	53,988	67,500
29A																
30	684	0%	5.0%	10.0%	20.0%	30.0%	131	170	22,189	28,845	22,306	1	1,784	-	23,973	30,630
31	254	0%	5.0%	10.0%	20.0%	30.0%	33	170	5,628	7,317	2,098	1	168	-	5,796	7,485
32	858	0%	5.0%	10.0%	20.0%	30.0%	165	170	28,088	36,515	35,446	1	2,836	-	30,924	39,351
33	789	0%	5.0%	10.0%	20.0%	30.0%	85	170	14,400	18,719	16,698	1	1,336	-	15,735	20,055
34	2,522	0%	5.0%	10.0%	20.0%	30.0%	346	170	58,812	76,456	220,037	1	17,603	-	76,415	94,059
35	3,892	0%	2.5%	5.0%	10.0%	15.0%	389	170	66,159	86,007	381,050	1	30,484	-	96,643	116,491
36	1,465	0%	1.3%	2.5%	5.0%	7.5%	72	170	12,262	15,941	24,505	1	1,960	-	14,223	17,901
37	4,276	0%	3.8%	7.5%	15.0%	22.5%	602	170	102,337	133,038	703,013	1	56,241	-	158,578	189,279
38	7,433	0%	2.5%	5.0%	10.0%	15.0%	722	170	122,659	159,457	1,086,652	1	86,932	-	209,591	246,389
39	2,932	0%	2.5%	5.0%	10.0%	15.0%	293	170	49,851	64,807	160,900	1	12,872	-	62,723	77,679
40	1,172	0%	3.8%	7.5%	15.0%	22.5%	161	170	27,292	35,480	47,119	1	3,770	-	31,062	39,249
40A																
41	3,242	0%	2.5%	5.0%	10.0%	15.0%	322	170	54,686	71,092	180,054	1	14,404	-	69,091	85,497
42	6,101	0%	2.5%	5.0%	10.0%	15.0%	608	170	103,376	134,388	646,540	1	51,723	-	155,099	186,111
43	5,956	0%	2.5%	5.0%	10.0%	15.0%	596	170	101,250	131,625	1,378,282	1	110,263	-	211,512	241,887
44	4,875	0%	2.5%	5.0%	10.0%	15.0%	485	170	82,381	107,095	356,688	1	28,535	-	110,916	135,630
45	1,923	0%	2.5%	5.0%	10.0%	15.0%	192	170	32,650	42,445	76,056	1	6,084	-	38,735	48,530
46	9,716	0%	0.5%	1.0%	2.0%	3.0%	194	170	33,034	42,945	370,763	1	29,661	-	62,695	72,606
47	8,574	0%	1.3%	2.5%	5.0%	7.5%	429	170	72,879	94,743	892,125	1	71,370	-	144,249	166,113
48	3,054	0%	1.3%	2.5%	5.0%	7.5%	153	170	25,959	33,747	100,629	1	8,050	-	34,009	41,797
49	-	0%	0.0%	0.0%	0.0%	0.0%	-	170	-	-	-	1	-	-	-	-
50	-	0%	0.0%	0.0%	0.0%	0.0%	-	170	-	-	-	1	-	-	-	-
Totals	**123,383**						**12,330**		**2,096,175**	**2,725,027**			**855,857**	**230,000**	**3,182,032**	**3,810,885**

TOTAL WASTEWATER FLOWS PER BASIN (EXISTING + FUTURE)

43,909	= Effective total population in Design Year	
130	= Max Month flow from all new and existing sources	
167	= Peak Day flow from all existing sources (gpcd)	
1.21	= Effective Peak Day to Max Month Factor	

Basin Number	Total Taps in Basin	Total Sanitary Flow (gpd)	Total Sanitary Peak Day Flow (gpd)	Total Summer I&I in basin (gpd)	Total High Discharger Flow (gpd)	Total Average Summer Flow in Basin (MGD)	Peak Day Flow = Peak Day Sanitary flows + constant I&I + High Discharger flows (gpd)
			1.3			Max Month	1.3 Peak Day
1	330	57,331	74,530.39	15,862	0	73,193	90,392
2	100	17,289	22,476	6,889	0	24,179	29,366
3	137	24,336	31,637	2,685	0	27,021	34,322
4	59	10,517	13,672	1,155	0	11,672	14,827
5	94	17,441	22,674	709	30,000	48,150	53,383
6	86	15,397	20,016	1,255	0	16,652	21,271
7	1,153	212,376	276,088	102,057	0	314,432	378,145
8	100	17,384	22,600	3,525	0	20,909	26,124
9	78	13,841	17,993	476	0	14,317	18,469
10	230	42,276	54,959	4,546	0	46,822	59,505
11	153	28,155	36,602	1,512	0	29,667	38,114
12	332	59,113	76,847	9,087	0	68,200	85,934
13	196	35,712	46,425	4,576	0	40,288	51,001
14	133	22,904	29,776	6,041	0	28,945	35,816
15	469	88,809	115,452	24,533	0	113,342	139,985
16	632	122,023	158,629	37,653	0	159,676	196,283
17	1,168	225,974	293,766	115,669	30000	371,643	439,435
18	1,364	245,946	319,730	85,157	30000	361,103	434,887
19	1,018	180,828	235,076	69,990	0	250,818	305,066
20	1,041	178,383	231,898	108,631	0	287,014	340,529
21	139	24,058	31,276	2,768	0	26,827	34,044
21A							-
22	910	174,816	227,260	50,290	45000	270,106	322,550
23	865	168,027	218,435	49,630	0	217,656	268,064
24	370	72,046	93,660	10,253	0	82,299	103,913
25	384	76,147	98,992	8,393	0	84,541	107,385
26	588	109,178	141,931	21,805	0	130,983	163,736
27	490	83,291	108,278	26,000	0	109,291	134,278
28	299	54,080	70,304	11,802	210000	275,882	292,107
29	713	134,414	174,739	46,785	0	181,199	221,523
29A							-
30	162	28,373	36,885	2,844	0	31,217	39,729
31	121	22,184	30,140	726	0	23,910	30,865
32	197	34,472	44,814	3,522	0	37,995	48,336
33	460	87,217	113,382	6,372	0	93,590	119,755
34	1,138	216,816	281,861	42,790	0	259,606	324,651
34A							-
35	389	66,159	86,007	30,484	0	96,643	116,491
36	94	16,651	21,647	2,185	0	18,836	23,831
37	865	154,805	201,247	59,312	0	214,118	260,559
38	940	166,150	215,995	103,348	0	269,498	319,343
39	293	49,851	64,807	12,872	0	62,723	77,679
40	263	47,641	61,934	5,865	0	53,506	67,799
40A							-
41	347	59,674	77,576	15,804	0	75,478	93,380
42	628	107,366	139,575	53,850	0	161,215	193,425
43	596	101,250	131,625	110,263	0	211,512	241,887
44	514	88,166	114,616	30,670	0	118,836	145,285
45	194	33,049	42,964	6,164	0	39,213	49,128
46	194	33,034	42,945	29,661	0	62,695	72,606
47	429	72,879	94,743	71,370	0	144,249	166,113
48	153	25,959	33,747	8,050	0	34,009	41,797
49	-		-	-	0	-	-
50	-		-	-	0	-	-
Totals	**21,496**	**3,924,792**	**5,102,229**	**1,425,885**	**345,000**	**5,695,677**	**6,873,115**

Table - 1D: Sewer Flows per Basin Spreadsheet

EXISTING WASTEWATER COLLECTION SYSTEM FLOW ANALYSIS - DIVIDED BY BASIN

30	= I&I max month (gpcd) for existing customers	
131	= Max Month flow from all existing sources (gpcd)	
159	= Peak Day flow from all existing sources (gpcd)	
1.22	= Effective Peak Day to Max Month Factor	

2.1	People/tap	
95	gpcd	
19,249	Eff. Exist. Pop.	
199.5	g/tap/day	

Basin Number	Assigned MH for Model Input	Basin Area (acres)	2015 Existing Customers in Basin (Equiv. Taps)	2009-2015 New Equiv. Taps	2008 Existing Customers in Basin (Equiv. Taps)	Existing Customer Flow Rate (g/tap/day)	Existing Customer Sanitary Flow (gpd)	Existing Sanitary Peak Day Flow (1.3)	Basin I&I Factor (No. Taps x Basin Area)	I&I Factor Relative to average basin I&I per acre (0.1)	Existing Summer I&I in basin (gpd)	Existing High Discharger Flow (gpd)	Sub-total Existing Flow in Basin (gpd) (Max Month)	Peak Day Flow = Peak Day Sanitary flows + constant I&I + High Discharger flows (gpd) (Peak Day)
1	D3-H7-14	508	40		40	199.5	7,980	10,374	20,320	2	4,064	-	12,044	14,438
2	E4-I8-4	732	12		12	199.5	2,394	3,112	8,786	2	1,757	-	4,151	4,869
3	E3-I7-64	180	33		33	199.5	6,584	8,559	5,925	2	1,185	-	7,768	9,744
4	E3-J7-8	177	15		15	199.5	2,993	3,890	2,650	2	530	-	3,522	4,420
5	F4-K8-24	83	49	20	29	199.5	9,776	12,708	4,083	1	408	10,000	20,184	23,116
6	F4-K8-12	123	28		28	199.5	5,586	7,262	3,441	2	688	-	6,274	7,950
7	F4-K9-93	987	557	20	537	199.5	111,122	144,458	550,035	1	55,004	-	166,125	199,461
8	F4-K9-93	427	12		12	199.5	2,394	3,112	5,124	1	512	-	2,906	3,625
9	F4-L8-14	54	21		21	199.5	4,190	5,446	1,144	2	229	-	4,418	5,675
10	F4-L8-8	145	107		107	199.5	21,347	27,750	15,565	2	3,113	-	24,460	30,863
11	F5-L10-28	73	70	10	60	199.5	13,965	18,155	5,130	2	1,024	-	14,989	19,178
12	F5-K11-22	320	88	10	78	199.5	17,556	22,823	28,201	1	2,820	-	20,376	25,643
13	F5-K11-15	264	82		82	199.5	16,359	21,267	21,681	1	2,168	-	18,527	23,435
14	F5-K11-15	558	9		9	199.5	1,796	2,334	5,018	1	502	-	2,297	2,836
15	G4-M9-7	179	310		310	199.5	61,845	80,399	55,638	4	22,255	-	84,100	102,654
16	G4-M9-116	181	493		493	199.5	98,354	127,860	89,101	4	35,640	-	133,994	163,500
16A	G5-M10-94													
17	G5-M10-156	296	928		928	199.5	185,136	240,677	274,937	4	109,975	10,000	305,111	360,652
17A	F4-L9-125													
18	F5-L10-117	374	1,055		1,055	199.5	210,473	273,614	394,570	2	78,914	10,000	299,387	362,528
19	F5-L10-60	807	261	20	241	199.5	52,070	67,690	210,716	1	21,072	-	73,141	88,762
20	F5-L10-60	1345	50		50	199.5	9,975	12,968	67,263	0.3	2,018	-	11,993	14,985
21	G4-N9-45	214	15		15	199.5	2,993	3,890	3,216	2	643	-	3,636	4,533
21A	H5-O10-31		-					-			-			-
22	G5-N10-4	325	684		684	199.5	136,459	177,395	222,139	2	44,428	15,000	195,886	236,823
23	G5-M10-167	321	713		713	199.5	142,244	184,917	228,689	2	45,738	-	187,981	230,654
23A	G5-M10-64													
23B	G5-M10-168													
24	G5-M11-12	154	309		309	199.5	61,646	80,139	47,502	2	9,500	-	71,146	89,640
25	G5-N11-61	112	368		368	199.5	73,416	95,441	41,247	2	8,249	-	81,665	103,690
26	G5-M11-49	409	310	20	290	199.5	61,845	80,399	126,880	1	12,688	-	74,533	93,087
27	G5-M11-45	663	-			199.5	-	-		1	-	-	-	-
28	H5-O10-62	318	110	30	80	199.5	21,945	28,529	34,972	2	6,994	70,000	98,939	105,523
29	H5-O10-74	422	448		448	199.5	89,376	116,189	189,175	2	37,835	-	127,211	154,024
29A	H5-P10-24		-											
30	G5-N10-36	171	31		31	199.5	6,185	8,040	5,298	2	1,060	-	7,244	9,099
31	H5-O11-51	63	88		88	199.5	17,556	22,823	5,578	1	558	-	18,114	23,381
32	H5-O11-26	215	32		32	199.5	6,384	8,299	6,865	1	687	-	7,071	8,986
33	G5-N11-33	197	365	20	345	199.5	72,818	94,663	71,952	0.7	5,037	-	77,854	99,699
34	H6-O12-33	636	792	20	772	199.5	158,004	205,405	503,733	0.5	25,187	-	183,191	230,592
34A	H6-O12-34		-											
35	H6-P12-7	979	-			199.5		-		1	-	-		
36	H6-P12-7	340	22		22	199.5	4,389	5,706	7,474	0.3	224	-	4,613	5,930
37	I4-Q9-12	1168	263	20	243	199.5	52,469	68,209	307,139	0.1	3,071	-	55,540	71,280
38	I5-Q10-16	1506	218		218	199.5	43,491	56,538	328,320	0.5	16,416	-	59,907	72,954
39	H5-P11-13	549	-			199.5	-	-	-	1	-	-	-	-
40	H6-P12-32	294	102		102	199.5	20,349	26,454	29,937	0.7	2,096	-	22,445	28,549
40A	H6-P12-7		-											
41	I6-Q12-25	560	25		25	199.5	4,988	6,484	13,993	1	1,399	-	6,387	7,883
42	I6-Q12-33	1063	20	10	10	199.5	3,990	5,187	21,265	1	2,126	-	6,116	7,313
43	I4-Q9-12	2314	-			199.5	-	-	-	1	-	-	-	-
44	I5-Q10-62	736	29		29	199.5	5,786	7,521	21,346	1	2,135	-	7,920	9,656
45	E4-J9-39	396	2		2	199.5	399	519	792	1	79	-	478	598
46	E3-I7-46	1,908	-		-	199.5	-	-	-	1	-	-	-	-
47	E3-I7-46	2,081	-		-	199.5	-	-	-	1	-	-	-	-
48	E3-I7-46	659	-		-	199.5	-	-	-	1	-	-	-	-
49					-	199.5	-	-	-	1	-	-	-	-
50					-	199.5	-	-	-	1	-	-	-	-
Totals		**26,588**	**9,166**	**200**	**8,966**	**--**	**1,828,617**	**2,377,202**			**570,028**	**115,000**	**2,513,645**	**3,062,230**

Notes: = Input cells that may be edited

ADDITIONAL WASTEWATER FLOWS PER BASIN - FROM FUTURE (NEW) CUSTOMERS ONLY

35	= I&I max month (gpcd) for new customers	
129	= Max Month flow from all new sources (gpcd)	
158	= Peak Day flow from all existing sources (gpcd)	
1.20	= Effective Peak Day to Max Month Factor	

2	People/tap	
85	gpcd	
36,991	Eff. New Pop.	
170	g/tap/day	

Basin Number	Comp Plan Ultimate Total Dwelling Units (Taps)	Existing Flows Only (0)	Basin Percentage Build-out from Existing to Design Year 0.5 (0.5)	Basin Percentage Build-out from Existing to Design Year 1 (1)	Basin Percentage Build-out from Existing to Design Year 2 (2)	Basin Percentage Build-out from Existing to Design Year 3 (3)	New Taps at design year (3)	New Customer Flow Rate (g/tap/day)	New Customer Sanitary Flow (gpd)	New Sanitary Peak Day Flow (1.3)	Basin I&I Factor (No. New Taps x Basin Area)	I&I Factor Relative to average new taps in basin I&I per acre	New Summer I&I in basin (gpd) (0.08)	New High Discharger Flow (gpd)	Sub-total New Flow in Basin (gpd) (Max Month)	Peak Day Flow = Peak Day Sanitary flows + constant I&I + High Discharger flows (gpd) (1.3)
1	2,943	0%	2.5%	5.0%	10.0%	15.0%	435	170	74,027	96,234	221,209	1	17,697	-	91,723	113,931
2	4,393	0%	0.5%	1.0%	2.0%	3.0%	131	170	22,343	29,046	96,229	1	7,698	-	30,041	36,744
3	1,077	0%	2.5%	5.0%	10.0%	15.0%	157	170	26,629	34,618	28,124	1	2,250	-	28,879	36,867
4	900	0%	1.3%	2.5%	5.0%	7.5%	66	170	11,286	14,672	11,728	1	938	-	12,225	15,611
5	500	0%	2.5%	5.0%	10.0%	15.0%	68	170	11,499	14,948	5,636	1	451	30,000	41,950	45,399
6	605	0%	2.5%	5.0%	10.0%	15.0%	87	170	14,716	19,131	10,637	1	851	-	15,567	19,982
7	4,526	0%	3.8%	7.5%	15.0%	22.5%	893	170	151,881	197,445	882,247	1	70,580	-	222,461	268,025
8	1,776	0%	1.3%	2.5%	5.0%	7.5%	132	170	22,486	29,231	56,478	1	4,518	-	27,004	33,750
9	305	0%	5.0%	10.0%	20.0%	30.0%	85	170	14,477	18,820	4,639	1	371	-	14,848	19,191
10	723	0%	5.0%	10.0%	20.0%	30.0%	185	170	31,395	40,813	26,864	1	2,149	-	33,544	42,962
11	487	0%	5.0%	10.0%	20.0%	30.0%	125	170	21,285	27,671	9,157	1	733	-	22,018	28,403
12	1,718	0%	3.8%	7.5%	15.0%	22.5%	367	170	62,336	81,036	117,508	1	9,401	-	71,736	90,437
13	1,220	0%	2.5%	5.0%	10.0%	15.0%	171	170	29,029	37,737	45,149	1	3,612	-	32,641	41,349
14	2,492	0%	1.3%	2.5%	5.0%	7.5%	186	170	31,663	41,162	103,854	1	8,308	-	39,972	49,471
15	1,103	0%	5.0%	10.0%	20.0%	30.0%	238	170	40,446	52,580	42,701	1	3,416	-	43,862	55,996
16	1,189	0%	5.0%	10.0%	20.0%	30.0%	209	170	35,504	46,155	37,745	1	3,020	-	38,523	49,174
17	2,129	0%	5.0%	10.0%	20.0%	30.0%	360	170	61,257	79,634	106,756	1	8,540	30,000	99,798	118,175
18	2,098	0%	5.0%	10.0%	20.0%	30.0%	313	170	53,210	69,173	117,062	1	9,365	30,000	92,575	108,538
19	4,048	0%	5.0%	10.0%	20.0%	30.0%	1,136	170	193,137	251,078	917,222	1	73,378	-	266,515	324,456
20	6,654	0%	3.8%	7.5%	15.0%	22.5%	1,486	170	252,612	328,396	1,998,999	1	159,920	-	412,532	488,316
21	635	0%	5.0%	10.0%	20.0%	30.0%	186	170	31,599	41,079	39,848	1	3,188	-	34,787	44,266
21A			0.0%													
22	1,812	0%	5.0%	10.0%	20.0%	30.0%	338	170	57,537	74,798	109,916	1	8,793	45,000	111,330	128,591
23	1,471	0%	5.0%	10.0%	20.0%	30.0%	227	170	38,675	50,277	72,969	1	5,837	-	44,512	56,115
24	615	0%	5.0%	10.0%	20.0%	30.0%	92	170	15,601	20,282	14,108	1	1,129	-	16,730	21,411
25	448	0%	5.0%	10.0%	20.0%	30.0%	24	170	4,097	5,326	2,701	1	216	-	4,313	5,542
26	1,702	0%	5.0%	10.0%	20.0%	30.0%	418	170	70,999	92,299	170,938	1	13,675	-	84,674	105,974
27	3,266	0%	3.8%	7.5%	15.0%	22.5%	735	170	124,936	162,417	487,503	1	39,000	-	163,936	201,417
28	1,065	0%	5.0%	10.0%	20.0%	30.0%	284	170	48,203	62,664	90,148	1	7,212	210,000	265,415	279,876
29	1,773	0%	5.0%	10.0%	20.0%	30.0%	397	170	67,557	87,825	167,807	1	13,425	-	80,982	101,249
29A																
30	684	0%	5.0%	10.0%	20.0%	30.0%	196	170	33,283	43,268	33,459	1	2,677	-	35,959	45,944
31	254	0%	5.0%	10.0%	20.0%	30.0%	50	170	8,442	10,975	3,148	1	252	-	8,694	11,227
32	858	0%	5.0%	10.0%	20.0%	30.0%	248	170	42,133	54,772	53,169	1	4,254	-	46,386	59,026
33	789	0%	5.0%	10.0%	20.0%	30.0%	127	170	21,599	28,079	25,046	1	2,004	-	23,603	30,083
34	2,522	0%	5.0%	10.0%	20.0%	30.0%	519	170	88,219	114,684	330,055	1	26,404	-	114,623	141,089
35	3,892	0%	2.5%	5.0%	10.0%	15.0%	584	170	99,239	129,011	571,575	1	45,726	-	144,965	174,737
36	1,465	0%	1.3%	2.5%	5.0%	7.5%	108	170	18,393	23,911	36,758	1	2,941	-	21,334	26,852
37	4,276	0%	3.8%	7.5%	15.0%	22.5%	903	170	153,505	199,557	1,054,519	1	84,362	-	237,867	283,919
38	7,433	0%	2.5%	5.0%	10.0%	15.0%	1,082	170	183,988	239,185	1,629,979	1	130,398	-	314,387	369,583
39	2,932	0%	2.5%	5.0%	10.0%	15.0%	440	170	74,777	97,210	241,350	1	19,308	-	94,085	116,518
40	1,172	0%	3.8%	7.5%	15.0%	22.5%	241	170	40,938	53,220	70,679	1	5,654	-	46,593	58,874
40A																
41	3,242	0%	2.5%	5.0%	10.0%	15.0%	483	170	82,030	106,639	270,081	1	21,606	-	103,636	128,245
42	6,101	0%	2.5%	5.0%	10.0%	15.0%	912	170	155,063	201,582	969,810	1	77,585	-	232,648	279,167
43	5,956	0%	2.5%	5.0%	10.0%	15.0%	893	170	151,874	197,437	2,067,423	1	165,394	-	317,268	362,831
44	4,875	0%	2.5%	5.0%	10.0%	15.0%	727	170	123,571	160,642	535,033	1	42,803	-	166,373	203,445
45	1,923	0%	2.5%	5.0%	10.0%	15.0%	288	170	48,975	63,668	114,084	1	9,127	-	58,102	72,795
46	9,716	0%	0.5%	1.0%	2.0%	3.0%	291	170	49,552	64,417	556,144	1	44,492	-	94,043	108,909
47	8,574	0%	1.3%	2.5%	5.0%	7.5%	643	170	109,319	142,114	1,338,187	1	107,055	-	216,373	249,169
48	3,054	0%	1.3%	2.5%	5.0%	7.5%	229	170	38,939	50,620	150,944	1	12,076	-	51,014	62,696
49	-	0%	0.0%	0.0%	0.0%	0.0%	-	170	-	-	-	1	-	-	-	-
50	-	0%	0.0%	0.0%	0.0%	0.0%	-	170	-	-	-	1	-	-	-	-
Totals	**123,383**						**18,496**		**3,144,262**	**4,087,541**			**1,283,786**	**345,000**	**4,773,048**	**5,716,327**

TOTAL WASTEWATER FLOWS PER BASIN (EXISTING + FUTURE)

56,240	= Effective total population in Design Year	
130	= Max Month flow from all new and existing sources	
156	= Peak Day flow from all existing sources (gpcd)	
1.20	= Effective Peak Day to Max Month Factor	

Basin Number	Total Taps in Basin	Total Sanitary Flow (gpd)	Total Sanitary Peak Day Flow (gpd) (1.3)	Total Summer I&I in basin (gpd)	Total High Discharger Flow (gpd)	Total Average Summer Flow in Basin (MGD) (Max Month)	Peak Day Flow = Peak Day Sanitary flows + constant I&I + High Discharger flows (gpd) (1.3)
1	475	82,007	106,608.45	21,761	0	103,767	128,369
2	143	24,737	32,158	9,456	0	34,193	41,614
3	190	33,212	43,176	3,435	0	36,647	46,611
4	81	14,279	18,563	1,468	0	15,747	20,031
5	117	21,274	27,657	859	40,000	62,133	68,516
6	115	20,302	26,393	1,539	0	21,841	27,932
7	1,450	263,003	341,903	125,583	0	388,586	467,487
8	144	24,880	32,344	5,031	0	29,910	37,374
9	106	18,667	24,267	600	0	19,267	24,867
10	292	52,741	68,563	5,262	0	58,003	73,825
11	195	35,250	45,825	1,757	0	37,007	47,582
12	455	79,892	103,859	12,221	0	92,112	116,080
13	253	45,388	59,004	5,780	0	51,168	64,784
14	195	33,459	43,496	8,810	0	42,269	52,306
15	548	102,291	132,979	25,671	0	127,963	158,650
16	702	133,857	174,014	38,660	0	172,517	212,674
17	1,288	246,393	320,311	118,515	40000	404,908	478,826
18	1,368	263,683	342,787	88,279	40000	391,962	471,066
19	1,397	245,207	318,769	94,449	0	339,656	413,218
20	1,536	262,587	341,364	161,938	0	424,525	503,302
21	201	34,591	44,969	3,831	0	38,422	48,800
21A							-
22	1,022	193,995	252,193	53,221	60000	307,216	365,414
23	940	180,918	235,194	51,575	0	232,494	286,769
24	401	77,247	100,421	10,629	0	87,876	111,050
25	392	77,513	100,767	6,465	0	85,979	109,233
26	728	132,844	172,698	26,363	0	159,207	199,061
27	735	124,936	162,417	39,000	0	163,936	201,417
28	394	70,148	91,192	14,206	280000	364,354	385,398
29	845	156,933	204,014	51,260	0	208,193	255,273
29A							-
30	227	39,467	51,307	3,736	0	43,204	55,044
31	138	25,998	33,798	810	0	26,808	34,608
32	280	48,517	63,072	4,940	0	53,457	68,012
33	492	94,417	122,742	7,040	0	101,457	129,782
34	1,311	246,223	320,090	51,591	0	297,814	371,681
34A							-
35	584	99,239	129,011	45,726	0	144,965	174,737
36	130	22,782	29,617	3,165	0	25,947	32,782
37	1,166	205,974	267,766	87,433	0	293,407	355,199
38	1,300	227,479	295,723	146,814	0	374,294	442,538
39	440	74,777	97,210	19,308	0	94,085	116,518
40	343	61,287	79,673	7,750	0	69,037	87,423
40A							-
41	508	87,017	113,122	23,006	0	110,023	136,128
42	932	159,053	206,769	79,711	0	238,765	286,481
43	893	151,874	197,437	165,394	0	317,268	362,831
44	756	129,356	168,163	44,937	0	174,293	213,100
45	290	49,374	64,187	9,206	0	58,580	73,392
46	291	49,552	64,417	44,492	0	94,043	108,909
47	643	109,319	142,114	107,055	0	216,373	249,169
48	229	38,939	50,620	12,076	0	51,014	62,696
49	-		-	-	0	-	-
50	-		-	-	0	-	-
Totals	**27,662**	**4,972,879**	**6,464,743**	**1,853,814**	**460,000**	**7,286,693**	**8,778,557**

Appendix C – Additional Information

Poor or Unverified Manhole Survey Data

MH_NAME	Poor_Data	Invert_Adjusted	MH_NAME	Poor_Data	Invert_Adjusted
G4-M9-8	yes	yes	G4-M9-22	yes	
E3-I7-9	yes	yes	G4-M9-108	yes	
D3-H7-12	yes	yes	G4-M9-25	yes	
F4-L9-13	yes	yes	G4-M9-27	yes	
E4-J8-18	yes	yes	E3-I7-32	yes	
F4-L8-21	yes	yes	E3-I7-34	yes	
F4-L8-22	yes	yes	G4-M9-40	yes	
F4-L8-24	yes	yes	G4-M9-41	yes	
F4-K8-29	yes	yes	G4-M9-66	yes	
E3-I7-33	yes	yes	G4-M9-78	yes	
G4-M9-72	yes	yes	G4-M9-87	yes	
G4-M9-90	yes	yes	F5-K11-16	yes	
G4-N9-62	yes	yes	F5-K11-17	yes	
F5-K11-23	yes	yes	F5-K11-18	yes	
G4-N9-60	yes	yes	F5-K11-19	yes	
G5-N10-8	yes	yes	F5-K11-20	yes	
G5-N11-20	yes	yes	F5-K11-21	yes	
H5-O11-18	yes	yes	F5-K10-53	yes	
H5-O11-19	yes	yes	F5-K10-54	yes	
H5-O11-20	yes	yes	F5-K10-55	yes	
H5-O11-30	yes	yes	F5-K10-56	yes	
H5-O11-58	yes	yes	F5-K10-48	yes	
F4-L8-32	yes	yes	F5-K10-49	yes	
H4-P9-6	yes	yes	F5-K10-65	yes	
H4-O9-12	yes	yes	G5-M10-84	yes	
H5-O10-102	yes	yes	G5-M10-94	yes	
F4-L9-121	yes	yes	G5-N10-3	yes	
F4-L9-127	yes	yes	H6-O12-42	yes	
F4-K9-91	yes	yes	H4-O9-1	yes	
F4-K9-93	yes	yes	H6-P12-8	yes	
F4-K9-95	yes	yes	H6-P12-9	yes	
F4-K9-94	yes	yes	H6-O12-83	yes	
E4-I8-25	yes	yes	H4-P9-9	yes	
E4-I8-24	yes	yes	I4-Q9-15	yes	
E4-I8-22	yes	yes	G4-M9-119	yes	
E4-I8-26	yes	yes	G5-N10-159	yes	
H4-O9-2	yes	yes	H4-O9-4	yes	
H4-O9-11	yes	yes	H5-P10-62	yes	
I4-Q9-13	yes	yes	F4-L9-131		yes
H5-P10-83	yes	yes	F4-K9-87		yes
H5-P10-84	yes	yes	D3-H7-11	yes	
H5-O10-108	yes	yes	E3-I7-11	yes	
D3-H7-1	yes		D3-H7-13	yes	
F4-L8-2	yes		E3-I7-13	yes	
D3-H7-5	yes		D3-H7-14	yes	

D3-H7-6	yes	E3-I7-15	yes
D3-H7-7	yes	G4-N9-15	yes
D3-H7-8	yes	G4-M9-21	yes
D3-H7-9	yes	D3-H7-10	yes

Sewer Pipe CIPP Scores and Data

Pipe ID	Upstream MH	Downstream MH	Street Location	Defect Score
1735	F4-L9-65	F4-L9-101	Between N 4th St and N 3rd St	35.25
1827	F5-L10-33	F5-L10-121	N Cedar Ave	34
1424	F5-L10-82	F5-L10-89	Between N 2nd St and N 1st St	25
2180	G5-M10-151	G5-M10-100	Between S 4th St and S 5th St	19.75
2491	G5-N10-137	G5-N10-102	Behind Brown Rd	19.25
2179	G5-M10-99	G5-M10-100	Between S 4th St and S 5th St	17.75
2219	G5-N10-158	G5-M10-4	Dover Rd	17.25
1365	F5-L10-59	F5-L10-67	Between E Main St and S 1st St	14.25
2218	F4-L9-101	F4-L9-124	Between N 4th St and N 3rd St	11.5
1356	F5-L10-88	F4-L9-59	Between N 2nd St and N 1st St	11.25
1579	F4-L9-112	F4-L9-60	Between N 1st St and E Main St	11
1338	F4-L9-60	F4-L9-128	Between N 1st St and E Main St	11
1409	F5-L10-111	F5-L10-76	Between S 2nd St and S 3rd St	10
988		F5-L10-20	Behind S 5th St	9.5
1418	G5-N11-57	G5-N11-58	Cambridge St	9
2914	G5-M10-130	G5-M10-132	Centennial Dr	9
2287	G5-N10-85	G5-N10-82	Eton Ct	8.75
3545	E6-J12-15	E6-J12-1	Las Vegas Dr	8.75
1570	G5-M11-5	G5-M11-7	Essex St	8
2239	G5-M10-125	G5-M10-129	Between Highland Dr and S 11th St	8
1696	G4-N9-49	G4-N9-58	Spruce Dr	7.75
1814	G5-N10-91	G4-N9-59	Spruce Dr	7.75
1987	G5-N10-75	G5-N10-81	Behind Aspen St	7.75
1750	G5-M10-135	G5-M10-71	Centennial Dr	7.5
1937	G4-M9-76	G4-M9-75	S 4th St	7.25
1978	G5-N10-78	G5-N10-107	Between Spruce Dr and Columbia Way	7
2990		F5-L10-121	N Cedar Ave	7
1337	G5-N11-72	G5-N11-96	Stellar Ct	6.5
1552	G5-M11-7	G5-M11-10	Essex St	6.5
1623	G5-N11-95	G5-N11-96	Stellar Pl	6.5
2142	G5-N11-98	G5-N11-95	Stellar Pl	6.5
2226	F5-L10-72	F5-L10-34	Between S 2nd St and S 3rd St	6.5
309	G5-N11-96	G5-N11-26	Stellar Pl	6.5
621	G5-N11-15	G5-N11-26	Star Ridge Dr	6.5
734	G6-N12-59	G5-N11-15	Star Ridge Dr	6.5
1549	G5-M10-40	G5-M10-82	Between S 5th St and S 6th St	6.25
2200	G5-M10-7	G5-M10-127	Between Ridge St and Highland St	6.25
2232	G5-M10-132	G5-M10-133	S 7th St	6.25
1405	F5-L10-22	F5-L10-65	S Pythian Ave	6
2171	G5-N10-132	G5-N10-66	Chatam Dr	6
1007	G5-N10-74	G5-N10-82	Avon St	5.5
1089	G4-N9-57	G4-N9-58	Columbia Way	5.5
2178	G5-M10-101	G5-M10-102	Between S 3rd St and S 4th St	5.5
1407		F5-L10-22	S 4th St	5.25
706	G5-N11-32	G5-N11-12	Ouray Dr	5
1557	G5-M10-60	G5-M10-61	Between S 6th St and S 7th St	5
2193	F5-L10-34	G5-M10-115	Between S 2nd St and S 3rd St	5
2922	G5-N10-67	G5-N10-146	Behind S 12th St	5
3087	G5-N10-146	G5-N10-128	Behind S 12th St	5
1360	F5-L10-87	F5-L10-88	N Lot Ave	4.75
2837	I5-R11-55	I5-R11-56	Crestview Dr	4.75

3397	F4-L9-48	Between N 7th St and N 6th St	4.75

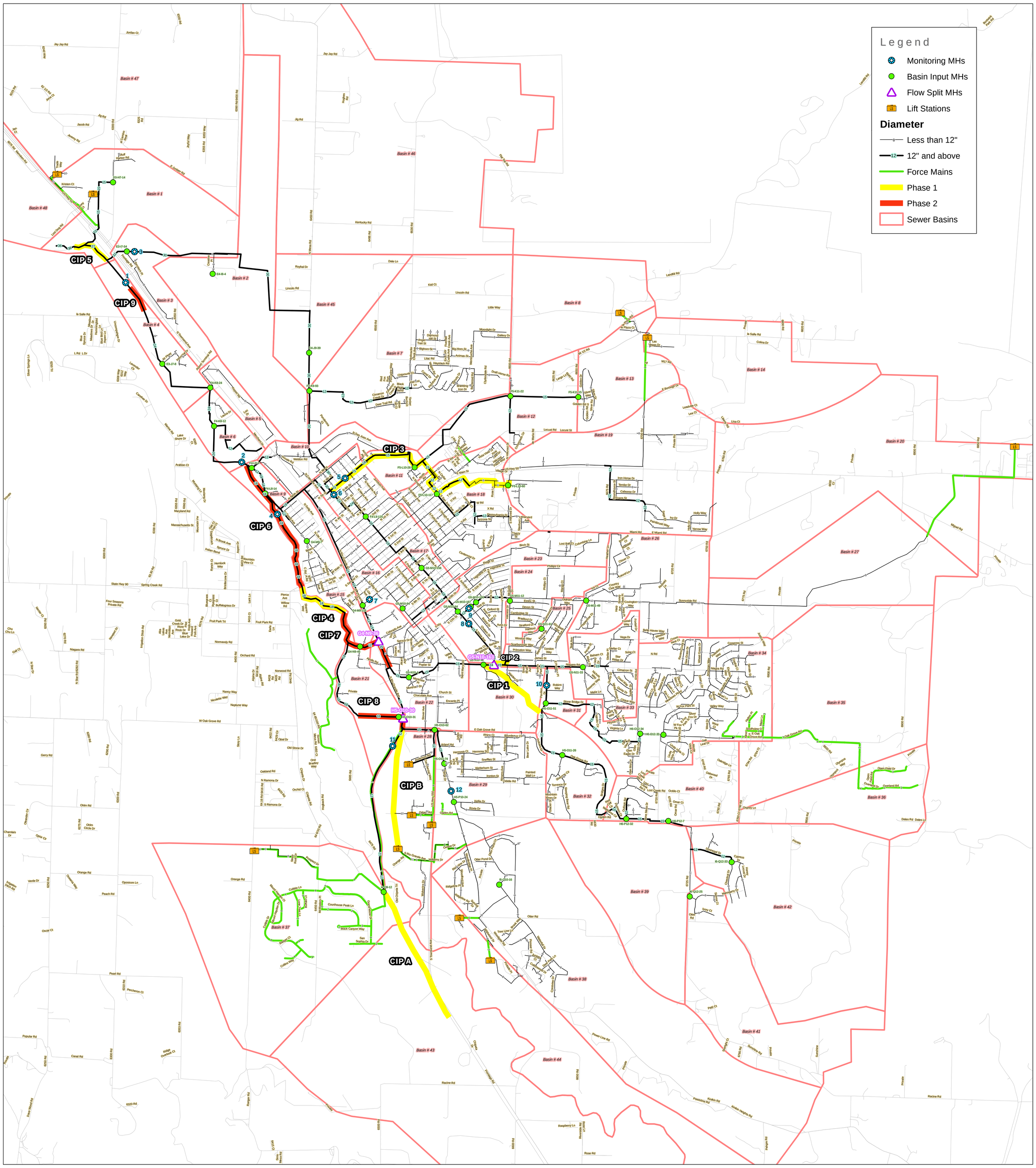
Sewer Pipe Replacement Scores and Data

Pipe ID	Upstream MH	Downstream MH	Street Location	Replacement Score
2641	F5-K11-27	F5-K11-26	6600 Rd	62.52
132	D3-H7-21	D3-H7-20	Denny Ct	37.23
1537	G5-N10-119	G5-N10-67	Behind S 12th St	33.18
2391	F4-L9-39	F4-L9-40	Between N 5th St and N 4th St	33.18
3255	H4-O9-16	H4-O9-15	Near S Rio Grande Ave	30.24
1377	G5-M10-98	G5-M10-118	S Junction Ave	29.79
1917	G5-M11-51	G5-M11-17	Sunnyside Rd	27.33
455	I5-R11-31	I5-R11-11	Perpendicular Crestview Dr	26.7
644	G5-N10-36	G5-N10-35	Niagara Rd	26.49
2990		F5-L10-121	N Cedar Ave	26.19
2219	G5-N10-158	G5-M10-4	Dover Rd	24.51
2180	G5-M10-151	G5-M10-100	Between S 4th St and S 5th St	22.5
1946	G5-M11-49	G5-M11-51	Sunnyside Rd	22.41
625	G5-N10-37	G5-N10-39	Niagara Rd	20.13
1241	G5-M10-41	G5-M10-34	Between S 10th St and S 11th St	19.38
1007	G5-N10-74	G5-N10-82	Avon Dr	17.16
1047	F4-K9-70	F4-K9-55	N 9th St	16.65
815	H5-O10-9	H5-O10-88	Stover Ave	15.75
86	G4-M9-121	G4-M9-16	Beach Ln	15.72
3058	H5-O11-84	H5-O11-37	Laura Ln	15.57
2184	F5-L10-15	F4-L9-61	Between E Main St and S 1st St	14.88
1157	F4-L9-96	F4-L9-102	Between N 3rd St and N 2nd St	13.38
1766	G4-M9-73	G4-M9-74	Between S 3rd St and S 4th St	13.05
2596	G6-N12-74	G6-N12-120	Natalia Way	13.05
262	G4-M9-23	G4-M9-13	N Maple Ave	12.75
1534	G5-M11-10	G5-M11-11	Essex St	12.54
6	G4-M9-106	G4-M9-13	Between W North 1st St and W Main St	11.64
1615		F4-L9-94	N 9th St	11.25
2170	G5-M10-115	G5-M10-13	Between S 2nd St and S 3rd St	10.86
1713	F4-K9-85	F4-K9-89	Cedar Creek Ave	10.71
2817	E5-J10-24	E5-J10-25	Barnwood Rd	10.71
2259	G5-M10-113	F5-L10-64	S Lot Ave	10.59
1579	F4-L9-112	F4-L9-60	Between N 1st St and E Main St	10.53
1338	F4-L9-60	F4-L9-128	Between N 1st St and E Main St	10.53
1195	G5-M10-160	G5-M10-1	Between S 8th St and S 9th St	9.72
1708	G4-M9-89	G4-M9-73	Between S 3rd St and S 4th St	9.54
1626	F4-K9-47	F4-K9-55	Behind N Nevada Ave	9.06
1416	F5-L10-65	F5-L10-64	Between S 3rd St and S 4th St	8.88
2426	E5-J11-9	F5-K11-25	6600 Rd	8.88
643	G5-N10-47	G5-N10-36	Niagara Rd	8.85
1559	G5-M10-16	G5-M10-156	Between S 5th St and S 6th St	8.34
1379	F4-L9-55	F4-L9-126	Between N 2nd St and N 1st St	7.89
1827	F5-L10-33	F5-L10-121	N Cedar Ave	7.89
2213	F5-L10-100	F5-L10-33	Between N 1st St and E Main St	7.89
2033	F5-L10-16	F5-L10-21	Behind E Main St	7.89
1367	F5-L10-77	F5-L10-66	Between S 2nd St and S 3rd St	7.77
988		F5-L10-20	Behind S 5th St	7.56
1440	F4-L9-73	F4-L9-124	Between N 4th St and N 3rd St	7.32
624	I5-Q11-16	I5-Q11-14	Otter Pond Cir	7.08
701	G4-N9-14	G4-N9-8	Apollo Rd	7.05
2950	H5-O11-76	H5-O11-75	Bear Lake Dr	6.87

1746	G5-N10-90	G5-N10-91	Akard Ave	6.45
1790	F5-L10-110	F5-L10-31	Behind N 2nd St	6.15
3079	I5-Q10-25	H5-P10-77	Woodgate Rd	6
2141	G4-M9-77	G4-M9-90	Between S 4th St and S 5th St	5.94

Sewer Pipes Previously Lined

Line_ID	Year_Lined	Length (Feet)	Line_ID	Year_Lined	Length (Feet)
457	2005	435	1507	2006	386
610	2005	112	1572	2006	424
623	2005	10	1574	2006	329
641	2005	412	1600	2006	339
643	2005	197	1626	2006	328
644	2005	168	1766	2006	465
648	2005	286	1811	2006	382
649	2005	374	1813	2006	386
659	2005	56	1869	2006	392
681	2005	255	1898	2006	175
692	2005	285	1915	2006	392
693	2005	396	2152	2006	279
724	2005	283	2160	2006	346
1917	2005	381	2167	2006	268
1946	2005	162	2399	2006	385
2153	2005	91	3010	2006	322
2983	2005	17	3396	2006	33
2984	2005	107	2167	2006	105
3055	2005	313	3564	2006	11
3006	2005	115	3729	2006	282
18	2006	309	1157	2006	404
256	2006	365	1466	2006	400
257	2006	167	1996	2006	88
701	2006	333	2035	2006	429
1012	2006	378	1333	2011	203
1047	2006	433	1369	2006	208
1113	2006	326	1377	2006	376
1125	2006	400	1387	2006	414
1235	2006	404	1388	2006	93
1241	2006	408	1391	2006	295
1307	2006	308	1410	2006	208
1332	2006	348	1416	2006	396
1336	2006	89	1417	2006	402
1362	2006	394	1473	2006	379
1364	2006	329	1479	2006	225
1366	2006	545			

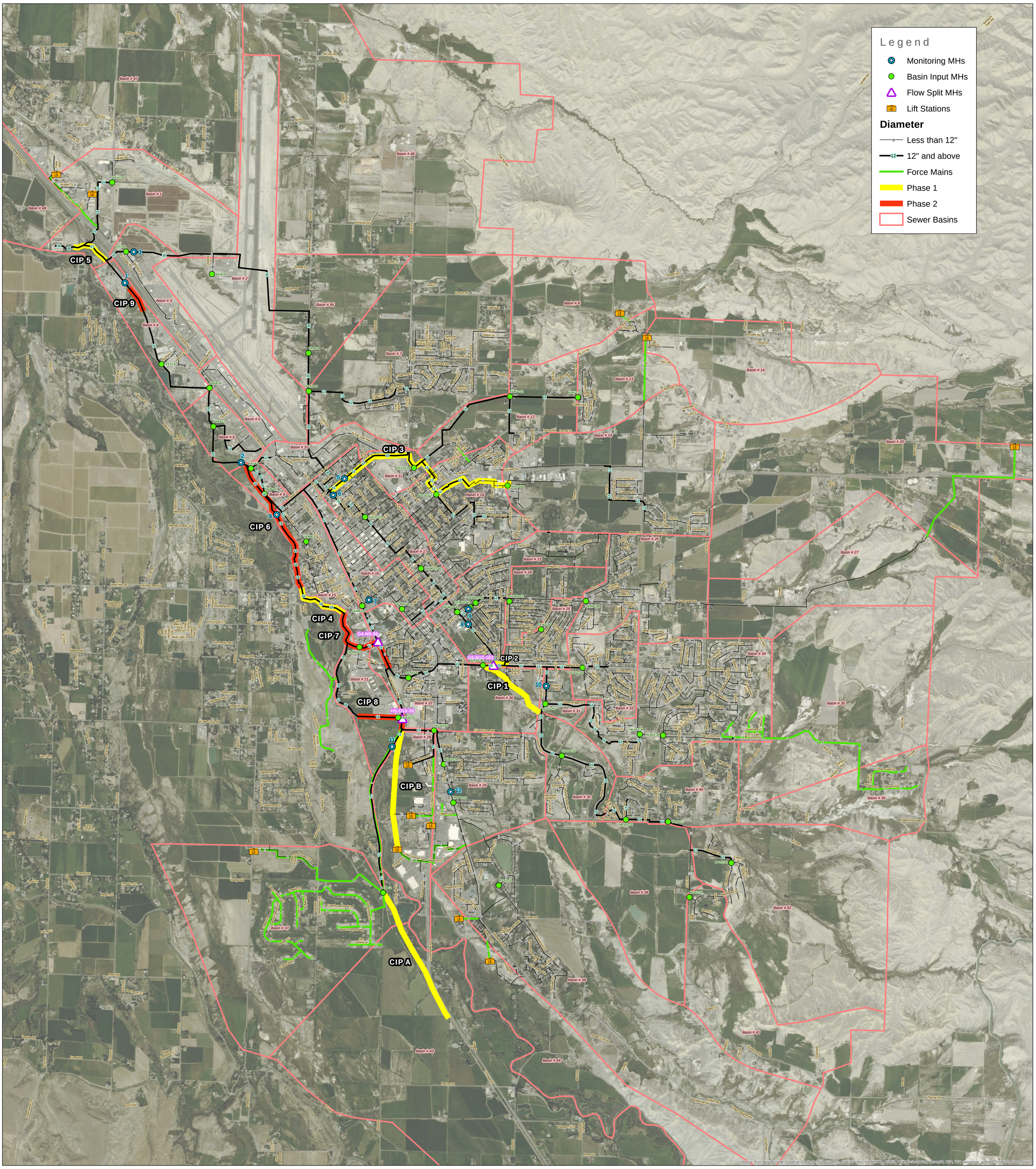


0 1 2 Miles

1/17/2016

Farnsworth GROUP

Montrose Sewer System CIP Map



N

0 1 2 Miles

1/17/2016

Farnsworth GROUP

Montrose Sewer System CIP Map