ATKINS

Sewer Model Update

Technical Report

City of Sparks

November 3, 2016

PROFESSIONAL ENGINEER – STATE OF NEVADA
DANIEL L. STUCKY
Exp. 6-30-18
CIVIL
No. 20946

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List of Abbreviations and Acronyms

ADS	ADS Environmental Services
ADWF	Average Dry Weather Flow
CCTV	Closed Circuit Television Inspection
CIP	Capital Improvement Project
d/D	Max Flow Depth/Pipe Diameter
DCA	Development Constraints Area
DU	Dwelling Unit
GID	General Improvement District
GIS	Graphical Information Systems
gpcd	Gallons per Capita per Day
gpm	Gallons per Minute
GT	Geographic Technologies
I&I	Inflow and Infiltration
IDF	Intensity-Duration-Frequency
mgd	Million Gallons per Day
NAIC	North American Industry Code
NDOT	Nevada Department of Transportation
NEXRAD	Next-Generation Radar
NOAA	National Oceanic and Atmospheric Administration
NRCS	National Resources Conservation Service
PDWF	Peak Dry Weather Flows
PUD	Planned Unit Developments
PVC	PolyVinyl Chloride
PWWF	Peak Wet Weather Flows
RDI&I	Rainfall Derived Infiltration and Inflow
RTC	Regional Transportation Commission
RTS	Return-to-Sewer
SCADA	Supervisory Control and Data Acquisition
SOI	Sphere of Influence
TMRPA	Truckee Meadows Regional Planning Agency
TMWA	Truckee Meadows Water Authority
TMWRF	Truckee Meadows Water Reclamation Facility

Executive Summary

The City of Sparks (City/Sparks) requested that ATKINS perform a detailed sewer master planning analysis for the approximately 42 square mile study area shown on **Figure 2-1**. The objectives of this Master Plan are to evaluate the system capacity of Sparks' conveyance system, develop an unsteady-flow, land-use based sewer model that integrates with the City's GIS database, and provide a comprehensive and prioritized list of capital improvement projects (CIPs) to improve system capacity. The Master Plan uses the most current information and data available to reflect the existing condition and anticipated future growth and is intended to provide the City with a valuable tool to effectively plan, evaluate and support future decisions associated with the construction, operation and maintenance of the city-wide sewer collection system.

In order to document land use and population growth projections within the study area, GIS-based land use and zoning data provided by the Truckee Meadows Regional Planning Agency (TMRPA) was utilized for this project and supplemented with additional data and information received from the City engineering and planning staff. The land use database used to evaluate the existing and buildout scenarios are shown on **Figure 2-2** and **Figure 2-3**, respectively.

As shown in **Figure 3-1**, a flow metering program was strategically implemented throughout Sparks to monitor flows from internal Sparks areas and external Washoe County areas in order to characterize wastewater flows throughout the system and to facilitate calibration of the new hydraulic sewer model. The existing metered flows were compared with land use data, population estimates, and water use records to develop unit wastewater generation rates. **Section 3.3** describes the datasets and presents the findings of the wastewater generation analysis and recommendations for future unit wastewater generation rates. The existing average wastewater flows generated within Sparks are approximately 7.86 mgd and anticipated to increase to 11.96 mgd in the buildout scenario. When subtracting the 4.39 mgd of capacity leases (Washoe County- 2.29 mgd and Sun Valley- 2.10 mgd) from the currently allocated City treatment capacity share (14.58 mgd of the TMWRF treatment capacity), the City has 10.19 mgd remaining in treatment capacity to accommodate existing and future flows. Under this scenario, the City is expected to exceed their designated treatment capacity by approximately 1.77 mgd in the buildout condition.

A capacity evaluation of Sparks' existing sanitary sewer system was completed to identify sewer pipelines and lift stations that may be deficient under recommended design criteria and to identify any upgrades needed to accommodate existing and projected dry and wet weather wastewater flows. The principal tool utilized in the capacity analysis was the InfoSWMM dynamic hydraulic computer sewer model. The model was developed based on specific physical collection system data and consists of several individual components (i.e. gravity mains, force mains, wet wells, lift stations, etc.) that collectively form the overall collection system. The modeling software allows for multiple types of loading including: external or direct inflows, dry weather inflows, rainfall derived inflow and infiltration (RDI&I). **Section 4.5** describes the process of loading the hydraulic model with the three inflow sources. The model was calibrated by refining model parameters under dry and wet weather conditions to the simulated flow conditions to reasonably approximate the measured flow conditions. Diurnal curves were adjusted for the dry weather calibration such that simulated and recorded wastewater flow, depth and volume hydrographs matched to within a reasonable level of accuracy. For the wet weather flow calibration, RTK parameters were adjusted such that simulated and recorded wastewater peak flows (significant wet-weather flow event occurred on June 30, 2015- see **Section 4.5.3** for details) matched to within a reasonable level of accuracy. Unit wastewater generation rates were "calibrated" to within ten percent of existing flows.

A capacity analysis of the existing collection system was performed under existing and forecasted dry and wet weather flow conditions. The results of the capacity analysis for the existing and buildout scenarios are presented in **Figure 4-11** and **Figure 4-12**, respectively. This analysis was conducted using the recommended evaluation criteria for existing facilities presented in **Table 4-6**. Model simulations were performed in order to identify potential improvement projects. CIPs were developed and prioritized based on methodology described in **Section 5.2**. The CIP improvements and estimated costs associated with existing condition and buildout condition deficiencies are summarized in **Table 5-2**. The total estimated costs of the existing condition deficiency CIPs and the buildout condition deficiency CIPs are approximately $10.24 million and $6.43 million, respectively. The total overall estimated CIP costs for all the recommended CIPs is approximately $16.67 million.

1. Introduction and Background

This Sewer Model Update represents the 2016 update to the City of Sparks' (City/Sparks) Sanitary Sewer Master Plan (Master Plan), previously prepared in 2005, for its sewer service area. This Master Plan reflects the growth and development the City has experienced since 2005, plans for future redevelopment areas within the urban core and other projected development throughout the City, accounts for modifications to the wastewater system, and incorporates changes to per-capita sewage generation resulting from ongoing water conservation efforts.

This introductory chapter to the Master Plan provides a summary of the:

- Master Plan objectives
- Contents and organization of this report
- Background information about Sparks' sanitary sewer system

1.1. Wastewater Master Plan Objectives

The objectives of this Master Plan are to evaluate the system capacity of Sparks' conveyance system, develop an unsteady-flow, land-use based sewer model that integrates with the City's GIS database, and provide a comprehensive and prioritized list of capital improvement projects (CIPs) to improve system capacity. The Master Plan uses the most current information and data available to reflect the existing condition and anticipated future growth and is intended to provide the City with a valuable tool to effectively plan, evaluate and support future decisions associated with the construction, operation and maintenance of the city-wide sewer collection system.

1.2. Report Organization

This Master Plan provides a comprehensive review and evaluation of Sparks' wastewater collection, conveyance and capacity requirements under existing and future conditions. Based on the findings of the evaluations, the Master Plan recommends facility improvements and identifies capital cost requirements to ensure that aging infrastructure maintains serviceable and allows for the City to continue to provide an acceptable level of service.

The Master Plan is presented in six (6) chapters:

- **Chapter 1** provides an introduction and background information pertaining to the project.
- **Chapter 2** presents an overview of the study area, land uses within the study area, and existing wastewater collection facilities.
- **Chapter 3** presents an overview of the sewer basins, flow metering, and provides an estimate of future wastewater generation rates and available regional flow capacity.
- **Chapter 4** presents the methodology and findings of the sewer capacity evaluation, including the criteria used to model and assess the system and the summaries of the hydraulic computer models used to analyze flow conditions.
- **Chapter 5** presents the recommended CIPs for the City sanitary sewer system.
- **Chapter 6** references the supporting documentation used to develop this technical report.

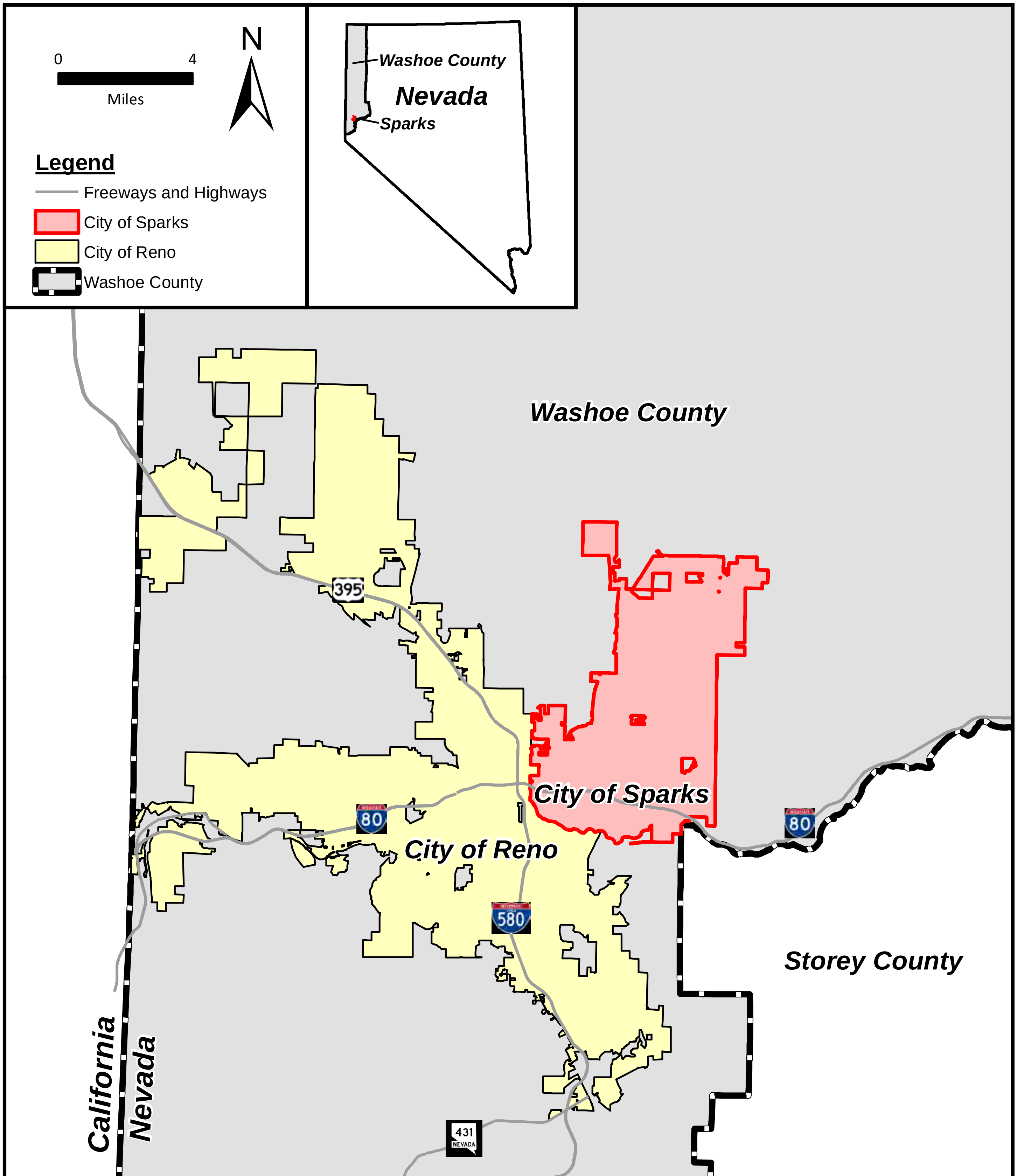
1.3. Background and Purpose

The City of Sparks is located in the southern portion of Washoe County, as shown in **Figure 1-1**, encompasses approximately 36 square miles of land area and contains a population of approximately 92,000 residents. The City owns, operates, and maintains approximately 355 miles of gravity sewer pipeline servicing approximately 40,000 residential and commercial customers. Wastewater is collected and conveyed to the Truckee Meadows Water Reclamation Facility (TMWRF), a 40-mgd regional facility. Two interceptor lines ("North" and "South") convey flows to TMWRF. The North Interceptor serves the City of Sparks, City of Reno, Sun Valley General Improvement District (GID), and unincorporated areas of Washoe County. The South Interceptor solely serves the City of Reno and Washoe County, therefore only the North Interceptor is analysed in this study.

In the last 10 years, the City has allocated a significant amount of time and effort advancing the City GIS database, as well as invested a substantial amount of capital to construct CIP recommendations and improve system capacity. The City of Sparks is likely to experience increased growth in the near future from new development and redevelopment. Additionally, since the last sewer master plan, the City has experienced significant growth and subsequent improvements to the sewer system without observing a substantial increase in sewage flows, thus suggesting a significant change in per-capita sewage generation. These aforementioned changes necessitated the need for an updated sanitary sewer model that is land-use based and integrates data from the City's robust GIS database. This sewer model is anticipated to be used to update City planning data, projected sewer flows, existing and future capacity evaluations, and required system improvements. This Master Plan update includes an updated hydraulic model using the latest unsteady flow sanitary sewer software, collection of additional flow monitoring data, GIS database review, CIP development, and select field verification of GIS data for the North Interceptor.

1.4. 2005 Sewer Master Plan

The 2005 Sewer Master Plan was the last sanitary sewer master plan performed for the City of Sparks. The previous master plan employed a steady-state, SewerCAD model to assess the collection system. The 2005 master plan focused on assessing the major interceptors and evaluating the impacts from anticipated growth and residential development in northern Sparks and Spanish Springs. In 2005, the population of the 44.6 square mile study area was estimated at 74,000, and the population for the year 2030 was projected to be 130,000. Average wastewater flows were calculated at a rate of 115 gallons per capita per day for residential properties and ranging from 10-238 gallons per employee per day for non-residential properties. The average wastewater flow generated within the City of Sparks was 8.14 mgd in 2005 and was estimated to increase to approximately 18.96 mgd in 2030. For the North Interceptor system the average flow was projected to increase from 15.69 mgd in 2005 to 35.78 mgd in 2030.



Sewer Model Update

Project Location

Figure 1-1

2. Study Area

This chapter provides a description of the Master Plan study area including:

- Existing and planned land uses
- Existing and projected populations
- Physical attributes of the existing sanitary sewer system
- Regional sewerage facilities serving Sparks

2.1. Study Area Description

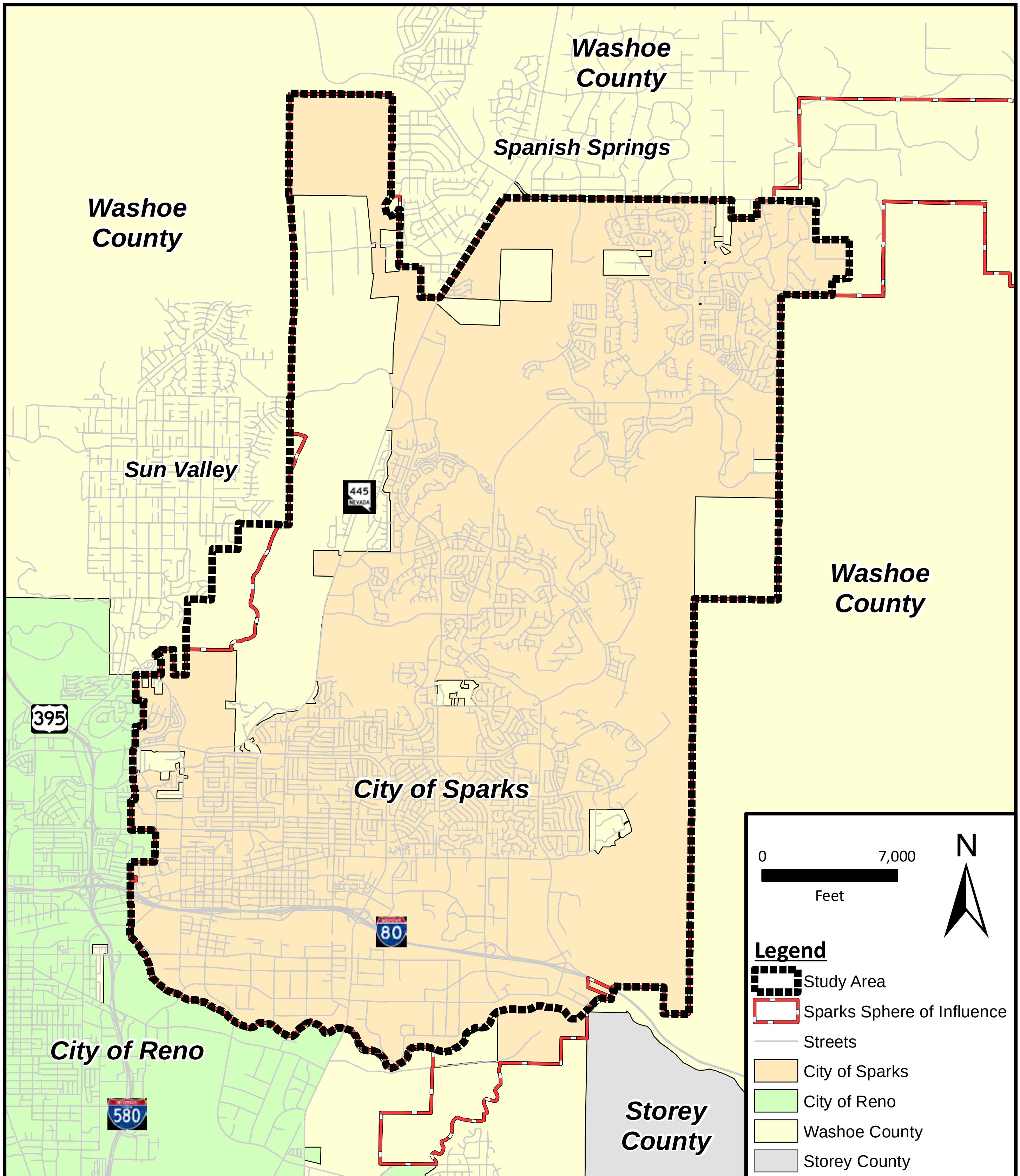
The City of Sparks is located east of the City of Reno, and for practical purposes bounded by Interstate 580 and Pyramid Highway to the west, La Posada Drive to the north, the Truckee River the south, and the Pah-Rah Mountain Range to the east. The City of Sparks service area includes approximately 36 square miles of developed and undeveloped areas. Sparks' sphere of influence (SOI) generally aligns with the City boundary, except along the northwest and northeast where the SOI extends beyond City limits into areas of unincorporated Washoe County.

The study area for this Master Plan encompasses approximately 42 square miles and includes Sparks' jurisdictional boundary and portions of the City SOI extensions into unincorporated Washoe County, including pockets of unincorporated Washoe County residential properties on septic systems. The unincorporated areas of Washoe County, located within the study area limits, that contribute sewage to the City sewer system were incorporated into the model using metered flow data. The model also includes wastewater contributions to the collection system from jurisdictional areas outside of the study area limits. These external sewage contributions to the North Interceptor from the City of Reno and unincorporated areas of Washoe County (primarily Sun Valley and Spanish Springs) were also metered at the points of entry into the City and incorporated into the model via inflow hydrographs. **Table 2-1** summarizes the study area component coverage and **Figure 2-1** presents the study area for the Master Plan.

The southern portion of the study area is predominantly built out, particularly within the urban core bounded to the north and east by McCarran Boulevard. However, this region is expected to experience several areas of redevelopment in the near future. The northern and eastern portions of Sparks contain significant portions of undeveloped areas where the majority of future growth is anticipated.

Table 2-1 Study Area

Jurisdiction	Area (Square Miles)	% of Study Area
City of Sparks	35.8	84%
Unincorporated Washoe County	6.6	16%
Study Area Total	42.4	100%



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Study Area

Figure 2-1

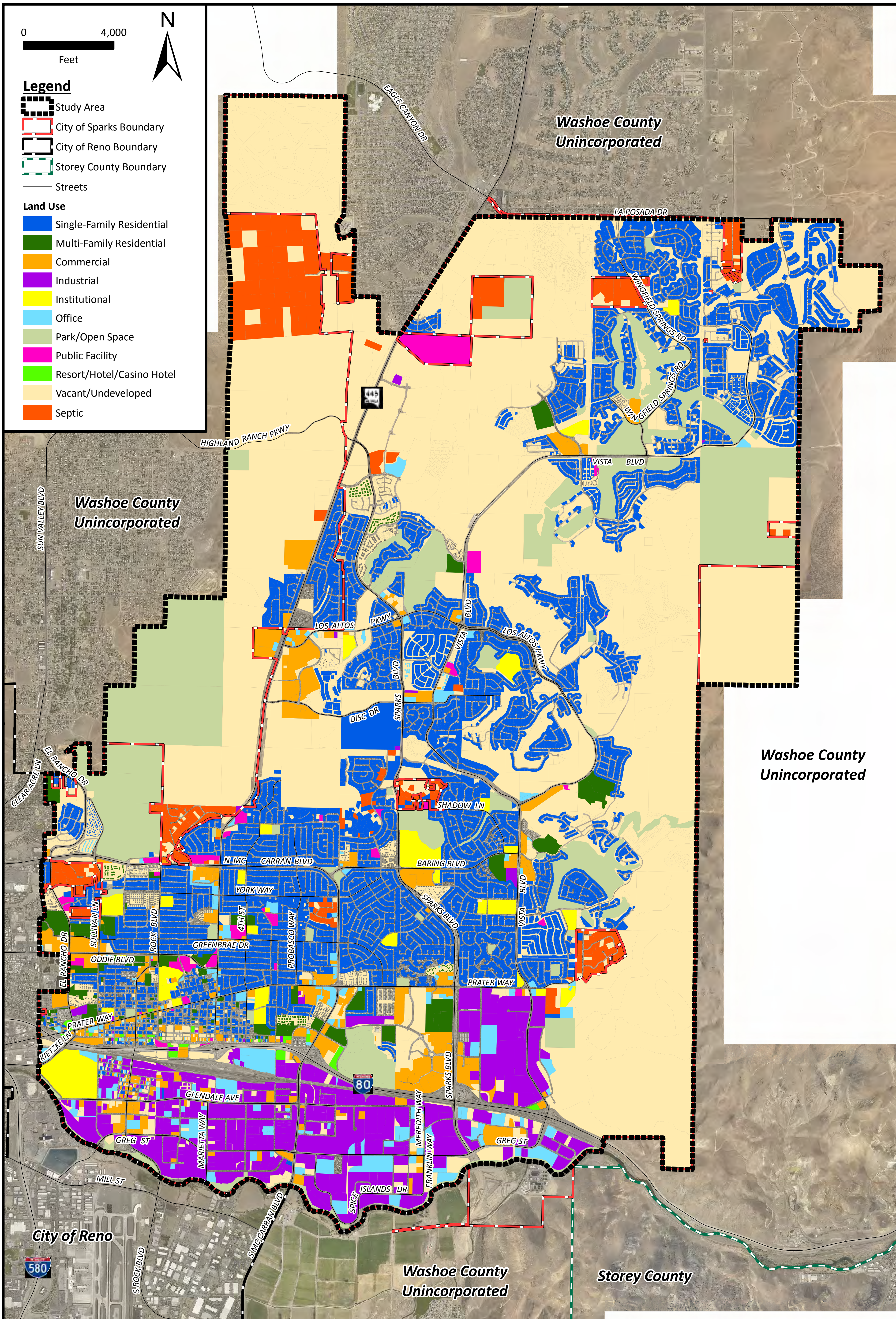
2.2. Land Use

In order to document land use and population growth projections within the study area, GIS-based land use and zoning data provided by the Truckee Meadows Regional Planning Agency (TMRPA) was utilized for this project. The primary function of the TMRPA land use model is to aid in producing mid-range and long-range demographic and economic forecasts for the Truckee Meadows region, as well as to assess future housing demand and the potential impacts of future development on wastewater infrastructure. The TMRPA incorporated data from the US Census Bureau, Nevada State Demographer, Truckee Meadows Water Authority (TMWA) and the local government jurisdictions (City of Sparks, City of Reno and Washoe County) to form a comprehensive land use database at the parcel-level scale. The City also provided GIS-based land use and zoning data at the parcel-level scale, therefore the two land use datasets were compared to identify discrepancies between the two and resolve any contradictions. Additionally, the TMRPA forecasts and spatial distributions of future growth were reviewed with City engineering and planning staff prior to use in the sewer model.

For this master plan, eleven (11) land use categories were used; single-family residential, multi-family residential (apartments, condominiums/townhouses/duplexes, and mobile homes), office, public facilities (museums, libraries, churches, etc.), commercial, hotel/resort (includes hotel portion of casino), industrial, institutional (schools, hospitals, etc.), parks and open space, vacant/undeveloped land (includes roadways and parking lots), and septic (developed parcels on septic systems). This land use categorization matches the land uses listed in the *City of Sparks Sewer Design Manual* for estimating wastewater generation from various land use types. The TMRPA existing land use coverage served as the base database for the existing land use coverage, as shown on **Figure 2-2**. The existing dwelling unit counts from the TMRPA land use database are based on 2013 dwelling unit data from Washoe County Community Development and augmented with data from the Washoe County Assessor's website for years 2014 and 2015 to form a current and comprehensive dataset. For the buildout land use database, the TMRPA projected land use coverage was used along with Sparks' zoning data to develop a buildout land use coverage, as shown in **Figure 2-3**. The spatial distribution of future single-family and multi-family residential developments incorporated in the buildout land use was based on data provided in the *Truckee Meadows Housing Study* completed by the TMRPA. This TMRPA regional housing study used a variety of geospatial variables to predict the spatial distribution of future residential development and forecast the year of development for a given parcel. The future non-residential developments included in the buildout land use were predicted based on active tentative maps and planned unit developments (PUDs), City zoning data, multiple discussions with City engineering and planning staff, and available buildable land. The buildout land use also included many areas of redevelopment identified by City of Sparks' staff. These redevelopment projects consist primarily of conversions of non-residential properties to multi-family residential developments. **Table 2-2** summarizes the existing and projected service areas and dwelling unit (DU) counts for residential parcels and non-residential parcels for the study area.

Table 2-2 Existing and Buildout Land Use Summary

Land Use Category	Service Area (Acres)		Dwelling Units (DU)	
	Existing (% of Total Study Area)	Buildout (% of Total Study Area)	Existing	Buildout
Single-Family Residential	4,884 (18%)	8,636 (32%)	25,475	36,206
Multi-Family Residential	641 (2%)	1,152 (4%)	13,297	21,539
Office	470 (2%)	936 (3%)	-	-
Public Facility	189 (1%)	230 (1%)	-	-
Commercial	825 (3%)	1,940 (7%)	-	-
Hotel/Resort/Casino Hotels	30 (< 1%)	51 (< 1%)	-	-
Industrial	1,550 (6%)	1,697 (6%)	-	-
Institutional	368 (1%)	476 (2%)	-	-
Parks and Open Space	2,689 (10%)	2,629 (10%)	-	-
Vacant/Undeveloped	14,520 (54%)	9,370 (35%)	-	-
Septic	951 (4%)	0 (0%)	404	0
Total	27,117	27,117	39,176	57,745



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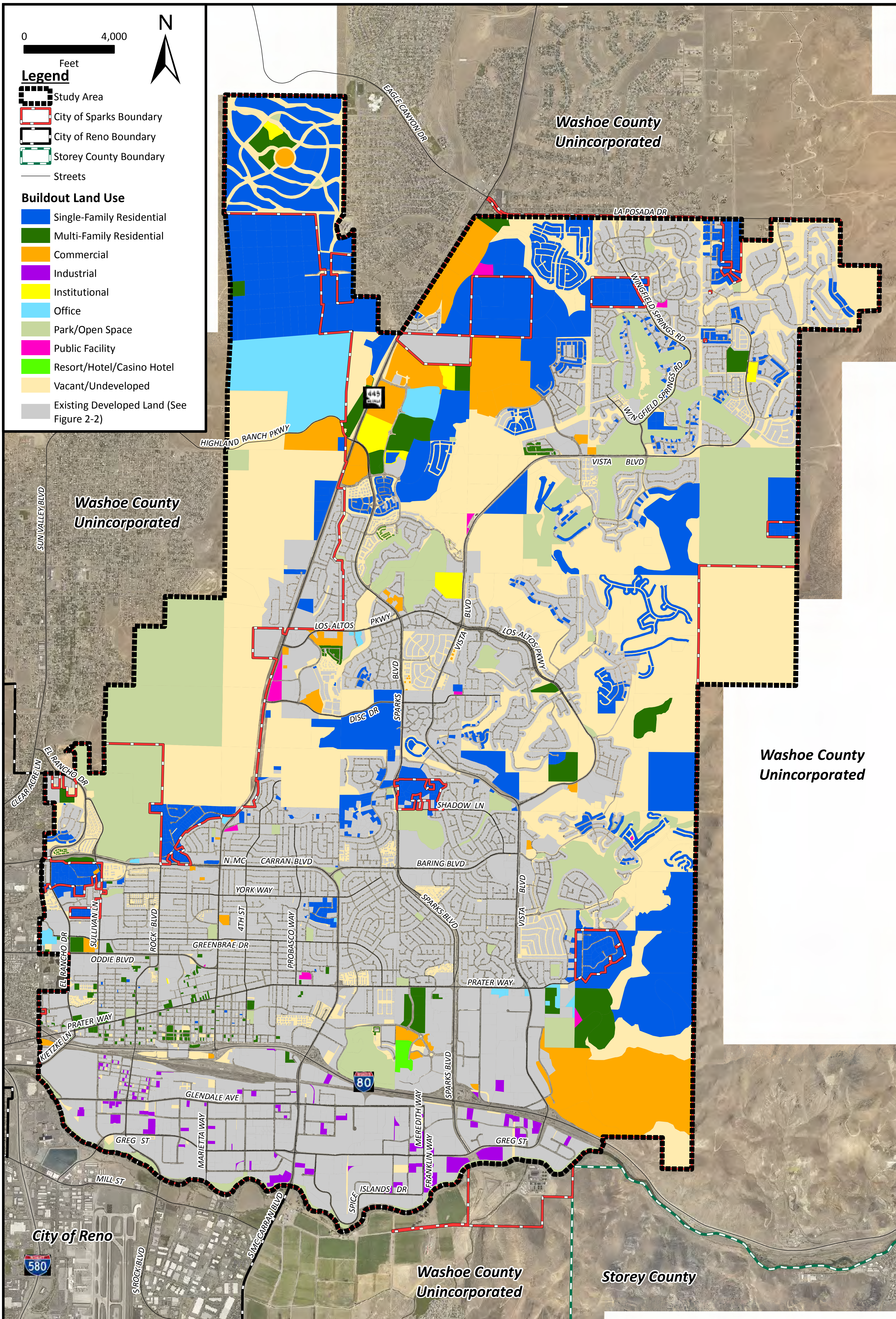
Existing Land Use

Figure 2-2



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Buildout Land Use

Figure 2-3

The following summarizes the anticipated major growth and redevelopment areas within the City:

- Redevelopment Areas- The redevelopment areas are primarily concentrated within the City urban core region bounded by McCarran Boulevard to the north and east. These redevelopment projects are predominately multi-family apartment complexes with a heavy concentration proposed near Victorian Square.
- Residential Developments- The future residential developments are spread throughout the large undeveloped growth regions of the City, primarily located in the north and northeast. The significant planned residential developments included in the buildout land use include:
  - Copper Canyon single and multi-family development (nearly 1,700 residential units)
  - Marina Gateway Drive multi-family development (nearly 1,400 residential units)
  - Wingfield Springs single-family development (approximately 500 residential units)
  - Stonebrook single-family development (approximately 2,200 residential units)
  - Pioneer Meadows single-family residential development (over 600 residential units)
  - Sonoma Highlands single and multi-family development (nearly 2,500 residential units)
  - Miramonte single and multi-family development (1,000 residential units)
  - Kiley Ranch North single and multi-family development (nearly 3,700 residential units)
- Non-Residential Developments- The future non-residential developments shown in the buildout land use coverage are located mostly in the north and east portions of the City limits, as well as near the Sparks Marina and within the industrial area south of Interstate 80. In the north part of the City, there are some large future commercial, office and mixed-use developments planned as part of the Kiley Ranch North, Stonebrook, and Pioneer Meadows developments. Additionally, a large business park development is planned along Highland Ranch Parkway. In the east, the Coper Canyon development includes a large area dedicated to commercial and business park type development. Near the Sparks Marina, multiple commercial developments and a hotel casino are anticipated in the buildout scenario.
- Septic Conversions- The existing condition contains approximately 400 dwelling units that are currently served with onsite septic systems. These parcels are mainly located within pockets of Washoe County spread throughout the City of Sparks service area. For the buildout scenario, these properties were assumed to connect and contribute wastewater flows to the City sewer system. This approach was approved by City engineering and planning staff.

2.3. Existing and Forecasted Populations

Residential and employment population estimates for the City of Sparks and the study area were determined using GIS data provided by the TMRPA for the existing (2014/2015) condition. The GIS database included residential and employment population data for the City of Sparks at the block-level scale based on data from the 2010 U.S. Census Bureau and more current data from 2014 and 2015 used by TMRPA to develop the *2014-2034 Washoe County Consensus Forecast*. Residential populations represent persons residing in a given area. Employment populations represent persons employed and performing work functions in a given area. In determining existing residential and employment populations for the study area extents, the existing residential (2.42 residents per dwelling unit) and employment (14.56 employees per acre) densities calculated for the populations within the City of Sparks were used. These densities were multiplied by the remaining dwelling units and developed non-residential acreage, respectively, outside of the City jurisdictional boundary to estimate populations for the study area limits. The calculations used to determine existing residential and employment densities for the City of Sparks are as follows:

(1) Existing residential density for City of Sparks = (91,551 persons/37,909 DU) = 2.41 residents per DU

(2) Existing employment density for City of Sparks = (48,146 employees/3,306 non-residential acres) = 14.56 employees per acre

Similarly, buildout residential and employment populations for the City of Sparks and study area extents were estimated by multiplying the existing population and employment densities by the projected buildout dwelling units and developable non-residential acreage, respectively. The developable non-residential acreage used in these buildout employment calculations excludes development constraints areas (DCAs), as the steep terrain in these regions limits the likelihood of future development. The majority of the buildout growth included in this

Master Plan update is projected to occur over the next 20 years according to the TMRPA growth model. **Table 2-3** summarizes the residential and employment population estimates for the existing and buildout scenarios for Sparks and the study area.

Table 2-3 Existing and Forecasted Populations

Planning Scenario	Populations	
	Residential	Employment
City of Sparks		
Existing (2014/2015)	91,551	48,146
Buildout	134,928	66,104
Study Area		
Existing (2014/2015)	94,611	50,014
Buildout	139,453	72,740

Notes:

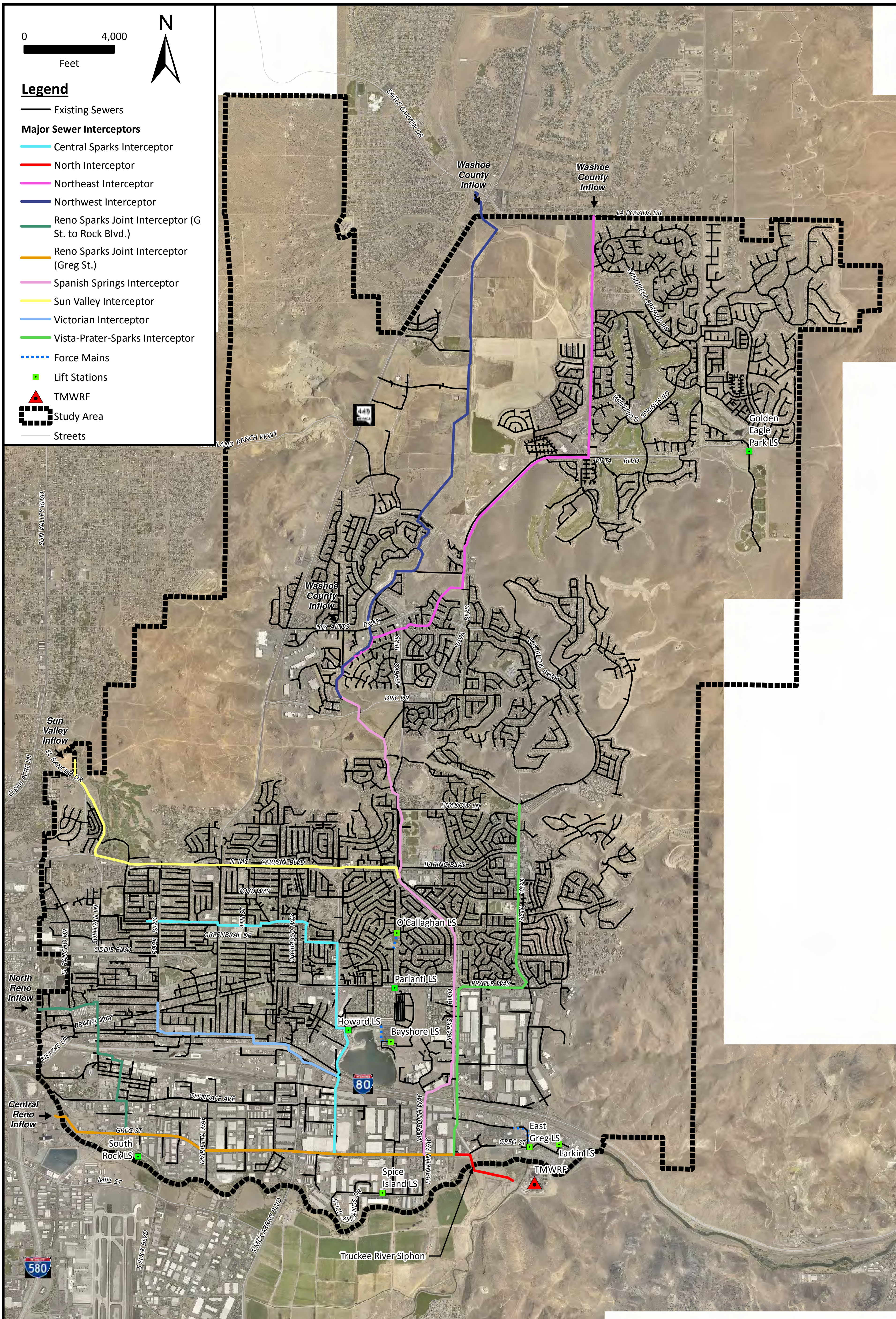
- Existing residential and employment populations for the City of Sparks were obtained from data provided by the TMRPA based on U.S. Census data and other data used to develop the *2014-2034 Washoe County Consensus Forecast*.
- Study area extents and buildout residential and employment population data is calculated using a population and employment density of 2.41 residents per DU and 14.56 employees per acre, respectively.

Based on the forecasted projections, residential populations within the study area are expected to grow by 46 percent in the buildout scenario. For this Master Plan, these residential and employment population projections were primarily used to verify model calibration results and provide per capita wastewater generation estimates for City planning purposes, as discussed in **Section 3.3.2**.

2.4. Existing Sanitary Sewer System

The City of Sparks' sanitary sewage is collected and conveyed to TMWRF, a 40-mgd regional facility. Sparks' existing sewer system consists of approximately 9,000 manholes, 355 miles of gravity mains, nine (9) lift stations and force mains, numerous flow combining/splitting structures, and an inverted siphon underneath the Truckee River. **Figure 2-4** depicts the existing sewer collection and conveyance system including gravity mains, manholes, force mains and pump stations based on the City's GIS database. As discussed previously, the City of Reno, Sun Valley and other unincorporated areas of Washoe County contribute sewage to the City sewer system in route to the TMWRF. The regional sewer system is discussed in more detail in **Section 2.5**. The collection mains and trunks convey flow to numerous large diameter interceptors throughout the City, which transport wastewater to the TMWRF. The primary sewer interceptors are summarized in **Table 2-4**.

The City's interceptors are supplied by gravity sewers, force mains, and lift stations and convey flow to TMWRF via the inverted siphon (triple-barrel, one 24-inch diameter barrel and two 48-inch diameter barrels) located below the Truckee River. **Table 2-5** and **Table 2-6** summarize Sparks' existing lift stations and force mains, respectively. The combined pumping capacity of all the existing lift stations is approximately 3.0 mgd. The largest lift station is the 850 gpm capacity Marina Village station, which was designed to accommodate future residential and commercial development. The nine (9) force mains operated and maintained in the City range in size from 4 to 8 inches in dimeter. The longest force main is the East Greg Street force main, which extends 1,480 linear feet from the intersection of Kleppe Lane/Greg Street to near the North Truckee Drain crossing along Kleppe Lane.



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Existing Sewer System

Figure 2-4

Table 2-4 Major Wastewater Interceptors

Interceptor	Pipe Diameter Range (Inches)	Length (Miles)
Central Sparks Interceptor	15 to 48	3.73
North Interceptor	60	0.61
Northeast Interceptor	15 to 36	5.41
Northwest Interceptor	30 to 42	5.09
Reno Sparks Joint Interceptor (G Street to Rock Boulevard)	33	1.88
Reno Sparks Joint Interceptor (Greg Street)	30 to 60	3.45
Spanish Springs Interceptor	54 to 60	4.47
Sun Valley Interceptor	21 to 24	3.53
Victorian Interceptor	15 to 24	1.94
Vista-Prater-Sparks Interceptor	15 to 42	3.53

Table 2-5 Lift Stations

Lift Station	Date Installed/ Upgraded	Design Discharge (gpm)	Design TDH (Feet)
1199 O'Callaghan Drive	1998	150	25.5
1102 Spice Island Drive	1997	250	25.0
2102 East Greg Street	1997	420	33.0
300 Howard Drive (Marina Park)	2001	200	27.0
1152 Bayshore Drive (Marina Village)	2003	850	53.0
Golden Eagle Park	2007	180	20.0
1515 South Rock Blvd (Rock Park)	2000	-	-
Parlanti Lane (Helms Trailer Park)	2012	-	-
Larkin Circle	2014	-	-

Notes:

- List station information obtained from design reports and as-built plans, *City of Sparks TMSA/FSA Conceptual Facility Master Plan*, and the *City of Sparks Public Works Department Supplemental Lift Station Operation & Maintenance Manual*.
- Only five (5) lift stations were included in the hydraulic sewer model. See **Section 4.4.3** for additional information.

Table 2-6 Force Mains

Force Main	Diameter (Inches)	Material	Length (Feet)
1199 O'Callaghan Drive	8	Concrete	745
1102 Spice Island Drive	8	Concrete	60
2102 East Greg Street	6	Concrete	1,480
300 Howard Drive (Marina Park)	-	-	-
1152 Bayshore Drive (Marina Village)	8	PVC	1,155
Golden Eagle Park	4	PVC	310
1515 South Rock Blvd (Rock Park)	-	-	-
Parlanti Lane (Helms Trailer Park)	-	-	-
Larkin Circle	8	PVC	70

Notes:

- Force main information acquired from City GIS database and as-built plans.

Nearly 80% of the sewer system consists of pipe diameters of 8-inches or smaller, as shown in **Table 2-7** and presented graphically in **Figure 2-5**.

Table 2-7 Gravity Collection System by Pipe Diameter

Pipe Size / "Type"	Length (Miles)	Percent of System
≤ 8-inch / "Main"	276	78%
10-inch to 12-inch / "Trunck"	30	8%
> 12-inch / "Interceptor"	49	14%
Total	355	100%

Table 2-8 is a summary of the existing gravity system by pipe material, and is presented graphically in **Figure 2-6**. The majority of the sewer system is composed of polyvinyl chloride (PVC) pipe, particularly in the newer developments of the City located in the north and northeast. There are significant pockets of asbestos concrete sewer pipe located in central Sparks, as well as in the industrial areas in eastern and southern Sparks.

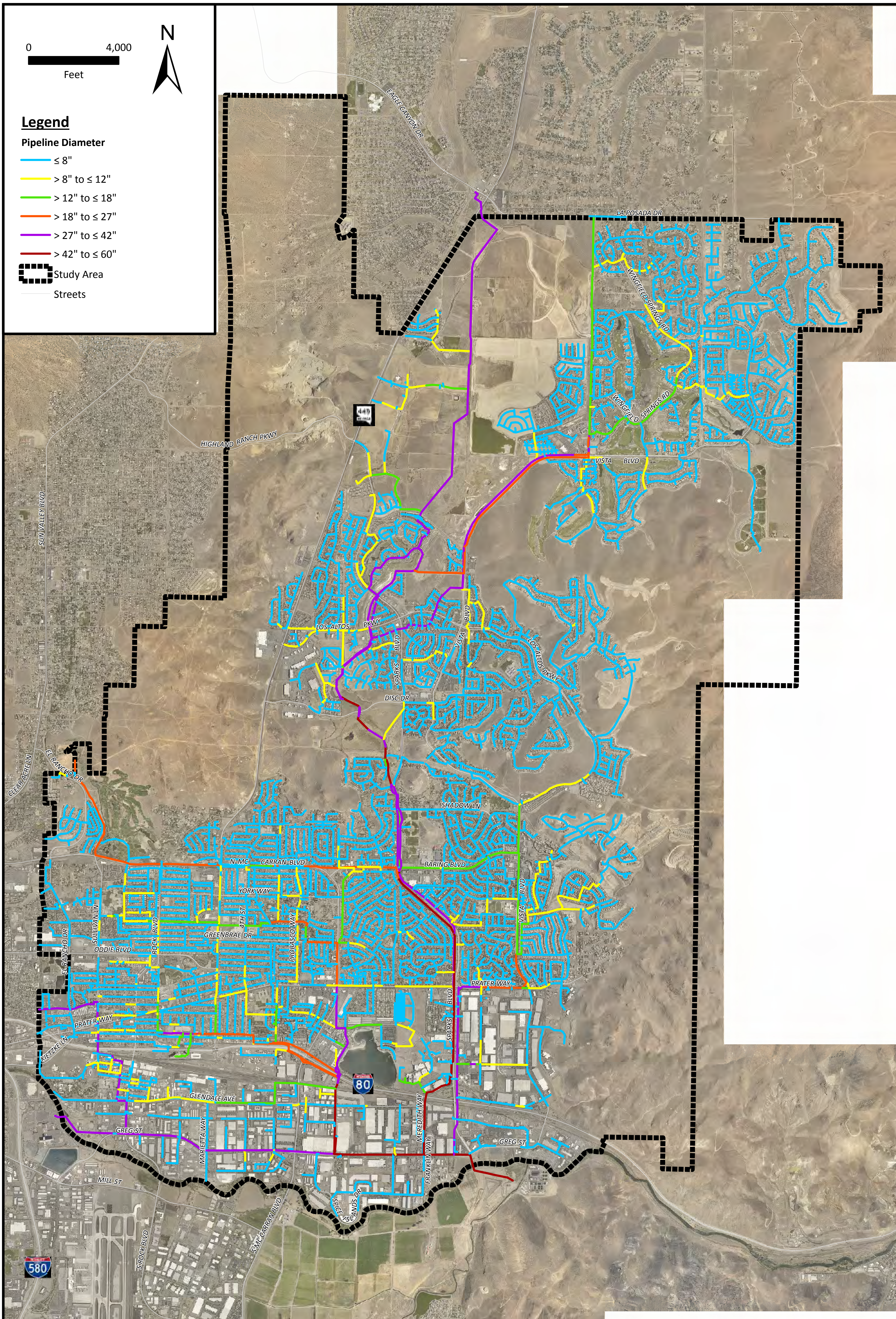
Table 2-8 Gravity Collection System by Pipe Material

Pipe Material	Length (Miles)	Percent of System
PVC	204	58%
RCP	64	18%
Asbestos Concrete	54	15%
Clay	5	1%
Fiberglass	3	< 1%
Other	25	7%
Total	355	100%

Table 2-9 is a summary of the existing gravity system by pipe age, and is presented graphically in **Figure 2-7**. Nearly 80% of the Sparks' sewer system was constructed after 1970, so the greater system is less than 50 years old. Depictions and accountings of pipe diameters, materials and age were derived from GIS information provided by the City. GIS information should be reviewed and maintained on an ongoing basis to ensure that records in the GIS reflect actual field conditions.

Table 2-9 Gravity Collection System by Age

Year Installed	Length (Miles)	Percent of System
1900 to 1950	13	4%
1951 to 1970	50	14%
1971 to 1990	98	28%
1991 to 2000	79	22%
2001 to 2015	104	29%
Undefined	11	3%
Total	355	100%



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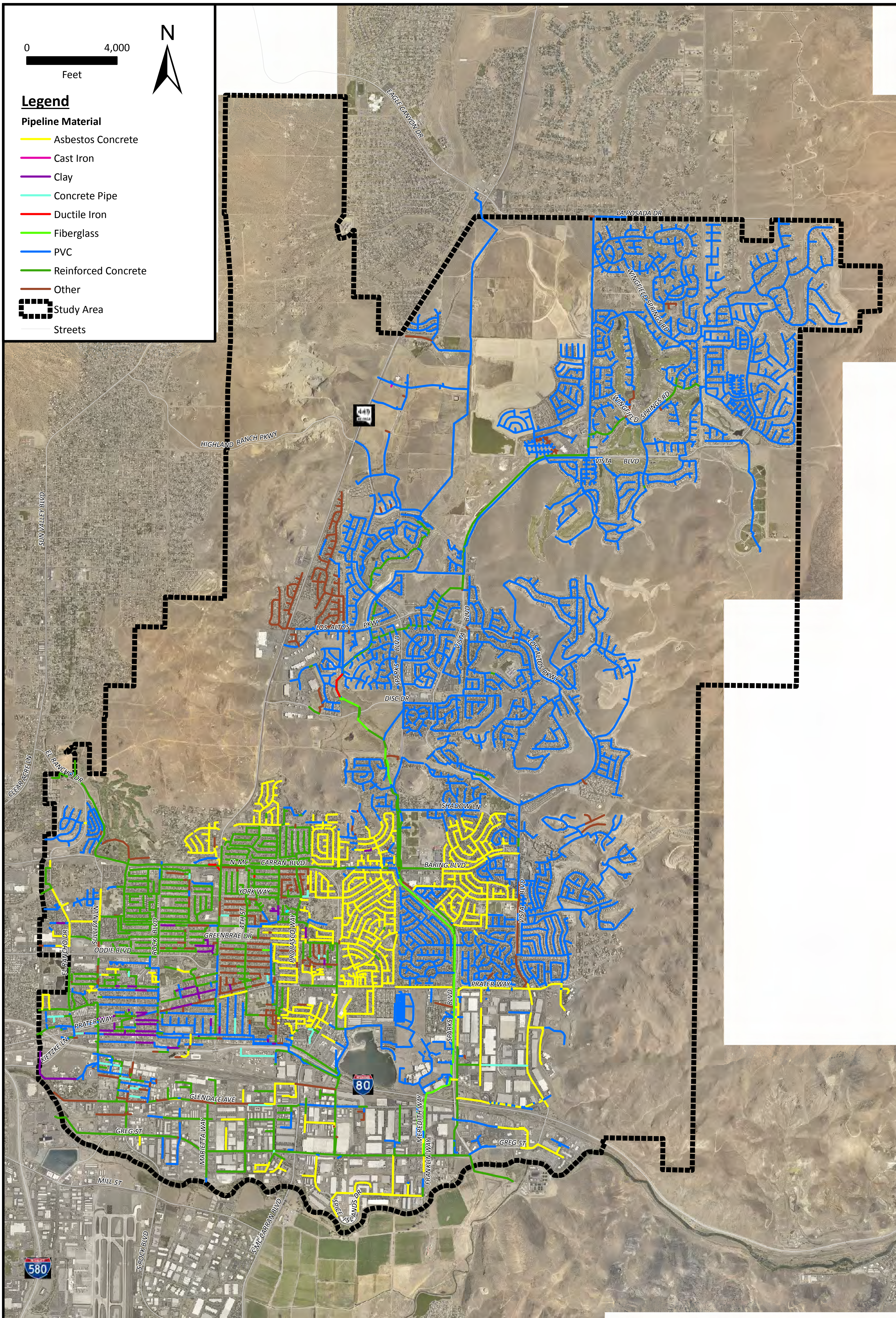
Existing Gravity Mains - Pipeline Diameter

Figure 2-5



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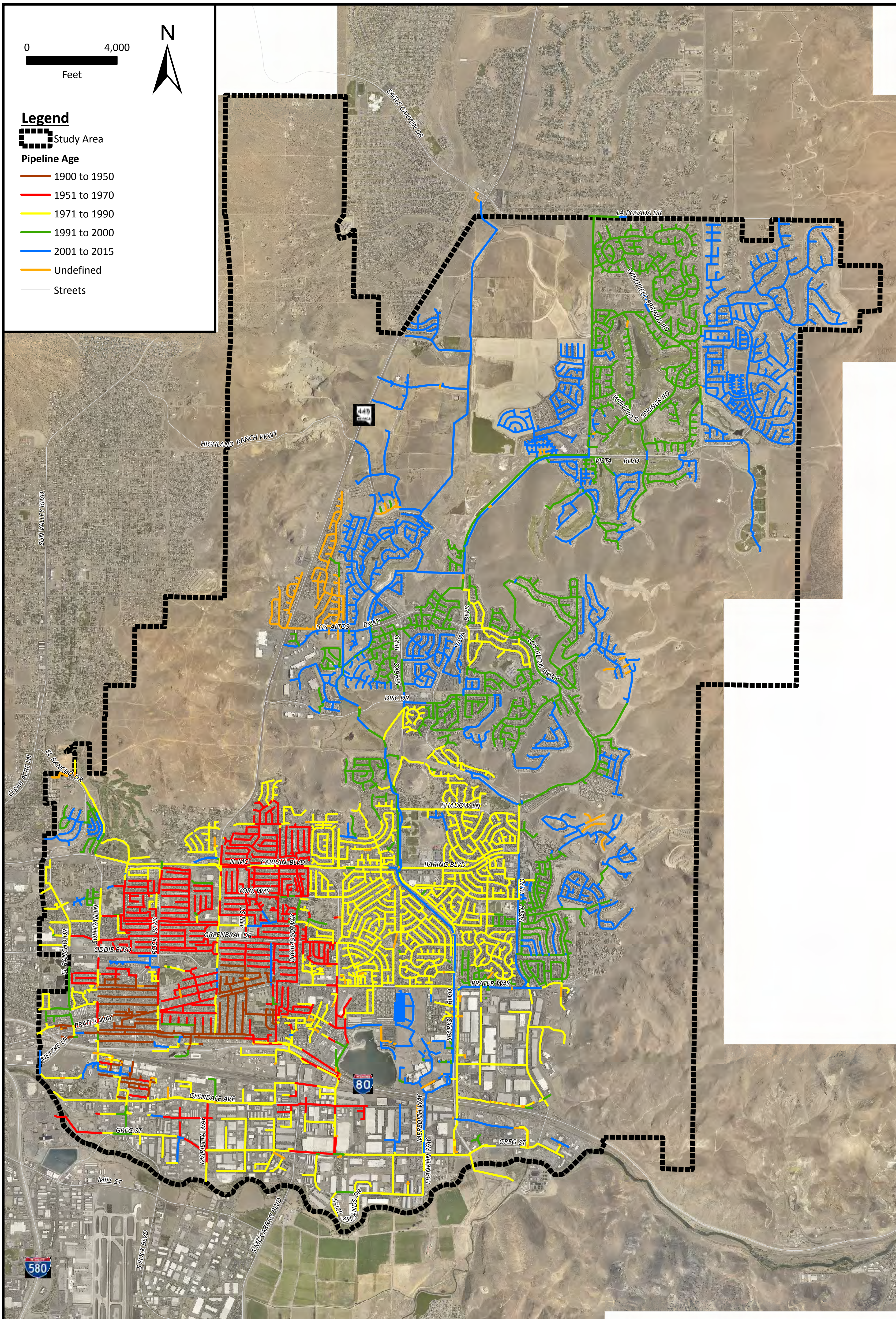
Existing Gravity Mains - Pipeline Material

Figure 2-6



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Sewer Model Update

Existing Gravity Mains - Pipeline Age

Figure 2-7

2.5. Regional Sewage Facilities

As discussed in **Section 2.5**, the City of Sparks sewer infrastructure conveys regional sewer flows within the City service area, as well as sewer flows generated within portions of the City of Reno, Sun Valley GID and other unincorporated areas of Washoe County for conveyance to the TMWRF for treatment and disposal. TMWRF receives flow contributions from two interceptor lines ("North" and "South"). The North Interceptor conveys flows generated within Sparks, Reno, Sun Valley and other unincorporated areas of Washoe County. The South Interceptor solely serves the City of Reno and Washoe County, therefore only the North Interceptor is included in this study.

Sparks has approximately 14.58 mgd of contracted treatment capacity at TMWRF, which equates to roughly 31.4% of the overall plant treatment capacity of 46.48 mgd. This allocation includes the capacity leases to Sun Valley and unincorporated Washoe County. Per the current agreement, the City leases approximately 2.10 mgd to Sun Valley and 2.29 mgd to Washoe County. The current jurisdictional sewer flow allocation for the North Interceptor is summarized in **Table 2-10** based on the permanent flow monitoring and the temporary flow monitoring performed for this project. Flow metering is discussed in greater detail in **Section 3.1**.

Table 2-10 North Interceptor Sewer Flow Distribution

Jurisdiction	Average Daily Flow (mgd)	% of North Interceptor Flow
Sparks	7.86	68%
Reno	2.20	19%
Unincorporated Washoe County	0.63	5%
Sun Valley	0.94	8%
Total (North Interceptor)	11.63	100%

Notes:

- Average daily flow values were calculated from permanent and temporary meter data collected during June 18 to July 1, 2015.

2.6. Historical Flows

Average annual wastewater flows for the North Interceptor, as measured at the TMWRF, are summarized for the past 15 years in **Figure 2-8**. As was typical for the region, flows likely decreased in the early 2000s due to water conservation measures and through the construction of newer homes and buildings equipped with low-flow appliances. Subsequently, flows then increased in the mid-2000s due to population increases from the housing boom and rapid development. During and following the economic downturn and housing crash of 2008, development drastically decelerated and sewer flows stabilized then decreased. Additionally, water conservation measures were encouraged throughout the Truckee Meadows due to drought conditions, which also likely contributed to the decreased sewer flows experienced after 2008.

Monthly wastewater flows averaged over the years 2000 to 2015 for the North Interceptor (again as measured at the TMWRF) are shown in **Figure 2-9**. From the chart, the late spring and summer months (May-September) typically generate the highest water demand and sewer generation throughout the year. Temporary flow monitoring for this Master Plan was performed during June and July, the respective 5th and 3rd highest sewage producing months of the year. Flow metering is discussed in **Section 3.1**.

Figure 2-8 Historical Wastewater Flows

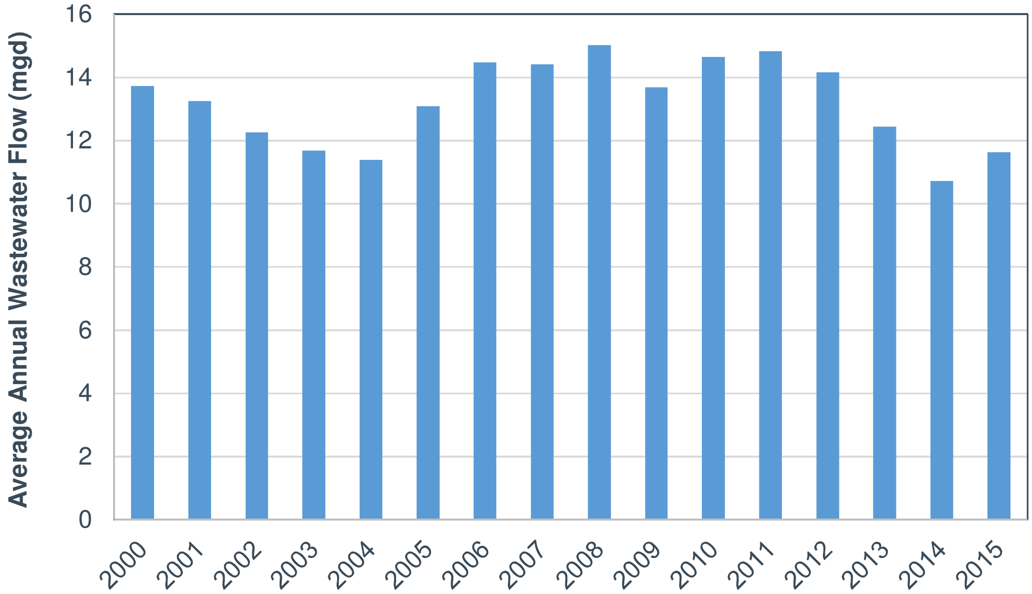
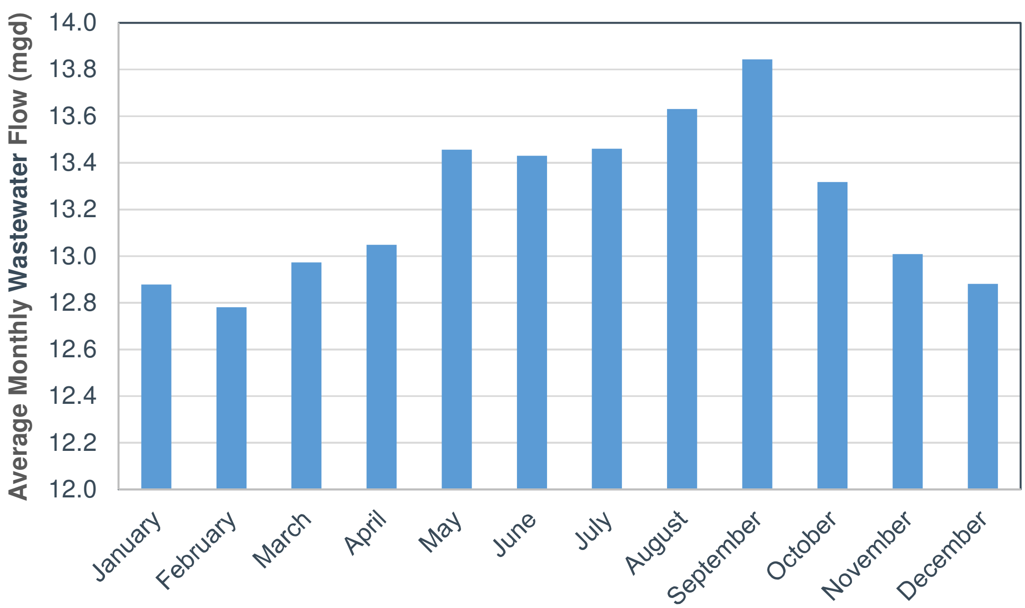


Figure 2-9 Monthly Wastewater Flow Variation



3. Wastewater Generation Analysis

This chapter provides a description of the wastewater generation including:

- Existing flow meter data summary
- Methodology for developing unit generation rates
- Recommended unit generation rates
- Estimated future wastewater flows

3.1. Flow Meters

As described in **Section 2.5**, the City of Sparks' sewer flows, as well as flow contributions from Washoe County and City of Reno, are conveyed through the City to the TMWRF for disposal. The existing sanitary sewer system has three permanent flow meters within the City (Site_05, Site_06 and Site_07), two permanent meters where flows enter Sparks from the City of Reno (Site_01 and Site_02), and one permanent meter where sewage enters from Sun Valley (Sun Valley). The permanent meters are maintained by the City's contractor ADS Environmental Services (ADS) with the exception of the Sun Valley meter, which is maintained by the Sun Valley GID. ADS flow data is available to member agencies from a web-based management system.

In order to characterize wastewater flows throughout the system and to facilitate calibration of the new hydraulic sewer model, ten temporary flow meters were strategically placed throughout Sparks to monitor flows from internal Sparks areas and external Washoe County areas. The metered basins varied by size and land use. ADS monitored these locations for a 14-day period, from June 18 to July 1, 2015. The temporary meter data was used in combination with the permanent meter data over the same duration to (1) characterize and quantify the average dry weather flows and diurnal patterns and (2) determine the magnitude and spatial distribution of rainfall derived inflow and infiltration. As discussed in **Section 2.6** and visualized in **Figure 2-9**, the June/July meter observation period corresponds with the historically higher water demand and sewer generation summer month periods of the year, thus an ideal period for model calibration and capacity analysis.

Table 3-1 and **Table 3-2** summarize the metered flow data observed during the June 18 to July 1, 2015 monitoring period at each of the permanent and the temporary meters, respectively. **Figure 3-1** presents the locations of the permanent and temporary meter locations and approximate sewershed areas. The ADS flow metering report and meter data are included in **Appendix A**. All ten (10) of the temporary meters were successful in obtaining useful data. As shown in the tables when comparing the average hourly peak flow to the average daily flow, the sewer peaking factors range from 1.3 to 2.8 for dry weather flow conditions. The higher peaking factor basins (i.e. Site_07 and Wldlsd08) usually contain a greater percentage of non-residential parcels (primarily commercial and industrial) dominated by distinct daytime peaks. The development and calibration of land use specific diurnal patterns is discussed in **Section 4.5**.

Table 3-1 Permanent Flow Metering Summary

Meter Name	Average Daily Flow (mgd)	Average Hourly Peak Flow (mgd)	Sewer Peaking Factor
Site_01	1.78	2.51	1.4
Site_02	0.42	0.72	1.7
Site_05	10.44	14.21	1.4
Site_06	1.16	1.93	1.7
Site_07	0.03	0.09	2.8
Sun Valley	0.94	1.41	1.5

Notes:

- Permanent and temporary meter data was collected during June 18 to July 1, 2015.
- The data excludes metered data collected during June 30, 2015 due to the influence of wet weather flows. Refer to **Section 4.5.3** and **Section 4.6.2** for details on the wet weather flow analysis and calibration, respectively.

Table 3-2 Temporary Flow Metering Summary

Meter Name	Average Daily Flow (mgd)	Average Hourly Peak Flow (mgd)	Sewer Peaking Factor
Pyram01	0.45	0.75	1.7
LosAl02	0.13	0.21	1.6
Sparks03	3.24	4.38	1.4
Victo04	0.94	1.62	1.7
Nugg05	2.60	3.83	1.5
Frank06	5.30	6.93	1.3
Matte07	0.23	0.36	1.5
Wldlsd08	0.11	0.21	1.9
Sulli09	0.24	0.36	1.5
LaPa10	0.05	0.09	1.9

Notes:

- Permanent and temporary meter data was collected during June 18 to July 1, 2015.
- The data excludes metered data collected during June 30, 2015 due to the influence of wet weather flows. Refer to **Section 4.5.3** and **Section 4.6.2** for details on the wet weather flow analysis and calibration, respectively.

Wastewater flows generated within the City of Sparks are metered in the interceptor pipelines upstream of the TMWRF near the intersection of Greg Street and Sparks Boulevard (Site_05, Site_06 and Site_07). Due to the upstream flow contributions from the City of Reno, unincorporated Washoe County and Sun Valley, the determination of flows generated entirely within the City of Sparks requires subtracting other agency flows from the meters upstream of the TMWRF, which increases the margin of error.

During the monitoring period, the existing average daily flow contributions from Sparks was approximated at 7.86 mgd by using the following formula:

Sparks Flow = (Site_05 + Site_06 + Site_07) – (Site_01 + Site_02) – Sun Valley – (Pyram01 + LosAl02 + LaPa10)

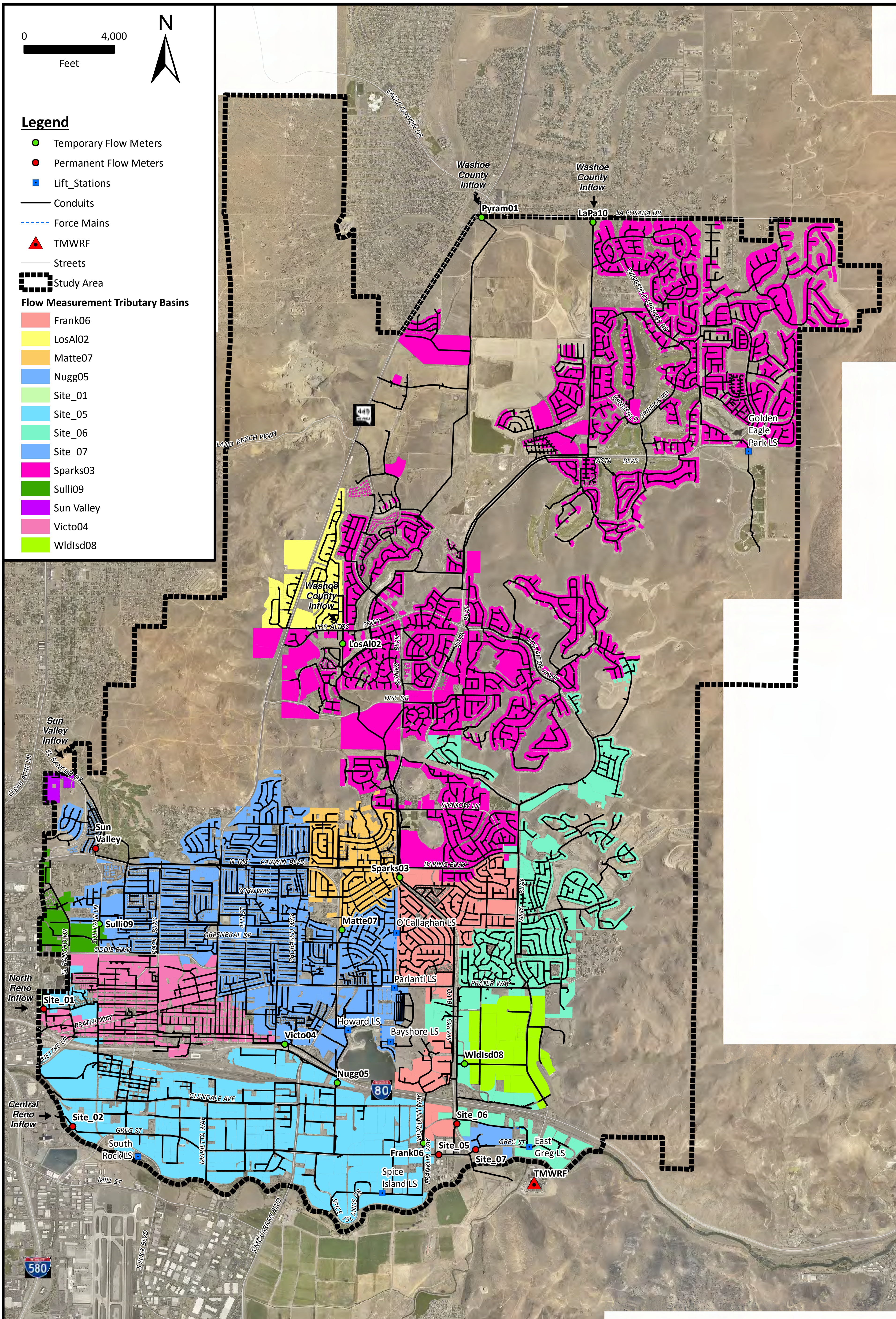
Additionally, a large storm event occurred during the monitoring period on June 30, 2015. This major event covered a significant portion of the City and assisted in evaluating rainfall derived inflow and infiltration (RDII) for the City sewer system and calibrating the model for wet weather events. The wet weather flow analysis and calibration is discussed in **Section 4.5.3** and **Section 4.6.2**, respectively.

3.2. Metered Sewer Basin Descriptions

Meter basins were delineated for all of the installed temporary and permanent flow meters and encompass all of Sparks' existing connected wastewater customers. Wastewater flows generated within each meter basin were estimated from the average flows observed at each meter. In some basins, this required the deduction of flows from upstream meters, which increases the margin of error. For example the Site_05 meter measures flows from permanent meters measuring City of Reno (Site_01 and Site_02 meter basins) and Sun Valley (Sun Valley meter basin) and all the remaining temporary meter basins except for Wldls08. Therefore, the existing average daily flow contributions generated within Site_05 meter basins was approximated at 0.34 mgd by using the following formula:

Site_05 Meter Basin Flow = Site_05 Meter Flow – (Site_01 + Site_02 + Nugg05 + Frank06) Meter Flows

Figure 3-2 displays a flow schematic of the meter basins and flow meters in Sparks' sanitary sewer system, including the nine (9) lift stations located throughout the system. **Table 3-3** summarizes the estimated average flow generated within each metered basin. The metering program is further described in The ADS flow metering report and meter data, included in **Appendix A**.



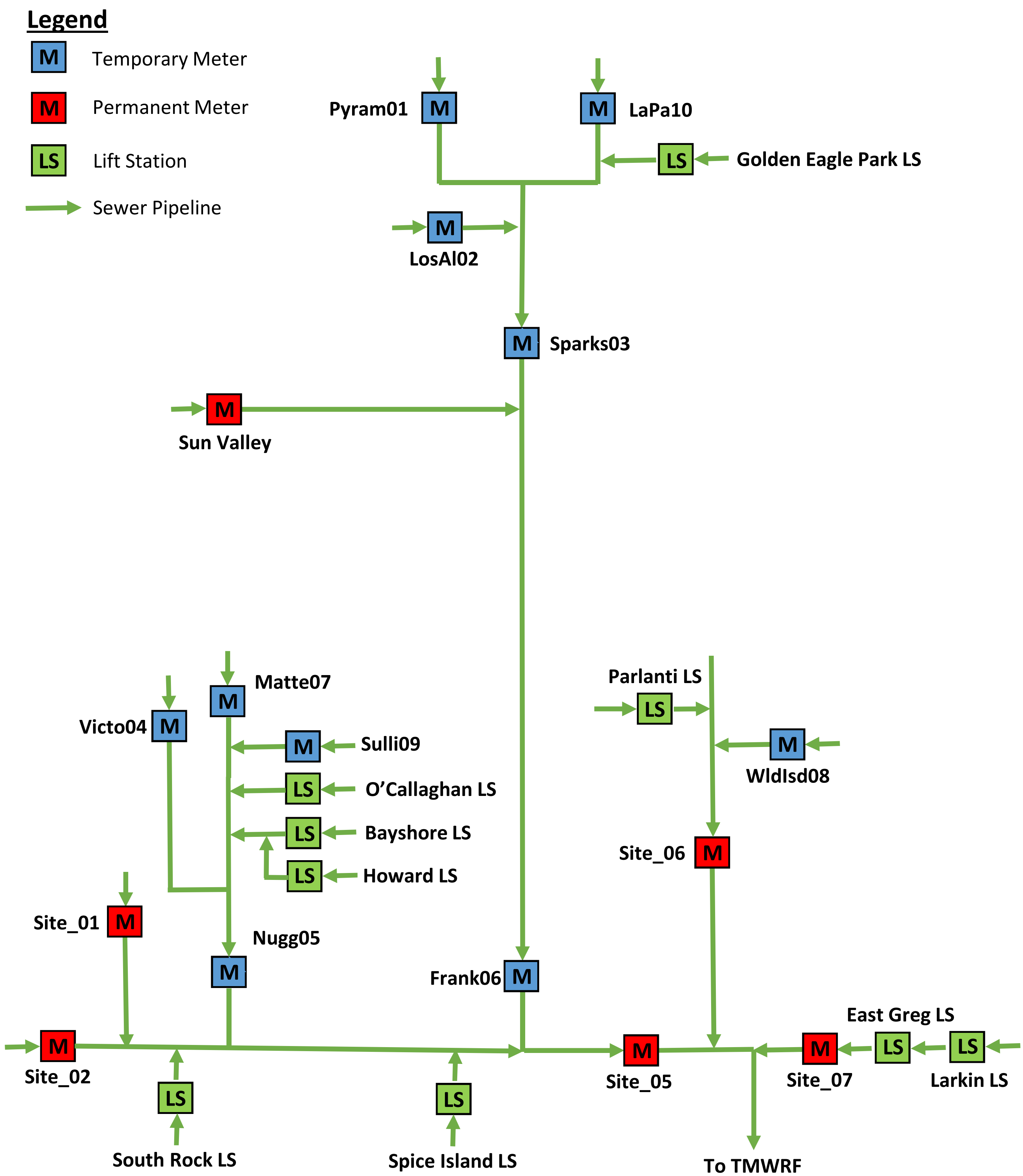
ATKINS

City of Sparks

Sewer Model Update

Flow Meter Locations and Tributary Basins

Figure 3-1



ATKINS

City of Sparks

Sewer Model Update

Flow Metering Schematic

Figure 3-2

Table 3-3 Metered Sewer Flows by Basin

Meter Name	Average Daily Flow (mgd)
Permanent Meter Basins	
Site_01	1.78
Site_02	0.42
Site_05	0.34
Site_06	1.05
Site_07	0.03
Sun Valley	0.94
Temporary Meter Basins	
Pyram01	0.45
LosAl02	0.13
Sparks03	2.61
Victo04	0.94
Nugg05	1.19
Frank06	1.12
Matte07	0.23
WldIsd08	0.11
Sulli09	0.24
LaPa10	0.05

Notes:

- Values shown summarize the estimated average flow generated within each metered basin.
- Permanent and temporary meter data was collected during June 18 to July 1, 2015.
- The data excludes metered data collected during June 30, 2015 due to the influence of wet weather flows. Refer to **Section 4.5.3** and **Section 4.6.2** for details on the wet weather flow analysis and calibration, respectively.

Descriptions of the sewer metering basins and significant observations from the monitoring results are summarized below.

3.2.1. Permanent Flow Meter Basins

The following describes the permanent flow meter basins.

Meter Site_01 Basin

The Site_01 meter is installed within the City sewer manhole (Sparks GIS Facility ID: SSN004979) located near the intersection of G Street and Cygnet Circle at the western portion of study area boundary. This permanent meter monitors incoming flows from the City of Reno contributing to the Reno Sparks Joint Interceptor (G Street to Rock Boulevard). The land use composition of this external meter basin was not analyzed (outside of the City of Sparks jurisdictional limits), however based on the diurnal pattern of the resulting hydrograph, this meter basin appears to be primarily residential with minor influences from non-residential sewage generation.

Meter Site_02 Basin

The Site_02 meter is installed within the City sewer manhole (Sparks GIS Facility ID: SSN005053) located across the Truckee River from the Grand Sierra Resort at the southwestern portion of study area boundary. This permanent meter monitors incoming flows from the City of Reno contributing to the Reno Sparks Joint Interceptor (Greg Street). The land use composition of this external meter basin was not analyzed (outside of the City of Sparks jurisdictional limits), however based on the diurnal pattern of the resulting hydrograph, this meter basin reveals strong influences from non-residential properties due to the significant decrease in sewer flow from the weekday to the weekend.

Meter Site_05 Basin

The Site_05 meter is installed within the City sewer manhole (Sparks GIS Facility ID: SSN005065) located within Greg Street between Franklin Way and Sparks Boulevard. This permanent meter monitors incoming flows from the majority of the City. The sewer flow generated within the Site_05 meter basin is characterized almost entirely by non-residential sewage production, primarily from industrial and office land use.

Meter Site_06 Basin

The Site_06 meter is installed within the City sewer manhole (Sparks GIS Facility ID: SSN005075) located within Sparks Boulevard between Greg Street and Kleppe Lane. This permanent meter monitors incoming flows from the eastern portion of the City and is located downstream of temporary meter Wldlsd08. Over 80% of the wastewater generated within the Site_06 meter basin is estimated to originate from single-family and multi-family residential properties. The remaining flow is primarily generated by the Northern Nevada Medical Center.

Meter Site_07 Basin

The Site_07 meter is installed within the City sewer manhole (Sparks GIS Facility ID: SSN033569) located within Greg Street between Hulda Way and Sparks Boulevard. This permanent meter monitors incoming flows from the south-eastern portion of the City. The wastewater generated within the Site_07 meter basin is produced entirely by non-residential land use, primarily from commercial and industrial land use.

Meter Sun Valley Basin

The Sun Valley meter is installed within the City sewer manhole (Sparks GIS Facility ID: SSN001733) located within Sullivan Lane near the intersection with North McCarran Boulevard. This permanent meter monitors incoming flows from Sun Valley. The wastewater generated within the Sun Valley meter basin is dominated primarily by residential sewage generation.

3.2.2. Temporary Flow Meter Basins

The following describes the temporary flow meter basins.

Meter Pyram01 Basin

The Pyram01 meter was installed within the City sewer manhole (Sparks GIS Facility ID: SSN006253) located near the intersection of Pyramid Highway (SR 445) and La Posada Drive at the northwest boundary of the city service area. This temporary meter monitored incoming flows from the portion of Washoe County contributing to the Northwest Interceptor. The land use composition of this external meter was not analyzed (outside of the City of Sparks jurisdictional limits), however based on the diurnal pattern of the resulting hydrograph, this meter basin appears to be primarily residential due to the presence of two prominent peaks occurring in the morning and evening time.

Meter LosAl02 Basin

The LosAl02 meter was installed within the City sewer manhole (Sparks GIS Facility ID: SSN004748) located approximately 500 feet west of the intersection between Los Altos Parkway and Ion Drive. Similarly to Meter Pyram01, this meter monitored incoming flows from the portion of Washoe County contributing to the Northwest Interceptor at this location. The land use composition of this external meter was not analyzed (outside of the City of Sparks jurisdictional limits), however based on the diurnal pattern of the resulting hydrograph, this meter basin appears to be primarily residential.

Meter Sparks03 Basin

The Sparks03 meter was installed within the City sewer manhole (Sparks GIS Facility ID: SSN035887) located approximately 500 feet south of the intersection between Sparks Boulevard and Baring Boulevard. Located along the Spanish Springs Interceptor, this meter monitored incoming flows from essentially the entire regions of Spanish Springs and northern Sparks prior to entering the central portion of the City. This sewershed consists largely of newer, suburban style single-family residential properties (nearly 90% of the basin sewage production), but also includes commercial properties and schools.

Meter Victo04 Basin

The Victo04 meter was installed within the City sewer manhole (Sparks GIS Facility ID: SSN003570) located along East Victorian Avenue near the intersection with Nichols Boulevard. The metered basin encompasses the older downtown Sparks/Victorian Square area, which consists primarily of hotel/casino (including the Nugget Casino Resort), commercial and residential land use. The metered flow pattern revealed a saw-toothed pattern indicative of lift station influence, presumably a result of the privately maintained lift station on the property of the Nugget Casino Resort.

Meter Nugg05 Basin

The Nugg05 meter was installed within the City sewer manhole (Sparks GIS Facility ID: SSN006250) located near the railroad tracks that can be accessed from East Nugget Avenue. This meter monitored flow prior to entering the industrial region south of the railroad/Interstate 80. This metered basin consists primarily of residential land use (approximately 80%), with a lesser amount of commercial and hotel/casino. Ultimately this meter, along with Frank06 and permanent meters (Site_01, Site_02 and Site_05), helped isolate the large industrial area sewer flows from other land use contributions.

Meter Frank06 Basin

The Frank06 meter was installed within the City sewer manhole (Sparks GIS Facility ID: SSN030256) located within Franklin Way approximately 500 feet north of the intersection with Greg Street. This meter basin consists primarily of residential and commercial (including The Legends at Sparks Marina) land uses. Similarly to Nugg05, this meter monitored flows prior to entering the large industrial region south of the railroad/Interstate 80 and was used to help isolate and determine unit generation rates for the industrial area near the Truckee River.

Meter Matte07 Basin

The Matte07 meter was installed within the City sewer manhole (Sparks GIS Facility ID: SSN003766) located 300 feet north of the intersection of Matteoni Drive and Van Meter Drive. This basin is predominantly older single-family residential (nearly 85%), but also includes a smaller portion of multi-family residential properties. The purpose of this location was to help define unit generation rates specific to single-family properties.

Meter WldIsd08 Basin

The WldIsd08 meter was installed within the City sewer manhole (Sparks GIS Facility ID: SSN019753) located in east Sparks in the Wild Island Family Adventure Park parking lot. The metered basin consists almost entirely of large industrial land use and contributed to estimating wastewater unit generation rates specific to industrial warehouse and manufacturing properties.

Meter Sulli09 Basin

The Sulli09 meter was installed within the City sewer manhole (Sparks GIS Facility ID: SSN002409) located along Sullivan Lane between Capurro Way and Greenbrae Drive. The metered basin consists predominantly of multi-family properties (approximately 70%) and a smaller portion of single family and commercial properties. The purpose of this location was to aid in calibrating unit generation rates specific to multi-family properties. This meter location aided in determining accurate multi-family residential flows necessary to predict impacts from redevelopment efforts within the City.

Meter LaPa10 Basin

The LaPa10 meter was installed within the City sewer manhole (Sparks GIS Facility ID: SSN004937) located on a bike path near La Posada Drive at the north end of the city service area. This meter monitored incoming flows from the portion of Washoe County contributing to the Northeast Interceptor. The land use composition of this external meter was not analyzed (outside of the City of Sparks jurisdictional limits), however based on the diurnal pattern of the resulting hydrograph, this meter basin appears to be primarily residential.

3.3. Wastewater Generation Rates

The purpose of establishing wastewater generation rates is to characterize the existing unit flow allocation by either land use, population, or water use data for use in forecasting future wastewater flows. The existing metered flows were compared with land use data, population estimates, and water use records to develop unit wastewater generation rates. Unit generation rates were determined using multiple data sources for comparison purposes: (1) TMRPA existing and planned land use coverage in combination with City of Sparks' land use/zoning data and discussions with City planning and engineering staff- see **Section 2.2**; (2) block-level scale employment and population data compiled by the United States Census Bureau and supplemented with more current data from TMRPA- see **Section 2.3**; and (3) parcel scale water use records provided by the Truckee Meadows Water Authority (TMWA). The land use based method was the primary approach used for developing wastewater generation rates, however population, employment and water use data were used to supplement, further refine and validate the land use-based wastewater generation analysis. Based on the findings of the unit generation rate analysis, recommended unit rates were established for use in forecasting future wastewater flows. The following describes the datasets and presents the findings of the wastewater generation analysis.

3.3.1. Land Use-Based Wastewater Generation

The purpose of estimating land use based unit generation rates is to establish the amount of wastewater generated in a typical day per land use unit (i.e., acre of land, hotel room, and dwelling unit) by general land use types in order to assist in estimating the amount of wastewater that the study area can expect for the buildout scenario. Land use based unit generation rates were determined by comparing existing land use units per land use type within a metered basin against the average wastewater flows observed at that flow meter and industry standard ranges.

As shown in **Figure 2-2** and discussed in **Section 2.2**, existing land uses include single-family residential, multi-family residential, office, public facility, commercial, hotel/resort, industrial, and institutional. The TMRPA land use GIS database includes parcel acreage and estimates of the number of single-family/multi-family dwelling units and hotel/resort rooms per parcel for the entire study area. Using this database and GIS spatial analysis tools, the number of dwelling units, hotel rooms and acreage per land use type was estimated for each metered basin prior to starting the calibration process.

Table 3-4 describes the average calibrated wastewater unit generation rates categorized by land use and the range of calibrated sewage rates across the metered sewersheds. The calibrated land use-based sewage generation rates analysis per metered basin is included in **Appendix B**. Unit wastewater generation rates were “calibrated” to within ten percent of the recorded flow at each meter. The calibration process is briefly discussed below, however the process and results are further discussed in **Section 4.6**. The iterative process of estimating unit wastewater generation rates for each of the eight (8) developed land use categories started with calibrating modeled flows in metered areas with predominantly one land use type with the metered flow for that basin. The initial wastewater generation rates used in the calibration process originated from industry standard rates typically reported in literature. Once the calibration rates was completed for meters with predominantly one land use, the calibrated generation rates were then used for metered locations with multiple land use categories to calibrate the remainder of the land use generation rates. Through the calibration process, noticeable differences were observed between the residential wastewater rates generated within the urban and suburban regions of the City. The Sparks’ urban core residential units, approximately defined as the region south and west of the McCarran Boulevard loop, typically produced smaller wastewater generation rates per dwelling unit than the suburban residential properties. This variance was primarily attributed to the typically larger homes and higher number of persons per household characteristic of the suburban areas of the City, relative to the urban areas. From a qualitative perspective, the style of living of urban residents perhaps leads to lower water use and subsequent sewer rates than the suburban residents. Due to the differences noted above, urban and suburban residential were considered separate categories and calibrated independently. On average, multi-family residential wastewater generation rates were approximately 65% of the respective single-family residential unit generation rates.

The metered sewersheds were typically dominated by residential land use, therefore residential/employment population data and water use records were used to supplement and refine the land use-based calibrated sewage rates, as discussed in **Section 3.3.2** and **Section 3.3.3**, respectively. The large variations in unit generation rates associated with the office, commercial, industrial and institutional land uses is primarily attributed to the aggregation of land use data into only a few broad land use categories. Additionally, the following summarizes other notable reasons for potential variance in sewage generation rates:

- Industrial sewage rates significantly varied within a metered basin dependant on the type of “industrial” development, such as light manufacturing, heavy manufacturing, and warehouse distribution.
- Office and commercial wastewater generation rates (gpd/acre) were typically greater in the urban core region of the City (i.e. Victorian Square) due to greater employment density. Additionally, the portion of the casino hotels designated as gaming/restaurant/entertainment space were classified as commercial. Therefore, large crowded casinos in the Victorian Square region (i.e., Nugget Casino Resort) drive sewage generation rates higher relative to other commercial properties.
- For institutional properties, large variations were primarily due to the impact of large hospitals on sewage generation rates. The Northern Nevada Medical Center wastewater rates were significantly higher than other properties classified as institutional. This rate was verified with TMWA water use data.

- The urban single- and multi-family wastewater generation rates for one metered basin (Sulli09) differed greatly from the other urban residential rates. After analysis of population density data, this high sewage rate outlier area was attributed to a pocket of particularly high density residential population.

Table 3-4 Calibrated Wastewater Unit Generation Rates (Land Use-Based)

Land Use Category (Land Use Unit)	Metered Basins Wastewater Unit Generation Rates Range	Metered Basins Wastewater Unit Generation Rates Average
Residential Land Use		
Single-Family Residential (gpd/DU)	130 – 200 (Urban) 210 (Suburban)	180
Multi-Family Residential (gpd/DU)	100 – 210 (Urban) 130 (Suburban)	120
Non-Residential Land Use		
Office (gpd/acre)	100 – 1,500	580
Public Facility (gpd/acre)	80 - 450	180
Commercial (gpd/acre)	250 – 3,000	915
Hotel/Resort/Casino Hotels (gpd/room)	70 - 115	105
Industrial (gpd/acre)	80 - 600	385
Institutional (gpd/acre)	200 – 2,500	500

Notes:

- gpd = gallons per day and DU = dwelling unit
- See **Appendix B** for detailed calibration data per metered basin and **Section 4.6** for calibration results

3.3.2. Population-Based Wastewater Generation

The purpose of estimating population-based unit generation rates is to establish the amount of wastewater a typical residential person and non-residential employee generates during an average day in order to assist the City with the future planning and forecasting of wastewater flows within the study area. Per capita unit generation rates were determined by comparing U.S. Census population and employment data within a metered basin against the average wastewater flows observed at that flow meter. The results of this analysis were primarily used to review against industry standard ranges and determine the appropriateness of the land-use based calibration.

TMRPA provided U.S. Census residential and employment population data at the block-level scale for the study area based on 2010 U.S. Census data and updated data from 2014 and 2015. The employment data was categorized into specific industries using the by the North American Industry Codes (NAICs). Therefore the NAICs were assigned the applicable Master Plan categories in order to organize employment data into the correct land use type. Using GIS spatial analysis tools, household and employment population density estimates were determined for the metered basins and the study area. **Table 3-5** summarizes average per capita generation rates for residential and employment populations within the study area. Per capita unit generation rates were calibrated to within 10 percent of the recorded wastewater flows at each meter. Typically, employment per capita rates range from approximately 10 to 60 gallons per capita per day (gpcd) depending on the type of development. For residential properties, per capita rates range from approximately 40 to 90 gallons per capita per day (gpcd) depending on types of water conservations practices utilized and types of water-conserving plumbing fixtures. Overall, Sparks' estimated residential and employment per capita unit generation rates are 65 gpcd and 42 gpcd, respectively.

Table 3-5 Calibrated Wastewater Unit Generation Rates (Population-Based)

Land Use Category	Average Residential Per Capita Generation Rates (gpcd)	Average Employment Per Capita Generation Rates (gpcd)
Residential Land Use (Residential Population)		
Single-Family Residential	69	-
Multi-Family Residential	55	-
Non-Residential Land Use (Employment Population)		
Office	-	33
Public Facility	-	19
Commercial	-	54
Hotel/Resort/Casino Hotels	-	50
Industrial	-	38
Institutional	-	42
Overall	65	42

Notes:

- gpcd = gallons per capita per day
- See **Appendix B** for detailed calibration data per metered basin and **Section 4.6** for calibration results

3.3.3. Water Use Data-Based Wastewater Generation

The purpose of analyzing water use data and comparing to estimated wastewater generation rates is to establish the amount of water usage for a specific land use that returns to the City sewer system. The estimation of return-to-sewer (RTS) ratios serves as another tool to compare to industry standards, validate the calibration process, and assist in forecasting future wastewater generation. Using parcel scale water-metering records for the City provided by TMWA, average water usage per specific land use category was determined. This information was used to determine an estimated sewer return ratio based on the recorded sewer flows in each meter basin. The results of this analysis were primarily used to review against industry standard return-to-sewer ranges and check the appropriateness of the land-use based calibration, particularly for non-residential land uses, and to assist in forecasting future wastewater generation.

TMWA provided records of all City accounts for years 2010 through 2015, however the water use analysis focused primarily on the 2015 data. Due to seasonal climate of the Truckee Meadows and the variability in outdoor water use throughout the year, water usage and RTS ratios significantly vary throughout the year. Although the water use analysis focused on the summer months (June and July of 2015) when the flow metering occurred, winter water metering records were also analyzed. Winter water usage is assumed to only include indoor water use, therefore water rates, in theory, are typically considered to equal wastewater flows. The water use for each metered basin was calculated by selecting the parcels within each basin. Through an iterative process, a return-to-sewer ratio was generated by comparing to the calibrated unit wastewater generation rates. Return-to-sewer ratios, using TMWA water metering records, were calibrated to within 10 percent of the observed sewer flows at each meter. **Table 3-6** presents the results of the return-to-sewer ratio calibration. As shown in the results, nearly 50% of the water use for single-family residential properties was allocated for outdoor water use. This is typical of regions that experience high temperatures in the summer months. For the non-residential land uses, industrial properties produced the highest RTS ratios. This is common due to the relatively low outdoor water usage and high density of paved areas associated with industrial parcels. Overall, Sparks' estimated return-to-sewer ratios for residential and non-residential land uses are approximately 50% and 85%, respectively.

Table 3-6 Calibrated Return-To-Sewer Ratios

Land Use Category (Land Use Unit)	Average Summer (June) Unit Water Demand	Average Unit Wastewater Generation	Return-To-Sewer Ratio
Residential Land Use			
Single-Family Residential (gpd/DU)	395	180	45%
Multi-Family Residential (gpd/DU)	145	120	80%
Overall Residential (gpd/DU)	310	160	50%
Non-Residential Land Use			
Office (gpd/acre)	785	580	75%
Public Facility (gpd/acre)	280	180	65%
Commercial (gpd/acre)	1,070	915	85%
Hotel/Resort/Casino Hotels (gpd/room)	130	105	80%
Industrial (gpd/acre)	395	385	95%
Institutional (gpd/acre)	770	500	65%
Overall Non-Residential (gpd/acre)	640	535	85%

Notes:

- gpd = gallons per day and DU = dwelling unit
- Return-to-sewer (RTS) ratios reported are reflective of summer ratios. Winter water usage generally match wastewater generation rates, therefore RTS ratios differ greatly from the summer RTS ratios.
- Overall non-residential statistics exclude hotel/resort/casino hotels lad use category due to difference in land use units (gpd/acre versus gpd/room).
- See **Appendix B** for detailed calibration data per metered basin and **Section 4.6** for calibration results

3.3.4. Recommended Future Unit Wastewater Generation Rates

Based on the unit wastewater generation rates analyzed and developed as part of **Section 3**, uniform land use- and population-based unit wastewater generation rates were recommended for use in future planning and forecasting of wastewater flows. For the existing system capacity analysis, the calibrated unit generation rates presented in **Table 3-4** were used. **Table 3-7** presents the recommended unit generation rates for estimating future flows within the study area. Although all unit wastewater generation rate methods (land use, population and return-to-sewer based) accurately characterize wastewater production, the calibrated land use-based sewage rates are recommended for future forecasting and were used for model loading and capacity analysis, as discussed in **Section 4.5**. The remaining calibrated population-based rates and return-to-sewer ratios presented in **Section 3** represent additional valuable forecasting tools available to the City staff. The calibrated and recommended future wastewater generation rates are within acceptable industry standards.

In developing the recommended sewage rates for future developments, typically the average calibrated values (presented in **Table 3-4**) for each land use category were used. However, based on review of TMWA water use records, certain properties used significant amounts of water, relative to other properties in the same land use class. Assumingly, this excessive water use subsequently contributed substantial amounts of flow to the sewer system, resulting in skewed unit rates for the corresponding land use category. For example, the gaming/restaurant space of the Nugget Casino Resort heavily skewed commercial wastewater generation rates higher, although this type of use is not representative of typical commercial properties throughout the

City. Per direction of City staff, these outliers were eliminated from the dataset and modified rates were calculated for use in determining future sewage rates. The statistical approach for removing the outlier properties was as follows:

- Reviewed a normal distribution on the TMWA water use data per land use.
- Removed data greater than 3 standard deviations from the mean (essentially the top 0.1% of the data set). Typically this approach only removed 2-3 parcels from a dataset for each land use category.
- Recalculated unit generation rate using the average of the modified data set and multiplying by the calibrated return-to-sewer ratios listed in **Table 3-6 f**or the applicable land use category.

This procedure only resulted in altered unit rates for the commercial and office land uses. These recommended unit generation rates are intended to serve as a guide for estimating sewer flows from potential future development projects.

Table 3-7 Recommended Unit Generation Rates

Land Use / Population (Unit)	Wastewater Unit Generation Rates [1]
Land Use	
Single-Family Residential (gpd/DU)	135 (Urban) 210 (Suburban)
Multi-Family Residential (gpd/DU)	110 (Urban) 130 (Suburban)
Office (gpd/acre)	405
Public Facility (gpd/acre)	180
Commercial (gpd/acre)	660
Hotel/Resort/Casino Hotels [2] (gpd/room)	105
Industrial (gpd/acre)	385
Institutional (gpd/acre)	500
Population	
Residential (gpcd)	65
Employment (gpcd)	42

Notes:

- gpd = gallons per day, DU = dwelling unit and gpcd = gallons per capita per day

1 These rates represent typical or average wastewater generation for each land use category. Adjustments to these rates may be necessary to accurately represent rates for atypical developments or land uses. **Table 3-4** summarizes the range of calibrated wastewater generation rates across the study area.

2 Total flow from a hotel casino are calculated based on using a commercial unit wastewater generation rate for the gaming/restaurant/commercial area of the casino and a hotel unit wastewater generation rate for each room.

In the Marina Gateway region, a proposed hotel casino was included in the buildout scenario. There was no data available in the TMRPA land use GIS database for the projected number of hotel rooms, so an area based rate was used to estimate wastewater generation from this parcel. The parcel was assumed to consist of 50% commercial space (gaming/restaurants) and 50% hotel space. For the hotel space portion, the estimated 105 gpd/room unit generation rate was converted to an area based rate of 8.300 gpd/acre based on the parcel areas for hotel casinos in the existing database. Additionally, for the future hospital proposed at the corner of Sparks Boulevard and Pyramid Way, existing TMWA water use data from the Northern Nevada Medical Center was used to project an estimated wastewater generation for this future property. The recommended average unit rate, listed in **Table 3-7**, was not used for this property because a hospital represents an atypical property within the institutional land use. Using the existing hospital water use and assumptions on return-to-sewer ratios for institutional type properties, an area based rate of 3.500 gpd/acre was used to estimate wastewater generation from this parcel.

3.4. Wastewater Flow Projections

Table 3-8 summaries the study area and Sparks estimated future flows for the buildout scenario. These flow projections were determined by applying the recommended land use-based wastewater generation rates to the planned future developments. The buildout sewer model also considered future flows from other jurisdictions (City of Reno, Washoe County, Sun Valley) entering the Sparks sewer system. This information on flow projections from outside agencies is summarized in **Section 4.5.1**.

Table 3-8 Study Area Wastewater Flow Projections

Jurisdiction	Estimated Wastewater Generation (mgd)	
	Existing	Buildout
City of Sparks	7.86	11.96
Unincorporated Washoe County	0.25	0.47
Study Area	8.11	12.43

3.5. Conclusions

Existing average wastewater flows generated with Sparks are approximately 7.86 mgd and anticipated to increase to 11.96 mgd in the buildout scenario. As discussed in **Section 2.5**, Sparks is allocated 14.58 mgd of the TMWRF treatment capacity. The City leases approximately 2.10 mgd and 2.29 mgd of their allotted capacity to Sun Valley GID and unincorporated Washoe County, respectively. When subtracting the 4.39 mgd of capacity leases from the currently allocated treatment capacity share, the City has 10.19 mgd remaining in treatment capacity to accommodate existing and future flows. Under this scenario, the City is expected to exceed their designated treatment capacity by approximately 1.77 mgd in the buildout condition. According to the TMRPA growth model, approximately 50% of the buildout development within the City is expected to occur over the next 20 years. Based on these projections, the City staff estimates that the City wastewater generation will still fall within the available allocated capacity over the next 20 years and exceedance of the designated capacity is not anticipated to occur until 2036 and beyond.

The previous 2005 master plan projected City of Sparks' average daily flows to increase to 18.96 mgd by 2030, which is significantly higher than the 12.43 mgd projected in this Master Plan for the buildout scenario. This difference is likely due to the significant variance in residential sewage rates used in both master plans. The previous master plan used average wastewater flows for residential properties of 115 gpcd, which is nearly double the estimated 65 gpcd for current residential land use used in this Master Plan. The newly calibrated wastewater unit rates shown in **Table 3-7** reflect the lower overall sewage flows observed by City staff over the last 10 years as shown in **Figure 2-8**, despite the increase in population and development over this same duration. Potential reasons for the decline in sewer flows are discussed in **Section 2.6**.

4. Capacity Evaluation

This chapter provides a description of the wastewater generation including:

- Evaluation criteria
- Model selection and development
- Dry and wet weather model calibration
- Capacity analysis

4.1. Background

A capacity evaluation of Sparks' existing sanitary sewer system was completed to identify sewer pipelines and lift stations that may be deficient under recommended design criteria and to identify any upgrades needed to accommodate existing and projected dry and wet weather wastewater flows. Based on the results of the capacity evaluation, facility improvements were identified to reduce the potential for sanitary sewer overflows, as well as to allow for projected growth within the study area.

4.2. Methodology

The principal tool utilized in the capacity analysis was a dynamic hydraulic computer sewer model. The hydraulic model simulates flow conditions, such as wastewater flow depth, flow rate, and velocity within pipes, manholes and lift stations in Sparks' sanitary sewer system. The model selected for this Master Plan is InfoSWMM (Innovyze, Version 13.0, Update #7), which is associated with a class of models referred to as dynamic wave models. These models provide a reasonable representation of hydraulic flow conditions over an extended period of time.

The model was developed using the physical collection system data, flow monitoring results, existing and forecasted residential and employment populations, historical water use data, diurnal patterns and rainfall events. The model was then calibrated to flow metering records for dry (weekday and weekend) and wet weather conditions. Once calibrated, the model was utilized to evaluate system optimization opportunities and assess the existing collection system under existing and projected peak flow conditions to identify potential recommended improvements to the existing collection system. The model is the primary tool for identifying capacity deficiencies in the gravity system.

4.3. Flow Monitoring

As noted in **Section 3.1**, sewer flows were monitored during the summer months (June and July), which typically correspond to the higher wastewater generation period of the year as shown in **Figure 2-9**. As previously discussed, six (6) permanent meters were evaluated along with ten (10) temporary meters that were installed for a 14-day period to evaluate flows within the study area. The meters continuously recorded flow, velocity and depth during the flow monitoring period from June 18 to July 1, 2015. This flow monitoring information was used to develop initial diurnal patterns and calibrate the existing dry weather hydraulic model scenario. During the monitoring period, a significant storm event occurred across the City on June 30, 2015. This storm event was used to calibrate the existing wet weather hydraulic model scenario and to determine the amount of rainfall induced inflow and infiltration.

4.4. Model Development

The InfoSWMM model was developed to reasonably represent the existing and projected flow conditions within the City wastewater collection system. The hydraulic model serves as the primary planning tool for the sewer capacity analysis and provides a reasonable representation of actual flow conditions within a sanitary sewer system in response to existing and future sewage loading. The accuracy of the simulation is directly related to the accuracy of the model input data, including the physical parameters and sewage loading projections.

The model was developed based on specific physical collection system data and consists of several individual components (i.e. gravity mains, force mains, lift stations, etc.) that collectively form the overall collection system. Each component contains specific roles and properties within the hydraulic model and represents an integral part of the actual and simulated physical collection system. The following details the procedures used to develop the hydraulic model, the application of sewage loading factors and rainfall events, and the significant model components incorporated into the model.

4.4.1. Data Collection and Plan Research

Data collection consisted of obtaining the latest GIS information from the City of Sparks Geographic Technologies (GT) office, researching available construction plans, performing field visits, and obtaining survey as needed. Necessary field visits to confirm the GIS sewer connectivity and manhole locations were completed. In coordination with the City, discrepancies were identified and corrected as necessary in order to update the database to more accurately represent the existing sewer infrastructure.

Four primary sources of the data were used during the review of the City's GIS database: design plans, the City's video database, field investigations, and survey data. The City's database of sewer videos and PDF plan sets were investigated to help determine sewer connectivity, pipe diameter, material, installation year, and lift station information. The plan sets occasionally did not match field conditions, suggesting that field modifications were made at the time of construction or post construction. Field investigations were performed at many locations to rectify sewer line size discrepancies between manholes, verify sewer pipe material, and verify sewer connectivity. In determining sewer information, data was considered from multiple sources. Generally, survey data and field investigations were the most reliable and accurate, the current video database was useful for general determinations, and design plans were used when no other information was available. Based on discussions with and approval by the City, vertical elevation information from as-built construction plans was used to populate attributes for a number of manholes throughout the City. Interpolation of invert and rim elevations for modeling purposes was used on a limited basis and focused primarily on regions inaccessible to survey or field visits (i.e. backyards).

The City GIS sewer manhole data is coded into six (6) categories based on the completeness/accuracy of the horizontal and vertical information present in the GIS database: green (all information present), yellow (location information present), red (best guess information), orange (feature located, cannot be raised), blue (feature located, needs to be raised), and pink (unable to locate feature after field visit). Prior to the start of the project, nearly 80% of the manholes in the City sewer database were coded as green, therefore survey efforts were relatively minimal in relation to the magnitude of the overall system. Survey efforts focused on the yellow and red coded GIS manhole locations with the intent to convert all of the critical data (data required to the construct the hydraulic model) to the green standard. Green coded survey data was reviewed and spot checked in areas that appeared incorrect or inconsistent. Rim elevations were surveyed and levelled before the manholes were dipped and sewer pipe sizes measured. Generally, the rim elevations surveyed as a part of this project matched the rim elevations associated with the existing yellow GIS data. A Pipe-Mic (survey rod extension) was used to accurately assess inverts. Overall, Atkins surveyed approximately 350 manholes, converted nearly 500 manholes from yellow coded to green coded, and identified/updated greater than 1,000 pipe diameters and/or pipe materials in the GIS database.

One moderate limitation of the City GIS database format is that upstream and downstream sewer elevations are not included in the attributes of the sewer gravity pipeline layer (polyline feature). Instead, invert elevations are represented at each manhole (point feature) with two invert elevations- a high pipe elevation and an invert elevation. The high pipe elevation field is typically left unpopulated or only used in extreme drop manholes where the elevation difference between the two pipes is significantly different. Therefore, in most instances, the invert elevation of the pipe(s) connecting to a manhole is assumed to be equal to the invert elevation of the manhole itself. Generally, this limitation was assumed to be inconsequential to the hydraulic modeling, as most of the City's sewer system contains relatively flat slopes. However, in instances where a mainline connects into a major interceptor without a vertical offset represented in the GIS database, the mainline is often flagged in the model as violating depth over diameter (d/D) criteria due to the artificially submerged representation of the pipeline in the model. In these scenarios, d/D violations were disregarded and formal CIPs were not developed for these occurrences, as discussed in **Section 4.8.2**.

4.4.2. Model Density

The desired model density was discussed with City staff early in the master planning process. The City preferred higher density modeling within the urban core and lower density modeling in northern Sparks. Overall, the model consisted of approximately 5,000 manholes and conduits with the following model density limits:

- Inside the Sparks urban core (region generally south and west of the McCarran Boulevard Loop)- modeled 8-inch diameter and larger pipelines.

- Outside the Sparks urban core (region generally north and east of the McCarran Boulevard Loop)- modeled 12-inch diameter and larger pipelines. An 8-inch split flow system (along Vista Boulevard, La Certa Drive and Hubble Drive in northeast Sparks) was incorporated into the model per the request of the City. Additionally, the City requested Atkins to expand the model to include 8- and 10-inch pipe segments near Pyramid Way which may potentially convey flows from west of Pyramid Way in the future.

4.4.3. Model Overview and System Features

The InfoSWMM model is constructed of junctions, conduits, storage units, outfalls, pumps and weirs. The following briefly describes the overall model and the individual components of the InfoSWMM hydraulic model utilized for this Master Plan. The complete list of attributes associated with each of the model features is included in **Appendix C**.

Junctions

Junctions represent the endpoints of every pipe segment in the modeled system. In a wastewater collection system, junctions typically represent manholes and contain the following key input parameters:

- Elevation information- Rim and invert elevation information was obtained from a variety of sources including: City GIS database, as-built construction plans and survey, as discussed in **Section 4.4.1**.
- Inflow data- Wastewater flows are applied and introduced into the modeled collection system at junctions. Model loading is discussed in **Section 4.5**.

Conduits (Gravity Mains, Siphons and Force Mains)

Conduits represent the conveyance element of the modeled system that transfer flow from junction to junction. In a wastewater collection system, conduits represent gravity pipes, siphons and force mains and contain the following significant input parameters:

- Pipe geometry and roughness information- Pipe length, material, cross-sectional geometry, entrance/exit losses and roughness (Manning's for gravity mains and Hazen Williams' C for pressurized systems) are required attributes in the model conduits. Pipe material and size was obtained from a variety of sources including: City GIS and CCTV video database, as-built construction plans, and survey, as discussed in **Section 4.4.1**. Typical Manning's n values (0.012 for PVC, 0.015 for RCP) and Hazen Williams' C values (C=130) were used to model existing sewers.
- Pipe connectivity- Upstream and downstream manhole identification numbers are required to inform the model of flow direction and pipe connectivity.

The dynamic InfoSWMM model allows for multiple outlet pipes from each junction, therefore effectively simulating flow splitting structures. The City system contains numerous flow combining/splitting structures, ten (10) of which were represented in the hydraulic model. The GIS database and as-built plans were used as sources of data to accurately model the flow splits. Many of the flow splitting/combining structures are located along the Northwest, Northeast and Spanish Springs Interceptors.

Only one force main was included in the hydraulic model, the Bayshore Drive (Marina Village) lift station and force main. The data required for this force main (size, material and length) was obtained from the City GIS database and from review of the *Marina Village Lift Station* design plans and report. The lift stations included in the model and selected for detailed modeling are discussed in the **Pumps** section below.

The wastewater system contains a triple-barrel (one 24-inch diameter barrel and two 48-inch diameter barrels) inverted siphon located underneath the Truckee River. Model inputs for the Truckee River siphon were acquired from the *Reno-Sparks Joint Sewerage System (Intercepting Sewer- Project No. 1)* as-built design plans from 1963. Prior to 1988 there were two (2) siphons within the City sewer system: one underneath the Truckee River and one underneath Interstate-80 along the Sparks Boulevard Interceptor. Based on as-built plan research and review of the City video database, the Sparks Boulevard siphon appeared to be replaced with jack and bore construction (Sparks GIS Facility ID: SSL000275) per the *Interstate-80 Sparks Boulevard (NDOT Contact 2260)* design plans from 1988. This abandonment of the old siphon structure was confirmed by survey and CCTV video review, which showed unsubmerged pipes at this location. Therefore, only one (1) siphon, the Truckee River siphon, was included in the hydraulic model.

Pumps

Pumps represent a conveyance component intended to lift flow to higher elevations and are a common feature in wastewater systems. InfoSWMM allows users to model pumps as "ideal" or "non-ideal". Ideal transfer pumps simply pump the entire flow entering the upstream junction, therefore no detailed pump information (i.e. pump curve) is required. Non-ideal pumps require detailed information and convey flow and head based on a manually entered pump curve. The hydraulic model included the following five (5) lift stations, only one of which was modeled in detail as a non-ideal pump:

- O'Callaghan Drive Lift Station (Ideal Pump)
- Spice Island Drive Lift Station (Ideal Pump)
- East Greg Street Lift Station (Ideal Pump)
- Larkin Circle Lift Station (Ideal Pump)
- Bayshore Drive (Marina Village) Lift Station (Non-Ideal Pump)

The Bayshore Drive (Marina Village) lift station was modeled in detail because there is a significant portion of undeveloped area upstream of the lift station, therefore the City was interested in the performance of this facility under buildout flow scenarios. The lift station modeled as ideal pumps were generally much smaller pump stations and were located in fully developed sewersheds, therefore these stations were not nearly as critical as the Bayshore Drive (Marina Village) lift station.

InfoSWMM non-ideal pumps require the following key input parameters:

- Pump curve and on/off control information- This information (head-discharge curve) and on/off status data for the Bayshore Drive (Marina Village) lift station was obtained from the *Marina Village Lift Station* design plans and report and included in **Appendix C**.

Storage Units (Wet Wells)

Storage units represent a specific junction type intended to serve as a storage point for the collection system. In a wastewater collection system, storage units typically represent wet wells for lift stations and contain the following significant input parameters in addition to the standard parameters identified in the **Junction** section:

- Storage curve- This information (storage curve) data for the Bayshore Drive (Marina Village) lift station wet well was obtained from the *Marina Village Lift Station* design plans and report. The overall storage volume was estimated at 8,200 gallons based on wet well plan dimensions.

Outfalls

The outfall is a specific node type which serves as the end of a wastewater collection basin. All flow in a basin must exit the system at an outfall in the modeling software. For the Sparks hydraulic model, the outfall is a manhole (Sparks GIS Facility ID: SSN004551) located approximately 500 feet upstream of the TMWRF, as this is the last downstream node included in the City GIS database. However, for all practical purposes the model outfall is interchangeably referred to as the TMRWF.

Weirs

The weir is a specific conduit type which represents traverse flow or weir flow from one junction to another. For the Sparks hydraulic model, the weir was used to represent the weir flow experienced between the triple barrels at the upstream structure of the Truckee River siphon. Model inputs for the Truckee River siphon weirs were acquired from the *Reno-Sparks Joint Sewerage System (Intercepting Sewer- Project No. 1)* plans.

4.5. Model Loading

The model incorporates wastewater flows by assigning loads to individual junctions. The model applies these assigned loads and the various optional loading characteristics to the junctions and simulates flow through the collection system. The modeling software allows for multiple types of loading including:

- External or direct inflows
- Dry weather inflows
- Rainfall derived inflow and infiltration (RDI&I)

External or direct inflows are user-defined, time series of inflows added directly to a junction. Dry weather inflows consist of continuous inflows that typically reflect the contribution from sanitary sewage in sewer systems or base flows in pipes. Wet weather flows, in particular rainfall derived inflow and infiltration (RDI&I), signify flow volumes produced from rainfall events which often test the upper limits of the system's hydraulic capacity. Direct flows and dry weather flows represent the critical loading sources and form the initial base flows in the hydraulic model. To load the model, an average wastewater load was determined for each parcel based on the wastewater generation analysis described in **Section 3**. In addition to an estimated wastewater load, each parcel in the land use database is assigned a tributary manhole to which the loads are applied in the hydraulic model. For the City of Sparks land use database, approximately 36,000 parcels were assigned flows and inflow manholes. The majority of these designations were performed manually, however InfoSWMM contains multiple analysis methods that automate this process using advanced spatial analysis tools. Once tributary manholes were applied to the parcel database, an InfoSWMM tool was used to import the applied loads into the modeling software from the GIS shapefiles in which the data was stored. This load allocation tool summarizes loads by land use type and imports the estimated load to the appropriate model junction.

The following sections further describe the process of loading the hydraulic model with the three inflow sources.

4.5.1. External Flows

External or direct inflow hydrographs were inputted into the model at specific locations to document incoming flows from outside jurisdictions (City of Reno, Washoe County, and Sun Valley) entering the Sparks sewer system. As discussed in **Section 3.1** and shown in **Figure 3-1**, these external inflows were metered with both temporary and permanent flow meters. For the existing condition model, the resultant dry weather weekday and weekend metered hydrographs were directly inputted into the hydraulic model at the corresponding manhole location. The buildout sewer model also considered future flows from these external jurisdictions entering the Sparks sewer system. The estimated buildout flow data was gathered from referencing capacity agreements between agencies, discussions with City of Reno and Washoe County staff, and previous and current master plans for these regions. **Table 4-1** summaries the estimated future average daily flows for the buildout scenario from the City of Reno, Washoe County and Sun Valley and the corresponding meter name and Sparks GIS facility number where the flow enters the system.

Table 4-1 External Wastewater Flow Projections

Meter Name (Sparks GIS Manhole Facility ID)	Jurisdiction	Estimated Wastewater Generation (mgd)	
		Existing	Buildout
Site_01 (SSN004979)	City of Reno	1.78	7.90
Site_02 (SSN005053)	City of Reno	0.42	2.50
Sun Valley (SSN001733)	Sun Valley	0.94	2.10
Pyram01 (SSN006253)	Washoe County	0.45	1.76
LosAl02 (SSN004748)	Washoe County	0.13	0.15
LaPa10 (SSN004937)	Washoe County	0.05	0.23
Total External Inflows		3.77	14.61

The following generally discusses the information gathered from each agency and the basic approach and assumptions used to estimate future flows.

City of Reno

City of Reno future buildout flows were discussed with the City of Reno sewer engineering staff. The guidance for future buildout flows at Site_01 and Site_02 meters was based on information provide in the *2013 Central & South Reno Sanitary Sewer Interceptor Capacity Analysis* and the *2006 North Virginia Street/Reno-Sparks Sanitary Sewer Interceptor Master Plan* report, respectively.

Washoe County

Washoe County future buildout inflows entering the Northwest Interceptor at Pyram01 meter and Northeast Interceptor at LaPa10 meter were discussed with Washoe County engineering staff and their respective engineering consultant. The buildout flows for both the Northwest and Northeast Interceptors assumes full buildout, as well as full conversion of Spanish Springs septic systems (completion of all nine planed phases) to Washoe County/Sparks sewer. Although Washoe County stated that the probability of full execution of the septic conversion project is relatively low, full completion was assumed to provide higher and more conservative planning flows in the hydraulic model. The buildout scenario estimates 1.99 mgd of wastewater from Spanish Springs contributing to the Northwest and Northeast Interceptors. This estimate is less than the

2.29 mgd (8.495 EDUs at 270 gpd/EDU) of capacity reserved for Washoe County in City sewer interceptors and at TMWRF under the current agreement between the City of Sparks and Washoe County.

Sun Valley

For Sun Valley buildout flows, the City of Sparks staff directed this Master Plan to assume that buildout flows equal the currently designated leased capacity of 2.10 mgd.

4.5.2. Dry Weather Flows

Dry weather inflows consist of the intentional, repeatable discharges into the collection system originating from a variety of residential and non-residential land use sources. These flows represent an average inflow rate that is periodically adjusted on a monthly, daily, and hourly basis by applying time pattern multipliers to the average inflow rate. A critical element of successful model loading and calibration is the application of these time period patterns, also referred to as diurnals. The development of multiple diurnal patterns is necessary to accurately reflect the varying types of sewer discharge patterns generated by different land use types. For instance, residential users typically discharge peak daily sewage during the early morning and early evening hours, while employment users typically discharge peak daily sewage in the middle of the day (generally following a bell curve). InfoSWMM has the capability to apply hourly, daily, weekly and monthly time patterns to dry weather flow inputs, which improves accuracy on extended period simulations and calibration. Once the average daily flow is established based on the month and day of the week of the simulation, an hourly pattern is applied based on the time step of the simulation. Finally, based on whether the day of the week of the simulation is a weekend, the hourly pattern is further modified by a weekend pattern to reflect the differences between weekly and weekend discharge patterns. **Figure 4-1** depicts the process of applying the several time period patterns available in InfoSWMM. For this Master Plan, hourly, daily and weekly time patterns were developed for each land use type based on the results of the flow monitoring. The calibrated land use-based weekday and weekend hourly diurnal patterns developed for this Master Plan are included in **Appendix B**. Additionally, information related to parcel-scale model loading in InfoSWMM using GIS attributes is also documented in **Appendix B**.

Figure 4-1 InfoSWMM Compounding Time Period Pattern Application

During dry weather events, groundwater infiltration is also a common source of constant inflow into the sewer system. The depth to groundwater table was reviewed across the City using data from the *National Resources Conservation Service (NRCS) Soil Survey*. The water table is generally greater than 8 feet deep (deeper than the majority of sewer lines) for the majority of the City, except for regions within the valley of Northern Sparks, near the Sparks Marina and within the industrial area near the Truckee River. Additionally, during the summer months (time of flow monitoring), the groundwater table is assumed to reach the lowest levels of the year and not significantly influence base dry weather flows. Therefore, dry weather groundwater influence was not analyzed as a part of this Master Plan. Any minor groundwater inflow experienced by the system is accounted for in the dry weather base flows.

4.5.3. Rainfall Derived Infiltration and Inflow

Rainfall derived inflow and infiltration (RDI&I) is the combination of wet weather infiltration and direct inflow that establishes the maximum required hydraulic capacity of the sanitary sewer system. Rainfall infiltration is water that enters the sanitary sewer system underground through holes, cracks and leaky joints in pipelines and manholes as a result of rainfall percolation and temporary rising of groundwater levels. While the amount of infiltration from rainfall events can be estimated from an evaluation of flow data and rainfall records, infiltration that occurs year-round in areas of high groundwater is typically only detected from pipeline video inspections or manhole inspections. This detection and analyses of groundwater infiltration was not included as part of this Master Plan. Rainfall inflow also refers to surface storm water that enters the collection system at manholes or from illicit connections to the sanitary sewer system, such as roof and yard drains and surface flows from parking lots. The primary characteristics of inflow are the rapid response to the onset and cessation of rainfall. The rate of inflow depends on the amount and intensity of a specific rainfall event and also previous rainfall events, which affect ground water saturation levels and the amount of surface runoff. The rainfall events reviewed, analyzed and used for the wet weather calibration process are discussed in the **Calibration Rainfall Event** section below. The RTK hydrograph method used for the wet weather calibration process is summarized in **RTK Hydrograph Method** section below.

Calibration Rainfall Event

During the temporary flow monitoring period, a significant storm event occurred across the City on June 30, 2015. This storm event generated a significant wet weather response in the sewer system at multiple metering locations and was selected for use in calibrating the wet weather model scenario. Level III NEXRAD (Next-Generation Radar) rainfall radar data, obtained from NOAA's National Climatic Data Center for the KRGX site in Reno, was analyzed for the rainfall event to more accurately determine the spatial distribution of rainfall depths throughout the City and metered sewer basins. The distribution of the 6/30/2015 rainfall depths throughout the City in NEXRAD grids, as well as storm depths obtained from various Weather Underground, Truckee River Flood Management Authority (TRFMA) and City of Sparks monitored gages are shown in **Figure 4-2**.

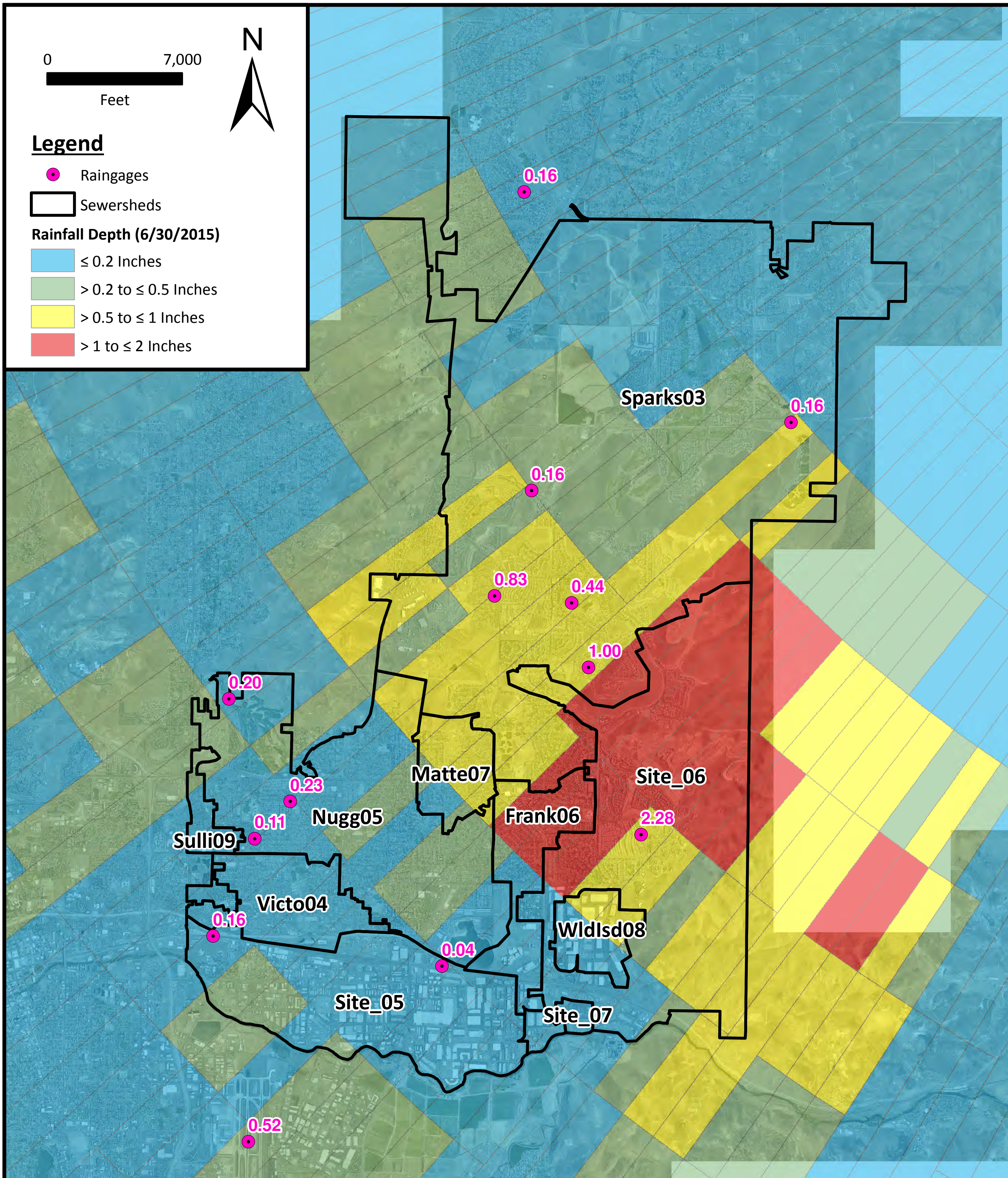
The NEXRAD data was used to determine the final 6/30/2015 precipitation depths. NEXRAD aerially weighted averages were determined for each metered basin and distributed based on the storm pattern recorded at the D' Andrea gage which reported a 2.28 inch storm total. The observed storm pattern at the D' Andrea gage is included in **Appendix E**. The weighted 6/30/2015 precipitation depths estimated for each metered basin are summarized in **Table 4-2.**

Table 4-2 June 30, 2015 Storm Totals by Basin

Meter Name	6/30/2015 Storm Total (inches)
Site_05	0.13
Site_06	1.17
Site_07	0.10
Sparks03	0.46
Victo04	0.15
Nugg05	0.22
Frank06	0.87
Matte07	0.66
Wldlsd08	0.39
Sulli09	0.12

These estimated rainfall depths in each metered basin were compared to multiple rainfall intensity-duration-frequency (IDF) curve constructed from typical design storms in the Sparks and the Truckee Meadows. As shown on the **Figure 4-3**, the rainfall event ranged from less than a 1-year event across the Site_07 sewershed to greater than a 100-year event over the Site_06 sewershed. On average across the City, the 6/30/2015 storm generated 0.44-inches of rainfall, which is approximately a 5-year event. The majority of sewer hydraulic models are used to predict peak wet weather flows from a large design storm, therefore also using large events (equivalent to 2-year design storm events) to calibrate wet weather parameters is ideal. The 6/30/2015 storm event is considered suitable for use in wet weather calibration.

Using the 6/30/2015 storm, RDI&I flows into the system are modeled by applying RTK parameters to the rainfall event. These parameters were refined during the wet weather model calibration to better simulate the observed peaking of the sewage flows. The RTK Hydrograph Method for parameterizing RDI&I is discussed below. The wet weather calibration process is discussed in **Section 4.6.2.**



ATKINS

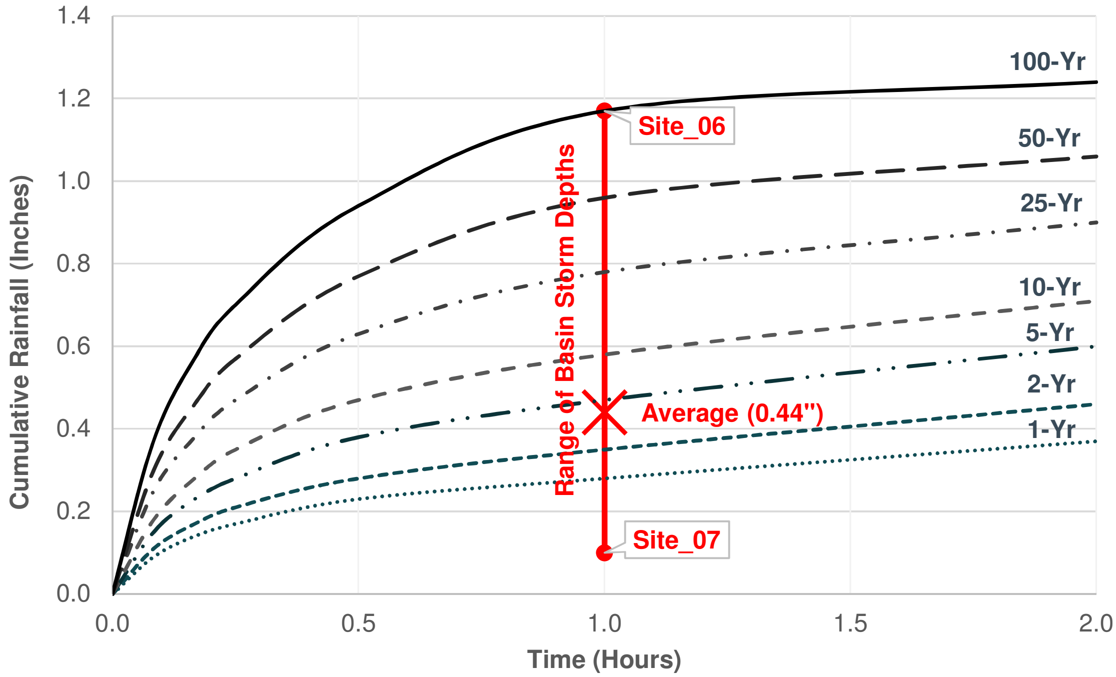
City of Sparks

Sewer Model Update

June 30, 2015 Precipitation Map

Figure 4-2

Figure 4-3 June 30, 2015 Rainfall IDF Curve



RTK Hydrograph Method

The RTK method uses sewer flow monitoring data and rainfall data to generate triangular hydrographs that represent amount of RDI&I from a specific metered basin. This method uses three parameters: R, T and K to define the shape of the RDI&I hydrograph and the resulting RDI&I volume for each metered basin. The R, T, and K parameters are defined as follows:

- R- Fraction of rainfall across the watershed that enters the sanitary sewer system. Typically, the total R value for sanitary sewer systems range from 0.02 to 0.04. Newer sewer systems in good condition exhibit R values of less than 0.01.
- T- Time to peak.
- K- Ratio of the time to recession to the time to peak.

The wet weather response hydrograph is separated into three triangular unit hydrographs:

- Rapid inflow- Rainfall-runoff entering through open cleanouts, manhole lids, connections from property storm drain and other sources that result in hydrographs with short durations and high peaks.
- Intermediate infiltration- Rainfall-runoff entering system with a medium, slightly delayed and attenuated response.
- Long-term infiltration- Slow response rainfall-runoff entering the system as a result of slow infiltration into the ground and subsequent cracks and joints of the pipe.

Therefore, a total of nine parameters were calibrated for the 6/30/2015 storm: a set of R, T, and K for each of the three hydrographs.

In estimating the amount of RDI&I entering the sewer system and developing unit hydrographs, a GIS spatial analysis was performed to determine the metered basin area that contributes flow to the collection system. The contributing sewershed area is a required input into the InfoSWMM model, along with the RTK parameters and the rainfall to predict runoff and subsequent RDI&I from an area. In developing sewershed areas for each metered sewershed, only developed areas were included in the total area. Therefore, parks, cemeteries and other large vacant or undeveloped areas that likely do not contribute flows to the collection system were not included. For metered regions outside the study area limits (i.e. Site_01, Site_02, Sun Valley, Pyram01, and LaPa10), most of the contributing sewershed areas were estimated based on a regression analysis between the known sewershed areas and observed metered flows used to develop a linear relationship. In some instances (Site_01 and Site_02), sewershed areas were obtained from referenced master plan reports by others. The regression analysis and a summary of the sewershed areas per metered basin used for RDI&I analysis are included in **Appendix E**. In the InfoSWMM model each junction (i.e. manhole) is loaded with RD&I flow parameters, therefore determining the sewershed area contributing to each junction was a necessary procedure. To simplify the method, the sewershed area of the metered basin was assumed to be allocated equally amongst each junction within the sewershed. This analysis of dividing the sewershed areas by the total number of junctions per metered basin is summarized and included in **Appendix E**. For the buildout model, newly developed parcels were assigned identical RTK parameters as the encompassing or nearest metered basin. The initial abstraction of the basin, a required input in InfoSWMM to determine RDI&I, includes all rainfall losses (interception, infiltration, and depression storage) that occur before runoff starts. The initial abstraction values used in the model vary from 0.10 to 0.20 depending on the type of land use dominant in each sewershed. These values were determined based on guidance from the *Truckee Meadows Regional Drainage Design Manual*. The calibrated RTK parameters and the wet weather calibration process are summarized in **Section 4.6.2**.

4.6. Model Calibration

The model was calibrated by refining model parameters under dry and wet weather conditions to the simulated flow conditions to reasonably approximate the measured flow conditions. Diurnal curves were adjusted for the dry weather calibration such that simulated and recorded wastewater flow, depth and volume hydrographs matched to within a reasonable level of accuracy. For the wet weather flow calibration, RTK parameters were adjusted such that simulated and recorded wastewater peak flows matched to within a reasonable level of accuracy. Unit wastewater generation rates were "calibrated" to within ten percent of existing flows.

4.6.1. Dry Weather Calibration

The model was calibrated to dry-weather meter data recorded during the temporary monitoring period of June 18 to July 1, 2015 at three (3) permanent and seven (7) temporary flow meters. The June 30, 2015 metering data was removed from the dry weather dataset due to the influence of wet weather inflow. The dry weather data was further separated into weekday and weekend data. The hourly peaks from each weekday were averaged to develop a composite hydrograph representative of a typical dry weather weekday. The same procedure was performed to develop a composite hydrograph for the weekend days. These composite hydrographs represented the observed flow at each meter and were the basis for the calibration process. Peak flow calibration was based on the highest observed flow included in the composite hydrograph. Simulated flow hydrographs at each meter location were compared with recorded discharge measurements. The purpose of the comparison is to refine the estimated model parameters to correlate with the simulated flow conditions to more closely reflect the measured flow conditions. These parameters generally include diurnal curve patterns and peak to average flow ratios (peaking factors). The calibration process for each meter continued until sewer volume and peak flows were calibrated within +/- 10% of field measurements, which represent an acceptable calibration accuracy for sewer master planning purposes. Additionally, the Nash-Sutcliffe model efficiency value or R-squared efficiency was also calculated to evaluate the shape and timing of the simulated hydrograph relative to the observed hydrograph. Generally, R-squared efficiency values greater than 0.5 signified a very good calibration of shape. Although calibration of peak and volume is more critical, this statistical analysis added another tool to evaluate the effectiveness of the calibration process.

The results of the dry weather weekday and weekend calibration for a few of the meters are presented graphically in **Figure 4-4** through **Figure 4-6**. The dry weather weekday and weekend calibration results for all the temporary and permanent meters are included in **Appendix D**.

Figure 4-4 Dry Weather Flow Calibration (Meter Sparks03)

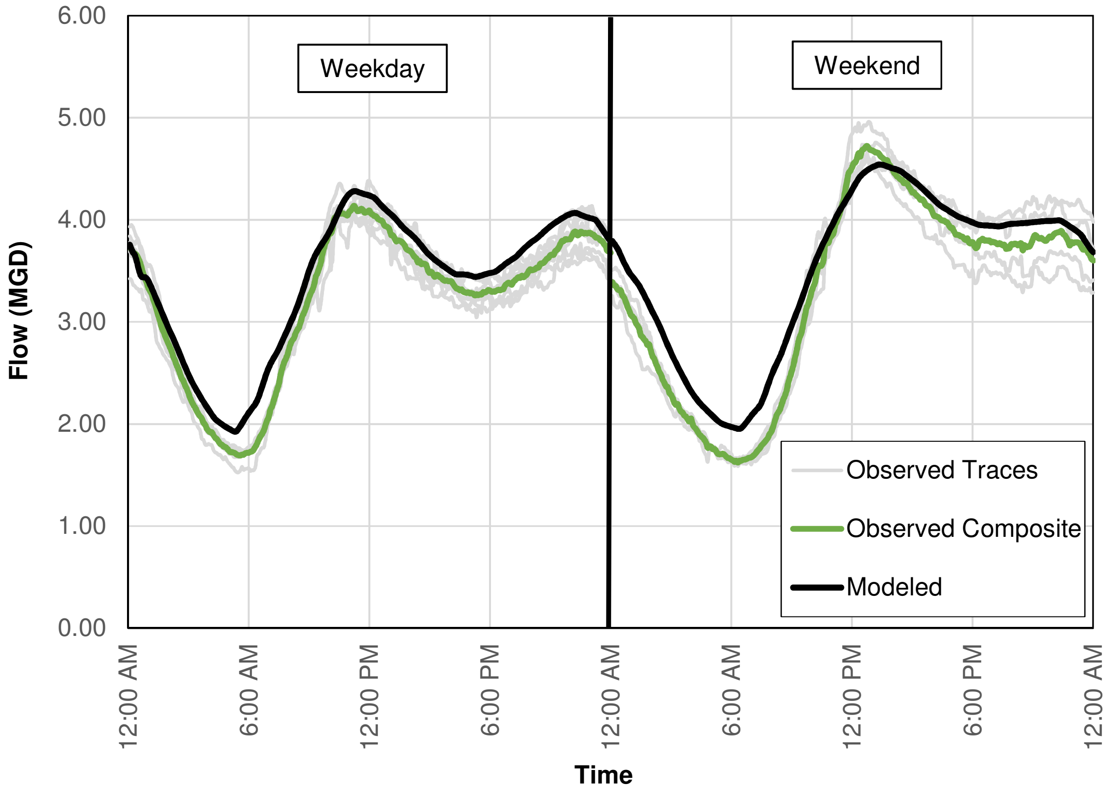


Figure 4-5 Dry Weather Flow Calibration (Meter Nugg05)

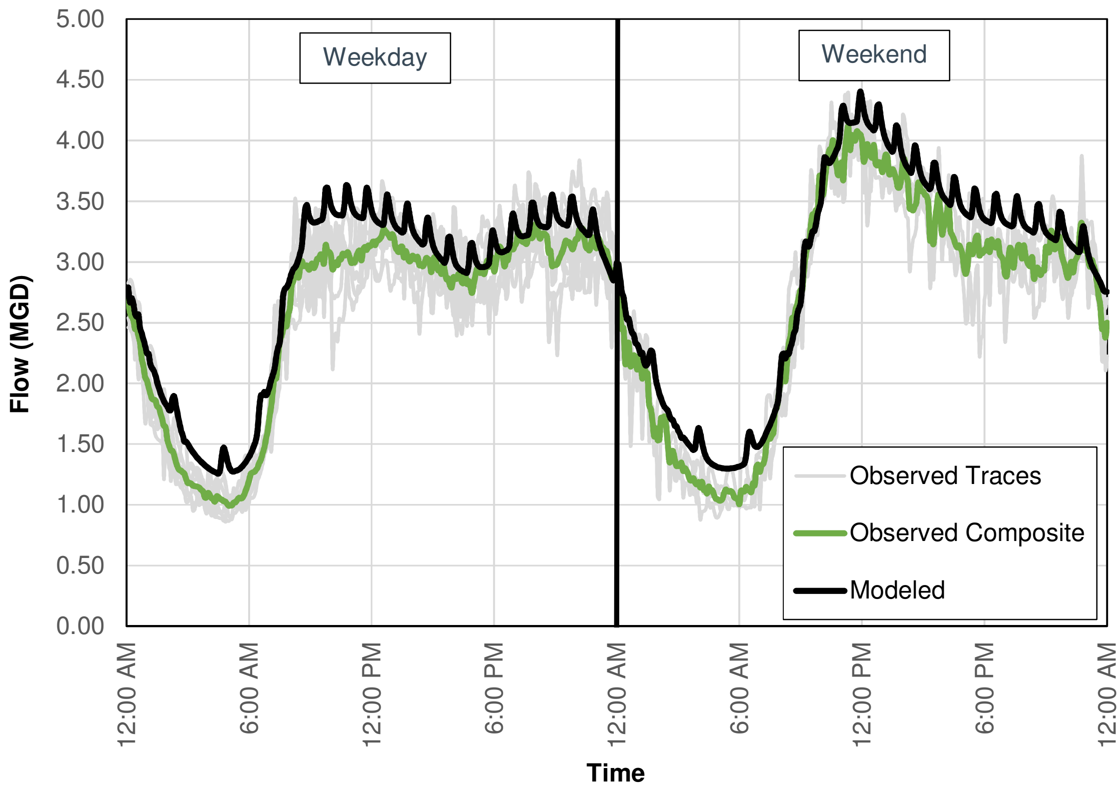


Figure 4-6 Dry Weather Flow Calibration (Meter Matte07)

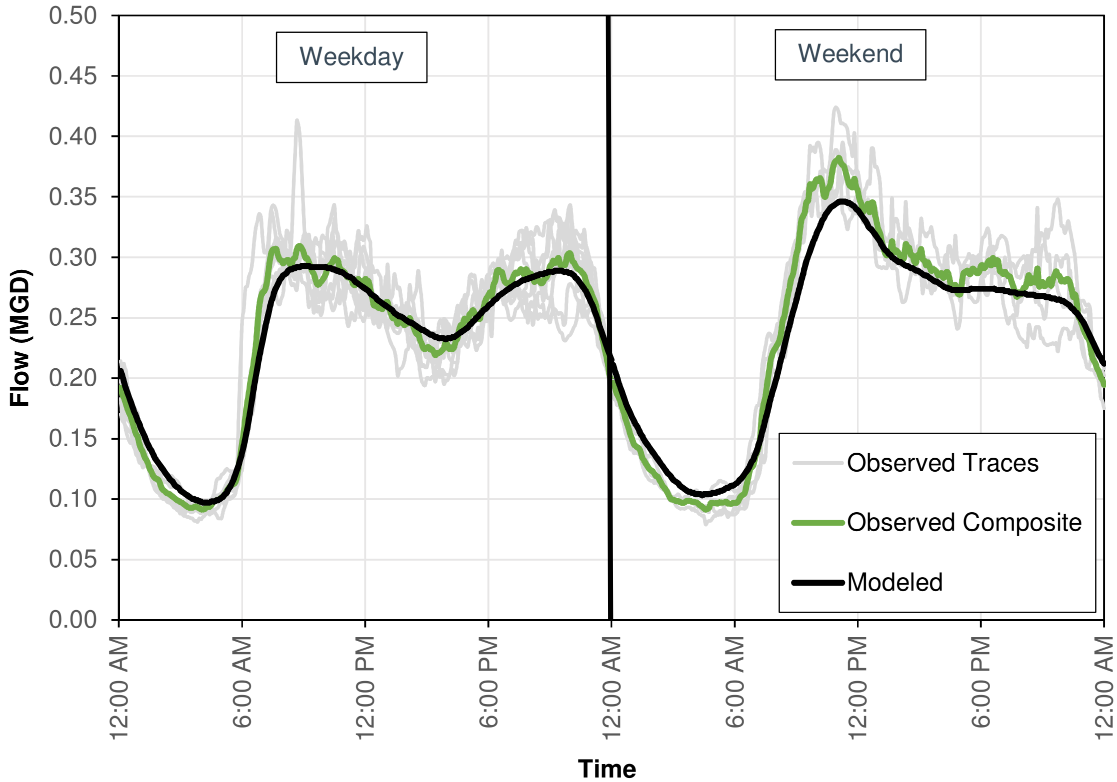


Table 4-3 and Table 4-4 summarize the results of the dry weather weekday and weekend calibration, respectively. The weekend patterns generated the highest peak flows in the meters dominated by residential land use. Conversely, weekend average and peak flows significantly decreased relative to weekday flows in the non-residential metered basins, thus capturing the impacts from reduced employment over the weekend days.

Table 4-3 Weekday Dry Weather Flow Calibration Summary

Meter Name	Observed Peak Flow (mgd)	Modeled Peak Flow (mgd)	% Error	Observed Average Daily Flow (mgd)	Modeled Average Daily Flow (mgd)	% Error
Site_05	13.38	13.51	+1.0%	10.36	10.60	+2.2%
Site_06	1.53	1.39	-9.6%	1.19	1.11	-6.9%
Site_07	0.06	0.06	-0.5%	0.04	0.04	-2.2%
Sparks03	4.14	4.28	+3.5%	3.20	3.40	+6.0%
Victo04	1.18	1.08	-8.8%	0.92	0.87	-5.4%
Nugg05	3.32	3.63	+9.4%	2.55	2.77	+8.5%
Frank06	6.48	5.98	-7.7%	5.21	4.79	-7.9%
Matte07	0.31	0.29	-5.2%	0.23	0.23	-0.5%
Wldlsd08	0.20	0.19	-4.4%	0.12	0.13	+5.9%
Sulli09	0.31	0.30	-1.8%	0.24	0.24	-2.3%

Table 4-4 Weekend Dry Weather Flow Calibration Summary

Meter Name	Observed Peak Flow (mgd)	Modeled Peak Flow (mgd)	% Error	Observed Average Daily Flow (mgd)	Modeled Average Daily Flow (mgd)	% Error
Site_05	13.06	14.31	+9.6%	10.54	10.48	-0.6%
Site_06	1.48	1.37	-7.2%	1.09	1.04	-4.6%
Site_07	0.05	0.05	-6.2%	0.03	0.03	+9.3%
Sparks03	4.72	4.54	-3.9%	3.29	3.50	+6.4%
Victo04	1.59	1.44	-9.3%	0.99	0.96	-2.8%
Nugg05	4.11	4.40	+7.0%	2.68	2.90	+8.2%
Frank06	6.80	6.63	-2.4%	5.44	4.96	-8.9%
Matte07	0.38	0.35	-9.5%	0.24	0.23	-2.8%
WldIsd08	0.10	0.10	+2.8%	0.07	0.08	+0.7%
Sulli09	0.33	0.36	+9.4%	0.24	0.24	+2.2%

4.6.2. Wet Weather Calibration

The purpose of wet weather calibration is to develop a set of hydrologic parameters that adequately predict the system response over a large storm event or a range of storm types. The model was calibrated to the peak wet-weather flow event that occurred on June 30, 2015 at all the temporary and permanent flow meters that revealed a wet weather response in the flow hydrograph. The RTK hydrograph method was used to calibrate the hydrologic parameters used to generate wet weather unit hydrographs. The June 30, 2016 storm event and the RTK hydrograph method are detailed in **Section 4.5.3**. Simulated flow hydrographs at each meter location were compared with recorded discharge measurements. The purpose of the comparison is to refine the estimated model wet weather parameters to correlate with the simulated RDI&I flow conditions to more closely reflect the measured RDI&I flow conditions. These parameters include the nine (9) R, T, and K parameters for each metered basin, as discussed in **Section 4.5.3**. The calibration process for each meter continued until sewer volume and peak flows were calibrated within +/- 10% of field measurements, which represent an acceptable calibration accuracy for sewer master planning purposes.

The system's response and wet weather calibration results are presented graphically in **Figure 4-7** through **Figure 4-9.** The wet weather calibration results for all the calibrated temporary and permanent meters are included in **Appendix E**. **Table 4-5** summarizes the results of the wet weather model calibration.

Figure 4-7 Wet Weather Flow Calibration (Meter Sparks03)

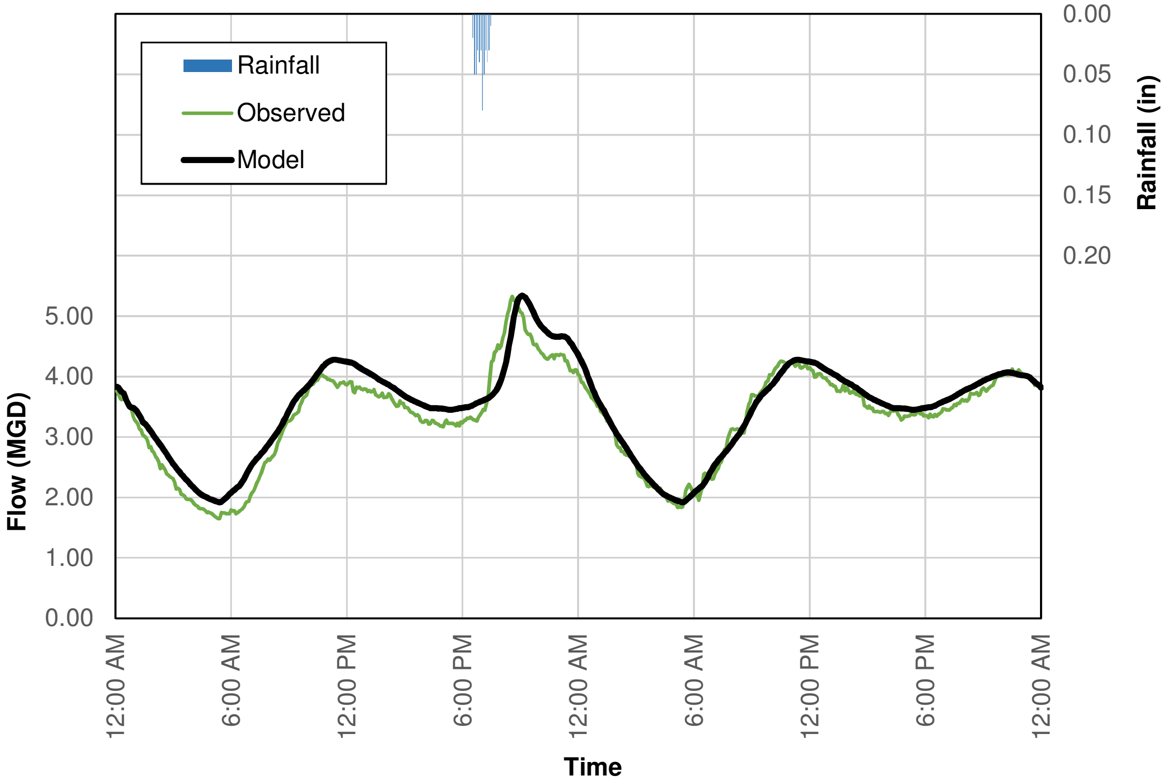


Figure 4-8 Wet Weather Flow Calibration (Meter Nugg05)

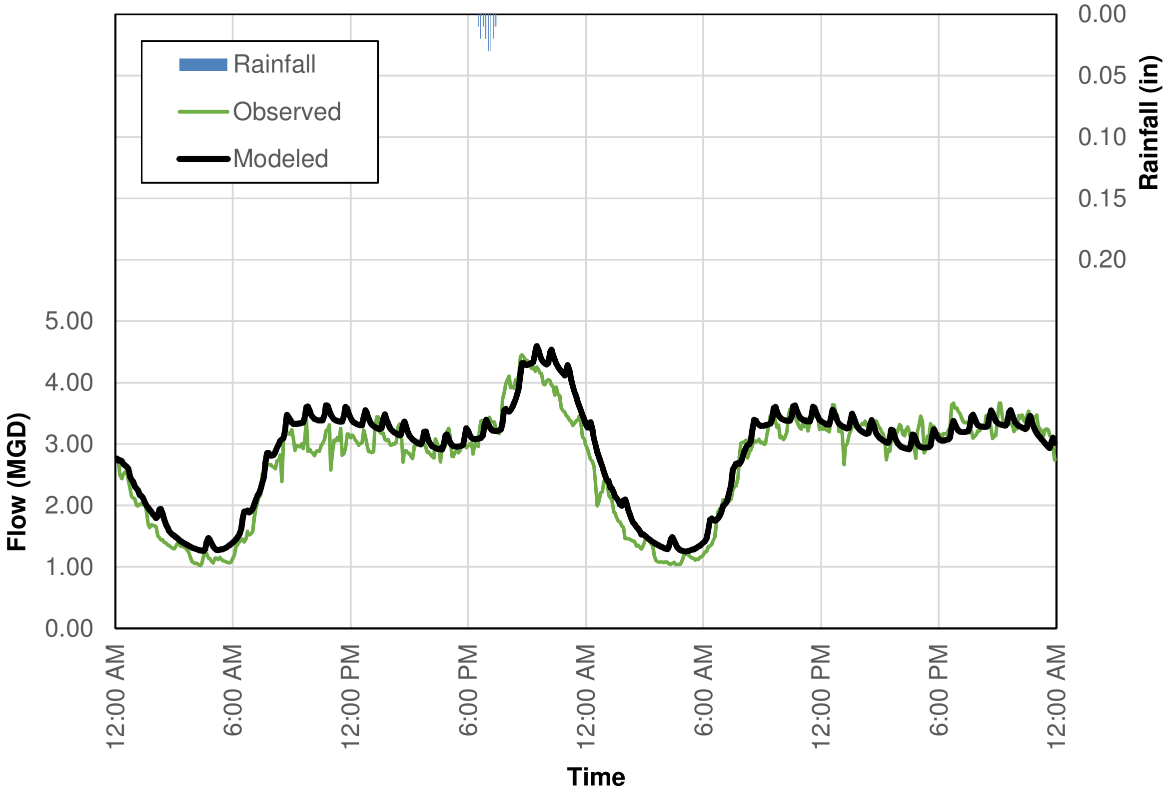


Figure 4-9 Wet Weather Flow Calibration (Meter Matte07)

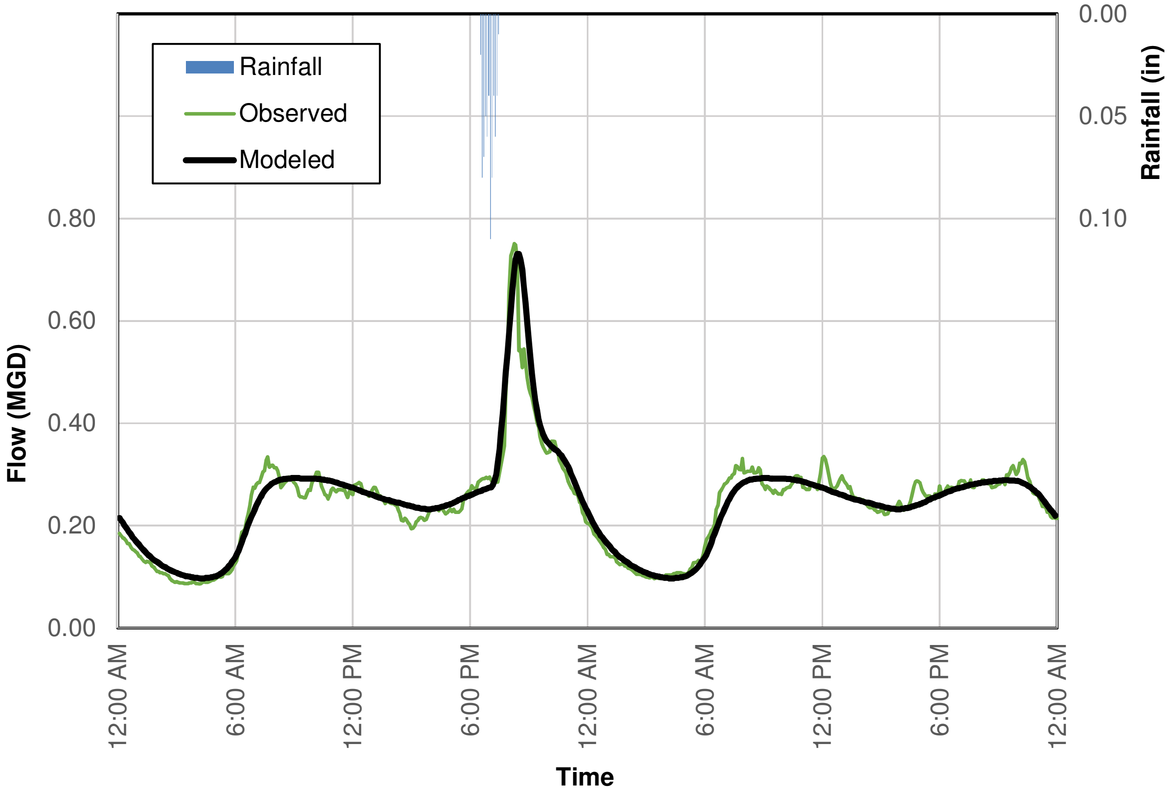


Table 4-5 Wet Weather Flow Calibration Summary

Meter Name	Observed Peak Flow (mgd)	Modeled Peak Flow (mgd)	% Error	Observed Average Daily Flow (mgd)	Modeled Average Daily Flow (mgd)	% Error
Site_01	4.06	3.81	-6.2%	1.85	1.85	+0.1%
Site_02	1.05	0.96	-8.9%	0.49	0.46	-6.6%
Site_05	16.33	16.81	+2.9%	10.14	10.87	+7.2%
Site_06	2.50	2.41	-3.6%	1.26	1.18	-6.7%
LosAl02	0.30	0.30	+2.0%	0.14	0.13	-5.1%
Sparks03	5.32	5.34	+0.3%	3.34	3.48	+4.3%
Victo04	1.85	1.36	-26.5%	0.89	0.87	-2.0%
Nugg05	4.46	4.60	+3.2%	2.71	2.91	+7.4%
Frank06	7.85	7.92	+0.9%	5.31	5.00	-5.8%
Matte07	0.75	0.73	-2.7%	0.24	0.24	+1.1%
Wldlsd08	0.57	0.53	-6.2%	0.17	0.16	-2.1%

Notes:

- Metered basins receiving negligible rainfall and subsequently revealing no response to wet weather in the resultant flow hydrographs were not included in the wet weather calibration process.

10% peak flow calibration was not achieved for the Victo04 meter due to the surge influence of the private lift station maintained by The Nugget. The calibrated RTK parameters of each metered basins included in the wet weather calibration process are included in **Appendix E**. The RTK method of calibration is generally more complex than other wet weather calibration methods and requires quality rainfall and flow data. However because the method produces unit hydrographs, these unit hydrographs, in theory, can be applied to other storm events (i.e. significant design storm events) to predict RDI&I. The calibrated total R-values for the different metered basins, defined as the fraction of rainfall over the sewershed entering the collection system, ranged from 0.002 to 0.027. Overall, the City experienced an average of approximately 0.01 or 1% of rainfall-runoff entering the sewer during the June 30, 2015 calibration storm event. Typically, the total R is approximately 0.01 or less in good condition sewer systems with typical sewer system values ranging from 0.02 to 0.04. For metered basins not included in the calibration process due to lack of wet weather response, RTK parameters from similar or adjacent basins were used when performing a capacity analysis for the wet weather flow scenario.

4.7. Evaluation Criteria

Recommended criteria were developed to evaluate the capacity of the existing collection system under existing and proposed dry and wet weather flow conditions. In determining the recommended criteria, the Sparks' previous Master Plan gravity main criteria was reviewed, along with additional criteria assembled from various agencies' design manuals, including the City of Sparks, City of Reno and Carson City. The recommended evaluation criteria are presented in **Table 4-6** and will be utilized to identify deficient facilities and size replacement infrastructure. This criteria was approved by City staff prior to evaluating the sewer system and identifying system deficiencies.

Table 4-6 Recommended Evaluation Criteria

Item	Recommended Evaluation Criteria
Gravity Main Criteria	
Minimum Pipe Diameter	8 inches
Minimum Velocity	2 fps at PDWF
Minimum Slope	1% for sewers with < 10,000 gallons per day For slopes < 1%, minimum velocity calculations govern
Existing Sewers - Maximum Peak d/D Ratio	0.50 PDWF for diameter < 18-inch 0.75 PDWF for diameter ≥ 18-inch 0.90 PWWF for all diameters
New Sewers - Maximum Peak d/D Design Criteria	0.50 PDWF and PWWF for diameter < 18-inch 0.75 PDWF and PWWF for diameter ≥ 18-inch
Force Main Criteria	
Minimum Pipe Diameter	4 inches
Minimum Velocity	2.5 fps
Maximum Velocity	8 fps
Lift Station Criteria	
Minimum Number of Pumps	2
Minimum Pump Capacity	110% of capacity of tributary system leading to station
Standby Capacity	100% of station capacity
Emergency Power	Required: Permanent or Portable Standby Generator
Emergency Storage Capacity	1 hour pumping volume at PWWF
Siphon Criteria	
Minimum Pipe Diameter	8 inch
Minimum Number of Pipes	2
Minimum Velocity	3 fps at PDWF

Notes:

- fps = feet per second, PDWF = peak dry weather flows, and PWWF = peak wet weather flows

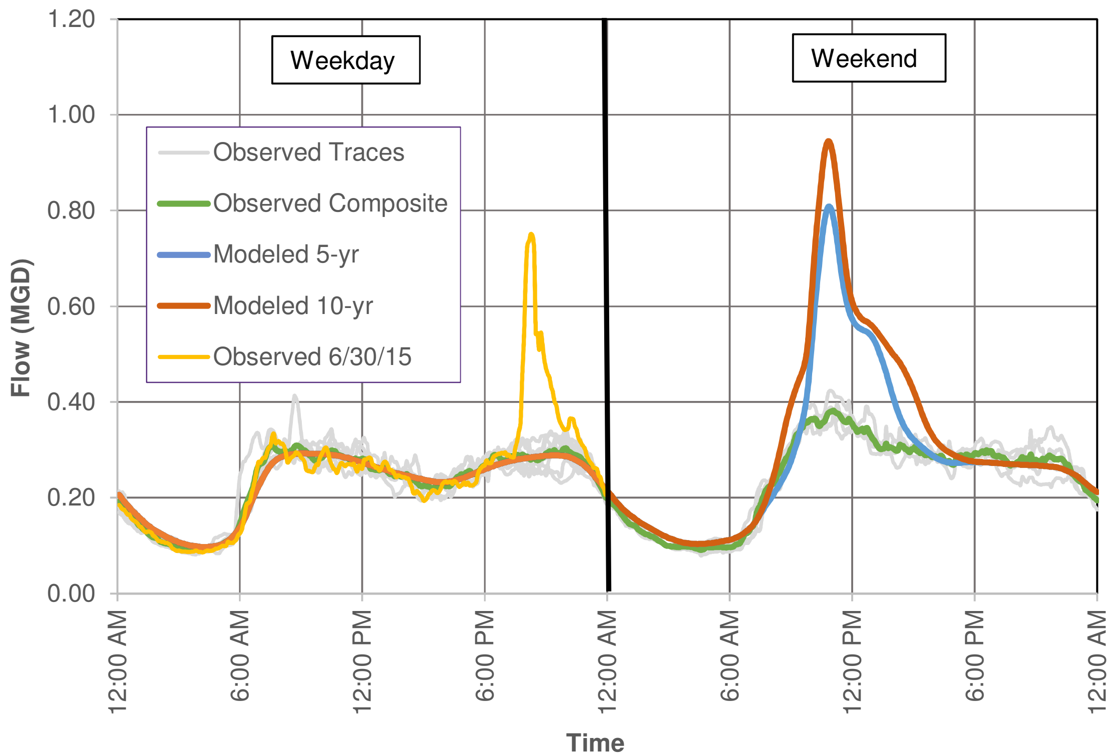
4.8. Capacity Analysis

A capacity analysis of the existing collection system was performed under existing and forecasted dry and wet weather flow conditions. This analysis was conducted using the criteria for existing facilities presented in **Table 4-6**. Model simulations were performed for the recommended buildout wastewater generation, as discussed in **Section 3**, in order to identify potential improvement projects. The proposed capital improvement projects are discussed and presented in **Section 5**.

4.8.1. Wet Weather Design Storm Selection

As discussed in **Section 4.5.3** the model was calibrated to an approximately a 5-year storm event across the City. Since the RTK method of calibration was used to develop unit hydrographs and wet weather parameters, these unit hydrographs were appropriate to use analyzing the system under extreme, synthetic storm events or design storms. Both the 5- and 10-year, 24-hour design storms were evaluated to see which event most appropriately balanced the City's ability to build and finance capital improvement programs with the risk associated with potential sewer overflows and social and environmental consequences. Typically, 2-year to 10-year design storms are used for analyzing wet weather peak flows for sewer master plans. **Figure 4-10** compares the 6/30/2015 event at Meter Matte07 (equivalent to an approximately 10-year, 2-hour event) with simulated flows produced by 5- and 10-year, 24-hour design storms for the same metered basin.

Figure 4-10 Wet Weather Flow Comparison (Meter Matte07)



Through discussions with the City and comparison of criteria violations generated by both the 5- and 10-year design storms, the 5-year, 24-hour design storm was selected for use in the wet weather capacity analysis. Typically storms are localized and do not occur with peak intensity over the entire watershed, therefore depth-area reduction factors (DARFs) were applied to the rainfall data based on the size of the approximately 40 square mile drainage area. The DARFs were obtained from the *Truckee Meadows Regional Drainage Design Manual* and are included in **Appendix E**. Additionally, the 5-year design storm was stacked to align with the corresponding peak dry weather weekday and weekend flows to represent a more extreme peak wet weather flow scenario. The 5-year event resulted in wet weather peaking factors (ratio of peak wet weather flow to average daily dry weather flow) typically ranging from approximately 2.5 to 6.0, depending on the size of the sewershed. Larger interceptors typically experienced lower wet weather peaking factors than smaller sewer trunk lines due to the flow attenuation experienced in a larger sewershed. This range represents acceptable peaking factors for the wet weather flow scenario.

4.8.2. Gravity Mains

The gravity mains were evaluated under existing and projected buildout wastewater flow conditions based upon the criteria presented in **Table 4-6**. Under peak dry and wet weather flow, gravity mains were identified as deficient in capacity if they did not satisfy the specified criteria. The capacity criteria evaluation primarily focused on the peak flow depth over diameter (d/D) parameter. For the peak dry weather flow (PDWF) scenario, pipelines exceeding 0.50 d/D (for diameters < 18-inches) and 0.75 d/D (for diameters ≥ 18-inches) were identified as deficient. Under peak wet weather flow (PWWF) conditions, pipeline capacity projects were identified if peak flows exceeded 0.90 d/D for all pipeline diameters. **Figure 4-11** and **Figure 4-12** present the locations of deficiencies for the dry and wet weather existing and buildout wastewater flow conditions, respectively. Upon completion of the PDWF and PWWF model simulations, potential capital improvement projects were evaluated through an iterative process. This process involved evaluating each of the identified capacity limitations. In some instances, smaller mains with sufficient capacity connect to major interceptors without a vertical offset in invert elevations, thus triggering a d/D violation in the artificially submerged smaller main. This scenario is the result of limitations in the GIS database, as discussed in **Section 4.4.1**, therefore these types of deficiencies were disregarded. Additionally, in other cases, adverse slopes caused low points in the system and resulted in d/D violations in the model. Although these locations may represent reality due to the relatively flat slopes in certain portions of the City collection system, these deficiencies were considered a low priority and not targeted for a capacity related improvement project. Lastly, backwater effects resulting from the modeled tailwater condition at the TMRWF results in d/D violations in the most downstream portion of the City system near the entrance to the TMWRF. These violations were ignored unless the full flow capacity of the pipe segments was exceeded. Isolated criteria violations were observed in a few locations, but did not significantly affect overall system capacity and therefore were not addressed.

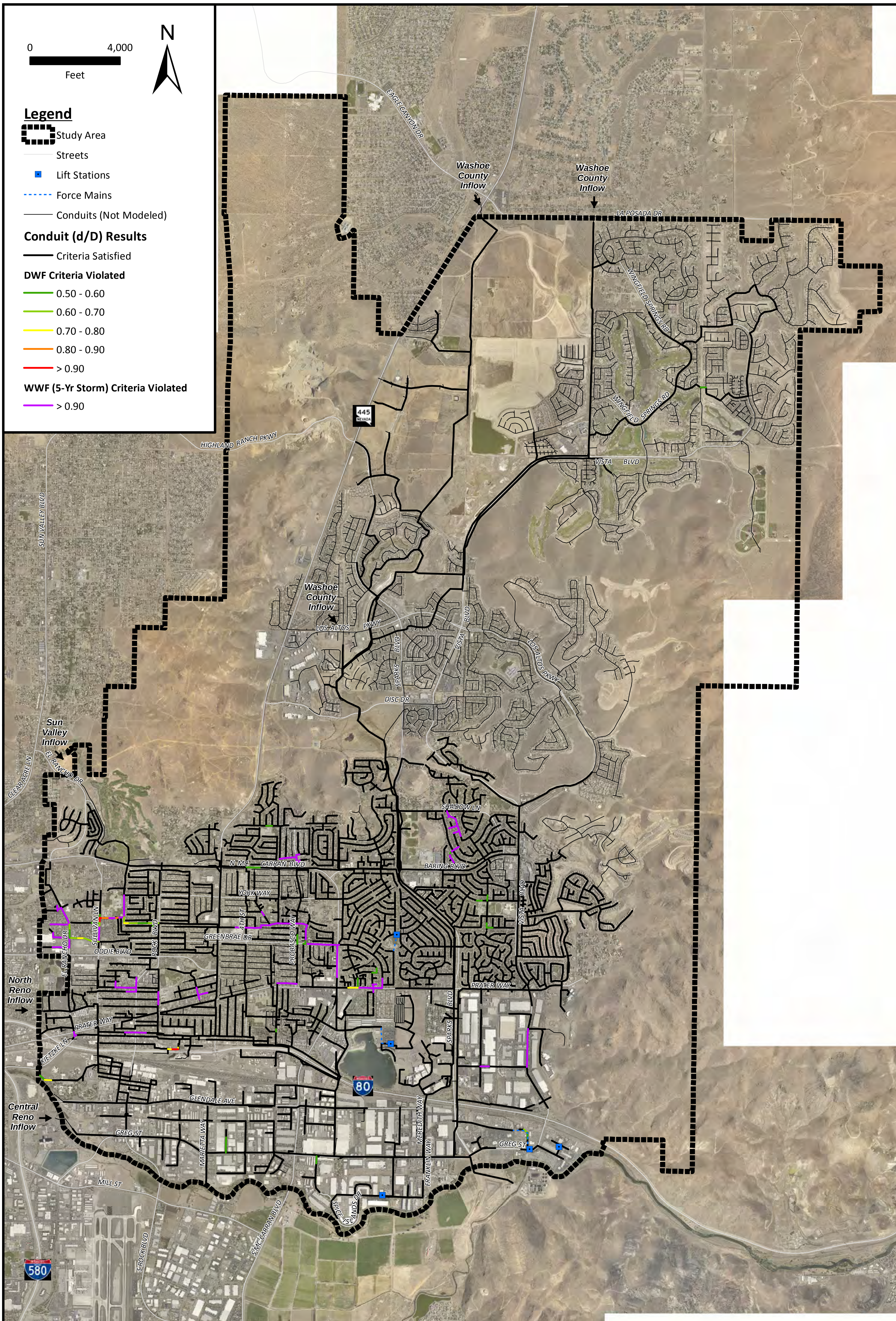
Due to the significant size of the hydraulic model (nearly 5,000 modeled conduits), the model results are best viewed spatially using GIS shapefiles. The procedure for viewing modeling results is summarized in **Appendix F**. For comparative purposes, **Table 4-7** presents the simulated existing and buildout flows at the downstream portion (denoted by the corresponding Sparks GIS facility ID) of the significant sewer interceptors throughout the City. **Figure 4-13** and **Figure 4-14** show the estimated available capacities for the major interceptors in the existing and buildout conditions, respectively, and represent a quick reference tool to review system capacity. However, these figures are not a substitute for site-specific modeling. The available capacity analysis only considered dry weather flows and criteria based on a maximum d/D of 0.75 for the PDWF condition. Additionally, the available capacity for the buildout condition assumes the full construction of all the CIPs listed in **Section 5.3**. The model results for the buildout condition display d/D criteria violations for significant portions of the Sun Valley Interceptor and the Reno Sparks Joint Interceptor. These violations are not the result of buildout flows generated within the City of Sparks, but primarily caused by projected buildout flow contributions from Sun Valley and the City of Reno. Therefore, formal CIPs were not developed for these systems.

Table 4-7 Major Wastewater Interceptor Simulated Flows

Interceptor	Sparks GIS Facility ID	Simulated ADWF (mgd)		Simulated PDWF (mgd)	
		Existing	Buildout	Existing	Buildout
Central Sparks Interceptor	SSL006167	3.04	3.31	4.50	4.88
North Interceptor	SSL000217	11.67	26.59	15.72	38.74
Northeast Interceptor	SSL034121	1.49	2.08	1.95	2.66
Northwest Interceptor	SSL034123	1.45	5.27	2.04	7.62
Reno Sparks Joint Interceptor (G Street to Rock Boulevard)	SSL000148	1.94	8.17	2.71	11.46
Reno Sparks Joint Interceptor (Greg Street)	SSL000207	10.54	24.66	14.31	33.71
Spanish Springs Interceptor	SSL018596	4.87	10.63	6.63	15.12
Sun Valley Interceptor	SSL021079	0.95	2.15	1.53	3.47
Victorian Interceptor	SSL020211	0.92	1.03	1.44	1.63
Vista-Prater-Sparks Interceptor	SSL000293	1.08	1.86	1.39	2.40

Notes:

- ADWF = average dry weather flow and PDWF = peak dry weather flow



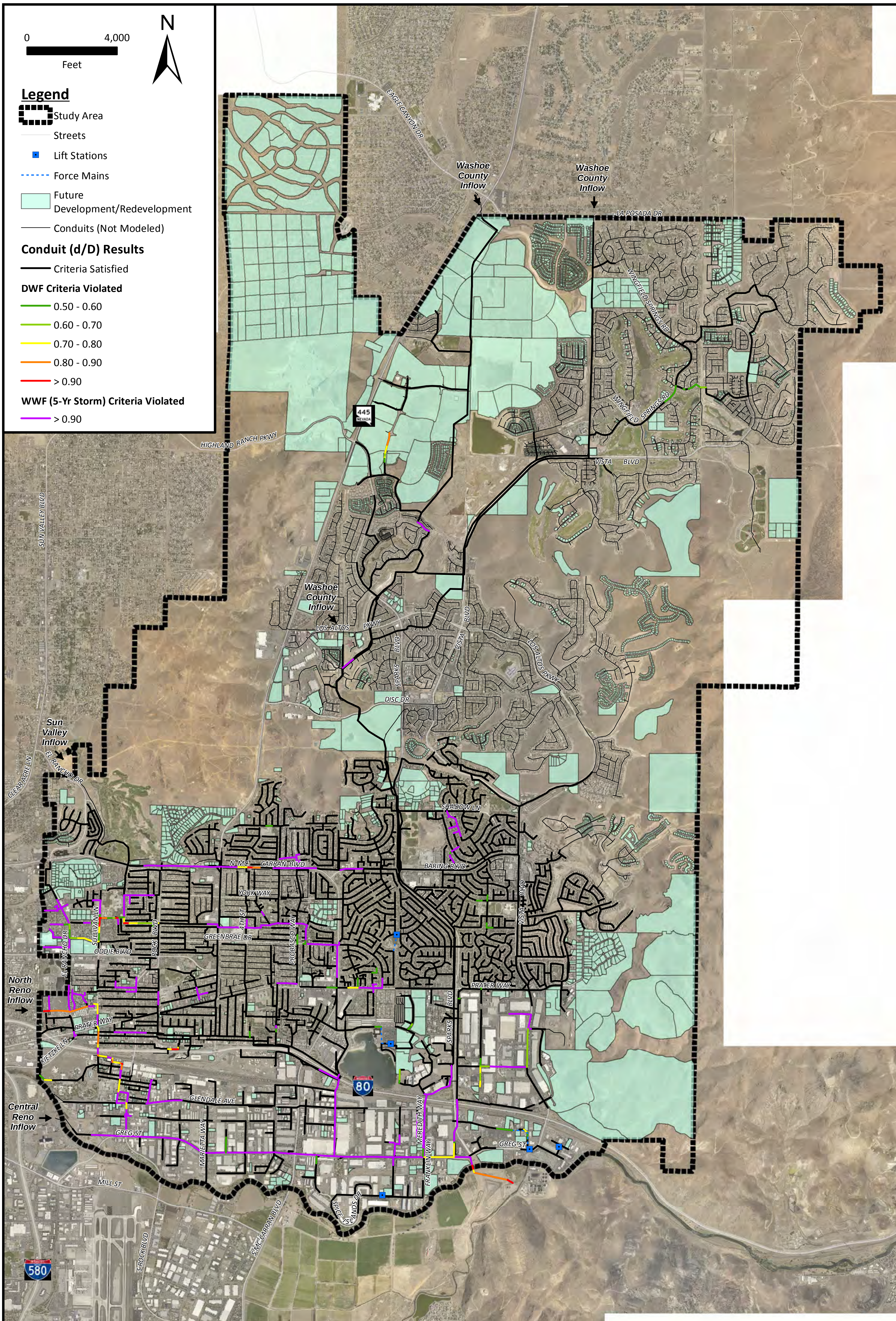
ATKINS

City of Sparks

Sewer Model Update

Existing Condition Pipeline Deficiencies

Figure 4-11



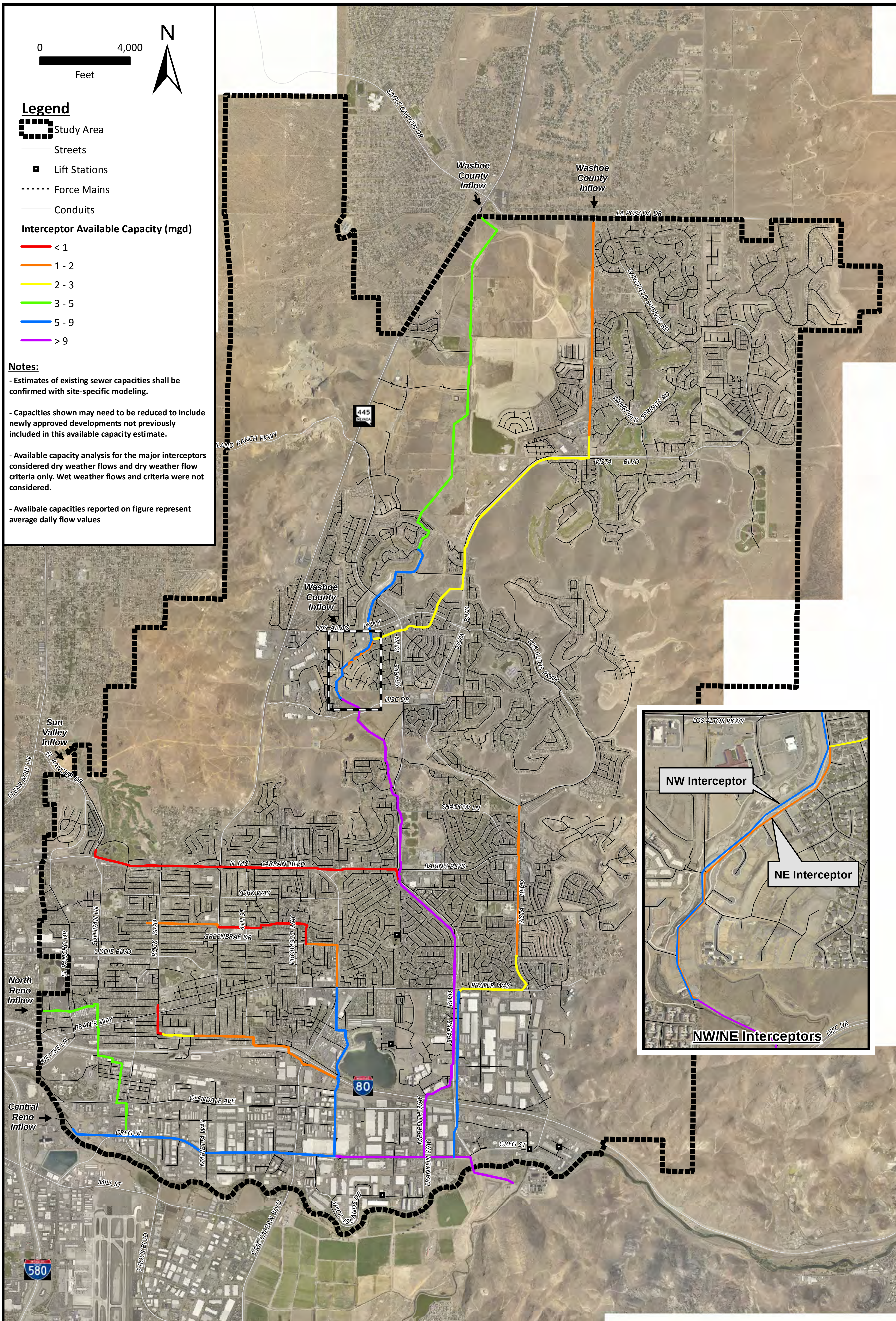
ATKINS

City of Sparks

Sewer Model Update

Buildout Condition Pipeline Deficiencies

Figure 4-12



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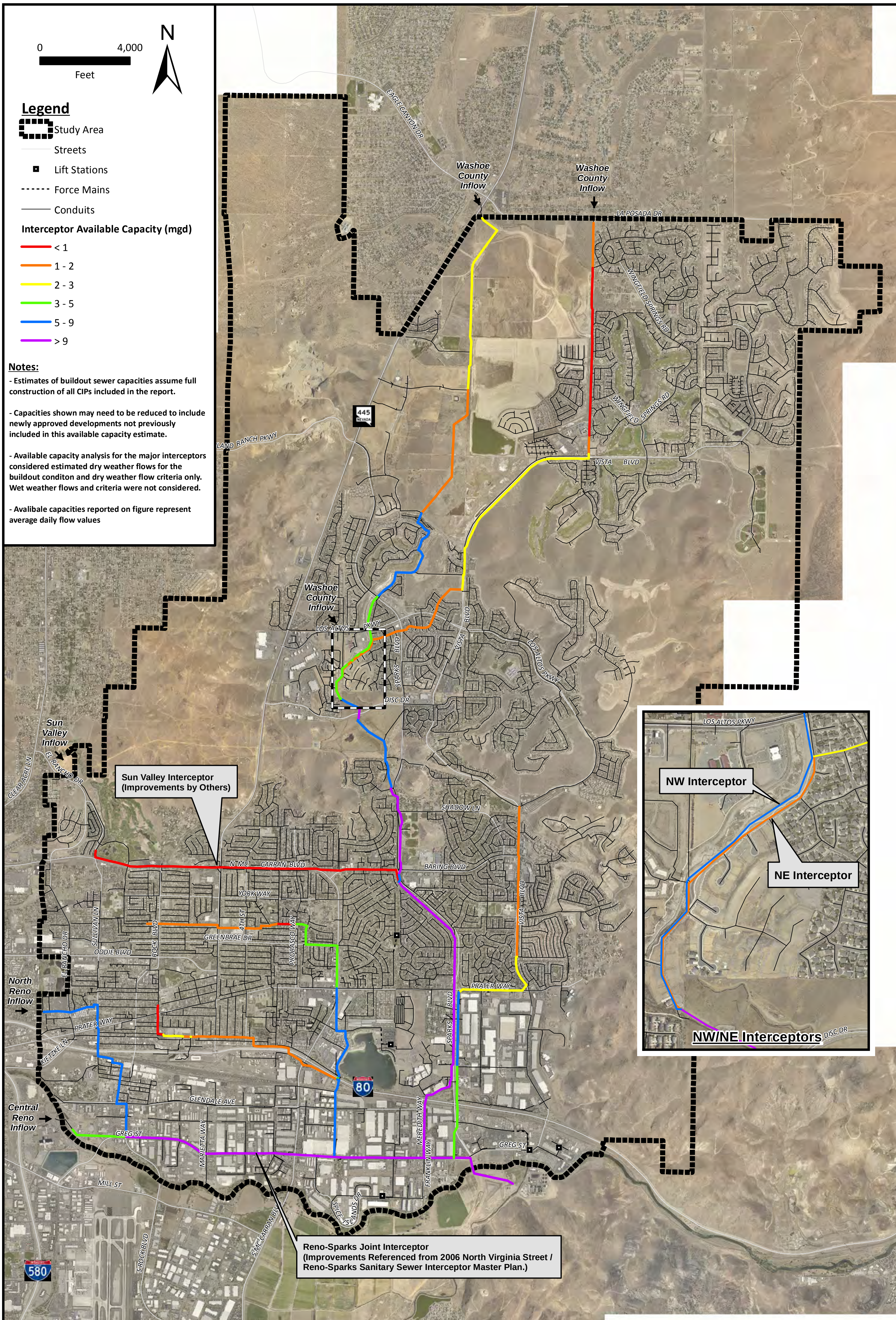
City of Sparks

Sewer Model Update

Estimate of Available Capacity for Major Interceptors (Existing Condition)*

*Assumes No Construction of CIPs

Figure 4-13



City of Sparks

Sewer Model Update

Estimate of Available Capacity for Major Interceptors (Buildout Condition)*

***Assumes Full Construction of all CIPs listed in Table 5-2**

Figure 4-14

4.8.3. Lift Stations

The lift stations and force mains owned and operated by Sparks were evaluated under existing and projected wastewater flows based upon the criteria listed in **Table 4-6**. As discussed in **Section 4.4.3**, the Bayshore Drive (Marina Village) lift station was the only lift station modeled in detail and fully evaluated. Although pumping capacity analysis was performed on other lift stations included in the model, if data was available for the current design capacities. **Table 4-8** summarizes the existing and future pump capacities for the Bayshore Drive (Marina Village) lift station. The lift station and force main data (capacities, wet well volume, etc.) is based on information obtained from the *Marina Village Lift Station* design plans and report and the City of Sparks' *Supplemental Lift Station Operation & Maintenance Manual.* Therefore, SCADA data was not reviewed as part of this Master Plan.

Table 4-8 Lift Station Pumping Capacities

Lift Station	Design Capacity (gpm)	Existing		Buildout	
		Dry Weather Peak Flow (gpm)	Wet Weather Peak Flow (gpm)	Dry Weather Peak Flow (gpm)	Wet Weather Peak Flow (gpm)
1199 O'Callaghan Drive	150	30	143	30	143
1102 Spice Island Drive	250	62	157	66	167
2102 East Greg Street	420	21	27	26	35
1152 Bayshore Drive (Marina Village)	850	45	159	267	442

Notes:

- gpm = gallons per minute
- Although included in the hydraulic model, no discharge capacity information was obtained for the Larkin Circle lift station. This was modeled as an "ideal" pump (see **Section 4.4.3** for details).

All the lift stations contain adequate pumping capacity to handle existing peak flows, as well as the estimated peak flows resulting from the significant planned development of the contributing upstream sewershed. The Bayshore Drive (Marina Village) force main was also evaluated to see if the existing and buildout peak velocities exceed the maximum criterion. Minimum velocities are required in force mains to keep solids suspended (a higher velocity is required to re-suspend solids that have previously been deposited). Additionally, force main velocities exceeding of 8 feet per second (fps) potentially cause damage in pipes due to excessive abrasion. The simulated peak wet weather flow maximum velocities for the existing and future condition were less than 8 fps, therefore satisfying the maximum velocity criteria.

Table 4-9 summarizes the lift station storage capacities for the existing and future scenarios. The Bayshore Drive (Marina Village) lift station includes an 11 foot by 10 foot by 10 foot wet well (equating to approximately 8,200 gallons for storage) installed with two pumps. Emergency power in the form of a generator is also available at the station. The lift station is estimated to currently contain approximately 0.9 hours of emergency storage under existing wet weather flow conditions and is projected to also possess less than one-hour of storage under future conditions. In both scenarios, the emergency storage capacity is less than the recommended minimum one hour of storage volume at peak wet weather flow. The insufficient emergency storage volume estimated for the Bayshore Drive (Marina Village) lift station is noted, however this deficiency was considered a low priority and not targeted for a capacity related improvement project.

Table 4-9 Lift Station Storage Capacities

Lift Station	Emergency Storage (gal)	Existing		Buildout	
		Wet Weather Peak Flow (gpm)	Storage (hours)	Wet Weather Peak Flow (gpm)	Storage (hours)
1152 Bayshore Drive (Marina Village)	8,200	159	0.9	442	0.3

Notes:

- gpm = gallons per minute, gal = gallons

5. Proposed Capital Improvement Projects

This chapter presents the proposed capital improvement projects (CIPs) based on the findings of the Master Plan and includes:

- Development of unit costs
- Identified sanitary sewer improvement projects
- CIP estimated costs and projected timelines

5.1. Development of Unit Costs

Planning level cost estimates were developed for the recommended improvement projects. The unit cost estimates include the construction costs (construction costs include 20% for contingency, mobilization and traffic control) plus a 30 percent allowance for planning, engineering design, environmental, legal, construction, construction management and contract administration. The values are presented in 2016 dollars based on local construction costs compiled from a database of construction bids from multiple local agencies, including the Nevada Department of Transportation (NDOT), City of Sparks, Washoe County, Regional Transportation Commission (RTC) of Washoe County, and the City of Reno. These estimates are based on representative available data at the time of this report; however, since prices of materials and labor fluctuate over time, and particular obstacles of individual projects cannot be foreseen, new estimates should be obtained at or near the time of construction of proposed facilities. It also was assumed that all improvements will be constructed within the existing City of Sparks right-of-way.

The base unit costs for pipeline material and installation, including repaving and system appurtenances that, collectively, constitute principal elements of the wastewater collection system facilities, are presented in **Table 5-1**. The unit costs provided reflect an average cost for full capitalization inclusive of planning, engineering design, construction (including all appurtenances), construction management and contract administration.

Table 5-1 Pipeline Unit Costs

Diameter (inches)	Sewer, Gravity
8	$280/LF
10	$305/LF
12	$335/LF
15	$385/LF
18	$415/LF
21	$455/LF
24	$500/LF
27	$550/LF
30	$620/LF
36	$695/LF
42	$775/LF
48	$875/LF
54	$955/LF
60	$1060/LF

5.2. Capital Improvement Project Priority Ranking Methodology

Sewer deficiencies for existing and future conditions are shown in **Figure 4-11 and Figure 4-12**. These deficiencies were determined based on criteria violations, as described in **Section 4.7**. In locations where deficiencies were identified, the associated pipeline was assigned a priority ranking from 1 (highest priority) to 4 (lowest priority). The highest priority deficiencies represent pipelines with criteria violations under existing peak dry weather flows with decreasing priority associated with deficiencies caused by wet weather flow criteria violations due to the sensitivity of the hydrologic analysis parameters. Criteria violations resulting from future development were also generally considered lower priority due to the risks and uncertainties associated with planned projects.

Priority rankings were assigned to deficiencies based on the following criteria:

- Priority 1: Sewers 15-inch in diameter or smaller with a ratio of flow depth to full diameter (d/D) greater than 0.50 and sewers 18-inch and larger with a d/D ratio greater than 0.75 under existing dry weather flow conditions.
- Priority 2: Sewers with no dry weather flow deficiencies, but a d/D ratio greater than 0.90 under existing wet weather flow conditions for the 5-year design storm event.
- Priority 3: Sewers 15-inch in diameter or smaller with a d/D ratio greater than 0.50 and sewers 18-inch and larger with a d/D ratio greater than 0.75 under future buildout dry weather flow conditions.
- Priority 4: Sewers with no dry weather flow deficiencies, but a d/D ratio greater than 0.90 under future buildout wet weather flow conditions for the 5-year design storm event.

The City of Sparks should consider implementing Priority 1 and 2 projects within the next 2 to 5 years due to the existing capacity deficiencies in the conveyance pipelines. Priority 3 and 4 projects were further segmented into short-term and long-term timeframes. Short-term future buildout projects include those expected to be developed in the next 5 years, while long-term projects are those with a projected time horizon greater than 5 years. The significant planned developments and the resources used to predict the spatial distribution and development year of future residential developments are discussed in **Section 2.2**. For each buildout CIP, primary triggers were identified to represent the future development estimated to contribute the greatest amount of wastewater to the improved pipeline. Typically, the estimated timeframe for a buildout CIP was heavily based on the forecasted development year of the primary trigger development for that CIP.

5.3. Recommended Capital Improvement Projects

The CIPs were separated into two main groups: (1) existing condition deficiency CIPs or recommended projects to address current criteria violations and (2) buildout condition deficiency CIPs or recommended projects to provide additional system capacity to accommodate future developments. Buildout CIPs assume that all existing condition CIPs are constructed. In some instances (CIP 10-E and CIP 10-F), an existing and future condition CIP is recommended at a location. For clarification in these cases, the CIP naming convention is represented with an –E for existing condition deficiency improvements required and –F for additional future condition deficiency improvements required if the future development occurs. This provides the City with the estimated costs for the existing and future improvements in the case that the City desires to build the future compatible system instead of the existing compatible system.

In the buildout scenario, wastewater flow increases in the Sun Valley Interceptor and the Reno Sparks Joint Interceptor results in significant capacity issues for large portions of both of these systems. These violations are not the result of buildout flows generated within the City of Sparks, but primarily caused by projected buildout flow contributions from Sun Valley and the City of Reno. Per the direction of the City of Sparks staff, no formal CIPs were developed to improve the capacity of these systems. However to eliminate the impacts of these bottlenecks on upstream systems, these interceptors were upsized in the CIP model. The size of the proposed improvements for both interceptors were implemented by referencing previous master plans conducted for the City of Reno and Sun Valley GID.

The CIP improvements and estimated costs are summarized in **Table 5-2**. Additionally, cost allocations for CIPs are included to distribute the potential cost share between existing and future users based on existing and future flow ratios, which may serve as a valuable tool for the future rate study analysis.

CIP #	CIP Name (Location)	CIP Priority	CIP Time Frame	Primary Trigger	Cost Allocations **		Preliminary Probable Cost	Improvements
					Existing Users	Future Users		
Existing Condition Deficiency CIP								
1	El Rancho Drive	1	Existing	Existing Condition	100%		$ 1,477,810	- Upsize El Rancho Drive sewer to a 12" PVC from Capurro Way to Greenbrae Drive - Abandon / remove 8" RCP connection to Greenbrae Drive sewer - Install new 15" PVC in El Rancho Drive from Greenbrae Drive to north of Pauline Avenue - Upsize El Rancho Drive sewer to a 15" PVC from north of Pauline Avenue to G Street (connect to 33" RCP Reno-Sparks Interceptor)
2	Tyler Way & 18th Street	1	Existing	Existing Condition	100%		$ 871,640	- Upsize 18th Street sewer to a 15" PVC from York Way to Tyler Way - Upsize Tyler Way sewer to a 15" PVC from 18th Street to Trabert Way/16th Street
3	Quail Street, Boise Drive & Greenbrae Drive	1	Existing	Existing Condition	100%		$ 888,235	- Abandon / remove 8" AC connection to Probasco Way sewer - Upsize Probasco Way sewer to a 12" PVC from O Street to Greenbrae Drive - Install new 24" PVC in E Greenbrae Drive from Probasco Way to Breaker Way - Upsize E Greenbrae Drive sewer to a 24" PVC from Breaker Way to Boise Drive (connect to 24" in E Greenbrae Drive) - Upsize Quail Street sewer to a 24" PVC from Probasco Way to Boise Drive - Upsize Boise Drive sewer to a 24" PVC from Quail Street to Greenbrae Drive
4	Prater Way & McCarran Boulevard	1	Existing	Existing Condition	100%		$ 1,974,105	-Upsize E Prater Way sewer to 15" PVC from E Greenbrae Drive to Howard Drive -Upsize E Prater Way sewer to 18" PVC from Howard Drive to N McCarran Boulevard -Upsize N McCarran Boulevard to 30" PVC from E Greenbrae Drive to E Prater Way
5	Springland Drive, Lida Lane & Montezuma Way	1	Existing	Existing Condition	100%		$ 1,027,780	-Upsize Springland Drive, Lida Lane and Montezuma Way sewer to 12" PVC from Baring Boulevard to bulb-out south of Shadow Lane
6	Stanford Way	1	Existing	Existing Condition	100%		$ 134,365	-Upsize Stanford Way sewer to 15" PVC from C Street to Fodrin Way
7	15th Street, H Street & I Street	2	Existing	Existing Condition	100%		$ 891,835	-Upsize sewer to 10" PVC in I Street between Rock and 19th Street -Upsize sewer to 12" PVC in alley between H Street and I Street from 15th Street to Rock; in Rock between alley and I Street -Upsize 15th Street sewer to 15" PVC from G Street to alley between H Street and I Street
8	G Street	2	Existing	Existing Condition	100%		$ 280,730	-Upsize G Street sewer to 12" PVC from Pyramid Way to 10th Street
9	Victorian Avenue and C Street	2	Existing	Existing Condition	100%		$ 1,250,555	-Upsize sewer in alley between Prater Way and Victorian Avenue and C Street to 12" PVC from El Rancho Drive to 15th Street
10-E	Vista Boulevard & Lillard Drive	2	Existing	Existing Condition	100%		$ 470,655	-Upsize Vista Boulevard sewer to 10" from manhole SSN000341 to manhole SSN000343 -Upsize Vista Boulevard sewer to 12" from manhole SSN000340 to manhole SSN000341 -Upsize sewer to 18" near Lillard Drive from manhole SSN053890 to manhole SSN019754
11	Probasco Way/Emerson Way to N. McCarran Boulevard	2	Existing	Existing Condition	100%		$ 167,750	-Upsize Probasco Way sewer to 10" PVC from N McCarran Boulevard to E Emerson Way
12	Centaurus	1	Existing	Existing Condition	100%		$ 565,565	-Upsize sewer to 15" PVC from manhole SSN022267 in Centaurus Drive to Wingfield Springs Road
13	1st Street	2	Existing	Existing Condition	100%		$ 237,850	-Upsize 1st Street sewer to 12" PVC from Quail Street to manhole SSN053733
							$ 10,238,875	**Total Cost of Existing Condition CIPs**

** Cost allocations based on ratio of existing flows to buildout flows
See **Section 5.2** of report for descriptions of CIP priority rankings and methodology

City of Sparks

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<u>Sewer Model Update</u>
Capital Improvement Projects Summary

Table
5-2 (1 of 2)

CIP #	CIP Name (Location)	CIP Priority	CIP Time Frame	Primary Trigger	Cost Allocations ** Existing Users	Cost Allocations ** Future Users	Preliminary Probable Cost	Improvements
Buildout Condition Deficiency CIP								
10-F	Vista Drive, Lillard Drive, and line West to Sparks Blvd	3	Long Term	Copper Canyon	30%	70%	$2,593,740	- Upsize Loop Road sewer to 10" PVC from MH SSN000346 to Vista Blvd. - Upsize Vista Blvd. sewer to 15" PVC from Loop Road to line running west from Vista to Sparks Blvd. - Upsize Lillard Drive sewer to 15" PVC from I-80 to line running west - Upsize line running west to 24" PVC from Vista Blvd. to Lillard Drive - Upsize line running west to 30" PVC from Lillard Drive to Sparks Blvd.
14	Wingfield Springs Road	3	Short Term	Wingfield Springs & The Foothills at Wingfield Spring	76%	24%	$364,370	- Upsize Wingfield Springs Road sewer to 18" PVC from Cinammon Drive to Diamond Wing Ct
15	David Allen Parkway	3	Short Term	Hospital (APN: 8302418) and Kiley Ranch North	0%	100%	$438,515	- Upsize David Allen Parkway sewer to 12" PVC from manhole SSN036713 to manhole SSN036707
16	Turnberry Drive and Vista Del Rancho Pkwy	4	Short Term	Pioneer Meadows, Kiley Ranch, Stonebrook, & Spanish Springs Developments	16%	84%	$1,277,975	- Upsize Vista Del Rancho and Turnberry Drive sewer to 42" from Kiley Meadows Way to Glen Abbey Court
17	Greenbrae Drive and N McCarran Boulevard	4	Long Term	Septic Conversions/Redevelopment	89%	11%	$871,100	- Upsize Greenbrae Drive sewer to 30" PVC between Boise Drive and N McCarren Boulevard.
18	El Rancho Drive	4	Long Term	Septic Conversion/Redevelopment	80%	20%	$250,405	- Upsize El Rancho Drive sewer to 10" PVC from Garfield Drive to Capurro Way
19	Byrd Drive and Sullivan Lane	3	Long Term	Septic Conversion/Redevelopment	80%	20%	$545,170	- Upsize Byrd Drive sewer to 15" PVC from 18th Street to Sullivan Lane - Upsize Sullivan Lane sewer to 10" PVC from Byrd Drive to Kelly Ranch Drive
20	Marina Gateway Drive	3	Short Term	Marina Gateway	11%	89%	$93,130	- Upsize Marina Gateway Drive sewer to 12" PVC from manhole SSN006237 to manhole SSN036038
							$ 6,434,405	**Total Cost of Buildout Condition CIPs**
							$ 16,673,280	**Total Cost Overall of Existing and Buildout Condition CIPs**

** Cost allocations based on ratio of existing flows to buildout flows

See **Section 5.2** of report for descriptions of CIP priority rankings and methodology

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City of Sparks

Sewer Model Update

Capital Improvement Projects Summary

Table 5-2 (2 of 2)

5.3.1. Existing Condition Deficiency CIPs

The following generally describes each recommended existing condition deficiency CIP. **Figure 5-1** serves as a key map to show the location of the various existing condition deficiency CIPs throughout the City, as well as to display the post-CIP modeling d/D results. **Figure 5-2** through **Figure 5-7** present the individual CIP improvements in greater detail. As discussed in **Section 4.8.2**, flagged deficiencies associated with adverse slopes, smaller main connections to interceptors without a vertical offset, or backwater effects resulting from the modeled tailwater condition at the TMRWF were disregarded and not addressed with CIPs.

CIP 1

CIP 1 includes installing new and upsizing the existing sewer in El Rancho Drive to 12-inch and 15-inch PVC and ultimately connecting a new system to the Reno Sparks Joint Interceptor near G Street. Included in this CIP is the abandonment of the connection between the El Rancho sewer system and the Greenbrae sewer system, which alleviates pressure on the downstream Greenbrae system and ultimately reduces the number of CIP improvements required in CIP 3, CIP 6 and in the Greenbrae system.

CIP 2

CIP 2 includes upsizing the 18th Street and Tyler Way sewers to 15-inch PVC.

CIP 3

CIP 3 includes abandoning the connection to the Probasco Way sewer system and upsizing the E Greenbrae Drive, Quail Street, and Boise Drive sewers to 24-inch PVC. This disconnection alleviates pressure on the Probasco system and reduces the magnitude of improvements required in CIP 6 and in the downstream portions of the Probasco system.

CIP 4

CIP 4 includes upsizing the Prater Way sewer to 15-inch or 18-inch PVC and upsizing the N McCarran Boulevard sewer to 30-inch PVC.

CIP 5

CIP 5 includes upsizing the Springland Drive, Lida Lane and Montezuma Way sewers to 12-inch PVC.

CIP 6

CIP 6 includes upsizing the Stanford Way sewer to 15-inch PVC.

CIP 7

CIP 7 includes upsizing the I Street sewer to 10-inch PVC, the alley sewer to 12-inch PVC and the G Street sewer to 15-inch PVC.

CIP 8

CIP 8 includes upsizing the G Street sewer to 12-inch PVC.

CIP 9

CIP 9 includes upsizing the sewer in the alley between Prater Way and Victorian Avenue to 12-inch PVC.

CIP 10-E

CIP 10-E includes upsizing the Vista Boulevard sewer to 10-inch or 12-inch PVC and upsizing sewer near Lillard Drive to 18-inch PVC.

CIP 11

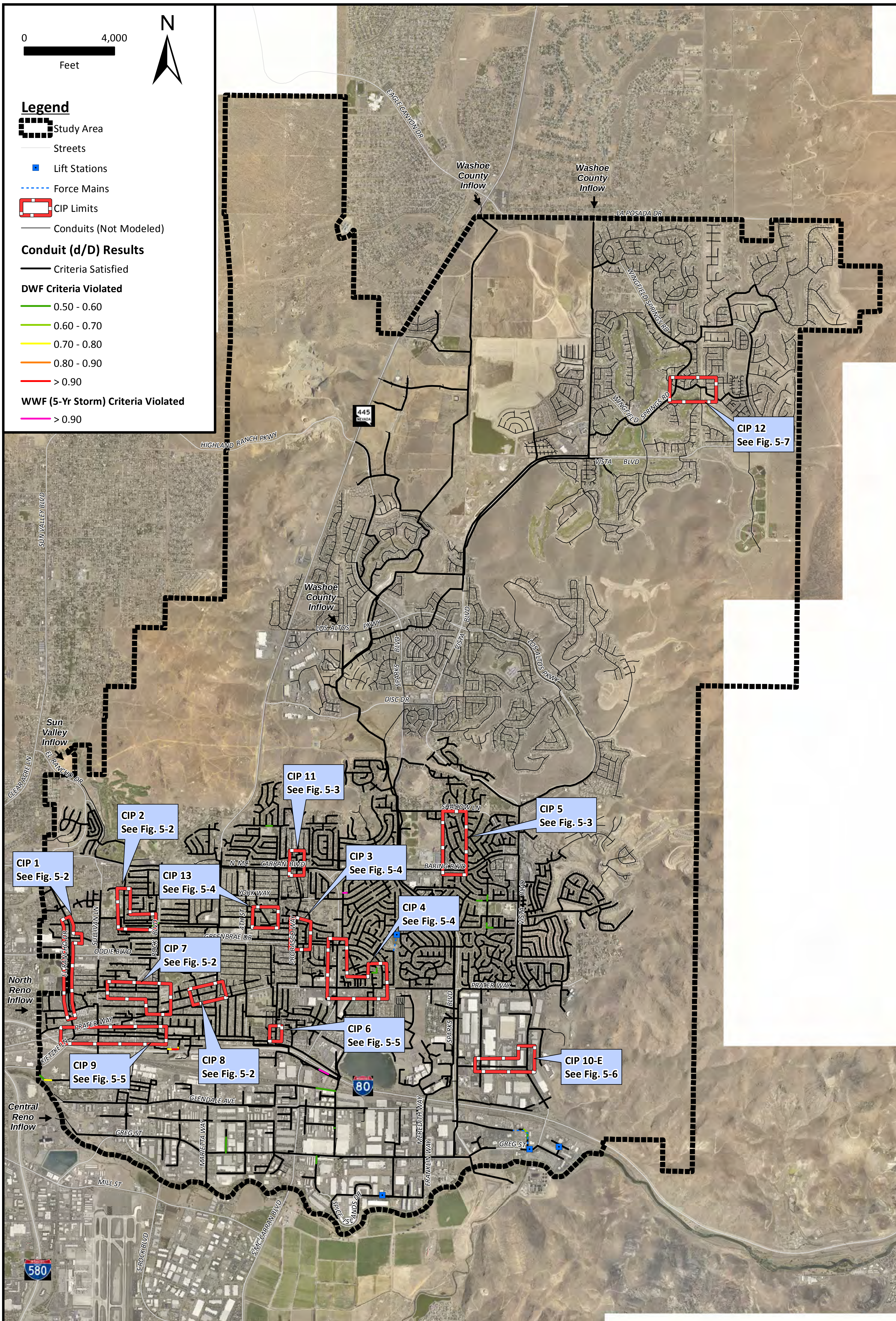
CIP 11 includes upsizing the Probasco Way sewer to 10-inch PVC.

CIP 12

CIP 12 includes upsizing the Centaurus Drive sewer to 15-inch PVC.

CIP 13

CIP 13 includes upsizing the 1st Street sewer to 12-inch PVC.



City of Sparks

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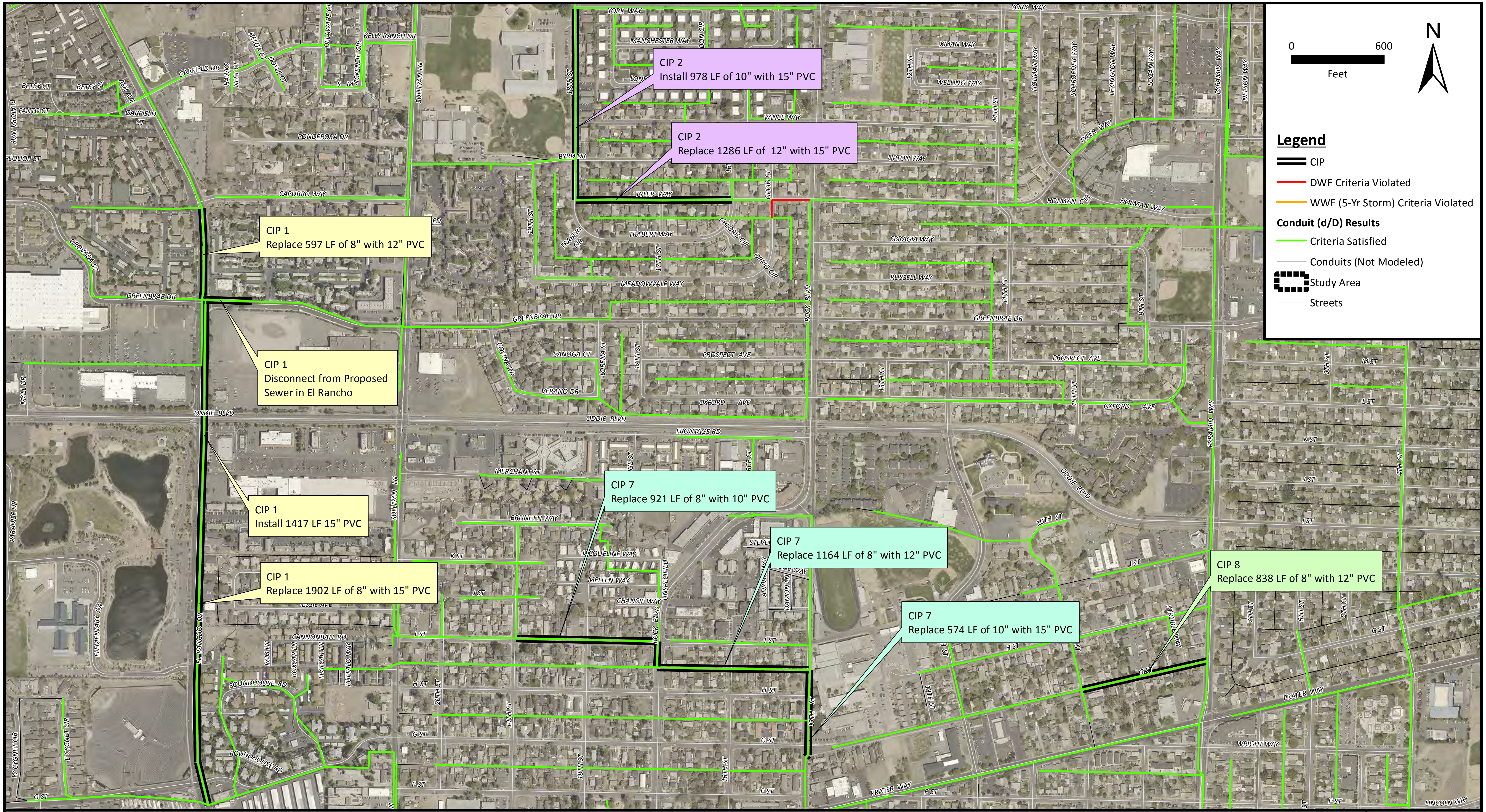
Sewer Model Update

Overall Existing Condition Deficiency CIP Summary Map

Figure 5-1



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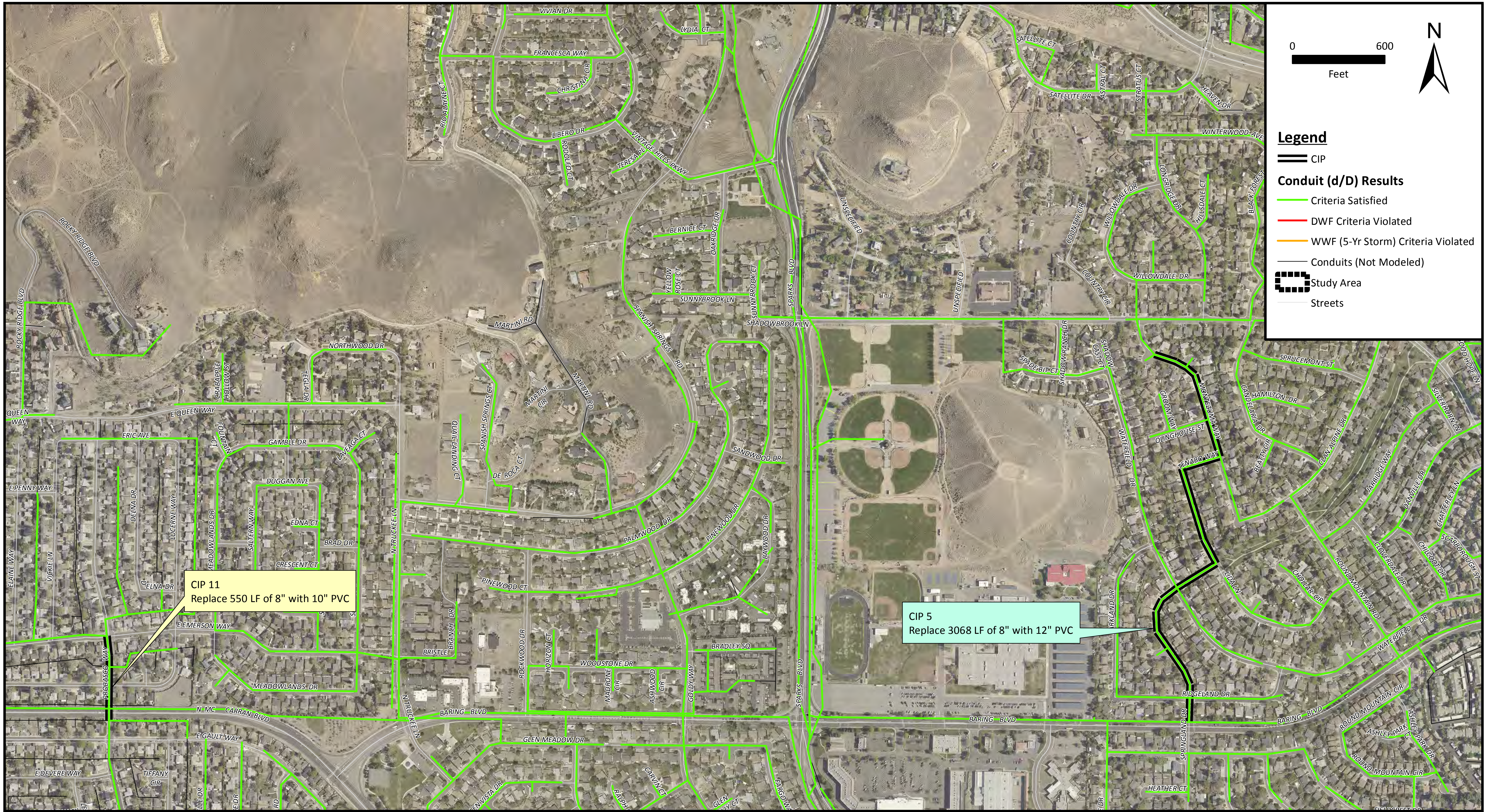
Existing Condition Deficiency CIP Summary Map 1

Figure 5-2



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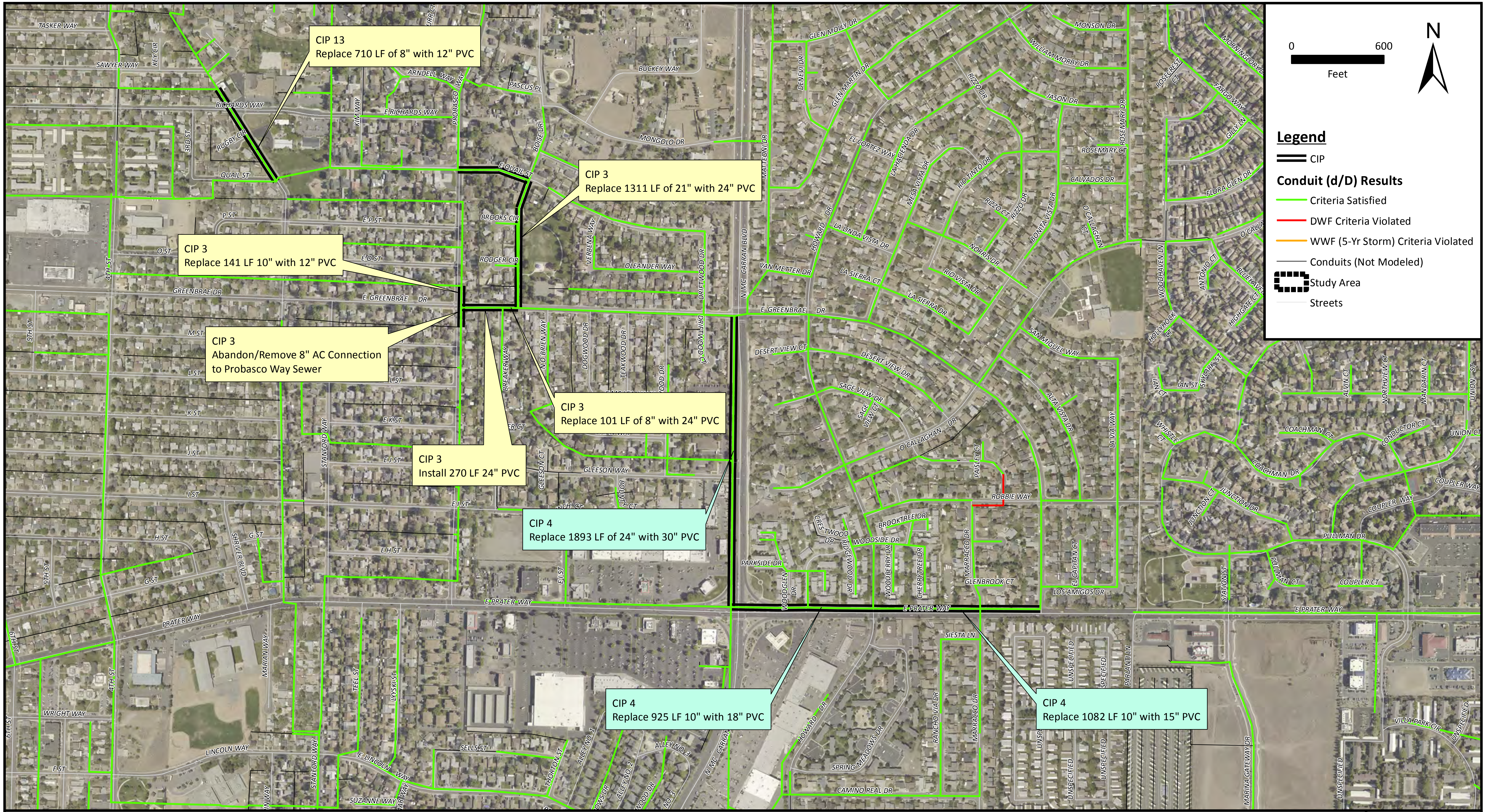
Existing Condition Deficiency CIP Summary Map 2

Figure 5-3



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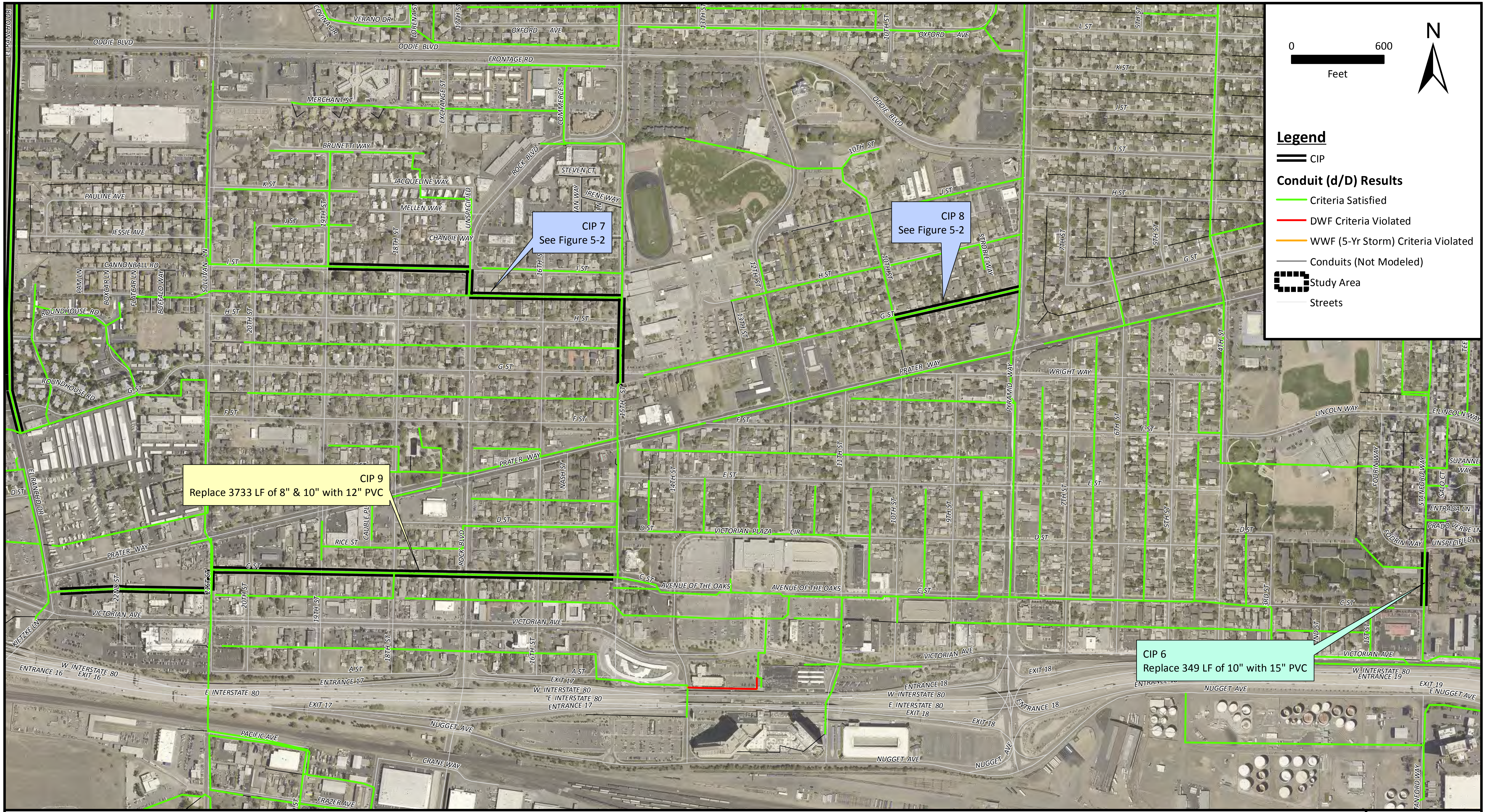
Existing Condition Deficiency CIP Summary Map 3

Figure 5-4



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Existing Condition Deficiency CIP Summary Map 4

Figure 5-5

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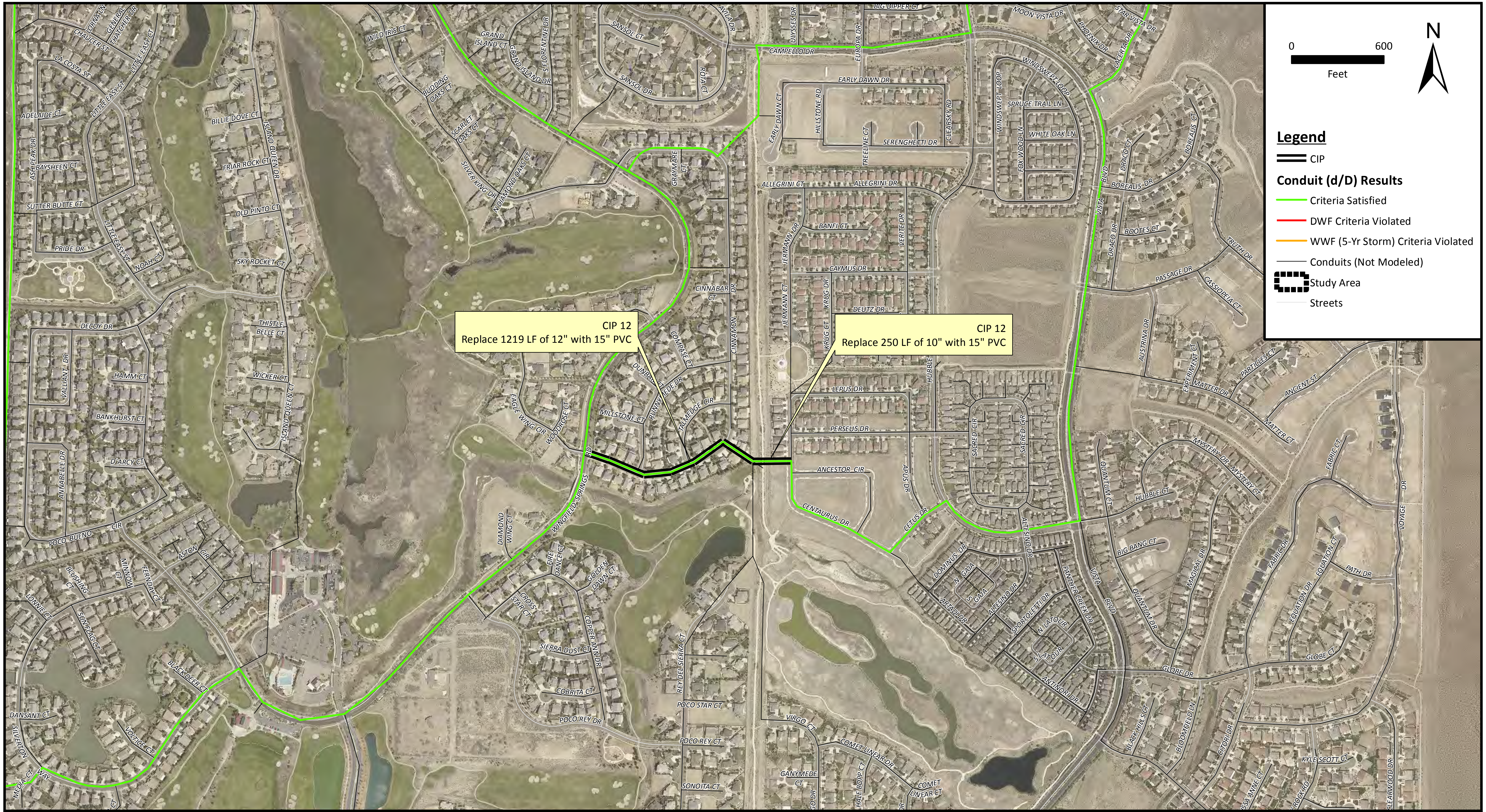
Existing Condition Deficiency CIP Summary Map 5

Figure 5-6



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Sewer Model Update

Existing Condition Deficiency CIP Summary Map 6

Figure 5-7

5.3.2. Buildout Condition Deficiency CIPs

The following generally describes each recommended buildout condition deficiency CIP. **Figure 5-8** serves as a key map to show the location of the various buildout condition deficiency CIPs throughout the City, as well as to display the post-CIP modeling d/D results. **Figure 5-9** through **Figure 5-14** present the individual CIP improvements in greater detail. As discussed in **Section 4.8.2**, flagged deficiencies associated with adverse slopes, smaller main connections to interceptors without a vertical offset, or backwater effects resulting from the modeled tailwater condition at the TMRWF were disregarded and not addressed with CIPs.

CIP 10-F

CIP 10-F includes upsizing the Loop Road sewer to 10-inch PVC, the Vista Boulevard and Lillard Drive sewers to 15-inch PVC, and the line running west to 24-inch or 30-inch PVC. The primary trigger for this CIP is the Copper Canyon development which contributes approximately 0.49 mgd of flow.

CIP 14

CIP 14 includes upsizing the Wingfield Springs Road sewer to 18-inch PVC. The primary triggers for this CIP include Wingfield Springs and The Foothills at Wingfield Springs developments, which contribute approximately 0.27 mgd of combined flow.

CIP 15

CIP 15 includes upsizing the David Allen Parkway sewer to 12-inch PVC. The primary triggers for this CIP include the hospital (APN: 8302418) and Kiley Ranch North residential development, which contribute approximately 0.26 mgd of combined flow.

CIP 16

CIP 16 includes upsizing the Vista Del Rancho and Turnberry Drive sewers to 42-inch PVC. The primary triggers for this CIP include Pioneer Meadows, Kiley Ranch and Stonebrook developments, as well as significant buildout flow contributions from developments in Spanish Springs (Washoe County). Overall, the flow within this system is anticipated to increase by approximately 4.73 mgd in the buildout scenario.

CIP 17

CIP 17 includes upsizing the Greenbrae Drive sewer to 30-inch PVC. The primary triggers for this CIP include septic conversions and infill redevelopment which contribute approximately 0.17 mgd of flow.

CIP 18

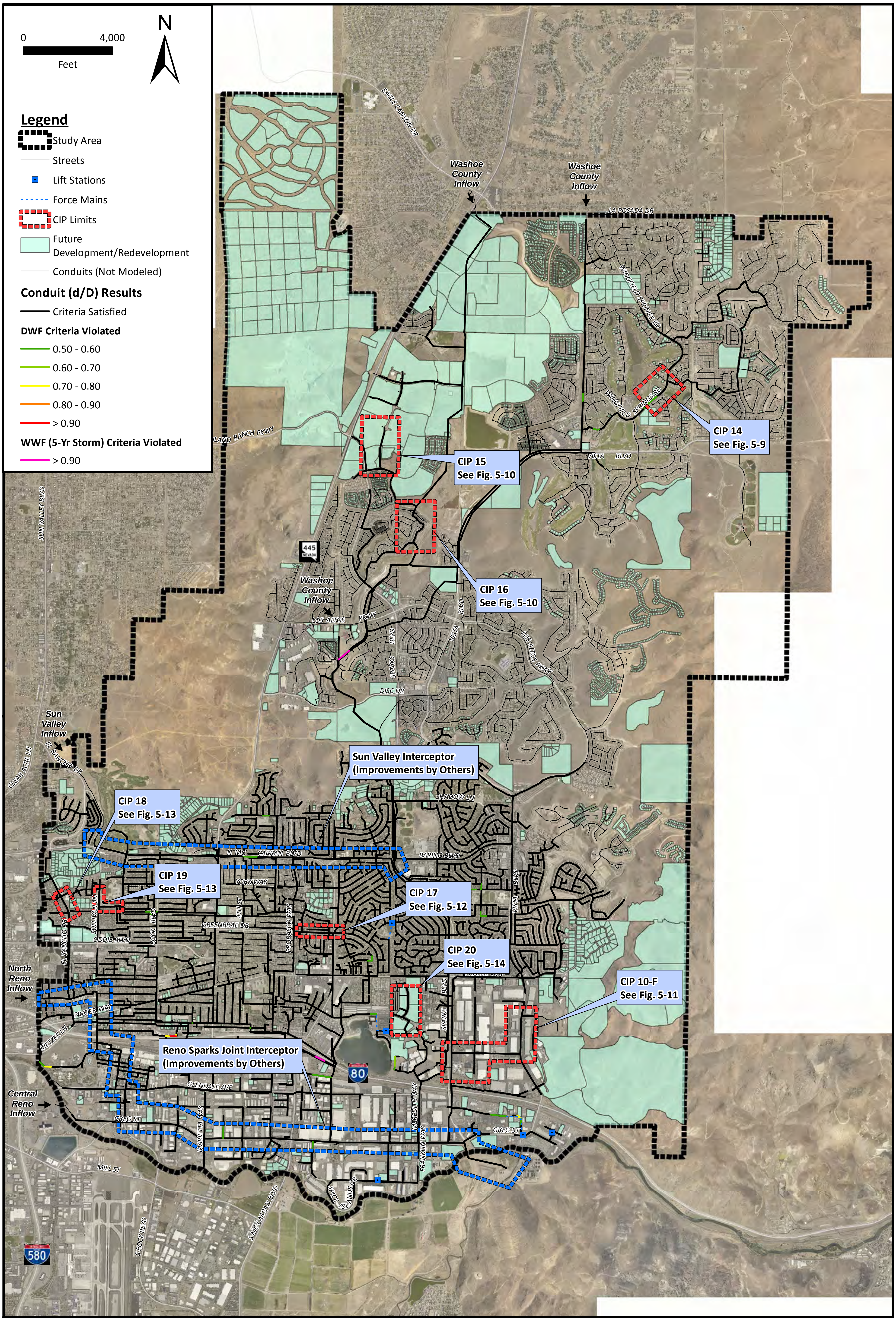
CIP 18 includes upsizing the El Rancho Drive sewer to 10-inch PVC. The primary triggers for this CIP include septic conversions and infill redevelopment which contribute approximately 0.02 mgd of flow.

CIP 19

CIP 19 includes upsizing the Sullivan Lane sewer to 10-inch PVC and the Byrd Drive sewer to 15-inch PVC. The primary triggers for this CIP are septic conversions and infill redevelopment which contribute approximately 0.11 mgd of flow.

CIP 20

CIP 20 includes upsizing the Marina Gateway Drive sewer to 12-inch PVC. The primary triggers for this CIP include the Marina Gateway multi-family unit developments which contribute approximately 0.23 mgd of flow in the buildout scenario.



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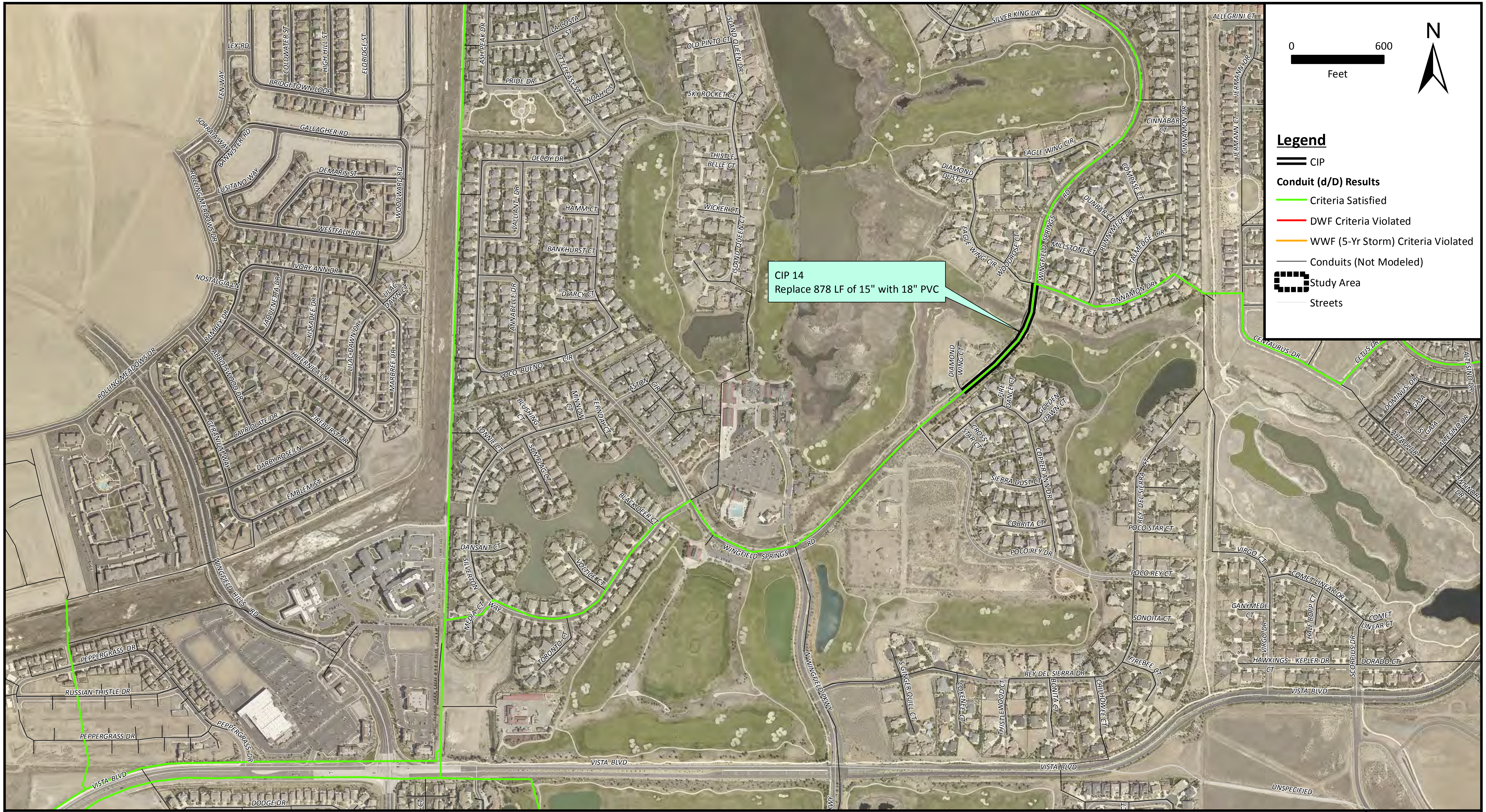
Overall Buildout Condition Deficiency CIP Summary Map

Figure 5-8



City of Sparks

Sewer Model Update

Buildout Condition Deficiency CIP Summary Map 1

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Figure 5-9

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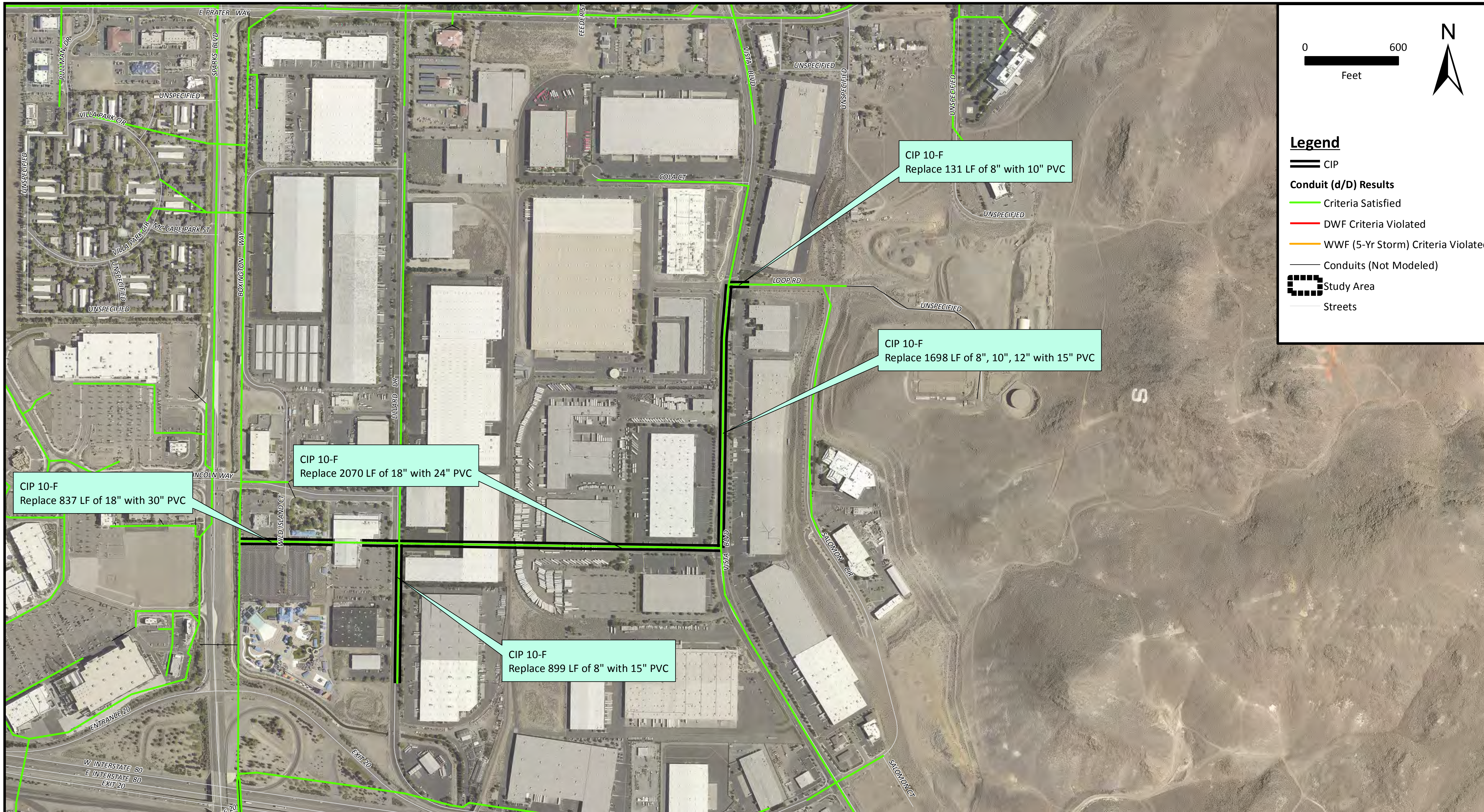
City of Sparks

Sewer Model Update

Buildout Condition Deficiency CIP Summary Map 2

Figure 5-10



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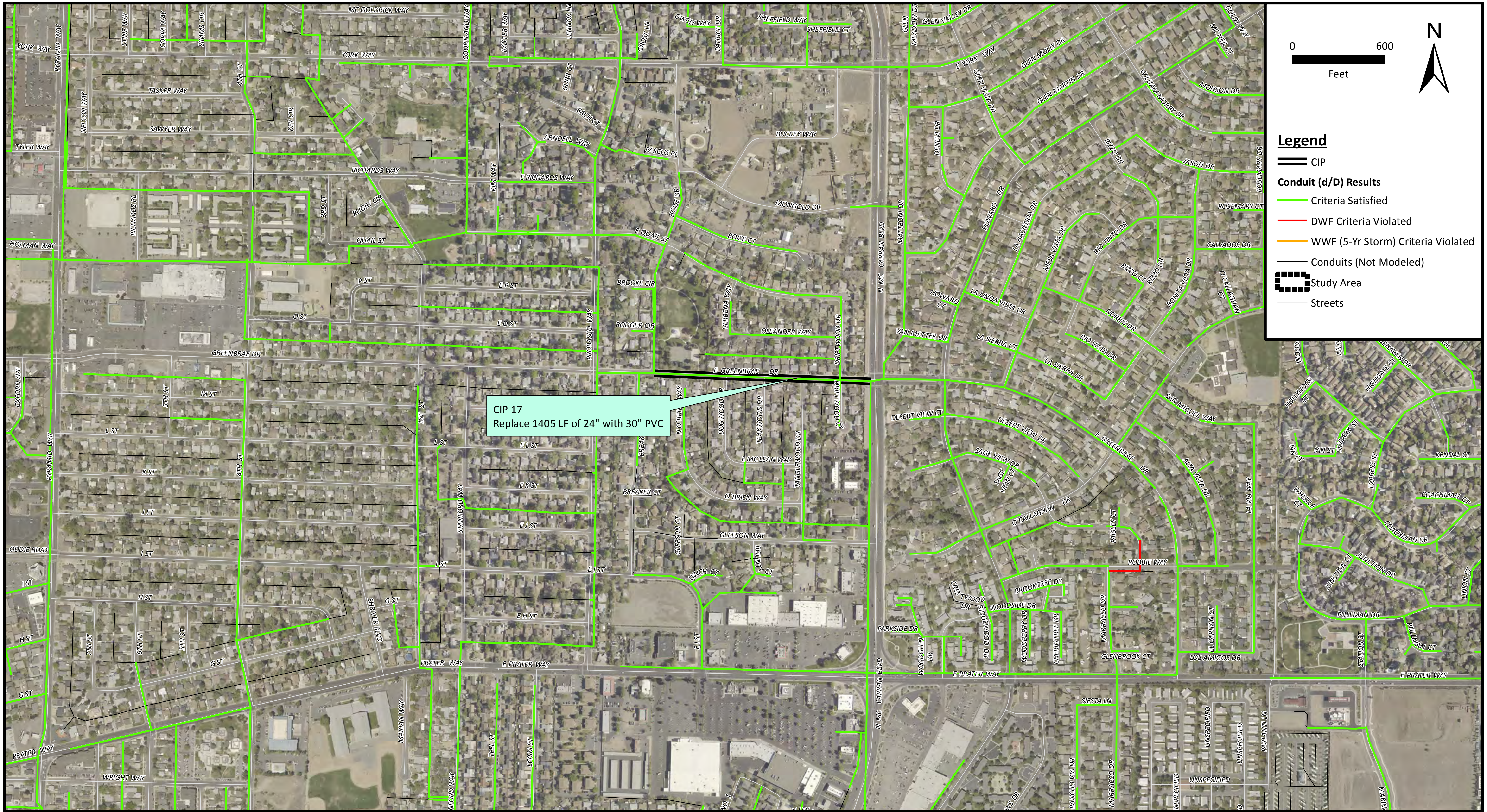
Buildout Condition Deficiency CIP Summary Map 3

Figure 5-11



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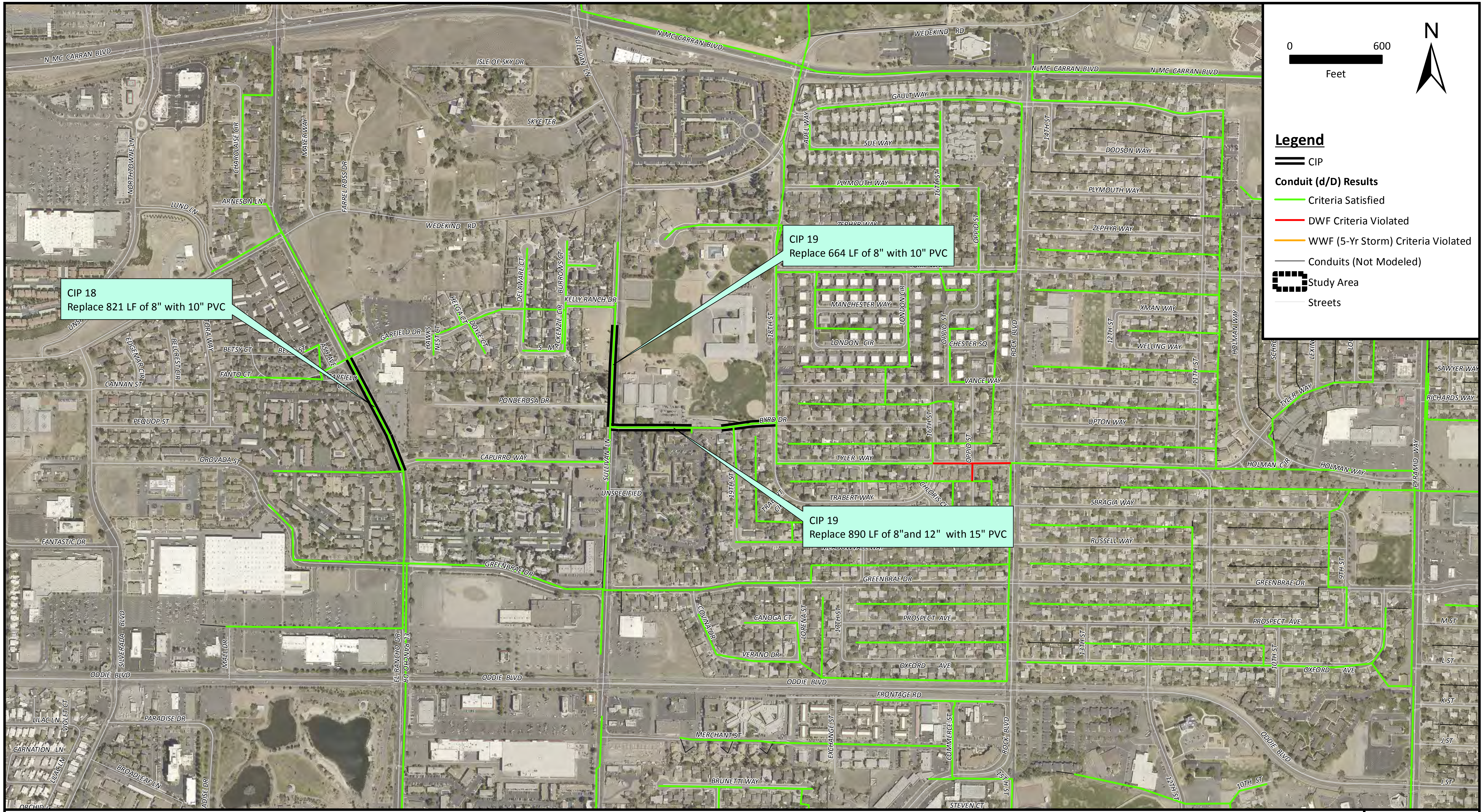
Buildout Condition Deficiency CIP Summary Map 4

Figure 5-12



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Buildout Condition Deficiency CIP Summary Map 5

Figure 5-13

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Sewer Model Update

Buildout Condition Deficiency CIP Summary Map 6

Figure 5-14

5.4. Recommended Capital Improvement Program

The CIP projects identify the facilities required to satisfy the existing system and future development capacity needs based on the City of Sparks' evaluation criteria for the sanitary sewer system. The CIPs presented in the Master Plan focus solely on capacity improvements, as condition assessment was not required as a part of this project. However, condition related improvement projects are also critical in maintaining an effective sewer collection system. As shown in **Table 2-9**, nearly 30% of the sewer collection system is exceeding or approaching 30 years in age, so condition assessment and rehabilitation projects will continue to be a priority for the City in the future, in addition to the capacity related improvements summarized in this Master Plan.

As previously discussed, the CIP projects were subdivided into two main categories, existing condition deficiency CIPs and buildout condition deficiency CIPs, and prioritized into one of four prioritization categories. The total estimated costs of the existing condition deficiency CIPs and the buildout condition deficiency CIPs are approximately $10.24 million and $6.43 million, respectively. The total overall estimated CIP costs for all the recommended CIPs is approximately $16.67 million. Based on the review of the *5-Year Capital Improvement Plan (2015/16 - 2019/20)* for the City of Sparks, the City budgeted approximately $3.4 million annually on sewer related projects over the next 5 years. However, roughly 75% of the allocated funds are focused on projects related to the TMWRF. Excluding the TMWRF and annual contingency for emergency allocated funds, the City budgeted approximately $500,000 annually for sewer rehabilitation projects. Although the construction of some of the CIPs is possible within the current budget, a future rate study is probably necessary to fund all the CIPs necessary to improve the current system deficiencies as well as future CIPs to accommodate planned development and City growth.

6. References

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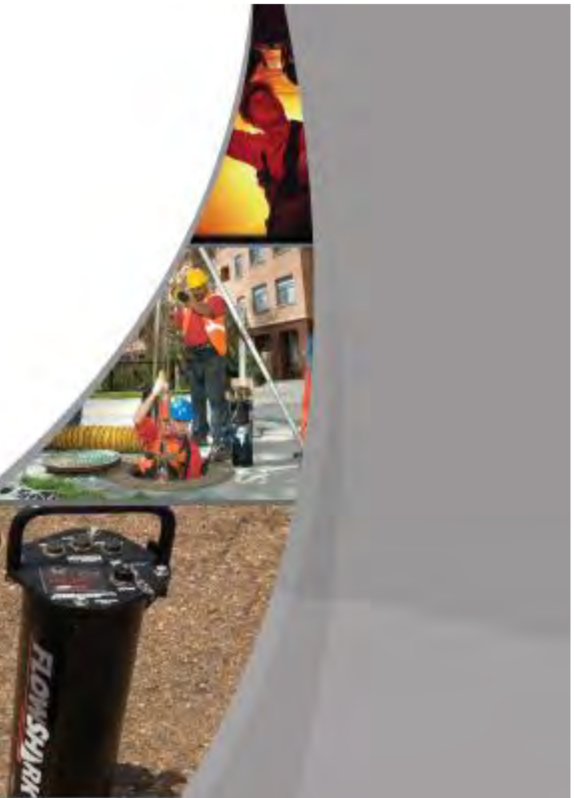
Dan Stucky, P.E.
Project Manager
Atkins
10509 Professional Circle, Suite 102
Reno, NV 89521

dan.stucky@atkinsglobal.com
775-789-9860

Appendices

Appendix A. ADS Temporary Flow Metering Report and Data

Sparks, NV Sewer Model Update
Temporary Flow Monitoring Report
June 18, 2015 – July 01, 2015



Final Report Submitted to:
ATKINS
July 24, 2015

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Flow Monitoring for Sewer Model Update, Sparks, NV

June 18, 2015 - July 1, 2015

Prepared for:

Brian Janes, P.E., CFM
Project Manager, Integrated Water Resources
ATKINS
10509 Professional Circle, Suite 102
Reno, NV 89521

Prepared by:

ADS, LLC
15201 Springdale Street
Huntington Beach, CA 92649

Letter of Transmittal

ADS LLC

July 22, 2015

Brian Janes, P.E., CFM
ATKINS
10509 Professional Circle, Suite 102
Reno, NV 89521

SUBJECT: Flow Monitoring for Sewer Model Update, Sparks, NV

Dear Mr. Janes,
ADS is pleased to submit the Report for the Sparks, NV Sewer Model Update Flow Study conducted on behalf of ATKINS. The metering was conducted for fourteen (14) days at ten (10) locations in the system. The study period is June 18, 2015 - July 1, 2015 . The report contains hourly averaged depth, velocity, and quantity hydrographs as well as daily long tables for the metering period in pdf format. Excel files containing depth, quantity, and velocity entities for each flow monitoring location in 5-minute format are also provided.

In addition, we would be happy to further explain any details about the report that may seem unclear. Should you have any questions or comments, you may contact the Project Manager, Paul Mitchell at (714) 379-9778 ext 223.

Thank you for choosing ADS products and services to meet your flow monitoring needs.

Sincerely,
ADS ENVIRONMENTAL SERVICES

Sean O'Donnell
Data Analyst

15201 Springdale Street • Huntington Beach, CA 92649-1156 • Phone: 714-379-9778

Introduction

Background and Scope

ATKINS entered into an agreement with ADS Environmental Services to conduct flow monitoring at (10) ten metering points located in the City of Sparks, NV. The study was conducted over a 14-day period.   The objective of this study was to measure depth, velocity, and quantify flows for verification of a sewer model.

Project Scope

The scope of this study involved using temporary flow monitors to quantify wastewater flows at the designated locations. Specifically, the study included the following key components.

- Investigate the proposed flow-monitoring sites for adequate hydraulic conditions.
- Flow monitor installations.
- Flow monitor confirmations and data collections.
- Flow data analysis.

Equipment installation was accomplished by June 17, 2015. The monitoring period began on June 18, 2015 and was completed on July 01, 2015 .

Equipment

Flow Monitoring Equipment

The ***ADS FlowShark Triton*** monitor was selected for this project. This flow monitor is an area velocity flow monitor that uses both the Continuity and Manning's equations to measure flow.

The ADS FlowShark Triton monitor consists of data acquisition sensors and a battery-powered microcomputer. The microcomputer includes a processor unit, data storage, and an on-board clock to control and synchronize the sensor recordings. The monitor was programmed to acquire and store depth of flow and velocity readings at 5-minute intervals.

The FS Triton monitor features cross-checking using multiple technologies in each sensor for continuous running of comparisons and tolerances. The FS Triton monitor can support two (2) sets of sensors. The sensor option used for this project was:

The Peak Combo Sensor installed at the bottom of the pipe includes three types of data acquisition technologies.

The ***up looking ultrasonic depth*** uses sound waves from two independent transceivers to measure the distance from the sensor upward toward the flow surface; applying the speed of sound in the water and the temperature measured by sensor to calculate depth.

The ***pressure depth*** is calculated by using a piezo-resistive crystal to determine the difference between hydrostatic and atmospheric pressure. The pressure sensor is temperature compensated and vented to the atmosphere through a desiccant filled breather tube.

To obtain ***peak velocity*,** the sensor sends an ultrasonic signal at an angle upward through the widest cross-section of the oncoming flow. The signal is reflected by suspended particles, air bubbles, or organic matter with a frequency shift proportional to the velocity of the reflecting objects. The reflected signal is received by the sensor and processed using digital spectrum analysis to determine the peak flow velocity.

Installation

Installation of flow monitoring equipment typically proceeds in four steps. First, the site is investigated for safety and to determine physical and hydraulic suitability for the flow monitoring equipment. Second, the equipment is physically installed at the selected location. Third, the monitor is tested to assure proper operation of the velocity and depth of flow sensors and verify that the monitor clock is operational and synchronized to the master computer clock. Fourth, the depth and velocity sensors are confirmed and line confirmations are performed.

In pipes up to 42 inches in diameter, the sensors were mounted on expandable stainless steel rings, inserted at least a foot upstream into influent pipes and tightened against the inside walls of the pipes. Influent pipe installations reduce the influences of turbulence and backwater often caused by changes in channel geometry in manholes.

Data Collection, Confirmation, and Quality Assurance
Data collects were done remotely via wireless connect on a weekly basis via ADS Field Representatives. During the monitoring period, field crews visit each monitoring location to verify proper monitor operation and document field conditions. The following quality assurance steps are taken to assure the integrity of the collected data:

Measure power supplies: monitors were powered by dry cell battery packs. Voltages were recorded and battery packs replaced, as necessary. Separate batteries provided back-up power to memory allowing primary batteries to be replaced without loss of data.

Clock synchronization: Field crews synchronized monitor clocks to master clocks.

Confirm depth and velocity readings: Field crews descended into meter manholes to manually measure depths and velocities and compare them meter readings to confirm that they agreed. They also measured silt levels, if any, in the inverts of the pipes. Silt areas were subtracted from flow areas to compute true areas of flow.

Confirm average velocities through cross-sectional velocity profiles: Since ADS velocity sensors measure peak velocity, field crews collected cross-sectional velocity profiles in order to develop a relationship between peak and average velocity in lines that meet the hydraulic criteria.

Upload and Review Data: Data collected from the monitors were uploaded and reviewed by a Data Analyst for completeness, outliers and deviations in the flow patterns, which indicate system anomalies or equipment failure.

Methodology

Flow Quantification Methods
There are two main equations used to measure open channel flow: the ***Continuity Equation*** and the ***Manning Equation.*** The Continuity Equation, which is considered the most accurate, can be used if both depth of flow and velocity are available. In cases where velocity measurements are not available or not practical to obtain, the Manning Equation can be used to estimate velocity from the depth data based on

certain physical characteristics of the pipe (i.e. the slope and roughness of the pipe being measured). However, the Manning equation assumes uniform, steady flow hydraulic conditions with non-varying roughness, which are typically invalid assumptions in most sanitary sewers. The Continuity Equation was used exclusively for this study.

Continuity Equation

The Continuity Equation states that the flow quantity (Q) is equal to the wetted area (A) multiplied by the average velocity (V) of the flow.

$$Q = A * V$$

This equation is applicable in a variety of conditions including backwater, surcharge, and reverse flow.

Data Analysis and Presentation

Data Analysis

A flow monitor is typically programmed to collect data at either 15-minute or 5-minute intervals throughout the monitoring period. The monitor stores raw data consisting of (1) the ultrasonic depth, (2) the peak velocity and (3) the pressure depth. The data is imported into ADS's proprietary software and is examined by a data analyst to verify its integrity. The data analyst also reviews the daily field reports and site visit records to identify conditions that would affect the collected data.

Velocity profiles and the line confirmation data developed by the field personnel are reviewed by the data analyst to identify inconsistencies and verify data integrity. Velocity profiles are reviewed and an average to peak velocity ratio is calculated for the site. This ratio is used in converting the peak velocity measured by the sensor to the average velocity used in the Continuity equation. The data analyst selects which depth sensor entity will be used to calculate the final depth information. Silt levels present at each site visit are reviewed and representative silt levels established.

Occasionally the velocity sensor's performance may be compromised resulting in invalid readings sporadically during the monitoring period. This is generally caused by excessive debris (silt) blocking the sensor's crystals, shallow flows (~< 2") that may drop below the top of the sensor or very clear flows lacking the particles needed to measure rate. In order to use the Continuity equation to quantify the flow during these periods, a Data Analyst and/or Engineer will use the site's historical pipe curve (depth vs. velocity) data along with valid field confirmations to reconstitute and replace the false velocity recordings with expected velocity readings for a given historical depth along the curve.

Selections for the above parameters can be constant or can change during the monitoring period. While the data analysis process is described in a linear manner, it often requires an iterative approach to accurately complete.

Data Presentation

This type of flow monitoring project generates a large volume of data. To facilitate review of the data, results have been provided in graphical and tabular formats. The flow data is presented graphically in the form of scattergraphs and hydrographs. Hydrographs are based on hourly averaging. Tables are provided in daily average format. These tables show the flow rate for each day, along with the daily minimum and maximums, the times they were observed, the total daily flow, and total flow for the month (or monitoring period). A sewer flow schematic showing the relative location of each of the sites has been provided for reference.

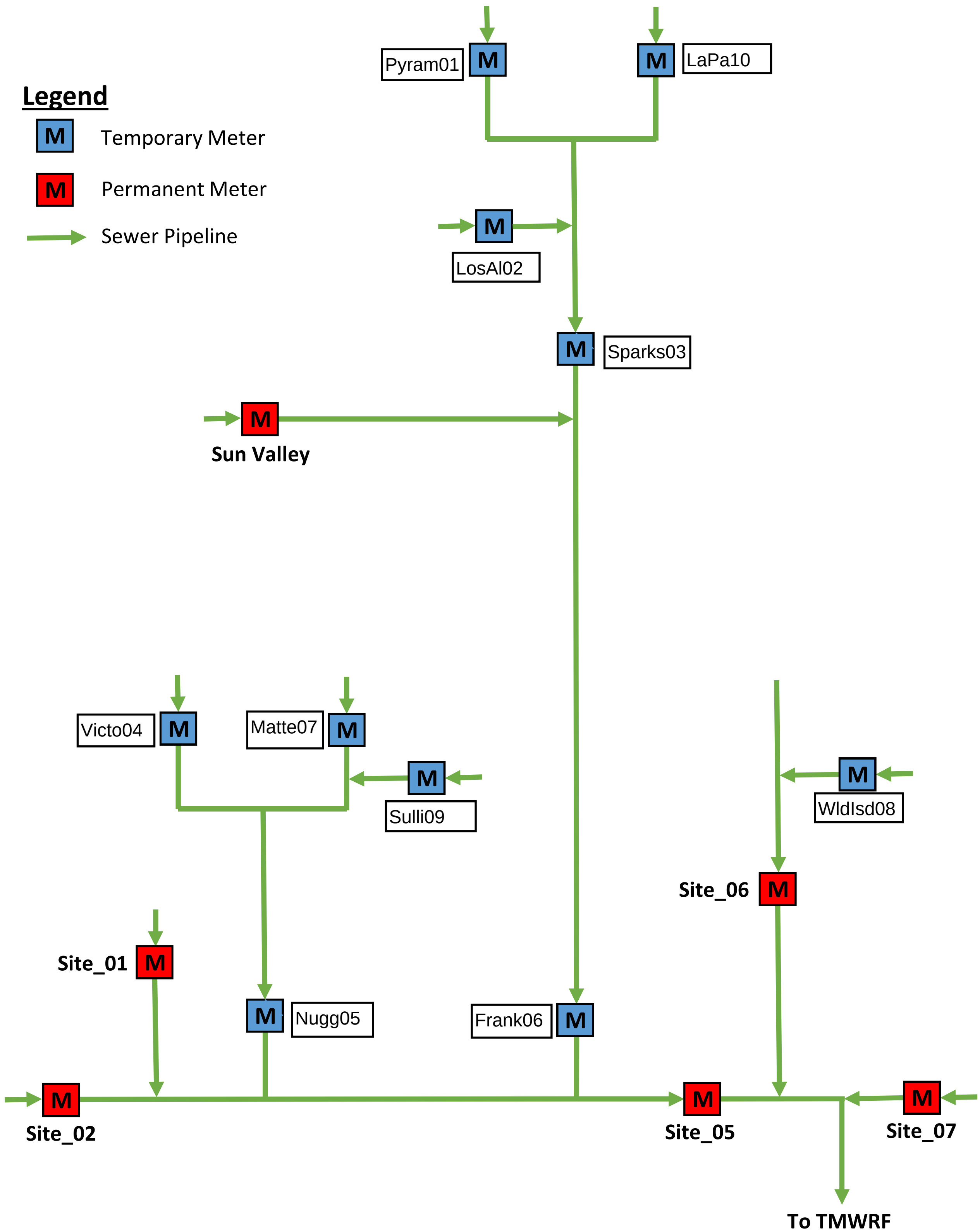
The following explanation of terms may aid in interpretation of the tables and hydrographs.

DEPTH - Final calculated depth measurement (in inches)

QUANTITY - Final calculated flow rate (in MGD)

VELOCITY - Final calculated flow velocity (in feet per second)

REPORT TOTAL - Total volume of flow recorded for the indicated time period (in MG)



City of Sparks Sewer Model Update

Flow Meter Schematic

Site Commentary

Site Information

Frank06	
Pipe Dimensions	59.63" x 60.63"
Silt Level	2.17"

Overview

Site Frank06 functioned under normal conditions during the period Thursday, June 18, 2015 to Wednesday, July 01, 2015 . Surcharge conditions were experienced daily at this location. Review of the scattergraph shows that flow in this line experienced backwater conditions throughout the study. An average silt measurement of 2.17 inches was recorded during field visits. The near continuous backwater conditions, along with sediment, results in a data set that is of lower confidence than typical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This line is located downstream of temporary location Sparks03 (See Flow Meter Schematic). A review of balancing indicated no problems. A net flow of 2.039 MGD was reported for the period.

Observations

Average flow depth, velocity, and quantity data observed during Thursday, June 18, 2015 to Wednesday, July 01, 2015 , along with observed minimum and maximum data, are provided in the following table. The values presented are based on 5-minute data. In regards to depth, this site flows at more than 2.0 feet above the crown of the pipe at its recorded hourly peak depth of 86.15 inches and approximately 72% full during the typical average depth of 43.16 inches.

Observed Flow Conditions			
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	43.16	0.74	5.287
Minimum	14.14	0.23	1.708
Maximum	89.71	1.86	7.906
Time of Minimum	6/28/2015 7:30 AM	6/24/2015 9:40 AM	6/28/2015 8:40 AM
Time of Maximum	6/30/2015 9:15 PM	6/25/2015 10:50 AM	6/26/2015 9:10 AM

Data Quality

Data uptime observed during the Thursday, June 18, 2015 to the Wednesday, July 01, 2015 monitoring period is provided in the table below. Based upon the quality

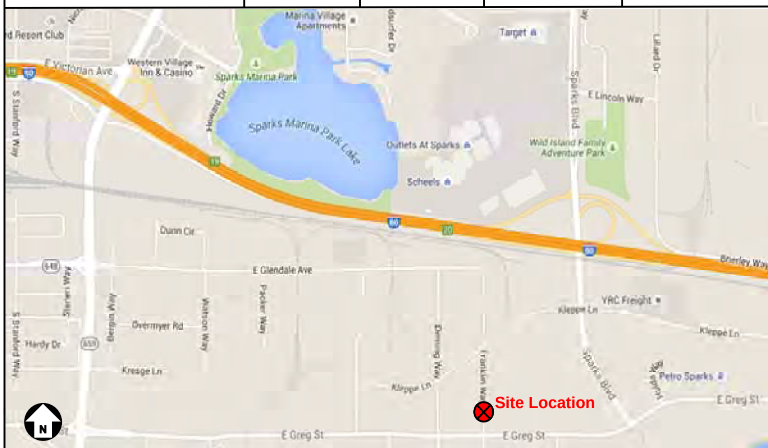
and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

ADS Site Report

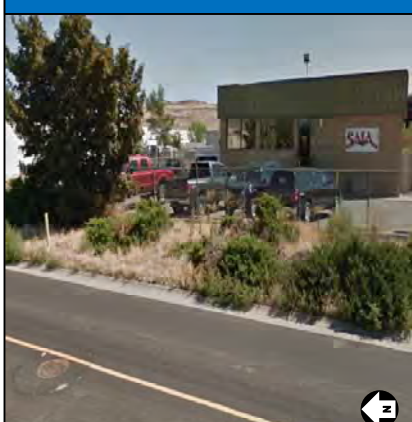
Quality Form

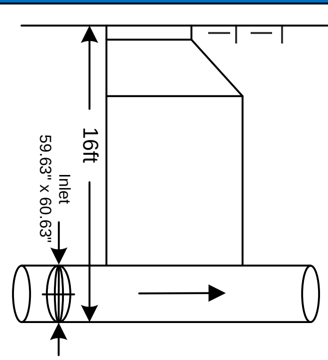
Project Name:	Sparks.Atkins.TFM.NV15	**Project No.**	22038	**City:**	Sparks, NV	**FM Initials:**	SW
Site Name:	Frank06	**Investigate Date:**	6/15/15	**Monitor Type**	Peak Doppler		
Address/Location:	1300 Franklin Way			**Monitor Model**	ADS Triton+		
				Data Acquisition	Wireless		
				Manhole ID	MH 030256		
Access: Drive	**Type of System:**	Sanitary [X]	Storm [ ]	Combined [ ]	**Pipe Height:**	59.63"	
					Pipe Width:	60.63"	



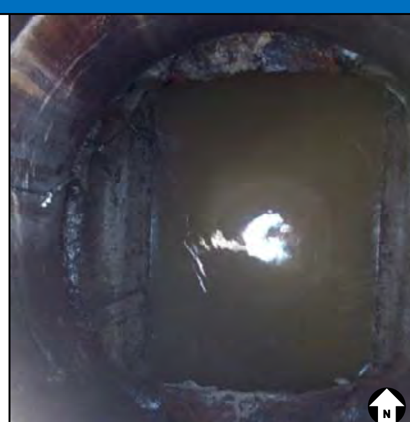
Investigation Information:		**Manhole Information:**	
Date/Time of Install:	6/16/15 @ 10:10		
Site Hydraulics:	Smooth and deep flow with some debris	**Manhole Material / Condition**	Concrete / Good
Upstream Input: (L/S, P/S)	N/A	**Pipe Material / Condition:**	Concrete w/Steel Lining / Good
Upstream Manhole:	1 inlet / 1 outlet	**Land Use:**	Residential [ ] Commercial [X] Industrial [ ] Trunk [ ]
Downstream Manhole:	1 inlet / 1 outlet		
Depth of Flow (DOF):	19.63" +/- 0.25"	**Safety Notes**	
Range (Air DOF):	40.00" +/- 0.25"	Standard Traffic Control (center lane closed)	
Peak Velocity:	2.00 fps		
Silt:	2.00 Inches		

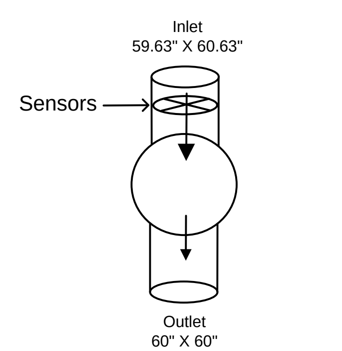
Other Information:





Cross Section





Plan

Installation Information		**Backup**	**Yes**	**No**	**?**	**Distance**
Installation Type:	Special	Trunk	[ ]	[X]	[ ]	
Sensors Devices:	Water Ultrasonic/ Pressure/ Velocity	Lift / Pump Station	[ ]	[X]	[ ]	
Surcharge Height:	~70"	WWTP	[X]	[ ]	[ ]	Line used as storage
Rain Gauge Zone:	NA	Other	[ ]	[X]	[ ]	

Additional Site Information / Comments:

SCATTERGRAPH REPORT

Frank06

Flow Monitor

Frank06

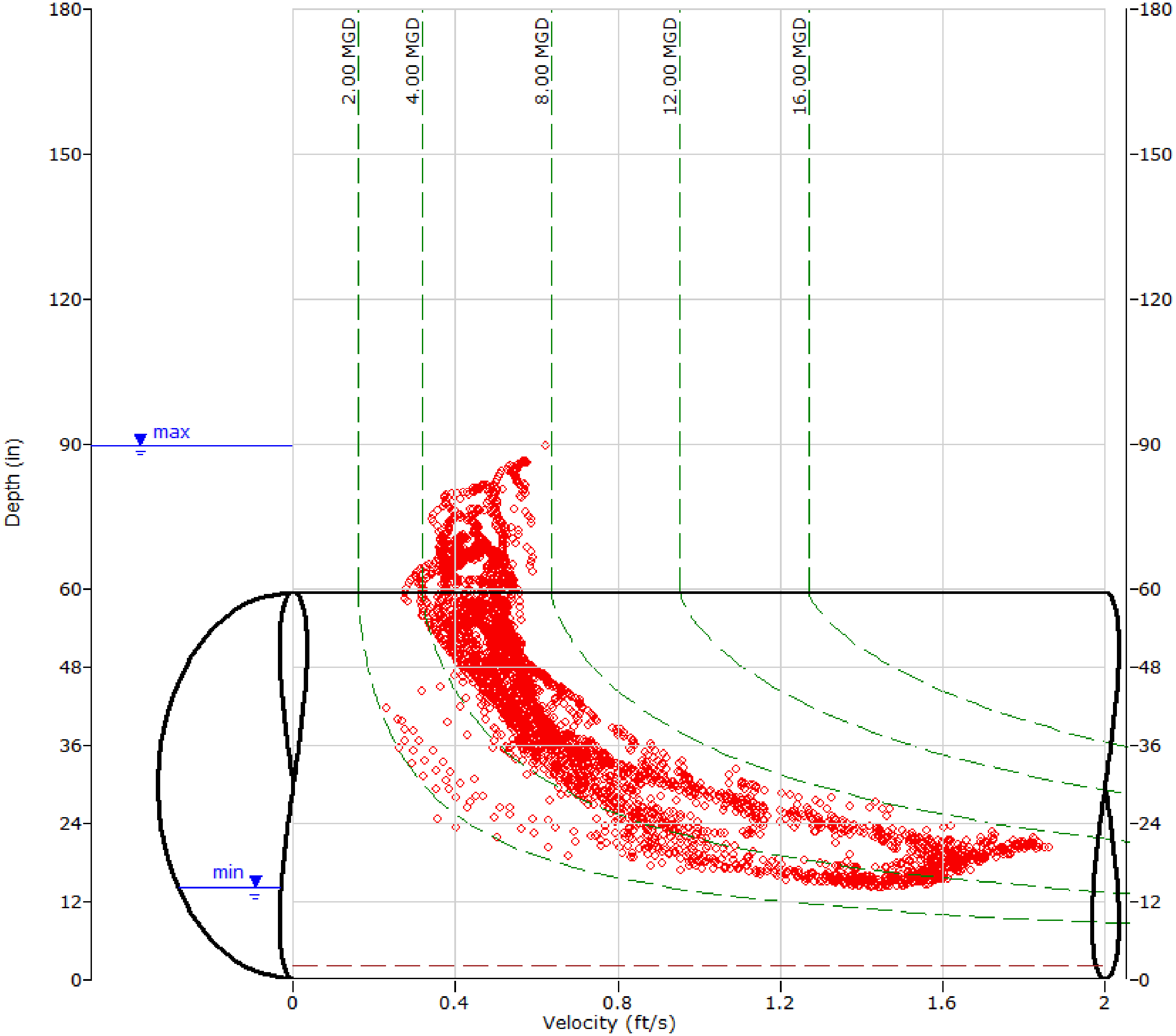
Pipe Height
59.63 in

Report Period

6/18/2015
To
7/1/2015

Legend

Depth - Velocity
Iso-Q™
Silt
Min-Max Depth

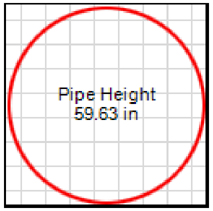


ADS ENVIRONMENTAL SERVICES

HYDROGRAPH REPORT

Frank06

Flow Monitor	**Frank06**

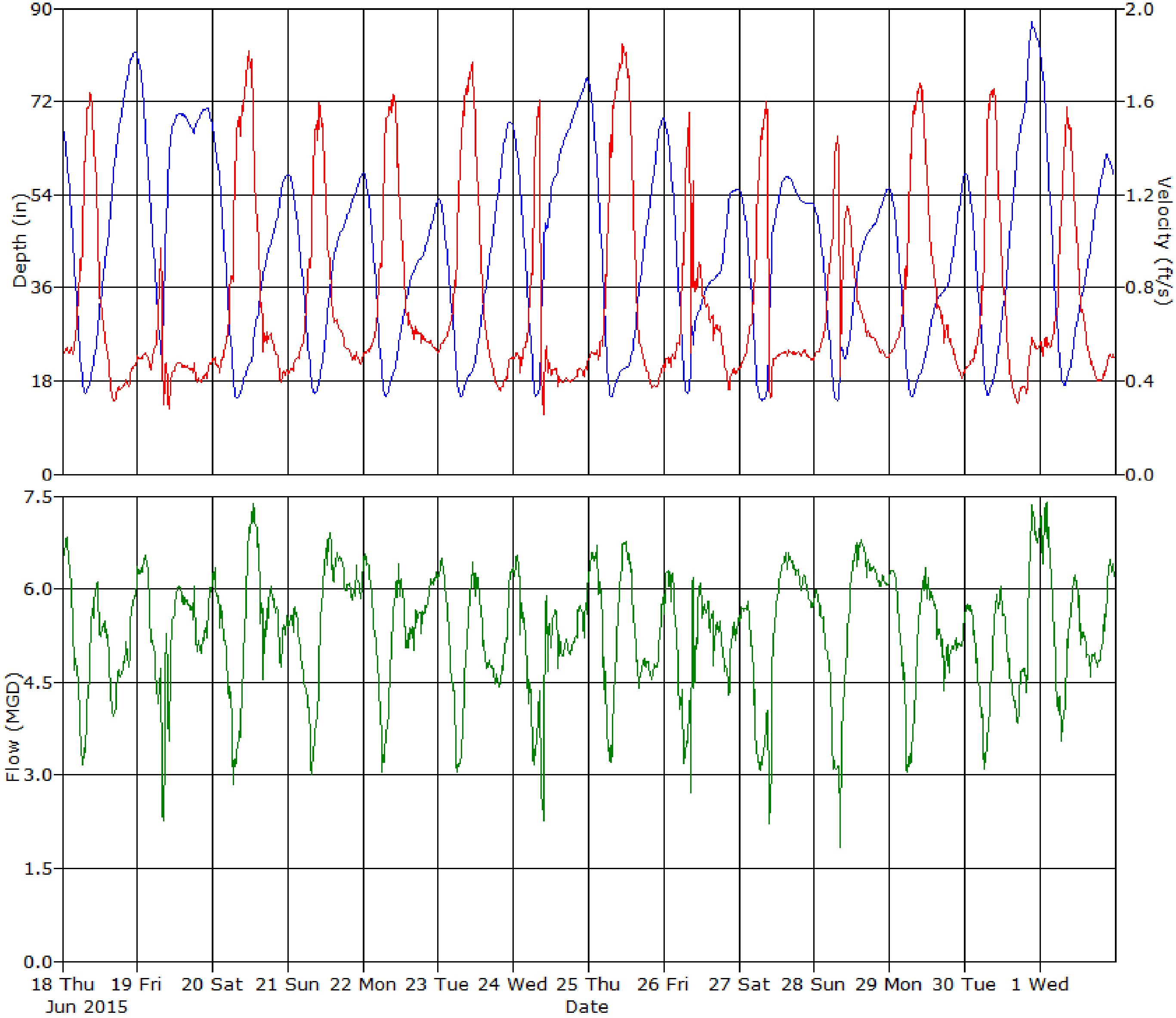


Report Period

6/18/2015
To
7/1/2015

Legend

- Depth
- Velocity
- Quantity



ADS ENVIRONMENTAL SERVICES

Daily Tabular Report For The Period 6/18/2015 - 7/1/2015

Frank06, Pipe Height: 59.63 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
6/18/2015	07:30	15.54	23:20	81.54	48.15	17:00	0.31	08:50	1.64	0.71	06:40	3.059	01:35	6.846	5.092	5.092	
6/19/2015	07:45	22.24	00:00	81.07	61.37	09:55	0.27	07:45	1.15	0.48	08:40	2.224	18:10	6.809	5.347	5.347	
6/20/2015	07:55	14.67	00:00	67.15	37.74	21:55	0.39	11:35	1.84	0.87	06:40	2.739	13:00	7.671	5.399	5.399	
6/21/2015	08:40	15.65	23:55	58.14	40.18	00:25	0.43	10:00	1.61	0.76	07:40	2.933	13:35	7.000	5.537	5.537	
6/22/2015	07:20	15.11	00:15	58.23	36.27	00:00	0.50	09:25	1.70	0.83	06:10	2.706	00:40	6.571	5.429	5.429	
6/23/2015	07:10	14.86	22:35	68.01	38.58	20:05	0.36	11:00	1.79	0.84	06:55	2.889	01:05	6.523	5.118	5.118	
6/24/2015	07:20	15.08	23:35	76.60	53.26	09:40	0.23	08:20	1.65	0.57	09:40	2.163	01:30	6.638	5.041	5.041	
6/25/2015	07:20	14.98	00:00	76.09	40.15	20:25	0.37	10:50	1.86	0.90	06:30	2.922	12:05	6.813	5.317	5.317	
6/26/2015	07:35	15.55	00:00	68.79	40.57	21:00	0.35	08:05	1.57	0.68	08:55	2.598	09:10	7.906	5.131	5.131	
6/27/2015	07:20	14.31	15:15	57.51	44.00	10:05	0.26	08:50	1.60	0.67	10:05	2.032	16:05	6.606	5.323	5.323	
6/28/2015	07:30	14.14	23:55	55.31	37.85	08:40	0.35	07:40	1.45	0.76	08:40	1.708	15:05	6.830	5.492	5.492	
6/29/2015	07:15	14.94	23:55	57.43	34.06	23:20	0.41	09:55	1.71	0.87	05:35	2.695	11:25	6.422	5.169	5.169	
6/30/2015	07:35	15.19	21:15	89.71	48.15	17:00	0.30	09:20	1.66	0.72	06:40	2.876	21:15	7.849	5.121	5.121	
7/1/2015	07:55	17.18	00:00	82.50	43.93	19:20	0.40	08:50	1.59	0.74	07:10	3.401	02:25	7.463	5.495	5.492	

Report Summary For The Period 6/18/2015 - 7/1/2015

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			74.009
Avg	43.16	0.74	5.287

Site Commentary

Site Information

LaPa10	
Pipe Dimensions	14.38" x 14.38"
Silt Level	0.00"

Overview

Site LaPa10 functioned under normal conditions during the period Thursday, June 18, 2015 to Wednesday, July 01, 2015 . No surcharge conditions were experienced at this location (See Observation Table For More Details). Review of the scattergraph shows that flow in this line remained free-flowing throughout the study.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This line is located upstream of location Sparks03. A review of balancing indicated no problems (See Sparks03 Site Commentary For More Details).

Observations

Average flow depth, velocity, and quantity data observed during Thursday, June 18, 2015 to Wednesday, July 01, 2015 , along with observed minimum and maximum data, are provided in the following table. The values presented are based on 5-minute data. In regards to depth, this site flows at approximately 17% full at its recorded hourly peak depth of 2.40 inches and approximately 13% full during the typical average depth of 1.86 inches.

Observed Flow Conditions			
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	1.86	0.77	0.045
Minimum	1.14	0.12	0.003
Maximum	2.61	1.27	0.109
Time of Minimum	6/19/2015 4:20 AM	6/19/2015 4:15 AM	6/19/2015 4:15 AM
Time of Maximum	6/28/2015 10:05 AM	6/21/2015 10:40 AM	6/28/2015 10:05 AM

Data Quality

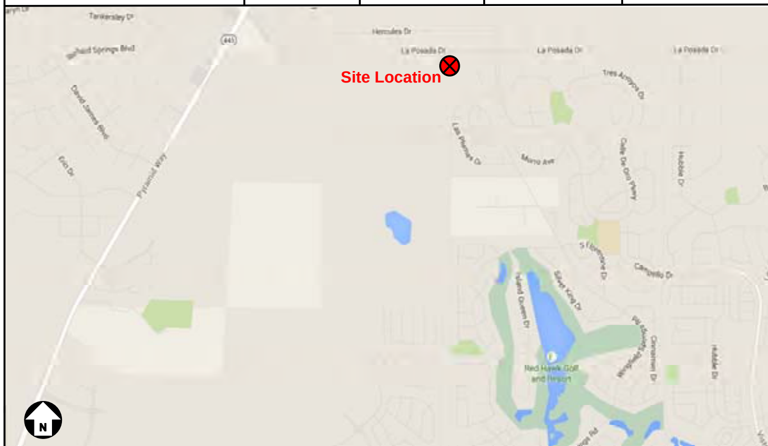
Data uptime observed during the Thursday, June 18, 2015 to the Wednesday, July 01, 2015 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

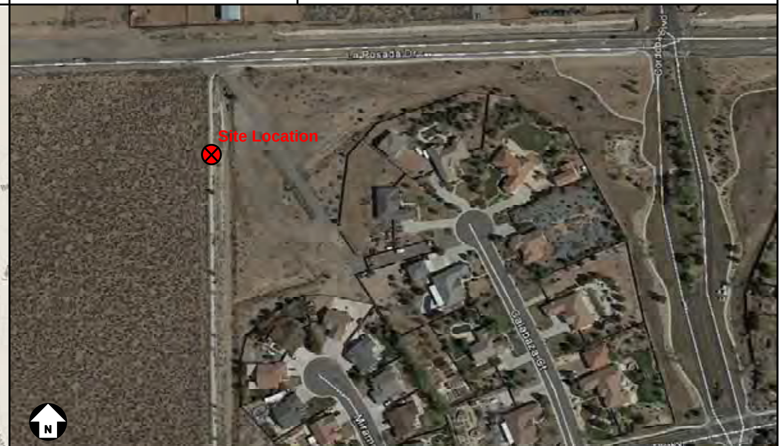
Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

ADS ENVIRONMENTAL SERVICES

ADS Site Report — Quality Form

Project Name: Sparks.Atkins.TFM.NV15	**Project No.** 22038	**City:** Sparks, NV	**FM Initials:** SW
Site Name: LaPa10	**Investigate Date:** 6/15/15	**Monitor Type**	Peak Doppler
Address/Location:	8091 Calabaza Ct (Behind residence on bike trail)	**Monitor Model**	ADS Triton+
		Data Acquisition	Wireless
		Manhole ID	MH 004937
Access: Drive	**Type of System:** Sanitary [X] Storm [ ] Combined [ ]	**Pipe Height:**	14.38"
		Pipe Width:	14.38"





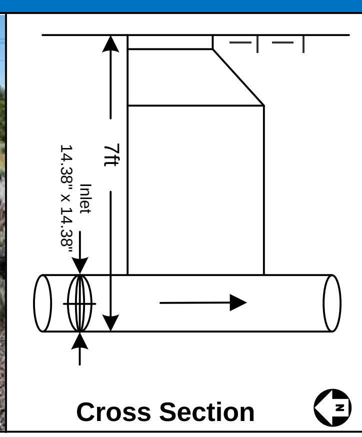
Investigation Information:

Date/Time of Install:	6/16/15 @ 16:00
Site Hydraulics:	Low depth, smooth, and slow moving flow
Upstream Input: (L/S, P/S)	N/A
Upstream Manhole:	2 inlets / 1 outlet
Downstream Manhole:	1 inlet / 1 outlet
Depth of Flow (DOF):	1.75" +/- 0.25"
Range (Air DOF):	12.63" +/- 0.25"
Peak Velocity:	0.80 fps
Silt:	0.00 Inches

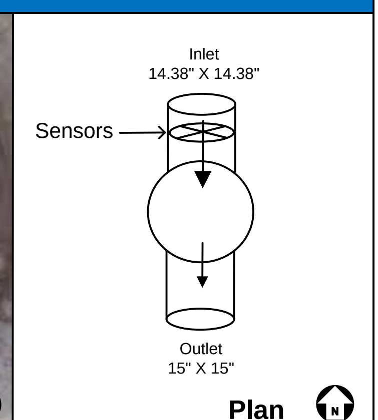
Manhole Information:

Manhole Material / Condition	Concrete / Good
Pipe Material / Condition:	PVC / Good
Land Use:	Residential [X] Commercial [ ] Industrial [ ] Trunk [ ]
Safety Notes	
	Need pedestrian barricade

Other Information:



Cross Section

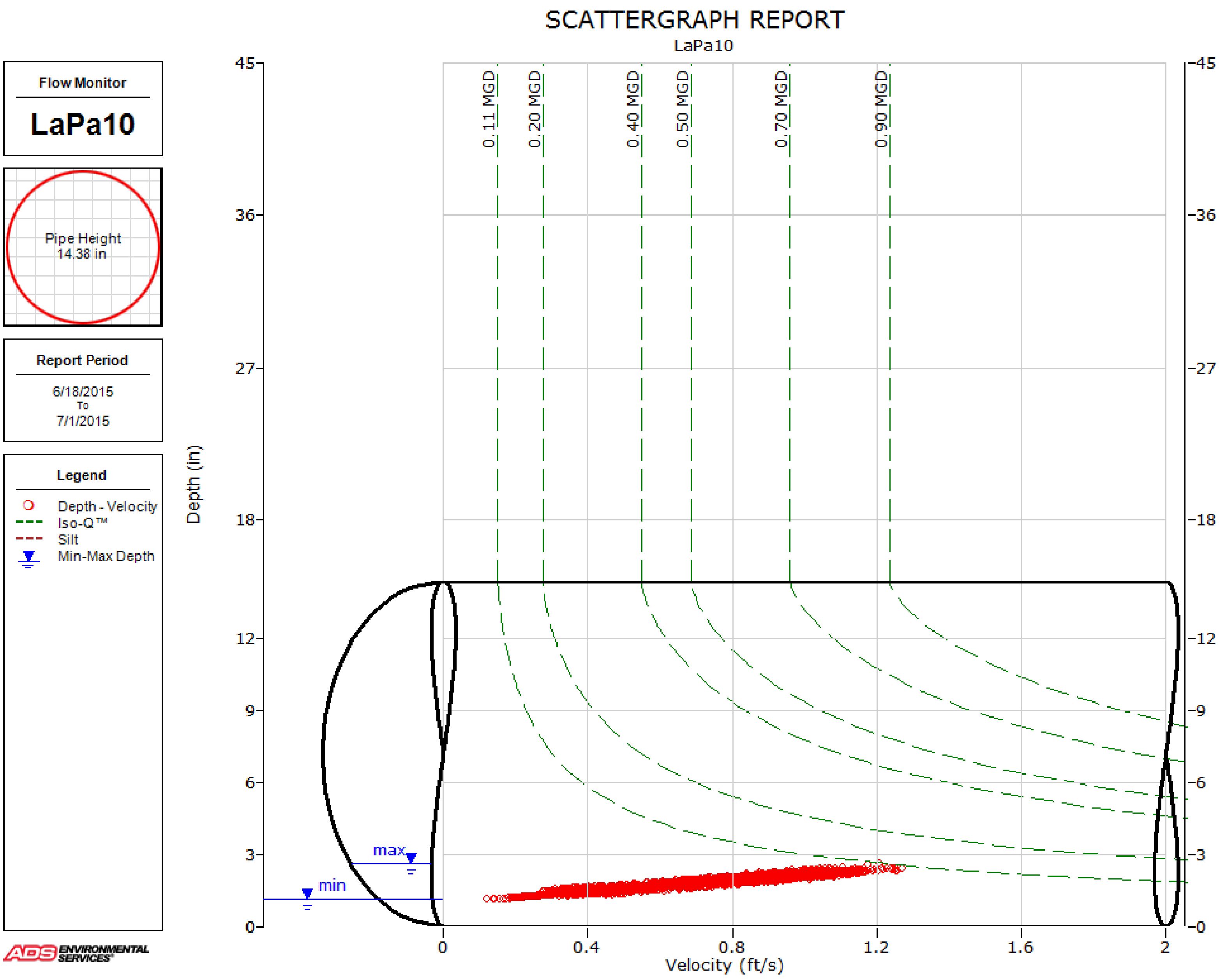


Plan

Installation Information	
Installation Type:	Ring
Sensors Devices:	Water Ultrasonic/ Pressure/ Velocity
Surcharge Height:	0
Rain Gauge Zone:	NA

Backup	Yes	No	?	Distance
Trunk	[ ]	[X]	[ ]	
Lift / Pump Station	[ ]	[X]	[ ]	
WWTP	[ ]	[X]	[ ]	
Other	[ ]	[X]	[ ]	

Additional Site Information / Comments:

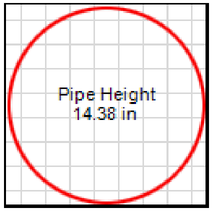

Flow Monitor
LaPa10
Pipe Height
14.38 in
Report Period
6/18/2015
To
7/1/2015
Legend
Depth - Velocity
Iso-Q™
Silt
Min-Max Depth
ENVIRONMENTAL SERVICES
SCATTERGRAPH REPORT
LaPa10
0.11 MGD
0.20 MGD
0.40 MGD
0.50 MGD
0.70 MGD
0.90 MGD
Depth (in)
Velocity (ft/s)
max
min
45
36
27
18
12
9
6
3
0
0.4
0.8
1.2
1.6
2

HYDROGRAPH REPORT

LaPa10

Flow Monitor

LaPa10

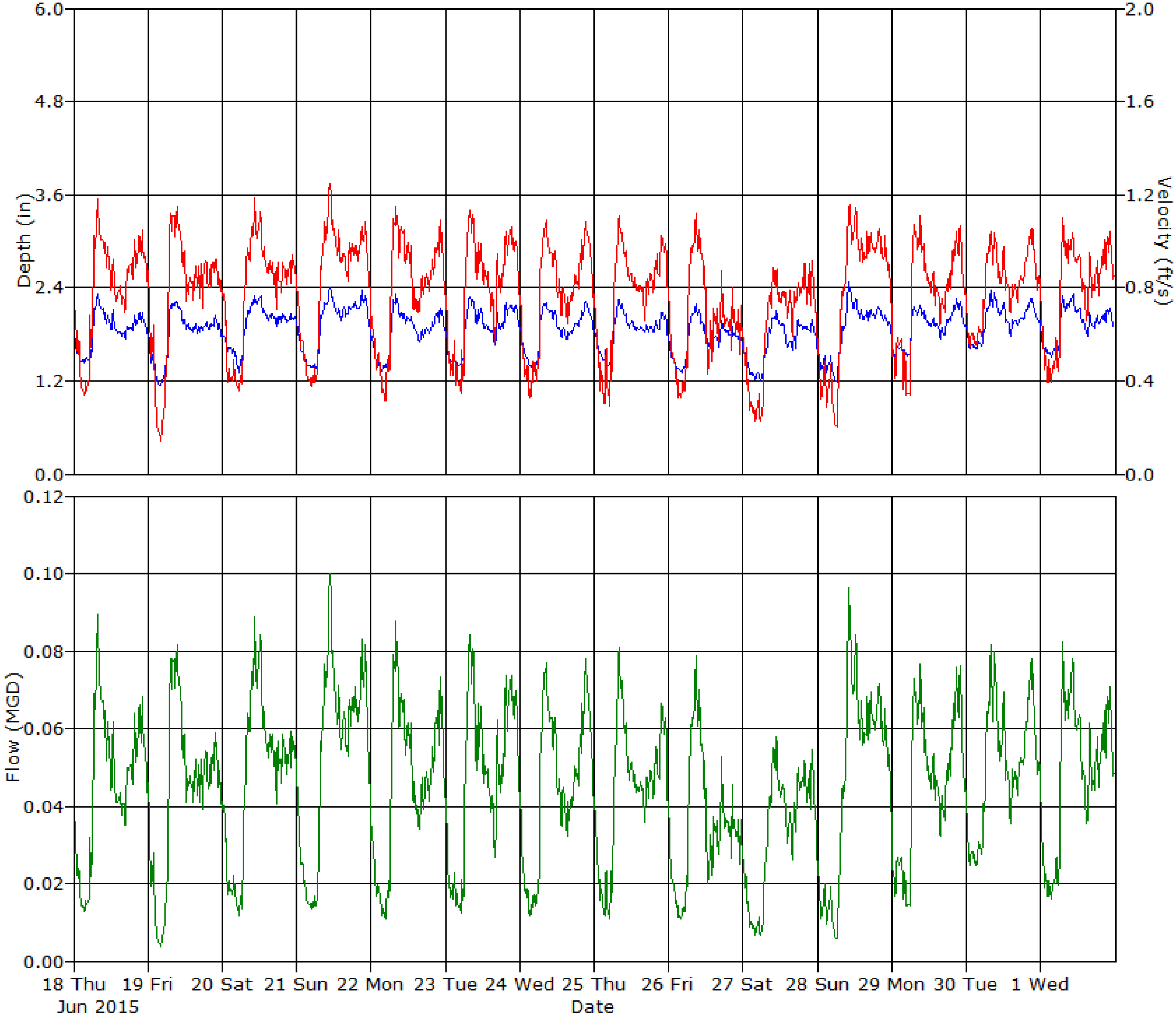


Report Period

6/18/2015
To
7/1/2015

Legend

- Depth
- Velocity
- Quantity



ADS ENVIRONMENTAL SERVICES

LaPa10, Pipe Height: 14.38 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
6/18/2015	03:40	1.44	07:55	2.35	1.86	03:45	0.33	07:55	1.24	0.80	03:45	0.013	07:55	0.097	0.046	0.046	
6/19/2015	04:20	1.14	09:00	2.25	1.80	04:15	0.12	09:30	1.17	0.77	04:15	0.003	09:30	0.083	0.044	0.044	
6/20/2015	05:30	1.29	10:30	2.31	1.92	05:35	0.34	10:25	1.26	0.79	05:35	0.011	10:30	0.095	0.048	0.048	
6/21/2015	06:30	1.36	10:50	2.41	1.95	05:30	0.33	10:40	1.27	0.83	05:30	0.012	10:40	0.101	0.053	0.053	
6/22/2015	03:45	1.31	08:00	2.34	1.84	04:25	0.29	08:10	1.16	0.79	04:25	0.010	08:00	0.089	0.046	0.046	
6/23/2015	04:20	1.38	07:40	2.30	1.88	05:10	0.34	07:55	1.19	0.80	05:10	0.012	07:55	0.088	0.048	0.048	
6/24/2015	05:10	1.31	21:25	2.24	1.86	03:20	0.28	08:25	1.12	0.77	03:20	0.010	08:30	0.079	0.045	0.045	
6/25/2015	04:40	1.39	07:55	2.28	1.85	03:00	0.27	07:55	1.17	0.77	05:10	0.011	07:55	0.087	0.044	0.044	
6/26/2015	04:15	1.31	08:55	2.21	1.74	03:45	0.32	08:55	1.15	0.67	03:45	0.011	08:55	0.082	0.035	0.035	
6/27/2015	05:50	1.20	10:55	2.11	1.70	05:50	0.22	19:55	0.96	0.64	05:50	0.006	11:00	0.058	0.033	0.033	
6/28/2015	06:30	1.18	10:05	2.61	1.85	06:30	0.20	10:05	1.21	0.78	06:30	0.006	10:05	0.109	0.047	0.047	
6/29/2015	01:05	1.50	21:00	2.26	1.90	04:40	0.33	09:20	1.14	0.77	04:55	0.014	09:20	0.079	0.046	0.046	
6/30/2015	01:10	1.60	08:00	2.39	1.98	01:15	0.54	20:40	1.09	0.81	01:15	0.024	08:00	0.084	0.051	0.051	
7/1/2015	03:40	1.48	10:30	2.34	1.94	03:40	0.36	07:15	1.13	0.80	03:40	0.014	07:15	0.085	0.049	0.049	

Report Summary For The Period 6/18/2015 - 7/1/2015

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			0.636
Avg	1.86	0.77	0.045

Site Commentary

Site Information

LosAl02	
Pipe Dimensions	10.00" x 9.75"
Silt Level	0.00"

Overview

Site LosAl02 functioned under normal conditions during the period Thursday, June 18, 2015 to Wednesday, July 01, 2015 . No surcharge conditions were experienced at this location (See Observation Table For More Details). An increase in both depth and velocity was exhibited by this line in response to the June 30, 2015 rain event. Review of the scattergraph shows that flow in this line remained free-flowing throughout the study.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This line is located upstream of location Sparks03. A review of balancing indicated no problems (See Sparks03 Site Commentary For More Details).

Observations

Average flow depth, velocity, and quantity data observed during Thursday, June 18, 2015 to Wednesday, July 01, 2015 , along with observed minimum and maximum data, are provided in the following table. The values presented are based on 5-minute data. In regards to depth, this site flows at approximately 38% full at its recorded hourly peak depth of 3.81 inches and approximately 29% full during the typical average depth of 2.86 inches.

Observed Flow Conditions			
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	2.86	1.57	0.134
Minimum	1.71	0.96	0.038
Maximum	4.18	2.17	0.295
Time of Minimum	6/23/2015 3:40 AM	6/28/2015 3:50 AM	6/23/2015 3:40 AM
Time of Maximum	6/30/2015 7:55 PM	6/30/2015 7:55 PM	6/30/2015 7:55 PM

Data Quality

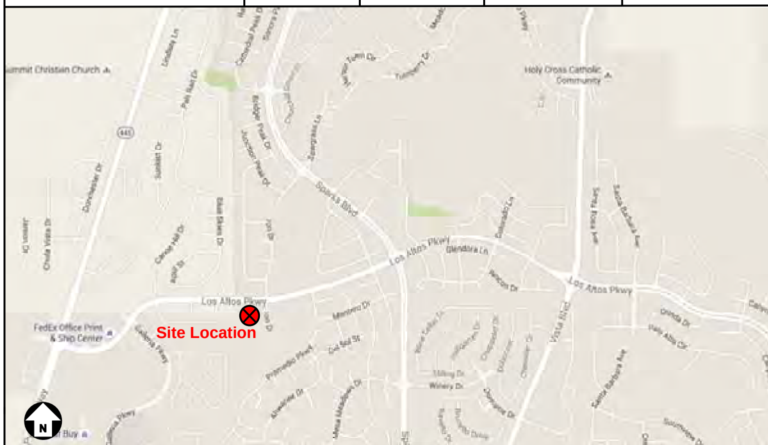
Data uptime observed during the Thursday, June 18, 2015 to the Wednesday, July 01, 2015 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

ADS Site Report

ADS ENVIRONMENTAL SERVICES® — **Quality Form**

Project Name: Sparks.Atkins.TFM.NV15	**Project No.** 22038	**City:** Sparks, NV	**FM Initials:** SW
Site Name: LosAl02	**Investigate Date:** 6/15/15	**Monitor Type**	Peak Doppler
Address/Location: 581 Los Altos Pkwy		**Monitor Model**	ADS Triton+
		Data Acquisition	Wireless
		Manhole ID	MH 004748
Access: Drive	**Type of System:** Sanitary [X] Storm [ ] Combined [ ]	**Pipe Height:**	10.00"
		Pipe Width:	9.75"



Investigation Information:

Date/Time of Install:	6/16/15 @ 16:45
Site Hydraulics:	Moderate flow and smooth
Upstream Input: (L/S, P/S)	N/A
Upstream Manhole:	1 inlet / 1 outlet
Downstream Manhole:	1 inlet / 1 outlet
Depth of Flow (DOF):	2.75" +/- 0.25"
Range (Air DOF):	7.25" +/- 0.25"
Peak Velocity:	1.90 fps
Silt:	0.00 Inches

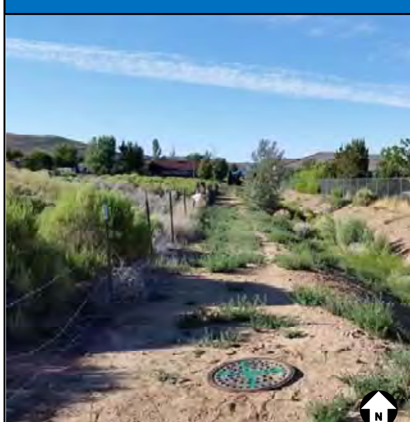
Manhole Information:

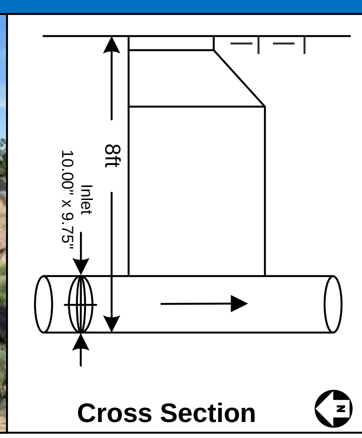
Manhole Material / Condition	Concrete / Good
Pipe Material / Condition:	PVC / Good
Land Use:	Residential [X] Commercial [ ] Industrial [ ] Trunk [ ]

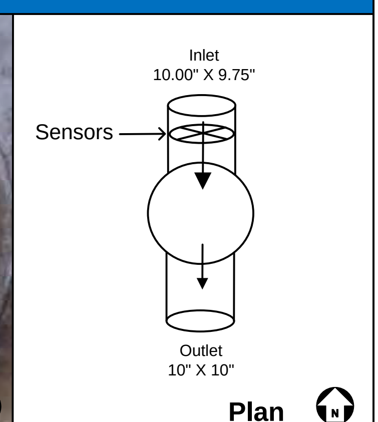
Safety Notes

No traffic control but rough terrain, be sure of footing and access with vehicle

Other Information:



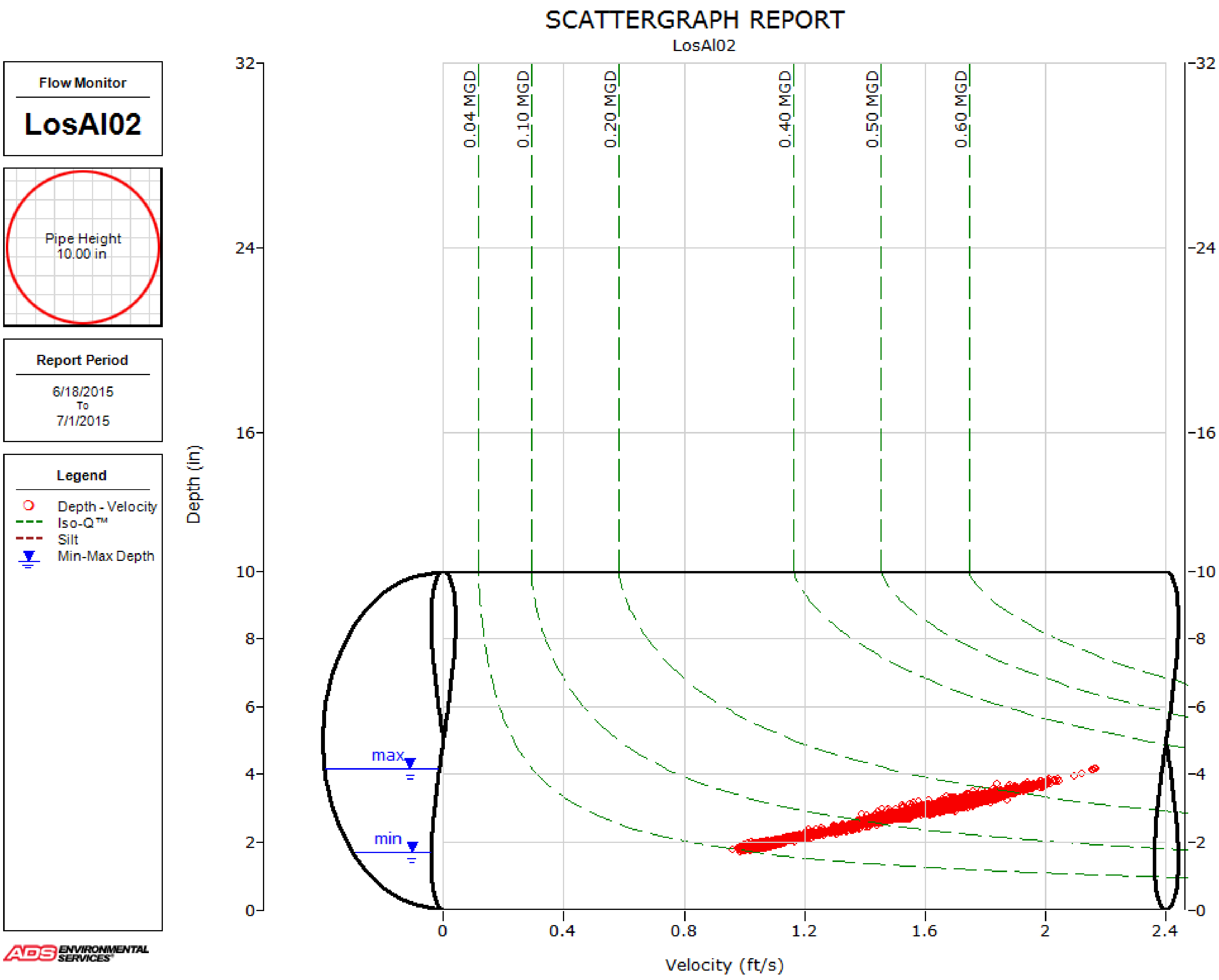




Installation Information	
Installation Type:	Ring
Sensors Devices:	Water Ultrasonic/ Pressure/ Velocity
Surcharge Height:	0
Rain Gauge Zone:	NA

Backup	Yes	No	?	Distance
Trunk		X		
Lift / Pump Station		X		
WWTP		X		
Other		X		

Additional Site Information / Comments:



SCATTERGRAPH REPORT
LosAl02
Flow Monitor
LosAl02
Pipe Height
10.00 in
Report Period
6/18/2015
To
7/1/2015
Legend
Depth - Velocity
Iso-Q™
Silt
Min-Max Depth
0.04 MGD
0.10 MGD
0.20 MGD
0.40 MGD
0.50 MGD
0.60 MGD
max
min
Depth (in)
Velocity (ft/s)
0
0.4
0.8
1.2
1.6
2
2.4
32
24
16
10
8
6
4
2
0
ADS ENVIRONMENTAL SERVICES

HYDROGRAPH REPORT

LosAl02

Flow Monitor

LosAl02

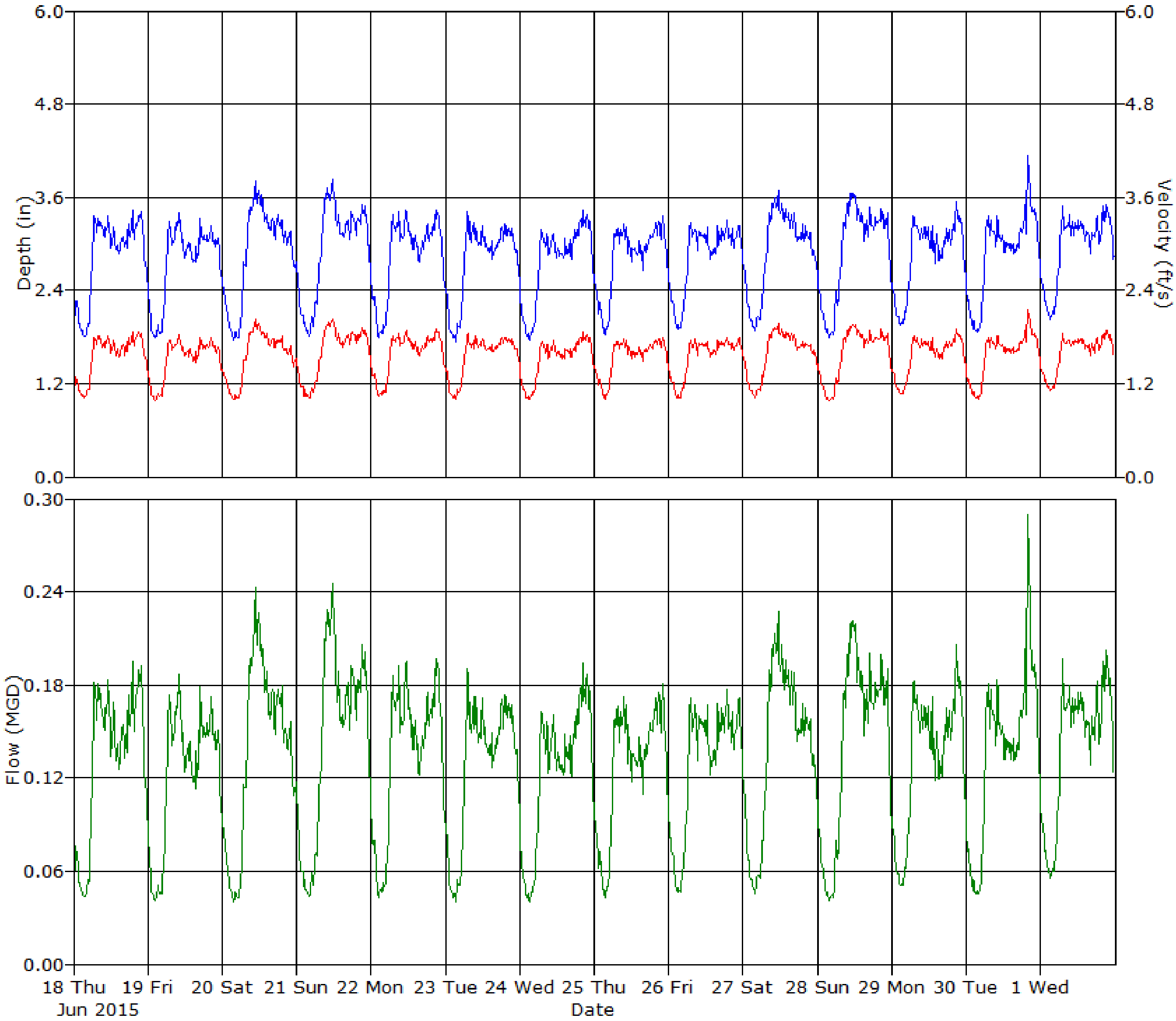
Pipe Height 10.00 in

Report Period

6/18/2015
To
7/1/2015

Legend

- Depth
- Velocity
- Quantity



ADS ENVIRONMENTAL SERVICES

Daily Tabular Report For The Period 6/18/2015 - 7/1/2015

LosAl02, Pipe Height: 10 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
6/18/2015	03:20	1.80	19:00	3.48	2.86	03:20	1.02	21:00	1.89	1.57	03:20	0.043	19:00	0.200	0.133	0.133	
6/19/2015	02:30	1.79	10:15	3.42	2.77	02:30	0.98	10:25	1.83	1.52	02:30	0.041	10:15	0.189	0.123	0.123	
6/20/2015	03:50	1.74	10:50	3.82	2.89	03:55	0.99	10:55	2.03	1.56	03:50	0.040	10:50	0.245	0.137	0.137	
6/21/2015	04:15	1.81	11:30	3.86	2.94	02:55	1.00	11:40	2.04	1.61	04:10	0.043	11:35	0.246	0.145	0.145	
6/22/2015	02:30	1.78	21:10	3.51	2.85	02:30	1.02	21:15	1.93	1.59	02:30	0.042	21:10	0.208	0.135	0.135	
6/23/2015	03:40	1.71	07:00	3.46	2.79	03:40	0.99	07:20	1.86	1.56	03:40	0.038	07:05	0.195	0.128	0.128	
6/24/2015	03:15	1.74	20:20	3.44	2.78	03:15	0.99	20:20	1.86	1.52	03:15	0.040	20:20	0.195	0.124	0.124	
6/25/2015	03:40	1.81	22:15	3.37	2.82	03:40	0.99	21:05	1.80	1.54	03:40	0.042	22:15	0.183	0.127	0.127	
6/26/2015	03:10	1.88	22:40	3.39	2.85	03:10	1.01	08:30	1.82	1.55	03:10	0.045	22:40	0.186	0.130	0.130	
6/27/2015	04:15	1.88	11:30	3.70	2.91	04:05	1.00	11:30	1.98	1.59	04:05	0.045	11:30	0.229	0.139	0.139	
6/28/2015	03:50	1.77	10:30	3.69	2.91	03:50	0.96	11:30	1.97	1.59	03:50	0.040	11:30	0.225	0.141	0.141	
6/29/2015	03:30	1.93	21:05	3.54	2.86	03:30	1.05	21:00	1.90	1.57	03:30	0.049	21:00	0.207	0.132	0.132	
6/30/2015	03:15	1.86	19:55	4.18	2.90	03:15	1.00	19:55	2.17	1.58	03:15	0.044	19:55	0.295	0.137	0.137	
7/1/2015	03:05	2.03	20:00	3.66	2.96	03:20	1.10	20:00	1.93	1.60	03:20	0.055	20:00	0.220	0.141	0.141	

Report Summary For The Period 6/18/2015 - 7/1/2015

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			1.870
Avg	2.86	1.57	0.134

Site Commentary

Site Information

Matte07	
Pipe Dimensions	15.94" x 15.94"
Silt Level	0.00"

Overview

Site Matte07 functioned under normal conditions during the period Thursday, June 18, 2015 to Wednesday, July 01, 2015 . No surcharge conditions were experienced at this location (See Observation Table For More Details). An increase in both depth and velocity was observed at this location following the rain event on June 30, 2015. Review of the scattergraph shows that flow in this line remained free-flowing for most of the study.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This line is located upstream of location Nugg05. A review of balancing indicated no problems (See Nugg05 Site Commentary For More Details).

Observations

Average flow depth, velocity, and quantity data observed during Thursday, June 18, 2015 to Wednesday, July 01, 2015 , along with observed minimum and maximum data, are provided in the following table. The values presented are based on 5-minute data. In regards to depth, this site flows at approximately 48% full at its recorded hourly peak depth of 7.73 inches and approximately 28% full during the typical average depth of 4.52 inches.

Observed Flow Conditions			
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	4.52	1.07	0.234
Minimum	2.92	0.67	0.079
Maximum	8.30	1.61	0.751
Time of Minimum	6/29/2015 3:45 AM	6/21/2015 4:35 AM	6/21/2015 4:35 AM
Time of Maximum	6/30/2015 8:20 PM	6/30/2015 8:05 PM	6/30/2015 8:15 PM

Data Quality

Data uptime observed during the Thursday, June 18, 2015 to the Wednesday, July 01, 2015 monitoring period is provided in the table below. Based upon the quality

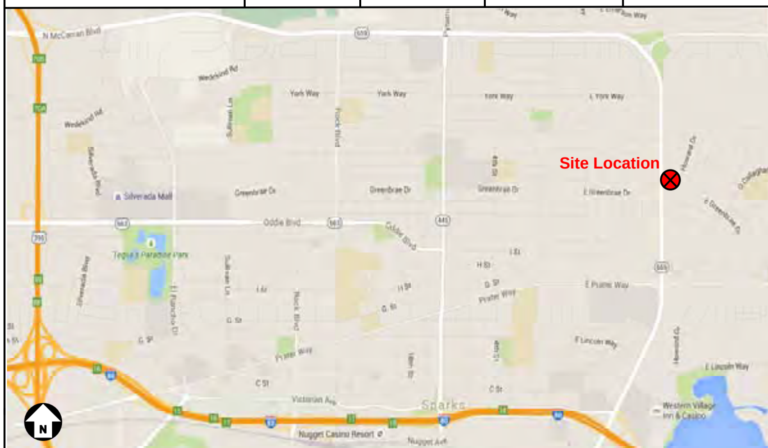
and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

ADS Site Report — Quality Form

ADS ENVIRONMENTAL SERVICES®

Project Name: Sparks.Atkins.TFM.NV15	**Project No.** 22038	**City:** Sparks, NV	**FM Initials:** SW
Site Name: Matte07	**Investigate Date:** 6/15/15	**Monitor Type**	Peak Doppler
Address/Location: 1848 Matteoni Dr.		**Monitor Model**	ADS Triton+
		Data Acquisition	Wireless
		Manhole ID	MH 003766
Access: Drive	**Type of System:** Sanitary [X] Storm [ ] Combined [ ]	**Pipe Height:**	16.00"
		Pipe Width:	16.00"



Investigation Information:

Date/Time of Install:	6/17/15 @ 13:10
Site Hydraulics:	Moderate and smooth flow
Upstream Input: (L/S, P/S)	N/A
Upstream Manhole:	2 inlets / 1 outlet
Downstream Manhole:	2 inlets / 1 outlet
Depth of Flow (DOF):	4.88" +/- 0.25"
Range (Air DOF):	11.13" +/- 0.25"
Peak Velocity:	1.22 fps
Silt:	0.00 Inches

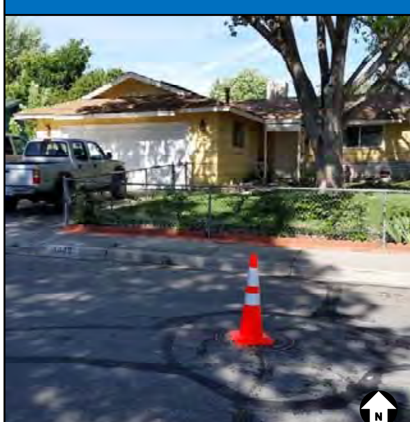
Manhole Information:

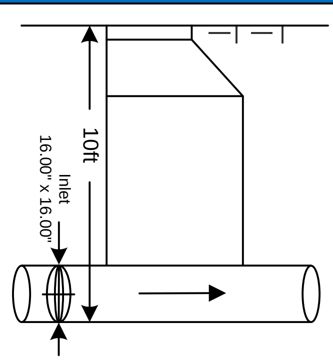
Manhole Material / Condition	Concrete / Good
Pipe Material / Condition:	Concrete / Good
Land Use:	Residential [X] Commercial [ ] Industrial [ ] Trunk [ ]

Safety Notes

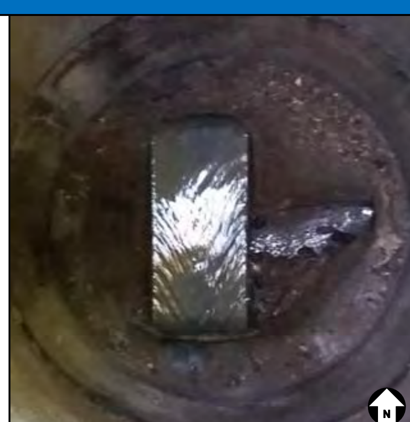
Standard Traffic Control (low volume)

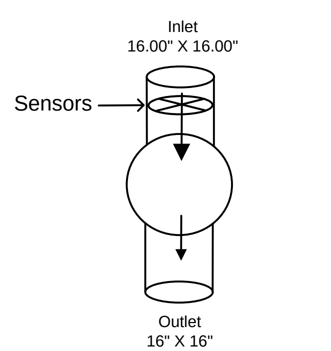
Other Information:





Cross Section





Plan

Installation Information	
Installation Type:	Ring
Sensors Devices:	Water Ultrasonic/ Pressure/ Velocity
Surcharge Height:	0
Rain Gauge Zone:	NA

Backup	Yes	No	?	Distance
Trunk	[ ]	[X]	[ ]	
Lift / Pump Station	[ ]	[X]	[ ]	
WWTP	[ ]	[X]	[ ]	
Other	[ ]	[X]	[ ]	

Additional Site Information / Comments:

SCATTERGRAPH REPORT

Matte07

Flow Monitor

Matte07

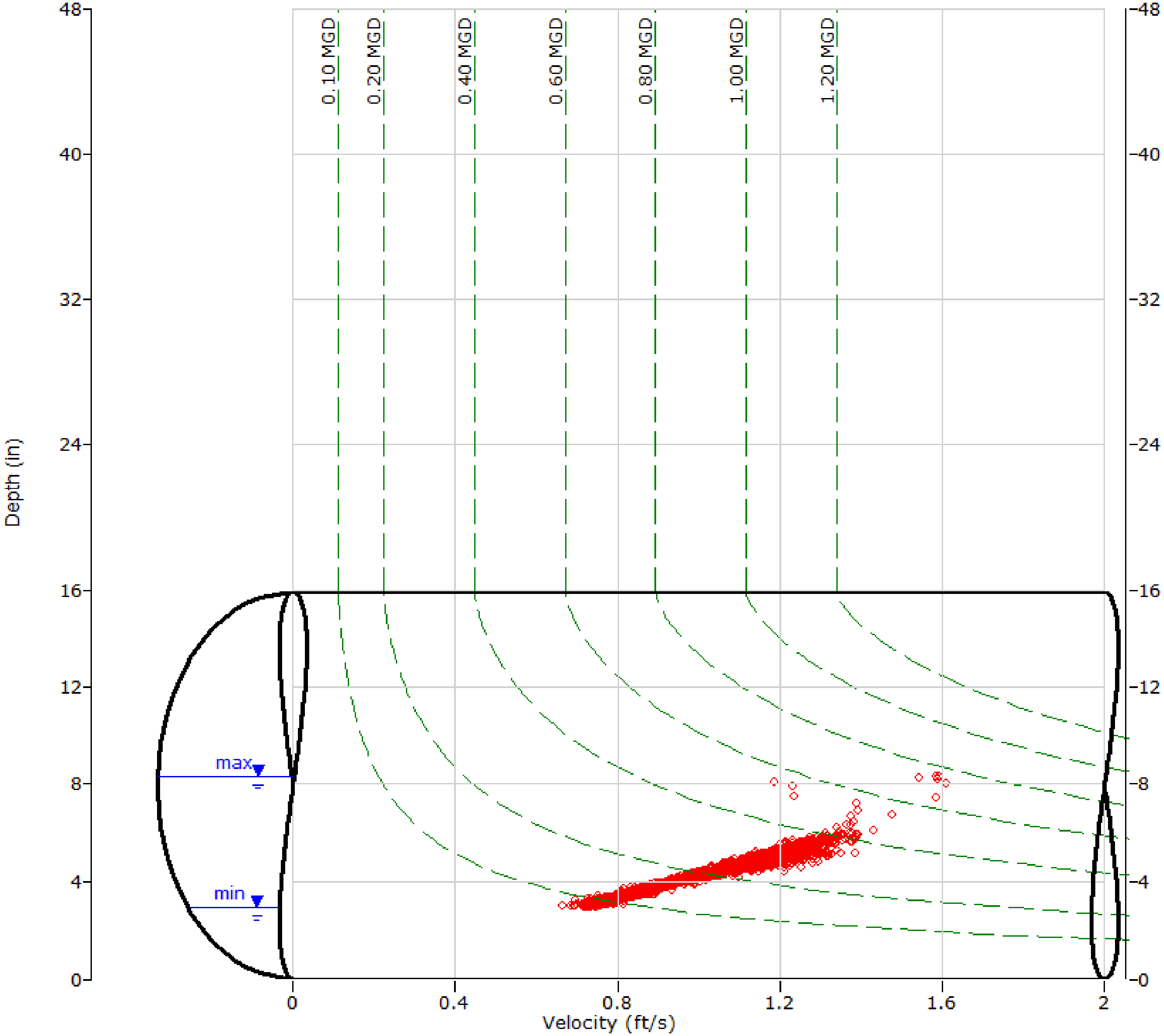
Pipe Height
15.94 in

Report Period

6/18/2015
To
7/1/2015

Legend

- Depth - Velocity
- Iso-Q™
- Silt
- Min-Max Depth



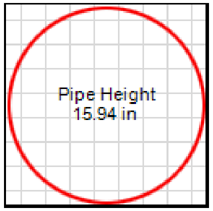
ADS ENVIRONMENTAL SERVICES

HYDROGRAPH REPORT

Matte07

Flow Monitor

Matte07



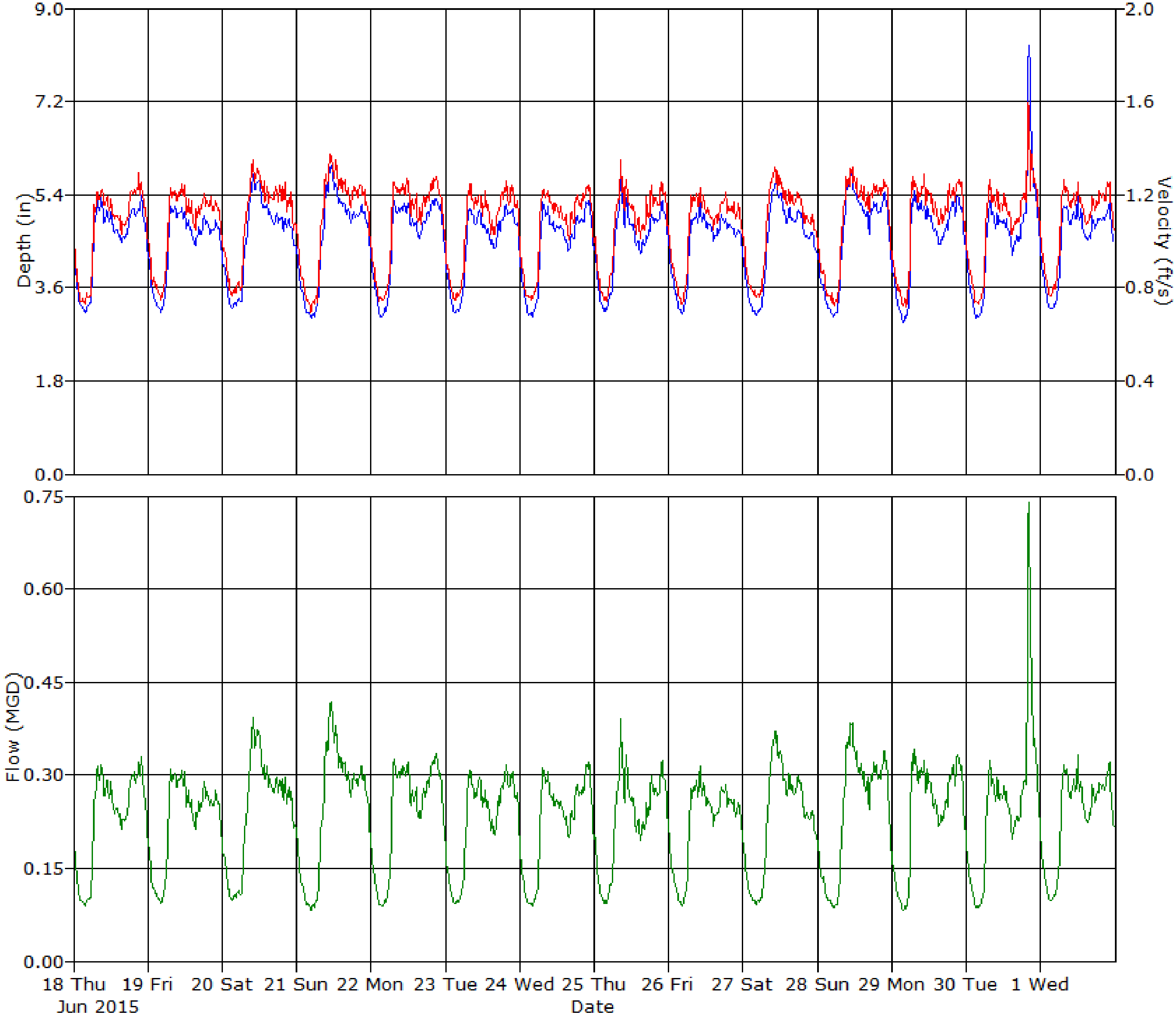
Report Period

6/18/2015
To
7/1/2015

Legend

- Depth
- Velocity
- Quantity

ADS ENVIRONMENTAL SERVICES



Matte07, Pipe Height: 15.94 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
6/18/2015	04:05	3.11	22:00	5.41	4.52	02:25	0.73	21:00	1.33	1.06	04:05	0.090	22:00	0.343	0.230	0.230	
6/19/2015	04:20	3.12	08:50	5.18	4.47	04:20	0.74	11:55	1.25	1.07	04:20	0.092	11:00	0.313	0.227	0.227	
6/20/2015	03:20	3.19	10:00	5.81	4.57	03:10	0.76	13:40	1.39	1.09	03:10	0.097	10:05	0.395	0.242	0.242	
6/21/2015	04:50	3.02	11:00	5.98	4.59	04:35	0.67	10:50	1.39	1.09	04:35	0.079	10:55	0.424	0.246	0.246	
6/22/2015	03:15	3.02	07:25	5.38	4.56	03:00	0.73	11:40	1.32	1.09	04:00	0.088	21:15	0.339	0.239	0.239	
6/23/2015	02:55	3.10	19:35	5.23	4.45	02:55	0.75	08:10	1.30	1.07	02:55	0.092	08:10	0.322	0.226	0.226	
6/24/2015	04:05	3.04	09:15	5.32	4.44	03:55	0.75	22:15	1.25	1.06	04:05	0.089	22:15	0.322	0.224	0.224	
6/25/2015	03:30	3.14	08:40	5.83	4.48	04:10	0.73	08:40	1.39	1.07	04:10	0.093	08:40	0.413	0.228	0.228	
6/26/2015	04:30	3.09	10:20	5.25	4.46	04:00	0.72	10:25	1.25	1.06	04:30	0.088	10:25	0.320	0.223	0.223	
6/27/2015	04:30	3.06	10:30	5.65	4.48	05:30	0.75	11:05	1.33	1.07	04:25	0.090	11:05	0.376	0.230	0.230	
6/28/2015	05:15	3.03	11:10	5.81	4.60	05:40	0.70	20:45	1.35	1.08	05:40	0.085	11:15	0.395	0.243	0.243	
6/29/2015	03:45	2.92	07:30	5.49	4.55	04:50	0.71	10:30	1.32	1.09	03:50	0.081	07:30	0.343	0.239	0.239	
6/30/2015	03:20	3.02	20:20	8.30	4.63	04:10	0.73	20:05	1.61	1.08	04:10	0.086	20:15	0.751	0.248	0.248	
7/1/2015	03:25	3.18	12:05	5.40	4.52	03:25	0.76	07:55	1.32	1.08	03:25	0.096	12:05	0.335	0.234	0.233	

Report Summary For The Period 6/18/2015 - 7/1/2015

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			3.279
Avg	4.52	1.07	0.234

Site Commentary

Site Information

Nugg05	
Pipe Dimensions	47.50" x 47.75"
Silt Level	7.75"

Overview

Site Nugg05 functioned under normal conditions during the period Thursday, June 18, 2015 to Wednesday, July 01, 2015 . No surcharge conditions were experienced at this location (See Observation Table For More Details). An increase in both depth and velocity was observed at this location following the rain event on June 30, 2015. An average silt measurement of 7.75 inches was recorded during field visits. The significant sediment level with respect to flow depth and swirls/surges result in a data set that is of lower confidence than typical. Review of the scattergraph shows that flow in this line remained free-flowing throughout the study.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This line is located downstream of locations Victo04, Matte07, and Sulli09 (See Flow Meter Schematic). A review of balancing indicated no problems. A net flow of 1.203 MGD was reported for the period.

Observations

Average flow depth, velocity, and quantity data observed during Thursday, June 18, 2015 to Wednesday, July 01, 2015 , along with observed minimum and maximum data, are provided in the following table. The values presented are based on 5-minute data. In regards to depth, this site flows at approximately 52% full at its recorded hourly peak depth of 24.53 inches and approximately 46% full during the typical average depth of 21.94 inches.

Observed Flow Conditions			
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	21.94	0.92	2.609
Minimum	18.50	0.42	0.861
Maximum	24.64	1.37	4.456
Time of Minimum	6/25/2015 4:45 AM	6/20/2015 4:05 AM	6/23/2015 4:50 AM
Time of Maximum	6/30/2015 8:15 PM	6/20/2015 11:15 AM	6/30/2015 8:45 PM

Data Quality

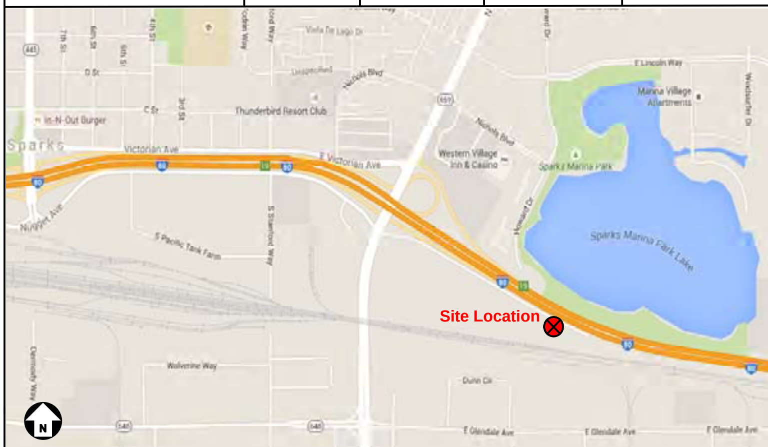
Data uptime observed during the Thursday, June 18, 2015 to the Wednesday, July 01, 2015 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

ADS ENVIRONMENTAL SERVICES®

ADS Site Report — Quality Form

Project Name: Sparks.Atkins.TFM.NV15	**Project No.** 22038	**City:** Sparks, NV	**FM Initials:** SW
Site Name: Nugg05	**Investigate Date:** 6/16/15	**Monitor Type**	Peak Doppler
Address/Location: 655 E. Nugget Ave		**Monitor Model**	ADS Triton+
		Data Acquisition	Wireless
		Manhole ID	MH 006250
Access: Drive	**Type of System:** Sanitary [X] Storm [ ] Combined [ ]	**Pipe Height:**	47.50"
		Pipe Width:	47.75"



Investigation Information:

Date/Time of Install:	6/16/15 @ 12:50
Site Hydraulics:	Deep smooth flow with silt
Upstream Input: (L/S, P/S)	Slight PS influence
Upstream Manhole:	1 inlet / 1 outlet (couldn't access)
Downstream Manhole:	1 inlet / 1 outlet (bad hydraulics)
Depth of Flow (DOF):	23.00" +/- 0.25"
Range (Air DOF):	24.50" +/- 0.25"
Peak Velocity:	1.22 fps
Silt:	7.75 Inches

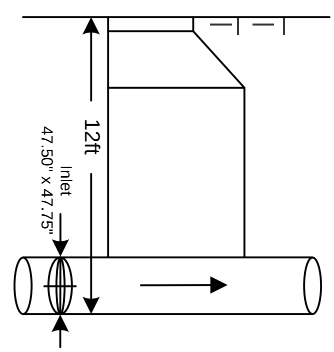
Manhole Information:

Manhole Material / Condition	Concrete / Good
Pipe Material / Condition:	Concrete / Good
Land Use:	Residential [X] Commercial [X] Industrial [ ] Trunk [ ]

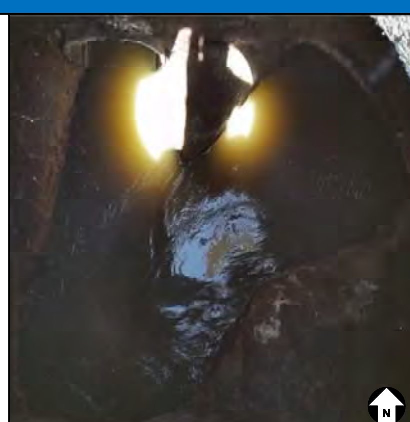
Safety Notes

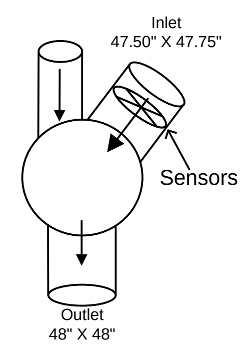
No traffic or pedestrian control

Other Information:



Cross Section





Plan

Installation Information	
Installation Type:	Ring
Sensors Devices:	Water Ultrasonic/ Pressure/ Velocity
Surcharge Height:	0
Rain Gauge Zone:	NA

Backup	Yes	No	?	Distance
Trunk	[ ]	X	[ ]	
Lift / Pump Station	[ ]	X	[ ]	
WWTP	[ ]	X	[ ]	
Other	[ ]	X	[ ]	

Additional Site Information / Comments:

SCATTERGRAPH REPORT

Nugg05

Flow Monitor

Nugg05

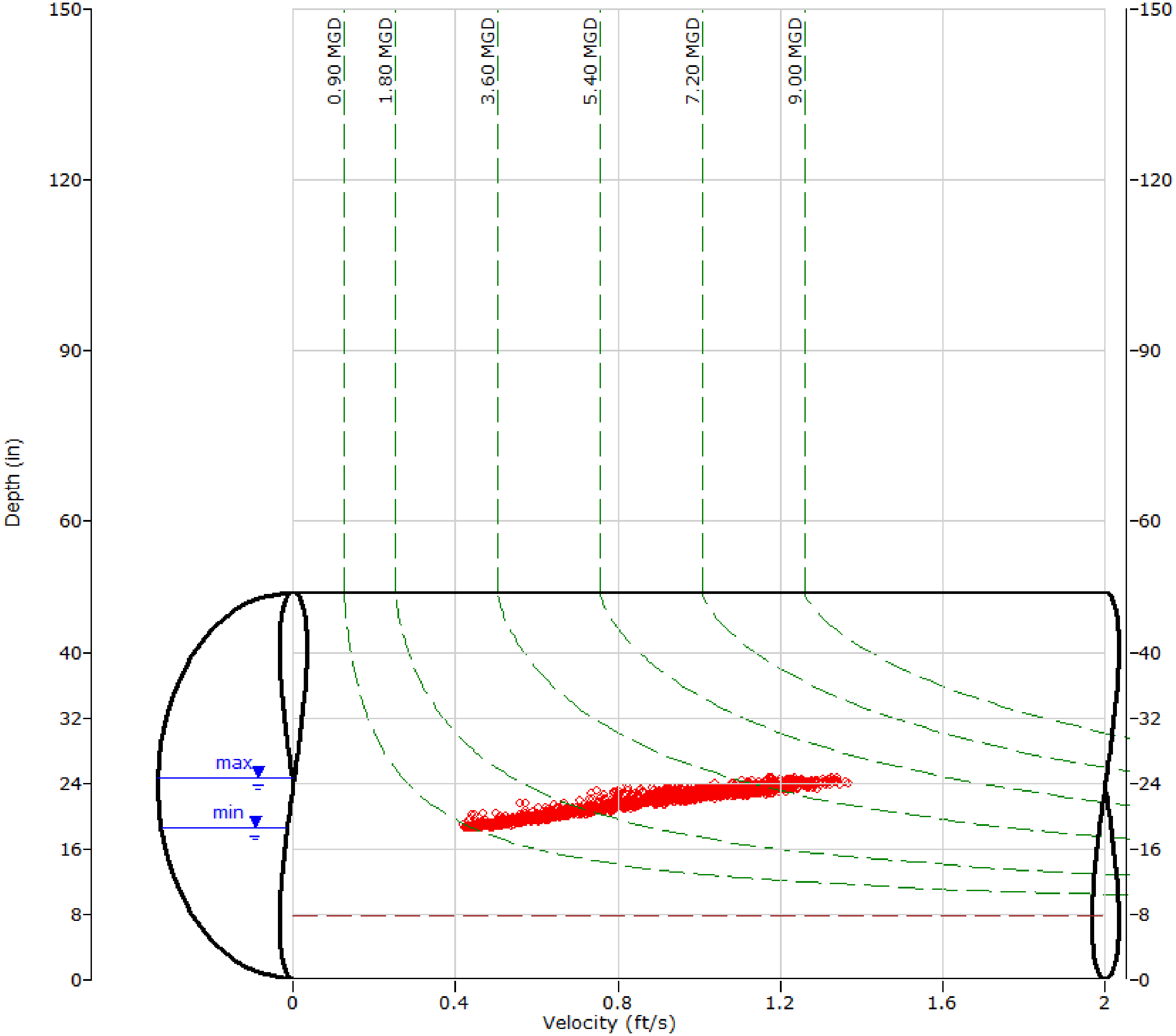
Pipe Height
47.50 in

Report Period

6/18/2015
To
7/1/2015

Legend

- Depth - Velocity
- Iso-Q™
- Silt
- Min-Max Depth



ADS ENVIRONMENTAL SERVICES

HYDROGRAPH REPORT

Nugg05

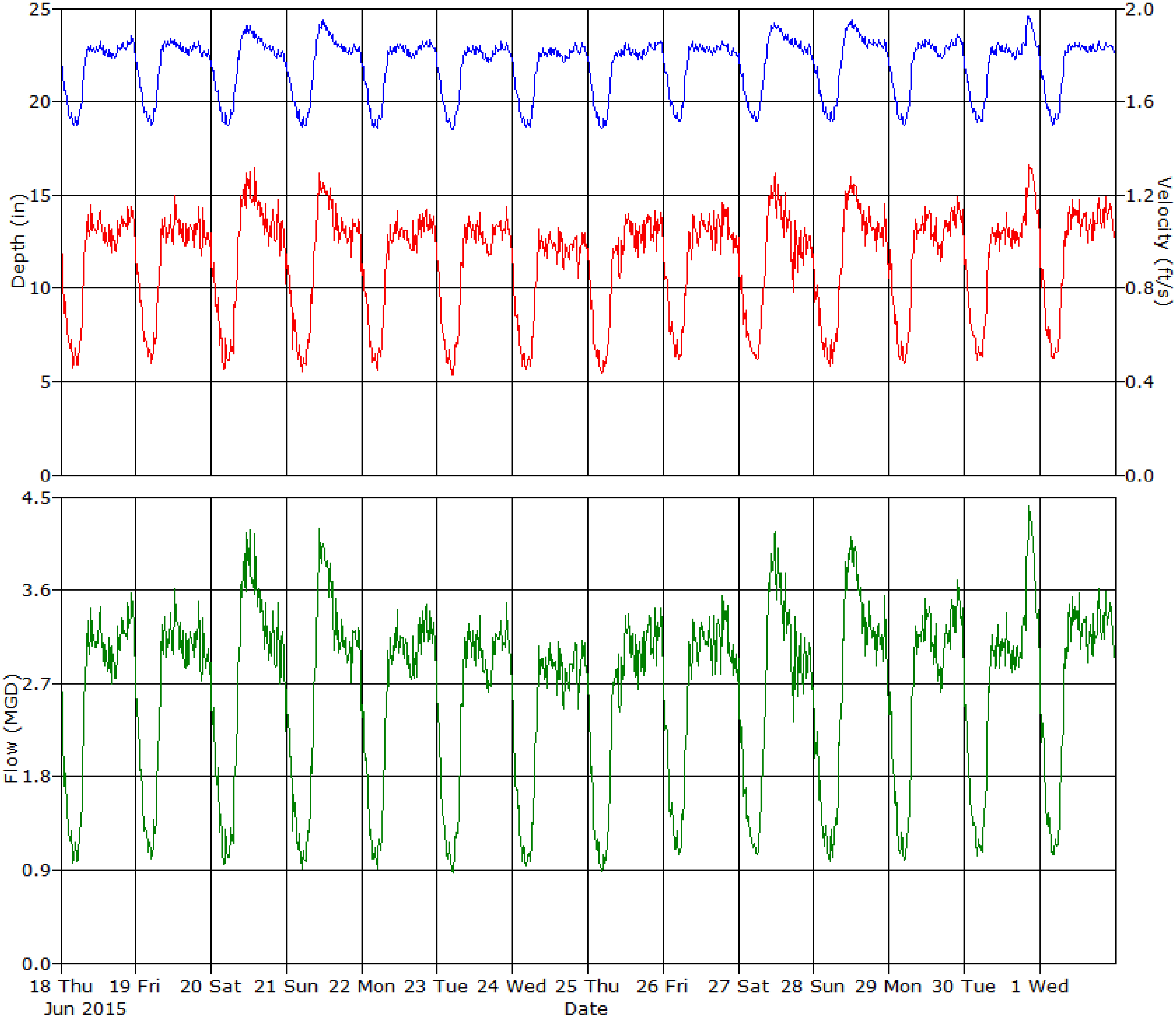
Flow Monitor
Nugg05

Pipe Height 47.50 in

Report Period
6/18/2015 To 7/1/2015

Legend

- Depth
- Velocity
- Quantity



ADS ENVIRONMENTAL SERVICES

Daily Tabular Report For The Period 6/18/2015 - 7/1/2015

Nugg05, Pipe Height: 47.5 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
6/18/2015	05:15	18.71	22:50	23.61	21.87	04:15	0.44	19:40	1.23	0.92	04:15	0.923	19:40	3.735	2.597	2.597	
6/19/2015	05:10	18.76	11:15	23.39	21.96	05:05	0.48	12:30	1.21	0.92	05:05	0.996	12:30	3.663	2.602	2.602	
6/20/2015	05:30	18.72	11:30	24.18	22.00	04:05	0.42	11:15	1.37	0.95	04:05	0.880	11:20	4.394	2.714	2.714	
6/21/2015	05:00	18.63	11:25	24.41	21.98	04:55	0.43	10:30	1.33	0.93	04:55	0.893	10:30	4.312	2.664	2.664	
6/22/2015	05:05	18.57	20:25	23.31	21.85	05:00	0.44	20:30	1.16	0.91	05:00	0.904	20:30	3.533	2.550	2.550	
6/23/2015	05:05	18.52	20:40	23.26	21.72	04:50	0.42	22:20	1.19	0.89	04:50	0.861	22:20	3.605	2.493	2.493	
6/24/2015	04:40	18.62	22:10	23.21	21.72	04:20	0.44	08:45	1.10	0.86	04:20	0.906	14:50	3.223	2.381	2.381	
6/25/2015	04:45	18.50	23:25	23.32	21.80	04:45	0.43	13:05	1.16	0.89	04:45	0.869	23:20	3.518	2.500	2.500	
6/26/2015	05:10	18.91	19:00	23.33	21.97	03:50	0.46	19:00	1.19	0.93	03:50	1.011	19:00	3.626	2.618	2.618	
6/27/2015	06:00	18.92	11:30	24.28	22.16	05:45	0.48	11:50	1.32	0.91	05:45	1.019	11:50	4.252	2.637	2.637	
6/28/2015	05:10	18.92	12:15	24.47	22.19	06:45	0.44	11:10	1.34	0.93	05:05	0.953	11:10	4.371	2.701	2.701	
6/29/2015	04:55	18.73	21:50	23.66	22.00	04:55	0.47	22:10	1.24	0.93	04:55	0.972	22:10	3.837	2.653	2.653	
6/30/2015	04:20	18.86	20:15	24.64	22.03	04:20	0.48	20:45	1.34	0.95	04:20	1.021	20:45	4.456	2.708	2.708	
7/1/2015	04:25	18.75	18:50	23.26	21.96	04:35	0.50	21:10	1.21	0.96	04:20	1.037	18:45	3.667	2.716	2.714	

Report Summary For The Period 6/18/2015 - 7/1/2015

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			36.530
Avg	21.94	0.92	2.609

Site Commentary

Site Information

Pyram01	
Pipe Dimensions	26.25" x 26.38"
Silt Level	0.00"

Overview

Site Pyram01 functioned under normal conditions during the period Thursday, June 18, 2015 to Wednesday, July 01, 2015 . No surcharge conditions were experienced at this location (See Observation Table For More Details). Review of the scattergraph shows that flow in this line remained free-flowing throughout the study.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This line is located upstream of location Sparks03. A review of balancing indicated no problems (See Sparks03 Site Commentary For More Details).

Observations

Average flow depth, velocity, and quantity data observed during Thursday, June 18, 2015 to Wednesday, July 01, 2015 , along with observed minimum and maximum data, are provided in the following table. The values presented are based on 5-minute data. In regards to depth, this site flows at approximately 20% full at its recorded hourly peak depth of 5.37 inches and approximately 15% full during the typical average depth of 4.06 inches.

Observed Flow Conditions			
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	4.06	1.77	0.449
Minimum	2.31	1.03	0.109
Maximum	5.54	2.34	0.865
Time of Minimum	6/19/2015 4:10 AM	6/27/2015 4:25 AM	6/19/2015 4:10 AM
Time of Maximum	6/21/2015 10:55 AM	6/27/2015 12:40 PM	6/21/2015 11:00 AM

Data Quality

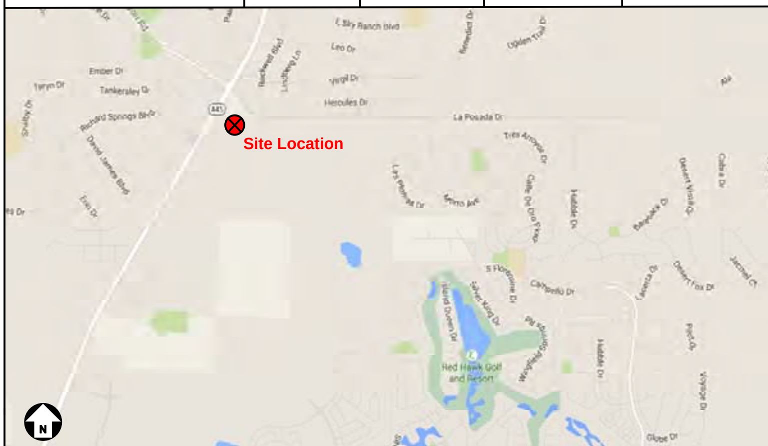
Data uptime observed during the Thursday, June 18, 2015 to the Wednesday, July 01, 2015 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

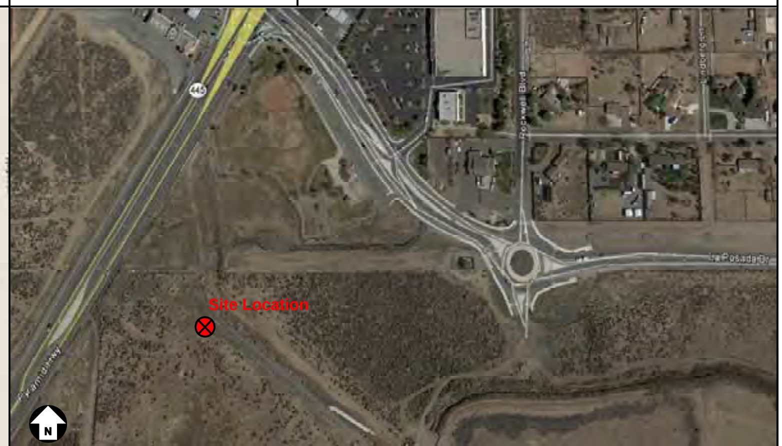
Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

ADS Site Report — Quality Form

ADS ENVIRONMENTAL SERVICES®

Project Name: Sparks.Atkins.TFM.NV15	**Project No.** 22038	**City:** Sparks, NV	**FM Initials:** SW
Site Name: Pyram01	**Investigate Date:** 6/15/15	**Monitor Type**	Peak Doppler
Address/Location: 9732 State Route 445		**Monitor Model**	ADS Triton+
		Data Acquisition	Wireless
		Manhole ID	MH 006253
Access: Drive	**Type of System:** Sanitary [X] Storm [ ] Combined [ ]	**Pipe Height:**	26.25"
		Pipe Width:	26.38"





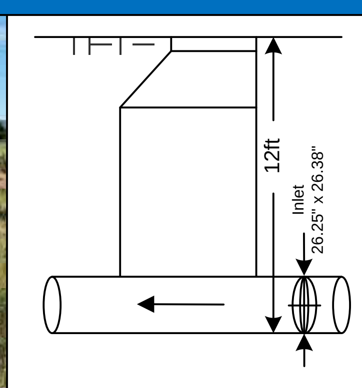
Investigation Information:

Date/Time of Install:	6/16/15 @ 14:10
Site Hydraulics:	Moderate flow with small waves
Upstream Input: (L/S, P/S)	Slight PS influence
Upstream Manhole:	1 inlet / 1 outlet
Downstream Manhole:	1 inlet / 1 outlet
Depth of Flow (DOF):	4.00" +/- 0.25"
Range (Air DOF):	22.25" +/- 0.25"
Peak Velocity:	2.10 fps
Silt:	0 Inches

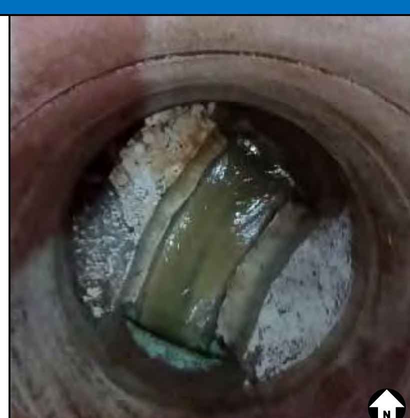
Manhole Information:

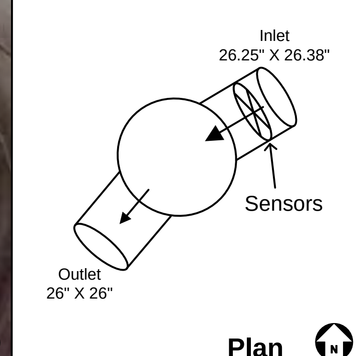
Manhole Material / Condition	Concrete / Good
Pipe Material / Condition:	PVC / Good
Land Use:	Residential [X] Commercial [ ] Industrial [ ] Trunk [ ]
Safety Notes	
No traffic or pedestrian control	

Other Information:



Cross Section





Plan

Installation Information	
Installation Type:	Ring
Sensors Devices:	Water Ultrasonic/ Pressure/ Velocity
Surcharge Height:	0
Rain Gauge Zone:	NA

Backup	Yes	No	?	Distance
Trunk	[ ]	[X]	[ ]	
Lift / Pump Station	[ ]	[X]	[ ]	
WWTP	[ ]	[X]	[ ]	
Other	[ ]	[X]	[ ]	

Additional Site Information / Comments:

SCATTERGRAPH REPORT

Pyram01

Flow Monitor

Pyram01

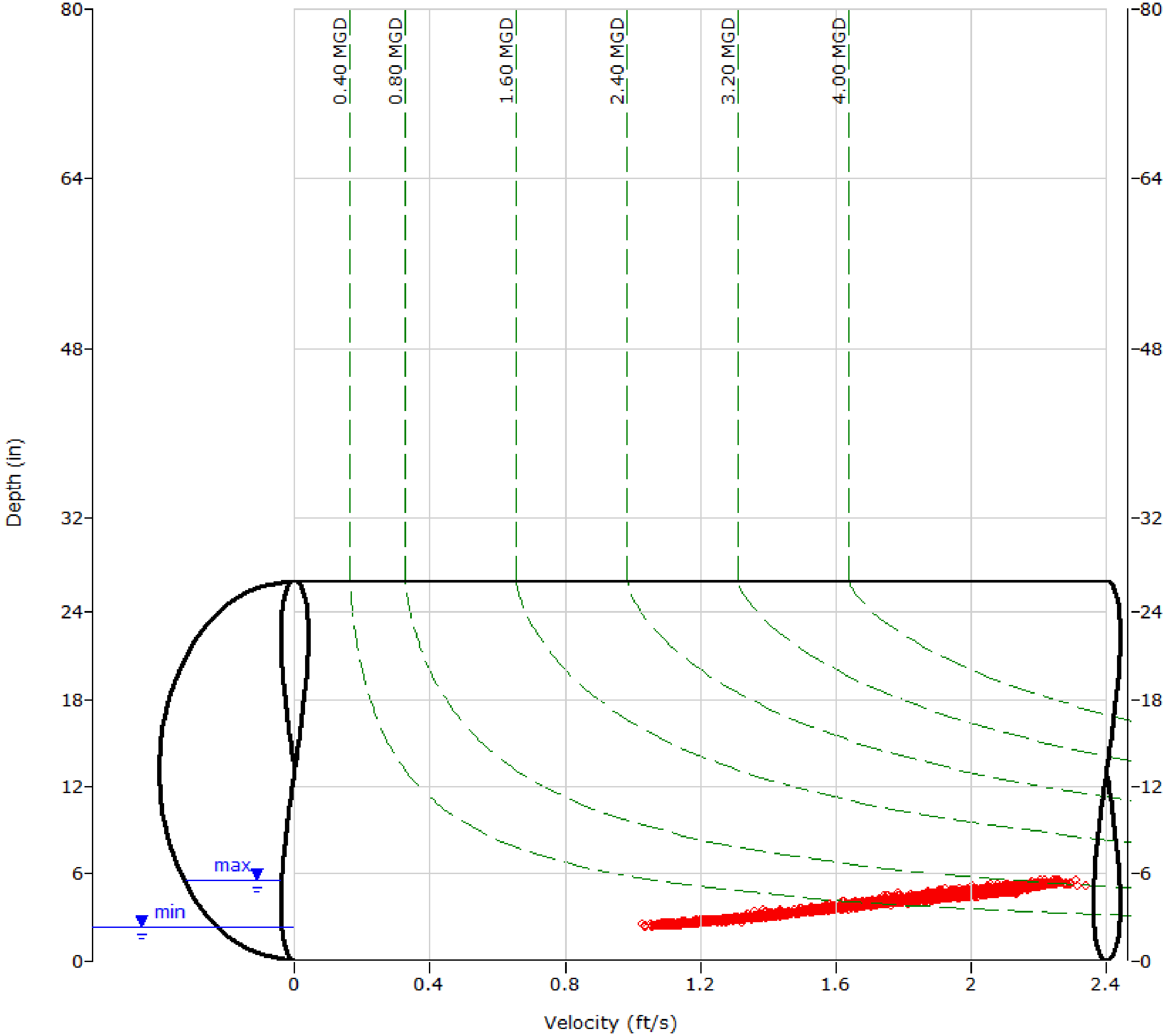
Pipe Height
26.25 in

Report Period

6/18/2015
To
7/1/2015

Legend

Depth - Velocity
Iso-Q™
Silt
Min-Max Depth



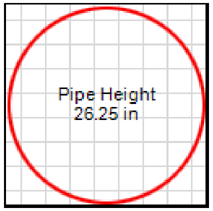
ADS ENVIRONMENTAL SERVICES

HYDROGRAPH REPORT

Pyram01

Flow Monitor

Pyram01

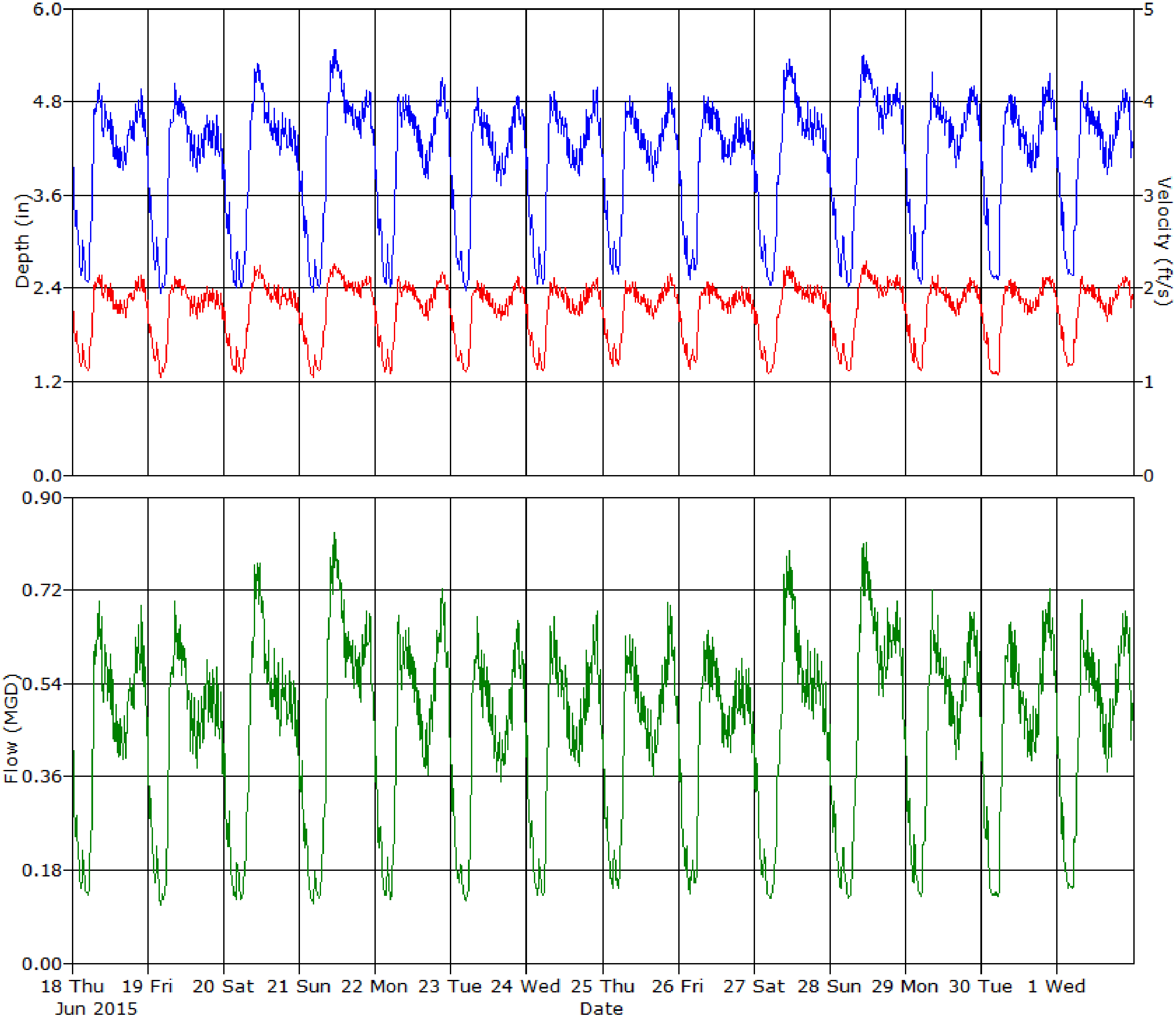


Report Period

6/18/2015
To
7/1/2015

Legend

- Depth
- Velocity
- Quantity



ADS ENVIRONMENTAL SERVICES

Daily Tabular Report For The Period 6/18/2015 - 7/1/2015

Pyram01, Pipe Height: 26.25 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
6/18/2015	05:25	2.47	08:40	5.08	4.05	05:25	1.11	08:30	2.18	1.78	05:25	0.129	08:35	0.720	0.447	0.447	
6/19/2015	04:10	2.31	08:50	5.08	3.98	04:10	1.03	08:50	2.15	1.74	04:10	0.109	08:50	0.713	0.428	0.428	
6/20/2015	04:10	2.39	10:55	5.36	4.00	05:30	1.07	11:35	2.28	1.75	05:30	0.119	10:55	0.804	0.440	0.440	
6/21/2015	04:30	2.35	10:55	5.54	4.13	04:40	1.04	11:00	2.31	1.80	04:40	0.113	11:00	0.865	0.481	0.481	
6/22/2015	05:15	2.42	21:10	5.17	4.07	05:10	1.09	21:15	2.18	1.78	05:10	0.122	21:15	0.739	0.452	0.452	
6/23/2015	04:55	2.36	08:35	5.00	3.97	04:50	1.10	21:30	2.15	1.74	04:55	0.119	21:25	0.691	0.426	0.426	
6/24/2015	03:45	2.45	22:15	5.04	4.01	05:15	1.11	22:15	2.13	1.75	05:15	0.128	22:15	0.697	0.434	0.434	
6/25/2015	03:30	2.55	20:50	5.05	4.03	03:25	1.15	21:35	2.16	1.76	03:25	0.142	20:50	0.700	0.438	0.438	
6/26/2015	03:40	2.50	09:15	4.91	4.03	03:40	1.13	09:10	2.09	1.76	03:40	0.134	09:10	0.661	0.435	0.435	
6/27/2015	05:10	2.44	11:15	5.34	4.07	04:25	1.03	12:40	2.34	1.77	05:10	0.124	11:15	0.805	0.456	0.456	
6/28/2015	06:10	2.41	10:30	5.50	4.17	05:55	1.11	11:40	2.32	1.80	06:10	0.125	10:25	0.837	0.484	0.484	
6/29/2015	05:00	2.45	08:20	5.20	4.13	05:10	1.11	08:25	2.20	1.77	05:00	0.128	08:25	0.749	0.459	0.459	
6/30/2015	05:15	2.51	21:30	5.19	4.10	04:15	1.05	21:30	2.20	1.76	04:15	0.127	21:30	0.751	0.453	0.453	
7/1/2015	04:50	2.57	07:40	5.15	4.11	03:30	1.15	07:40	2.15	1.79	03:30	0.142	07:40	0.728	0.456	0.456	

Report Summary For The Period 6/18/2015 - 7/1/2015

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			6.289
Avg	4.06	1.77	0.449

Site Commentary

Site Information

Sparks03	
Pipe Dimensions	60.25" x 60.50"
Silt Level	0.00"

Overview

Site Sparks03 functioned under normal conditions during the period Thursday, June 18, 2015 to Wednesday, July 01, 2015 . No surcharge conditions were experienced at this location (See Observation Table For More Details). An increase in both depth and velocity was observed at this location in response to the rain event on June 30, 2015. Review of the scattergraph shows that flow in this line remained free-flowing throughout the study.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This line is located downstream of locations Pyram01, LaPa10, and LosAl02 (See Flow Meter Schematic). A review of balancing indicated no problems. A net flow of 2.620 MGD was reported for the period.

Observations

Average flow depth, velocity, and quantity data observed during Thursday, June 18, 2015 to Wednesday, July 01, 2015 , along with observed minimum and maximum data, are provided in the following table. The values presented are based on 5-minute data. In regards to depth, this site flows at approximately 23% full at its recorded hourly peak depth of 13.75 inches and approximately 18% full during the typical average depth of 10.96 inches.

Observed Flow Conditions			
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	10.96	1.99	3.248
Minimum	8.15	1.42	1.526
Maximum	14.10	2.37	5.324
Time of Minimum	6/28/2015 6:20 AM	6/26/2015 5:25 AM	6/26/2015 5:25 AM
Time of Maximum	6/30/2015 8:40 PM	6/27/2015 12:30 PM	6/30/2015 8:35 PM

Data Quality

Data uptime observed during the Thursday, June 18, 2015 to the Wednesday, July 01, 2015 monitoring period is provided in the table below. Based upon the quality

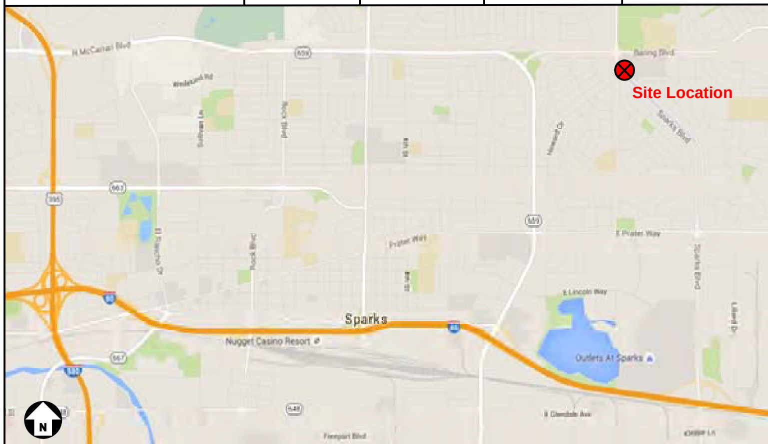
and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

ADS Site Report — Quality Form

ADS ENVIRONMENTAL SERVICES®

Project Name: Sparks.Atkins.TFM.NV15	**Project No.** 22038	**City:** Sparks, NV	**FM Initials:** SW
Site Name: Sparks03	**Investigate Date:** 6/17/15	**Monitor Type**	Peak Doppler
		Monitor Model	ADS Triton+
Address/Location:	1211 Baring Blvd	**Data Acquisition**	Wireless
		Manhole ID	MH 035887
Access: Drive	**Type of System:** Sanitary [X] Storm [ ] Combined [ ]	**Pipe Height:**	60.25"
		Pipe Width:	60.50"



Investigation Information:

Date/Time of Install:	6/17/15 @ 09:20
Site Hydraulics:	Deep and smooth flow
Upstream Input: (L/S, P/S)	No influence
Upstream Manhole:	1 inlet / 1 outlet
Downstream Manhole:	2 inlets / 1 outlet
Depth of Flow (DOF):	12.00" +/- 0.25"
Range (Air DOF):	48.25" +/- 0.25"
Peak Velocity:	2.45 fps
Silt:	0 Inches

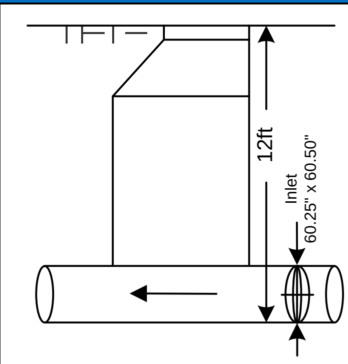
Manhole Information:

Manhole Material / Condition	Concrete / Good
Pipe Material / Condition:	Concrete with steel line / Good
Land Use:	Residential [X] Commercial [X] Industrial [ ] Trunk [ ]

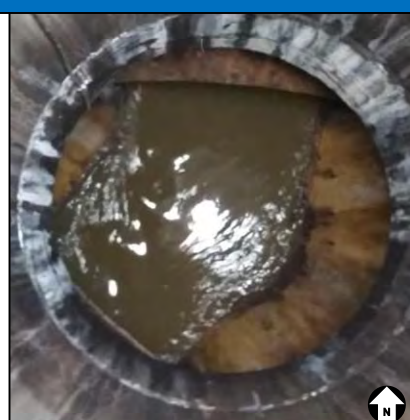
Safety Notes

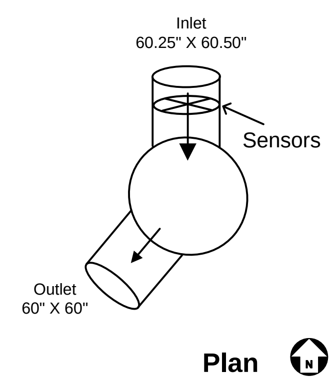
Heavy traffic, City of Sparks will setup traffic control

Other Information:



Cross Section





Plan

Installation Information	
Installation Type:	Special
Sensors Devices:	Water Ultrasonic/ Pressure/ Velocity
Surcharge Height:	0
Rain Gauge Zone:	NA

Backup	Yes	No	?	Distance
Trunk	[ ]	X	[ ]	
Lift / Pump Station	[ ]	X	[ ]	
WWTP	[ ]	X	[ ]	
Other	[ ]	X	[ ]	

Additional Site Information / Comments:

SCATTERGRAPH REPORT

Sparks03

Flow Monitor

Sparks03

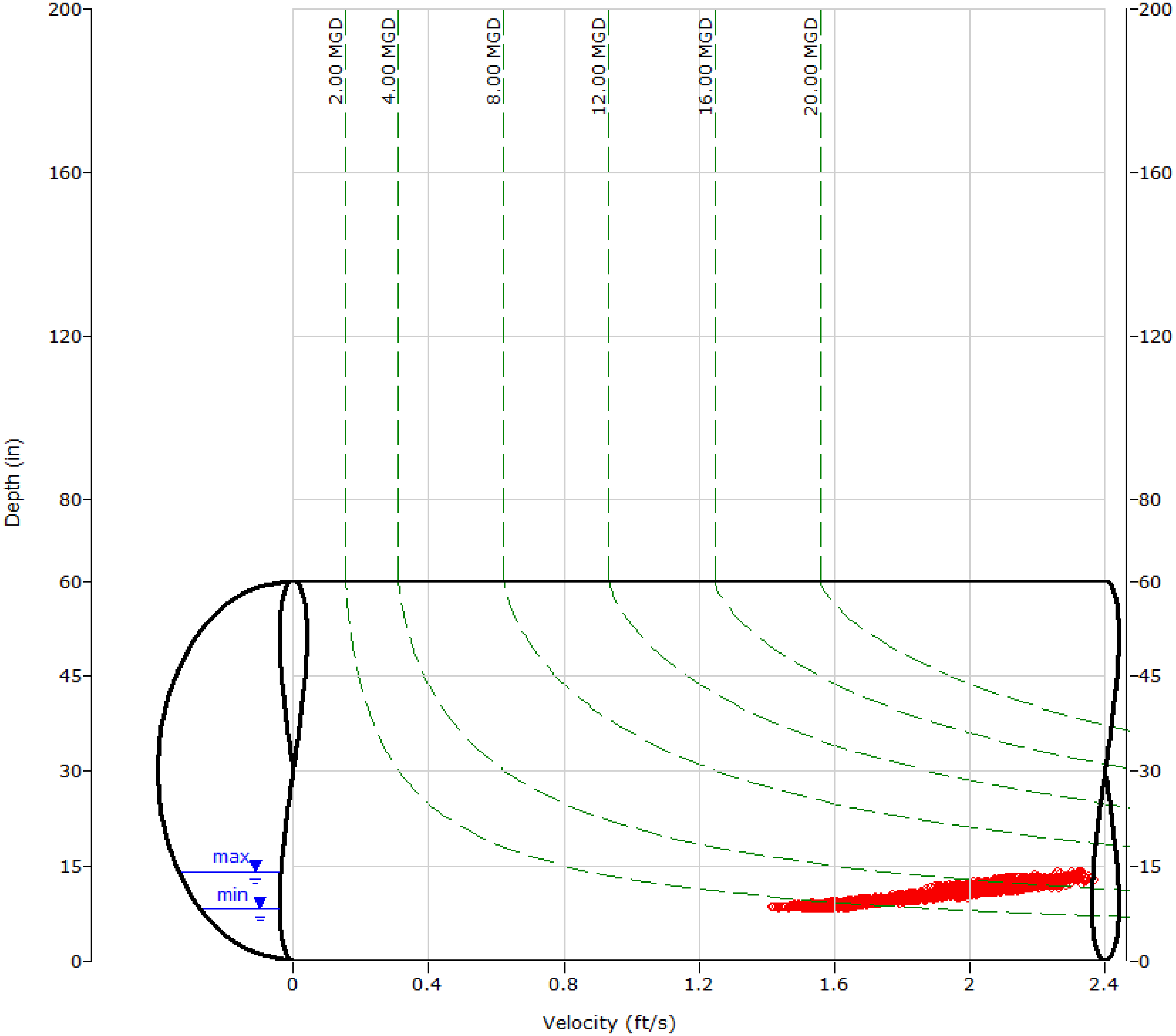
Pipe Height
60.25 in

Report Period

6/18/2015
To
7/1/2015

Legend

- Depth - Velocity
- Iso-Q™
- Silt
- Min-Max Depth



HYDROGRAPH REPORT

Sparks03

Flow Monitor

Sparks03

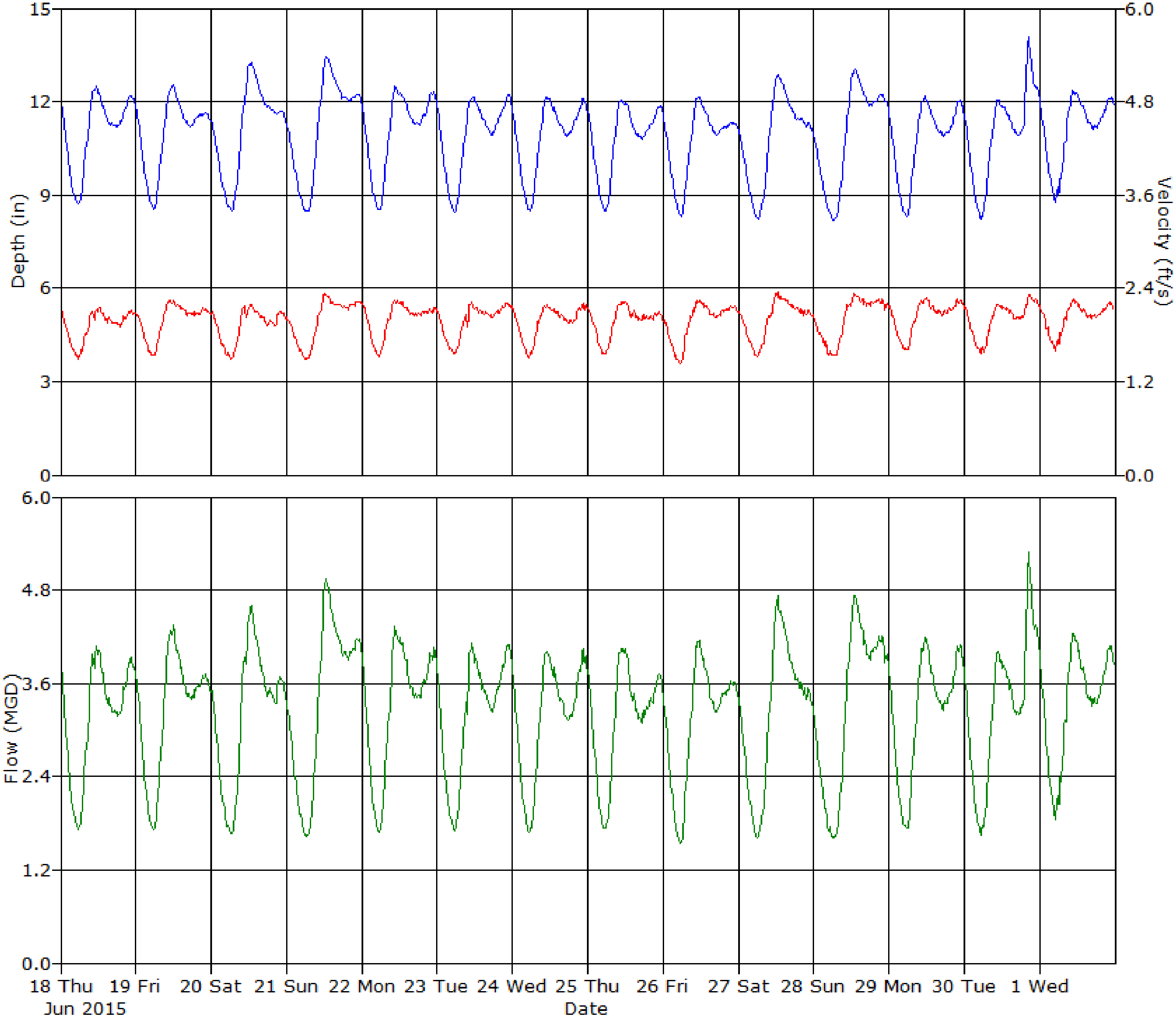
Pipe Height 60.25 in

Report Period

6/18/2015
To
7/1/2015

Legend

- Depth
- Velocity
- Quantity



ADS ENVIRONMENTAL SERVICES

Daily Tabular Report For The Period 6/18/2015 - 7/1/2015

Sparks03, Pipe Height: 60.25 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
6/18/2015	05:40	8.70	11:25	12.49	11.09	05:30	1.49	12:20	2.16	1.93	05:30	1.709	11:25	4.116	3.180	3.180	
6/19/2015	05:40	8.52	11:55	12.61	10.98	05:05	1.52	11:15	2.27	2.00	05:40	1.708	12:00	4.382	3.258	3.258	
6/20/2015	06:45	8.50	12:45	13.26	11.12	06:10	1.48	12:45	2.21	1.93	06:40	1.659	12:45	4.634	3.217	3.217	
6/21/2015	06:45	8.46	12:45	13.45	11.23	06:20	1.48	12:20	2.35	2.00	06:50	1.634	12:50	4.961	3.408	3.408	
6/22/2015	05:35	8.52	10:30	12.50	11.08	05:30	1.52	10:25	2.26	2.01	05:30	1.686	10:30	4.353	3.323	3.323	
6/23/2015	05:45	8.41	23:00	12.26	10.90	05:35	1.54	11:15	2.27	1.99	05:40	1.685	11:15	4.185	3.205	3.205	
6/24/2015	05:50	8.50	10:55	12.14	10.87	05:20	1.51	22:30	2.22	1.97	05:30	1.673	22:30	4.075	3.166	3.166	
6/25/2015	05:35	8.49	10:35	12.04	10.80	05:00	1.54	11:55	2.24	1.98	05:45	1.723	11:15	4.070	3.142	3.142	
6/26/2015	06:00	8.31	11:20	12.17	10.72	05:25	1.42	11:35	2.27	1.97	05:25	1.526	11:35	4.184	3.111	3.111	
6/27/2015	06:15	8.22	12:40	12.90	10.81	06:10	1.51	12:30	2.37	2.01	06:10	1.589	12:30	4.733	3.227	3.227	
6/28/2015	06:20	8.15	13:25	13.03	10.94	04:50	1.47	13:10	2.34	2.01	06:20	1.586	13:10	4.757	3.316	3.316	
6/29/2015	05:50	8.32	11:40	12.19	10.78	05:45	1.60	12:00	2.33	2.04	05:45	1.719	12:00	4.264	3.241	3.241	
6/30/2015	05:20	8.23	20:40	14.10	11.03	05:25	1.56	20:35	2.33	2.01	05:25	1.648	20:35	5.324	3.320	3.320	
7/1/2015	05:25	8.75	10:35	12.37	11.12	05:10	1.58	11:00	2.26	2.03	05:20	1.833	11:00	4.253	3.356	3.354	

Report Summary For The Period 6/18/2015 - 7/1/2015

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			45.469
Avg	10.96	1.99	3.248

Site Commentary

Site Information

Sulli09	
Pipe Dimensions	9.94" x 9.94"
Silt Level	0.00"

Overview

Site Sulli09 functioned under normal conditions during the period Thursday, June 18, 2015 to Wednesday, July 01, 2015 . No surcharge conditions were experienced at this location (See Observation Table For More Details). Review of the scattergraph shows that flow in this line remained free-flowing throughout the study. Due to the frequently variable flow conditions, this data set is of slightly lower confidence than typical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This line is located upstream of location Nugg05. A review of balancing indicated no problems (See Nugg05 Site Commentary For More Details).

Observations

Average flow depth, velocity, and quantity data observed during Thursday, June 18, 2015 to Wednesday, July 01, 2015 , along with observed minimum and maximum data, are provided in the following table. The values presented are based on 5-minute data. In regards to depth, this site flows at approximately 34% full at its recorded hourly peak depth of 3.36 inches and approximately 27% full during the typical average depth of 2.73 inches.

Observed Flow Conditions			
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	2.73	3.01	0.239
Minimum	1.78	1.74	0.086
Maximum	4.10	3.67	0.428
Time of Minimum	7/1/2015 4:05 AM	6/19/2015 4:25 AM	6/19/2015 4:25 AM
Time of Maximum	6/26/2015 5:50 PM	6/28/2015 9:25 AM	6/26/2015 5:50 PM

Data Quality

Data uptime observed during the Thursday, June 18, 2015 to the Wednesday, July 01, 2015 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

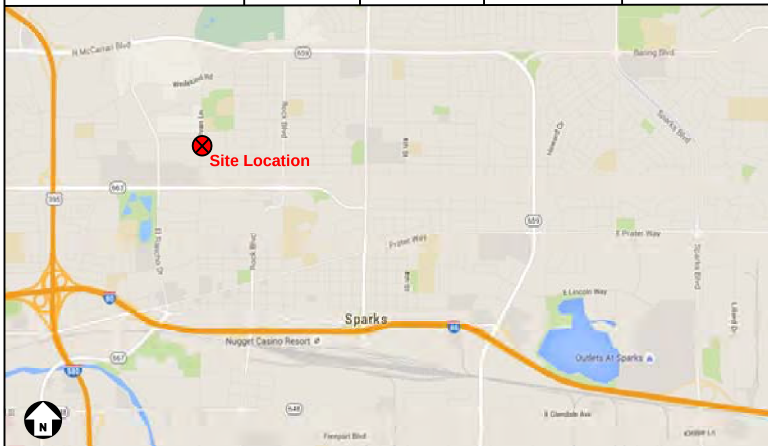
Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

ADS ENVIRONMENTAL SERVICES

ADS Site Report

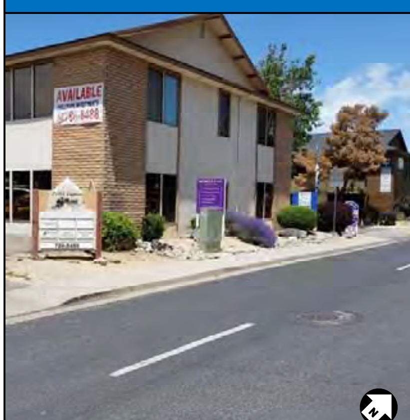
Quality Form

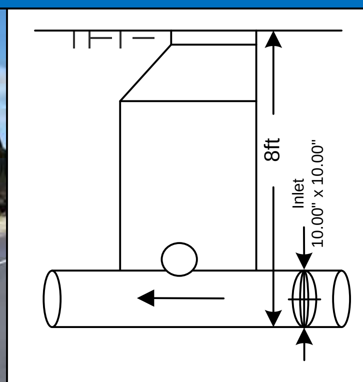
Project Name: Sparks.Atkins.TFM.NV15	**Project No.** 22038	**City:** Sparks, NV	**FM Initials:** SW
Site Name: Sulli09	**Investigate Date:** 6/17/15	**Monitor Type**	Peak Doppler
Address/Location: 2105 Capurro Way		**Monitor Model**	ADS Triton+
		Data Acquisition	Wireless
		Manhole ID	MH 002409
Access: Drive	**Type of System:** Sanitary [X] Storm [ ] Combined [ ]	**Pipe Height:**	10.00"
		Pipe Width:	10.00"



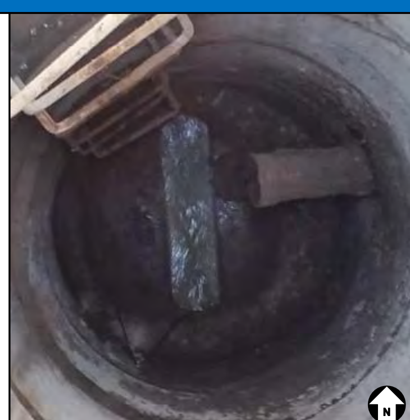
Investigation Information:		Manhole Information:	
Date/Time of Install:	6/17/15 @ 12:10		
Site Hydraulics:	Fast flow with waves	**Manhole Material / Condition**	Concrete / Good
Upstream Input: (L/S, P/S)	No influence	**Pipe Material / Condition:**	Concrete / Good
Upstream Manhole:	2 inlets / 1 outlet	**Land Use:**	Residential [X] Commercial [ ] Industrial [ ] Trunk [ ]
Downstream Manhole:	2 inlets / 1 outlet		
Depth of Flow (DOF):	2.75" +/- 0.25"	**Safety Notes**	
Range (Air DOF):	7.25 +/- 0.25"	Standard Traffic Control (right lane closure)	
Peak Velocity:	3.30 fps		
Silt:	0 Inches		

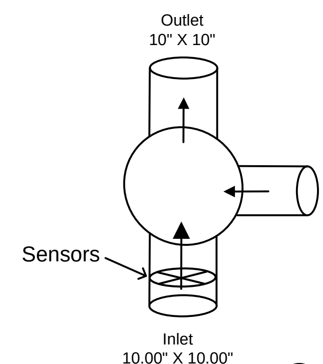
Other Information:





Cross Section





Plan

Installation Information		Backup	Yes	No	?	Distance
Installation Type:	Ring	Trunk	[ ]	[X]	[ ]	
Sensors Devices:	Water Ultrasonic/ Pressure/ Velocity	Lift / Pump Station	[ ]	[X]	[ ]	
Surcharge Height:	0	WWTP	[ ]	[X]	[ ]	
Rain Gauge Zone:	NA	Other	[ ]	[X]	[ ]	

Additional Site Information / Comments:

SCATTERGRAPH REPORT

Sulli09

Flow Monitor

Sulli09

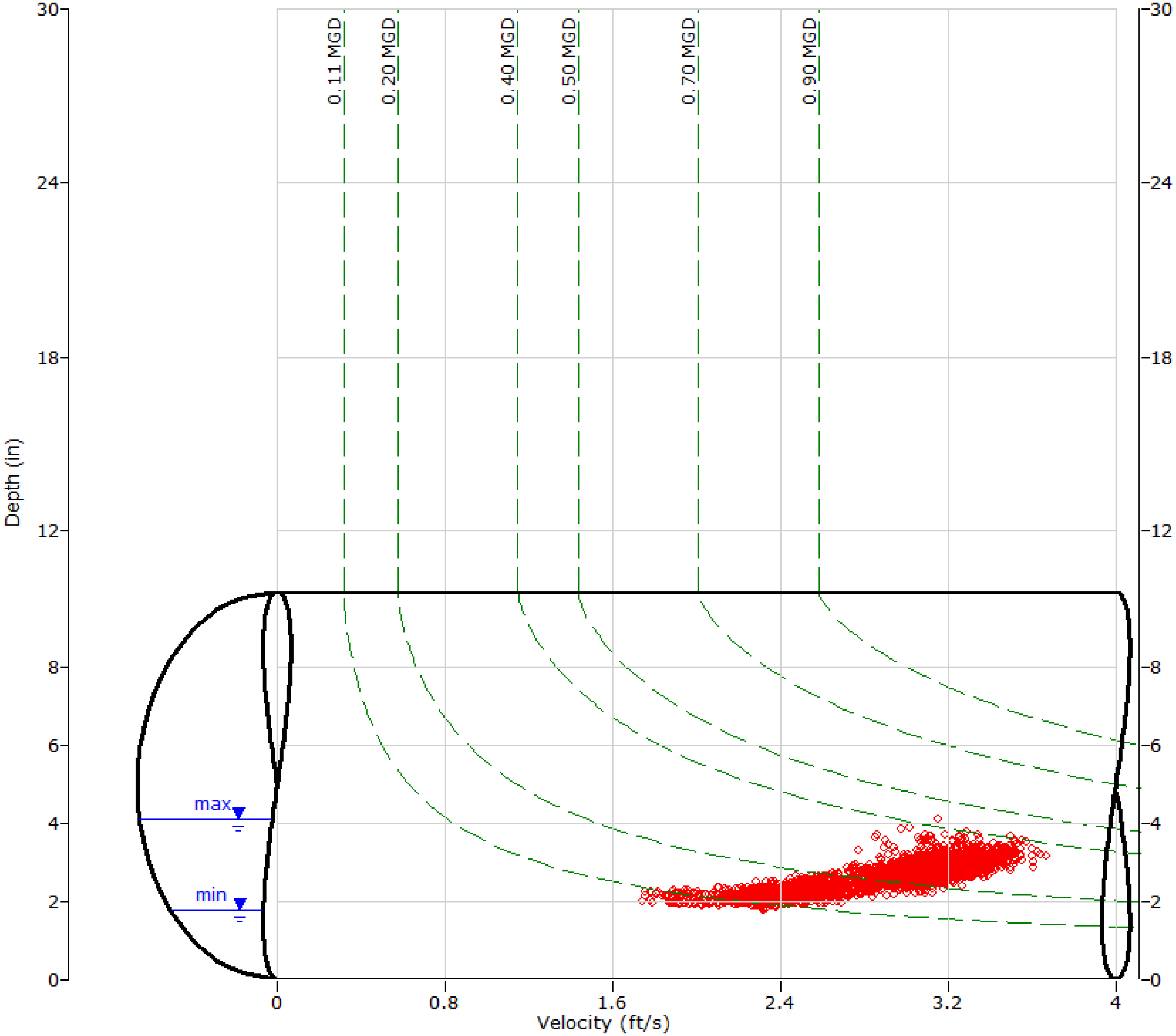
Pipe Height
9.94 in

Report Period

6/18/2015
To
7/1/2015

Legend

- Depth - Velocity
- Iso-Q™
- Silt
- Min-Max Depth



ADS ENVIRONMENTAL SERVICES

HYDROGRAPH REPORT

Sulli09

Flow Monitor

Sulli09

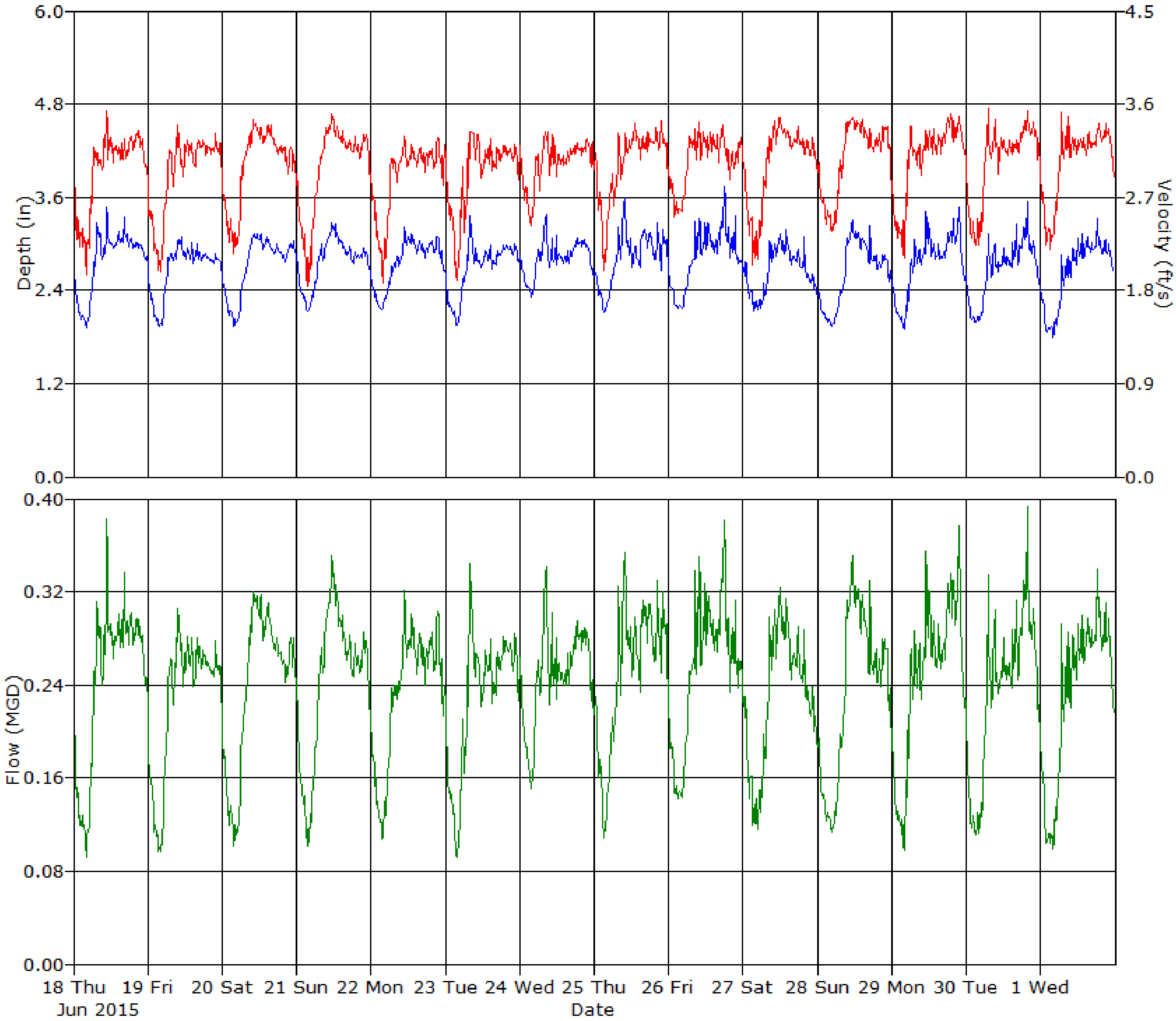
Pipe Height
9.94 in

Report Period

6/18/2015
To
7/1/2015

Legend

- Depth
- Velocity
- Quantity



ADS ENVIRONMENTAL SERVICES

Daily Tabular Report For The Period 6/18/2015 - 7/1/2015

Sulli09, Pipe Height: 9.940001 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
6/18/2015	04:20	1.91	10:55	3.53	2.79	05:00	1.78	10:55	3.57	2.97	05:00	0.090	10:55	0.395	0.244	0.244	
6/19/2015	03:45	1.92	14:20	3.17	2.68	04:25	1.74	09:35	3.42	2.94	04:25	0.086	09:35	0.311	0.228	0.228	
6/20/2015	03:50	1.91	14:15	3.17	2.73	02:20	1.96	09:50	3.50	3.01	03:45	0.096	10:05	0.332	0.239	0.239	
6/21/2015	03:25	2.12	12:30	3.53	2.78	03:00	1.76	11:25	3.52	2.98	03:50	0.097	12:30	0.358	0.243	0.243	
6/22/2015	03:40	2.13	10:55	3.26	2.76	04:00	1.78	10:45	3.39	2.89	03:45	0.102	10:55	0.330	0.232	0.232	
6/23/2015	04:15	1.95	08:00	3.38	2.70	04:00	1.87	16:40	3.35	2.93	04:00	0.090	08:00	0.348	0.229	0.229	
6/24/2015	03:55	2.32	11:55	3.69	2.82	03:35	2.23	09:10	3.34	3.04	03:35	0.137	07:15	0.344	0.248	0.248	
6/25/2015	03:10	2.11	09:55	3.67	2.82	03:10	1.90	21:45	3.47	3.03	03:10	0.103	09:55	0.363	0.250	0.250	
6/26/2015	03:05	2.15	17:50	4.10	2.83	03:05	2.48	17:35	3.51	3.07	03:05	0.138	17:50	0.428	0.255	0.255	
6/27/2015	05:35	2.09	19:50	3.84	2.65	03:00	1.89	10:10	3.64	3.01	04:40	0.107	08:35	0.380	0.229	0.229	
6/28/2015	04:35	1.94	17:00	3.38	2.63	04:25	2.20	09:25	3.67	3.08	04:25	0.106	11:20	0.360	0.233	0.233	
6/29/2015	04:00	1.89	11:00	3.76	2.75	03:55	2.02	12:10	3.60	3.07	04:00	0.093	21:35	0.409	0.247	0.247	
6/30/2015	03:00	1.96	19:55	3.56	2.66	03:00	2.07	07:05	3.64	3.04	03:00	0.101	19:55	0.399	0.234	0.234	
7/1/2015	04:05	1.78	13:40	3.68	2.63	03:20	1.99	06:50	3.61	3.04	03:20	0.095	13:40	0.374	0.231	0.231	

Report Summary For The Period 6/18/2015 - 7/1/2015

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			3.342
Avg	2.73	3.01	0.239

Site Commentary

Site Information

Victo04	
Pipe Dimensions	26.00" x 26.00"
Silt Level	0.00"

Overview

Site Victo04 functioned under normal conditions during the period Thursday, June 18, 2015 to Wednesday, July 01, 2015 . The flow pattern exhibited by this line shows a saw-toothed like pattern which is generally indicative of pump station influence. No surcharge conditions were experienced at this location (See Observation Table For More Details). Review of the scattergraph shows that flow in this line remained free-flowing throughout the study.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

This line is located upstream of location Nugg05. A review of balancing indicated no problems (See Nugg05 Site Commentary For More Details).

Observations

Average flow depth, velocity, and quantity data observed during Thursday, June 18, 2015 to Wednesday, July 01, 2015 , along with observed minimum and maximum data, are provided in the following table. The values presented are based on 5-minute data. In regards to depth, this site flows at approximately 19% full at its recorded hourly peak depth of 4.95 inches and approximately 15% full during the typical average depth of 3.82 inches.

Observed Flow Conditions			
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	3.82	4.19	0.933
Minimum	2.30	3.41	0.360
Maximum	5.92	4.74	1.915
Time of Minimum	6/23/2015 4:50 AM	6/18/2015 5:40 AM	7/1/2015 4:30 AM
Time of Maximum	6/21/2015 10:10 AM	6/28/2015 2:45 PM	6/21/2015 10:10 AM

Data Quality

Data uptime observed during the Thursday, June 18, 2015 to the Wednesday, July 01, 2015 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

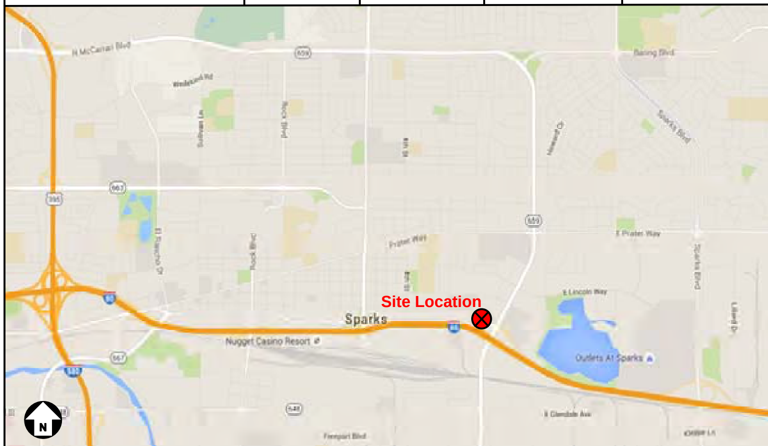
Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

ADS ENVIRONMENTAL SERVICES

ADS Site Report

Quality Form

Project Name: Sparks.Atkins.TFM.NV15	**Project No.** 22038	**City:** Sparks, NV	**FM Initials:** SW
Site Name: Victo04	**Investigate Date:** 6/17/15	**Monitor Type**	Peak Doppler
Address/Location: 60 E Victorian Ave		**Monitor Model**	ADS Triton+
		Data Acquisition	Wireless
		Manhole ID	MH 003570
Access: Drive	**Type of System:** Sanitary [X] Storm [ ] Combined [ ]	**Pipe Height:**	26.00"
		Pipe Width:	26.00"



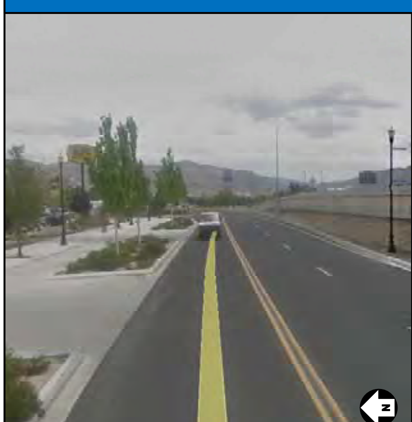
Investigation Information:

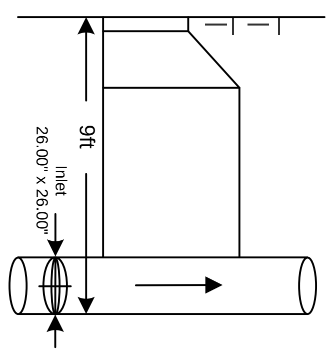
Date/Time of Install:	6/17/15 @ 11:15
Site Hydraulics:	Fast flow with waves
Upstream Input: (L/S, P/S)	PS
Upstream Manhole:	1 inlet / 1 outlet
Downstream Manhole:	1 inlet / 1 outlet (90 degree bend)
Depth of Flow (DOF):	5.00" +/- 0.25"
Range (Air DOF):	21.00" +/- 0.25"
Peak Velocity:	4.90 fps
Silt:	0 Inches

Manhole Information:

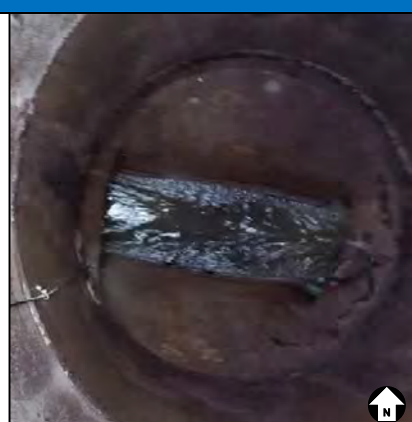
Manhole Material / Condition	Concrete / Good
Pipe Material / Condition:	PVC / Good
Land Use:	Residential [X] Commercial [X] Industrial [ ] Trunk [ ]
Safety Notes	
Standard Traffic Control (left lane closure)	

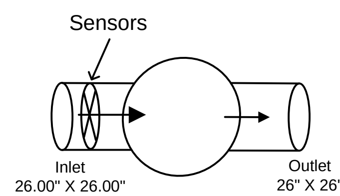
Other Information:





Cross Section





Plan

Installation Information	
Installation Type:	Ring
Sensors Devices:	Water Ultrasonic/ Pressure/ Velocity
Surcharge Height:	0
Rain Gauge Zone:	NA

Backup	Yes	No	?	Distance
Trunk	[ ]	[X]	[ ]	
Lift / Pump Station	[ ]	[X]	[ ]	
WWTP	[ ]	[X]	[ ]	
Other	[ ]	[X]	[ ]	

Additional Site Information / Comments:

SCATTERGRAPH REPORT

Victo04

Flow Monitor

Victo04

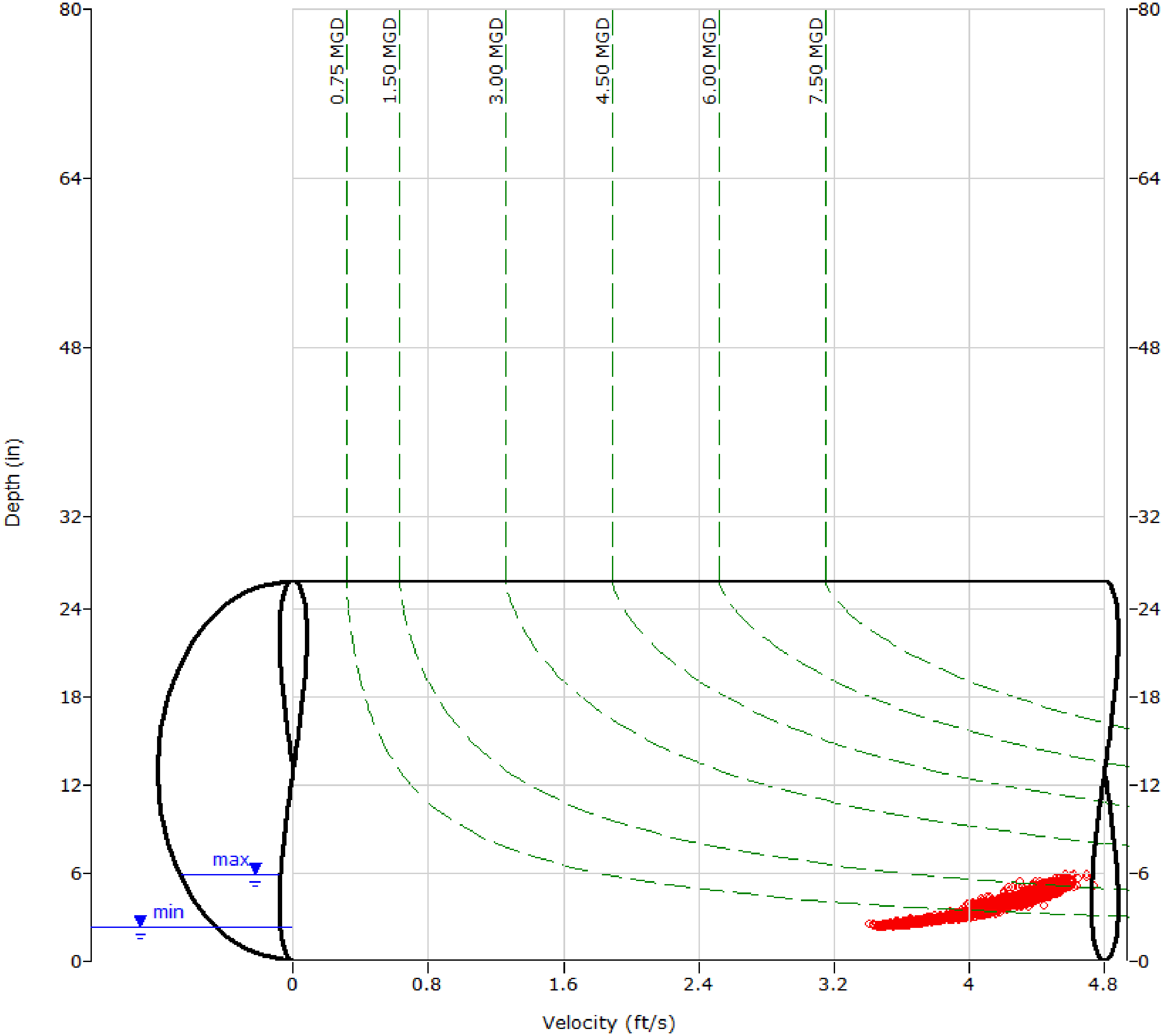
Pipe Height
26.00 in

Report Period

6/18/2015
To
7/1/2015

Legend

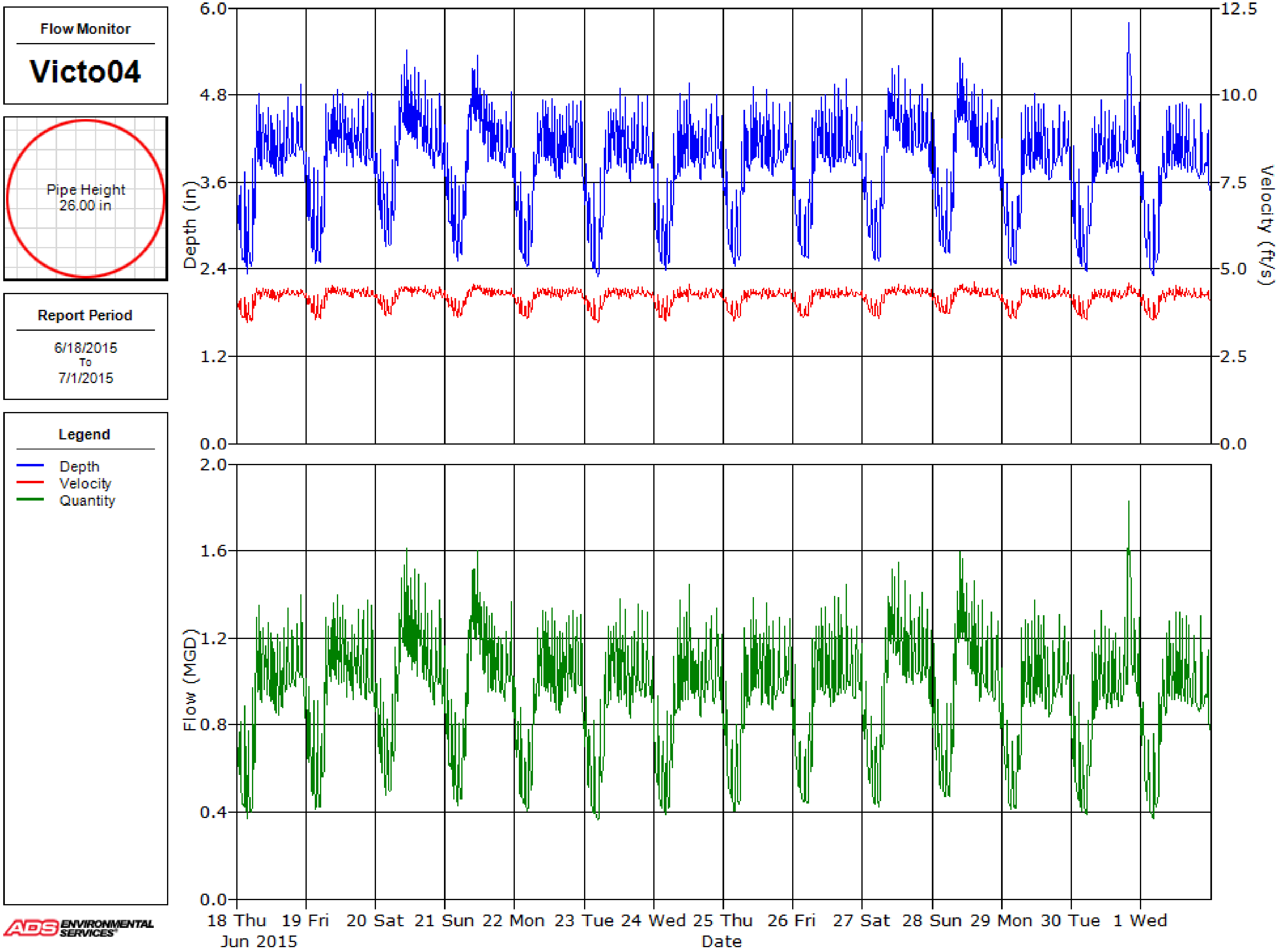
- Depth - Velocity
- Iso-Q™
- Silt
- Min-Max Depth



ADS ENVIRONMENTAL SERVICES

HYDROGRAPH REPORT

Victo04



Victo04, Pipe Height: 26 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
6/18/2015	04:10	2.33	08:05	5.28	3.78	05:40	3.41	12:10	4.50	4.16	04:00	0.365	08:05	1.538	0.912	0.912	
6/19/2015	03:35	2.47	19:40	5.42	3.88	03:30	3.54	09:55	4.57	4.21	03:35	0.406	19:40	1.622	0.957	0.957	
6/20/2015	03:55	2.70	13:45	5.59	4.01	03:45	3.64	22:20	4.57	4.24	03:55	0.477	11:05	1.698	1.012	1.012	
6/21/2015	04:30	2.52	10:10	5.92	3.94	04:15	3.57	10:10	4.70	4.22	04:15	0.425	10:10	1.915	0.983	0.983	
6/22/2015	04:35	2.43	18:55	5.25	3.80	04:45	3.58	08:55	4.57	4.20	04:30	0.405	18:55	1.558	0.928	0.928	
6/23/2015	04:50	2.30	21:50	5.18	3.73	04:55	3.48	12:20	4.54	4.17	04:50	0.360	18:30	1.506	0.900	0.900	
6/24/2015	04:25	2.38	12:15	5.22	3.73	04:00	3.49	09:15	4.56	4.16	04:25	0.382	12:15	1.551	0.895	0.895	
6/25/2015	04:25	2.44	15:00	5.17	3.78	03:45	3.43	16:05	4.62	4.16	03:45	0.401	13:55	1.528	0.910	0.910	
6/26/2015	04:05	2.55	15:45	5.26	3.83	03:35	3.59	20:10	4.53	4.18	04:00	0.434	15:45	1.562	0.931	0.931	
6/27/2015	05:40	2.50	10:05	5.57	3.95	05:35	3.58	19:25	4.61	4.22	05:40	0.420	10:05	1.713	0.987	0.987	
6/28/2015	06:05	2.62	09:50	5.83	3.92	04:35	3.68	14:45	4.74	4.22	04:35	0.464	09:50	1.823	0.974	0.974	
6/29/2015	03:35	2.39	23:10	5.11	3.72	05:25	3.50	19:45	4.57	4.17	03:35	0.390	10:20	1.482	0.892	0.892	
6/30/2015	05:15	2.35	19:55	5.85	3.77	05:15	3.52	19:55	4.62	4.17	05:15	0.377	19:55	1.854	0.914	0.914	
7/1/2015	04:30	2.31	15:35	5.19	3.65	04:30	3.46	12:15	4.61	4.15	04:30	0.360	15:35	1.547	0.868	0.867	

Report Summary For The Period 6/18/2015 - 7/1/2015

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			13.064
Avg	3.82	4.19	0.933

Site Commentary

Site Information

WldIsd08	
Pipe Dimensions	18.38" x 18.38"
Silt Level	0.00"

Overview

Site WldIsd08 functioned under normal conditions during the period Thursday, June 18, 2015 to Wednesday, July 01, 2015 . Surcharge conditions were experienced at this location. Review of the scattergraph shows that flow in this line experienced both free-flow and backwater conditions during the study. Due to the low flow conditions for the size of the pipe and frequent backwater events, this set of data is of lower confidence than typical.

Flow depth and velocity measurements recorded by the flow monitor are consistent with field confirmations conducted to date and support the relative accuracy of the flow monitor at this location.

Observations

Average flow depth, velocity, and quantity data observed during Thursday, June 18, 2015 to Wednesday, July 01, 2015 , along with observed minimum and maximum data, are provided in the following table. The values presented are based on 5-minute data. In regards to depth, this site flows at approximately 98% full at its recorded hourly peak depth of 17.95 inches and approximately 19% full during the typical average depth of 3.42 inches.

Observed Flow Conditions			
Item	Depth (in)	Velocity (ft/s)	Quantity (MGD)
Average	3.42	0.79	0.114
Minimum	2.15	0.15	0.040
Maximum	18.51	1.23	0.569
Time of Minimum	6/28/2015 4:15 AM	6/18/2015 10:50 PM	6/28/2015 3:25 AM
Time of Maximum	6/30/2015 9:50 PM	7/1/2015 2:00 PM	6/30/2015 8:20 PM

Data Quality

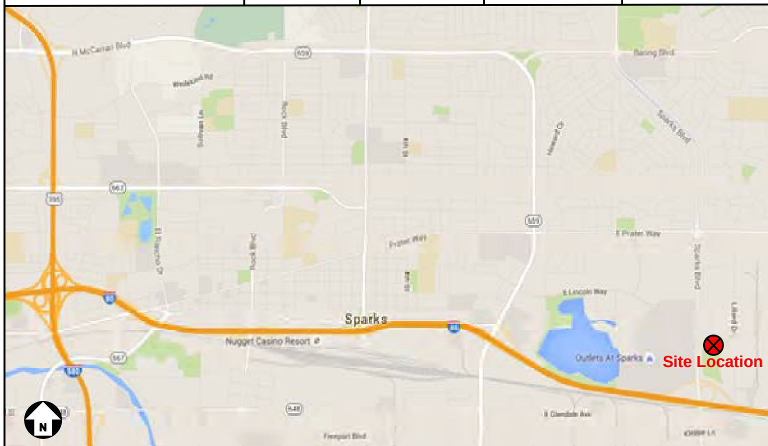
Data uptime observed during the Thursday, June 18, 2015 to the Wednesday, July 01, 2015 monitoring period is provided in the table below. Based upon the quality and consistency of the observed flow depth and velocity data, the Continuity equation was used to calculate flow rate and quantities during the monitoring period.

Percent Uptime	
Depth (in)	100
Velocity (ft/s)	100
Quantity (MGD)	100

ADS ENVIRONMENTAL SERVICES®

ADS Site Report — Quality Form

Project Name: Sparks.Atkins.TFM.NV15	**Project No.** 22038	**City:** Sparks, NV	**FM Initials:** SW
Site Name: Wldlsd08	**Investigate Date:** 6/15/15	**Monitor Type**	Peak Doppler
Address/Location: 250 Wild Island Ct		**Monitor Model**	ADS Triton+
		Data Acquisition	Wireless
		Manhole ID	MH 019753
Access: Drive	**Type of System:** Sanitary [X] Storm [ ] Combined [ ]	**Pipe Height:**	18.38"
		Pipe Width:	18.50"



Investigation Information:

Date/Time of Install:	6/16/15 @ 07:30
Site Hydraulics:	Slow and smooth flow
Upstream Input: (L/S, P/S)	No Influence
Upstream Manhole:	1 inlet / 1 outlet
Downstream Manhole:	2 inlets / 1 outlet
Depth of Flow (DOF):	3.50" +/- 0.25"
Range (Air DOF):	14.88" +/- 0.25"
Peak Velocity:	0.90 fps
Silt:	0 Inches

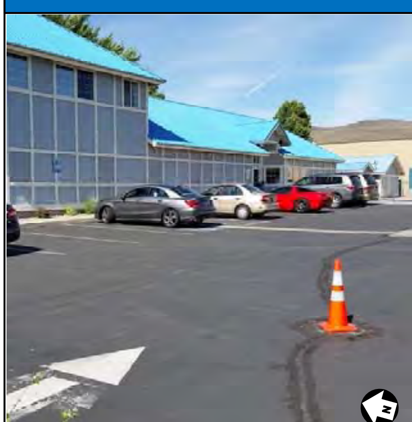
Manhole Information:

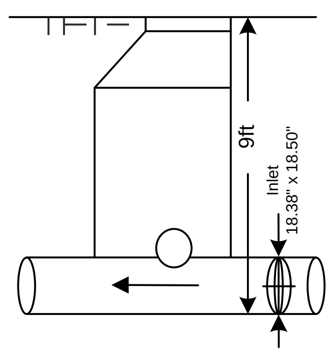
Manhole Material / Condition	Concrete / Good
Pipe Material / Condition:	Concrete / Good
Land Use:	Residential [X] Commercial [X] Industrial [ ] Trunk [ ]

Safety Notes

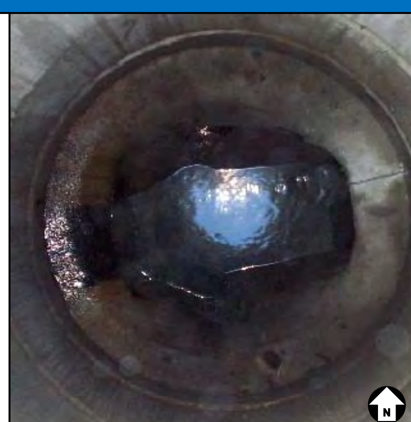
Located in parking lot car and pedestrian control needed

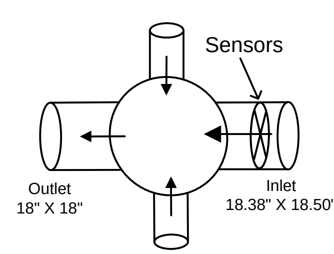
Other Information:





Cross Section





Plan

Installation Information	
Installation Type:	Ring
Sensors Devices:	Water Ultrasonic/ Pressure/ Velocity
Surcharge Height:	0
Rain Gauge Zone:	NA

Backup	Yes	No	?	Distance
Trunk		X		
Lift / Pump Station		X		
WWTP		X		
Other		X		

Additional Site Information / Comments:

SCATTERGRAPH REPORT

WldIsd08

Flow Monitor

WldIsd08

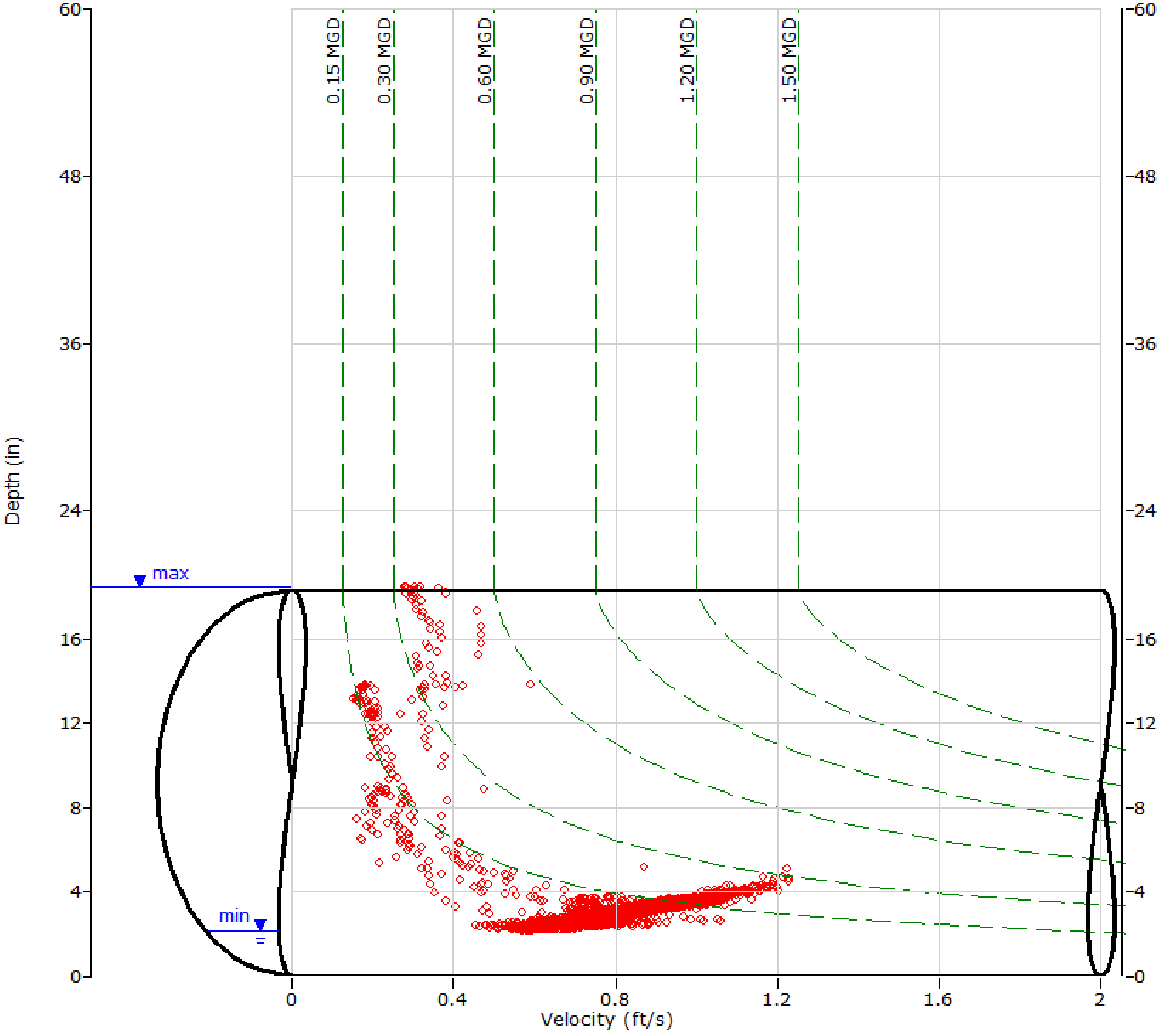
Pipe Height
18.38 in

Report Period

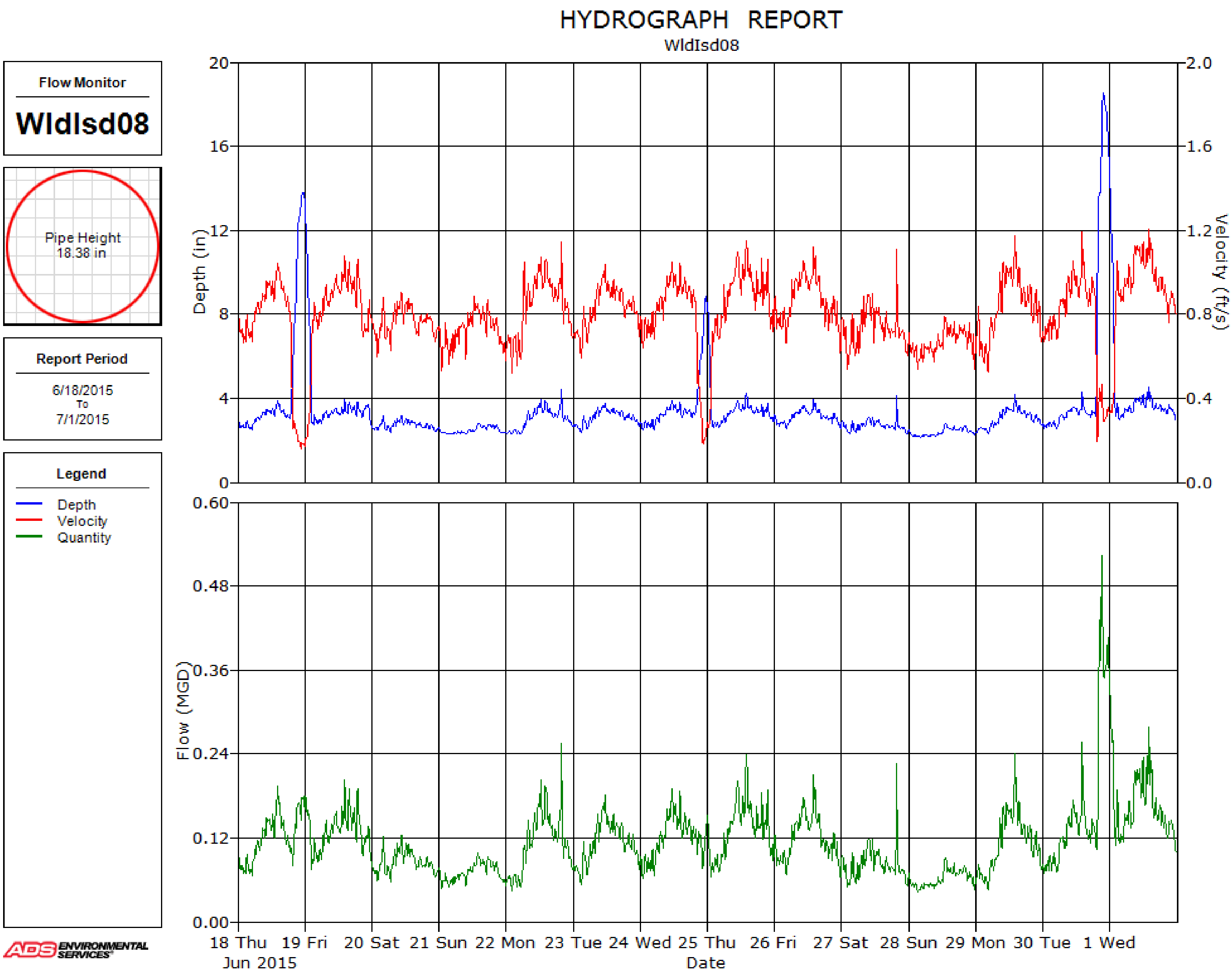
6/18/2015
To
7/1/2015

Legend

- Depth - Velocity
- Iso-Q™
- Silt
- Min-Max Depth



ADS ENVIRONMENTAL SERVICES


HYDROGRAPH REPORT
WldIsd08
Flow Monitor
WldIsd08
Pipe Height
18.38 in
Report Period
6/18/2015
To
7/1/2015
Legend
Depth
Velocity
Quantity
Depth (in)
Velocity (ft/s)
Flow (MGD)
18 Thu 19 Fri 20 Sat 21 Sun 22 Mon 23 Tue 24 Wed 25 Thu 26 Fri 27 Sat 28 Sun 29 Mon 30 Tue 1 Wed
Jun 2015
Date
ADS ENVIRONMENTAL SERVICES

Daily Tabular Report For The Period 6/18/2015 - 7/1/2015

Wldlsd08, Pipe Height: 18.38 in

Daily Tabular Report

Date	Depth (in)					Velocity (ft/s)					Quantity (MGD - Total MG)						Rain (in)
	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Time	Min	Time	Max	Avg	Total	Total
6/18/2015	05:10	2.46	23:30	13.80	4.55	22:50	0.15	14:05	1.06	0.72	05:10	0.063	14:05	0.197	0.121	0.121	
6/19/2015	03:20	2.71	00:00	13.55	3.93	00:05	0.16	14:20	1.08	0.81	02:30	0.060	14:20	0.211	0.132	0.132	
6/20/2015	06:50	2.35	10:45	3.20	2.72	02:00	0.59	10:40	0.91	0.77	06:50	0.056	10:45	0.128	0.086	0.086	
6/21/2015	09:55	2.29	13:50	2.81	2.48	03:50	0.47	13:10	0.93	0.73	03:50	0.041	13:55	0.099	0.070	0.070	
6/22/2015	05:15	2.26	19:40	5.12	3.02	03:45	0.48	19:45	1.23	0.84	02:10	0.044	19:45	0.329	0.113	0.113	
6/23/2015	02:45	2.36	11:25	3.79	3.09	02:55	0.59	11:20	1.04	0.83	02:45	0.053	11:25	0.185	0.113	0.113	
6/24/2015	05:15	2.46	23:35	8.90	3.69	22:40	0.16	11:30	1.07	0.78	01:05	0.061	11:30	0.197	0.120	0.120	
6/25/2015	04:25	2.56	00:00	8.56	3.49	00:30	0.26	14:10	1.17	0.86	01:30	0.058	14:10	0.241	0.132	0.132	
6/26/2015	23:50	2.53	14:05	3.94	3.13	23:30	0.60	14:05	1.12	0.87	23:50	0.062	14:05	0.212	0.120	0.120	
6/27/2015	23:25	2.29	19:45	4.67	2.70	02:25	0.49	19:45	1.21	0.74	02:25	0.046	19:45	0.291	0.082	0.082	
6/28/2015	04:15	2.15	13:25	2.81	2.38	23:45	0.49	21:55	0.84	0.67	03:25	0.040	13:20	0.095	0.061	0.061	
6/29/2015	04:45	2.30	14:05	4.20	3.04	04:25	0.45	14:20	1.20	0.83	04:25	0.041	14:05	0.247	0.113	0.113	
6/30/2015	04:55	2.51	21:50	18.51	5.53	19:40	0.18	14:10	1.19	0.76	04:55	0.066	20:20	0.569	0.165	0.165	
7/1/2015	23:50	2.92	00:00	14.74	4.10	00:05	0.31	14:00	1.23	0.93	23:50	0.097	00:10	0.347	0.168	0.168	

Report Summary For The Period 6/18/2015 - 7/1/2015

	Depth (in)	Velocity (ft/s)	Quantity (MGD - Total MG)
Total			1.596
Avg	3.42	0.79	0.114

Appendix B. Wastewater Generation Rate Analysis and Model Loading

- Wastewater Generation Analysis
- Wastewater Model Loading GIS Database Flow Chart
- Weekday Diurnal Patterns
- Weekend Diurnal Patterns

Wastewater Generation Analysis

(Land Use-, Population- and Water Use-Based Unit Generation Rate Analyses)

Land Use-Based Wastewater Generation Analysis
City of Sparks Sewer Model Update

Meter	Calibrated Unit Wastewater Generation per Land Use Category								Observed Average Daily Flow at Meter (mgd)	Modeled Average Daily Flow at Meter (mgd)	% Error
	Single-Family Residential (gpd/DU)	Multi-Family Residential (gpd/DU)	Office (gpd/acre)	Public Facility (gpd/acre)	Commercial (gpd/acre)	Resort/Hotel/Casino (gpd/room)	Industrial (gpd/acre)	Institutional (gpd/acre)			
Frank06	166	121	150		650		100	200	5.21	4.79	-7.9%
Matte07	149	105	550	150	650				0.23	0.23	-0.5%
Nugg05	130	100	700	250	1200	80	200	300	2.55	2.77	8.5%
Site_05	130	100	700		650	70	400	300	10.36	10.6	2.2%
Site_06	210	115	300	450	1000	80	200	2500	1.19	1.11	-6.9%
Site_07			300		1100		600		0.04	0.04	-2.2%
Sparks03	210	130	250	80	500		80	250	3.2	3.4	6.0%
Sulli09	200	210	100	200	250				0.24	0.24	-2.3%
Victo04	130	100	800	450	3000	115	100	500	0.92	0.87	-5.4%
Wldlsd08			300		950		500		0.12	0.13	5.9%
Overall Average	180	116	576	178	915	102	381	496			

Notes:

- gpd = gallons per day and DU = dwelling unit
- Permanent and temporary meter data was collected during June 18 to July 1, 2015. See **Appendix A** for flow metering report from ADS Environmental Services (ADS).
- The data excludes metered data collected during June 30, 2015 due to the influence of wet weather flows.

Population-Based Wastewater Generation Analysis
City of Sparks Sewer Model Update

Meter	Land Use Category: Single-Family Residential			Multi-Family Residential			Office			Public Facility			Commercial			Resort/Hotel/Casino			Industrial			Institutional		
	Residential Density (pop./DU)	Calibrated Unit Wastewater Generation (gpd/DU)	Per Capita Wastewater Generation (gpcd)	Residential Density (pop./DU)	Calibrated Unit Wastewater Generation (gpd/DU)	Per Capita Wastewater Generation (gpcd)	Employment Density (pop./acre)	Calibrated Unit Wastewater Generation (gpd/acre)	Per Capita Wastewater Generation (gpcd)	Employment Density (pop./acre)	Calibrated Unit Wastewater Generation (gpd/acre)	Per Capita Wastewater Generation (gpcd)	Employment Density (pop./acre)	Calibrated Unit Wastewater Generation (gpd/acre)	Per Capita Wastewater Generation (gpcd)	Employment Density (pop./room)	Calibrated Unit Wastewater Generation (gpd/room)	Per Capita Wastewater Generation (gpcd)	Employment Density (pop./acre)	Calibrated Unit Wastewater Generation (gpd/acre)	Per Capita Wastewater Generation (gpcd)	Employment Density (pop./acre)	Calibrated Unit Wastewater Generation (gpd/acre)	Per Capita Wastewater Generation (gpcd)
Frank06	2.5	166	65	1.9	121	64	29.8	150	5				16.3	650	40				6.4	100	16	10.8	200	18
Matte07	2.7	149	55	1.9	105	55	40.5	550	14	10.8	150	14	14.1	650	46									
Nugg05	2.8	130	46	2.2	100	45	25.9	700	27	15.7	250	16	18.9	1200	63	1.6	80	50	27.2	200	7	11.3	300	27
Site_05	2.1	130	62	2.4	100	42	10.7	700	65				22.7	650	29	2.3	70	30	10.5	400	38	10.1	300	30
Site_06	2.4	210	89	1.7	115	68	20.3	300	15	46.9	450	10	18.2	1000	55	1.3	80	60	9.2	200	22	22.8	2500	110
Site_07							4.0	300	74				7.8	1100	141				55.1	600	11			
Sparks03	2.6	210	80	2.1	130	61	23.4	250	11	2.6	80	31	13.9	500	36				9.3	80	9	8.0	250	31
Sulli09	2.5	200	80	2.4	210	87	19.8	100	5	8.9	200	22	5.1	250	49									
Victo04	2.2	130	59	2.2	100	46	44.5	800	18	22.4	450	20	17.0	3000	176	2.2	115	53	12.1	100	8	21.2	500	24
Wldlsd08							21.8	300	14				45.8	950	21				6.4	500	78			
Overall Average	2.6	180	69	2.1	116	55	17.5	576	33	9.4	178	19	16.9	915	54	2.0	102	50	10.0	381	38	11.8	496	42

Notes:

- gpd = gallons per day, gpcd = gallons per capita per day, and DU = dwelling unit
- TMRPA provided U.S. Census residential and employment population data at the block-level scale for the study area based on 2010 U.S. Census data and updated data from 2014 and 2015.
- The employment data was categorized into specific industries using the by the North American Industry Codes (NAICs). Therefore the NAICs were assigned the applicable Master Plan categories in order to organize employment data into the correct land use type.

Water Use Data-Based Wastewater Generation Analysis
City of Sparks Sewer Model Update

Meter	Land Use Category																							
	Single-Family Residential (gpd/DU)			Multi-Family Residential (gpd/DU)			Office (gpd/acre)			Public Facility (gpd/acre)			Commercial (gpd/acre)			Resort/Hotel/Casino (gpd/room)			Industrial (gpd/acre)			Institutional (gpd/acre)		
	Unit Water Demand (June)	Calibrated Unit Wastewater Generation	Return-To-Sewer Ratio	Unit Water Demand (June)	Calibrated Unit Wastewater Generation	Return-To-Sewer Ratio	Unit Water Demand (June)	Calibrated Unit Wastewater Generation	Return-To-Sewer Ratio	Unit Water Demand (June)	Calibrated Unit Wastewater Generation	Return-To-Sewer Ratio	Unit Water Demand (June)	Calibrated Unit Wastewater Generation	Return-To-Sewer Ratio	Unit Water Demand (June)	Calibrated Unit Wastewater Generation	Return-To-Sewer Ratio	Unit Water Demand (June)	Calibrated Unit Wastewater Generation	Return-To-Sewer Ratio	Unit Water Demand (June)	Calibrated Unit Wastewater Generation	Return-To-Sewer Ratio
Frank06	331	166	50%	135	121	90%	231	150	65%				743	650	87%				116	100	86%	323	200	62%
Matte07	367	149	41%	181	105	58%	923	550	60%	247	150	61%	809	650	80%									
Nugg05	328	130	40%	145	100	69%	1129	700	62%	325	250	77%	1572	1200	76%	107	80	75%	263	200	76%	566	300	53%
Site_05	289	130	45%	139	100	72%	883	700	79%				746	650	87%	99	70	71%	451	400	89%	549	300	55%
Site_06	353	210	59%	129	115	89%	364	300	82%	527	450	85%	1244	1000	80%	87	80	92%	250	200	80%	3053	2500	82%
Site_07							451	300	67%				1456	1100	76%				728	600	82%			
Sparks03	456	210	46%	139	130	94%	285	250	88%	152	80	53%	521	500	96%				88	80	91%	283	250	88%
Sulli09	464	200	43%	261	210	80%	209	100	48%	423	200	47%	353	250	71%									
Victo04	255	130	51%	139	100	72%	957	800	84%	635	450	71%	3444	3000	87%	139	115	83%	114	100	88%	691	500	72%
Wldlsd08							404	300	74%				1036	950	92%				535	500	93%			
Overall Average	395	180	45%	146	116	80%	787	576	75%	278	178	65%	1071	915	85%	127	102	80%	394	381	95%	770	496	65%

Notes:

- gpd = gallons per day and DU = dwelling unit
- Return-to-sewer (RTS) ratios reported are reflective of summer ratios. Winter water usage generally match wastewater generation rates, therefore RTS ratios differ greatly from the summer RTS ratios.
- Water use data obtained from Truckee Meadows Water Authority (TMWA) for the years 2010-2015

Wastewater Model Loading GIS Database Flow Chart

Wastewater Model Loading GIS Database Flow Chart

Below describes the process of finding the parcel loading information used in the model (existing and buildout model scenarios) from the parcel shapefiles.

1. Existing Parcel Model Loading (**Sparks_DWFParcels.shp**) shapefile definitions:
    - **APN**: accessor's parcel number of parcel
    - **Inf_Node**: Assigned manhole where parcel flow enters the model
    - **Sparks_LU**: Existing land use category (1-12)
    - **LU_Desc**: Description of existing land use category
    - **DU_2013**: Existing dwelling units used in calculating dwelling unit-based wastewater generation
    - **TOTAL_ACRE**: Area used in calculating area-based wastewater generation
    - **Rooms**: Number of hotel/motel rooms for a specific parcel
    - **UnitRate**: The unit rate either per dwelling unit or per acre depending on land use category
    - **ADWF_GPD**: Average daily dry weather flow (depending on land use category) calculated in gallons per day (gpd) using either DU_2013, Rooms, or TOTAL_ACRE multiplied by the UnitRate
    - **ADWF_MGD**: Average daily dry weather flow calculated in million gallons per day (mgd)
    - **LU_Notes**: Notes used to describe pertinent information related to a specific parcel
    - **Septic**: 0= parcel contributes to City sewer system, 1= parcel contains on-site septic system
    - **IS_Usage**: Number used for model loading in InfoSWMM to assign appropriate land use category
    - **Meter**: Permanent or temporary meter sewershed encompassing parcel
    - **Res**: Describes residential parcel as either suburban or urban
    - **TMRPA_ID**: unique identifier for each parcel that corresponds to the TMRPA land use database
    - **City**: Identified whether parcel is within the City of Sparks, City of Reno or Washoe County
    - **X**: easting at centroid of parcel
    - **Y**: northing at centroid of parcel

2. Buildout Parcel Model Loading (**Sparks_DWFParcels_Future.shp**) shapefile definitions:
    - **APN**: accessor's parcel number of parcel
    - **Future**: 0= no change in wastewater generation from existing condition loading, 1= change in wastewater generation from existing loading
    - **Fut_Inf_No**: Assigned manhole where parcel flow enters the model
    - **LU_Fut**: Future land use category (1-12)
    - **LU_Fut_Des**: Description of future land use category

- **BO_DU**: Future dwelling units used in calculating dwelling unit-based wastewater generation Future dwelling units used in calculating flow
- **UC_Area**: Unconstrained area used in calculating area-based wastewater generation
- **Rooms**: Number of hotel/motel rooms for a specific parcel
- **UnitRate**: The unit rate either per dwelling unit or per acre depending on land use category
- **ADWF_GPD**: Average daily dry weather flow (depending on land use category) calculated in gallons per day (gpd) using either BO_DU, Rooms, or UC_Area multiplied by the UnitRate
- **ADWF_MGD**: Average daily dry weather flow calculated in million gallons per day (mgd)
- **Notes**: Notes used to describe pertinent information related to a specific parcel
- **20_Yr**: Projected development year of development according to TMRPA forecasting model
- **PUD_Name**: Name of planned development
- **Septic**: 0= parcel contributes to City sewer system, 1= parcel contains on-site septic system
- **IS_Usage**: Number used for model loading in InfoSWMM to assign appropriate land use category
- **Res**: Describes residential parcel as either suburban or urban
- **TMRPA_ID**: unique identifier for each parcel that corresponds to the TMRPA land use database
- **City**: Identified whether parcel is within the City of Sparks, City of Reno or Washoe County
- **X**: easting at centroid of parcel
- **Y**: northing at centroid of parcel

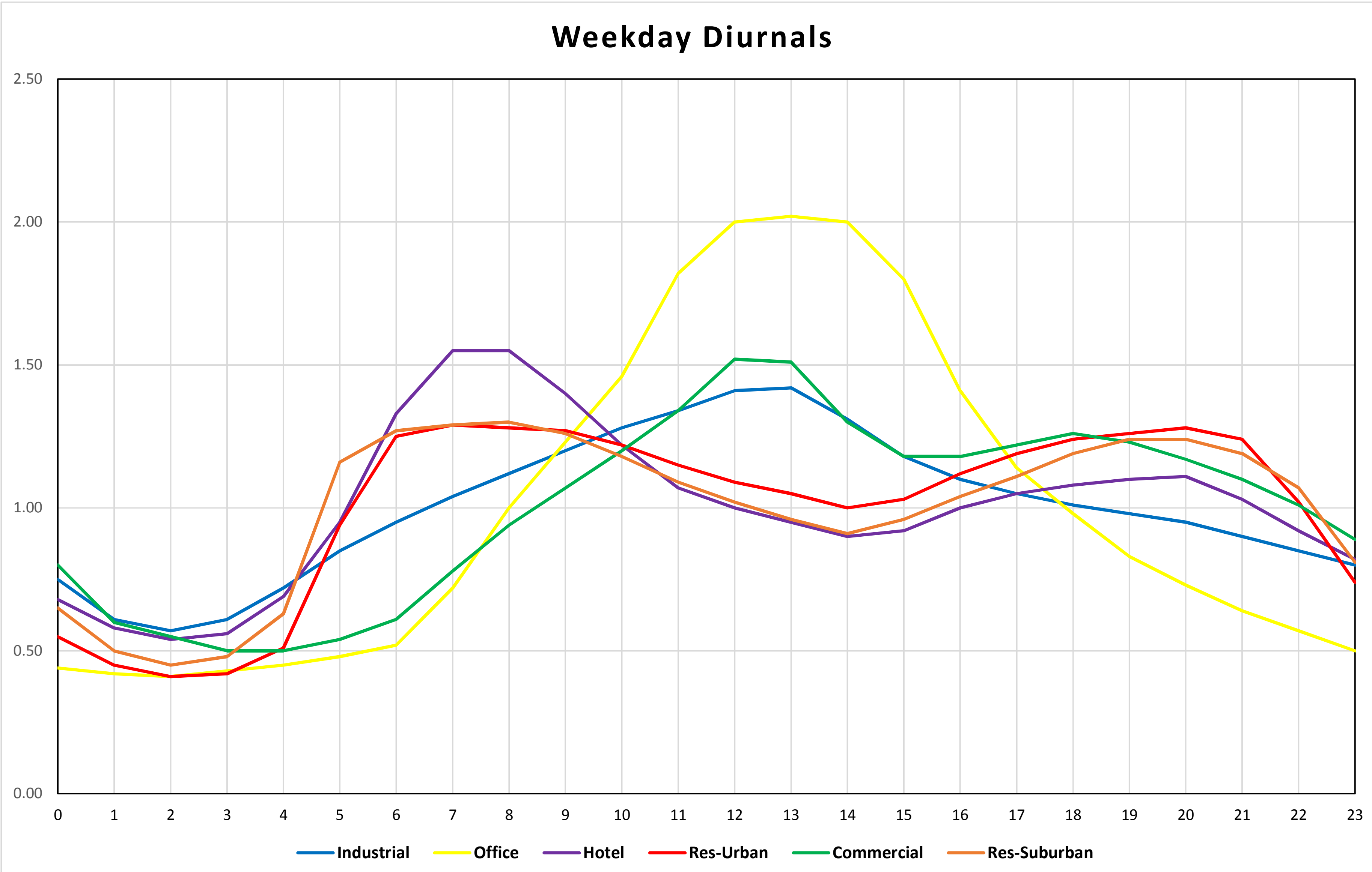
Weekday Diurnal Patterns

Weekday Diurnals

Hour	(1) Industrial	(2) Commercial	(3) Office/ Public Facility/ Institutional	(4) Hotel	(5) Residential- Urban (Weekday)	(6) Residential- Suburban (Weekday)
0.00	0.75	0.80	0.44	0.68	0.55	0.65
1.00	0.61	0.60	0.42	0.58	0.45	0.50
2.00	0.57	0.55	0.41	0.54	0.41	0.45
3.00	0.61	0.50	0.43	0.56	0.42	0.48
4.00	0.72	0.50	0.45	0.69	0.51	0.63
5.00	0.85	0.54	0.48	0.95	0.94	1.16
6.00	0.95	0.61	0.52	1.33	1.25	1.27
7.00	1.04	0.78	0.72	1.55	1.29	1.29
8.00	1.12	0.94	1.00	1.55	1.28	1.30
9.00	1.20	1.07	1.23	1.40	1.27	1.26
10.00	1.28	1.20	1.46	1.22	1.22	1.18
11.00	1.34	1.34	1.82	1.07	1.15	1.09
12.00	1.41	1.52	2.00	1.00	1.09	1.02
13.00	1.42	1.51	2.02	0.95	1.05	0.96
14.00	1.31	1.30	2.00	0.90	1.00	0.91
15.00	1.18	1.18	1.80	0.92	1.03	0.96
16.00	1.10	1.18	1.41	1.00	1.12	1.04
17.00	1.05	1.22	1.14	1.05	1.19	1.11
18.00	1.01	1.26	0.98	1.08	1.24	1.19
19.00	0.98	1.23	0.83	1.10	1.26	1.24
20.00	0.95	1.17	0.73	1.11	1.28	1.24
21.00	0.90	1.10	0.64	1.03	1.24	1.19
22.00	0.85	1.01	0.57	0.92	1.02	1.07
23.00	0.80	0.89	0.50	0.82	0.74	0.81
SUM =	24.00	24.00	24.00	24.00	24.00	24.00

Notes:

(1) used primarily Wild Island meter w/ smoothing and some Site_07 influence
(2) generic commerical pattern from reference
(3) generic non-residential pattern from reference
(4) generic hotel pattern from reference
(5) used Matte07 pattern with smoothing
(6) used Sparks03 pattern with smoothing


Weekday Diurnals
2.50
2.00
1.50
1.00
0.50
0.00
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Industrial
Office
Hotel
Res-Urban
Commercial
Res-Suburban

Weekend Diurnal Patterns

Weekend Diurnals

Hour	(1) Industrial	(2) Commercial	(3) Office/ Public Facility/ Institutional	(4) Hotel	(5) Residential-Urban (Weekend)	(6) Residential-Suburban (Weekend)
0.00	0.81	0.80	0.44	0.68	0.60	0.73
1.00	0.77	0.60	0.42	0.58	0.48	0.61
2.00	0.75	0.50	0.41	0.54	0.42	0.51
3.00	0.77	0.42	0.43	0.52	0.44	0.52
4.00	0.82	0.42	0.45	0.55	0.47	0.53
5.00	0.88	0.48	0.48	0.58	0.52	0.67
6.00	0.99	0.58	0.52	0.75	0.79	1.00
7.00	1.08	0.75	0.72	1.10	1.03	1.25
8.00	1.15	0.90	1.00	1.55	1.31	1.32
9.00	1.19	1.07	1.23	1.69	1.48	1.31
10.00	1.21	1.22	1.46	1.69	1.51	1.29
11.00	1.23	1.45	1.82	1.40	1.40	1.23
12.00	1.25	1.60	2.00	1.20	1.28	1.16
13.00	1.24	1.60	2.02	1.10	1.25	1.13
14.00	1.17	1.50	2.00	1.05	1.21	1.10
15.00	1.11	1.35	1.80	1.04	1.16	1.08
16.00	1.07	1.28	1.41	1.05	1.18	1.08
17.00	1.03	1.20	1.14	1.06	1.18	1.11
18.00	1.00	1.18	0.98	1.07	1.16	1.14
19.00	0.97	1.15	0.83	1.07	1.15	1.16
20.00	0.94	1.09	0.73	1.04	1.14	1.14
21.00	0.89	1.02	0.64	1.01	1.11	1.12
22.00	0.85	0.95	0.57	0.90	0.94	0.98
23.00	0.83	0.89	0.50	0.78	0.79	0.83
SUM =	24.00	24.00	24.00	24.00	24.00	24.00

Notes:

(1) used primarily Wild Island meter w/ smoothing and some Site_07 influence

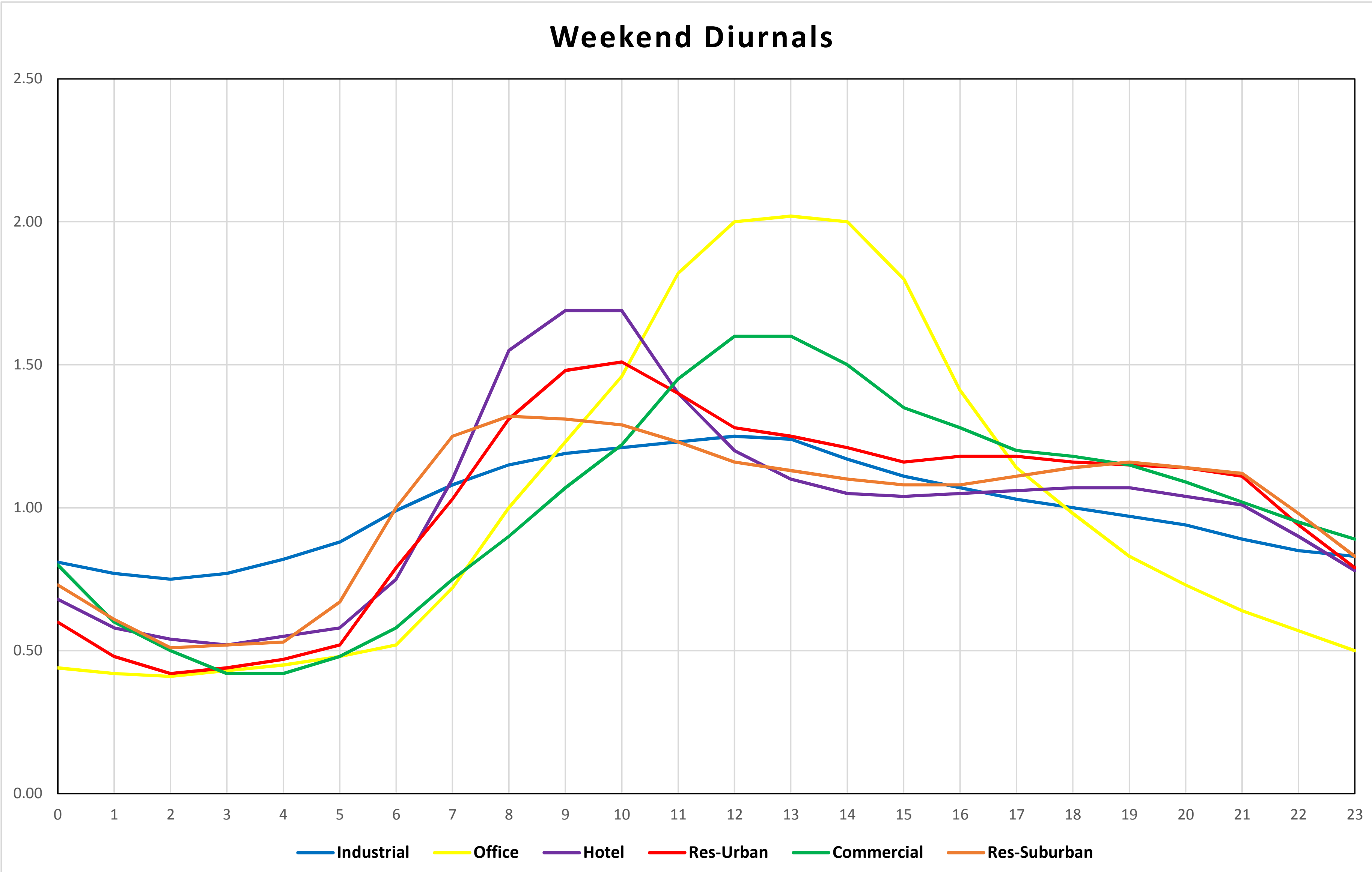
(2) generic commerical pattern from reference

(3) generic non-residential pattern from reference

(4) generic hotel pattern from reference

(5) used Matte07 pattern with smoothing

(6) used Sparks03 pattern with smoothing


Weekend Diurnals
2.50
2.00
1.50
1.00
0.50
0.00
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Industrial
Office
Hotel
Res-Urban
Commercial
Res-Suburban

Appendix C. InfoSWMM Model Development

- InfoSWMM Model Input Parameter Definitions
- Lift Station Information and Pump Curves

InfoSWMM Model Input Parameter Definitions

B.3 Junction Properties

Name	User-assigned junction name.
X-Coordinate	Horizontal location of the junction on the Study Area Map. If left blank then the junction will not appear on the map.
Y-Coordinate	Vertical location of the junction on the Study Area Map. If left blank then the junction will not appear on the map.
Description	Optional description of the junction.
Tag	Optional label used to categorize or classify the junction.
Inflows	Click on the button and select Inflow to assign time series, dry weather, or RDII inflows to the junction.
Treatment	Click on the button and select Treatment to edit a set of treatment functions for pollutants entering the node.
Invert El.	Invert elevation of the junction (feet or meters).
Max. Depth	Maximum depth of junction (i.e., from ground surface to invert) (feet or meters).
Initial Depth	Depth of water at the junction at the start of the simulation (feet or meters).
Surcharge Depth	Additional depth of water beyond the maximum depth that is allowed before the junction floods (feet or meters). This parameter can be used to simulate bolted manhole covers.
Ponded Area	Area occupied by ponded water atop the junction after flooding occurs (sq. feet or sq. meters). If the Allow Ponding Simulation Option is turned on, a non-zero value of this parameter will allow ponded water to be stored and subsequently returned to the conveyance system when capacity exists.

B.4 Outfall Properties

Name	User-assigned outfall name.
X-Coordinate	Horizontal location of the outfall on the Study Area Map. If left blank then the outfall will not appear on the map.
Y-Coordinate	Vertical location of the outfall on the Study Area Map. If left blank then the outfall will not appear on the map.
Description	Optional description of the outfall.
Tag	Optional label used to categorize or classify the outfall.
Inflows	Click on the  button and select Inflow to assign time series, dry weather, or RDII inflows to the outfall.
Treatment	Click on the  button and select Treatment to edit a set of treatment functions for pollutants entering the node.
Invert El.	Invert elevation of the outfall (feet or meters).
Tide Gate	***YES -*** tide gate present which prevents backflow ***NO -*** no tide gate present
Type	Type of outfall boundary condition: ***FREE:*** outfall stage determined by minimum of critical flow depth and normal flow depth in the connecting conduit ***NORMAL:*** outfall stage based on normal flow depth in connecting conduit ***FIXED:*** outfall stage set to a fixed value ***TIDAL:*** outfall stage given by a table of tide elevation versus time of day ***TIMESERIES:*** outfall stage supplied from a time series of elevations.
Fixed Stage	Water elevation for a ***FIXED*** type of outfall (feet or meters).
Tidal Curve Name	Name of the Tidal Curve relating water elevation to hour of the day for a ***TIDAL*** outfall (double-click to edit the curve).
Time Series Name	Name of time series containing time history of outfall elevations for a ***TIMESERIES*** outfall (double-click to edit the series).

B.6 Storage Unit Properties

Name	User-assigned storage unit name.
X-Coordinate	Horizontal location of the storage unit on the Study Area Map. If left blank then the storage unit will not appear on the map.
Y-Coordinate	Vertical location of the storage unit on the Study Area Map. If left blank then the storage unit will not appear on the map.
Description	Optional description of the storage unit.
Tag	Optional label used to categorize or classify the storage unit.
Inflows	Click on the  button and select Inflow to assign time series, dry weather, or RDII inflows to the storage unit.
Treatment	Click on the  button and select Treatment to edit a set of treatment functions for pollutants entering the storage unit.
Invert El.	Elevation of the bottom of the storage unit (feet or meters).
Max. Depth	Maximum depth of the storage unit (feet or meters).
Initial Depth	Initial depth of water in the storage unit at the start of the simulation (feet or meters).
Ponded Area	Surface area occupied by ponded water atop the storage unit once the water depth exceeds the maximum depth (sq. feet or sq. meters). If the **Allow Ponding** analysis option is turned on, a non-zero value of this parameter will allow ponded water to be stored and subsequently returned to the drainage system when capacity exists.
Evap. Factor	The fraction of the potential evaporation from the storage unit's water surface that is actually realized.
Shape Curve	Method of describing the geometric shape of the storage unit. ***FUNCTIONAL*** shape uses the function Area = A*(Depth)^B + C to describe how surface area varies with depth. ***TABULAR*** shape uses a tabulated area versus depth curve. In either case, depth is measured in feet (or meters) and surface area in sq. feet (or sq. meters).
FUNCTIONAL	
- Coeff.	A-value in the functional relationship between surface area and storage depth.
- Exponent	B-value in the functional relationship between surface area and storage depth.

- Constant	C-value in the functional relationship between surface area and storage depth.
TABULAR	
- Curve Name	Name of the Storage Curve containing the relationship between surface area and storage depth (double-click to edit the curve).

B.7 Conduit Properties

Name	User-assigned conduit name.
Inlet Node	Name of node on the inlet end of the conduit (which is normally the end at higher elevation).
Outlet Node	Name of node on the outlet end of the conduit (which is normally the end at lower elevation).
Description	Optional description of the conduit.
Tag	Optional label used to categorize or classify the conduit.
Shape	Click on the  button and select Conduit Shape to edit the geometric properties of the conduit's cross section.
Length	Conduit length (feet or meters).
Roughness	Manning’s roughness coefficient (see Section A.7 for closed conduit values or Section A.8 for open channel values).
Inlet Offset	Height of the conduit invert above the node invert at the upstream end of the conduit (feet or meters).
Outlet Offset	Height of the conduit invert above the node invert at the downstream end of the conduit (feet or meters).
Initial Flow	Initial flow in the conduit at the start of the simulation (flow units).
Entry Loss Coeff.	Head loss coefficient associated with energy losses at the entrance of the conduit.
Exit Loss Coeff.	Coefficient associated with energy losses at the exit of the conduit.
AVG. LOSS COEFF.	Coefficient associated with energy losses along the length of the conduit.
Flap Gate	***YES*** if a flap gate exists which prevents backflow through the conduit, or ***NO*** if no flap gate exists.
Diameter/Max Depth	Diameter for circular conduits and max depth for non-circular cross-sections. There is an operational setting that can be changed to enter circular conduits in units of inches or millimeters instead of feet and inches
Number of Barrels	Enter the number of conduits with the same properties of invert elevation and cross-section that act together.
Transect	If an Irregular section is chosen then choose or create a Transect that defines the cross-section
Max. Flow	Enter the maximum flow allowed in the conduit. Flow will only be limited if a non-zero value is entered.
Shape Curve	If the Custom Shape is chosen then a Shape Curve must be entered that defines the depth/full depth vs. width/full depth relationship.

Forcemain	If a conduit is downstream of a pump and is expected to be pressurized, it is modeled as a forcemain and "Yes" should be chosen.
Roughness	If the conduit is specified as a forcemain, choose the Hazen-Williams or Darcy-Weisbach roughness factor.
Culvert Code	If a conduit is subject to inlet-control, you can specify it as a culvert. A culvert code of zero equates to no inlet control. Otherwise, codes 1-57 are available.

B.8 Pump Properties

Name	User-assigned pump name.
Inlet Node	Name of node on the inlet side of the pump.
Outlet Node	Name of node on the outlet side of the pump.
Description	Optional description of the pump.
Tag	Optional label used to categorize or classify the pump.
Pump Curve	Name of the Pump Curve which contains the pump's operating data (double-click to edit the curve).
Initial Status	Status of the pump (***ON*** or ***OFF***) at the start of the simulation.

B.10 Weir Properties

Name	User-assigned weir name.
Inlet Node	Name of node on inlet side of weir.
Outlet Node	Name of node on outlet side of weir.
Description	Optional description of the weir.
Tag	Optional label used to categorize or classify the weir.
Type	Weir type: **TRANSVERSE**, **SIDEFLOW**, **V-NOTCH**, or **TRAPEZOIDAL**
Height	Vertical height of weir opening (feet or meters)
Length	Horizontal length of weir opening (feet or meters)
Side Slope	Slope (width-to-height) of side walls for a ***V-NOTCH*** or ***TRAPEZOIDAL*** weir.
Crest Height	Height of bottom of weir opening from invert of inlet node (feet or meters).
Discharge Coeff.	Discharge coefficient for flow through the central portion of the weir (for flow in CFS when using US units or CMS when using SI units). Typical values are: 3.33 US (1.84 SI) for sharp crested transverse weirs, 2.5 - 3.3 US (1.38 - 1.83 SI) for broad crested rectangular weirs, 2.4 - 2.8 US (1.35 - 1.55 SI) for V-notch (triangular) weirs
Flap Gate	***YES*** if the weir has a flap gate that prevents backflow, ***NO*** if it does not.
End Coeff.	Discharge coefficient for flow through the triangular ends of a ***TRAPEZOIDAL*** weir. See the recommended values for V-notch weirs listed above.
End Contractions	Number of end contractions for a ***TRANSVERSE*** or ***TRAPEZOIDAL*** weir whose length is shorter than the channel it is placed in. Either 0, 1, or 2 depending on if no ends, one end, or both ends are beveled in from the side walls.

Lift Station Information and Pump Curves

Marina Pump Station

Pump

Gorman Rupp model T6A-B-4, 25 HP, 1250 RPM; 12.38” impeller diameter

Pump Curve

Head (ft)	Discharge (MGD)
80	0
77	0.144
74	0.288
72	0.432
69	0.576
66	0.72
63	0.864
60	1.008
55	1.152
54	1.188
53	1.224
52	1.26
51	1.296
50	1.332
49	1.368
48	1.404
47	1.44
44	1.584
38	1.728
33	1.872

Wet Well

11’x10’x10’ Precast Jensen WetWell

Wet Well Sump Elevation: 4357.50

Startup Depth (Lead Pump “On” Elevation): 6 ft (4363.50)

Shutoff Depth (Elevation): 2 ft (4359.50)

Wet Well equivalent Diameter: 11.70 ft

Wet Well Surface Area: 110 ft^2

12” Gravity Main Inlet Elevation: 4364.30

Suction Line Intake Elevation: 4358.20

Pump Suction Elevation: 4373.42

Discharge Elevation (CL): 4380.08

Force Main

8” PVC Force Main

Force Main Outfall Elevation: 4390.00

Force Main Length: 1120 ft

Friction Coefficient (Hazen Williams) for PVC: 130

Minor Loss Coefficient – Force Main: 2.85

PERFORMANCE CHART NO. T6A-4 2-21-79

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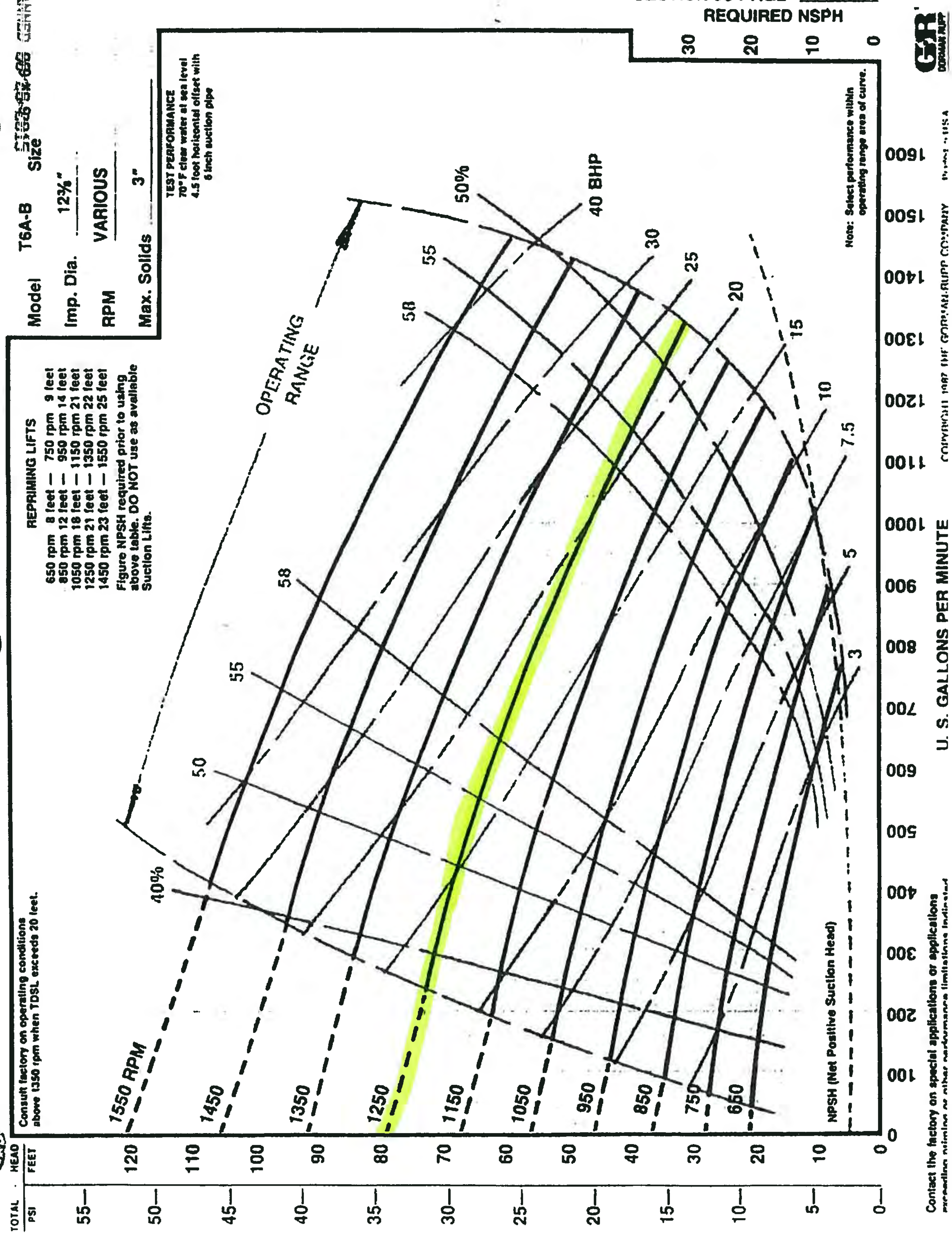
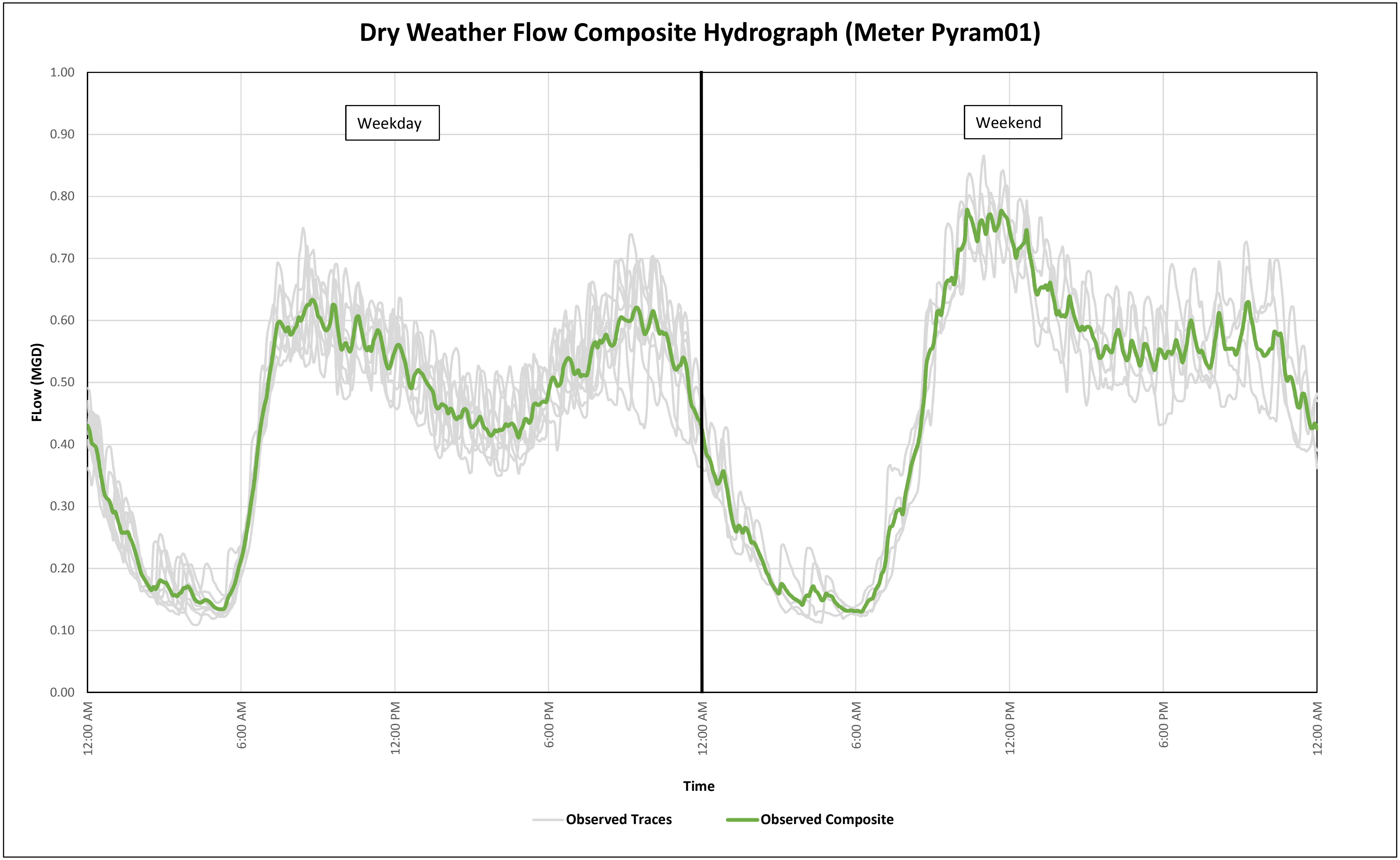
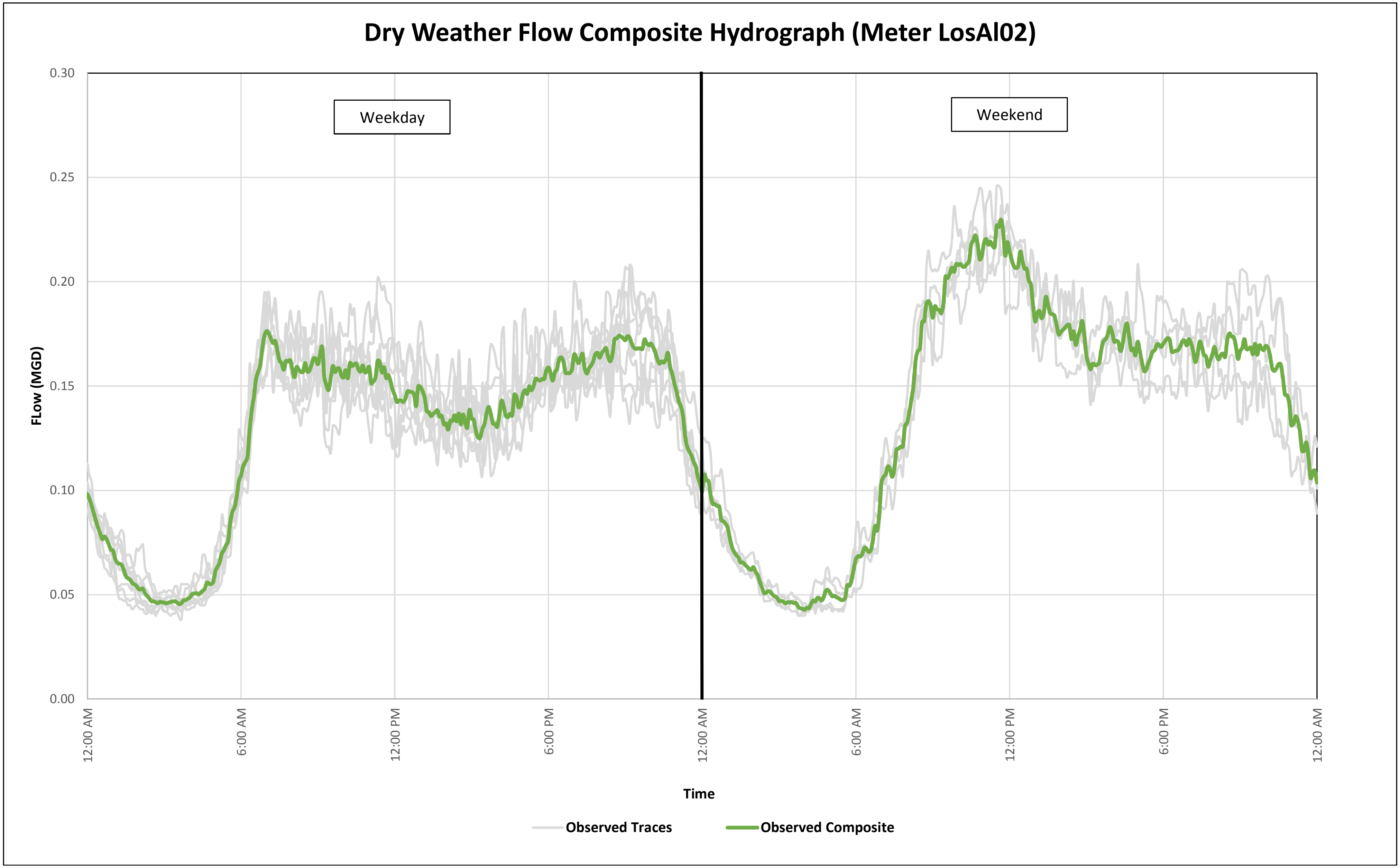


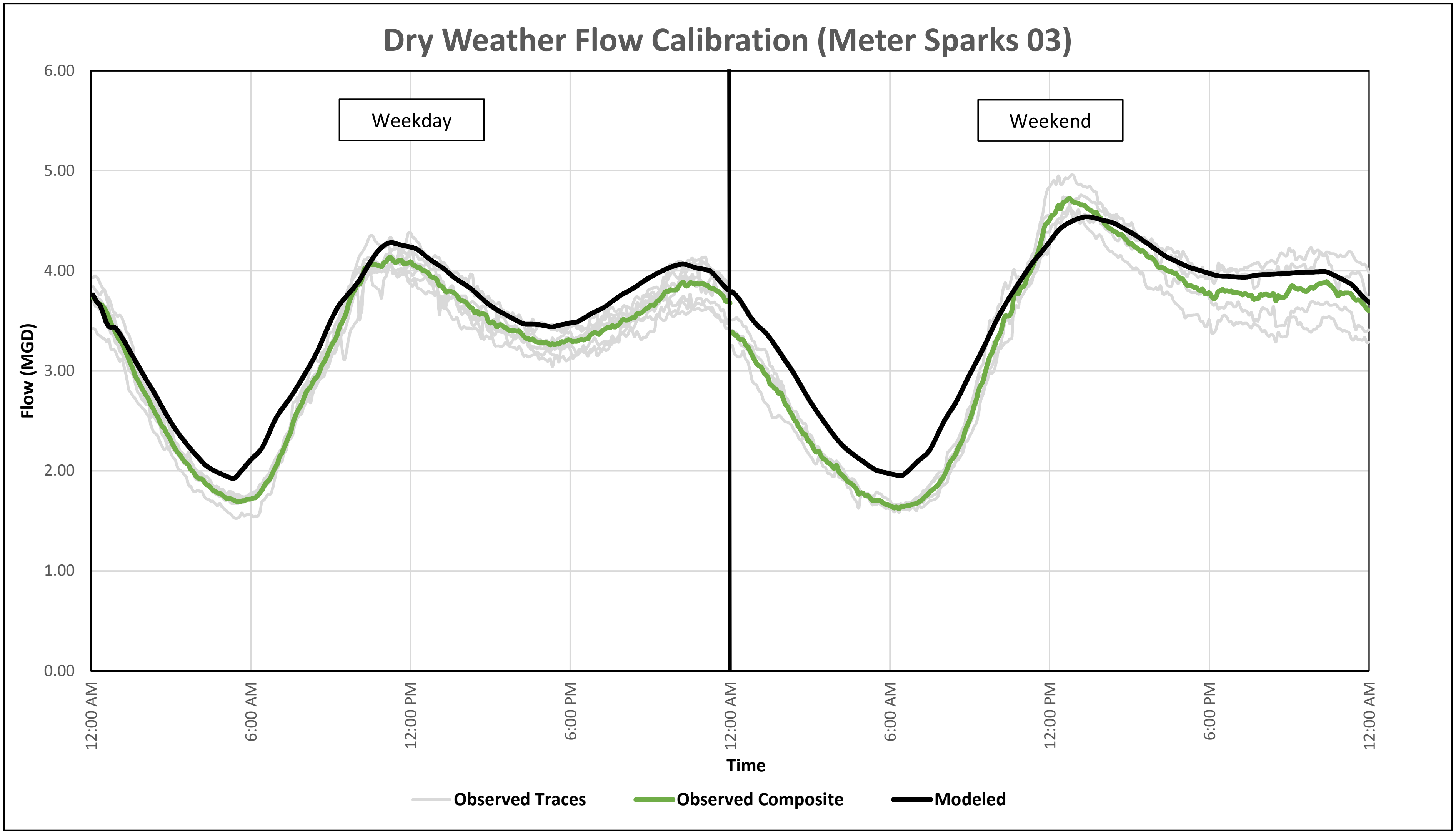
Appendix D. Dry Weather Calibration


Dry Weather Flow Composite Hydrograph (Meter Pyram01)
Weekday
Weekend
FLow (MGD)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
12:00 AM
6:00 AM
12:00 PM
6:00 PM
12:00 AM
6:00 AM
12:00 PM
6:00 PM
12:00 AM
Time
Observed Traces
Observed Composite


Dry Weather Flow Composite Hydrograph (Meter LosAl02)
Weekday
Weekend
FLow (MGD)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
12:00 AM
6:00 AM
12:00 PM
6:00 PM
12:00 AM
6:00 AM
12:00 PM
6:00 PM
12:00 AM
Time
Observed Traces
Observed Composite

	Weekday		
	Modeled	Metered	% Error
Peak Flow (mgd) =	4.281	4.136	3.5%
Volume (mg) =	3.396	3.203	6.0%
R2eff =	0.915		

	Weekend		
	Modeled	Metered	% Error
Peak Flow (mgd) =	4.540	4.724	-3.9%
Volume (mg) =	3.504	3.293	6.4%
R2eff =	0.915		

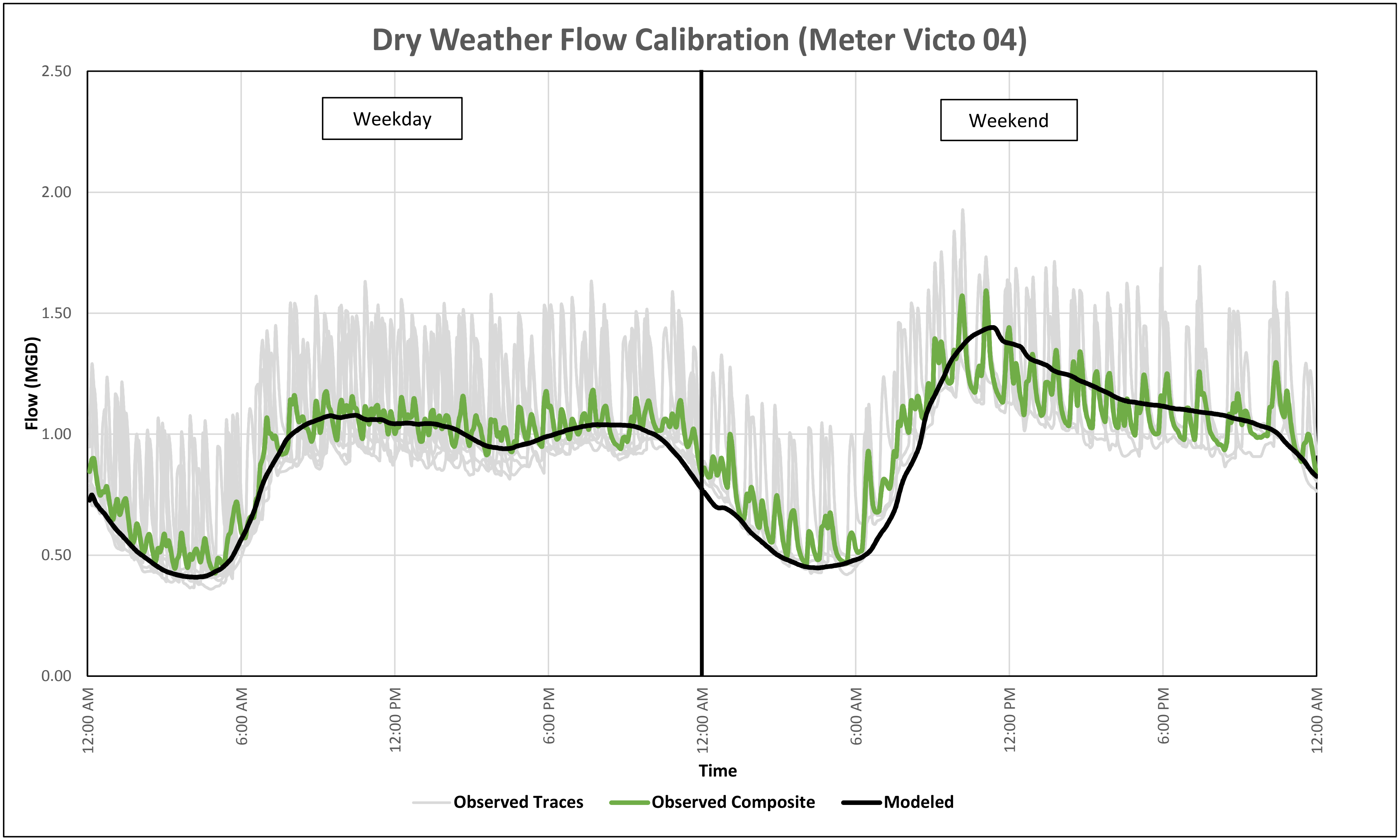


Weekday

	Modeled	Metered	% Error
Peak Flow (mgd) =	1.078	1.182	-8.8%
Volume (mg) =	0.866	0.916	-5.4%
R2eff =	0.852		

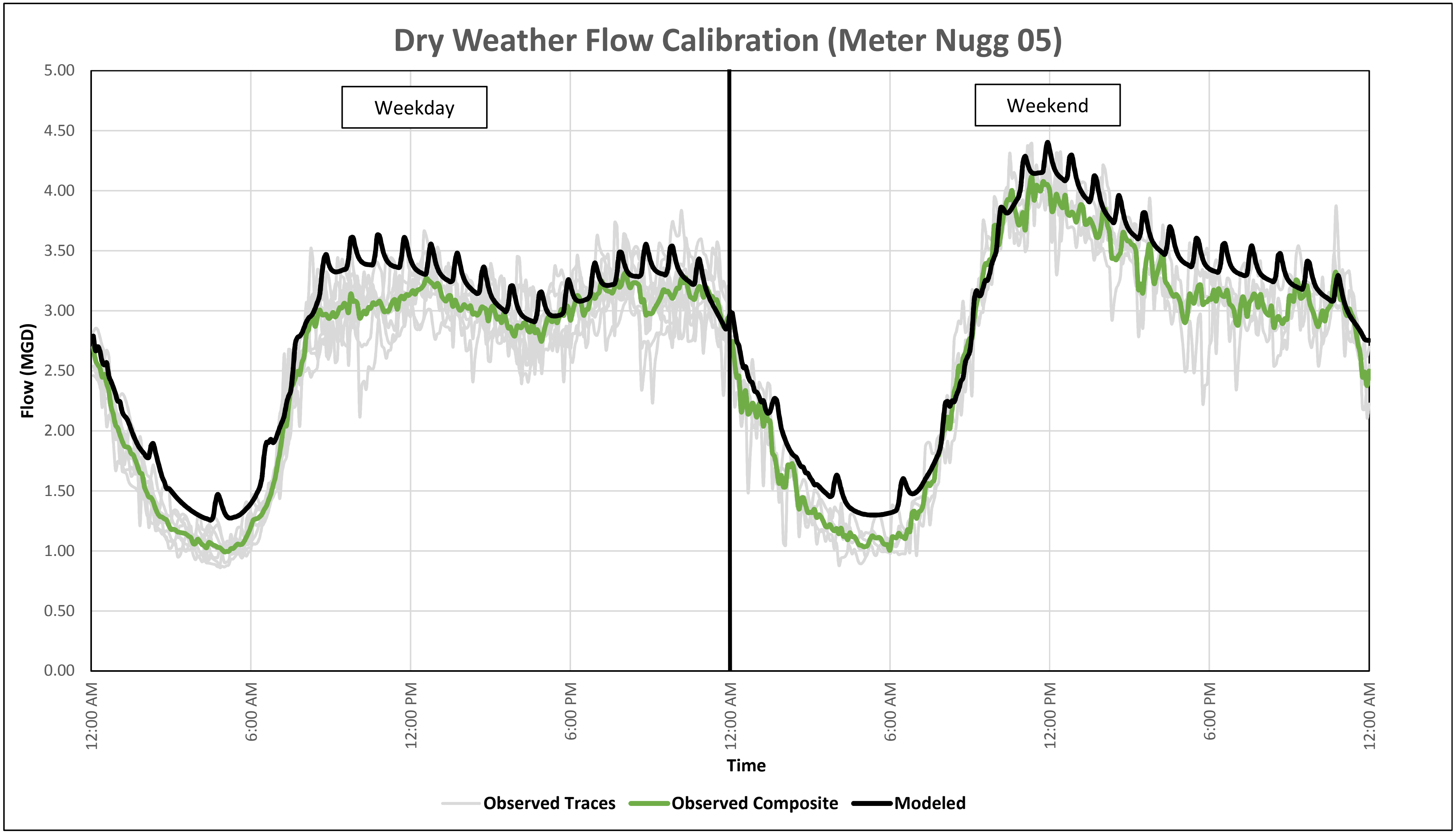
Weekend

	Modeled	Metered	% Error
Peak Flow (mgd) =	1.441	1.589	-9.3%
Volume (mg) =	0.961	0.989	-2.8%
R2eff =	0.721		



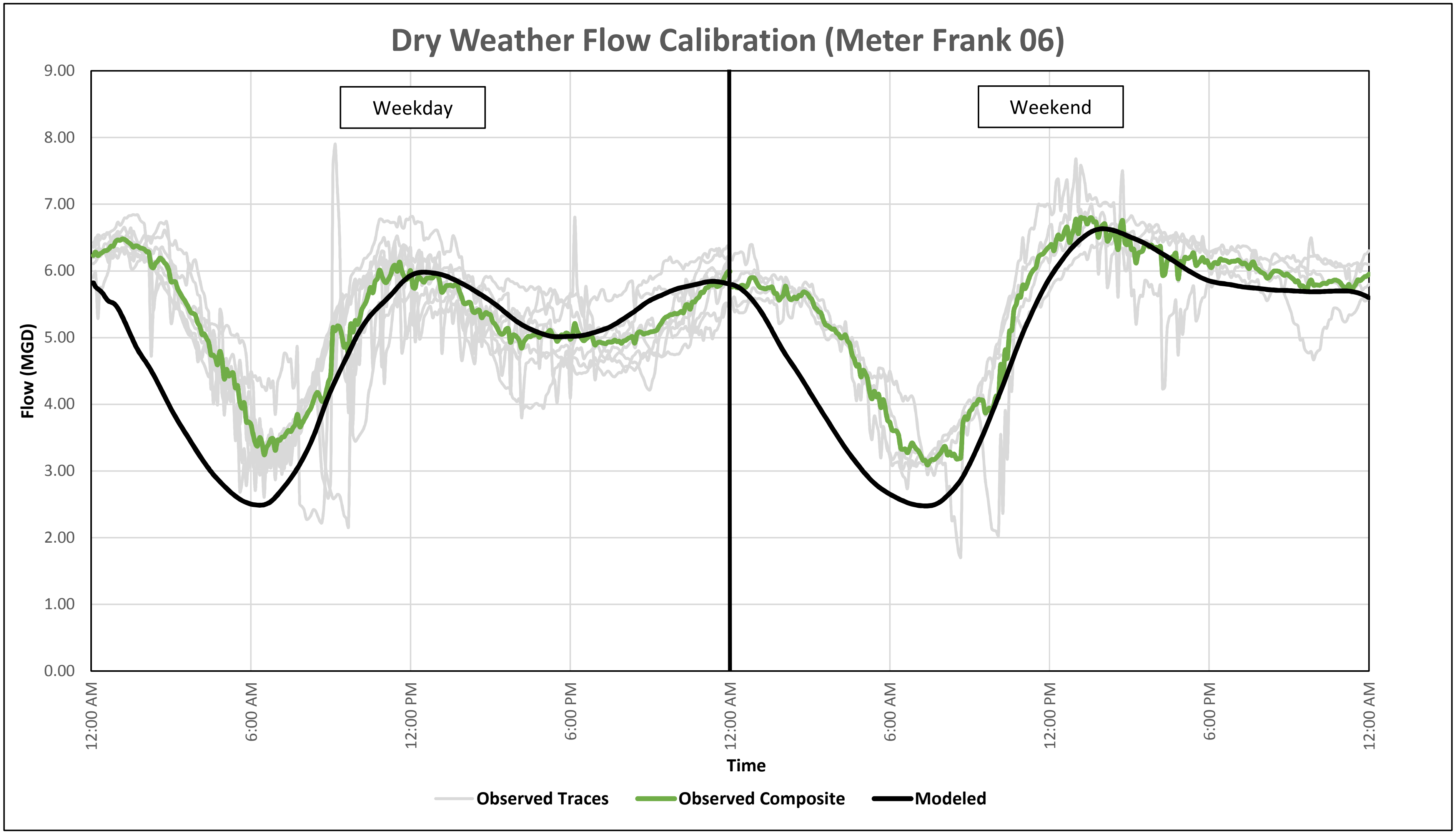
	Weekday		
	Modeled	Metered	% Error
Peak Flow (mgd) =	3.631	3.318	9.4%
Volume (mg) =	2.767	2.550	8.5%
R2eff =	0.886		

	Weekend		
	Modeled	Metered	% Error
Peak Flow (mgd) =	4.403	4.114	7.0%
Volume (mg) =	2.897	2.678	8.2%
R2eff =	0.916		



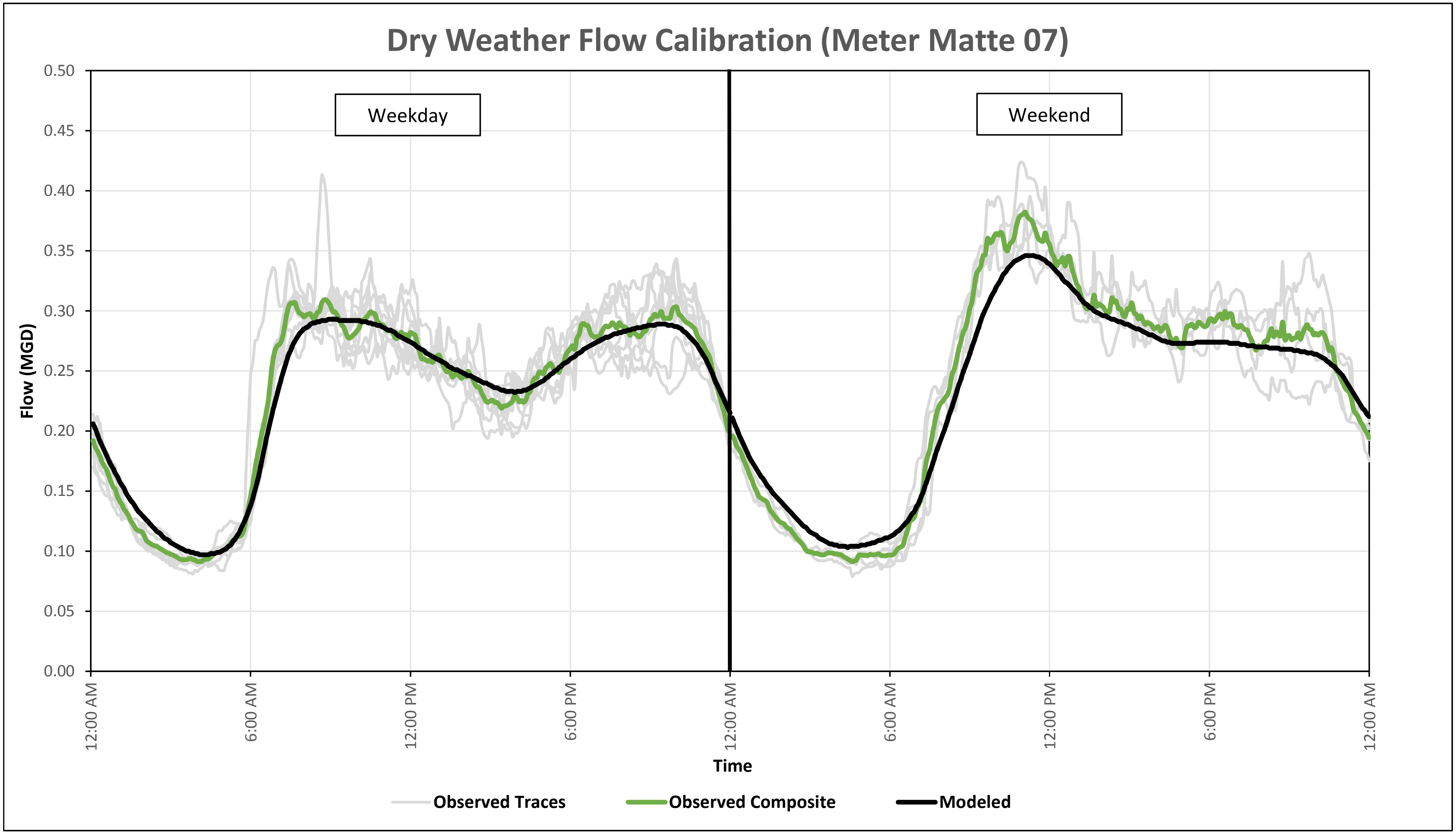
	Weekday		
	Modeled	Metered	% Error
Peak Flow (mgd) =	5.982	6.481	-7.7%
Volume (mg) =	4.792	5.205	-7.9%
R2eff =	-0.209		

	Weekend		
	Modeled	Metered	% Error
Peak Flow (mgd) =	6.633	6.798	-2.4%
Volume (mg) =	4.955	5.438	-8.9%
R2eff =	0.577		



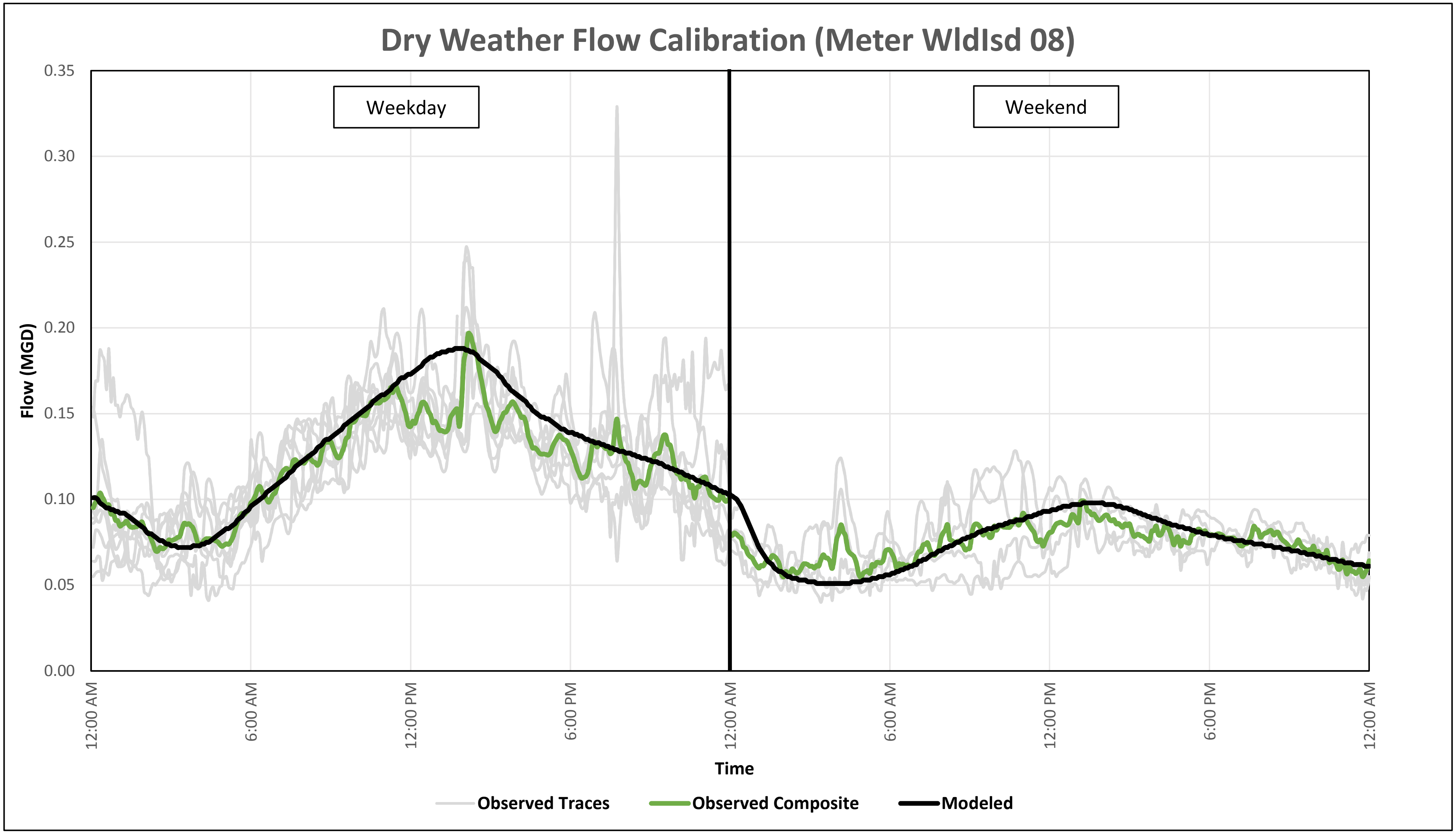
	Weekday		
	Modeled	Metered	% Error
Peak Flow (mgd) =	0.293	0.309	-5.2%
Volume (mg) =	0.228	0.230	-0.5%
R2eff =	0.970		

	Weekend		
	Modeled	Metered	% Error
Peak Flow (mgd) =	0.346	0.382	-9.5%
Volume (mg) =	0.233	0.240	-2.8%
R2eff =	0.957		



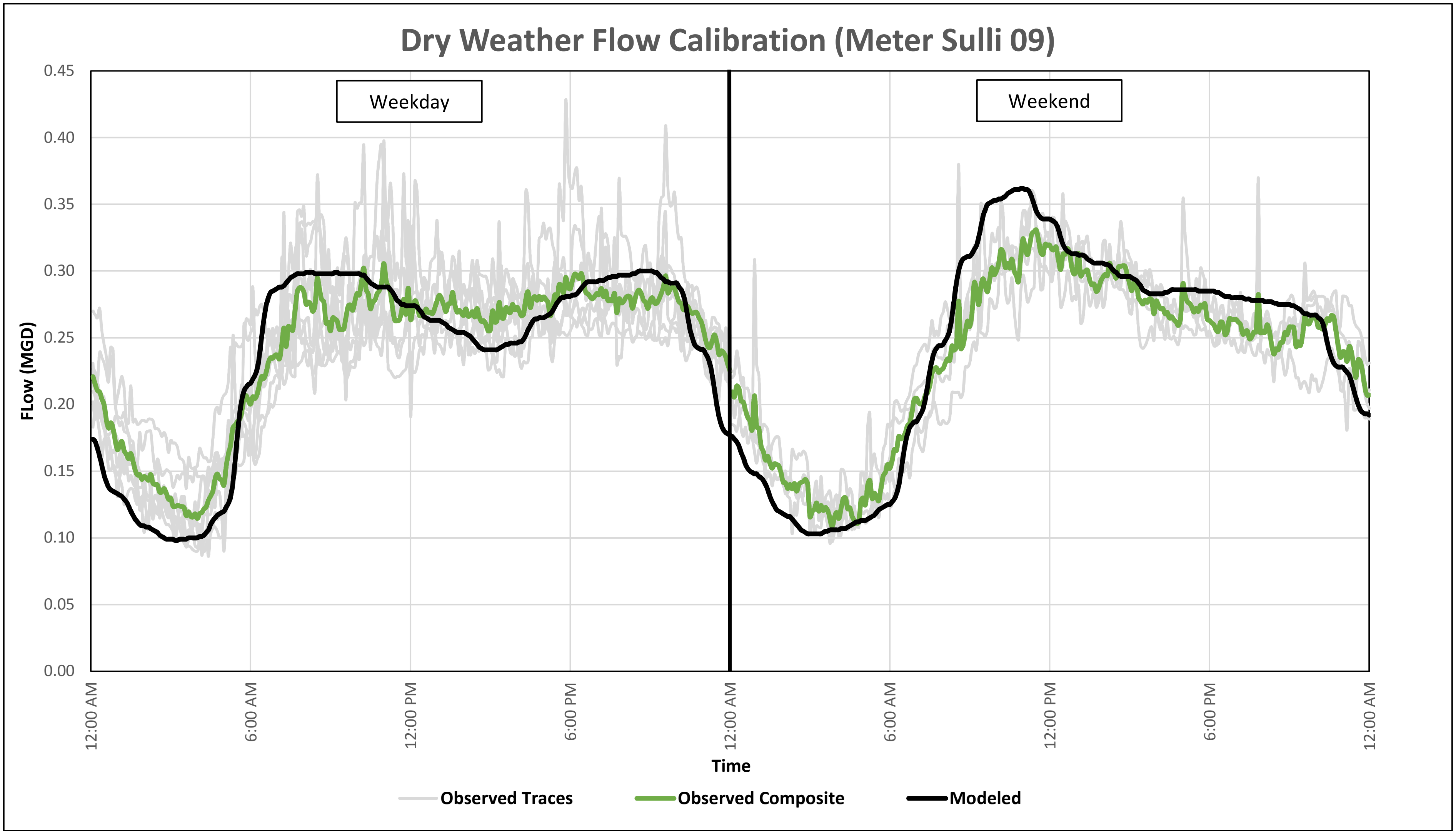
	Weekday		
	Modeled	Metered	% Error
Peak Flow (mgd) =	0.188	0.197	-4.4%
Volume (mg) =	0.128	0.120	5.9%
R2eff =	0.743		

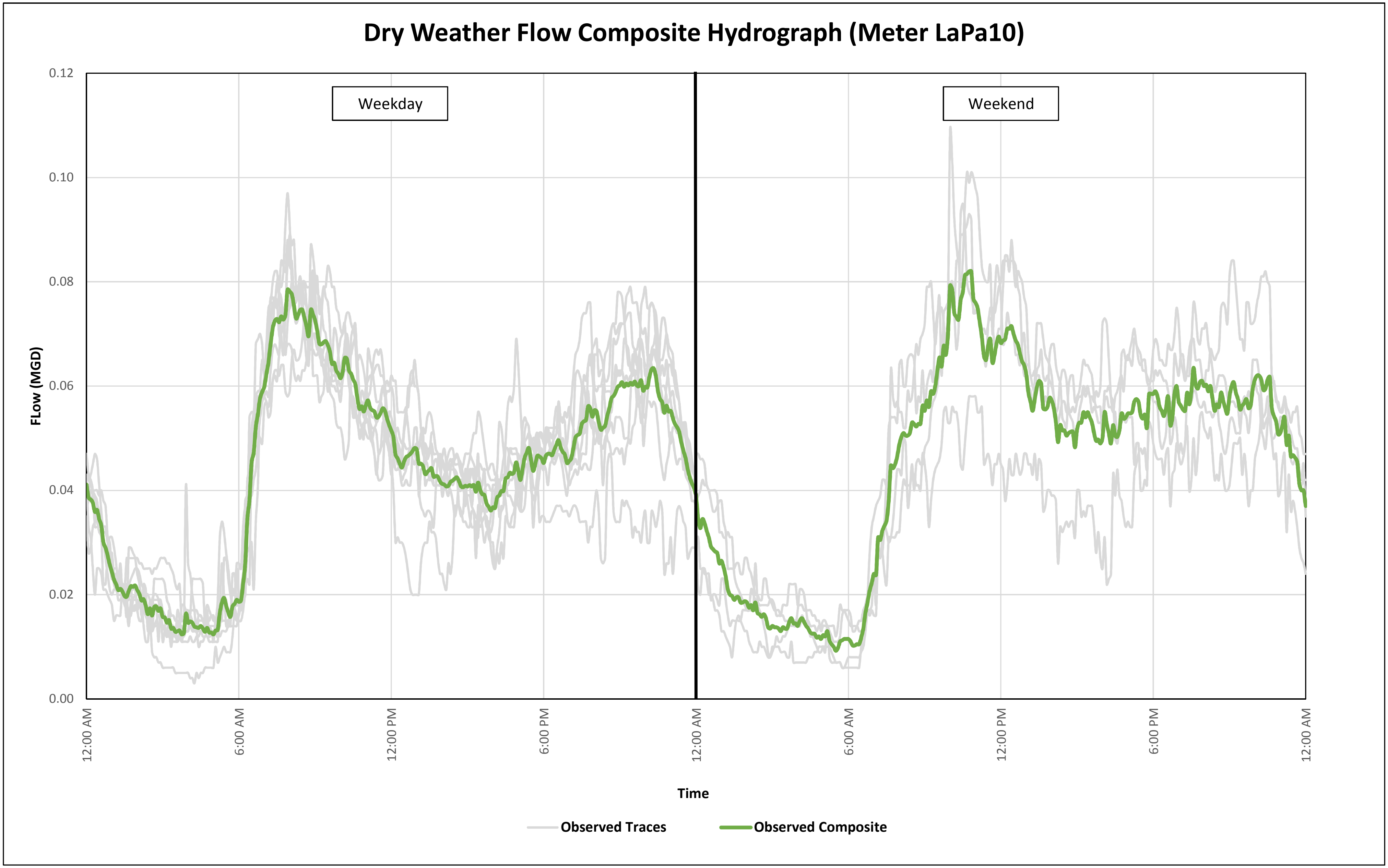
	Weekend		
	Modeled	Metered	% Error
Peak Flow (mgd) =	0.102	0.099	2.8%
Volume (mg) =	0.075	0.074	0.7%
R2eff =	0.183		



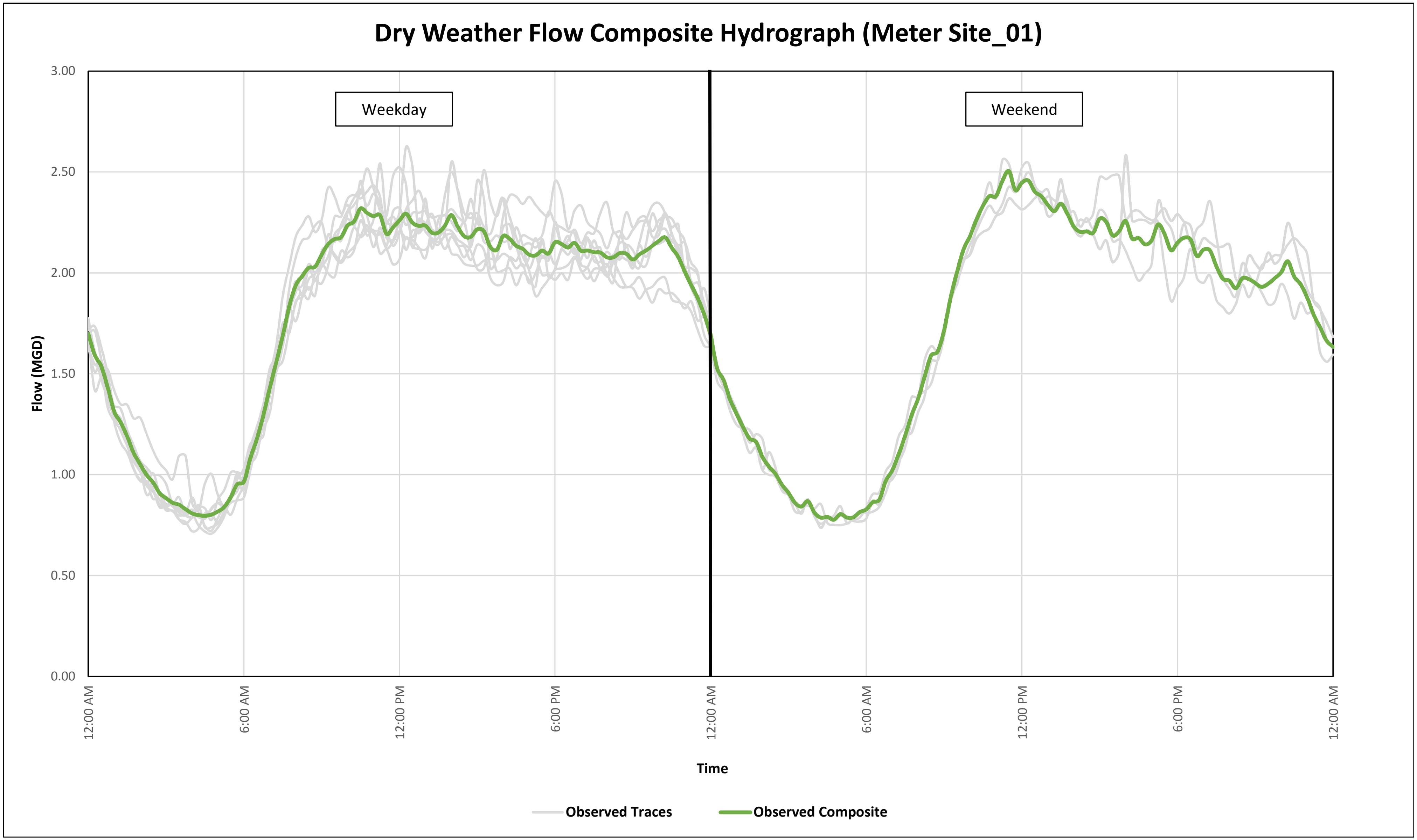
	Weekday		
	Modeled	Metered	% Error
Peak Flow (mgd) =	0.300	0.306	-1.8%
Volume (mg) =	0.236	0.242	-2.3%
R2eff =	0.776		

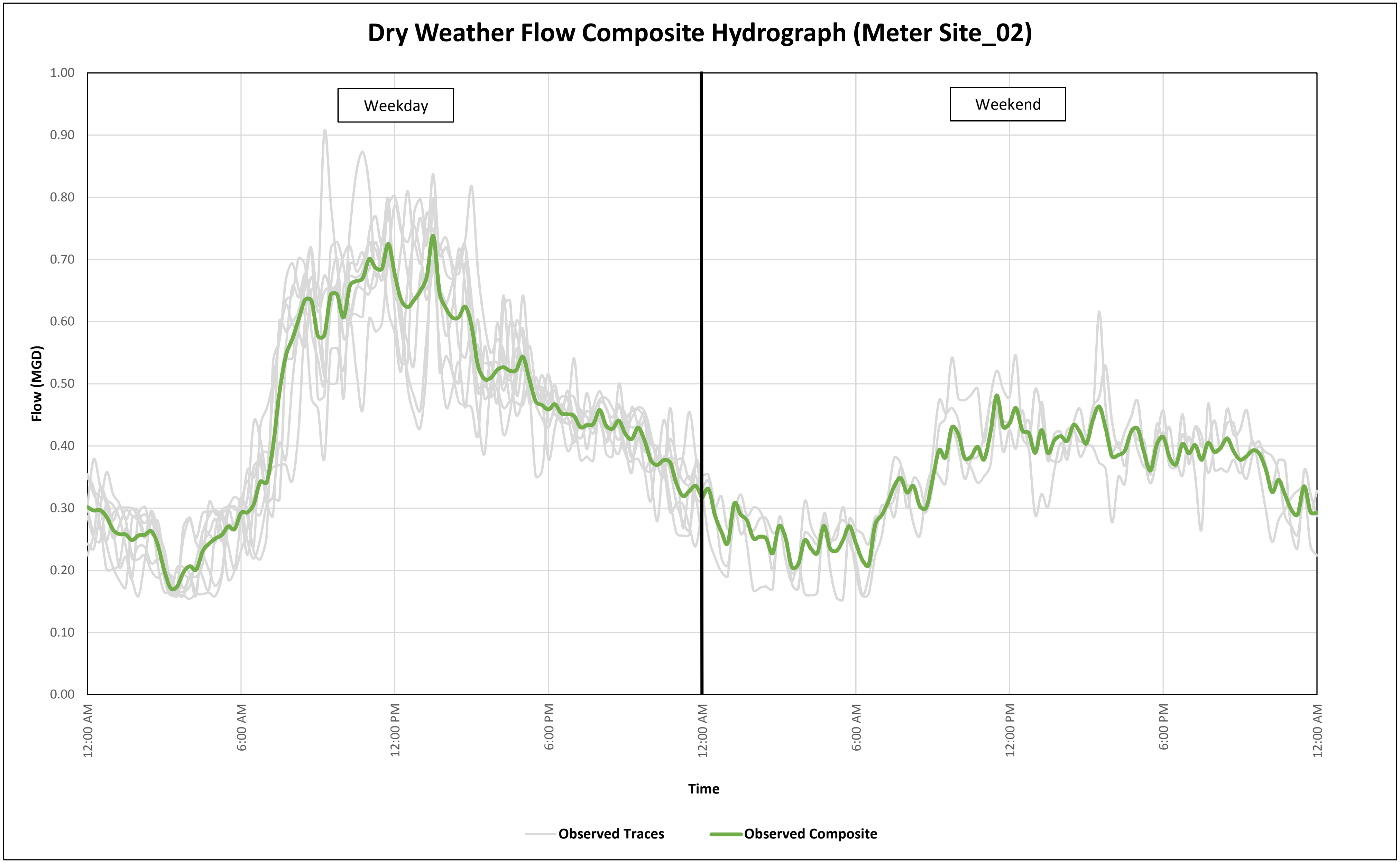
	Weekend		
	Modeled	Metered	% Error
Peak Flow (mgd) =	0.362	0.331	9.4%
Volume (mg) =	0.241	0.236	2.2%
R2eff =	0.820		





Dry Weather Flow Composite Hydrograph (Meter LaPa10)
Weekday
Weekend
FLow (MGD)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
12:00 AM
6:00 AM
12:00 PM
6:00 PM
12:00 AM
6:00 AM
12:00 PM
6:00 PM
12:00 AM
Time
Observed Traces
Observed Composite

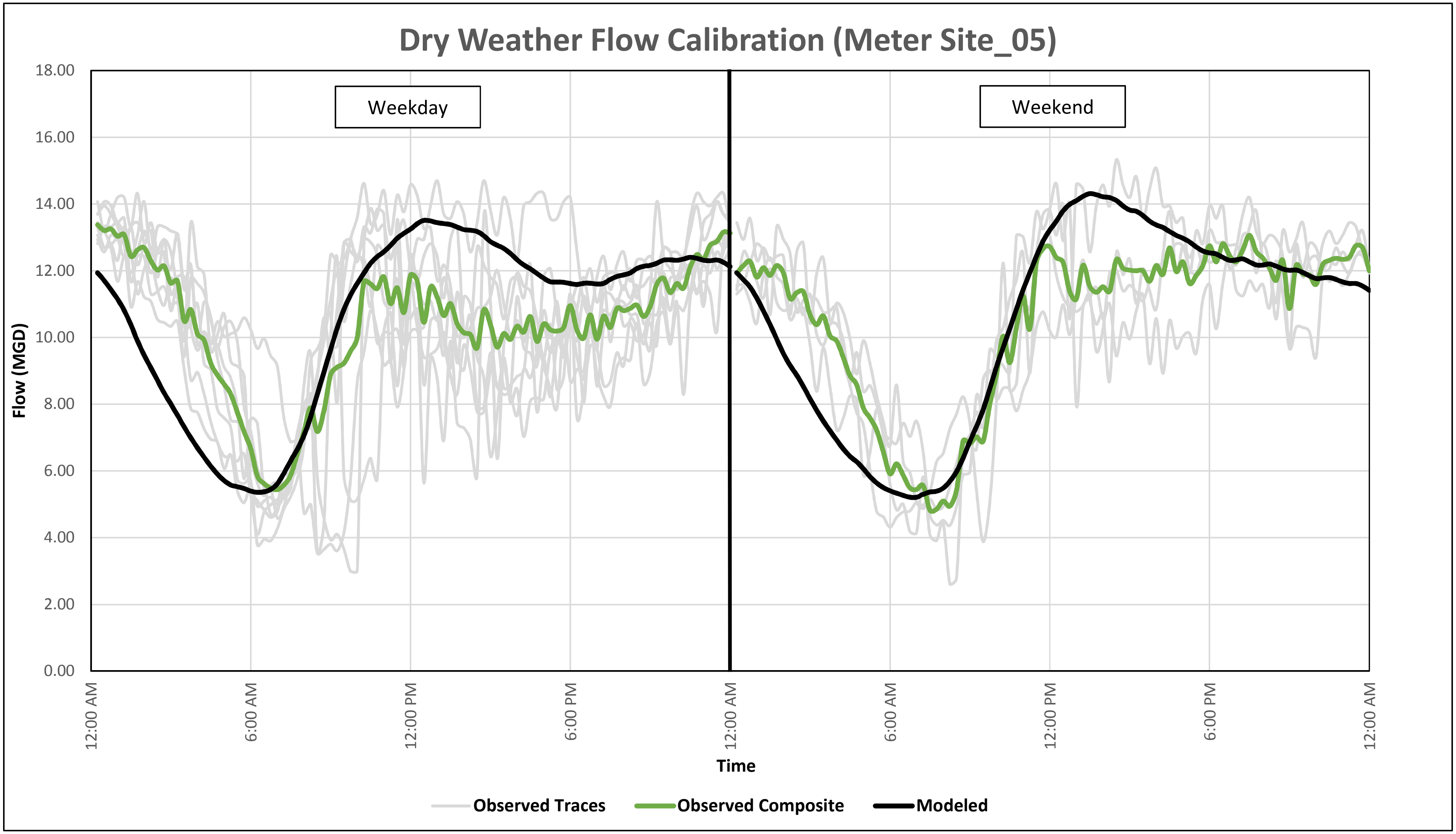

Dry Weather Flow Composite Hydrograph (Meter Site_01)
Weekday
Weekend
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Flow (MGD)
12:00 AM
6:00 AM
12:00 PM
6:00 PM
12:00 AM
6:00 AM
12:00 PM
6:00 PM
12:00 AM
Time
Observed Traces
Observed Composite



Dry Weather Flow Composite Hydrograph (Meter Site_02)
Weekday
Weekend
Flow (MGD)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
12:00 AM
6:00 AM
12:00 PM
6:00 PM
12:00 AM
6:00 AM
12:00 PM
6:00 PM
12:00 AM
Time
Observed Traces
Observed Composite

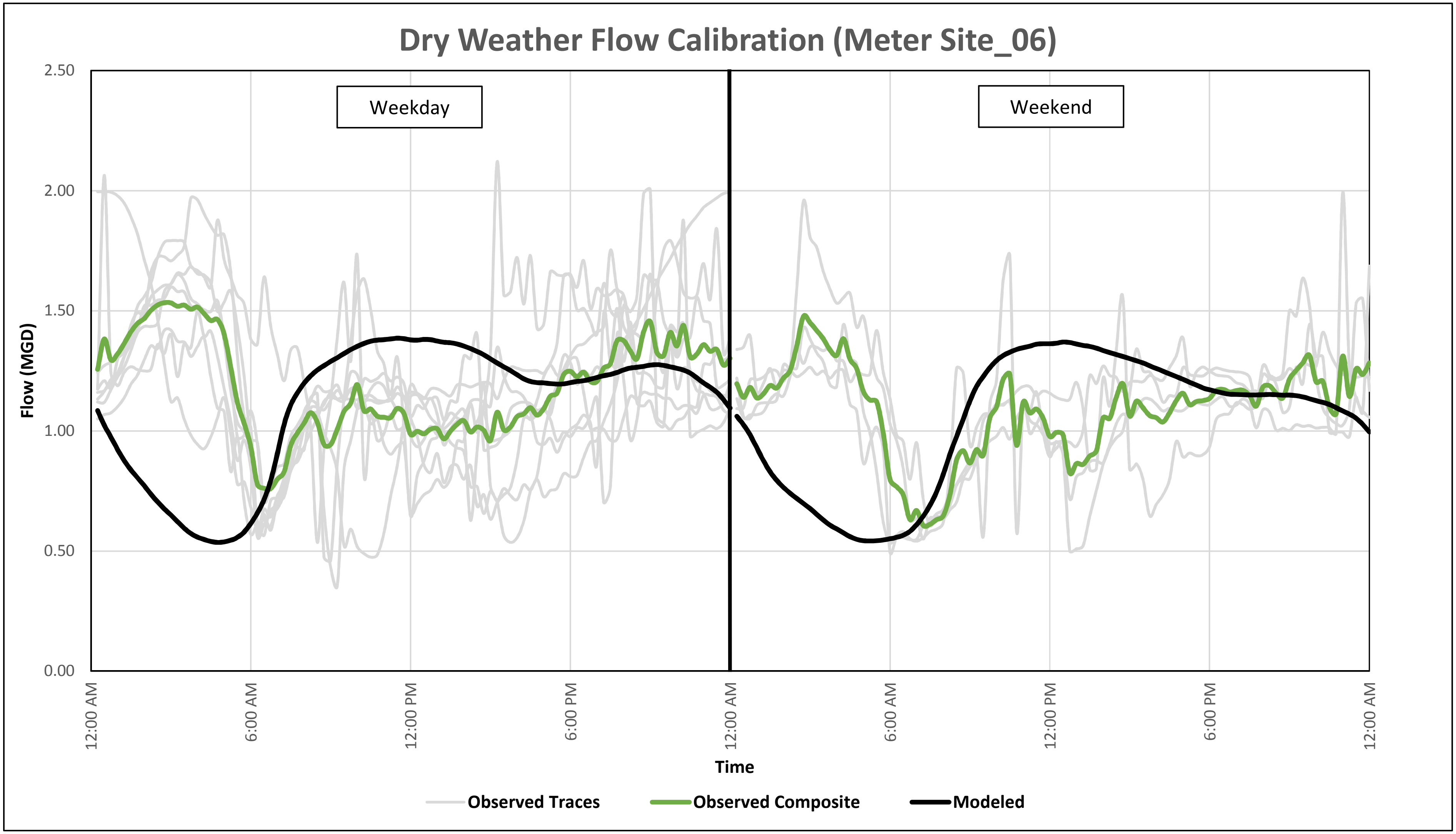
	Weekday		
	Modeled	Metered	% Error
Peak Flow (mgd) =	13.510	13.380	1.0%
Volume (mg) =	10.595	10.364	2.2%
R2eff =	-0.045		

	Weekend		
	Modeled	Metered	% Error
Peak Flow (mgd) =	14.312	13.064	9.6%
Volume (mg) =	10.476	10.536	-0.6%
R2eff =	0.643		



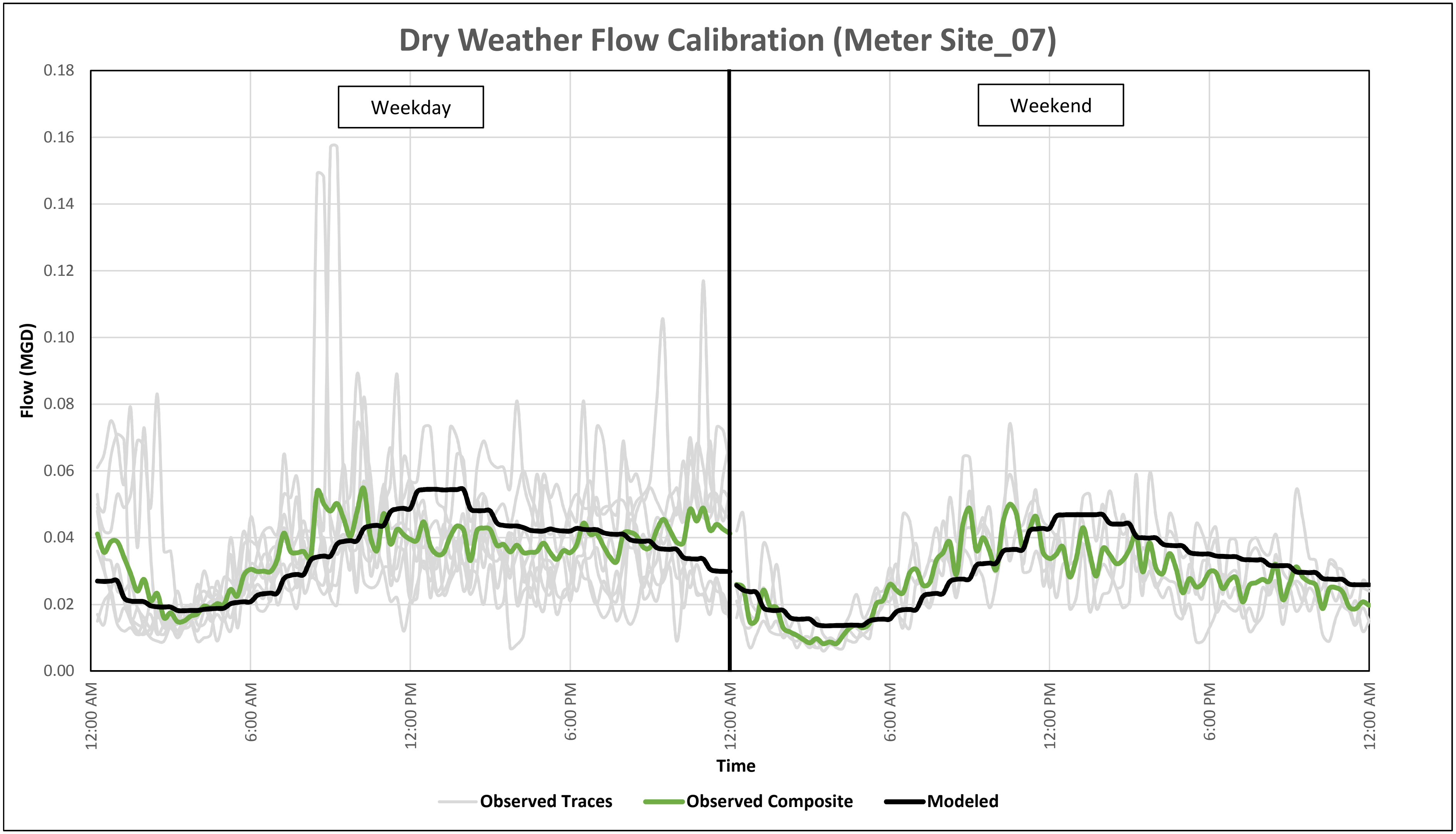
	Weekday		
	Modeled	Metered	% Error
Peak Flow (mgd) =	1.386	1.534	-9.6%
Volume (mg) =	1.106	1.188	-6.9%
R2eff =	-3.084		

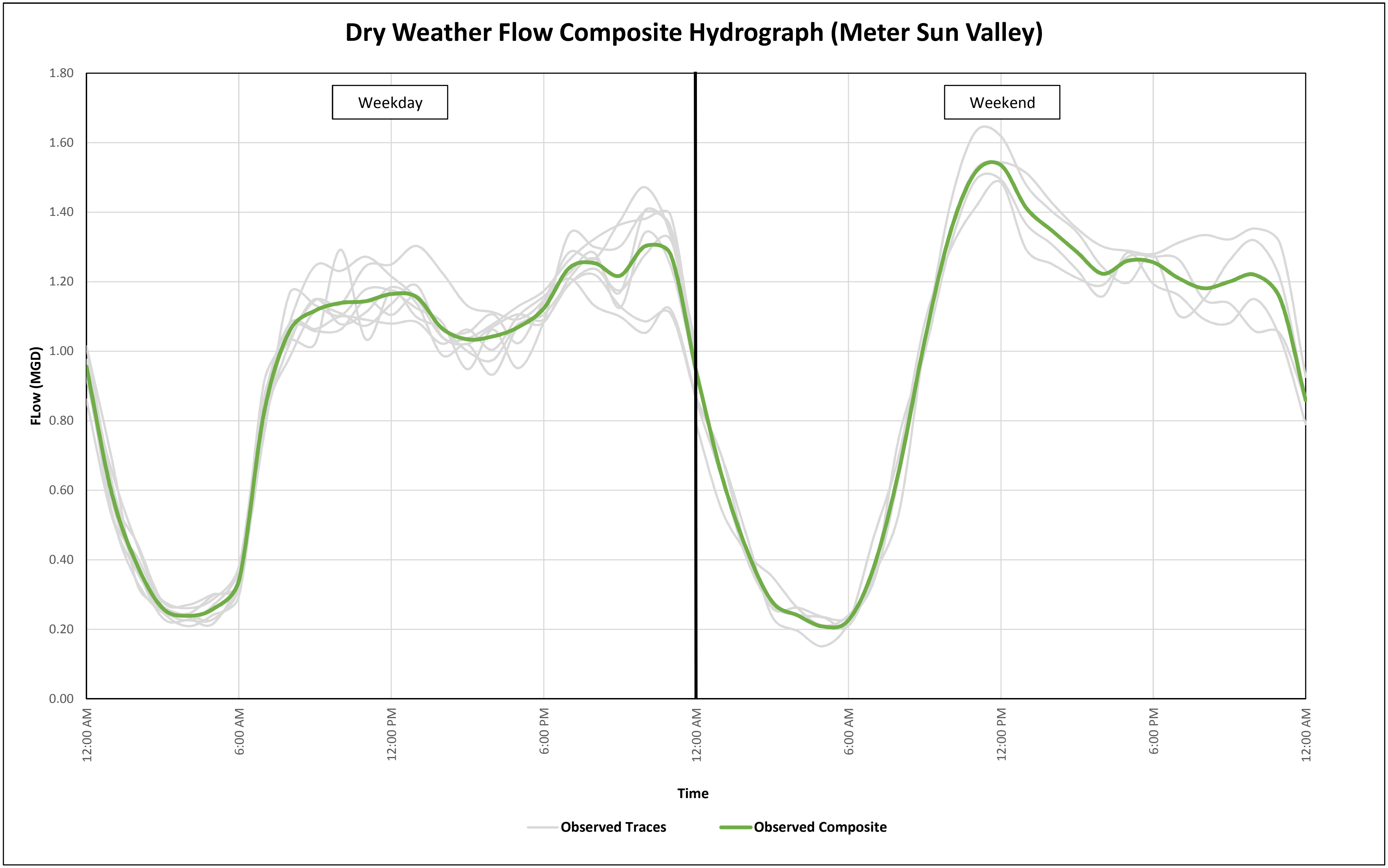
	Weekend		
	Modeled	Metered	% Error
Peak Flow (mgd) =	1.370	1.477	-7.2%
Volume (mg) =	1.040	1.090	-4.6%
R2eff =	-2.164		



	Weekday		
	Modeled	Metered	% Error
Peak Flow (mgd) =	0.055	0.055	-0.5%
Volume (mg) =	0.035	0.036	-2.2%
R2eff =	0.040		

	Weekend		
	Modeled	Metered	% Error
Peak Flow (mgd) =	0.047	0.050	-6.2%
Volume (mg) =	0.030	0.027	9.3%
R2eff =	0.343		

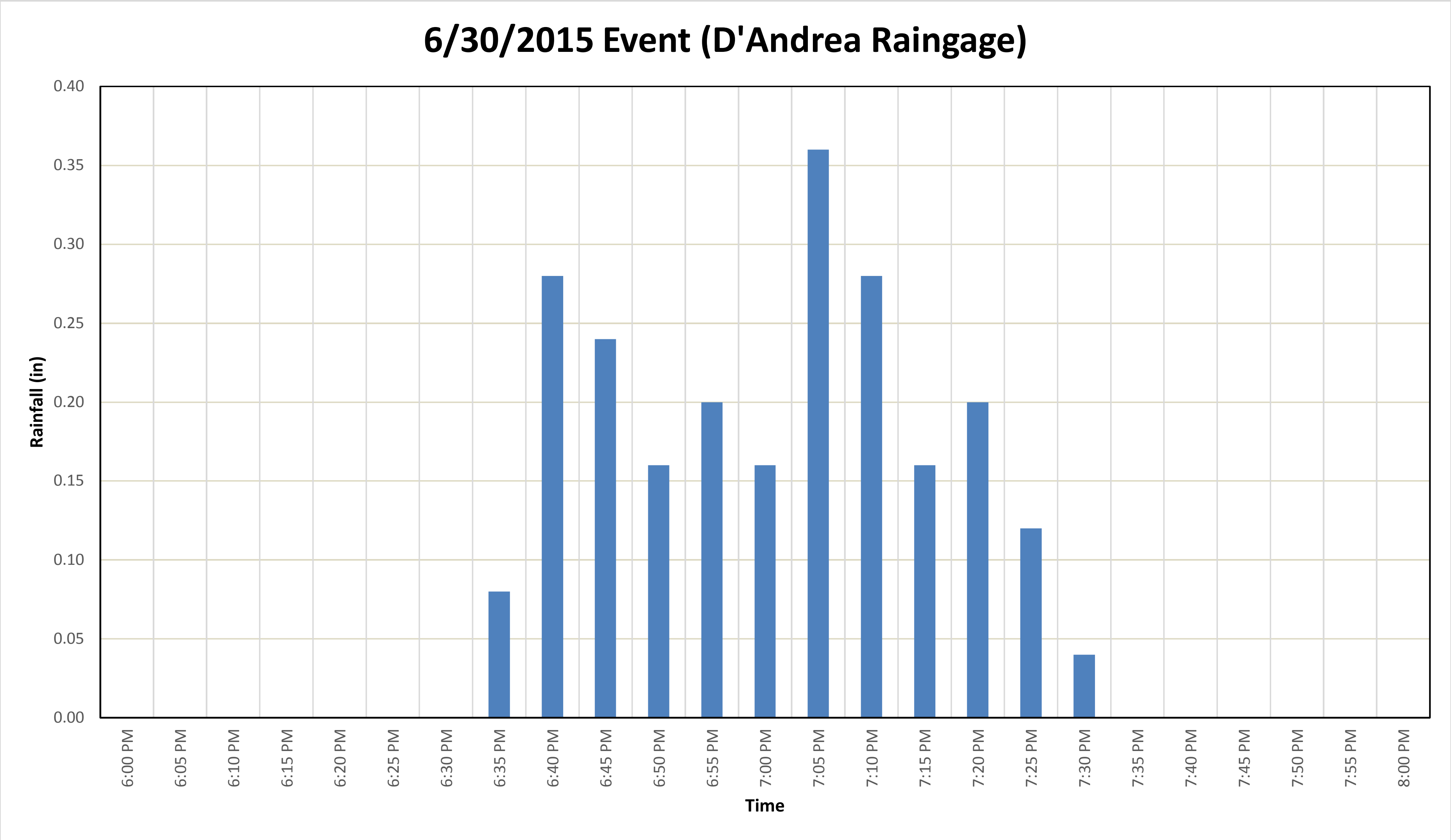



Dry Weather Flow Composite Hydrograph (Meter Sun Valley)
Weekday
Weekend
FLow (MGD)
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
12:00 AM
6:00 AM
12:00 PM
6:00 PM
12:00 AM
6:00 AM
12:00 PM
6:00 PM
12:00 AM
Time
Observed Traces
Observed Composite

Appendix E. Wet Weather Calibration

- Rainfall Dependent Inflow and Infiltration (RDI&I) Methodology and Analysis
- Wet Weather Calibration Figures
- Truckee Meadows Depth Area Reduction Factors (DARFs)

Rainfall Dependent Inflow and Infiltration (RDI&I) Methodology and Analysis



6/30/2015 Event (D'Andrea Raingage)
Rainfall (in)
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
6:00 PM
6:05 PM
6:10 PM
6:15 PM
6:20 PM
6:25 PM
6:30 PM
6:35 PM
6:40 PM
6:45 PM
6:50 PM
6:55 PM
7:00 PM
7:05 PM
7:10 PM
7:15 PM
7:20 PM
7:25 PM
7:30 PM
7:35 PM
7:40 PM
7:45 PM
7:50 PM
7:55 PM
8:00 PM
Time

Metered Sewershed Flow vs. Sewershed Area (RDI&I Calibration and Analysis)

Meter	Area (ac)	Metered ADF (mgd)	Upstream Sewersheds	Contributing Upstream ADF (mgd)	Estimated Total Sewershed ADF (mgd)
Metered Sewersheds (Inside Study Limits)					
Frank06	688	5.20	Sparks03, Sun Valley	4.13	1.07
Matte07	415	0.23			0.23
Nugg05	2224	2.55	Victo04, Matte07, Sulli09	1.39	1.16
Site_05	2187	10.36	Site_02, Site_01, Nugg05, Frank06	10.00	0.36
Site_06	1459	1.19	Wldlsd08	0.12	1.07
Site_07	71	0.04			0.04
Sparks03	5959	3.20	LosAl02, Pyram01, LaPa10	0.61	2.59
Sulli09	141	0.24			0.24
Victo04	736	0.92			0.92
Wldlsd08	336	0.12			0.12
Projected Existing Sewershed Areas (Outside of Study Limits)					
Pyram01	843	0.44			0.44
LaPa10	85	0.04			0.04
LosAl02	247	0.13			0.13
Sun Valley	1780	0.93			0.93
Site_01	3457	1.80			1.80
Site_02	856	0.45			0.45
Projected Buildout Sewershed Area (Outside of Study Limits)					
Pyram01	4410	2.30			2.30
LaPa10	441	0.23			0.23
LosAl02	288	0.15			0.15
Sun Valley	3969	2.07			2.07
Site_01*	6614	1.80			7.90
Site_02*	1549	0.45			2.50

Notes:

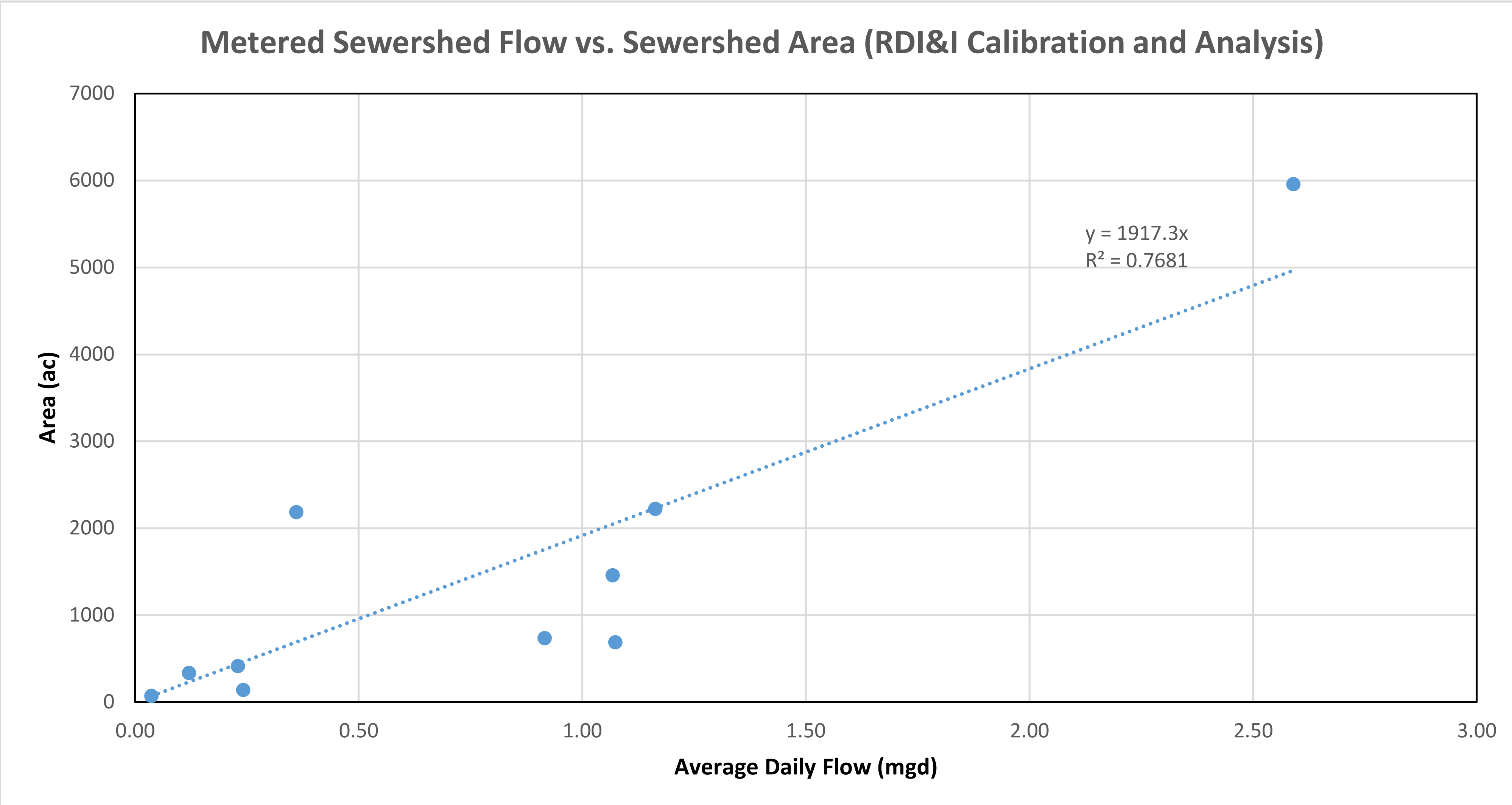
• Regression analysis used in RDI&I analysis and RTK parameterization to estimate the size of contributing sewershed areas for areas outside of the study limits

* Estimated areas obtained from previous City of Reno Sewer Master Plans:

Stantec Consulting, Inc. (May 17, 2013). Central & South Reno Sanitary Sewer Interceptor Capacity Analysis Systems 1 through 15.

Stantec Consulting, Inc. (August 29, 2006). North Virginia Street / Reno-Sparks Sanitary Sewer Interceptor Master Plan.

[Blue shaded cell] Estimated areas using regression analyis equation



Metered Sewershed Flow vs. Sewershed Area (RDI&I Calibration and Analysis)
7000
6000
5000
4000
3000
2000
1000
0
Area (ac)
y = 1917.3x
R^2 = 0.7681
0.00
0.50
1.00
1.50
2.00
2.50
3.00
Average Daily Flow (mgd)

Sewershed Area to Junction Allocation (RDI&I Calibration and Analysis)

Existing				Buildout			
Meter	**Area (ac)**	**Number of Junctions/ Sewershed**	**Sewershed Area/Junction**	**Meter**	**Area**	**Number of Junctions/ Sewershed**	**Sewershed Area/Junction**
Frank06	688	447	1.54	Frank06	688	Added sewershed areas contributing RDI&I loading in the buildout condition were allocated to specific inflow junctions in the system	
Matte07	415	295	1.41	Matte07	415		
Nugg05	2224	1408	1.58	Nugg05	2224		
Site_05	2187	501	4.37	Site_05	2187		
Site_06	1459	665	2.19	Site_06	1459		
Site_07	71	9	7.90	Site_07	71		
Sparks03	5959	917	6.50	Sparks03	5959		
Sulli09	141	47	3.01	Sulli09	141		
Victo04	736	399	1.84	Victo04	736		
WldIsd08	336	50	6.73	WldIsd08	336		
Pyram01	843	1	843	Pyram01	4410	1	4410
LaPa10	85	1	85	LaPa10	441	1	441
LosAl02	247	1	247	LosAl02	288	1	288
Sun Valley	1780	1	1780	Sun Valley	3969	1	3969
Site_01	3457	1	3457	Site_01*	6614	1	6614
Site_02	856	1	856	Site_02*	1549	1	1549

Notes:

* Estimated areas obtained from previous City of Reno Sewer Master Plans:

Stantec Consulting, Inc. (May 17, 2013). Central & South Reno Sanitary Sewer Interceptor Capacity Analysis Systems 1 through 15.

Stantec Consulting, Inc. (August 29, 2006). North Virginia Street / Reno-Sparks Sanitary Sewer Interceptor Master Plan.

[Blue shading] Estimated areas using regression analyis equation

Calibrated RTK Parameters (RDI&I Calibration and Analysis)

Existing												
Meter	Area (ac)	Estimated Rainfall Depth (in)	R1	R2	R3	Total R	T1 (hr)	T2 (hr)	T3 (hr)	K1	K2	K3
Frank06	688	0.87	0.0038	0.0022	0.003	0.0090	0.5	1.0	2.0	1.0	1.0	0.8
Matte07	415	0.66	0.0039	0.0009	0.0012	0.0060	0.2	0.4	2.5	1.0	2.5	0.4
Nugg05	2224	0.22	0.0066	0.0053	0.0042	0.0161	1.5	2.5	3.5	0.7	0.4	0.3
Site_05	2187	0.13	0.0026	0.0016	0.0018	0.0060	1.0	2.0	3.0	1.0	0.5	0.3
Site_06	1459	1.17	0.0005	0.0005	0.0007	0.0017	0.5	1.0	2.0	1.0	1.0	0.3
Site_07	71	0.10	0.0026	0.0016	0.0018	0.0060	1.0	2.0	3.0	1.0	0.5	0.3
Sparks03	5959	0.46	0.0030	0.0003	0.0004	0.0037	1.0	2.0	3.5	1.0	1.0	0.6
Sulli09	141	0.12	0.0059	0.0021	0.0039	0.0119	0.2	0.3	1.5	1.0	1.8	0.7
Victo04	736	0.15	0.0078	0.0033	0.0067	0.0178	0.1	0.2	0.5	1.0	1.0	1.0
WldIsd08	336	0.39	0.0056	0.0066	0.0148	0.0270	1.0	2.0	4.0	1.0	1.5	0.9
Pyram01	843	0.10	0.0014	0.0012	0.0014	0.0040	0.5	1.0	2.0	1.0	0.5	0.3
LaPa10	85	0.10	0.0014	0.0012	0.0014	0.0040	0.5	1.0	2.0	1.0	0.5	0.3
LosAl02	247	0.46	0.0014	0.0012	0.0014	0.0040	0.5	1.0	2.0	1.0	0.5	0.3
Sun Valley	1780	0.22	0.0014	0.0012	0.0014	0.0040	0.5	1.0	2.0	1.0	0.5	0.3
Site_01	3457	0.22	0.0036	0.0015	0.0022	0.0073	0.5	1.0	2.0	1.0	1.0	0.5
Site_02	856	0.22	0.0039	0.0029	0.0022	0.0090	0.5	1.0	2.0	1.0	1.0	0.5

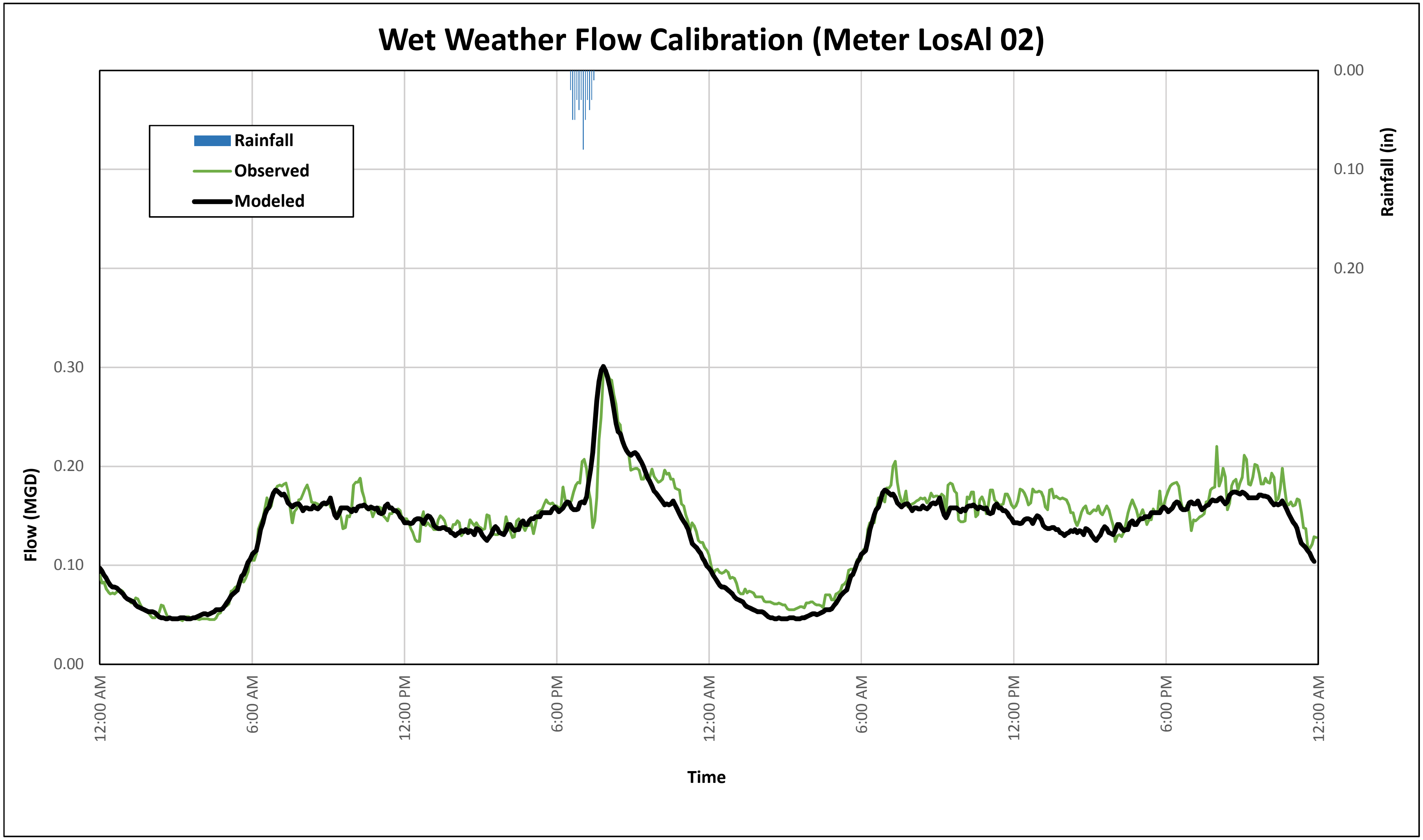
Notes:

- Rainfall depth estimated using NEXRAD rainfall data from the 6/30/2015 storm event

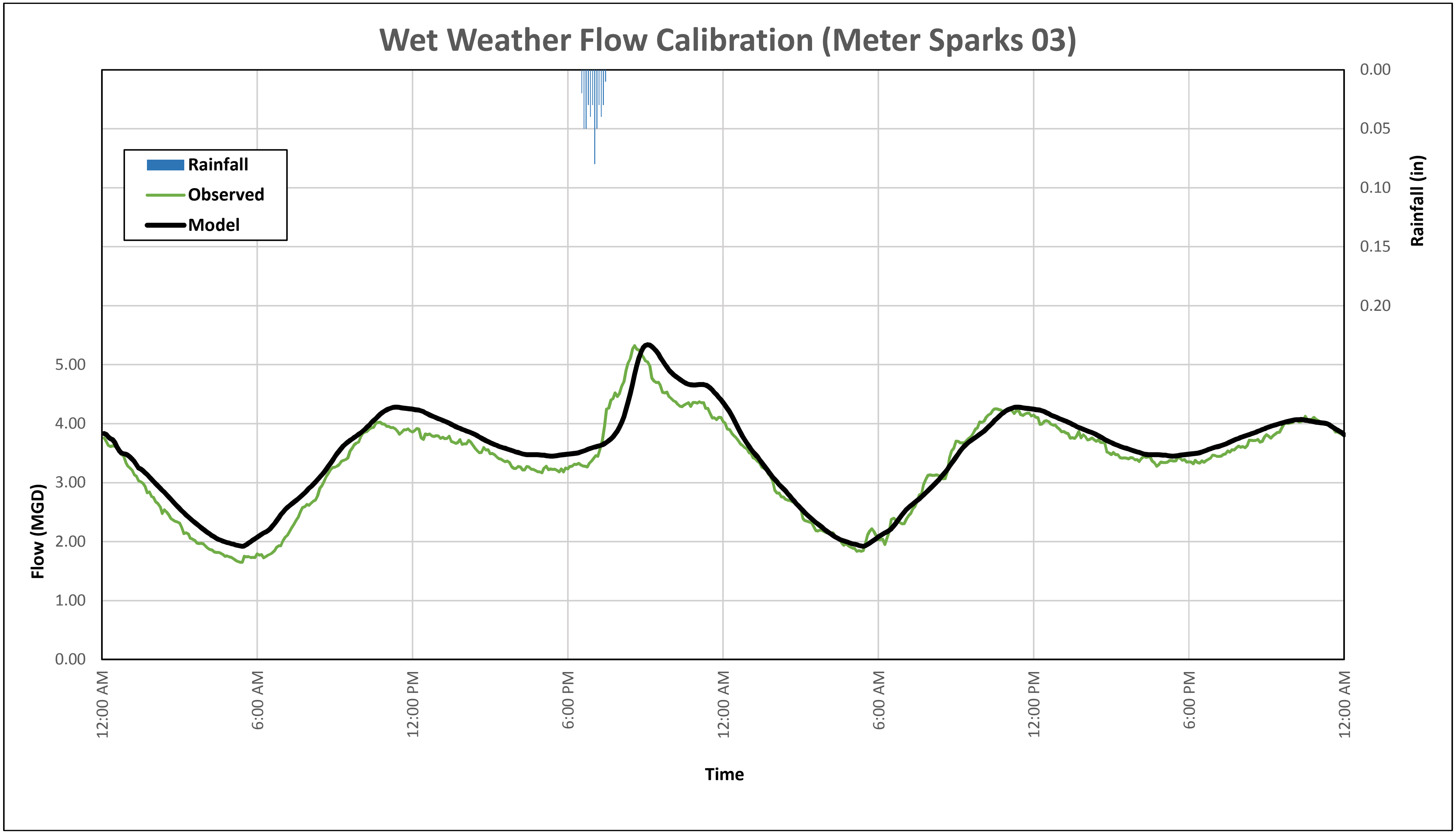
[shaded] Estimated areas using regression analyis equation

Wet Weather Calibration Figures

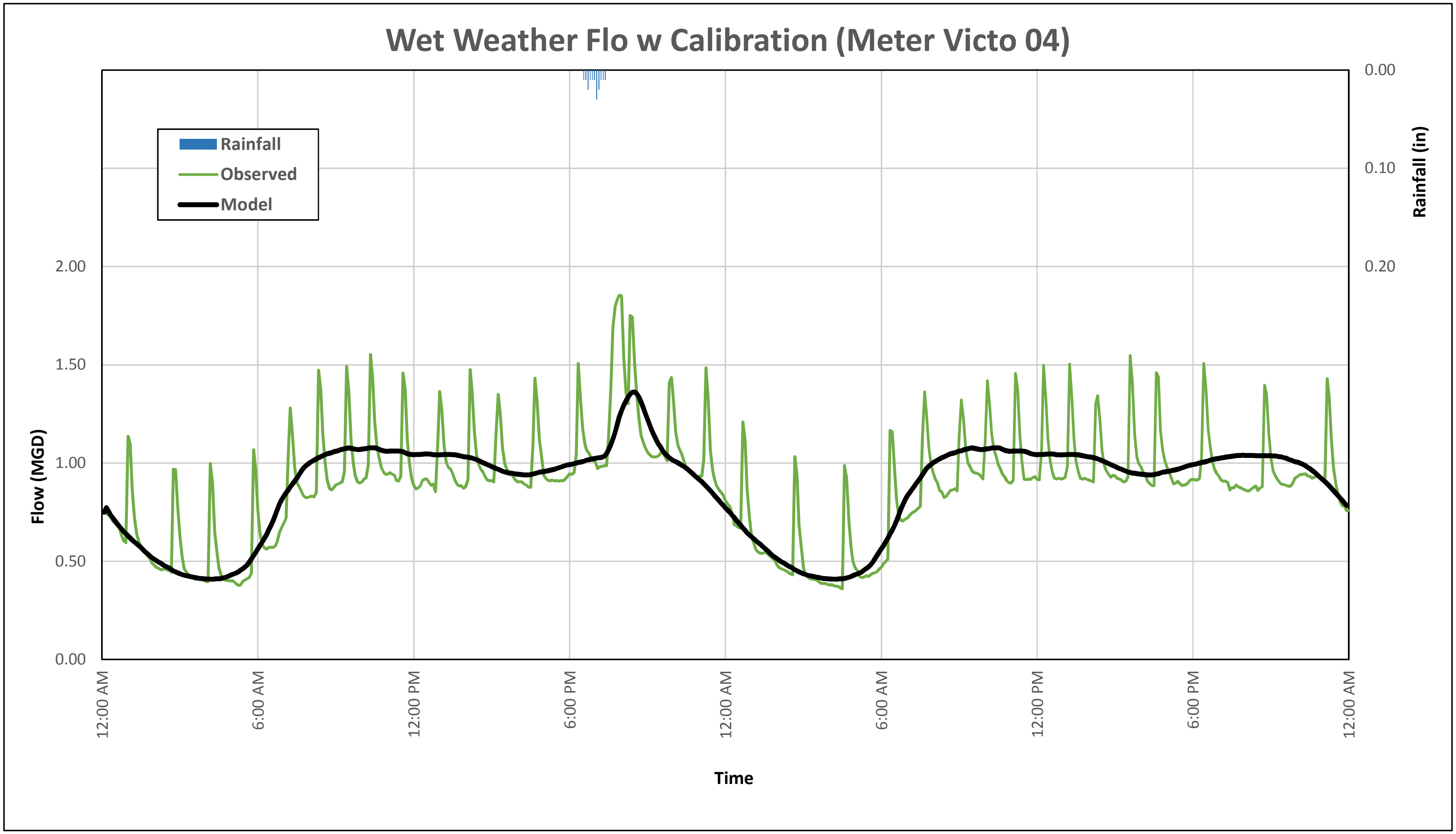
	Modeled	Metered	% Error
Peak Flow (mgd) =	0.301	0.295	2.0%
Volume (mg) =	0.132	0.139	-5.1%
R2eff =	0.876		
Total Rainfall (in) =	0.460		



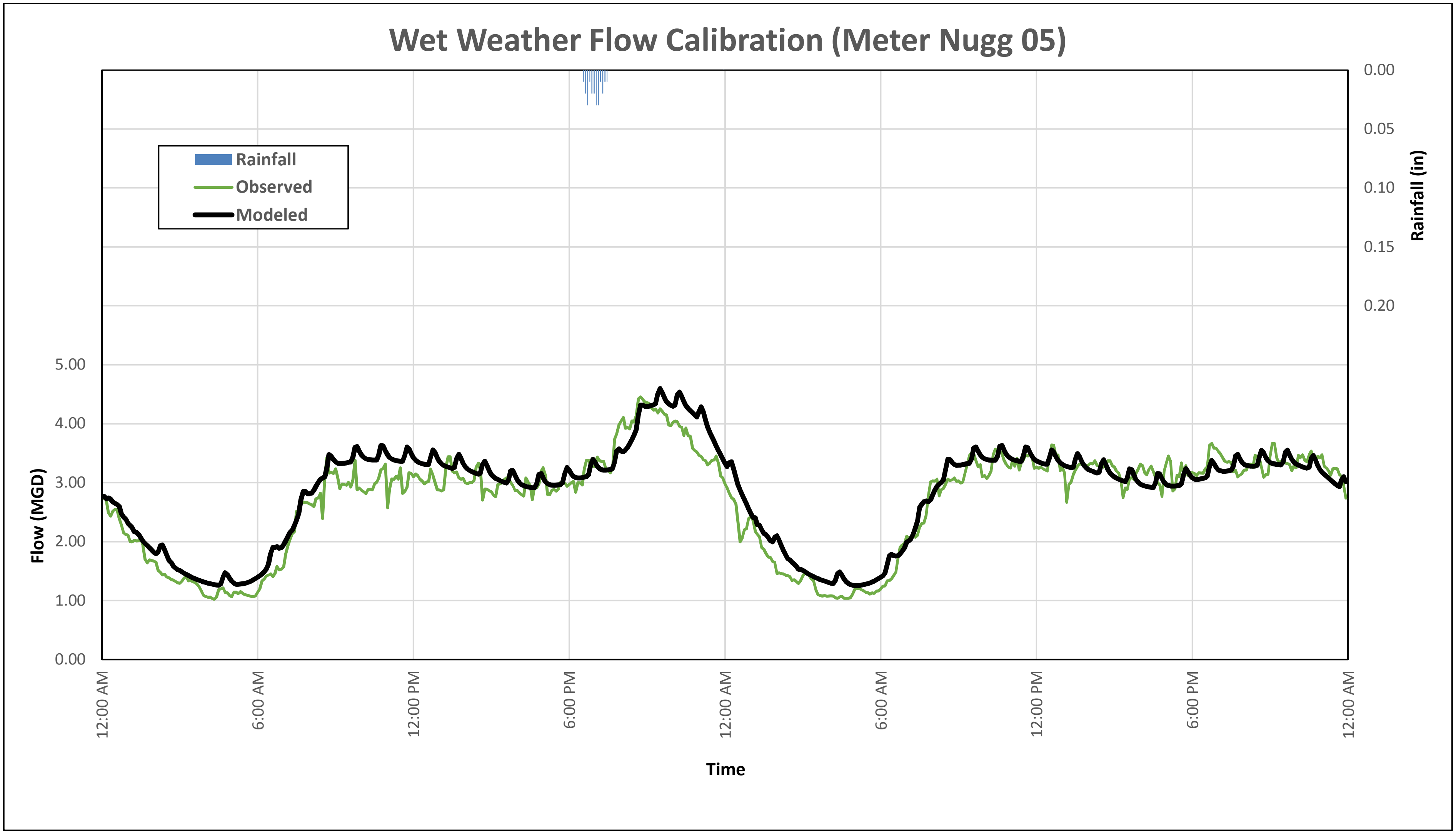
	Modeled	Metered	% Error
Peak Flow (mgd) =	5.339	5.324	0.3%
Volume (mg) =	3.482	3.338	4.3%
R2eff =	0.909		
Total Rainfall (in) =	0.46		



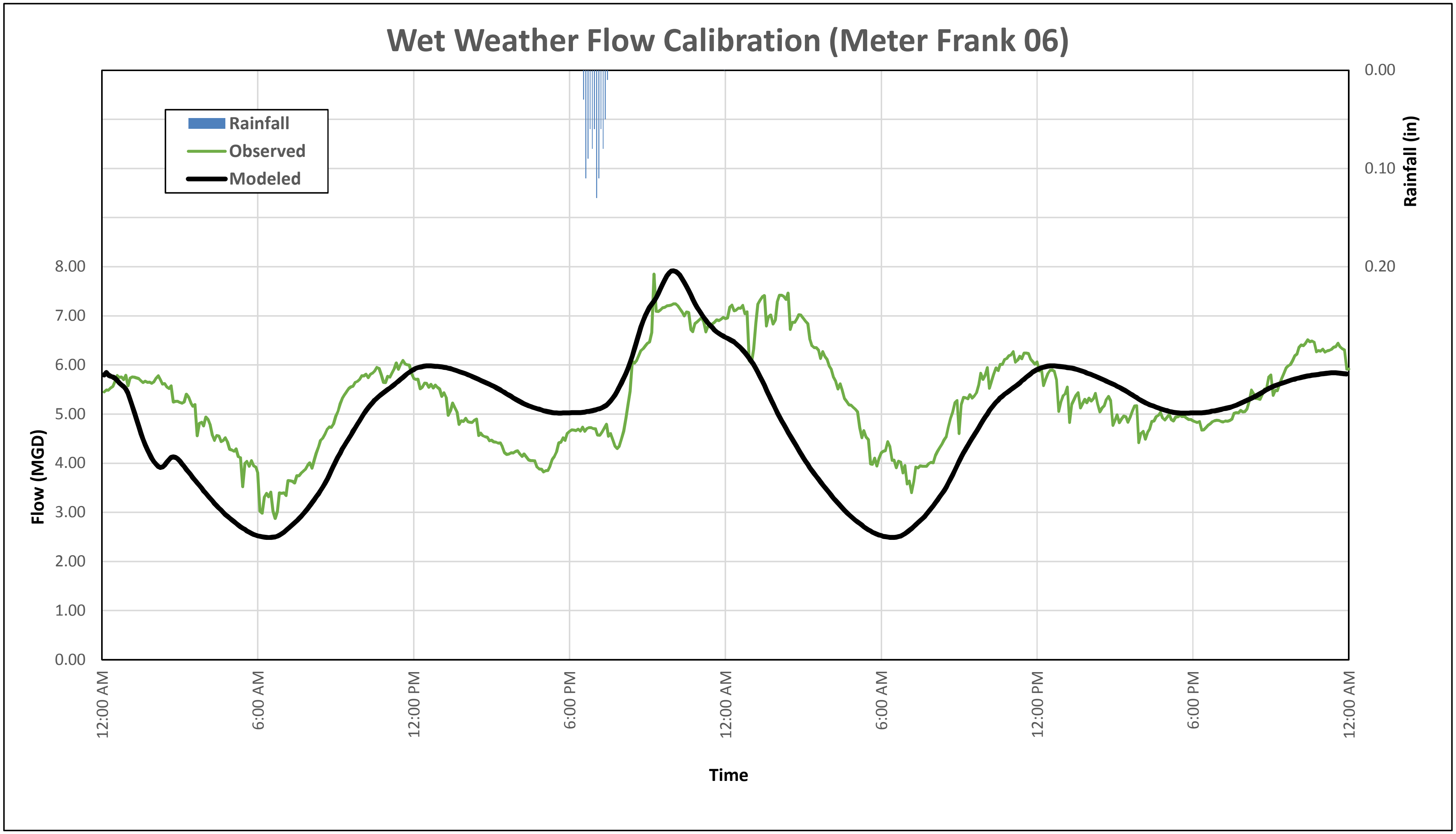
	Modeled	Metered	% Error
Peak Flow (mgd) =	1.362	1.854	-26.5%
Volume (mg) =	0.874	0.891	-2.0%
R2eff =	0.571		
Total Rainfall (in) =	0.15		



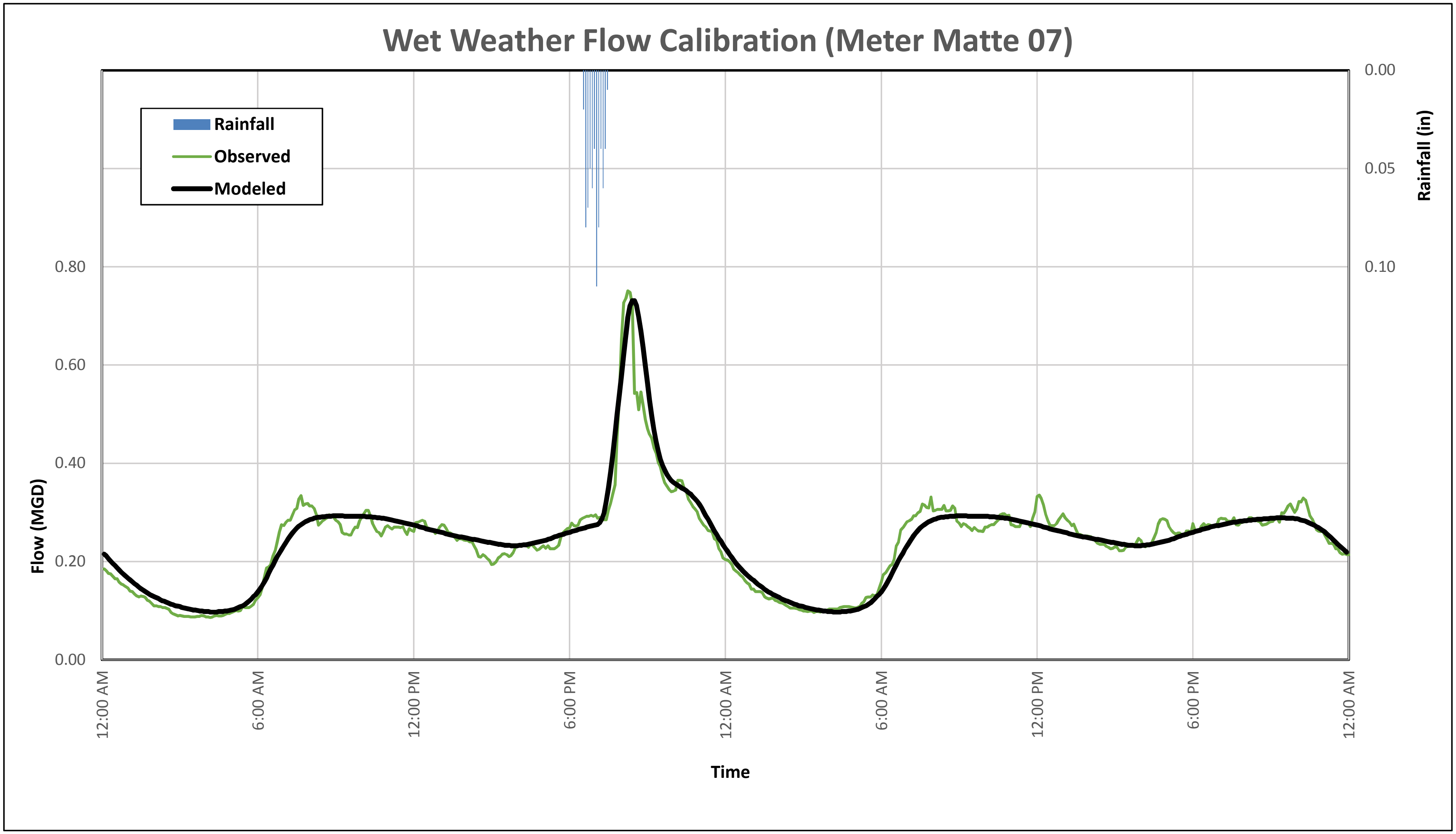
	Modeled	Metered	% Error
Peak Flow (mgd) =	4.598	4.456	3.2%
Volume (mg) =	2.913	2.712	7.4%
R2eff =	0.881		
Total Rainfall (in) =	0.22		



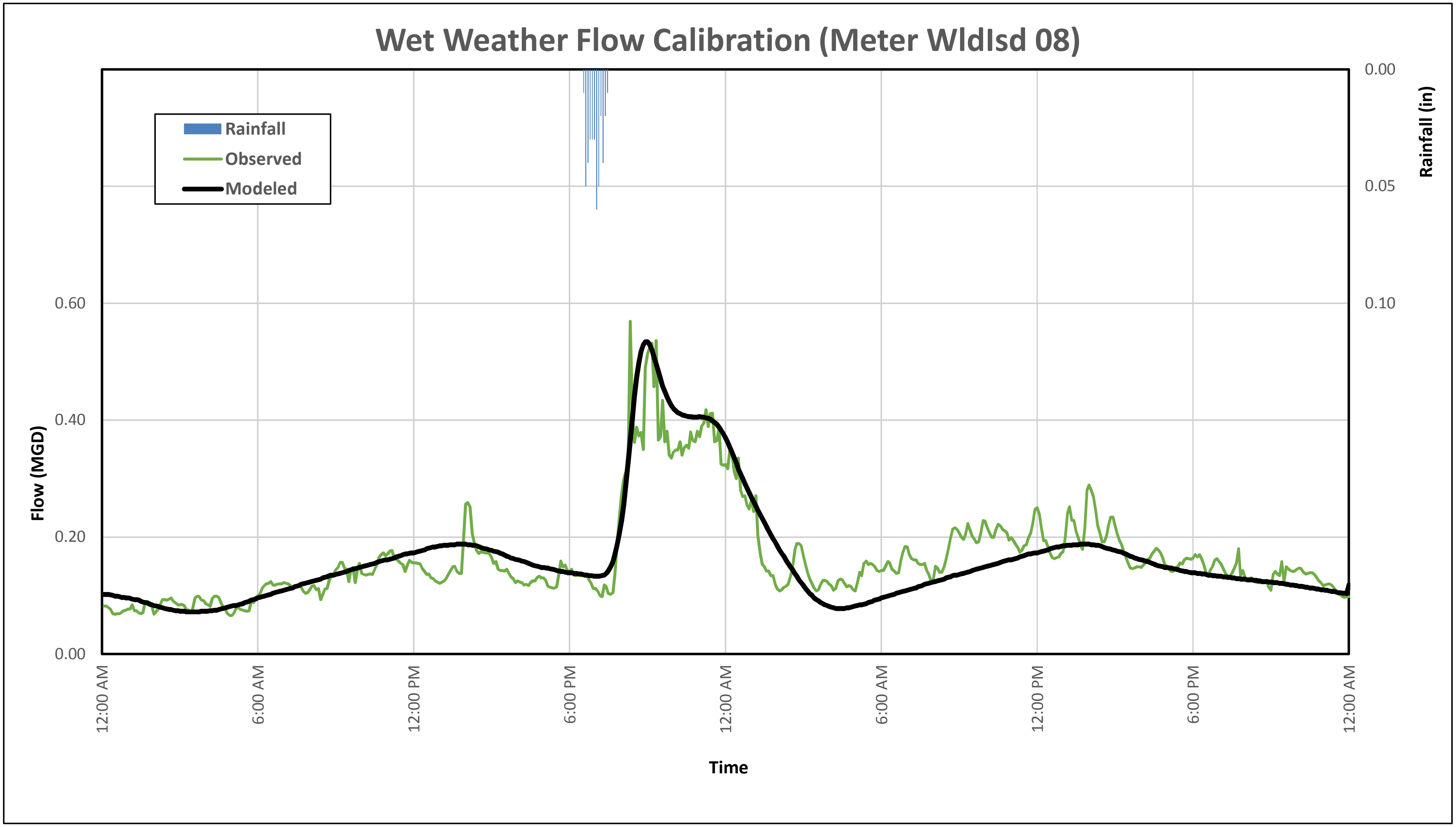
	Modeled	Metered	% Error
Peak Flow (mgd) =	7.917	7.849	0.9%
Volume (mg) =	5.001	5.308	-5.8%
R2eff =	-0.202		
Total Rainfall (in) =	0.87		



	Modeled	Metered	% Error
Peak Flow (mgd) =	0.731	0.751	-2.7%
Volume (mg) =	0.243	0.241	1.1%
R2eff =	0.913		
Total Rainfall (in) =	0.66		

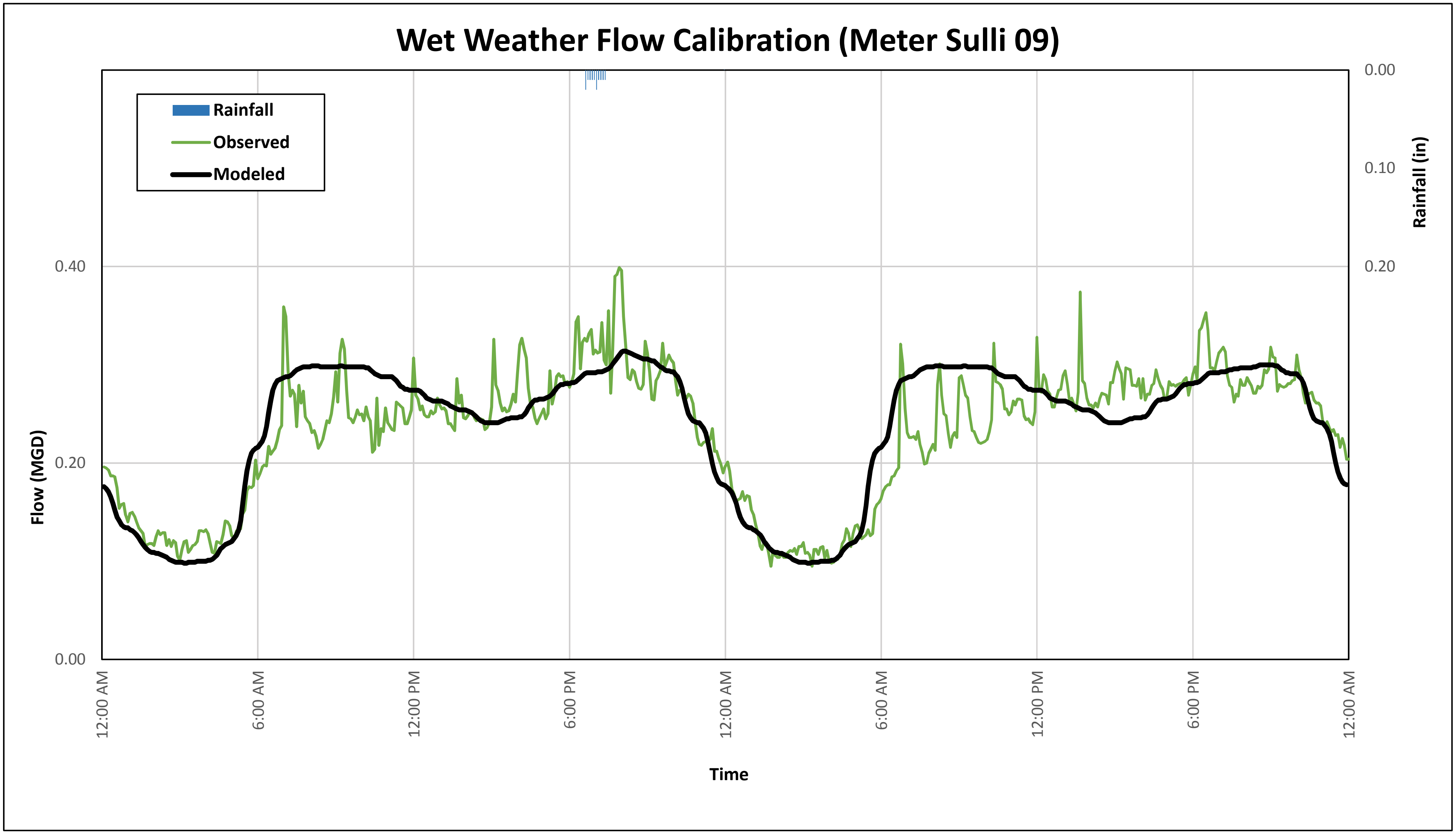


	Modeled	Metered	% Error
Peak Flow (mgd) =	0.534	0.569	-6.2%
Volume (mg) =	0.163	0.167	-2.1%
R2eff =		0.791	
Total Rainfall (in) =		0.39	

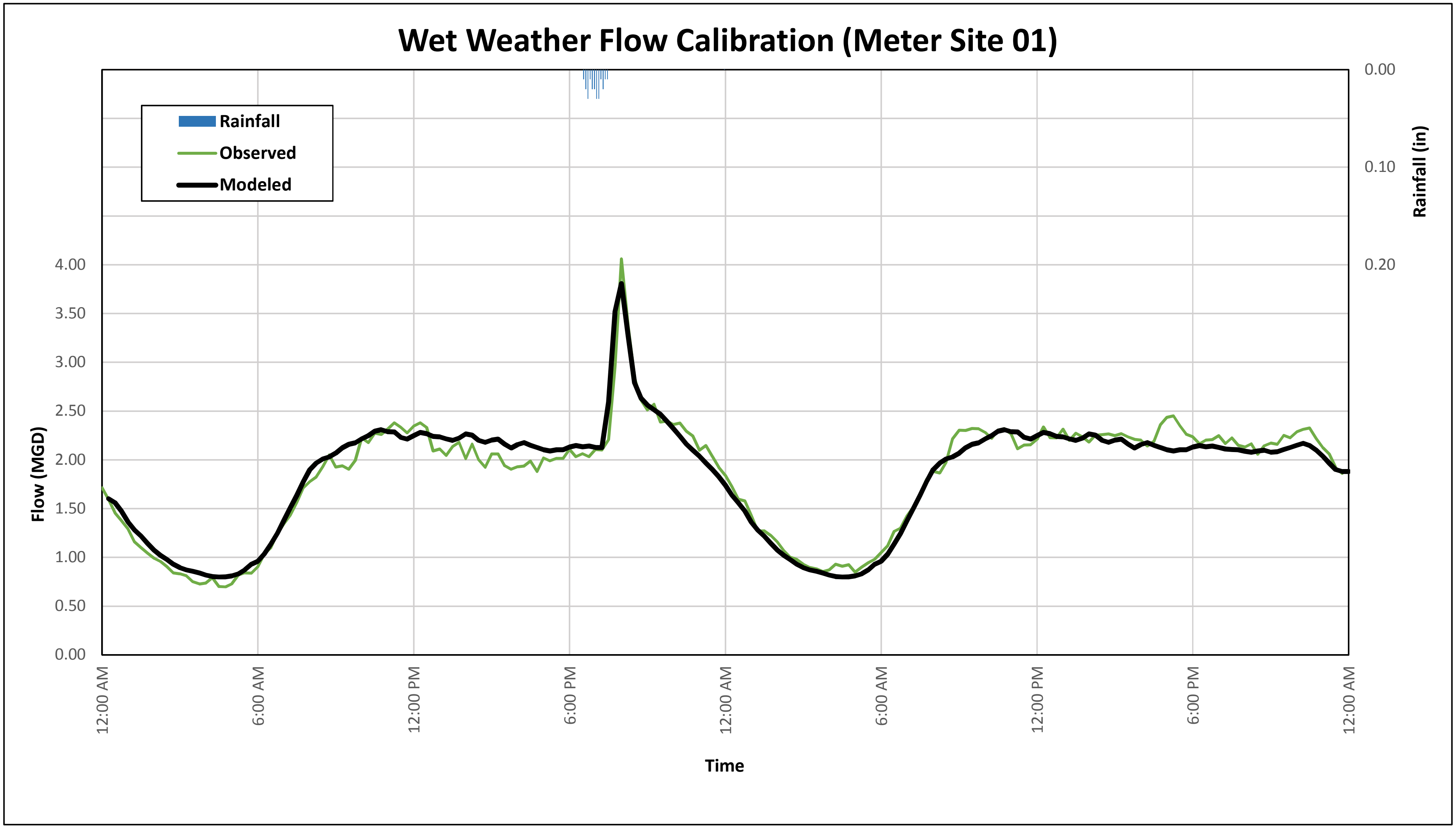


	Modeled	Metered	% Error
Peak Flow (mgd) =	0.314	0.399	-21.3%
Volume (mg) =	0.236	0.232	1.6%
R2eff =	0.727		
Total Rainfall (in) =	0.12		

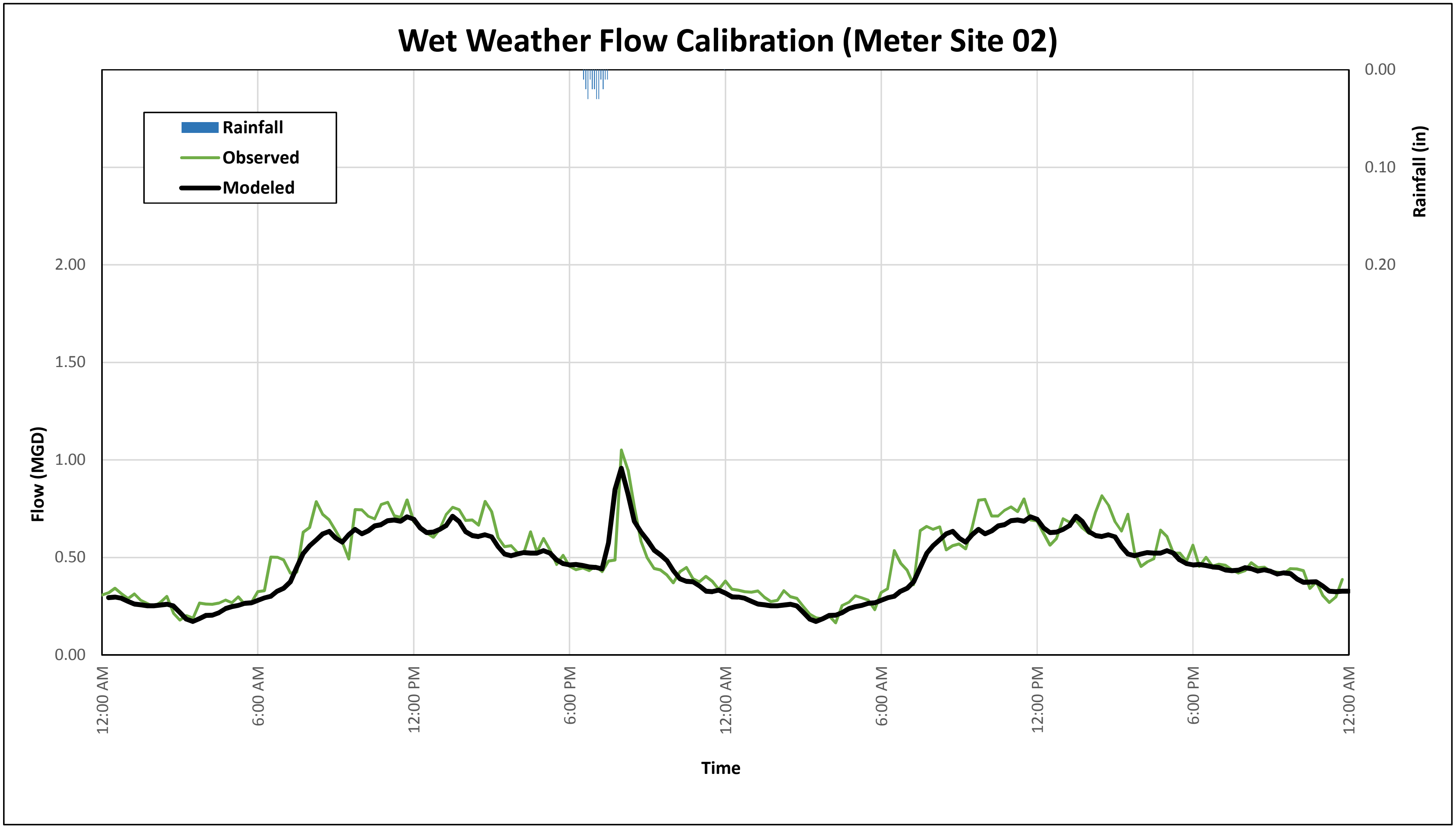
Meter not calibrated, as no WWF response observed. Adjacent meter RTK partameters used



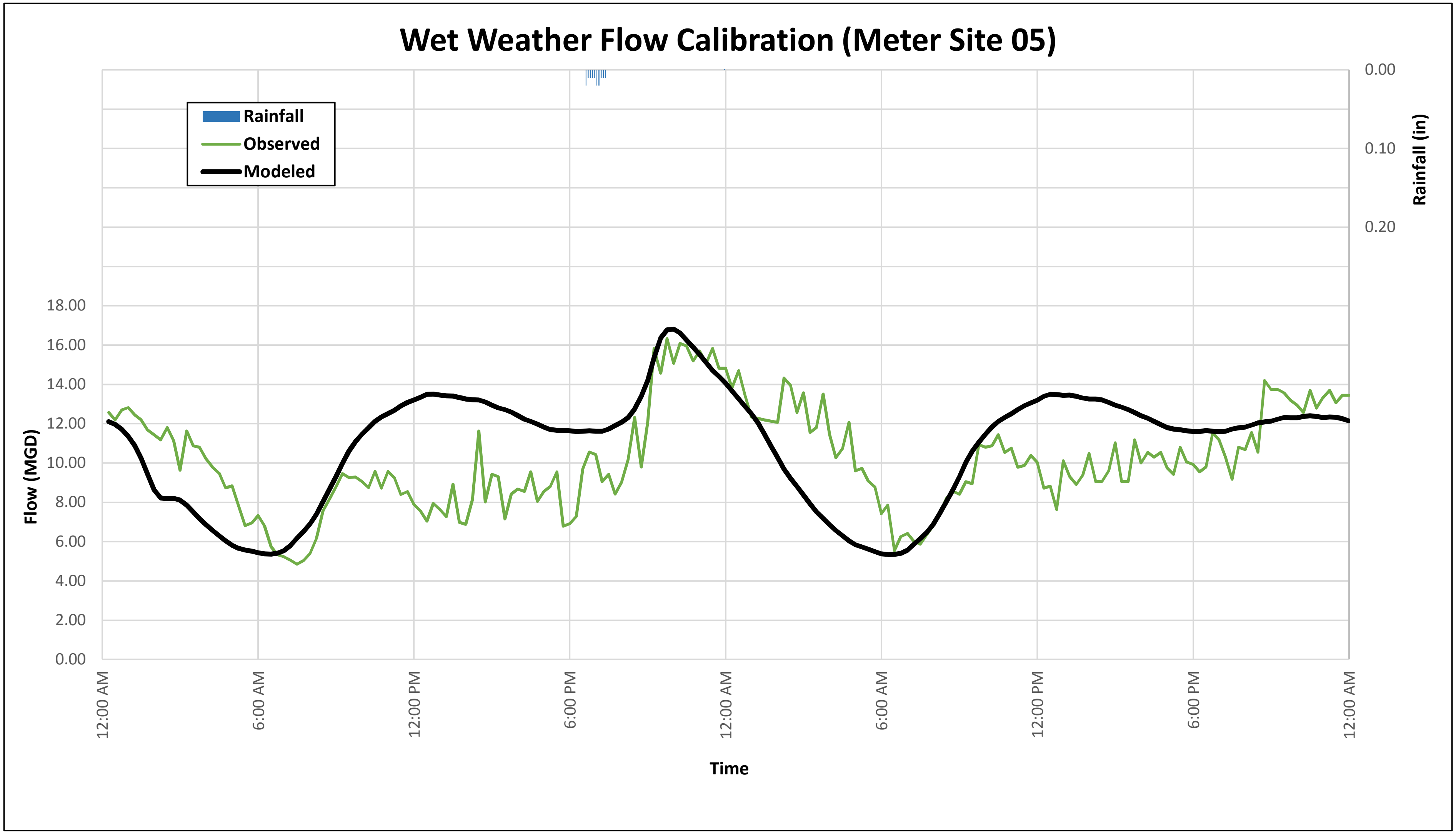
	Modeled	Metered	% Error
Peak Flow (mgd) =	3.808	4.060	-6.2%
Volume (mg) =	1.847	1.846	0.1%
R2eff =	0.957		
Total Rainfall (in) =	0.22		



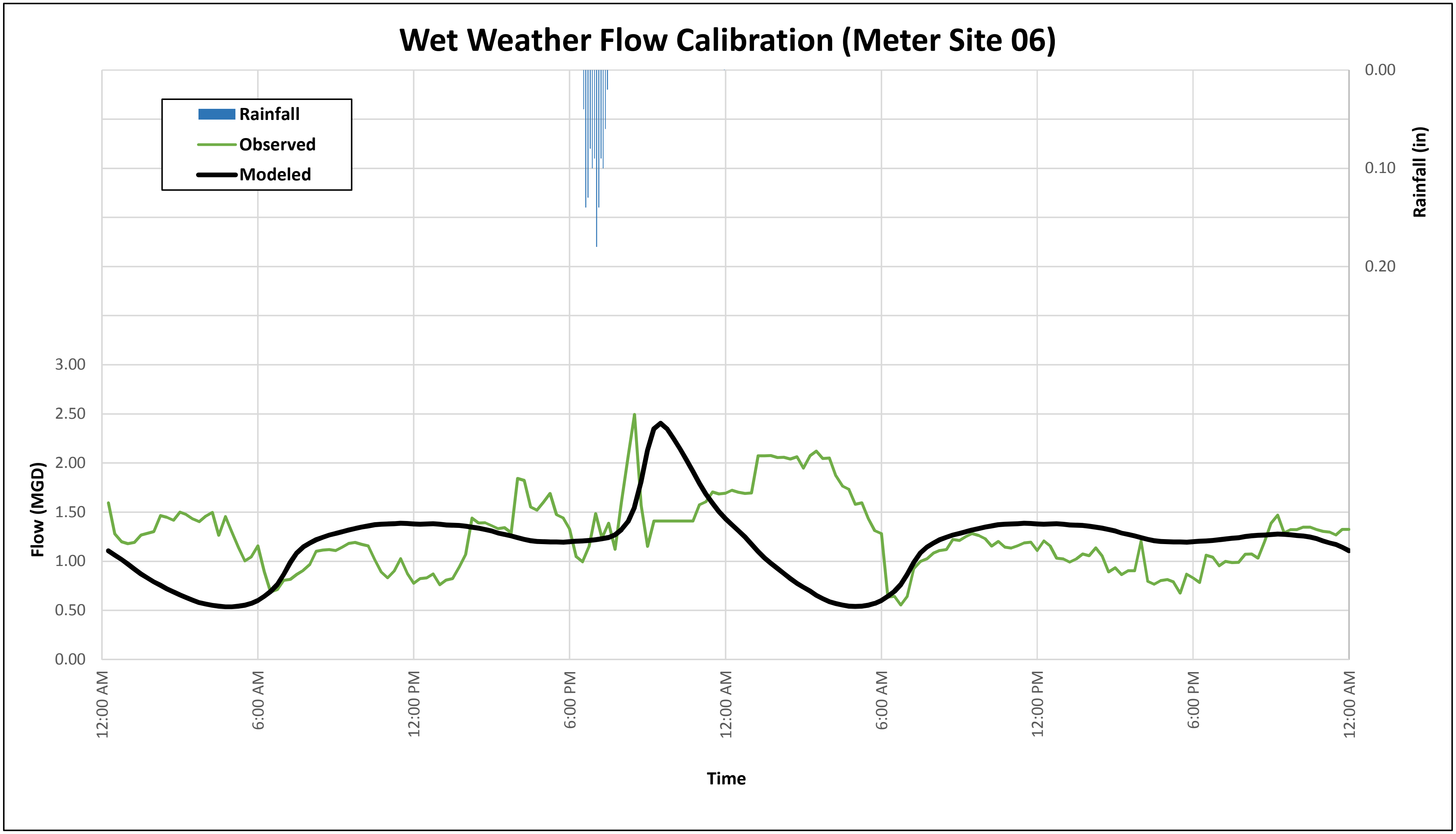
	Modeled	Metered	% Error
Peak Flow (mgd) =	0.957	1.051	-8.9%
Volume (mg) =	0.460	0.493	-6.6%
R2eff =	0.826		
Total Rainfall (in) =	0.22		



	Modeled	Metered	% Error
Peak Flow (mgd) =	16.806	16.333	2.9%
Volume (mg) =	10.871	10.139	7.2%
R2eff =	-0.252		
Total Rainfall (in) =	0.130		

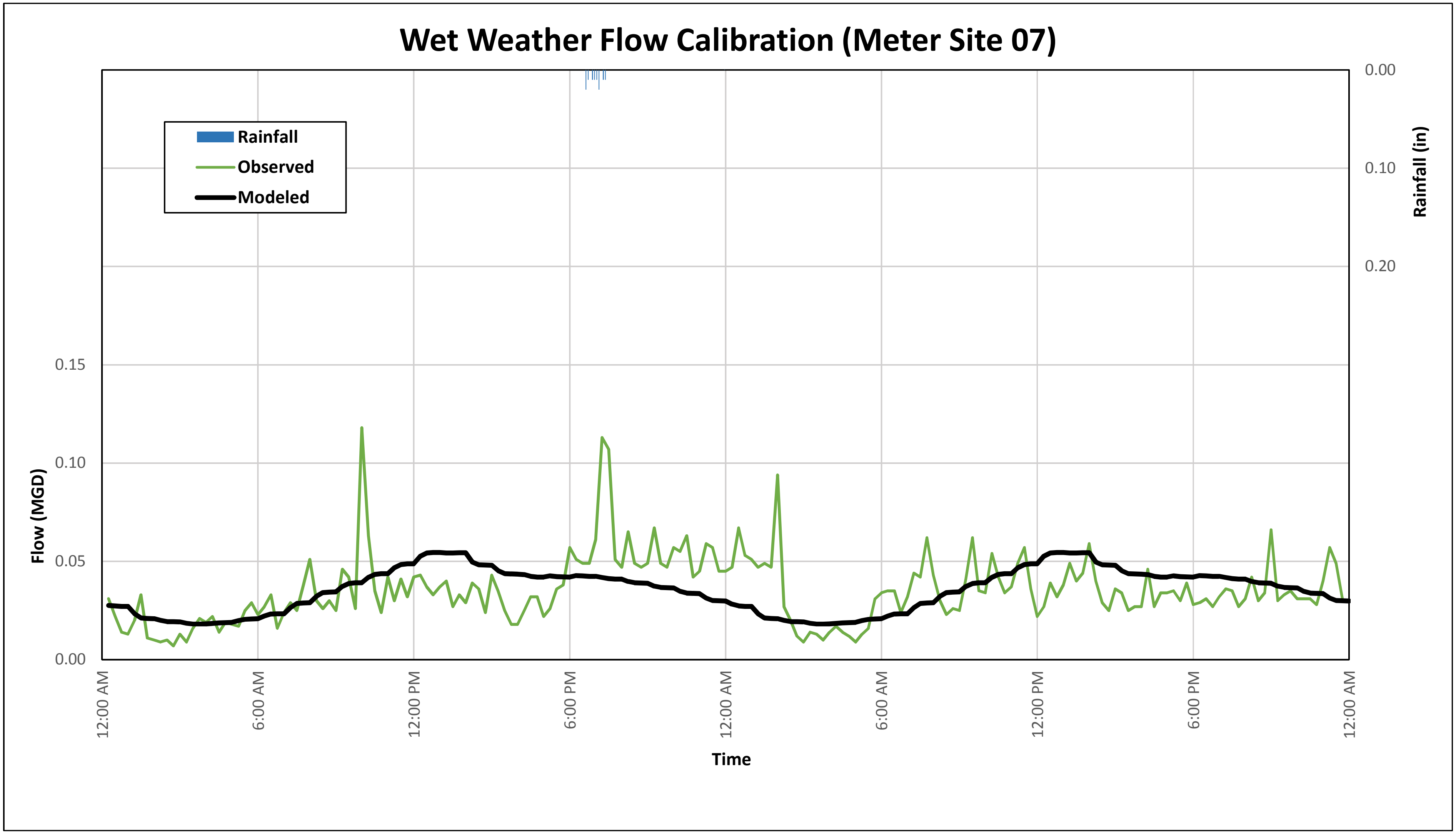


	Model	Metered	% Error
Peak Flow (mgd) =	2.405	2.495	-3.6%
Volume (mg) =	1.175	1.260	-6.7%
R2eff =	-1.263		
Total Rainfall (in) =	1.17		



	Modeled	Metered	% Error
Peak Flow (mgd) =	0.055	0.118	-53.8%
Volume (mg) =	0.035	0.035	-0.2%
R2eff =	0.006		
Total Rainfall (in) =	0.10		

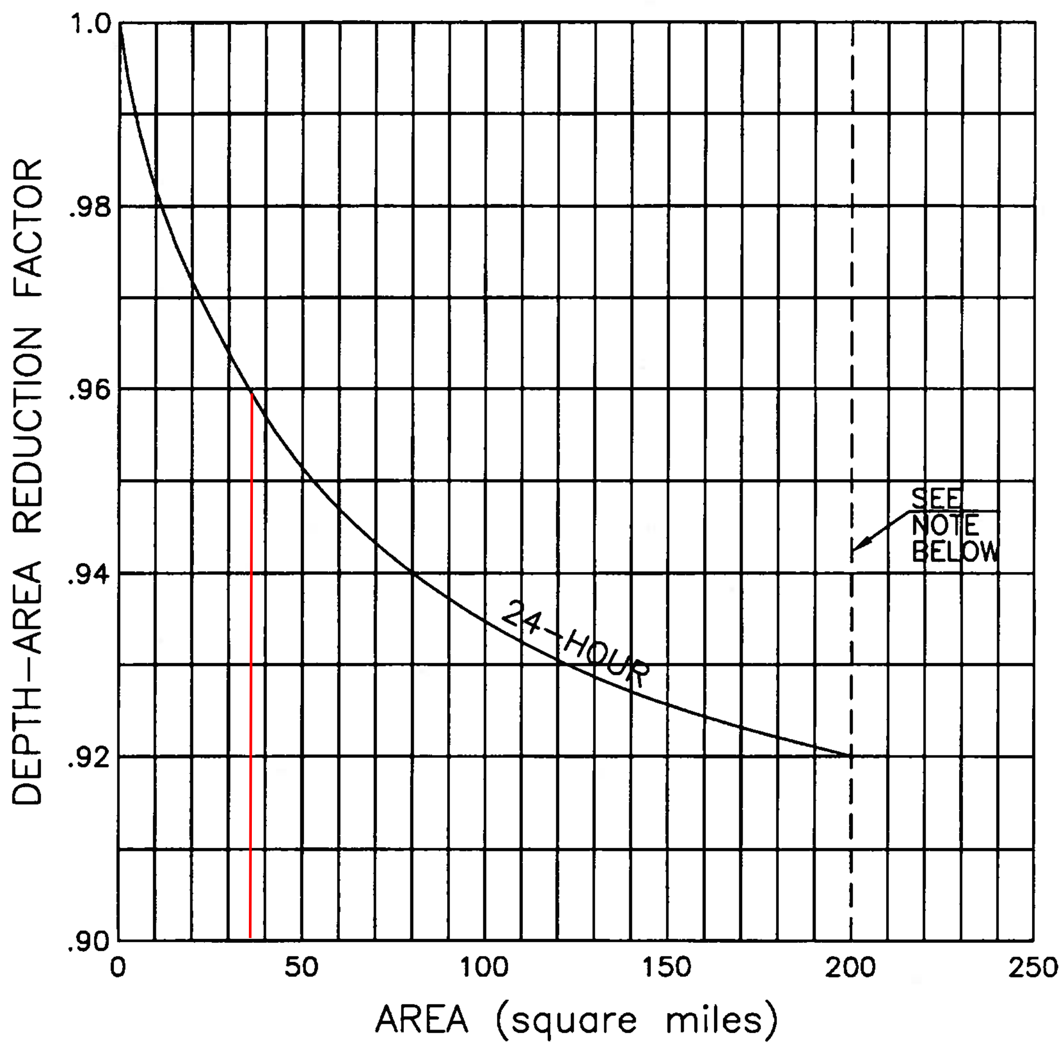
Meter not calibrated, as no WWF response observed. Adjacent meter RTK partameters used



Truckee Meadows Depth Area Reduction Factors (DARFs)

Applied to Design Storms for Wet Weather Flow Analysis

DEPTH-AREA REDUCTION CURVE



City of Sparks City Limits = 36 sqmi
DARF = 0.96

NOTE:

1. CONSULT WITH THE CITY OF SPARKS FOR GUIDANCE IN USING THE DEPTH-AREA REDUCTION FACTORS AND STORM CENTERING FOR MODELLING OF DRAINAGE AREAS GREATER THAN 200 MILES.

VERSION: July 30, 1998	REFERENCE: U.S. DEPT. OF COMMERCE, NOAA ATLAS No. 2, 1973	FIGURE 605
WRC NEVADA, INC		

1576, 1576-604.DWG 1:100MS 5-30-97 JLH

Appendix F. InfoSWMM Modeling Results

ATKINS

InfoSWMM Modeling Results

Below is the process of finding the model results within the model results (existing and buildout) shapefiles.

1. Model Results Shape Files:
   - **Ex_DWF.shp**: Existing dry weather flow model
   - **EX_WWF.shp**: Existing wet weather flow model
   - **Fut_DWF.shp**: Future dry weather flow model
   - **Fut_WWF.shp**: Future wet weather flow model
   - **CIP_Ex_DWF.shp**: Existing dry weather flow with existing CIP improvements model
   - **CIP_EX_WWF.shp**: Existing wet weather flow with existing CIP improvements model
   - **CIP_Fut_DWF.shp**: Future dry weather flow with future CIP improvements model
   - **CIP_Fut_WWF.shp**: Future wet weather flow with future CIP improvements model

2. Pipe Results (Definitions of GIS Attribute Fields in Model Shapefiles):
   - **Maximum d/D**: MXFUL_DEPT column
   - **Maximum Flow**: MXFUL_FLOW column x FULL_FLOW column
   - **Maximum Velocity**: MAX_VELOC column
   - **Reserve Capacity (Maximum Flow subtracted from Full-Flow Pipe Capacity)**: RESERV_CAP column

Appendix G. Sewer Model Software Evaluation and Selection Memorandum

Memo

To:	Andy Hummel, P.E., City of Sparks
From:	Brian Janes, P.E., Atkins Dan Stucky, P.E., Atkins
Date:	June 2, 2015
Subject:	Sewer Model Software Selection City of Sparks Sewer Model Update

As part of this sewer model update, Atkins evaluated various sanitary sewer modeling software packages in order to determine the most appropriate model to satisfy the City of Sparks' specific modeling needs and anticipated future uses. This project will utilize the functionality of the sewer model software in order to evaluate the hydraulic capacity of the collection system for existing and future flow conditions, identify possible deficiencies in the system and help prioritize capital improvement projects (CIPs) for the City. The model is also intended to be used to quantify any potential infiltration/inflow (I/I) problems in the collection system. Therefore, the selected software should employ a stable hydraulic engine, which will closely represent the real-world conditions and significantly reduce the time required for model construction, validation, and quality assurance/quality control (QA/QC). At the same time, the software should provide a user-friendly graphical interface that will facilitate the decision-making process for the City in future planning. Both considerations are equally important in the selection of a software package.

Atkins has hands-on experience with all the major sewer modeling software packages and is very knowledgeable of the strengths and weaknesses of each. Some of the key factors considered in this model evaluation include the ease of use, "stand-alone" ability, ability to integrate with GIS, report generation capabilities, infiltration/inflow analysis (for wastewater), coordination with CCTV inspection data, scenario management, and SCADA interfaces. Additionally, it is our understanding that the City may be interested in hosting the model in-house in the future, therefore vendor support and software costs are also extremely important factors to consider. The following table shows a simplified matrix comparing some of the key features among the sewer models evaluated.

Sewer Model Software Evaluation Matrix

Categories	Sewer Models					
	XPSWMM	InfoSWMM	H2O Map SWMM	InfoWorks CS	SewerGEMS	SewerCAD
User-friendly	Yes	Yes	No	No	Yes	Yes
ArcGIS Integration	Stand-alone (Linked)	Direct	Stand-alone (Linked)	Stand-alone (Linked)	Direct	Stand-alone (Linked)
Software Cost	$$$	$$$	$$	$$$$$	$$$	$$
Fully-Dynamic Model	Yes	Yes	Yes	Yes	Yes	No
I&I Analysis	Yes	Yes	Yes	Yes	Yes	Yes
Stormwater Modeling Capabilities	Yes	Yes	Limited	Yes	Limited	No

Model Selection Conclusions and Recommendations

Based on the summarized features above and our understanding of the City's modeling needs, XPSWMWM and InfoSWMM best addressed the key selection criteria consisting of dynamic modeling capabilities, GIS integration capabilities, user-friendly graphical interfaces, reasonable software cost and excellent technical support. Additionally both of these models offer effective stormwater modeling capabilities, therefore in the case that the City hosts the model in the future, then either of these software packages could effectively model both the City's stormwater and sanitary sewer systems, thus eliminating the need for two separate models. The following table compares the license and maintenance costs for both InfoSWMM and XPSWMM and hopefully provides the City with a general idea of the expected costs associated with hosting the models in-house in the future.

InfoSWMM and XPSWMM Software Costs (2015 Pricing)

Number of Nodes	InfoSWMM		* XPSWMM	
	License Cost (Fixed/Floating)	Annual Maintenance/ Renewal Fee	License Cost (Fixed/Floating)	Annual Maintenance/ Renewal Fee
1,000	$6,000 / $9,000	$1,000	$10,000 / $12,500	$1,500
5,000	$11,000 / $16,500	$2,000	$13,000 / $16,250	$1,950
Unlimited	$18,000 / $27,000	$2,500	$17,000 / $21,250	$2,550

*Atkins' Consolidated Purchasing Contract with XP Solutions does provide for an additional 10% discount on software purchases made on behalf of clients.

Although both XPSWMM and InfoSWMM satisfy the City's specific modeling needs, Atkins recommends the City select InfoSWMM by Innovyze as the hydraulic modeling software for the following key reasons:

- Represents a fully dynamic wave model
- Provides a highly advanced sewer modeling platform that produces accurate infiltration and inflow (I&I) analyses
- Direct integration with ArcGIS, rather than linked, thus allowing engineers/modelers to command powerful GIS analysis and hydraulic modeling in a single environment using a single dataset. This feature will reduce time required for model construction, validation, and quality assurance/quality control (QA/QC).
- Ability to manage multiple sewer pump stations including wet well volume and start and stop with level controls
- Exports model results to GIS layers, allowing for instant display and review within ArcGIS and efficient creation of various results figures (d/D, velocities, flows, etc.)
- Reasonably priced compared to other fully dynamic models