NORTH OF RIVER SANITARY DISTRICT
NORSD

SANITARY SEWER MASTER PLAN

FINAL

MARCH 2023

ARDURRA

Sanitary Sewer Master Plan

North of River Sanitary District

FINAL

Prepared for:

North of River Sanitary District

204 Universe Avenue,

Bakersfield, CA 93308

March 1, 2023

Prepared by:

ARDURRA

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Table of Contents

Figures

Tables

Appendices

Abbreviations

ADWF	Average Dry Weather Flow
ASCE	American Society of Civil Engineers
Bakersfield	City of Bakersfield
CCTV	Closed Circuit Television
CI	Cast Iron
CIP	Capital Improvement Program
CMMS	Computerized Maintenance Management System
CSA-71	County (of Kern) Service Area 71
DI	Ductile Iron
District	North of River Sanitary District
du	dwelling unit
DWF	Dry Weather Flow
EPA	Environmental Protection Agency
Facility ID	Unique identifier geodatabase assigned to a facility like pipe, manhole, etc.
FAR	Floor Area Ratio
FOG	Fats, Oils and Grease
fps	feet per second
FY	Fiscal Year (e.g., FY 2023 is July 1, 2022, to June 30, 2023)
GIS	Geographic Information System
gpd	gallons per day
GWI	Groundwater Infiltration
HDPE	High Density Polyethylene
I/I	infiltration and inflow
IEC	Infrastructure Engineering Corporation (now Ardurra)
JPA	Joint Powers Authority
lf	lineal feet
Master Plan	Sanitary Sewer Master Plan
mg	million gallons
mgd	million gallons per day
mgd/ac	million gallons per day/acre
NASSCO	National Association of Sewer Service Companies
NEMA	National Electrical Manufacturers Association
NORSD	North of River Sanitary District
O&M	Operations and Maintenance
Oildale	an unincorporated community, east of Hwy 99 and north of the Kern River
Outfall Sewer	Main east-west trunk line 33-inch to 54-inch from Oildale to WWTP
PACP	Pipeline Assessment and Certification Program
PDF	Peak Design Flow
PDWF	Peak Dry Weather Flow
PLC	Programmable Logic Controller
PVC	Poly-vinyl chloride
PWWF	Peak Wet Weather Flow
RDI/I	Rainfall Dependent Infiltration and Inflow
SB	Senate Bill
SCADA	Supervisory Control and Data Acquisition

Abbreviations

SFRE	Single Family Residential Equivalent
Shafter	City of Shafter
SOI	Sphere of Influence
SGMA	Sustainable Groundwater Management Act
sq. ft.	square feet
SSMP	Sewer System Management Plan
SSO	Sanitary Sewer Overflow
U.S.	United States
USEPA	United States Environmental Protection Agency
VCP	Vitrified Clay Pipe
WEF	Water Environmental Federation
WWTP	Wastewater Treatment Plant

Executive Summary

This report presents an evaluation of the sanitary sewer system within the North of River Sanitary District (NORSD or District) service area that encompasses the City of Shafter, the unincorporated community of Oildale, and the northern portion of County Service Area 71 (CSA 71) which includes parts of the City of Bakersfield. The NORSD collection system drains to its Wastewater Treatment Plant (WWTP) located on Palm Avenue and Seventh Standard Road via a trunk sewer main referred to as “Outfall Sewer.” This 2022 Sewer Master Plan (Master Plan) updates the 2018 document to include a facilities condition assessment for its lift stations, force mains, and gravity sewers, updates to sewer load projections and peaking factors, land use and development changes, and hydraulic model updates derived from updated field survey and flow meter data.

This Master Plan presents the findings, conclusions, and recommendations regarding the existing and projected state of the NORSD collection system. A 10-year Capital Improvement Plan (CIP) for the District is developed based on the capacity and condition related deficiencies identified. Improvements generally consists of rehabilitation work on its existing lift stations, force mains, and capacity-related improvements to its gravity sewers.

Activities during Master Plan development included a field assessment of District lift stations by Ardurra and field data checks of sewer inverts and flow monitoring data collection by District staff. A desktop condition assessment of the District’s gravity sewers was performed based on existing pipe condition rating data developed from Closed-Circuit Television (CCTV) inspections conducted by District staff. Sewer flow projections were developed for near-term future and build out conditions using updated development plans. A hydraulic model was developed and calibrated in InfoSWMM (by Innovyze, now Autodesk) based on flow metering data and utilized to identify sewer capacity deficiencies. Projects were developed and prioritized based on the deficiencies and capital costs were prepared for a 10-year planning horizon as shown in Table ES-1.

Key Findings

The sewer capacity evaluation found that the existing system has sufficient capacity under existing and near-term future peak design flow (PDF) conditions except for the 10-inch diameter main along Lincoln Avenue and Oildale Avenue between Hurrle Ave and Decatur St. As development increases and buildout conditions are reached, further capacity-related improvements will be required. A total of thirteen capacity-related projects are proposed as shown in Figure ES-1. CIP1 is proposed for near-term future, and the remaining projects are proposed for buildout conditions. During model development and system evaluation, inconsistent inverts were found at various locations primarily due to GIS input errors and different datums used in as-builts. It is recommended that the District further review these areas and field verify if needed.

The desktop pipeline condition assessment found a high number of 8-inch vitrified clay pipes (VCP) that were built over 60 years ago to be in the Grade 5 PACP category, which means they are in very poor structural condition. These mains will need to be replaced within the next 5 to 10 years. The rest of the Grade 5 mains that were constructed in 1960 onwards are recommended to be subject to spot repairs.

The lift station and force main assessment found Lift Stations 3 and 5 to be in the best overall condition and Lift Stations 2 and 4 to be in overall fair condition. Common to all lift station sites is the need to replace gates for security, improve the grades and add crushed rock, and install flow meters. Specifically, Lift Station 1 will require site improvements that consist of upgrading to a larger gate for access and improving the driveway surface to minimize stormwater ponding. In addition, District staff currently installs and configures temporary equipment at the station premises in order to switch operations between the active and redundant force mains; therefore, installation of permanent valving and piping is required. Lift Station 2 will require rehabilitating the wet well and replacing all the corroded interior piping, valves, and supports. Lift Station 3 will require replacing all the corroded interior piping, valves, and supports as well. Lift Station 4 is being relocated in the near future and Lift Station 5 requires a compatible backup generator, which the District is currently procuring.

Manhole assessments were not performed as part of this project scope. However, as part of its asset management program, the District is performing ten manhole rehabilitation projects along its Outfall Sewer trunk lines. The District has completed two projects. Projects 3 and 4 are currently under construction. The remaining six projects are expected to be completed in the next ten years. Further, it is recommended that manhole inspections be performed prior to any main replacement work to ensure each manhole’s structural integrity in anticipation of future flows.

Recommendations

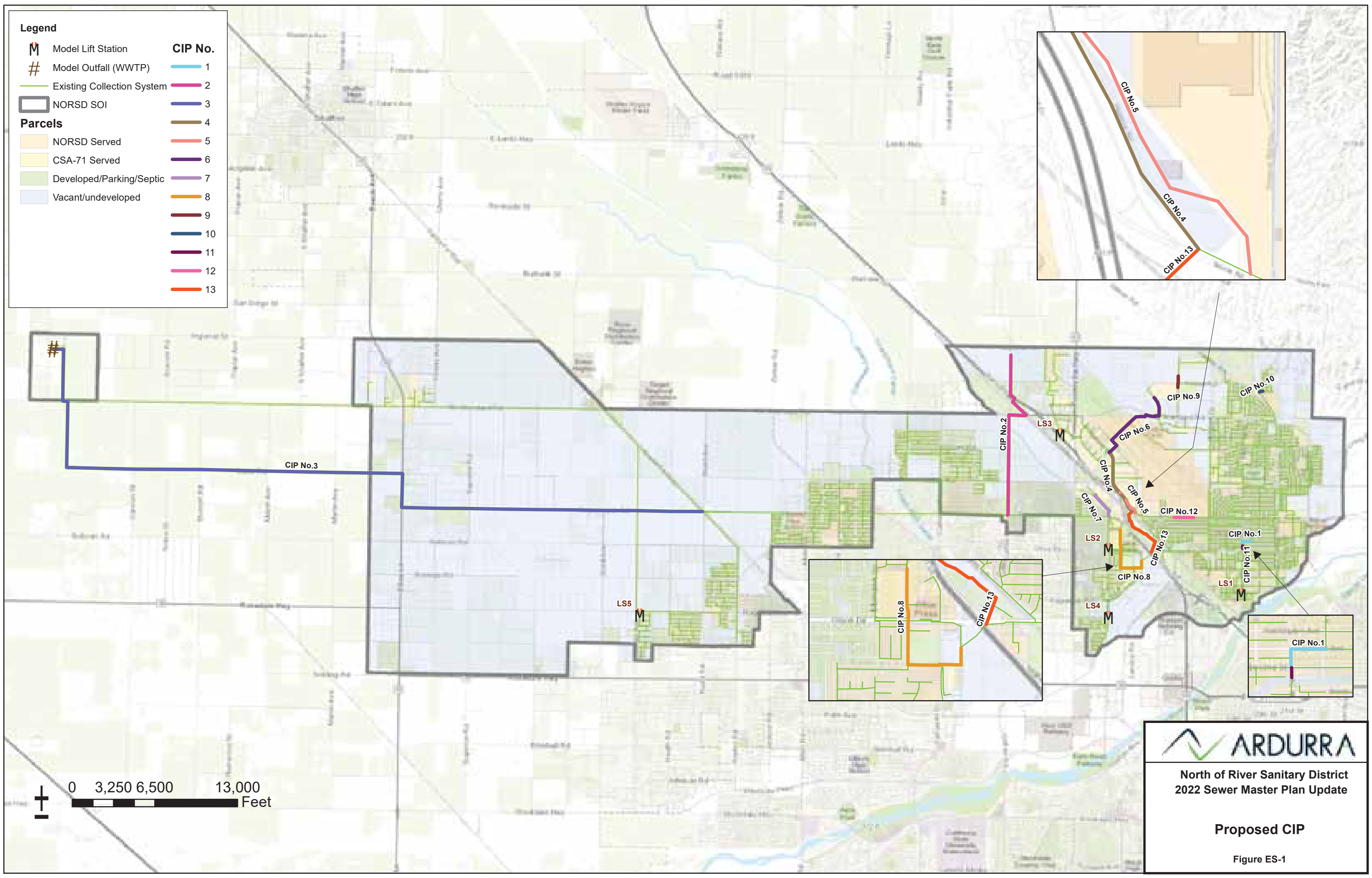
Based on the findings of this study, a recommended CIP was developed for sewer improvements in the NORSD service area. A prioritized CIP is presented in Table ES-1 for a 10-year (near-term) planning period that is phased in 5-year increments and recommended projects to be considered as the system reaches buildout (FY 2033 – 2050) conditions. All cost estimates from previous years, specifically for Lift Station 3 force main are brought to 2022 costs using ENR[1]'s cost index table as of October 2022. Cost estimates for the Wastewater Treatment Plant is from a more recent February 2023 estimation provided by Woodard & Curran. All costs are rounded to the nearest $1,000. Cost estimation details are included in Section 9.

Total CIP cost for FY 2023 – 2028, FY 2028 – 2033, and FY 2033 – 2050 are $22,035,000, $299,341,000, and $235,150,000 respectively.

[1] Engineering News Record (www.enr.com)

Table ES-1. Capital Improvement Plan

Item No.	Category	Facility	Summary Project Description	FY 2023-2028	FY 2028-2033	FY 2033 - 2050
1	Capacity-Related Improvements	Pipe	CIP1, Upsize ~ 1,020 feet of 10- to 15-inch on Lincoln Ave. & Oildale	$466,000		
2	Capacity-Related Improvements	Pipe	CIP3, Add ~ 13,028 feet of 42-inch and ~ 50,374 feet of 48-inch trunk line between Rudd Ave. and WWTP Outfall along Kratzmeyer Rd. and Snow Road; includes ~ 106 new manholes at 600-ft apart			$59,191,000
3	Capacity-Related Improvements	Pipe	CIP4 to CIP13, Upsize or install ~45,698 feet of main; no new manhole installations will be required			$16,693,000
4	Site Improvements	Lift Station (LS) 1	Rehabilitation	$554,000		
5	Site Improvements	LS 2	Rehabilitation	$498,000		
6	Site Improvements	LS 3	Improvements	$302,000		
7	Site Improvements	LS 5	Improvements	$357,000		
8	Force Main Improvements	LS 1 Force Main	Rehabilitate old force main (FM1)	$900,000		
9	Force Main Improvements	LS 1 Force Main	Replace 3,800 feet of 10-inch FM 2 in 2040			$1,482,000
10	Force Main Improvements	LS 2 Force Main	Replace ~ 1,100 feet of 10-inch PVC force main with kind along Olive Drive from Mohawk Road to Victor Street	$429,000		
11	Force Main Improvements	LS 3 Force Main	Construct force main redundancies	$858,000		
12	Force Main Improvements	LS 3 Force Main	Complete 1,900 feet of redundant 8-inch force main in 2050			$684,000
13	Force Main Improvements	LS 4 Force Main	Relocate lift station; could result in addition of redundant force main (NORSD portion is approx. 2/3 of total cost)	$3,901,000		
14	Force Main Improvements	LS 5 Force Main				
15	Condition-Related Improvements	Pipe	Remove and Replace (R/R) ~ 23,937 feet of Grade 5 PACP Pipes	$4,330,000	$4,330,000	$21,600,000
16	Condition-Related Improvements	Pipe	Spot Repair ~ 7,305 feet of Grade 5 PACP Pipes	$7,908,000	$7,908,000	$21,600,000
17	Condition-Related Improvements	Manholes	Rehabilitate Manholes along Outfall Sewer	$1,500,000	$1,500,000	
18	Other	Flow Meters	Two Permanent Installations	$32,000	$3,000	
19	WWTP Expansion	WWTP	12 MGD Expansion		$285,600,000	
20	WWTP Expansion	WWTP	18 MGD Expansion			$113,900,000
	TOTAL			**$22,035,000**	**$299,341,000**	**$235,150,000**


Legend
Model Lift Station
Model Outfall (WWTP)
Existing Collection System
NORSD SOI
Parcels
NORSD Served
CSA-71 Served
Developed/Parking/Septic
Vacant/undeveloped
CIP No.
1
2
3
4
5
6
7
8
9
10
11
12
13
CIP No.3
CIP No.2
LS3
CIP No.9
CIP No.10
CIP No.6
CIP No.4
CIP No.5
CIP No.7
CIP No.12
CIP No.1
CIP No.13
LS2
CIP No.8
CIP No.11
LS1
LS4
LS5
0 3,250 6,500 13,000
Feet
ARDURRA
North of River Sanitary District
2022 Sewer Master Plan Update
Proposed CIP
Figure ES-1

1. Introduction

This section provides an overview of the project background, purposes of this Sanitary Sewer Master Plan (Master Plan), and associated scope of work.

1.1. Background and Purpose

North of River Sanitary District (NORSD or District) was formed in 1940 as an independent Special District of the State of California to serve the unincorporated community of Oildale located north of the Kern River in Kern County. In 1990, a Joint Powers Agreement[2] (JPA) was executed by NORSD, Kern County (County Service Area 71 [CSA-71]), and the City of Shafter for NORSD to administer, operate, and maintain wastewater collection and treatment facilities within its service area. At present, the District's service area spans approximately 54 square miles and serves a total population of approximately 71,000 which includes the unincorporated Oildale area, northwest portions of the City of Bakersfield, and the City of Shafter.

Due to continued growth in its service area since the JPA, the District's collection system and wastewater treatment plant (WWTP) have undergone several improvements based on results from several sewer system master plans and studies. In 2013, a sewer master plan (SMP) completed by AECOM and a subsequent update by the same firm was completed in 2018. Both sewer system master plans recommended improvements to the WWTP and collection system to mitigate capacity limitations based on growth projections within the District's service area.

Since 2018, the District has made several advances in terms of gathering better Geographic Information System (GIS) data of its collection system, condition of its mains, and invested in more flow meters (both temporary and permanent) to provide more accurate wastewater flow measurements. This information can be used to refine flow projections and to build and calibrate a better hydraulic model to understand existing and future system capacity limitations. In addition, due to changing hydrological patterns and declining aquifer water tables[3] as well as implementation of water conservation measures in the region, wastewater generation factors used and flows projected in the previous master plans will need to be reviewed and updated, particularly for build-out. The combination of better data and changing water use patterns are the main drivers for a new master plan in 2023 that will be used to refine improvement costs related to WWTP expansion and determine project costs to mitigate capacity-deficient sewers. In addition, the 2023 Master Plan incorporates improvements recommended from lift station facilities assessments, improvements from a previous force main study performed by IEC in 2020 and results from the District's pipeline condition assessments via its asset management plan database. A capital improvement program (CIP) is developed for a 10-year (near-term) and buildout planning period.

The Sewer Capacity Fee study will be updated to estimate availability of adequate funds for capital projects developed from the 2023 Master Plan associated with future needs. The Sewer Service Charge will be updated to account for current expenses, revenues, debt service, and reserves. For the Sewer Capacity Fee and Service Charge tasks, Ardurra has sub-contracted with Bartle Wells. The CIP will differentiate which improvement provides benefits to existing customers versus future customers so as to facilitate setting defensible capacity fees and service charges.

1.2. Scope of Work

This Master Plan includes the following tasks:

- Partner with District staff to perform data review and field verifications on areas with missing/inconsistent invert data
- Clean up and update the District's sewer collection system Geographic Information System (GIS) database with available as-built drawings, inspection reports, and field verified data
- Analyze data from recent flow monitoring performed by District staff to capture the current flow characteristics for model verifications
- Update existing and future flows based on the latest flow monitoring data and land use information

[2] Refer to Page 14 JPA

[3] Section 2, North of River Sanitary District, Recycled Water Study, Provost & Pritchard Consulting Group, December 2019

- Build and calibrate an InfoSWMM-based sewer model using new field data and updated GIS network
- Review and update the District's planning criteria based on professional manual and planning criteria used by other local agencies
- Evaluate the system under various flow conditions using the updated model and identify capacity-related issues
- Estimate CIP costs in Master Plan from condition assessment studies performed by the District. Include areas of concerns like hot spots, overflows, and areas requiring odor control in Master Plan.
- Develop a prioritized and phased capital improvement projects based on condition assessment results and capacity analysis results
- Develop a 2023 Sewer Master Plan Report
- Perform Sewer Capacity Fee Study
- Develop Sewer Service Charge

1.3. Authorization

The Master Plan project was approved by the Board on June 28th, 2022. Ardurra entered into an agreement with NORSD to develop the Master Plan on June 29th, 2022.

1.4. Data Sources

This Master Plan was developed using various data and information, including but not limited to the following:

- North of River Sanitary District, Sewer Master Plan Update, AECOM, March 30, 2018 (2018 SMP)
- North of River Sanitary District No.1, Sewer Master Plan, AECOM, February 28, 2013 (2013 SMP)
- North of River Sanitary District, Sewer Force Main Study, Technical Memorandum, IEC, April 28, 2020
- North of River Sanitary District, Recycled Water Study, Provost & Pritchard Consulting Group, December 2019
- Oildale Mutual 2020 Urban Water Management Plan
- City of Bakersfield 2020 Urban Water Management Plan
- City of Shafter 2020 Urban Water Management Plan
- The Metropolitan Bakersfield General Plan
- Kern Council of Governments, Regional Growth Forecast for Kern Council of Governments Methodology and Forecasts 2020 to 2050, The California Economic Forecast, December 2019 (2020-2050 Reginal Forecast)
- Kern Council of Governments, 2022 Regional Transportation Plan/Sustainable Communities Strategy, June 2022 (2022 RTP/SCS)
- Field Trip – Lift Station Assessments, August 5th, 2022
- District Flow Metering, September 4 – September 9, 2022
- NORSD GIS layers
- NORSD Parcel and Tax Roll database
- Lift Station pump Tests, Curves, As-Builts
- NORSD Asset Management Plan database
- NORSD District No. 1 Sphere of Influence Update and Amendment, AECOM, April 2019

- District and local bid results
- Phase 1 Investigation – S. Oildale Drive Backup Force Main from Lift Station #1 to Decatur Street, Provost & Pritchard Consulting Group, September 2022

1.5. Report Organization

This Master Plan is presented with the following sections:

- Executive Summary
- Section 1 – Introduction
- Section 2 – Planning Area
- Section 3 – Existing System Description
- Section 4 – Wastewater Flow Characteristics and Projections
- Section 5 – Planning Criteria
- Section 6 – Hydraulic Model Build & Calibration
- Section 7 – Capacity Evaluation
- Section 8 – Facilities Condition Assessments
- Section 9 – Capital Improvement Program

1.6. Acknowledgments

Ardurra would like to thank District personnel Pat Ostly, Joe Ferrari, and Raymond Arredondo for their help throughout this Master Plan development.

2. Planning Area

This section provides a description of the geography, land use, and population of the NORSD service area.

2.1. Study Area

NORSD is located east of Interstate 5 (I-5) in northern Kern County, California. The NORSD sewer service area is approximately bounded by State Highway 99 to the east, Beech Avenue to the west, and Imperial Street to the north (about half a mile north of Seventh Standard Road). Its southern boundary jogs between Rosedale Highway to the west and Snow Road to the east. The District's sphere of influence (SOI) includes two large parcels located about 15 miles west of Highway 99 at approximately 640-acres each. One parcel is a dairy farm located at the intersection of Sullivan Road and Brandt Road which the District doesn't own but retains some mineral rights. the other parcel which is owned by the District is the District's Wastewater Treatment Plant (WWTP) located near the intersection of Palm Ave. and Seventh Standard Road.

The District provides wastewater collection services to the City of Shafter, the unincorporated community of Oildale, and the northern portion of County Service Area 71 (CSA-71) which includes portions of the City of Bakersfield. The District, in total, serves a population of approximately 71,000 that spans a service area of approximately 30 square miles. The District's SOI designates its probable future boundary and service area[4] and therefore dictates its current buildout boundary spanning an area of approximately 54 square miles. The study area, the District's service area boundary, adjoining municipality and agency boundaries, and SOI limits are shown in Figure 2-1.

The topography east of Hwy 99 around Oildale slopes up gently from elevations of about 400 to 500 feet above sea level (ASL) to about 730 feet ASL the northeast. The topography west of Hwy 99 is generally flatter with small changes in elevation either north to south or east to west. On average, the ground elevation west of Highway 99 to the WWTP changes east-west from about 450 feet to 300 feet ASL over a distance of approximately 15 miles from Oildale area to the plant. Table 7 (page 20) of the 2013 SMP provides more details of the ground surface slopes in the study area.

The climate is typical of the San Joaquin Valley with hot, dry summers and mild, foggy winters. Average summer temperatures[5] typically vary between 60- and 90 plus- degrees Fahrenheit (F) and often exceed 100 degrees F. Average winter temperatures vary between 40- and 60-degrees F, with night and morning ground fog and occasional frosts. Average annual total precipitation is about 6 to 7 inches, most occurring between November and April. Evapotranspiration rates[6] averages about 5 feet per year, with higher rates occurring between April and August. Average wind speeds in winter are about 4 to 6 miles per hour and slightly higher in summer at about 7 to 8 miles per hour[7]. Table 2-1 summarizes recent climate data from the California Irrigation Management Information System (CIMIS) website, which includes the range in temperatures, evapotranspiration rates and precipitation for the past year at its monitoring station in Shafter.

The four primary water purveyors that serve NORSD include Oildale Mutual Water Company, California Water Service Company, City of Bakersfield Domestic Water System, and Vaughn Water Company. Potable water supply sources within the District's service area include groundwater, surface water from Kern River, and water from the California State Water Project. The U.S. Drought Monitor (USDM) update on August 16, 2022, notes that a majority of Kern County including NORSD is within an Exceptional Drought (D4) Category, which is the most severe in rank. Due to low precipitation, groundwater table levels are below 25th percentile of normal levels[8].

As a result, inflow, and infiltration (I/I) into the sewer system from ground water and rainfall were assumed to be non-significant factors in the capacity analysis detailed in Section 4. It should also be noted that due to the water supply constraints mentioned and encouraged by the 2014 Sustainable Groundwater Management Act (SGMA) ruling, one of NORSD's future goal is to produce recycled water at its WWTP.

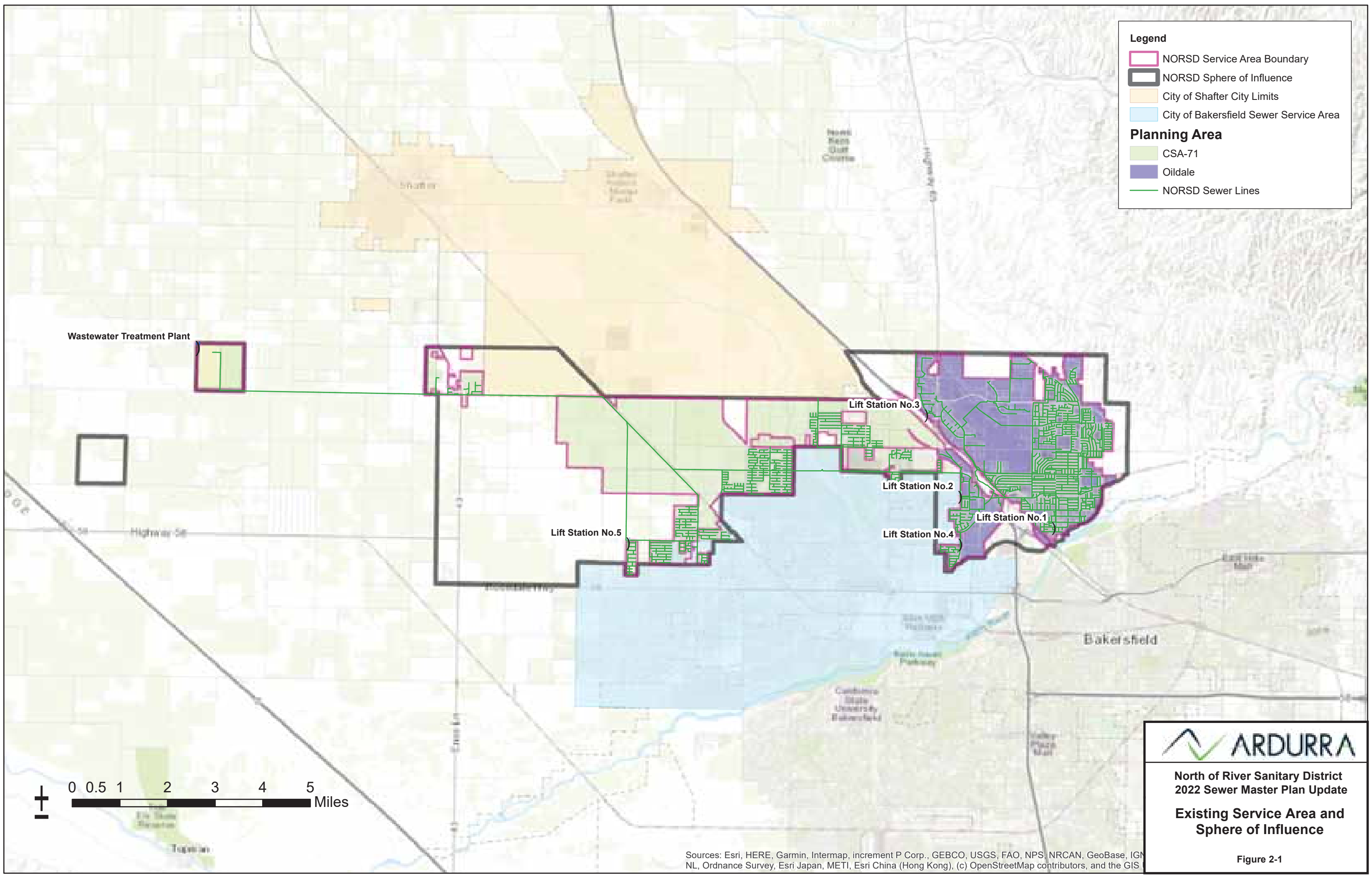
4 https://calafco.org/lafco-law/faq/what-are-sphere-influence-studies

5 Source: Western Regional Climate Center (https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca0442)

6 Source: California Irrigation Management Information System (https://cimis.water.ca.gov/Content/pdf/CimisRefEvapZones.pdf)

7 Source: https://www.ncei.noaa.gov/pub/data/ccd-data/wndspd20.dat

8 Source: California Water Watch (Statewide Hydroclimate and Water Supply Conditions Map) https://cww.water.ca.gov/maps?tab=gwLevels


Legend
NORSD Service Area Boundary
NORSD Sphere of Influence
City of Shafter City Limits
City of Bakersfield Sewer Service Area
Planning Area
CSA-71
Oildale
NORSD Sewer Lines
Wastewater Treatment Plant
Lift Station No.3
Lift Station No.2
Lift Station No.1
Lift Station No.4
Lift Station No.5
Shafter
Highway 58
Bakersfield
0 0.5 1 2 3 4 5
Miles
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN
NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS
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2022 Sewer Master Plan Update
Existing Service Area and
Sphere of Influence
Figure 2-1

Table 2-1. Climate Data

Month	Average Max. Temperature (F)	Average Min. Temperature (F)	Average Total Precipitation (in.)	Evapotranspiration Rate (in.) for Zone 15
Jan	57.4	38.5	1.04	1.24
Feb	63.6	42.1	1.16	2.24
Mar	69.0	45.4	1.12	3.72
Apr	75.7	49.7	0.67	5.70
May	84.2	56.6	0.21	7.44
Jun	92.1	63.3	0.07	8.10
Jul	98.6	69.2	0.01	8.68
Aug	96.7	67.7	0.04	7.75
Sep	91.0	63.1	0.10	5.70
Oct	80.5	54.0	0.30	4.03
Nov	67.3	44.1	0.59	2.10
Dec	57.8	38.5	0.85	1.24
ANNUAL	77.8	52.7	6.17	57.94

2.2. NORSD Service Area Population Projections

Table 2-2 and Table 2-3 contains a summary of population projections and percent growth rates calculated for Oildale, CSA-71, and the City of Shafter throughout 2050. Population by buildout is not provided as the time of buildout is unknown, but this Master Plan is aiming to proactively plan for future capacity needs and serves as a road map for the District to build necessary wastewater facilities by the time buildout is reached.

The baseline population and growth rate for the City of Shafter was determined from the Shafter's 2020 UWMP. Shafter's population[9] in 2020 was estimated to be 20,441 which includes the Southeast Shafter area also referred to as the Gossamer Grove (Gossamer) development. The growth rate projected of 2.15% for the City of Shafter was taken from its 2020 UWMP.

Based on Kern County's 2020-2050 Reginal Forecast, the average household size for SF home is approximately 3.5 since 2017. The baseline population for CSA-71 was determined from the District's Tax Roll Database. Each single family (SF) residential unit was assigned a multiplier of 1. Each SF unit was assumed to have a population of 3.5 and a total of 4,022 SF units accounted for 14,077 people. There were 7 residential areas (not units) designated as multi-family (MF) residential use in the database. The multipliers for this category ranged from 2 to 4 depending on the size of the development. A similar multiplier of 3.5 persons per unit was applied to 7 MF units totaling 56 persons. An additional 644 SF units are from Kern County. The base population of 16,387 for the CSA-71 was derived from the residential unit estimations above. The growth rate projected of 4.6% for CSA-71 were determined based on review and analysis of new service connection records from 2013 to 2021 obtained from the District's permit history database and upon discussion with District.

The Oildale Mutual Water Company (OMWC) service area population is estimated to be 36,726 in its 2020 UWMP. OMWC's area includes the Southeast Shafter or Gossamer development. To approximate the Oildale community population contributing flows to the NORSD system (Oildale – NORSD), the population from Gossamer development (since its captured in the City of Shafter population count above) and areas east and west of OMWC not contributing to the NORSD system would need to be subtracted. The 2020 Gossamer development from Table 2-4 shows approximately 790 SF units had a Certification of Occupancy[10]. From this, we can assume that these homes are habitable, and the maximum population in 2020 was approximately 2,765 using the 3.5 persons/SF unit factor. The east and west areas surrounding the Oildale community is

[9] Source: City of Shafter 2020 UWMP, Table 2.4 – Recent City/Water Service Area Population

[10] Source: City of Shafter's Community Development Department

farmland, industrial, business, and oil fields. From the Google Earth "time-lapse" feature, aerial imagery in 2020 shows about a dozen large SF residential lots north of Kern River and Panorama Park which could account for approximately 38 people. Based on these assumptions and the methodology discussed above, the Oildale – NORSD 2020 base population is estimated to be 33,919. The growth rate projected of 0.24% for Oildale was also determined based on review and analysis of new service connection records obtained from the District's permit history database and refined upon discussion with District.

Table 2-2. District Population Forecast

Year	City of Shafter	Oildale - NORSD	CSA-71	Total Estimated
Base Year - 2020	20,441	33,919	16,387	70,747
2021	20,880	34,000	17,141	72,022
2022	21,329	34,082	17,929	73,341
2023	21,788	34,164	18,754	74,706
2024	22,256	34,246	19,617	76,119
2025	22,735	34,328	20,519	77,582
2026	23,224	34,410	21,463	79,097
2027	23,723	34,493	22,450	80,666
2028	24,233	34,576	23,483	82,292
2029	24,754	34,659	24,563	83,976
2030	25,286	34,742	25,693	85,721
2031	25,830	34,825	26,875	87,530
2032	26,385	34,909	28,111	89,405
2033	26,953	34,993	29,404	91,350
2034	27,532	35,077	30,757	93,366
2035	28,124	35,161	32,172	95,457
2036	28,729	35,245	33,652	97,626
2037	29,346	35,330	35,200	99,876
2038	29,977	35,415	36,819	102,211
2039	30,622	35,500	38,512	104,634
2040	31,280	35,585	40,284	107,149
2041	31,953	35,670	42,137	109,760
2042	32,640	35,756	44,075	112,471
2043	33,341	35,842	46,103	115,286
2044	34,058	35,928	48,224	118,210
2045	34,791	36,014	50,442	121,246
2046	35,539	36,100	52,762	124,401
2047	36,303	36,187	55,189	127,679
2048	37,083	36,274	57,728	131,085
2049	37,880	36,361	60,384	134,625
2050	38,695	36,448	63,161	138,304

Table 2-3. Estimated Annual Growth Rates in Communities Served by NORSD

City of Shafter	Oildale – NORSD	CSA-71
2.15%*	0.24%	4.6%

**Note: includes the high growth rate area of Gossamer Grove*

Table 2-4. Gossamer Grove Development Occupancy Certificate

Year	Total SF Units
2016	169
2017	118
2018	188
2019	137
2020	178
2021	186
August 2022	138

Data Source: City of Shafter's Community Development Department

2.3. Land Use

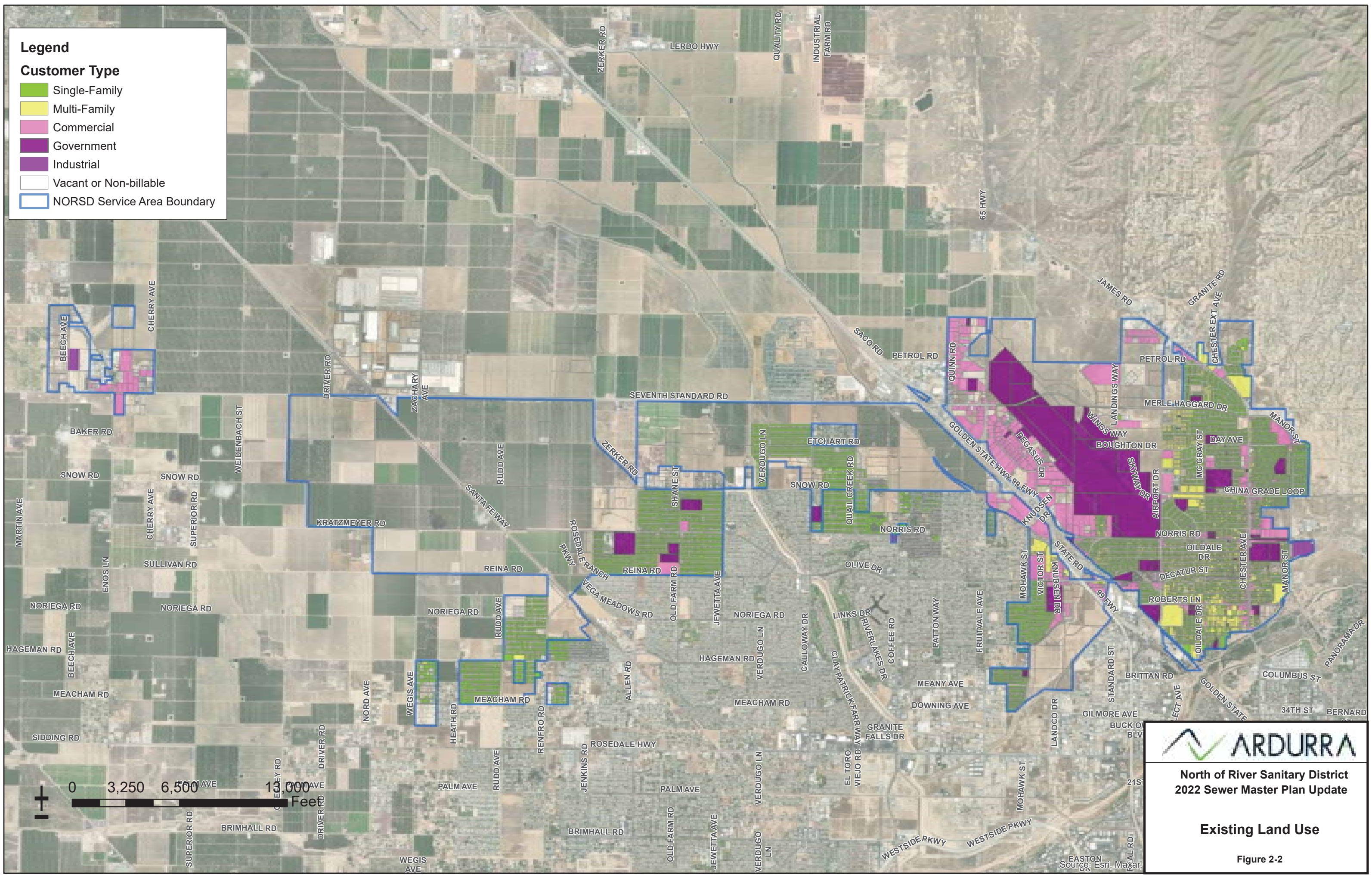
2.3.1. Existing Land Use

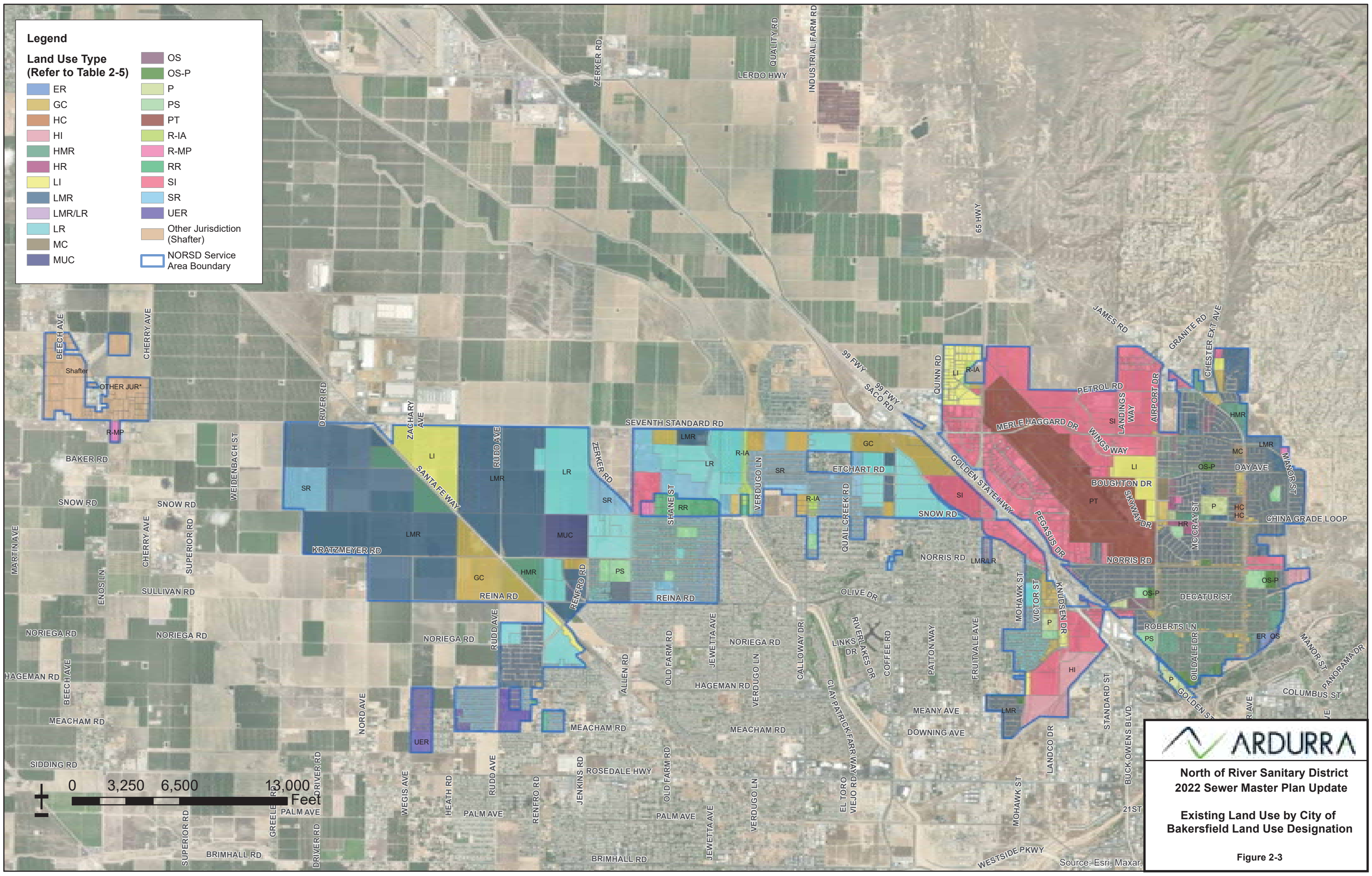
The District's annexed service area encompasses approximately 25 square miles. Approximately 39% of the service area is developed and the remaining area is vacant or undeveloped. Undeveloped parcels were determined based on the District's tax roll information, the City of Bakersfield's building footprint GIS layer, and ESRI's aerial imagery. The District categorizes its customers into five land use types which includes single-family residential, multi-family residential, commercial, government, and industrial, as shown in Figure 2-2. There are a few parcels outside of the District service boundary that are currently served by the District or discharge wastewater into the District's collection system. Approximately 69% of the Oildale area is developed while approximately 17% of the CSA-71 area is developed.

Figure 2-3 shows the District's service area by City of Bakersfield's land use designation. Table 2-5 summarizes the District's existing land use information.

Table 2-5. Existing Land Use Summary

Land Use Type	Description	CSA-71 Area				Oildale Area				Total District Service Area			
		Developed (acres)	Undeveloped (acres)	Total (acres)	% Developed	Developed (acres)	Undeveloped (acres)	Total (acres)	% Developed	Developed (acres)	Undeveloped (acres)	Total (acres)	% Developed
R-IA	RESOURCE – INTENSIVE AGRICULTURE	2.9	58.4	61.3	4.8%	0.0	11.1	11.1	0.0%	2.9	69.5	72.4	4.1%
GC	GENERAL COMMERCIAL	2.1	636.3	638.3	0.3%	202.2	39.8	242.0	83.5%	204.3	676.1	880.3	23.2%
HC	HEAVY COMMERCIAL	0.0	0.0	0.0	-	25.8	0.3	26.1	99.0%	25.8	0.3	26.1	99.0%
MC	MAJOR COMMERCIAL	0.0	0.0	0.0	-	26.7	14.9	41.6	64.2%	26.7	14.9	41.6	64.2%
MUC	MIXED USE COMMERCIAL	0.0	158.8	158.8	0.0%	0.0	0.0	0.0	-	0.0	158.8	158.8	0.0%
PT	PUBLIC TRANSPORTATION CORRIDORS	0.0	0.0	0.0	-	764.2	199.3	963.5	79.3%	764.2	199.3	963.5	79.3%
P	PUBLIC FACILITIES	0.0	0.0	0.0	-	77.9	46.5	124.4	62.6%	77.9	46.5	124.4	62.6%
HI	HEAVY INDUSTRIAL	0.0	0.0	0.0	-	24.2	169.3	193.6	12.5%	24.2	169.3	193.6	12.5%
LI	LIGHT INDUSTRIAL	0.0	316.4	316.4	0.0%	122.4	181.8	304.2	40.2%	122.4	498.2	620.5	19.7%
SI	SERVICE INDUSTRIAL	0.0	215.7	215.7	0.0%	859.9	1092.1	1952.0	44.1%	859.9	1307.8	2167.6	39.7%
OTHER JURIS	OTHER JURISDICTION	97.0	389.3	486.3	19.9%	0.0	0.0	0.0	-	97.0	389.3	486.3	19.9%
R-MP	RESOURCE – MINERALS & PETROLEUM	17.0	14.4	31.4	54.0%	4.4	10.4	14.8	29.5%	21.3	24.9	46.2	46.2%
OS-P	PARKS AND RECREATION	0.0	0.0	0.0	-	58.3	11.6	69.9	83.4%	58.3	11.6	69.9	83.4%
ER	ESTATE RESIDENTIAL	0.0	0.0	0.0	-	2.8	8.4	11.1	25.0%	2.8	8.4	11.1	25.0%
HMR	HIGH MEDIUM RESIDENTIAL	0.0	197.1	197.1	0.0%	746.5	32.6	779.0	95.8%	746.5	229.7	976.1	76.5%
HR	HIGH DENSITY RESIDENTIAL	0.0	0.0	0.0	-	74.6	0.6	75.2	99.2%	74.6	0.6	75.2	99.2%
LMR	LOW MEDIUM DENSITY RESIDENTIAL	172.7	2522.7	2695.4	6.4%	1023.8	129.5	1153.3	88.8%	1196.5	2652.2	3848.7	31.1%
LMR/LR	LOW MEDIUM DENSITY RESIDENTIAL / LOW DENSITY RESIDENTIAL	13.3	0.6	13.9	95.9%	0.0	0.0	0.0	-	13.3	0.6	13.9	95.9%
LR	LOW DENSITY RESIDENTIAL	283.0	1421.0	1703.9	16.6%	115.9	0.4	116.3	99.6%	398.8	1421.4	1820.2	21.9%
RR	RURAL RESIDENTIAL	3.8	113.8	117.6	3.2%	0.0	0.0	0.0	-	3.8	113.8	117.6	3.2%
SR	SUBURBAN RESIDENTIAL	626.4	610.3	1236.7	50.7%	41.7	3.5	45.2	92.3%	668.1	613.8	1281.9	52.1%
UER	URBAN ESTATE RESIDENTIAL	65.9	148.4	214.3	30.8%	0.0	0.0	0.0	-	65.9	148.4	214.3	30.8%
PS	PUBLIC/PRIVATE SCHOOLS	99.4	0.0	99.4	100.0%	93.1	0.0	93.1	100.0%	192.5	0.0	192.5	100.0%
OS	OPEN SPACE	0.0	0.0	0.0	-	3.0	1.8	4.7	62.4%	3.0	1.8	4.7	62.4%
Total		**1,383**	**6,803**	**8,187**	**16.9%**	**4,267**	**1,954**	**6,221**	**68.6%**	**5,651**	**8,757**	**14,408**	**39.2%**


Legend
Customer Type
Single-Family
Multi-Family
Commercial
Government
Industrial
Vacant or Non-billable
NORSD Service Area Boundary
0 3,250 6,500 13,000 Feet
ARDURRA
North of River Sanitary District
2022 Sewer Master Plan Update
Existing Land Use
Figure 2-2
Source: Esri, Maxar
LERDO HWY
ZERKER RD
QUALITY RD
INDUSTRIAL FARM RD
65 HWY
JAMES RD
GRANITE RD
CHESTER EXT AVE
SACO RD
PETROL RD
QUINN RD
LANDINGS WAY
SEVENTH STANDARD RD
MERLE HAGGARD DR
MANOR ST
DAY AVE
WINGS WAY
BOUGHTON DR
PEGASUS DR
GOLDEN STATE HWY 99 FWY
SKYWAY DR
AIRPORT DR
MC CRAY ST
CHINA GRADE LOOP
NORRIS RD
OILDALE DR
DECATUR ST
ROBERTS LN
CHESTER AVE
BEECH AVE
CHERRY AVE
DRIVER RD
ZACHARY AVE
BAKER RD
SNOW RD
WEIDENBACH ST
RUDD AVE
SANTA FE WAY
SUPERIOR RD
MARTIN AVE
KRATZMEYER RD
ENOS LN
SULLIVAN RD
REINA RD
ROSEDALE RANCH PKWY
SHANE ST
VERDUGO LN
ETCHART RD
QUAIL CREEK RD
OLIVE DR
NORIEGA RD
VEGA MEADOWS RD
OLD FARM RD
JEWETTA AVE
HAGEMAN RD
CALLOWAY DR
LINKS DR
RIVERLAKES DR
COFFEE RD
PATTON WAY
FRUITVALE AVE
MOHAWK ST
VICTOR ST
KNUDSEN DR
STATE RD
99 FWY
STANDARD ST
BRITTAN RD
COLUMBUS ST
PANORAMA DR
MEACHAM RD
WEGIS AVE
HEATH RD
RENFRO RD
NORD AVE
ALLEN RD
CLAY PATRICK FARR WAY
MEANY AVE
DOWNING AVE
GRANITE FALLS DR
LANDCO DR
GILMORE AVE
34TH ST
BERNARD
SIDDING RD
ROSEDALE HWY
JENKINS RD
EL TORO VIEJO RD
PALM AVE
BRIMHALL RD
WESTSIDE PKWY
EASTON DR



North of River Sanitary District
2022 Sewer Master Plan Update

Existing Land Use by City of Bakersfield Land Use Designation

Figure 2-3

2.3.2. Future Land Use

Future land use for the District is analyzed within the District's Sphere of Influence (SOI) for near-term future (in 10 years, or by 2032) and buildout conditions. Buildout time frame was not defined as discussed in Section 2.2. Future land use estimation is based on the *Metropolitan Bakersfield General Plan*, the recently completed *Coffee Road Interceptor Sewer Feasibility Analysis* as well as District staff input.

For near-term future condition, a list of specific developments is anticipated to be completed by near-term future with infill developments in the remaining areas proportionate to population growth. Table 2-6 summarizes the anticipated developments over the next 30 years based on input and discussion with District staff. These future developments are categorized as near-term and buildout. Figure 2-4 shows the locations of the anticipated developments.

For buildout condition, all undeveloped areas within the District's SOI are assumed to be developed, the existing developed areas and specific future developments are assumed to remain unchanged through build out. Buildout land use estimation follows the methodology used in the 2013 SMP and 2018 SMP, which assumed development densities in terms of Single-Family Residential Equivalent (SFRE) per acre for each land use type per the Metropolitan Bakersfield General Plan land use designations. Land use shapefiles were obtained from the City of Bakersfield's website. Future land use for areas north of 7th Standard Rd within the City of Shafter's jurisdiction were not analyzed due to lack of information. Assumption is made that City of Shafter would construct additional sewer to convey wastewater exceeding Shafter's existing capacity right of 3.0 MGD in the existing Outfall Sewer. Figure 2-5 shows the land use within the District's SOI per City of Bakersfield's *Metropolitan Bakersfield General Plan* land use designation. Estimation of future SFRE is further discussed in **Section 4.4 – Wastewater Flow Projection**.

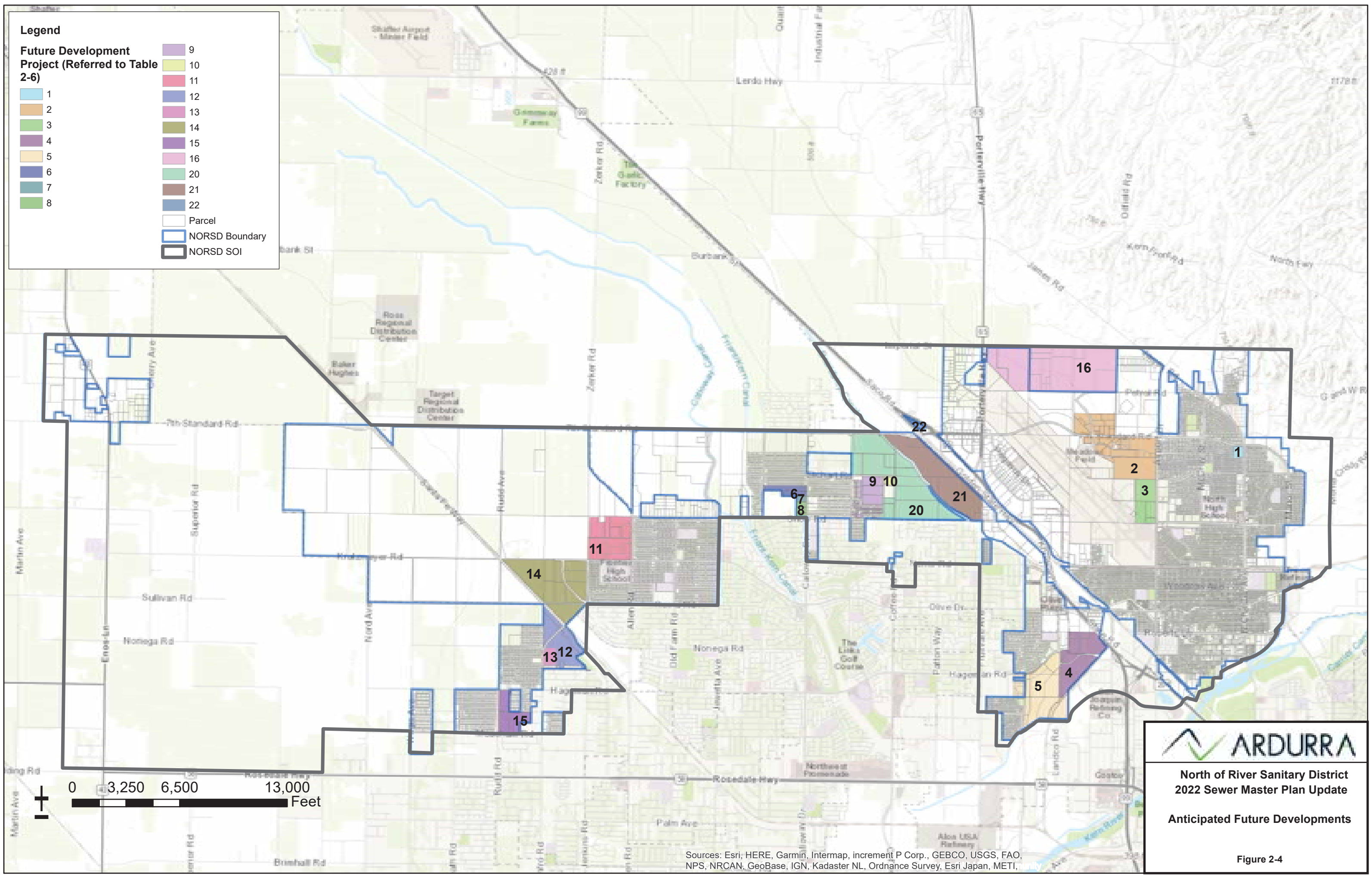
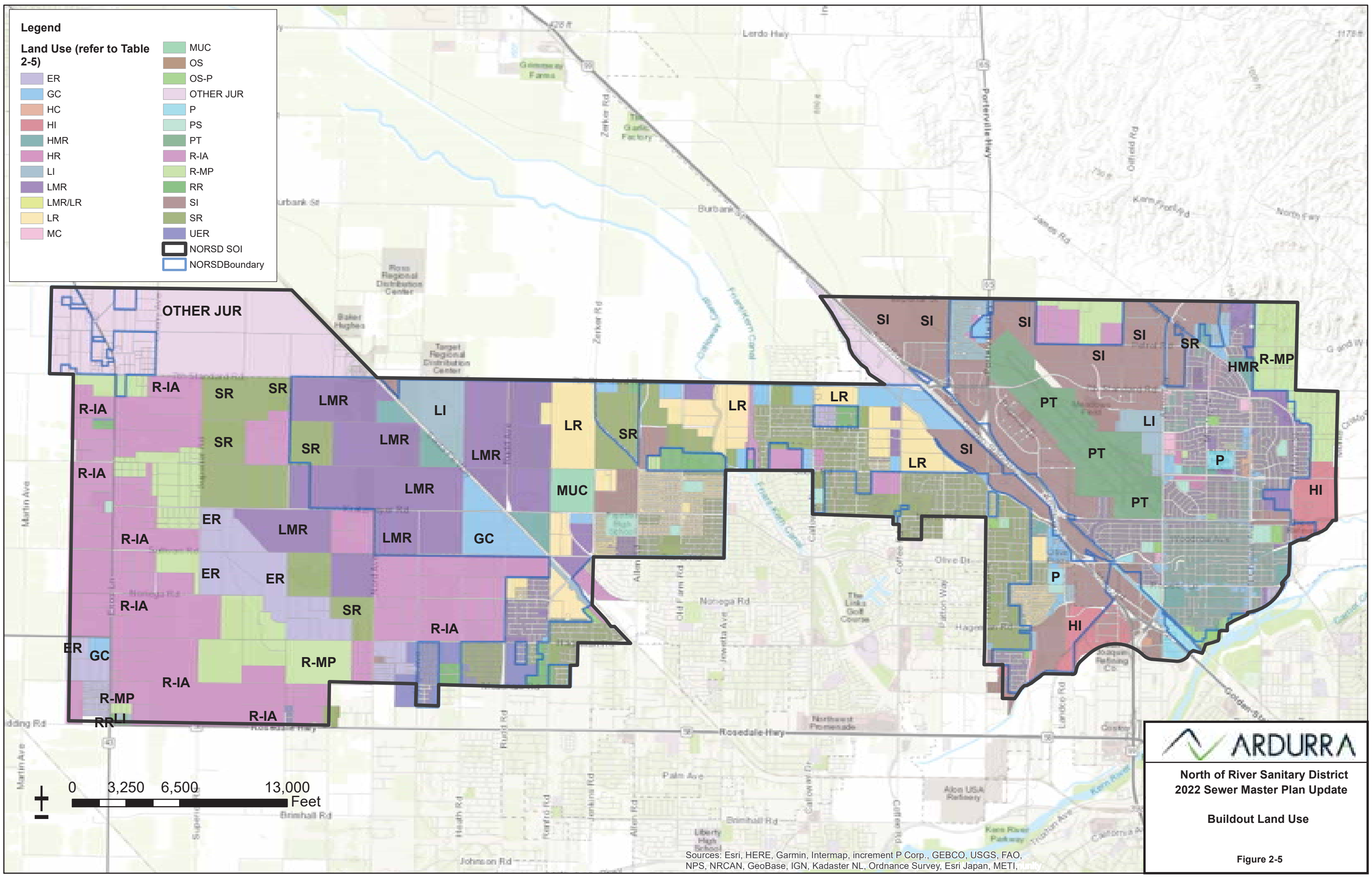

Legend
Future Development Project (Referred to Table 2-6)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
20
21
22
Parcel
NORSD Boundary
NORSD SOI
0 3,250 6,500 13,000
Feet
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
20
21
22
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI,
ARDURRA
North of River Sanitary District
2022 Sewer Master Plan Update
Anticipated Future Developments
Figure 2-4

Table 2-6. Anticipated Future Developments

Project Number	Category	Location	Single Family (acre)	Multi-Family (unit)	Multi-Family (acre)	Commercial (acre)	Industrial (acre)	Institutional (acre)	Development Timeline
1	*1 – Multifamily*	*APN 491-012-17; 3601 N. Chester Ave., Bakersfield; Oildale Area*		152					within 5 Years
2	*2A – Commercial*	*Oildale*				246			within 5 Years
3	*2B – Commercial*	*Oildale*				78			within 10 Years
4	*3A – Commercial*	*CSA-71*				138			within 5 Years
5	*3B – Commercial*	*CSA-71*				196			within 10 Years
6	*4A – School*	*CSA-71*						29	within 5 Years
7	*4B – Multifamily*	*APN 492-090-34; CSA-71*			5				within 10 Years
8	*4C – Commercial*	*CSA-71*				14			within 5 Years
9	*5A – Single Family*	*CSA-71*	79						within 5 Years
10	*5B – Multifamily*	*CSA-71*	6						within 10 Years
11	*6 – Single Family*	*CSA-71*	157						within 5 Years
12	*7A – Single Family*	*CSA-71*	104						within 10 Years
13	*7B – Single Family*	*CSA-71*	18						within 5 Years
14	*8 – Single Family*	*CSA-71*	254						within 10 Years
15	*9 – Single Family*	*CSA-71*	70						within 5 Years
16	*Subarea C*	*North of Highway 99 and south of Imperial Road*					750		Buildout
17	*Subarea D*	*To ½ mile north of Imperial Road*					890		Buildout
18	*Subarea E*	*To ½ mile north of Imperial Road (Burbank Road)*					830		Buildout
20	*Subarea A, Residential*	*South of the Beardsley/Lerdo Canal*	270						Buildout
20	*Subarea A, Commercial*	*South of the Beardsley/Lerdo Canal*				80			Buildout
21	*Subarea B 1, Industrial*	*North of the Beardsley/Lerdo Canal and south of Highway 99*					130		Buildout
21	*Subarea B 1, Commercial*	*North of the Beardsley/Lerdo Canal and south of Highway 99*				120			Buildout
22	*Subarea B 2, Industrial*	*North of the Beardsley/Lerdo Canal and south of Highway 99*					10		Buildout

Note: Projects 1 through 15 were provided by District staff and most probably developed within 5 to 10 years. Acreage for these projects were calculated from GIS. Projects 16 through 22 were obtained from the March 2019 "Final Coffee Road Interceptor Analysis" report, by AECOM.


Legend
Land Use (refer to Table 2-5)
ER
GC
HC
HI
HMR
HR
LI
LMR
LMR/LR
LR
MC
MUC
OS
OS-P
OTHER JUR
P
PS
PT
R-IA
R-MP
RR
SI
SR
UER
NORSD SOI
NORSDBoundary
OTHER JUR
R-IA
SR
LMR
LI
LR
MUC
GC
ER
R-MP
RR
SI
PT
HMR
HI
P
0 3,250 6,500 13,000 Feet
ARDURRA
North of River Sanitary District
2022 Sewer Master Plan Update
Buildout Land Use
Figure 2-5
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI,

3. Existing Sewer System Description

The District's sewer collection system was constructed in the early 1940's to serve the present-day Oildale community, north of Kern River. As the original treatment plant outgrew its capacity to serve developing communities in the surrounding area, a Joint Powers Agreement (JPA) was executed in 1990 by NORSD, CSA-71, and the City of Shafter to construct a new wastewater treatment plant (WWTP). The trunk sewer line that ranges in size from 33- to 54-inches in diameter was constructed from the original plant to the current WWTP and is commonly referred to as the "Outfall Sewer". In 2022, the District's collection system includes approximately 191 miles of gravity sewers ranging from 6-inch to 54-inch in diameter, five lift stations with two to three pumps each, about 2.4 miles of force mains ranging from 4-inch to 10-inch in diameter, and one wastewater treatment plant (WWTP). Collector sewers convey flows from Oildale, Shafter and CSA-71 communities to the Outfall Sewer which gravity flows into the District's WWTP near the intersection of Palm Avenue and Seventh Standard Road. The existing plant's wastewater treatment capacity is 7.5 million gallons per day (MGD). The plant undergoes an "undisinfected secondary" treatment process and effluent is discharged into nearby storage ponds. The WWTP is monitored via a Supervisory Control and Data Acquisition (SCADA) System. Figure 3-1 shows the District's existing collection system layout.

3.1.1. Service Areas

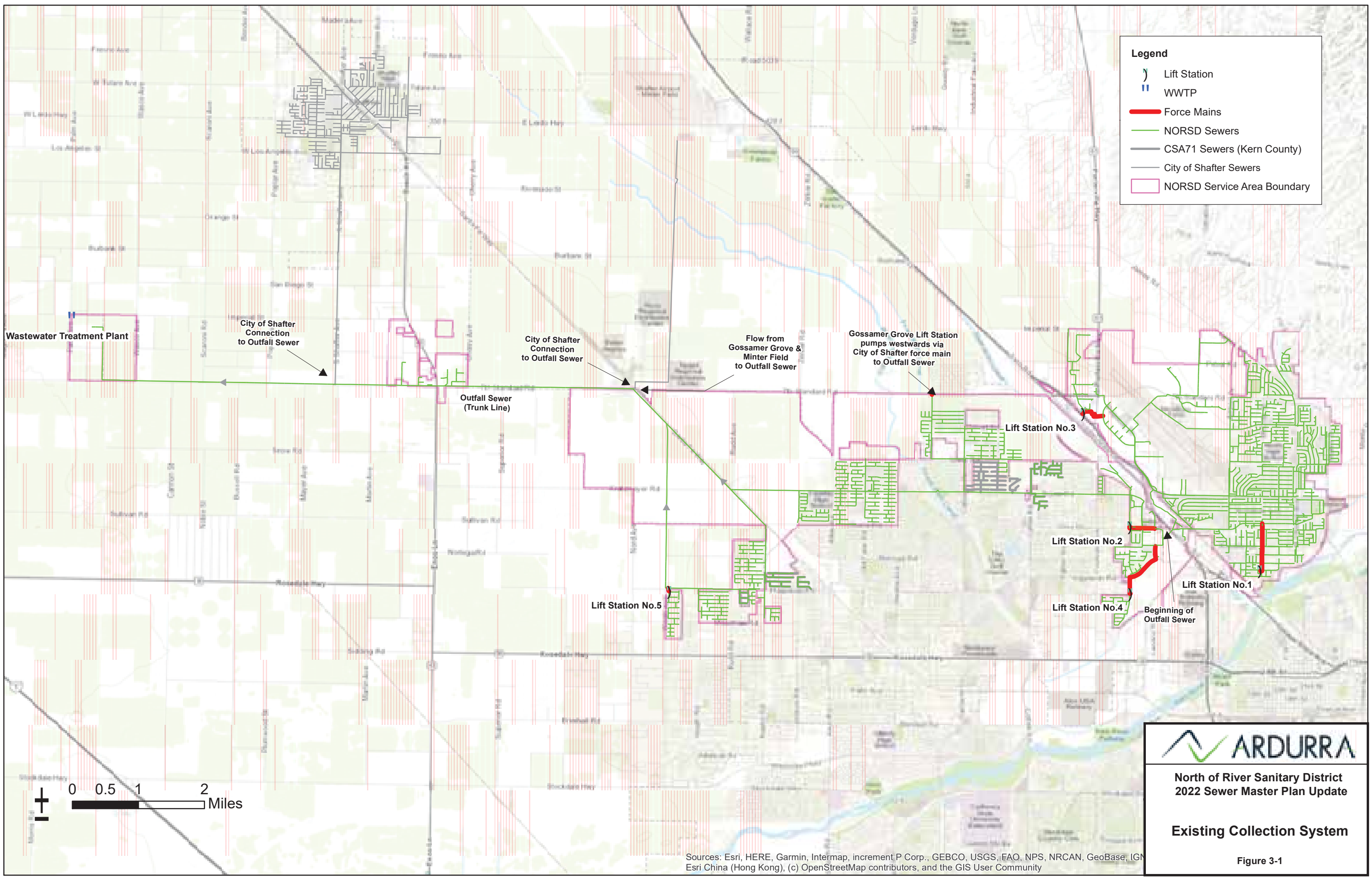
As mentioned, the three communities that discharge into the District's collection system are CSA-71, Oildale area, and the City of Shafter. The City of Shafter connects to the Outfall Sewer at Shafter Avenue and at Santa Fe Way along 7th Standard Road. Flows from Gossamer Grove area and Minter Field enter the Outfall Sewer at the Santa Fe Way connection. The connecting sewers are owned and maintained by the City of Shafter. Flow from the Oildale community west of Highway 99 are discharged into the 33-inch Vitrified Clay Pipe (VCP) pipe underneath Highway 99 near Olive Drive and State Road gravitationally. Flows from area south of the Beardsley Canal and area north of intersection of Highway 99 and Highway 65 are pumped by Lift Station 1 and Lift Station 3, respectively. Flows from these two pump stations consequently converge into the 33-inch pipe underneath Highway 99 near Olive Drive and State Road. This 33-inch line is the beginning of the Outfall Sewer trunk line. East of Highway 99, gravity flows into Lift Stations 2 and 4 are pumped north towards a 33-inch trunk line south of Olive Road near Knudsen Dr. The CSA-71 service area includes the rest of the customers in the NORSD service area.

3.1.2. Trunk and Gravity Sewers

Table 3-1 shows the gravity sewers by material and size. About 67% of the sewers in the District are 8-inch in diameter and about half of these are of VCP type. The Outfall Sewer which is a trunk main, constitutes pipes between 33- and 54-inches, most of which are made of High Density Polyethylene (HDPE) material.

Table 3-1. Gravity Sewers by Material and Size

Diameter	Pipe Lengths (ft) by Material					Total Length (ft)	Percentage (%)
	CI	DI	HDPE	PVC	VCP		
6				64	18,524	18,588	2%
8	102			325,707	324,529	650,338	67%
10				19,653	50,629	70,282	7%
12	425			19,506	25,724	45,655	5%
14		910				910	0%
15				21,479	22,850	44,329	5%
18			2,624	2,672	5,274	10,570	1%
21				7,801		7,801	1%
24				2,676	12,972	15,648	2%
27				7,768		7,768	1%
30				5,192		5,192	1%
33			14,420		2,316	16,737	2%
36			21,695			21,695	2%
42			23,806			23,806	2%
48			13,631			13,631	1%
54			23,781			23,781	2%
Total	**527**	**910**	**99,956**	**412,518**	**462,819**	**976,730**	**100%**



Legend
Lift Station
WWTP
Force Mains
NORSD Sewers
CSA71 Sewers (Kern County)
City of Shafter Sewers
NORSD Service Area Boundary
Wastewater Treatment Plant
City of Shafter Connection to Outfall Sewer
City of Shafter Connection to Outfall Sewer
Flow from Gossamer Grove & Minter Field to Outfall Sewer
Gossamer Grove Lift Station pumps westwards via City of Shafter force main to Outfall Sewer
Outfall Sewer (Trunk Line)
Lift Station No.3
Lift Station No.2
Lift Station No.1
Lift Station No.4
Beginning of Outfall Sewer
Lift Station No.5
0 0.5 1 2
Miles
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN
Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
ARDURRA
North of River Sanitary District
2022 Sewer Master Plan Update
Existing Collection System
Figure 3-1

3.1.3. Lift Stations

The District owns and operates five sewer lift stations with two to three pumps at each station. Lift Stations (LS) 1 and 3 are located in the Oildale area. LS 2 and 4 are located west of Highway 99 along Mohawk Street. LS 5 is the newest station and located in the Rosedale area towards the west end of the system. LS 1 is the only station with an on-site emergency generator. All stations except LS 2 have a connection for a portable emergency generator and a bypass pump. Table 3-2 summarizes the pump and wet well information of the lift stations.

Table 3-2. Lift Station and Wet Well Summary Description

Lift Station (LS)	Year Installed/ Rehabilitated	Location	No. of Pumps	Pump Capacities (gpm)	Wet Well Invert Elevation (ft) | Maximum Depth (ft)
LS 1	1955/ 2016	Southwest corner of S. Oildale Drive & Huskey Drive	3 (2 speed)	850/1200; 850/1200; 850/1200	390.68 | 18.57
LS 2	1971/ 1978	Northeast corner of Olive Drive & Mohawk Street	2	810; 810	405.96 | 23.05
LS 3	2000/NA	Spectrum Parkway (in easement of Barry's RV Outlet Property)	2	300; 300	441 | 15.5
LS 4	2000/NA	Northeast of intersection of Mohawk Street & Krebs Road	3	990; 990; 600	377.7 | 32.8
LS 5	2016/NA	Northwest of Northfield Way and Stonewick Drive	2	480; 480	316.77 | 20.97

3.1.4. Force Mains

The system consists of approximately 2.4 miles of force mains ranging from 4-inch to 10-inch in diameter. Table 3-3 summarizes the force main information. LS 1 has two 10-inch force mains; one for pumping from the lift station to manhole MH 3276 just north of the Beardsley Canal (FM2) and the other, a much older one (FM1), pumps to DMH-846 in Decatur St. and is used for emergency backup purposes with the bypass pump.

Table 3-3. Lift Station Force Main Summary Description

Lift Station (LS)	Year Installed	Diameter	Material	Length (ft)
LS 1	2016 (FM2)	10-inch	Ductile Iron (DI)	3,750
LS 1	1940/1950 (FM1)	10-inch	Cast Iron (CI)	3,800
LS 2	1971	10-inch	Polyvinyl Chloride (PVC)	2,100
LS 3	2000	8-inch	PVC	2,200
LS 4	2000	10-inch	PVC	4,300
LS 5	2016	4-inch	PVC	255

3.1.5. Wastewater Treatment Plant

The NORSD wastewater treatment plant (WWTP) is located near the intersection of Palm Avenue and Seventh Standard Road, approximately 15 miles west of Highway 99. The current plant has a treatment capacity of 7.5 MGD. A review of recent plant data from 2020 through August 2022 shows that average monthly flow between 5.4 and 5.9 MGD. The plant utilizes an undisinfected secondary treatment process whereby wastewater is oxidized and until sufficient organic matter is removed to enable effluent usage for surface irrigation of limited crops. Plant effluent is currently discharged into four unlined effluent storage ponds. Water is pumped to irrigate feed and fodder crops (alfalfa, wheat, corn), with some minor losses due to evaporation and percolation into the groundwater. With the passage of California’s Sustainable Groundwater Management Act in 2014 (SGMA), NORSD recognized the potential increase in value of the treated effluent for higher reuse quantities and contracted with Provost and Pritchard (P & P) to conduct a study in 2019. The 2019 P & P Recycled Water Study recommends that the District explore local partnerships for recycled water use and apply for State grant funding for plant upgrades to meet the required effluent standards. A WWTP-specific master planning effort is currently being conducted by another consultant; therefore, will not be evaluated for capital improvements in this sewer system master plan but is included as part of capital budgeting in Section 9.

3.1.6. Operation and Maintenance

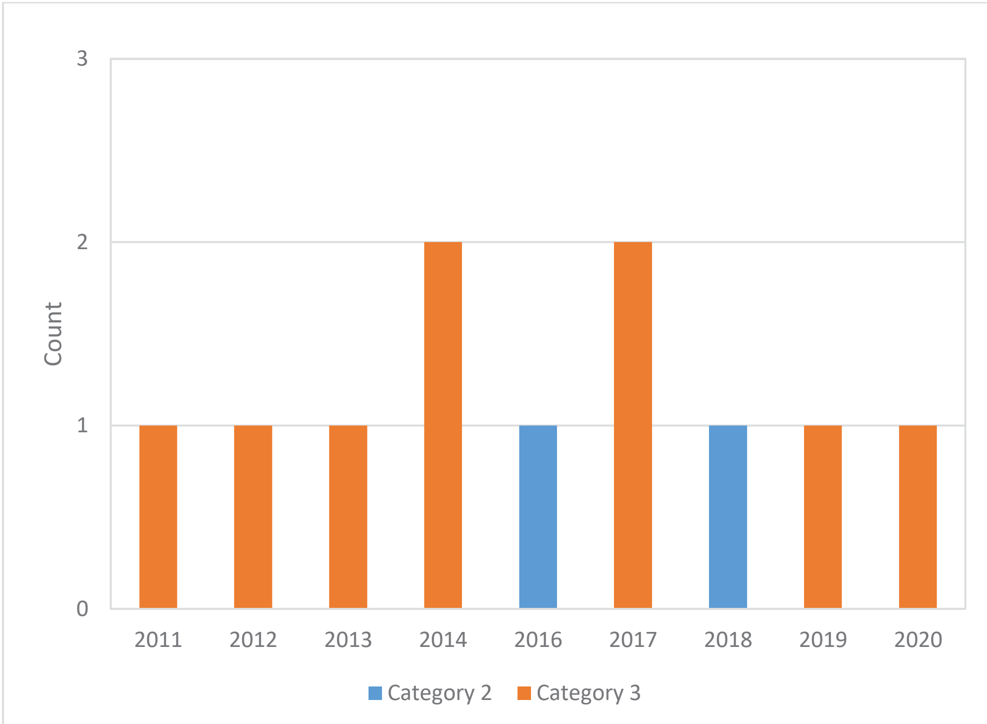
The District’s 2015 Sewer System Management Plan (SSMP) details the District’s asset management program (AMP) which includes its sewer system operation and maintenance (O&M) efforts. The program is managed by District staff via a GIS-based system that is used to track inspection observations, assign work orders, and schedule maintenance activities by staff and contractors. An outside GIS vendor periodically updates the mapping components (e.g., pipes, valves, manholes, lift stations, interagency connections, boundary data, etc.) and associated attributes to the asset management database.

The District performs routine inspections of its collection systems facilities which includes, but not limited to, manholes, lift stations, force mains, and Closed-Circuit Television (CCTV) camera inspections of its sewer mains. Known problem areas in the collection system are logged in the AMP system and categorized into frequency of cleaning such as bi-weekly, monthly, quarterly, semi-annually, and annually. Routine main flushing also includes areas requiring frequent cleaning or referred to as “hot spot” areas of the system. Maintenance activities at lift stations include weekly visual inspections and valve exercising, monthly valve cleaning, FOG removal, annual backflow prevention inspections, annual inspection of submersible pumps, maintenance of spare pumps, etc. Work orders are generated and archived in the AMP system and are associated with specific sewer system assets.

Using the information derived from the AMP system, the District has developed a rehabilitation and replacement plan to identify and prioritize collection system deficiencies and implement short-term and long-term rehabilitation actions to address each deficiency. For example, CCTV inspections that are performed by staff on a weekly basis are coded in accordance with NASSCO’s Pipeline Assessment & Certification Program (PACP). Based on the observations, the asset is assigned a grade of 0 to 5. The higher grade indicates a further state of degradation. Assets graded 5 are placed on a rehabilitation list typically for replacement or spot repair. All other grades are monitored and reviewed for further degradation.

Figure 3-2 shows SSO occurrences in the District system between 2011 and 2020 by Category per the State Water Resource Control Board SSO reporting website. Most events fall under Category 3 which are minor spills that were less than 1,000 gallons and did not reach any surface water. Most SSO events occurred in the Oildale area with the exception of three events that occurred at LS 1 and 4 force mains. According to the District, none of these events were due to main capacity-related deficiencies. The District also has several manholes installed with SmartCover© monitoring devices, five are located in the collection system and one is located within the WWTP. These devices provide remote monitoring and alarming capabilities when flows reach restricted levels in a manhole and helps staff with early detections of SSOs in the District collection system.

Figure 3-2. Existing Sanitary Sewer Overflows by Spill Category



Source: State Water Resources Control Board SSO Reporting website
(https://www.waterboards.ca.gov/water_issues/programs/sso/docs/index.php)

4. Wastewater Flow Characteristics and Projections

This section discusses the District's wastewater flow characteristics under existing conditions as well as wastewater flow projections under near-term future, and buildout conditions.

4.1. Wastewater Flow Component

Below are brief descriptions of wastewater flow components used in this Master Plan.

4.1.1. Average Dry Weather Flow

The Average Dry Weather Flow (ADWF) includes base wastewater flow (BWF) and groundwater infiltration (GWI). BWF is domestic (or sanitary) wastewater flow from residential, commercial, institutional, and industrial wastewater. GWI is defined as groundwater entering the collection system through pipe joints and manhole walls due to structural defects or improper construction.

4.1.2. Peak Dry Weather Flow

Domestic sewer flows vary throughout the day due to different customer water use patterns. Peak Dry Weather Flow (PDWF) is the highest hourly peak flow during dry period and is determined by multiplying a peaking factor to the ADWF.

4.1.3. Peak Wet Weather Flow

Peak Wet Weather Flow (PWWF) is the highest hourly flow during a significant rain event and is estimated as Peak Dry Weather Flow (PDWF) plus Peak Rainfall Dependent Infiltration/Inflow (RDII). Typically, peak RDII was derived from flow monitoring data collected for wet weather events. However, flow monitoring data for wet weather condition was not available during this master plan, so PWWF cannot be determined.

4.1.4. Peak Design Flow

Due to the absence of flow data to study system response during a wet weather condition, Peak Design Flow (PDF) is used instead, for system capacity evaluation in this Master Plan. PDF is determined based on peak daily flow data recorded at the treatment plant over the past five years as well as peaking factors used by neighboring agencies. More information is provided in the following section.

4.2. Flow Monitoring Study

Flow data from various sources were used to characterize the District's wastewater. A few permanent meters were installed to record treatment plant influent and wastewater discharged from the City of Shafter. Flow data was collected from permanent meters installed at the discharge side of the influent pump station at the WWTP, at the City of Shafter's interceptor connection at Shafter Avenue (Shafter Ave Interceptor), at the pump discharge of the Gossamer Grove Pump Station, and at the City of Shafter's interceptor connection capturing flows from the Minter Field Airport area (Minter Field Interceptor). In addition, Wonderful Industrial Park within the City of Shafter also discharges wastewater into the District's collection system, but it is unmetered. Wastewater from Gossamer Grove Pump Station, Minter Field Interceptor, and Wonderful Industrial Park are discharged into District's 42-inch trunk line (Outfall Sewer) at intersection of Santa Fe Way and Seventh Standard Road (MH-2631).

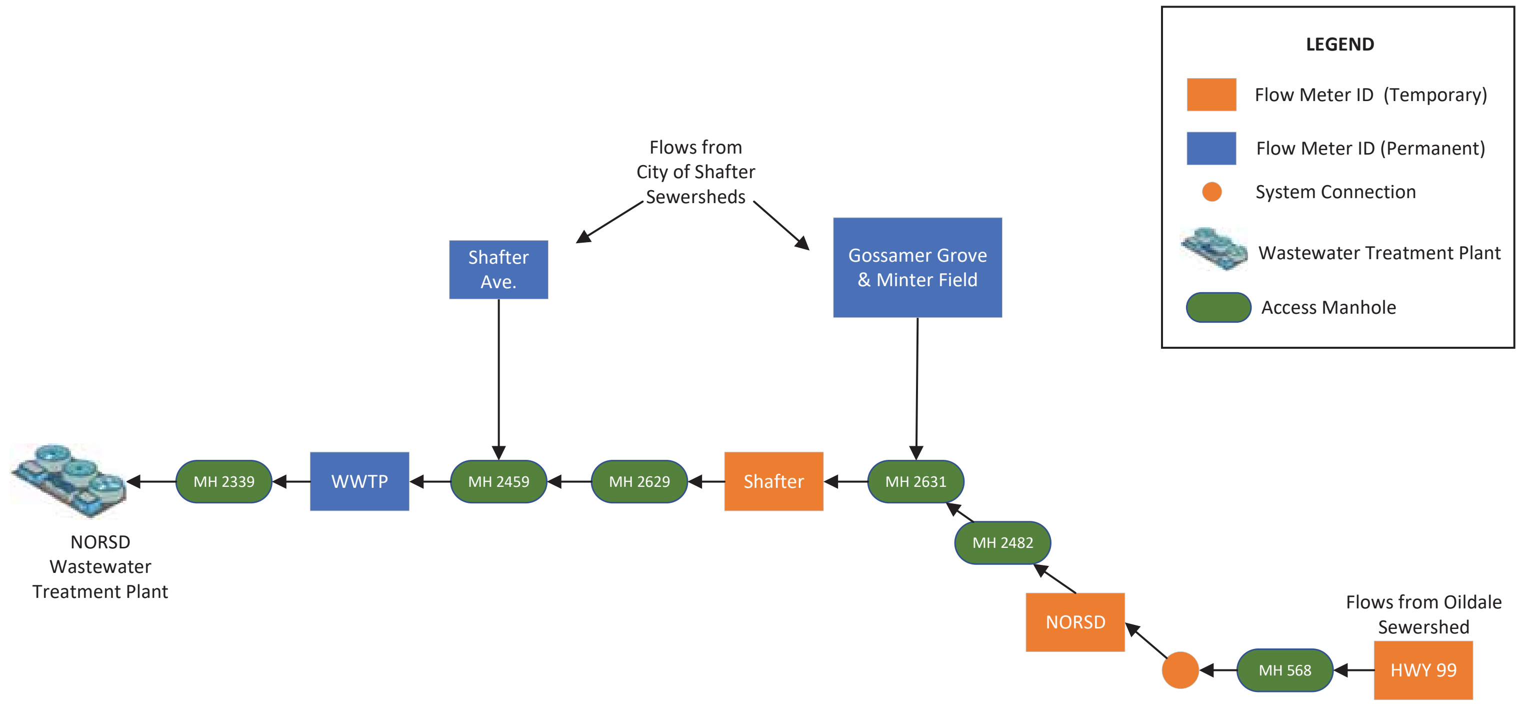
The District recently installed a permanent meter upstream of the WWTP to capture plant influent flow quantities and patterns more accurately. As part of this Master Plan, a flow monitoring study was conducted by District staff between September 4 and September 9, 2022, for the purposes of model calibration and developing sewer generation factors. Data from three temporary flow meters and four permanent meters were analyzed as shown in the flow schematic in Figure 4-1. Figure 4-2 shows the locations of these meters.

4.2.1. Flow Monitoring Sites

The location, description, and type of data collected at each flow metering site is shown in Table 4-1.

Table 4-1. Flow Meter Locations

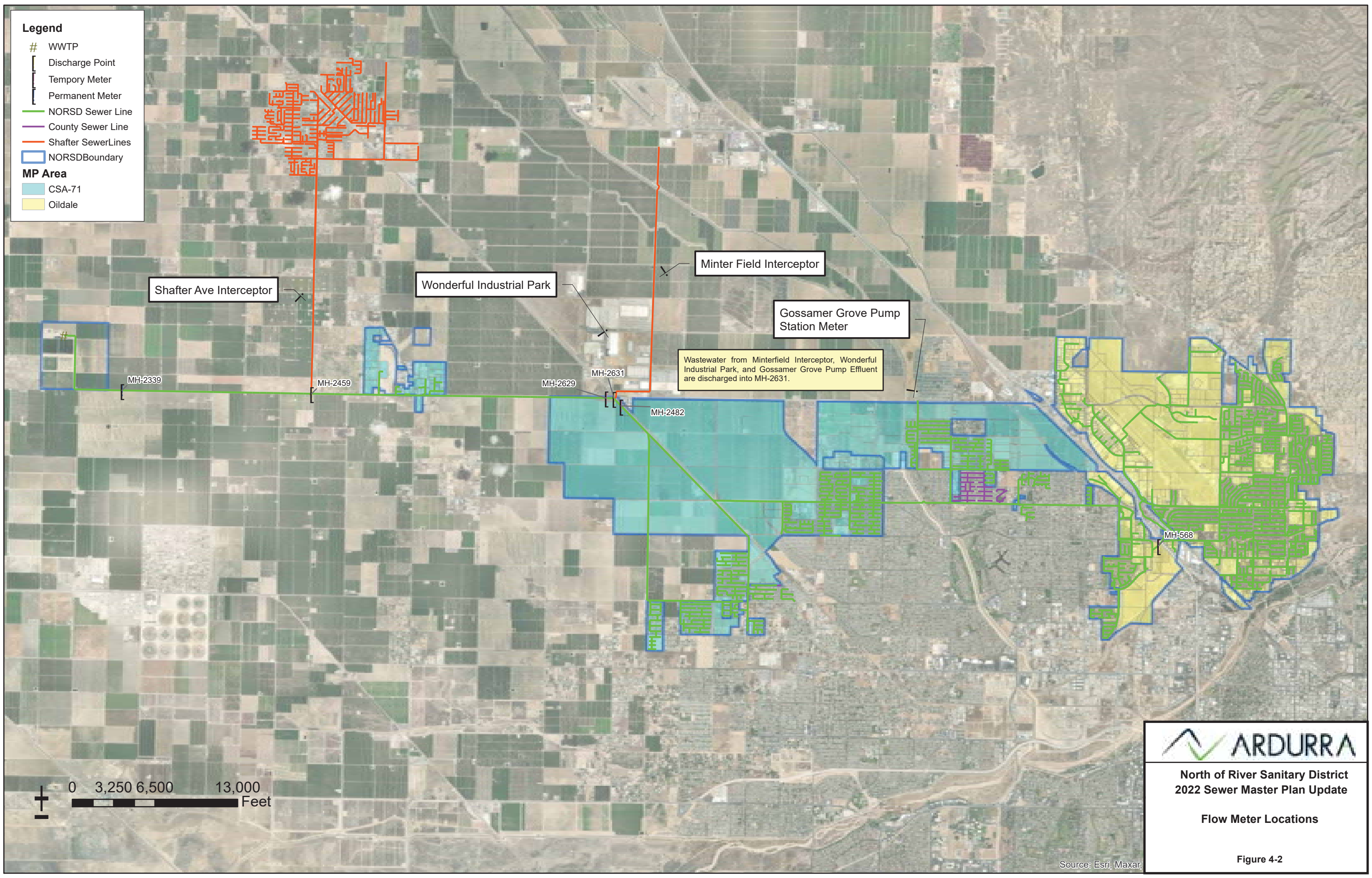
Monitor ID	Access Manhole ID	Flow Meter Location	Monitored Pipe Diameter (in.)	Notes
NORSD	MH-2482	Upstream inlet to manhole; along Santa Fe Highway	42	5-min interval flows; Submersible probes; Meter captures flow, velocity, head; Temporary Meter
Shafter	MH-2629	Upstream inlet to manhole; adjacent to 4430 Bowles St., Shafter, CA along Seventh Standard Rd.	42	5-min interval flows; Submersible probes; Meter captures flow, velocity, head; Temporary Meter
Hwy 99	MH-568	Upstream Inlet to manhole	33	5-min interval flows; Meter captures flow, velocity, head, area; Temporary Meter
WWTP	MH-2339	Upstream of MH Inlet	54	15-min interval flows; Raven-Eye installed by District; Permanent Meter
Shafter Avenue	MH-2459	Shafter Avenue	unavailable	10-sec interval flows from District SCADA; Permanent Meter
Gossamer Grove	Gossamer Grove Pump Station	Effluent side of Gossamer Grove Pump Station, discharge to MH-2629.	Unavailable	10-sec interval flows from District SCADA; Permanent Meter
Minter Field	Minter Field Trunk Line	Minter Field Airport	unavailable	Daily flows; Permanent Meter



ARDURRA

North of River Sanitary District
Sewer Master Plan

Flow Monitoring Schematic
Figure 4-1



Legend
WWTP
Discharge Point
Tempory Meter
Permanent Meter
NORSD Sewer Line
County Sewer Line
Shafter SewerLines
NORSDBoundary
MP Area
CSA-71
Oildale
Shafter Ave Interceptor
Wonderful Industrial Park
Minter Field Interceptor
Gossamer Grove Pump Station Meter
Wastewater from Minterfield Interceptor, Wonderful Industrial Park, and Gossamer Grove Pump Effluent are discharged into MH-2631.
MH-2339
MH-2459
MH-2629
MH-2631
MH-2482
MH-568
0 3,250 6,500 13,000
Feet
Source: Esri, Maxar
ARDURRA
North of River Sanitary District
2022 Sewer Master Plan Update
Flow Meter Locations
Figure 4-2

4.2.2. Flow Monitoring Results

Flow monitoring data collected from the temporary meters and permanent meters was evaluated to determine the ADWF, PDWF, PDF, as well as sewer generation factor for the District. Due to flow meter calibration issues and mass balance inaccuracies, meter data at MH-2482 and MH-2629 was omitted, and flow data between 9/6/2022 and 9/9/2022 was used for model calibration.

4.2.2.1. Dry Weather Flow Data

Table 4-2 summarizes the observed ADWF and PDWF from different sources of flow data. To be consistent, flow data between 9/6/2022 and 9/9/2022 from the temporary meters and the permanent meters were used for the analysis.

Table 4-2. Dry Weather Data Summary Table

FM Site	Monitored Pipe Diameter (in.)	Observed ADWF (mgd)	Observed PDWF (mgd)	Observed PDWF Factor
HWY99 (MH-548)	33	2.680	3.70	1.38
NOR_WWTP (MH-2339)	42	5.497	7.07	1.29
Gossamer Grove	-	0.045	0.11	2.44
Minter Field	-	0.012	-	-
Shafter Ave	-	1.284	2.00	1.56
Wonderful Industrial Park	-	0.020*	-	-

* Wastewater from Wonderful Industrial Park is unmetered, and the flow rate is estimated by the number of employees of all businesses located in the industrial park.

4.2.2.1. Historical Plant Influent

Due to time constraints, the flow monitoring study was conducted for a short period (less than a week) which cannot capture flow characteristics during weekends and wet weather condition. Flow data at the discharge side of the influent pump station at the WWTP was utilized to check the historical plant influent flows. Table 4-3 summarizes the historical plant influent for the past 5 years.

Table 4-3. Historical Plant Influent

	Influent Flow		Shafter Ave		Gossamer Grove	
Year	Average Daily Influent Flow (mgd)	Max. Daily Influent Flow (mgd)	Average Shafter Ave Flow (mgd)	Max. Shafter Ave Daily Flow (mgd)	Average Gossamer Grove Flow (mgd)	Max. Gossamer Grove Daily Flow (mgd)
2017	5.44	6.44	1.40	1.80	unavailable	unavailable
2018	5.59	6.74	1.29	1.67	0.05	0.11
2019	5.64	7.57	1.34	1.85	0.05	0.16
2020	5.77	7.61	1.35	1.88	0.08	0.27
2021	5.78	6.52	1.33	1.54	0.10	0.16
Average	**5.64**	**6.98**	**1.34**	**1.75**	**0.07**	**0.17**

The average daily flow for the past 5 years (2017-2021) based on the plant influent data is estimated to be **5.64 mgd**, **1.34 mgd**, **0.07 mgd** for plant influent, Shafter Ave Trunk Line, and Gossamer Grove Pump Effluent, respectively, and are used as existing ADWF for this Master Plan.

4.2.2.2. Peak Design Flow

Due to the absence of wet weather flow data, Peak Design Flow (PDF) was established to evaluate system capacity. As shown in Table 4-3, the maximum daily influent flow observed from the past 5 years is 7.61 mgd, which occurred on 4/8/2020. It was within the region's typical wet season from October to May.[11] Based on the historical precipitation data at the Meadows Field Station from Weather Underground[12], there was a rain event between 4/5/2020 and 4/10/2020 with the highest daily precipitation of 0.91 inch occurred on 4/8/2020. Since more granular data is not available for flow data and precipitation data, the system's RDII response to rain events cannot be determined.

The historical maximum daily influent flow is approximately 1.36 times the existing ADWF. This factor applies to the observed PDWF factor at the HWY99 (MH-548) Meter resulting in a peaking factor of 1.88. To evaluate the capacity of the existing collection system, a peaking factor of **2** is used in this Master Plan. This is also a peaking factor that is used by various neighboring agencies as shown in Appendix A – Design Criteria. Existing gravity mains were evaluated against the "trigger" depth over diameter (d/D) ratios of 0.70 and 0.85 depending on sizes, which are further discussed in Section 6. Remaining capacity in the pipe is reserved for additional wet weather flows.

Additional flow monitoring study is recommended for the District for future update of the Master Plan or hydraulic model. The flow monitoring study is recommended to capture flow data during significant rain events with longer monitoring period, which can be used to study the District's collection system responses during wet weather events and update the peaking factor to account for PWWF if needed.

4.3. Wastewater Generation Factors

The District's sewer connection fees and sewer service charges are calculated based on Single Family Residential Equivalents (SFRE). Numbers of current SFRE are determined based on the following criteria provided by the District:

- Single family residential: 1 unit = 1 SFRE
- Multi-family residential: 1st unit = 1 SFRE, remaining units = 72% of SFRE
- Commercial: Sewer Service Charge (SSC) Multiplier times 0.21 to determine number of SFRE
- Government and Industrial: determine number of SFRE based on the number of SFRE from provided invoices

The District's service area can be divided into two parts: Oildale and CSA-71. The District's collection system collects wastewater from Oildale and CSA-71 areas plus wastewater from City of Shafter. HWY99 Meter (MH-548) captures wastewater from the majority of Oildale area, and the observed ADWF is 2.68 mgd as shown in Table 4-2. Based on the flow data listed in Table 4-2, ADWF from CSA-71 area and a small portion of Oildale area as shown in Figure 4-2 can be calculated by subtracting the ADWFs of HWY99, Gossamer Grove, Minter Field, and Shafter Ave Sites from the NOR_WWTP site, and is determined to be 1.48 mgd. Calculated gallons per day per SFRE (gpd/ SFRE) for the two areas are shown in Table 4-4.

[11] City of Bakersfield 2020 Urban Water Management Plan
[12] https://www.wunderground.com/history/monthly/us/ca/bakersfield/KBFL/date/2020-4

Table 4-4. Sewer Generation Factor Calculation

Flow Meter Tributary Area	Estimated SFRE	Metered ADWF[2] (mgd)	gpd/ SFRE
Oildale (MH-568)	14,317	2.68	187.2
CSA-71[1]	7,053	1.48	209.3
Total	21,370	4.16	194.5

1. CSA-71 Tributary Area includes a small portion of Oildale area west of Hwy 99.
2. Refer to Table 4-2. Metered ADWF for CSA-71 Tributary Area was estimated by subtracting ADWF of HWY99, Gossamer Grove, Minter Field, Shafter Ave, and Wonderful Industrial Park from NOR_WWTP.

In the District's 2013 SMP, the gpd/SFRE determined for the Oildale area is 245, and the gpd/SFRE determined from CSA-71 is 297. The reduction in flows per SFRE is most likely the effects of increase water conservation measures implementation and mandated water conservation restrictions in the past few years. A wastewater generation factor of 300 gpd/SFRE was used for estimating buildout flows in both the 2013 SMP and the 2018 SMP. To be conservative by applying a 5% safety factor to the higher gpd/SFRE of 209.3, a wastewater generation factor of 220 gpd/SFRE is used to project buildout flows for capacity evaluation.

4.4. Future Wastewater Flow Projection

The District's wastewater flow is projected for near-term future (in 10 years, or 2032), and buildout conditions. As shown in Section 2.3.2, a list of known future developments were provided by the District. Projects 1-15 are anticipated to be completed in near-term future, and the remaining ones are anticipated to be completed by buildout. This master plan follows the same assumptions on development densities used in the 2013 SMP to calculate additional SFRE within the District's SOI for future phases. SFRE densities for undeveloped areas were assumed by land use type based on the Metropolitan Bakersfield General Plan, Projected SFRE is then multiplied by the wastewater generation factor of 220 gpd/SFRE to estimate the additional future flows. The number of additional SFRE from City of Shafter was not considered and wastewater flow from City of Shafter is assumed to be capped at Shafter's capacity right of 3 mgd in the existing Outfall Sewer. Details of the SFRE density assumption and breakdown of sewer flows by map sections within the SOI are included in Appendix B – Buildout Wastewater Flow Estimations. Table 4-5 summarized the calculated SFRE for existing and buildout conditions.

Table 4-5. SFRE Estimations

Area	Existing SFRE	Buildout SFRE
Oildale	16,102	33,735
CSA-71	5,268	58,857
Total	**21,370**	**92,591**

Near-term future (2032) flow and 2050 flows without water saving reduction are projected by calculating the near-term future project flows plus the projected increase in existing flow due to infill growth. Increase in existing flow is assumed to be proportionate to population growth to account for densification and changes in land use in existing developed areas and remaining vacant areas. Growth rates for each planning areas are listed in Table 2-3. Buildout flow is projected by assuming all undeveloped areas within the District's SOI to be developed. Table 4-6 lists the projected near-term future (2032) wastewater flow, 2050 wastewater flow, and buildout wastewater flow.

Table 4-6. Wastewater Flow Estimations

Area	Existing (mgd)	Near-term 2032 (mgd)	2050 (mgd)	Buildout (mgd)	2050 with Water Saving Reduction (mgd)	Buildout with Water saving reduction (mgd)
Oildale	3.05	4.01	4.14	6.91	3.81	5.64
CSA-71	1.10	2.79	4.92	12.89	3.89	8.98
Shafter	1.44	1.78	2.62	3.00	2.33	3.00
Total	5.60	8.58	11.68	22.81	10.03	17.62

In 2018, the California Legislature enacted Senate Bill 606 (SB 606) and Assembly Bill 1688 (AB 1688) that establishes long-term standards for water suppliers. The two laws emphasize on water efficiency and set indoor residential water use standard to be 55 gallons per capita per day (gpcd) until January 2025 and decreasing to 50 gpcd in January 2030. On September 28, 2022, Governor Newsom approved SB 1157 which further reduces indoor residential water use standards from 52.5 gpcd to 47 gpcd between January 1st, 2025, and January 1st, 2030, and from 50 gpcd to 42 gpcd in January 2030. Assuming a 100% return to sewer ratio and a SF household size of 3.5, the wastewater generation factor would be reduced to 147 gpd/SFRE. With consideration of effects of the water efficiency legislature and other applicable standards and plumbing codes, new developments are assumed to be able to achieve 147 gpd/SFRE through water-efficient appliances, fixtures, and design. Existing users are assumed to stay at current wastewater generation rate as the existing flows already reflect the effects of continuous water conservation implementations over the past few years. The wastewater generation factor of 147 gpd/SFRE is approximately 75.6% of the existing system-wide wastewater generation factor of 194.5 gpd/SFRE as listed in Table 4-4. For the 2050 flow projection with water saving reduction, a factor of 0.756 is applied to the projected increase in existing flow due to infill growth to account for water saving reduction. Flows from new developments are estimated with the wastewater generation factor of 147 gpd/SFRE. Wastewater flow estimated for 2050 and buildout conditions with water saving reduction are shown in Table 4-6.

For conservative purposes of evaluating the collection system capacity to accommodate future flows, flows projected without water saving reduction in Table 4-6 are used as the future ADWFs for hydraulic analysis. Similar to estimation of existing PDF, a peaking factor of 2 was applied to future ADWFs to estimate future PDFs.

5. Hydraulic Model Build & Calibration

In support of the Master Plan, a wastewater collection system hydraulic model was developed to conduct a capacity analysis for the system. The District's sewer system model was built and calibrated in the InfoSWMM software environment. This platform combines a fully dynamic hydraulic modeling engine developed and approved by the Environmental Protection Agency (EPA) with Geographic Information System (GIS) integration that can take advantage of the District's sewer system GIS database developed over time.

5.1. Model Network Build

The District's sewer system GIS database was utilized to build the collection system model via the "GIS gateway" tool in InfoSWMM. An initial quality check of the District's GIS database was performed before importation. Invert information of manholes and gravity mains in the GIS database were from two primary sources: 1. As-builts, and 2. Field measurements. For field measurements, District staff measures the manhole inverts by measuring manhole rim elevations and depth to manhole center bottom. Pipe inverts at outlet/inlets to a manhole were not measured. Based on the GIS database review, field measured inverts are not quite consistent with as-built inverts. More than 80% of the inverts have +/- 0.5 ft difference between field measurement and as-built inverts, and approximately 40% of the inverts have +/- 1 ft difference between field measurement and as-builts inverts. Inverts from both sources result in negative slopes and extreme steep slopes at a small portion of pipes, but inverts from as-builts were found with less discrepancies and better reflecting the actual slopes in field. Therefore, inverts from as-builts were used as the primary invert source input for the model.

A list of sewer lines with negative slopes, slope greater than 10%, and or missing upstream and/or downstream inverts were provided to the District for clarification and correction. District staff reviewed invert data and performed field measurements to close data gaps for about top 50 data records out of about 250 records that showed negative slopes.

Once the District's sewer GIS database were imported into InfoSWMM, the network was reviewed for connectivity. Areas with discrepancies were documented. Once system network connectivity check was completed, the system was also loaded with dummy flows to further check on areas with surcharge issues. Sewer line profiles of these areas were checked and profiles that did not show downward slopes were modified/corrected based on as-builts or nearest upstream and downstream sewer line/ manhole inverts. During this process, a few areas were found with different datums used from different as-builts. Modifications were made to these areas and documented in the model as well as a separate model error log document. Fields were created in InfoSWMM to log the facilities with modifications made. As a result, further data scrubbing was performed in InfoSWMM to be able to execute the modeling program.

5.2. Flow Allocation

Wastewater flows were loaded to the model apportioned on a manhole-by-manhole basis. Based on the SFRE and gpd/SFRE estimated for existing flow as shown in Table 4-4, sewer flow was calculated on a parcel level. Each parcel was assigned to a tributary manhole in the collection system based on spatial joint to the closest manhole and manually checked and modified at areas near pump stations, force mains, and parallel pipes. Sewer flows to each tributary manhole were summed and loaded in the model.

5.3. Model Calibration

To make sure that the model accurately represents the existing system conditions, the model was calibrated based on flow monitoring data. Model calibration is an iterative process of comparing model prediction to actual field data and adjusting model parameters to produce model results that are within an acceptable agreement of the field measurements. The model was only calibrated to dry weather conditions as there was not wet weather events captured during the flow monitoring study.

There are no established standards on the calibration accuracy for hydraulic model calibration in the United States as the required level of accuracy depends on the expected use of the model. However, a popular source referenced in the U.S. for model calibration criteria comes from a U.K. based organization called the Chartered Institute of Water and Environmental Management (CIWEM) that produces the "Wastewater Planning Users Group Code of Practice for the Hydraulic Modeling of Sewer Systems" or WaPUG Manual. Table 5-1 below lists the WaPUG calibration criteria.

Table 5-1. WaPUG Calibration Criteria[13]

Parameter	General	Critical Locations	Comments
Shape*	Good match (NSEC if used >0.5)	Good match (NSEC if used >0.5)	An evaluation technique may be used to compare the shape such as the Nash-Sutcliffe Efficiency Co-efficient (NSEC) method together with a visual check.
Time of peaks and troughs	+/- 0.5 hour	+/- 0.5 hour	The timing of peaks and troughs should be similar having regard to the duration of the event
Peak depth (unsurcharged)	+/- 0.33 ft or +/- 10% whichever is greater	+/- 0.33 ft	
Peak depth (surcharged)	1.64 ft to - 0.33 ft	+/- 0.33 ft	Relaxation may be appropriate in deep sewers. Where coupled 1D-2D models are used the 'critical locations' criteria should be applied
Peak flow	+ 25% to -15%	+/- 10%	
Flow volume	+20% to -10%	+/- 10%	Excluding poor/missing data

* Shape or pattern of the flow and depth

September 7, 2022, was selected as the representative day for dry weather flow calibration. Hourly diurnal patterns were initially created by averaging the hourly flows between 9/6/2022 and 9/9/2022 at HWY99 meter site and the Shafter Ave interceptor flow data and input into the model for calibration. Calibration is an iterative process with model input parameters such as diurnal patterns, demands, and roughness coefficients being adjusted. During the calibration process, diurnal patterns were modified for better match to observed flow shape at the two meter sites. No other changes were made to the final calibrated model. Figure 5-1 shows the calibrated and normalized diurnal patterns.

[13] CIWEN Wastewater Planning Users Group Code of Practice for the Hydraulic Modeling of Urban Drainage Systems, Version 01, 2017

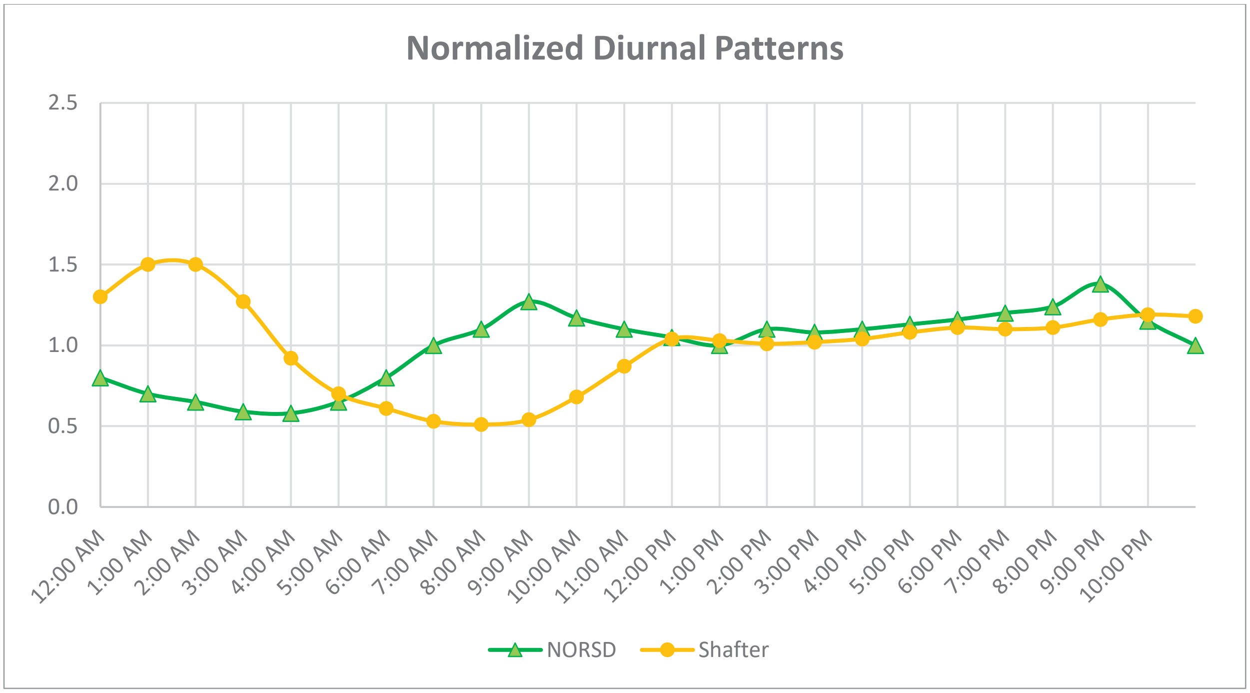


Figure 5-1. Normalized Diurnal Patterns

Table 5-2 summarizes the metered and modeled data at the two meter sites. Comparison graphs of the metered flow and depth to model predictions are shown in Figure 5-2 to Figure 5-5.

Table 5-2. Model Calibration Summary for September 7, 2022

Location	Model	Metered	Percent Difference
HWY99 (MH-548)			
Peak Flow (mgd)	3.51	3.80	-7.6%
Maximum Depth (ft)	12.28	12.19	0.7%
Average Depth (ft)	10.61	10.24	3.6%
Minimum Depth (ft)	8.26	8.00	3.3%
Total Volume (MG)	5.38	5.36	0.3%
NOR_WWTP (MH-2339)			
Peak Flow (mgd)	7.09	7.19	-1.4%
Maximum Depth (ft)	17.88	19.61	-8.8%
Average Depth (ft)	15.62	16.98	-8.0%
Minimum Depth (ft)	12.61	13.68	-7.8%
Total Volume (MG)	11.05	10.63	3.9%

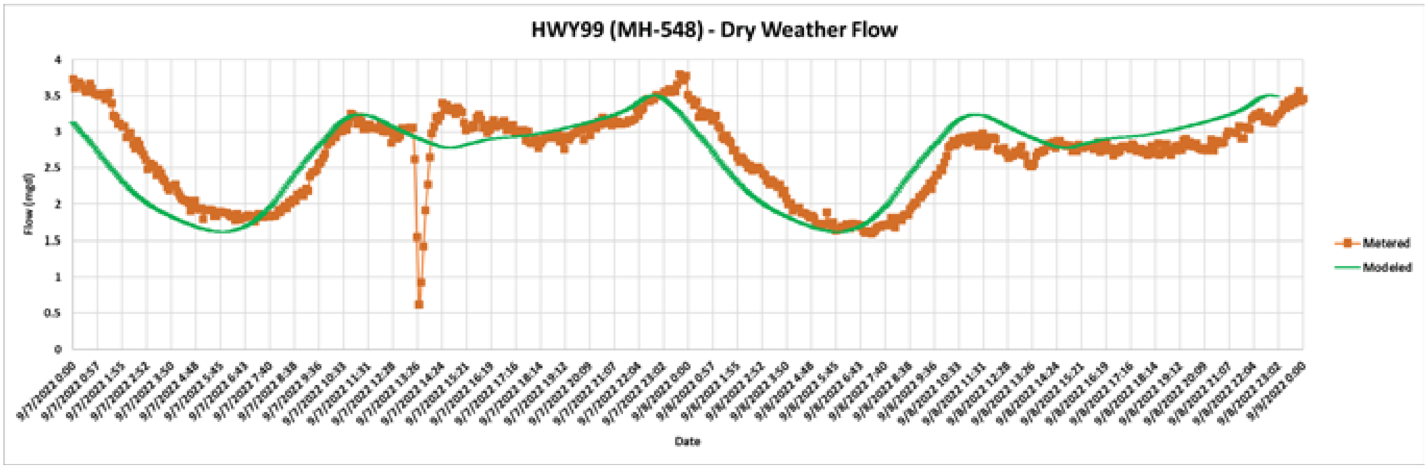


Figure 5-2. Model Flow and Metered Flow Comparison at HWY99 (MH-548)

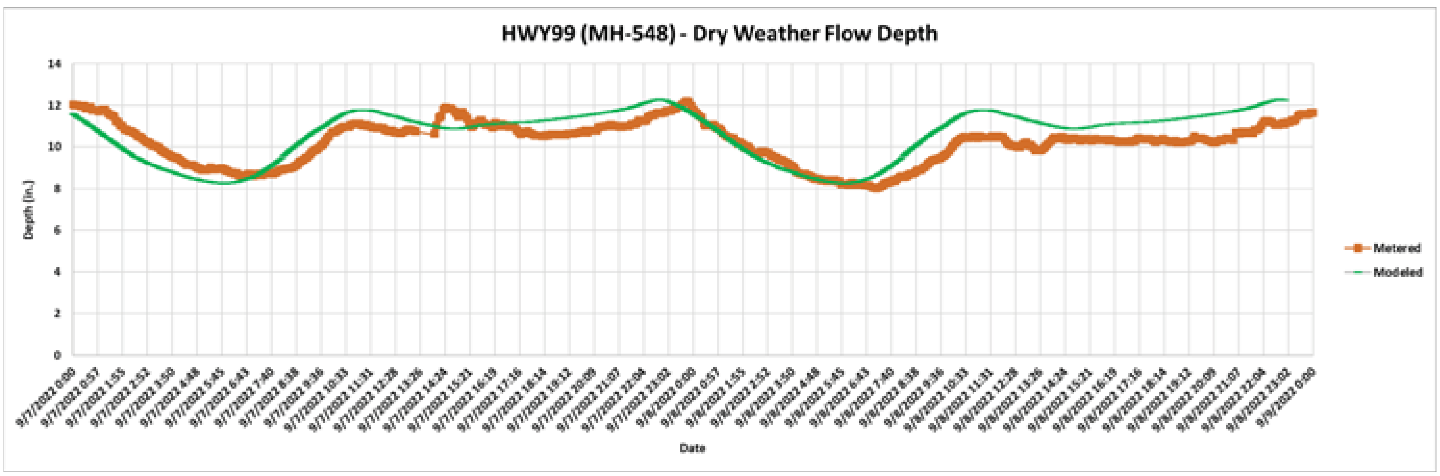


Figure 5-3. Model Depth and Metered Depth Comparison at HWY99 (MH-548)

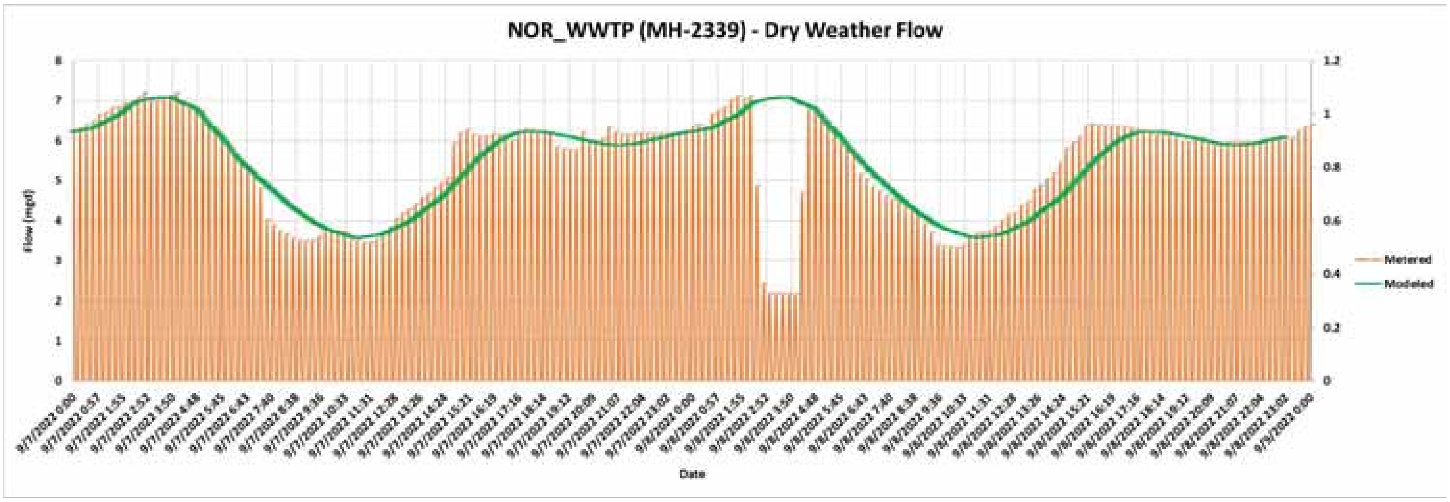


Figure 5-4. Model Flow and Metered Flow Comparison at NOR_WWTP (MH-2339)

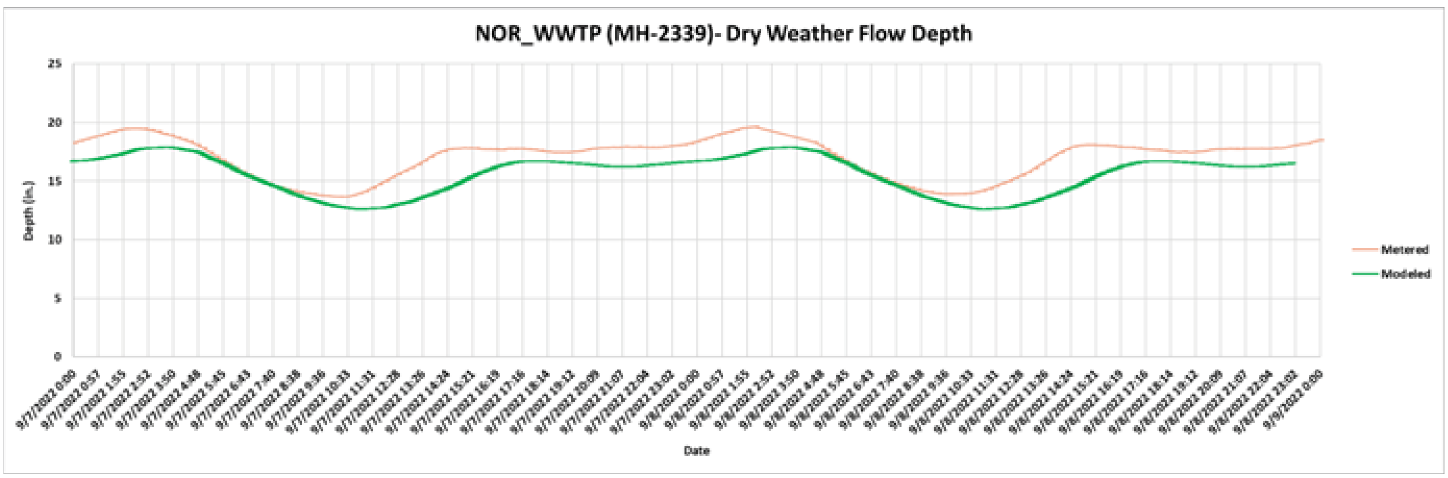


Figure 5-5. Model Depth and Metered Depth Comparison at NOR_WWTP (MH-2339)

Overall, the model flows and depths agree closely with the observed data and are within 10% difference. Adjusting the diurnal pattern to bring closer match at NOR_WWTP site would result in model peak time deviating from the observed peak time at the HWY99 site. The calibration results were reviewed and approved by District staff before performing capacity evaluation. In order to further refine the model in future updates, it is recommended that the District conduct additional flow monitoring study in the system capturing flows in smaller tributary areas over longer periods as well as during wet weather events.

6. Planning Criteria

As part of the Master Plan, the District's sewer design criteria were reviewed and compared against criteria used by other agencies and local municipalities within Central Valley along with industry standards recommended in the Gravity Sanitary Sewer Design and Construction Manual[15]. The comparison matrix and recommended design criteria details are presented in Appendix A. Based on discussions with the District, the design criteria used for the capacity evaluation and improvements in this Master Plan are summarized below.

6.1. Gravity Sewers

Table 6-1 is a summary of planning criteria for the District's gravity sewers.

Table 6-1. Planning Criteria for Gravity Mains

Design Criteria	Parameter
Depth to diameter (d/D) for existing gravity mains	Maximum d/D = 0.70 for 12-inch or smaller pipes Maximum d/D = 0.85 for pipes greater than 12"
Depth to diameter (d/D) for new gravity mains	Maximum d/D = 0.50 for 12-inch or smaller pipes Maximum d/D = 0.75 for pipes greater than 12"
Minimum velocity	2 fps when flowing half full
Maximum velocity	10 fps
Minimum diameter for new pipe	8 inches
Manning's n	0.013
Minimum Slope (ft /100 ft)	6" - 0.5% 8" - 0.5% 10" - 0.25% 12"- 0.2% 15" - 0.15% 18" - 0.12% 21" - 0.11% > 21"- 0.1% or sloped to provide 2 fps min. velocity

6.2. Manhole

For new manholes, spacing is recommended to be 400 feet for sewers 12-inches or smaller in diameter and 600 feet for sewers greater than 12-inches in diameter.

[15] Gravity Sanitary Sewer Design and Construction (2nd Ed. WEF Manual of Practice no. FD-5) is published by the American Society of Civil Engineers (ASCE) and the Water Environment Federation (WEF).

6.3. Lift Station and Force Main

6.3.1. Firm capacity for Pumps

Pumps at each lift station should be capable of handling Peak Design Flow with the largest pump out of service/operation.

6.3.2. Force Main Criteria

Minimum diameter of a new force main shall be 4-inches. The force main should be of pressure-rated DIP, HDPE, or PVC material with a Hazen-Williams roughness coefficient factor of C=130. Force mains should be sized to meet pipe velocity requirements and optimal pump design (e.g., highest efficiency with lowest energy cost) under minimum and maximum pumping flow conditions. Under all conditions force mains should exhibit a velocity of 3 fps to re-suspend settled solids and a maximum velocity of 8 fps to minimize surge.

7. Capacity Evaluation

This section discusses the model results on system capacity evaluation for existing and future conditions and identified system deficiencies per planning criteria presented in Section 6.

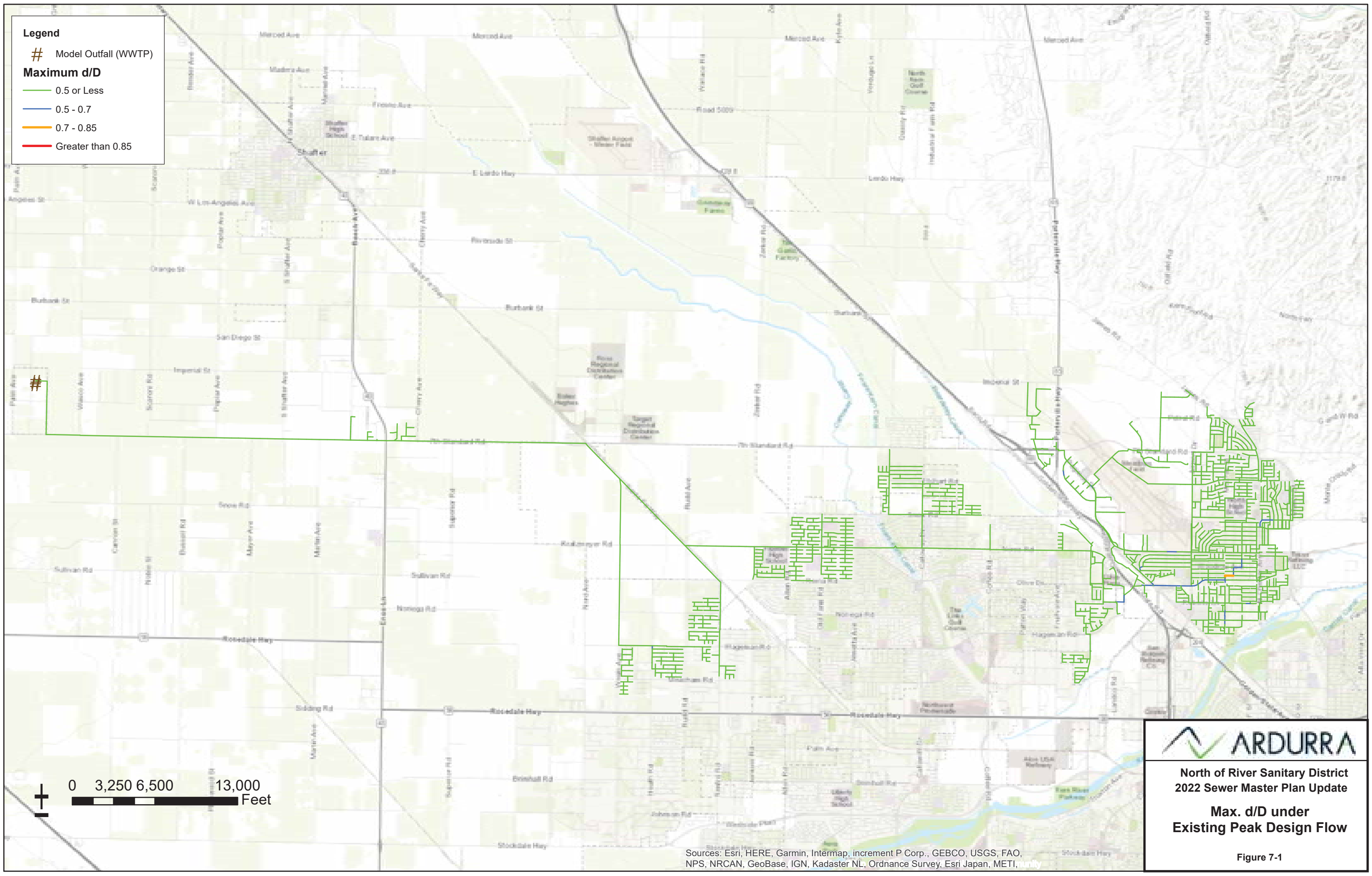
7.1. Capacity Evaluation

7.1.1. Gravity Mains

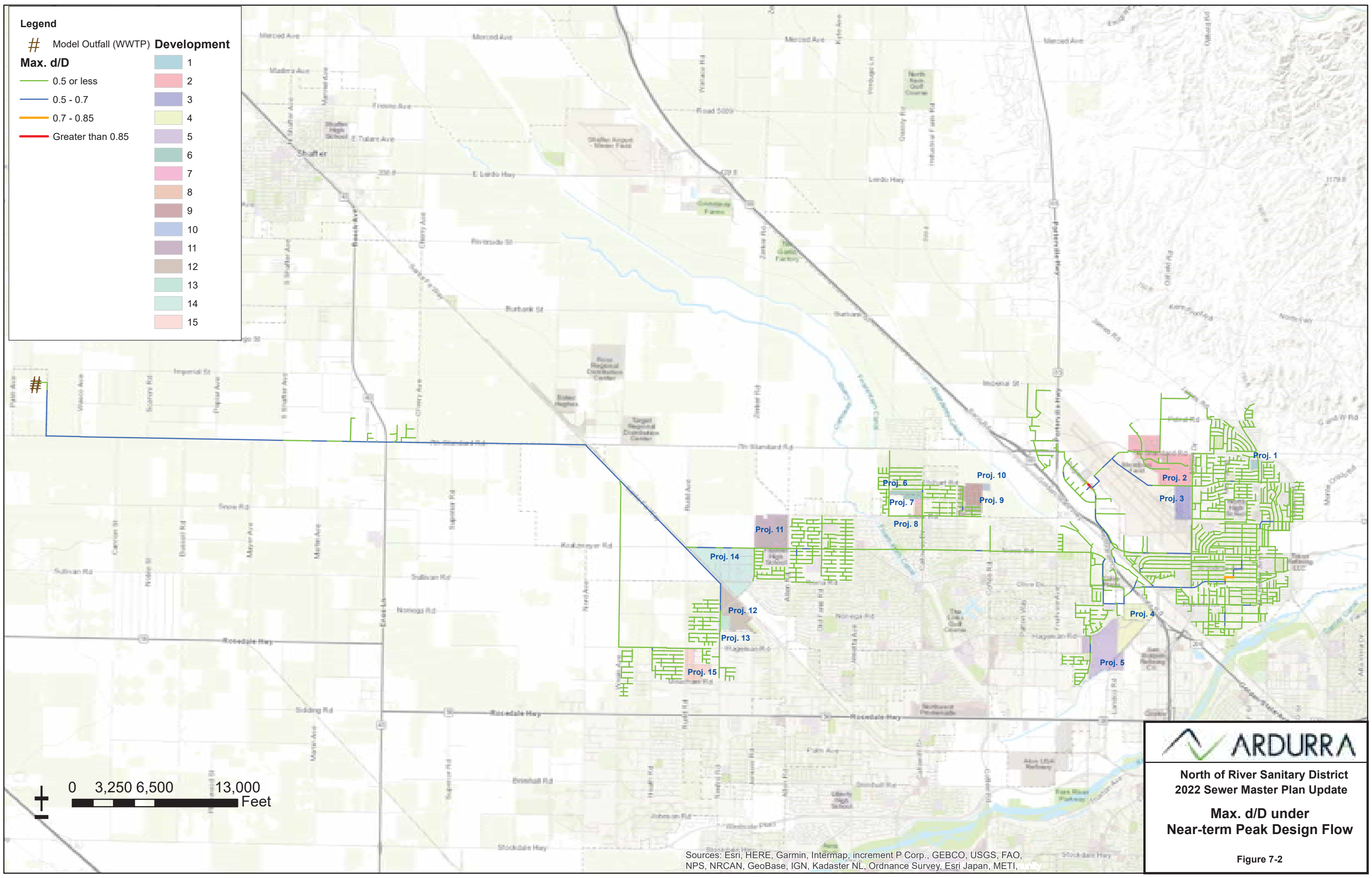
The system was evaluated utilizing the calibrated model under three scenarios: Existing PDF condition, Near-term PDF condition, and Buildout PDF condition. Capacity analysis of gravity mains is generally evaluated based on the depth of flow to the diameter of the pipe (d/D) under PDF scenario. Model results for existing, near-term future, and buildout under PDF conditions were evaluated to identify the deficient pipelines for each time frame. Figures 7-1 to 7-3 illustrates the locations of the deficient pipelines for existing, near-term future, and buildout PDF conditions, respectively. Model results are included as Appendix C – InfoSWMM Hydraulic Model Results.

Some of the deficient pipelines shown in the figures were due to backwater condition of their downstream deficient pipelines and will meet the planning criteria once the downstream deficient pipelines are upsized. Model results indicate that the existing system have sufficient capacity for existing PDF except three 10-inch line segments in Lincoln Ave and Oildale Dr exhibiting maximum d/D exceeding 0.7. The existing system can accommodate near-term future growth at most areas except the aforementioned area and at two 15-inch line segments near Pegasus Drive and Mars Court, as shown in Figure 7-4. However, these two line segments are predicted to exhibit backwater condition due to smaller outlet pipes and higher outlet inverts downstream. It is recommended this area to be field verified.

Model results show the existing system cannot accommodate buildout flows under PDF condition. Two major areas include the system upstream of Norris Rd and Hwy99, and the existing Outfall Sewer west of Pather Falls Ave and Calloway Canal. Some of the collector sewer show deficiencies due to allocating future loadings. It is likely that new collector sewers and interceptor sewers will be built for the new developments. The existing Outfall Trunk line cannot accommodate build out flows resulting in flows backing up at upstream interceptor sewers and collector sewers as shown in Figure 7-3.



Legend
Model Outfall (WWTP)
Maximum d/D
0.5 or Less
0.5 - 0.7
0.7 - 0.85
Greater than 0.85
0 3,250 6,500 13,000
Feet
ARDURRA
North of River Sanitary District
2022 Sewer Master Plan Update
Max. d/D under
Existing Peak Design Flow
Figure 7-1
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO,
NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI,



Legend
Model Outfall (WWTP)
Max. d/D
0.5 or less
0.5 - 0.7
0.7 - 0.85
Greater than 0.85
Development
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Proj. 1
Proj. 2
Proj. 3
Proj. 4
Proj. 5
Proj. 6
Proj. 7
Proj. 8
Proj. 9
Proj. 10
Proj. 11
Proj. 12
Proj. 13
Proj. 14
Proj. 15
0 3,250 6,500 13,000
Feet
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI,
ARDURRA
North of River Sanitary District
2022 Sewer Master Plan Update
Max. d/D under
Near-term Peak Design Flow
Figure 7-2

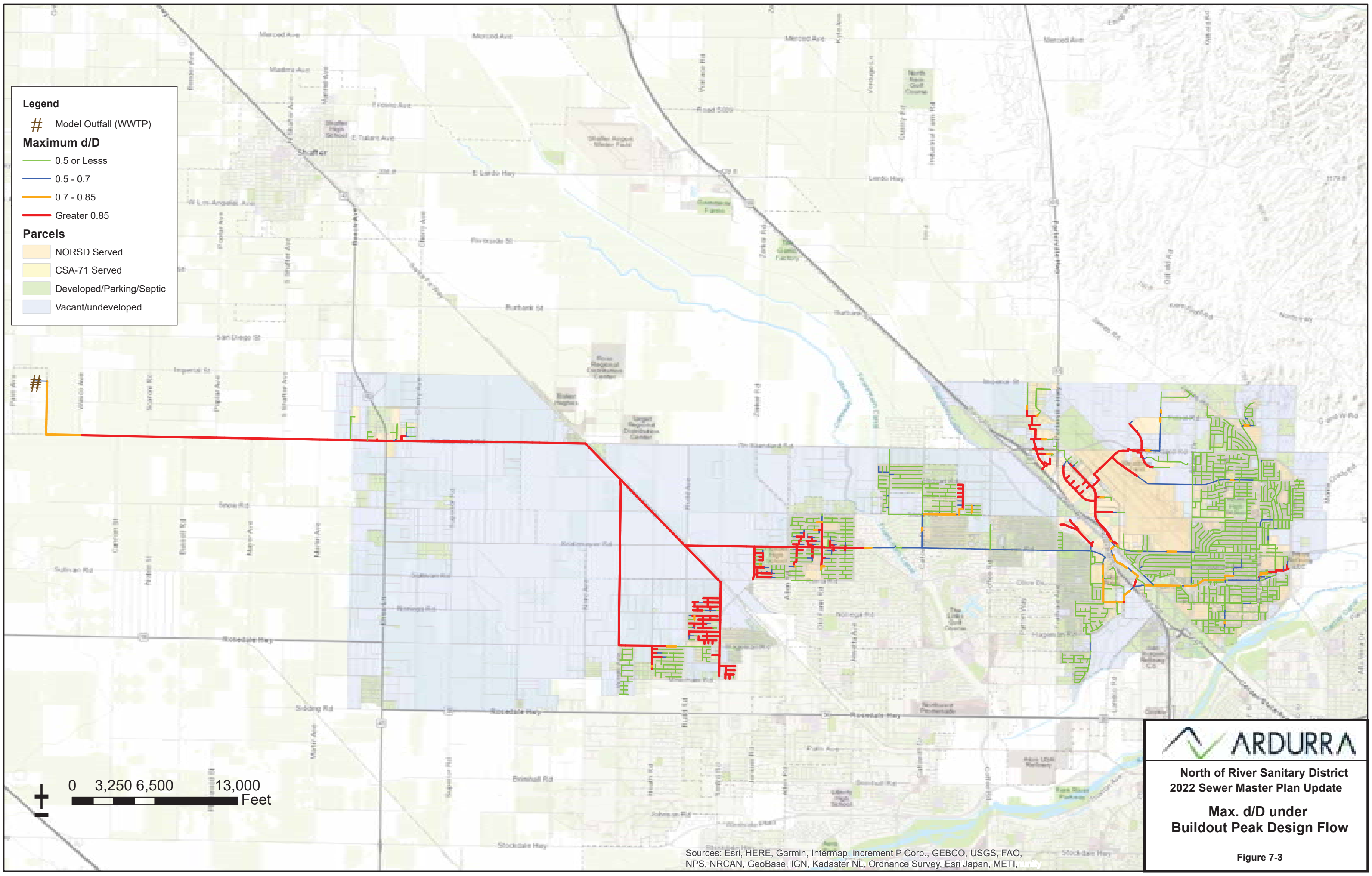

Legend
Model Outfall (WWTP)
Maximum d/D
0.5 or Lesss
0.5 - 0.7
0.7 - 0.85
Greater 0.85
Parcels
NORSD Served
CSA-71 Served
Developed/Parking/Septic
Vacant/undeveloped
0 3,250 6,500 13,000
Feet
ARDURRA
North of River Sanitary District
2022 Sewer Master Plan Update
Max. d/D under
Buildout Peak Design Flow
Figure 7-3
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI,

Figure 7-4. Area Recommended for Field Verification

7.1.2. Lift Stations

Model results indicated that all lift stations have sufficient capacity to accommodate future growth through buildout under PDF condition except LS 3. LS 3 shows sufficient capacity to accommodate near-term future growth but becomes deficient under buildout PDF condition. This is based on the assumption that the undeveloped areas north of LS 3 will be served by LS 3. A new interceptor was proposed in the March 2019 "Final Coffee Road Interceptor Analysis" report, which was prepared by AECOM, to convey any future flows from the undeveloped areas north of LS 3. Additional information is provided in Section 9. Table 7-1 summarizes the model results of maximum influents to the lift stations under existing, near-term, and buildout PDF conditions.

Table 7-1. Model Results for Lift Station

Lift Station (LS)	Design Capacity (mgd)	Existing Max. Influent (mgd)	Near-term Max. Influent (mgd)	Buildout Max. Influent (mgd)
LS 1	1.73	1.21	1.23	1.38
LS 2	1.17	0.11	0.11	0.24
LS 3	0.43	0.12	0.12	1.42*
LS 4	2.40	0.34	0.81	0.94
LS 5	0.69	0.03	0.04	0.17

* Model results indicated flooding upstream. Max. Influent is estimated using a peaking factor of 2 to ADWF.

7.1.3. Force Main

Model results for force mains are summarized in Table 7-2. Model results indicate that maximum velocities of all force mains are below the design criteria requirement of 8 fps under PDF conditions with the exception of the 4-inch force main at LS 5.

Table 7-2. Model Results for Force Mains

Name	Size (in.)	Max. Flow (mgd)	Max. Velocity (fps)	Note
LS 1 FM	10	1.6	4.5	Two pumps turn on at maximum under existing, near-term, and buildout PDF conditions
LS 2 FM	10	2.4	6.8	Two pumps turn on at maximum under existing, near-term, and buildout PDF conditions
LS 3 FM	8	0.94	4.2	One pump turns on at maximum under existing and near-term PDF conditions and two pumps turn on at maximum under buildout PDF condition
LS 4 FM	10	2.6	7.4	One pump turns on at maximum under existing and near-term PDF conditions and two pumps turn on at maximum under buildout PDF condition
LS 5 FM	4	0.56	9.9	One pump turn on at maximum under existing, near-term, and buildout PDF conditions

8. Facilities Condition Assessment

A desktop condition assessment of the District's collection system mains and a field inspection of its lift stations were completed as part of this Master Plan.

8.1. Gravity Mains

The District's mains are CCTV-ed on a regular basis and a PACP rating is assigned to each pipe upon inspection. The rating is input and documented in the District's AMP database as mentioned in Section 3.1.6.

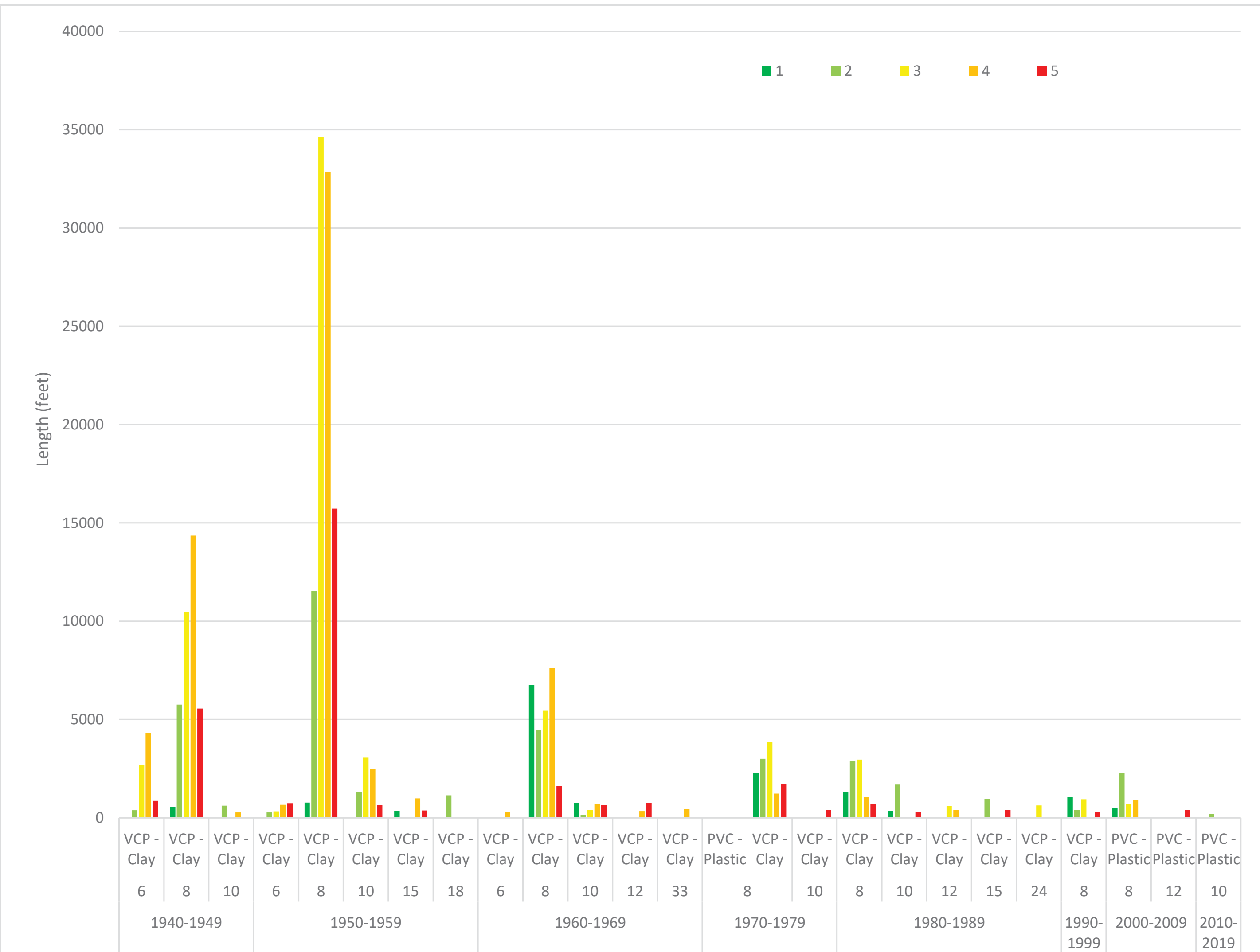
8.1.1. Pipe Condition Assessment Summary

Sewer mains graded with a PACP rating of 5 have the poorest condition and are typically set aside by the District for capital improvements. The District performs rehabilitation via spot-repair or remove and replace methodology. Grade 5 pipes tend to have structural issues like major cracks in pipes or joints, severe sags, or other degradation that reduces its function to direct sewer flow efficiently. Pipes with a rating less than 5 are monitored and reviewed for further degradation during routine inspections. Table 8-1 shows that pipes with the highest percentage in Grade 4 and 5 categories are 8-inch VCPs that were constructed before 1960. Figure 8-1 shows District pipes broken down by material, size, age, and PACP Grade.

Table 8-1. Gravity Mains Grade 4 and 5 PACP Ratings by Age, Size, and Material

Install Period	Diameter (in)	Material	Grade 4 (ft.)	Grade 5 (ft.)	Percentage of Grade 4 Pipes	Percentage of Grade 5 Pipes
1940-1949	6	VCP - Clay	4,338	865	6%	3%
	8	VCP - Clay	14,352	5,564	21%	18%
	10	VCP - Clay	276			
1950-1959	6	VCP - Clay	673	743	1%	2%
	8	VCP - Clay	32,873	15,722	48%	50%
	10	VCP - Clay	2,468	662	4%	2%
	15	VCP - Clay	991	381	1%	1%
	18	VCP - Clay				
1960-1969	6	VCP - Clay	326			
	8	VCP - Clay	7,608	1,616	11%	5%
	10	VCP - Clay	695	646	1%	2%
	12	VCP - Clay	348	759	1%	2%
	33	VCP - Clay	452		1%	0%
1970-1980	8	PVC - Plastic	47			
	8	VCP - Clay	1,234	1,729	2%	6%
	10	VCP - Clay		401	0%	1%
1980-1990	8	VCP - Clay	1,043	715	2%	2%
	10	VCP - Clay		326	0%	1%
	12	VCP - Clay	400		1%	0%
	15	VCP - Clay		398	0%	1%
	24	VCP - Clay				
1990-2000	8	VCP - Clay		316	0%	1%
2000-2010	8	PVC - Plastic	899		1%	0%
	12	PVC - Plastic		399	0%	1%
2010-2020	10	PVC - Plastic				
TOTAL			**69,021**	**31,242**	**100%**	**100%**

Figure 8-1. District Pipe Lengths by Diameter, Age, Material, and PACP Grade



Source: NORSD Asset Management database (Grades 1 through 5 PACP Rating), 10/27/2022

8.1.2. Hot Spot Areas

Hot spot areas are sewers that require frequent flushing because of sediment accumulations or low/stagnant flows that develop odor issues. The District's hot spot areas are mostly located in the Oildale area and are identified in its AMP database.

8.2. Lift Stations

As part of the facilities assessment, a field visit was conducted on August 5th, 2022, to evaluate the condition of the District's five existing lift stations. An evaluation of the electrical, mechanical, and civil components of each facility was performed based on a combination of visual inspections, record drawings reviews and interviews with District staff. Details of the assessments including site visit photographs to substantiate observations are documented in the Lift Station Condition Assessment Technical Memorandum (LS Assessment TM) in Appendix D. Summary findings are presented in Table 8-2 below.

Table 8-2. Lift Station and Wet Well Condition Summary

Lift Station (LS)	Electrical	Mechanical	Civil / Site	Wet Well Lining
LS 1	Good	Good	Fair	Epoxy, Good
LS 2	Fair	Fair	Fair	Bitumastic, Fair
LS 3	Good	Good	Good	Good
LS 4	Fair	Fair (Except for Wet Well Piping, Poor)	Fair	PVC, Fair
LS 5	Good	Good	Good	Good

A good condition indicates that the equipment is new or does not need repair or replacement within the next five years. A fair condition indicates that the equipment is in working order. A poor condition indicates that some components are out of order and require repair or replacement within the next CIP budget cycle. The electrical condition considers the motor control panel, emergency generator connection and/or onsite emergency generator, site lighting, and SCADA integration. The mechanical condition considers the condition of wet well piping and pumps, dry well piping, valves, and pressure gauges, and emergency bypass pumping. The civil condition considers the site ground surface, fence, and gate. The wet well lining condition identifies the type of lining, as applicable, and the condition of that lining.

8.3. Force Mains

Ardurra (formerly IEC) completed a Sewer Force Main Study (2020 FM Study) in April of 2020 to document the velocities in the lift station force mains and identify the potential to construct a redundant crossing under State Route 65 for the LS 3 Force Main. Another force main study was conducted by AECOM in July 2022 to evaluate the feasibility to relocate the current LS 4 in preparation for a proposed expansion to serve anticipated future developments in the vicinity. The 2020 FM Study and the 2022 LS 4 Study are both included as attachments within the LS Assessment TM located in Appendix D of this Master Plan. Summary findings are discussed below.

Table 8-3 lists force main installation year and expected useful-life expectancy based on construction materials for each lift station. Life expectancy was estimated using Ardurra' s experience, including recently collected CCTV and condition assessment data of similar diameter (4- to 24-inch) and material type (PVC and DI). The District's AMP database also tracks life expectancies of its sewer assets but may need to be updated to reflect more recent values.

A new redundant force main (FM2) was constructed at LS 1 in 2015. The older force main (FM1) was retained as an emergency backup and to facilitate maintenance activities. Corrosion assessments for these force mains were recommended in the 2020 FM Study due to their age and material susceptibility to corrosion. The District is scheduling to conduct a CCTV inspection of FM1 in 2023 to determine areas of corrosion defects as it plans to rehabilitate FM1 and integrate it back into the system to provide redundancy[16]. LS 2 force main is past its useful life and a portion of it is scheduled for replacement in 2023. The District plans to replace about 1,100 feet of the 10-inch force main with kind. Force mains for LS 3, 4 and 5 are newer PVC force mains and are recommended to be inspected as they are near their respective useful lives.

Table 8-3. Expected Useful Life of Existing Force Mains

Lift Station	Year Installed	Diameter	Material	Length (ft)	Useful Life (Years)	Estimated Replacement Year
LS 1	2015 (FM2)	10-inch	Ductile Iron (DI)	3,750	25	2040
LS 1	1955 (FM1)	10-inch	Cast Iron (CI)	3,800	-	2023
LS 2	1971	10-inch	Polyvinyl Chloride (PVC)	2,100	50 - 70	2021 - 2041
LS 3	2000	8-inch	PVC	2,200	50 - 70	2050 - 2070
LS 4	2000	10-inch	PVC	4,300	50 - 70	2050 - 2070
LS 5	2015	4-inch	PVC	255	50 - 70	2065 - 2085

16 Source: Phase 1 Investigation – S. Oildale Drive Backup Force Main from Lift Station #1 to Decatur Street, Provost & Pritchard Consulting Group, September 2022

8.4. Wastewater Treatment Plant

A condition assessment of the WWTP is not part of this Master Plan scope.

9. Capital Improvement Program

9.1. Capacity-related Improvements

Profiles of the deficient pipelines identified from the model results were further reviewed, and profiles that do not show downward slopes were checked against as-builts if available or modified by interpolation based on nearest upstream and downstream pipe/manhole inverts. Areas with potential incorrect flow direction, pipe size, input errors, or different datums are noted for the District to further review and field verification.

Pipes 12-inch or smaller in size exhibiting d/D greater than 0.7 and pipes greater than 12-inch in size exhibiting d/D greater than 0.85 are recommended to be upsized. Exceptions are made to segments that are the sole segments within the vicinity slightly exceeding the maximum d/D criteria. These segments are not proposed to be upsized. Existing interceptor is not available nearby for the majority of undeveloped parcels within the CSA-71 Area. New interceptor sewers and collector sewers are assumed to be built by the developers for these areas and are assumed to eventually discharge into the District's Outfall Sewer or the proposed new parallel Outfall Sewer.

Proposed pipeline improvements were grouped into projects, as shown in Figure 9-1. Table 1 summarizes the proposed capacity-related CIP projects.

Table 9-1. Proposed CIP Summary

CIP No.	Name	Existing Diameter (in.)	Future Diameter	Length (ft)
1	Lincoln Ave & Oildale	10	15	1,011
1 Total				**1,011**
2	Coffee Rd Interceptor	-	15	9,412
			18	5,255
2 Total				**14,667**
3	Kratzmeyer Rd/Snow Rd Trunk Line	-	42	13,028
			48	50,374
3 Total				**63,403**
4	Pegasus Rd Interceptor	8, 10, 15, 18	15	160
			18	2,233
			24	2,911
4 Total				**5,304**
5	Pegasus Rd Collector	8	12	3,464
5 Total				**3,464**
6	Merle Haggard Dr/Wings Way	10,12,14,15	15	4,202
			18	3,355
6 Total				**7,557**
7	Dole Ct	8	12	2,172
7 Total				**2,172**
8	Victor St	33	36	5,172
8 Total				**5,172**
9	Landings Way	8, 10	12	919
9 Total				**919**

Table 9-1. Proposed CIP Summary (cont.)

CIP No.	Name	Existing Diameter (in.)	Future Diameter	Length (ft)
10	Countryside Dr	8	12	291
10 Total				**291**
11	Oildale Dr	10	15	186
11 Total				**186**
12	Norris Rd	10	12	1,543
12 Total				**1,543**
13	HWY99	24	27	3,793
			30	632
13 Total				**4,424**
Grand Total				**110,112**

CIP1 is recommended for existing condition, and the remaining CIP projects are recommended for buildout condition. CIP2 and CIP3 recommended herein were also proposed in other planning documents. CIP2 was developed based on the proposed alignment presented in the Coffee Road Interceptor Sewer Feasibility Analysis prepared by AECOM in March 2019. With implementation of CIP2, LS 3 will not need to be upsized.

CIP3 was developed based on the proposed alignment presented in the District's 2018 SMP. A parallel Trunk Sewer was proposed in the 2018 SMP to handle peak flows starting at Victor St parallel along existing Outfall Sewer alignment to the WWTP. An alternative alignment was proposed between Kratzmeyer Rd/Snow Rd. With the updated peaking factor as well as sewer generation factor used in this Master Plan, sufficient capacity was shown in the existing Outfall Sewer between Victor St and Alderbrook Ln under Buildout PDF condition. In addition, less subsurface space is available in a portion of 7th Standard Road with installation of the 24-inch gas main by Southern California Gas Company. CIP3 proposes a new trunk line in Kratzmeyer Rd/Snow Rd between Santa Fe Way and WWTP following the proposed alignment in the 2018 SMP. A portion of the existing Outfall Sewer between Lanco Dr and Victor St is proposed to be upsized as CIP8.

CIP4, CIP5, CIP6, and CIP13 are recommended as the existing sewer mains in 7th Standard Rd crossing the Meadows Field Airport and along Pegasus Dr do not have sufficient capacity to accommodate build-out flows from the undeveloped areas east of the Meadows Field Airport and are recommended to be upsized.

Table 9-2 and Table 9-3 summarize the inverts and pipe sizes used for the conceptual alignments for CIP2 and CIP3, respectively. Manhole IDs presented in the tables are shown in Figure 9-2 and Figure 9-3.

Table 9-2. Coffee Rd Interceptor Conceptual Alignment Summary

Manhole	Length	Invert (ft)	Ground Elev. (ft)*	Slope	Depth (ft)
MH-1288	-	390.3	406.5	0.35%	-
JCT_56	2666	399.6	412.6	0.35%	13.1
JCT_58	2589	408.7	422.1	0.60%	13.4
JCT_54	2640	424.5	440.8	0.60%	16.3
JCT_52	1251	432.0	452.8	0.60%	20.8
JCT_50	128	432.8	452.8	0.60%	20.0
JCT_48	1489	441.7	456.4	0.60%	14.7
JCT_46	336	443.7	460.9	0.60%	17.1
JCT_44	426	446.3	460.3	0.90%	14.0
JCT_42	3143	474.6	494.0	-	19.4

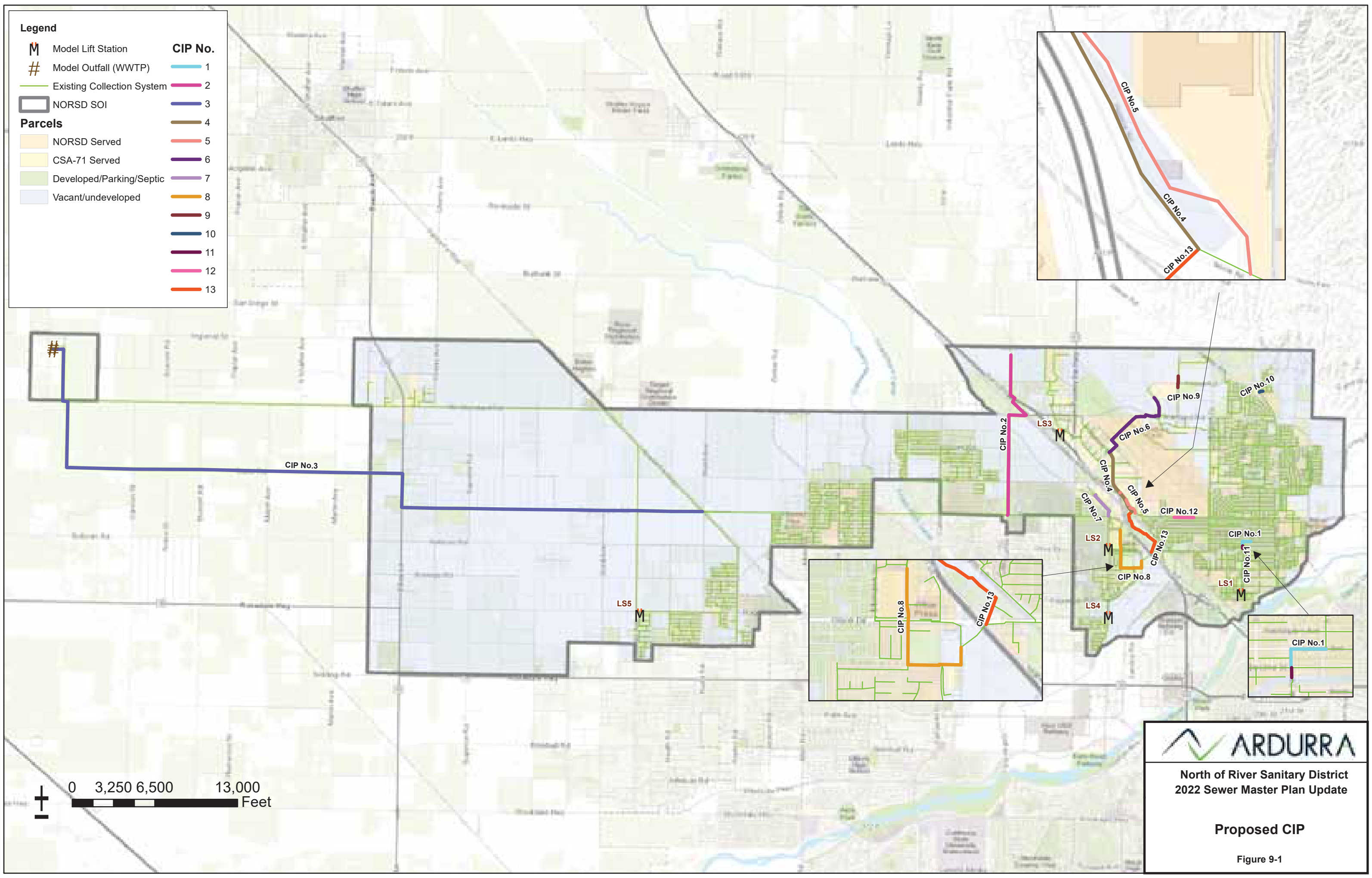
* Note: Ground elevation obtained from USGS 1/3 Arc Second n36w120 20210610

Table 9-3. Kratzmeyer Rd/Snow Rd Trunk Line Conceptual Alignment Summary

Manhole	Length	Invert (ft)	Ground Elev. (ft)	Slope	Depth (ft)
Outfall	-	289.9	315.0	0.060%	25.1
JCT_88	5033	292.9	308.7	0.060%	15.9
JCT_90	468	293.2	307.9	0.060%	14.7
JCT_86	5178	296.3	304.3	0.065%	8.0
JCT_84	5258	299.7	311.7	0.065%	12.0
JCT_82	5279	303.1	317.9	0.065%	14.8
JCT_80	5314	306.6	323.8	0.065%	17.2
JCT_78	5314	310.0	328.4	0.065%	18.4
JCT_76	5267	313.4	329.9	0.065%	16.5
JCT_74	2631	315.2	332.9	0.066%	17.7
JCT_72	2664	316.9	332.6	0.066%	15.6
JCT_70	2682	318.7	332.7	0.066%	14.0
JCT_68	2631	320.4	335.7	0.066%	15.2
JCT_66	2656	322.2	337.3	0.066%	15.1
JCT_64	2634	323.9	339.6	0.066%	15.7
JCT_62	2654	325.7	342.3	0.066%	16.7
MH-1032	2638	327.4	337.5	0.066%	10.1
JCT_60	2627	329.1	347.9	0.066%	18.8
MH-1085	2475	330.8	346.0	-	15.2

* Note: Ground elevation obtained from USGS 1_3 Arc Second n36w120 20210610

Finally, due to uncertainties related to amount and location of future sewer loads from redevelopment projects, it is recommended that the capacity evaluation be updated as more refined sewer loadings become available for the NORSD service area.


Legend
Model Lift Station
Model Outfall (WWTP)
Existing Collection System
NORSD SOI
Parcels
NORSD Served
CSA-71 Served
Developed/Parking/Septic
Vacant/undeveloped
CIP No.
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CIP No.1
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CIP No.3
CIP No.4
CIP No.5
CIP No.6
CIP No.7
CIP No.8
CIP No.9
CIP No.10
CIP No.11
CIP No.12
CIP No.13
LS1
LS2
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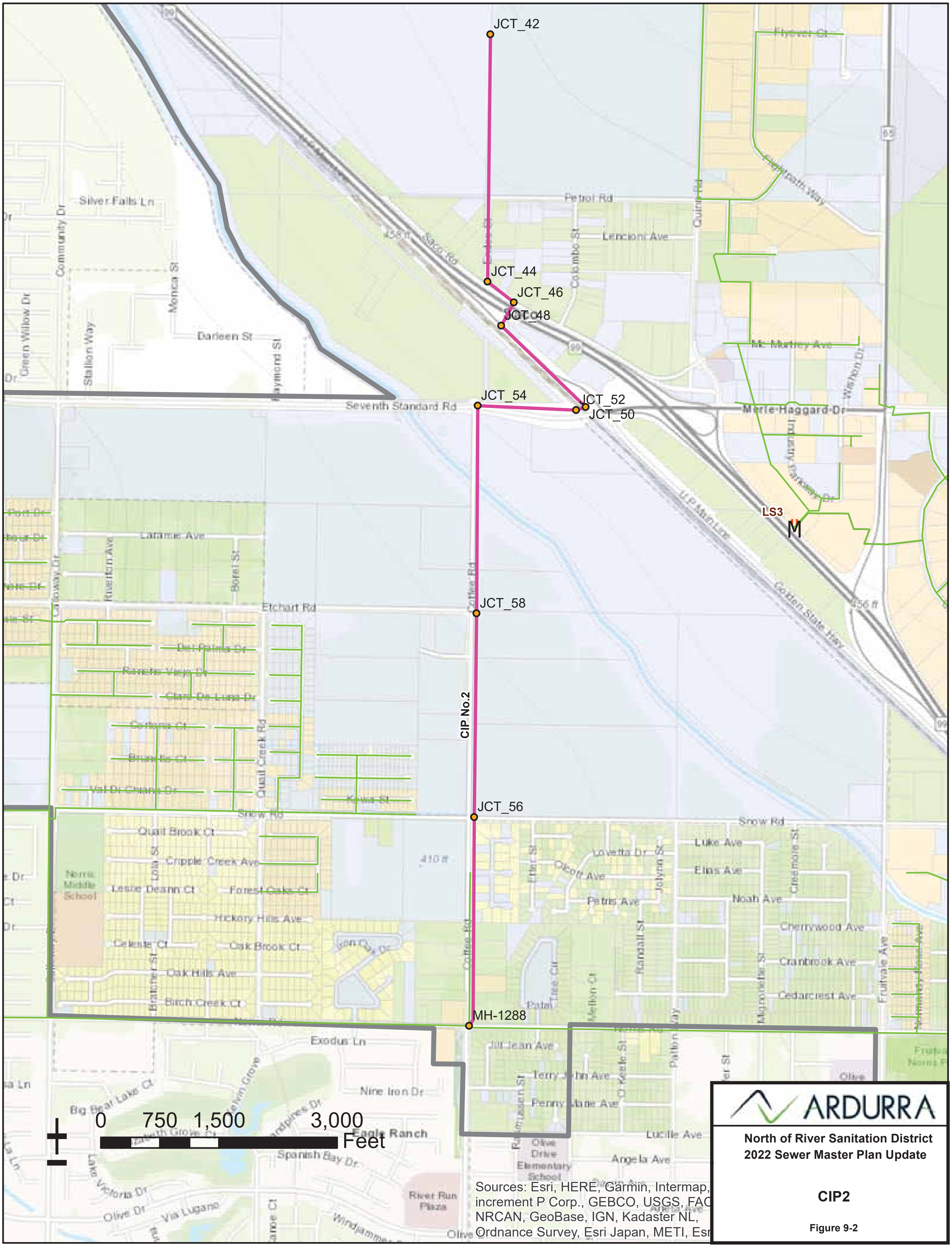
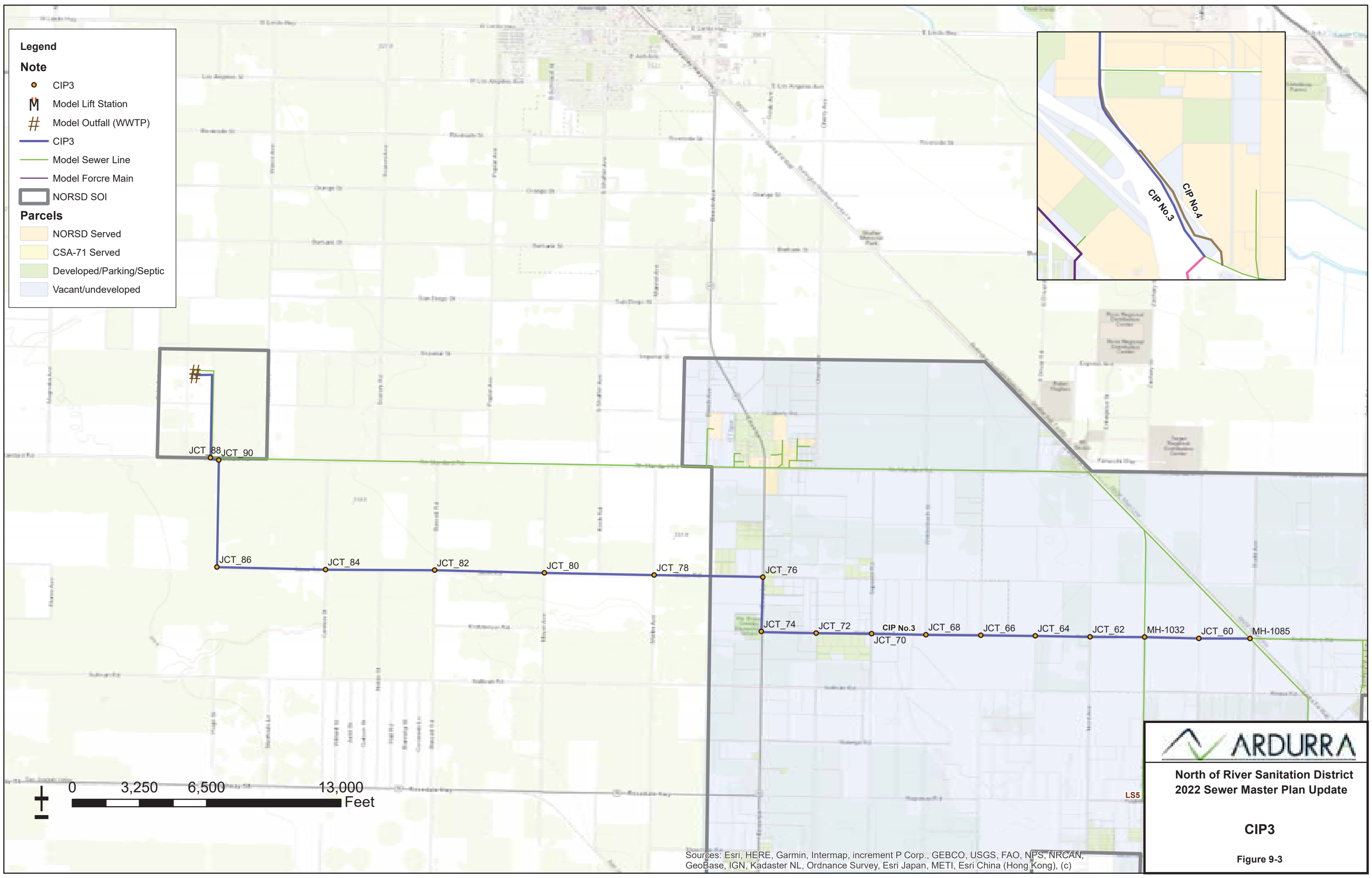
0 3,250 6,500 13,000
Feet
ARDURRA
North of River Sanitary District
2022 Sewer Master Plan Update
Proposed CIP
Figure 9-1



North of River Sanitation District
2022 Sewer Master Plan Update

CIP2

Figure 9-2



Legend
Note
CIP3
Model Lift Station
Model Outfall (WWTP)
CIP3
Model Sewer Line
Model Forcre Main
NORSD SOI
Parcels
NORSD Served
CSA-71 Served
Developed/Parking/Septic
Vacant/undeveloped
CIP No.4
CIP No.3
JCT_88
JCT_90
JCT_86
JCT_84
JCT_82
JCT_80
JCT_78
JCT_76
JCT_74
JCT_72
CIP No.3
JCT_70
JCT_68
JCT_66
JCT_64
JCT_62
MH-1032
JCT_60
MH-1085
LS5
0
3,250
6,500
13,000
Feet
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c)
ARDURRA
North of River Sanitation District
2022 Sewer Master Plan Update
CIP3
Figure 9-3

9.2. Condition-related Improvements

9.2.1. Gravity Mains

For capital improvement budgeting purposes, it is recommended that gravity mains with Grade 5 or poor condition ratings and constructed before 1960 be replaced. These VCP pipes are all located in the Oildale area and are shown in Figure 9-4 which is generated from the District's AMP database. Pipes with Grade 5 rating and constructed from 1960 onwards are recommended to be rehabilitated via spot repairs. At the time of this report, there are no capacity-related projects that coincide with pipes shown in Figure 9-4 that require replacements. However, it is recommended that the District check for pipes with poor condition rating in the vicinity of and at the beginning of any capacity-related improvement in the future.

9.2.2. Lift Stations and Force Mains

Based on site investigations, studies, and District interviews, below is a summary of recommended improvements at each lift station including connected force main(s). Tables 9-4 through 9-8 lists details of observations made during site visit and recommended improvements at each lift station.

9.2.2.1. Lift Station 1

Site improvements are recommended as referenced in Table 9-4. The District is starting to rehabilitate the older force main (FM1) and should consider replacing the newer force main (FM2) in 2040.

9.2.2.2. Lift Station 2

Site improvements are recommended as referenced in Table 9-5. Lift Station 2 exhibited the most advanced corrosion of the five lift stations and is recommended to be rehabilitated first. It is recommended that about 1,100 feet of 10-inch PVC force main should be replaced with kind between Mohawk Road and Victor Street. The rest of the force main should be replaced in 2050.

9.2.2.3. Lift Station 3

Site improvements are recommended as referenced in Table 9-6. Pump capacities will need to be increased as Buildout conditions are reached.

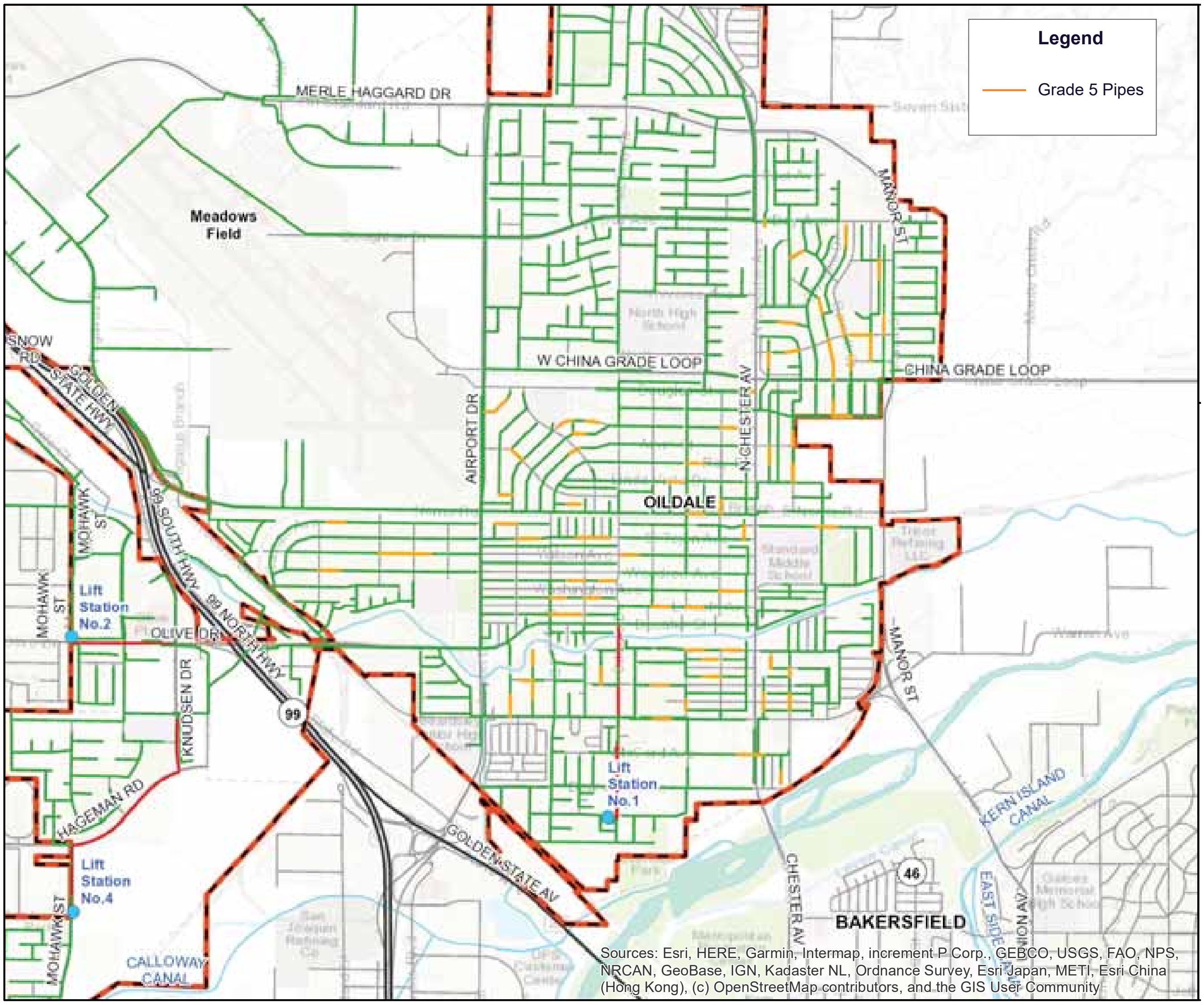
9.2.2.4. Lift Station 4

The area around this lift station may be developed in the near future. As a result, this lift station will be relocated and expanded in capacity to serve the community and paid for by the developer. If the development falls through, the force main will need to be replaced in 2050 and site improvements will need to be addressed as recommended in Table 9-7.

9.2.2.5. Lift Station 5

This is the newest lift station in NORSD. Site improvements are recommended as referenced in Table 9-8. Model results indicate that the force main exhibited velocity constraints. It is recommended to be replaced in 2065.

Figure 9-4. Pipes Requiring Replacements Due to Grade 5 Condition Rating (10/27/2023)



Source: District Asset Management platform

Table 9-4. Lift Station 1 Condition and Recommendations

Improvement Recommendation/Existing Defect	Source	Recommendation
Replace control system, electrical facilities and mechanical systems at 20 years of age	Standard Useful Life	MCC is in good condition and was replaced in 2016. Recommend that MCC remain.
Reconstruct/refurbish the roof of the control building	District input – prior to condition assessment visit	Reroof structure during rehabilitation
Fence repairs and gate replacement	District input – prior to condition assessment visit	Replace fence and install new gates during rehabilitation
SCADA upgrades	District input – prior to condition assessment visit	Recommend installation of PLC that will comply with the standards developed in the SCADA master plan.
Electrical and instrumentation upgrades to allow for remote operation	District input – prior to condition assessment visit	Starters in MCC should be modified to allow the starters to be controlled via the PLC. PLC will monitor the wet well level and control the pumps based on level. Floats would remain and be used as a backup to the level transmitter. PLC will monitor the pumps and provide alarms directly to the operator.
With SCADA/electrical upgrades may need AC in building	District input – prior to condition assessment visit	PLC's are typically rated for either 122 degrees Fahrenheit or 140 degrees Fahrenheit. UPS units recommended by the SCADA Master Plan will be evaluated for the ambient temperature. Ventilation should be adequate for the upgrades but may be reevaluated in the design once equipment is selected.
Rehabilitate the existing force main	District input – prior to condition assessment visit	Inspection currently in progress, rehabilitation planned for old force main following inspection
Piping improvements to allow for LS discharge to either force main and for bypass pumping to either force main	District input – prior to condition assessment visit	Install new bypass valves and connections during lift station rehabilitation.
Flow meter (magmeter) on discharge tied into SCADA	District input – prior to condition assessment visit	A flow meter would be provided on the discharge. The flow meter may be directly buried, with the electronics above grade, or a vault may be constructed around the flow meter.
Additional gravel placement	Condition assessment site visit	Install additional gravel
Replace rear gate with gate larger than existing 12-foot gate	Condition assessment site visit	Install larger rear gate.

Table 9-5. Lift Station 2 Condition and Recommendations

Improvement Recommendation/Existing Defect	Source	Recommendation
Replace control system, electrical facilities and mechanical systems at 20 years of age	Standard Useful Life	Operations staff regularly maintains mechanical equipment. Mechanical and electrical equipment with noted wear or defects are proposed for replacement below.
New fencing and gate	District input – prior to condition assessment visit	Replace fencing and gate
Gravel surfacing	District input – prior to condition assessment visit	Install additional gravel surface
SCADA upgrades	District input – prior to condition assessment visit	A PLC, in a dedicated NEMA 4X enclosure, will be selected in compliance with the SCADA Master Plan.
Electrical and instrumentation upgrades to allow for remote operation	District input – prior to condition assessment visit	It is recommended that a new pump control panel be provided to allow monitoring by the new PLC.
Security – panel and wet well alarms	District input – prior to condition assessment visit	It is recommended that the new PLC be provided with inputs that will have position indication of the wet well hatches, the pump control panel and the PLC panel.
Flow meter (mag meter) on discharge tied into SCADA	District input – prior to condition assessment visit	A flow meter would be provided on the discharge. The flow meter may be directly buried, with the electronics above grade, or a vault may be constructed around the flow meter.
Heavy corrosion on wet well piping	Condition assessment site visit	Replace piping in wet well
Bitumastic peeling on discharge piping	Condition assessment site visit	Abrasive blast and field paint discharge piping
One discharge isolation valve is broken open	Condition assessment site visit	Replace isolation valves
Pressure gauges are corroded	Condition assessment site visit	Replace pressure gauges
Pipe supports are rusted	Condition assessment site visit	Replace pipe supports
Some spalling of concrete in wet well, aggregate visible	Condition assessment site visit	Repair concrete surface and install new interior lining
Some pitting of wet well access hatch	Condition assessment site visit	Replace wet well access hatch
Bitumastic on interior of valve vault hatch peeling	Condition assessment site visit	Hatches are stainless and otherwise in good condition, wire brush to remove peeling bitumastic
Add canopy and fan to prevent overheating	Condition assessment site visit	Add canopy and fan to prevent overheating
Operations reports occasional issues with bubbler system	Condition assessment site visit	Replace with 2 pressure transducer in bubbler system
Pump control panel in fair condition, consider new PLC	Condition assessment site visit	The pump control panel is in fair condition. It is recommended that a new pump control panel be provided with logic to interface with the new PLC.

Table 9-6. Lift Station 3 Condition and Recommendations

Improvement Recommendation/Existing Defect	Source	Recommendation
Replace control system, electrical facilities and mechanical systems at 20 years of age	Standard Useful Life	The pump control panel appears to be in good condition, and it is recommended that the panel remain in service. In general, mechanical equipment is in good condition. Apart from items noted below, it is recommended mechanical equipment remain in service and be re-evaluated within 5 years for continued service
Gravel surfacing	District input – prior to condition assessment visit	Install additional gravel surfacing
SCADA upgrades	District input – prior to condition assessment visit	A PLC, in a dedicated NEMA 4X enclosure, will be selected in compliance with the SCADA Master Plan.
Electrical and instrumentation upgrades to allow for remote operation	District input – prior to condition assessment visit	The pump control logic will be modified in the field to allow control from the PLC with the floats as a backup control.
Security – panel and wet well alarms	District input – prior to condition assessment visit	It is recommended that the new PLC be provided with inputs that will have position indication of the wet well hatches, the pump control panel and the PLC panel.
Flow meter (magmeter) on discharge tied into SCADA	District input – prior to condition assessment visit	A flow meter would be provided on the discharge. The flow meter may be directly buried, with the electronics above grade, or a vault may be constructed around the flow meter.
Force main redundancy Project	District input – prior to condition assessment visit	Install redundant crossing of force main across Highway 65
Access is difficult through existing gate	Condition assessment site visit	Add large gates in corner and relocate site water backflow preventor for increased accessibility

Table 9-7. Lift Station 4 Condition and Recommendations

Improvement Recommendation/Existing Defect	Source	Recommendation
Replace control system, electrical facilities and mechanical systems at 20 years of age. Lift station is currently 22 years of age.	Standard Useful Life	The short-term plan is to replace this lift station with a lift station in a different location. It is not recommended to replace the electrical or mechanical equipment at this time.
Supports in the valve box – need to put in stainless steel supports	District input – prior to condition assessment visit	District is in the process of replacing the pipe supports
Longer term – relocate entire LS with new force main (existing FM to be backup) and demo existing LS	District input – prior to condition assessment visit	In the event the developer driven replacement does not move forward, reassess the lift station for rehabilitation.
SCADA upgrades	District input – prior to condition assessment visit	The short-term plan is to replace this lift station with a lift station in a different location. It is recommended that the auto-dialer remain in service for alarms until this lift station is taken out of service.
Electrical and instrumentation upgrades to allow for remote operation	District input – prior to condition assessment visit	The short-term plan is to replace this lift station with a lift station in a different location. It is not recommended to replace the electrical equipment at this time.
Security – panel and wet well alarms	District input – prior to condition assessment visit	The short-term plan is to replace this lift station with a lift station in a different location. It is not recommended to add security inputs to the auto-dialer.
Flow meter (mag meter) on discharge tied into SCADA	District input – prior to condition assessment visit	It is recommended that a flow meter be included with the new lift station.
Heavy corrosion product on wet well piping	Condition assessment site visit	Piping to remain in place. In the event the developer driven replacement does not occur, replace wet well piping
Wet well lining is T-lock. Some bubbling of T-lock is visible but no major delamination is present.	Condition assessment site visit	Lining to remain in place. In the event the developer driven replacement does not occur, consider rehabilitation of liner
Valve vault drainage drains to wet well, no flapper is present.	Condition assessment site visit	In the event the developer driven replacement does not occur, install flapper to prevent backup of sewer gasses into the valve vault.
Some areas of ground cover have thin gravel cover	Condition assessment site visit	In the event the developer driven replacement does not occur, install additional gravel cover

Table 9-8. Lift Station 5 Condition and Recommendations

Improvement Recommendation/Existing Defect	Source	Recommendation
Replace control system, electrical facilities and mechanical systems at 20 years of age. Lift station is currently 6 years of age and in good condition.	Standard Useful Life	Assess lift station in intervals of or about 5 years for maintenance updates and in 15 years for full rehabilitation.
SCADA upgrades	District input – prior to condition assessment visit	A PLC, in a dedicated NEMA 4X enclosure, will be selected in compliance with the SCADA Master Plan.
Electrical and instrumentation upgrades to allow for remote operation	District input – prior to condition assessment visit	The pump control panel appears to be in good condition, and it is recommended that the panel remain in service. The pump control logic will be modified in the field to allow control from the PLC with the floats as a backup control.
Security – panel and wet well alarms	District input – prior to condition assessment visit	A flow meter would be provided on the discharge. The flow meter may be directly buried, with the electronics above grade, or a vault may be constructed around the flow meter.
Flow meter (magmeter) on discharge tied into SCADA	District input – prior to condition assessment visit	A flow meter would be provided on the discharge. The flow meter may be directly buried, with the electronics above grade, or a vault may be constructed around the flow meter.
Provide 480V to 120/208V step down transformer for connection to portable generator	Assessment visit	The electricity to the pump station is provided at 120/208V, instead of 480V. In order to provide consistency for the portable generator, it is recommended that a step down transformer be provided to allow the same procedures to be followed as the other lift stations.

9.3. Other Recommended Improvements

9.3.1. Permanent Flow Meter Installations

Add two (2) Raven-Eye (by Trimble) permanent flow meters - one at Hw99 the other before Shafter Avenue connection. This will help the District understand flow characteristics from Oildale area as well as the high growth portions of the City of Shafter.

9.3.2. Wastewater Treatment Plant

Table 9-9 below is sourced from the 2018 SMP prepared by AECOM. These improvements were recommended to meet anticipated future developments in the NORSD service area as projected in the 2018 SMP and to facilitate higher use of its treated effluent to offset potable water use in the area. This plan is currently being revised under a new WWTP-specific master planning effort.

Table 9-9. WWTP CIP from 2018 Master Plan

	Existing	Expansion to			
	7.5 MGD	12 MGD	18 MGD	24 MGD	30 MGD
Process or Equipment / Year	2018	2022			
Headworks Channels & Screens	2	2	4	4	5
Headworks Pumping Capacity w/ largest out of service	13.2 MGD	21 MGD	33 MGD	44 MGD	55 MGD
Grit Removal Capacity	12 MGD	24 MGD	36 MGD	48 MGD	48 MGD
Primary Clarifiers	1	2	3	4	4
Trickling Filter	1	0	0	0	0
Aeration Basins	0	3	4	6	8
Blowers	0	3	4	6	8
Secondary Clarifiers	1	3	4	6	7
Digesters	2	2	3	4	6
Sludge Holding Tanks	0	2	2	2	2
Screw Presses	1	2	3	4	5

9.4. Cost Estimates

Tables 9-10 through 9-13 includes unit costs associated with pipe and manhole replacement and rehabilitation work. Unit costs were developed from analyzing bid results received from the District and local area from 2021 through 2022. Unit costs are rounded to the nearest $10.

Construction Unit Costs for Table 9-10 through 9-12 were derived from averaging unit costs from bid results for the rehabilitation or construction type. The Capital Unit Cost includes a construction contingency based on the average ratio between the listed rehabilitation/replacement construction costs and the overall project construction costs. Construction contingency would typically account for mobilization and demobilization, traffic control, sheeting, bypassing, shoring, and bracing, easement site restoration, and lateral reinstatement, pre-and post-cleaning costs. The Capital Unit Costs, therefore, accounts for about 40% construction contingency and other soft costs like 10% engineering cost, 10% construction management cost, and 10% project administration cost. Since costs were only available for pipe sizes between 6 and 10-inches in most cases, unit costs for other pipe sizes were estimated based on those developed from other recent planning projects.

Table 9-10. Unit Costs for Pipe Replacement

Pipe Size	Construction Unit Costs ($/LF)	Capital Unit Cost ($/LF)
6	190	350
8	200	360
10	220	390
12	230	420
15	250	460
18	280	500
21	300	540
24	320	580
27	340	620
30	360	660
36	410	740
42	450	820
48	500	900

Table 9-11. Unit Costs for CIPP Rehabilitation

Pipe Size	Construction Unit Costs ($/LF)	Capital Unit Cost ($/LF)
6	30	50
8	30	50
10	40	70
12	50	80
15	50	100
18	80	140
21	120	210
24	140	250
27	160	290

Table 9-12. Unit Costs for Point Repair

Pipe Size	Construction Unit Costs ($/LF)	Capital Unit Cost ($/LF)
6	920	1,670
8	1,100	2,010
10	1,240	2,260
12	1,340	2,440
15	1,510	2,740
18	1,630	2,960
21	1,710	3,110
24	1,760	3,200
27	1,780	3,240

Table 9-13. Unit Costs for Manhole Rehabilitation

Rehabilitation Method	Construction Unit Costs ($ea.)	Capital Unit Cost ($ ea.)
Rehabilitation/Repair	1,560	2,840
Replacement (<5 ft. manhole diameter)	8,130	14,790
Replacement (CIP3, 84-inch manhole diameter)	16,490	30,000

9.5. Recommended Capital Improvement Plan (CIP)

Table 9-14 shows the 10-Year CIP for NORSD with summary descriptions and costs phased per fiscal year (FY) ending in June of 2023 and phased in 5-year increments to FY 2033. The table also includes a list of projects recommended as buildout conditions (FY 2033 – 2050) are reached. Sources of cost estimates are included for future reference. All costs are rounded to the nearest $1000.

Cost estimates from previous years, specifically for LS 3 force main are brought to 2022 year costs using ENR[17]'s October 2022 construction cost index table. Cost estimates for the Wastewater Treatment Plant is from a more recent February 2023 estimation provided by Woodard & Curran. Please note that LS 4 improvements are anticipated to be funded in part by the developer. Cost escalation factors are included in the 2023 Sewer Service Charge & Capacity Fee Study Report by Bartle Wells to account for anticipated inflation trends.

Manhole assessments were not performed as part of this project scope. However, as part of an existing capital improvement and in line with its asset management program, the District is performing ten manhole rehabilitation projects along its Outfall Sewer trunk lines. The District has completed two projects. Projects 3 and 4 are currently under construction. The remaining six projects are expected to be completed at a rate of $500,000/year over the next ten years. Further, it is recommended that existing manholes for pipes recommended for CIP be inspected per NASSCO standards and checked for structural integrity and replaced if required during main improvements. Manhole installation costs are included for CIP3 project.

Total CIP cost for FY 2023 – 2028, FY 2028 – 2033, and FY 2033 – 2050 are $22,035,000, $299,341,000, and $235,150,000 respectively.

[17] Engineering News Record (www.enr.com)

Table 9-14. District Capital Improvement Program

Item No.	Category	Facility	Summary Project Description	FY 2023-2028	FY 2028-2033	FY 2033 - 2050	Notes	Cost Source
1	Capacity-Related Improvements	Pipe	CIP1, Upsize ~ 1,020 feet of 10- to 15-inch on Lincoln Ave. & Oildale	$466,000			Estimated Start Year: 2025	Table 9-1; Refer to Table 9-10 for unit costs
2	Capacity-Related Improvements	Pipe	CIP3, Add ~ 13,028 feet of 42-inch and ~ 50,374 feet of 48-inch trunk line between Rudd Ave. and WWTP Outfall along Kratzmeyer Rd. and Snow Road; includes ~ 106 new manholes at 600-ft apart			$59,191,000	Estimated Start Year: 2033	Table 9-1; Refer to Tables 9-10 & 9-13 for unit costs
3	Capacity-Related Improvements	Pipe	CIP4 to CIP13, Upsize or install ~45,698 feet of main; no new manhole installations will be required			$16,693,000	Estimated Start Year: 2033	Table 9-1; Refer to Tables 9-10 & 9-13 for unit costs
4	Site Improvements	Lift Station (LS) 1	Rehabilitation	$554,000			Estimated Start Year: 2025	Base Cost: $553,518; Appendix D - Lift Station Condition Assessments, Attachment A
5	Site Improvements	LS 2	Rehabilitation	$498,000			Estimated Start Year: 2027	Base Cost: $497,839; Appendix D - Lift Station Condition Assessments, Attachment A
6	Site Improvements	LS 3	Improvements	$302,000			Estimated Start Year: 2025; Note that additional capital post FY 2033 may be required as pump exhibited capacity issues at Buildout conditions in model	Base Cost: $301,635; Appendix D - Lift Station Condition Assessments, Attachment A
7	Site Improvements	LS 5	Improvements	$357,000			Estimated Start Year: 2027	Base Cost: $356,916; Appendix D - Lift Station Condition Assessments, Attachment A
8	Force Main Improvements	LS 1 Force Main	Rehabilitate old force main (FM1)	$900,000			Estimated Start Year: 2024	Base Cost: $900,000; Provost & Pritchard 2022 Phase 1 Investigation - S.Oildale Drive Backup Force Main from LS 1 to Decatur Street TM
	Force Main Improvements	LS 1 Force Main	Replace 3,800 feet of 10-inch FM 2 in 2040			$1,482,000	Estimated Start Year: 2050	Refer to Table 9-10 for unit costs
9	Force Main Improvements	LS 2 Force Main	Replace ~ 1,100 feet of 10-inch PVC force main with kind along Olive Drive from Mohawk Road to Victor Street	$429,000			Estimated Start Year: 2026; Abandon rest of force main	Refer to Table 9-10 for unit costs
10	Force Main Improvements	LS 3 Force Main	Construct force main redundancies	$858,000			Estimated Start Year: 2026	Base Cost: $757,800 in 2020; Appendix D - Lift Station Condition Assessments, Attachment H
	Force Main Improvements	LS 3 Force Main	Complete 1,900 feet of redundant 8-inch force main in 2050			$684,000	Estimated Start Year: 2040	Refer to Table 9-10 for unit costs
11	Force Main Improvements	LS 4 Force Main	Relocate lift station; could result in addition of redundant force main (NORSD portion is approx. 2/3 of total cost)	$3,901,000			Estimated Start Year: 2024; Note to replace original force main in 2051	Base Cost: $5,851,000; AECOM 2022 Lift Station No.4 Relocation Feasibility Analysis
12	Force Main Improvements	LS 5 Force Main					Replace original force main in 2065; velocity constraints under PDF noted	
13	Condition-Related Improvements	Pipe	Remove and Replace (R/R) ~ 23,937 feet of Grade 5 PACP Pipes	$4,330,000	$4,330,000	$21,600,000	Assumes ~ $865,902 per year investment for the next 10 years and all pipes with Grade 5 defects installed before 1960 will need replacement; Assumes ~ $800,000/yr investment for R/R after 10 years to buildout	Table 8-1; Refer to Tables 9-10 and 9-12 for unit costs

Table 9-14. District Capital Improvement Program (cont.)

Item No.	Category	Facility	Summary Project Description	FY 2023-2028	FY 2028-2033	FY 2033 - 2050	Notes	Cost Source
14	Condition-Related Improvements	Pipe	Spot Repair ~ 7,305 feet of Grade 5 PACP Pipes	$7,908,000	$7,908,000	$21,600,000	Assumes $1,581,550 per year investment for the next 10 years and all pipes with Grade 5 defects installed after 1960 will spot repairs; Assumes ~800,000/yr investment for spot repairs after 10 years to buildout	Table 8-1; Refer to Tables 9-10 and 9-12 for unit costs
15	Condition-Related Improvements	Manholes	Rehabilitate Manholes along Outfall Sewer	$1,500,000	$1,500,000			Existing capital improvement project
16	Other	Flow Meters	Two Permanent Installations	$32,000	$3,000		Estimated Start Year: 2025; $500/year monitoring cost	District estimate from Trimble
17	WWTP Expansion	WWTP	12 MGD Expansion		$285,600,000		Estimated Start Year: 2028	2023 Woodard & Curran estimate per email (2/3/23) x 70% soft costs and construction contingencies
18	WWTP Expansion	WWTP	18 MGD Expansion			$113,900,000	Estimated Start Year: 2050	2023 Woodard & Curran estimate per email (2/3/23) x 70% soft costs and construction contingencies
	TOTAL			**$22,035,000**	**$299,341,000**	**$235,150,000**		