Planning Commission
Remote Meeting Instructions for July 27, 2021 Meeting

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> **E-mail – Submit to** cd_admin_team@greeleygov.com
> All comments submitted by e-mail will be read into the record at the appropriate points during the meeting in real time. Comments can be submitted up to and throughout the meeting.
>
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> All written comments must be received no later than the day of the meeting. Written comments received by mail will also be read into the record in real time.

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Planning Commission Agenda

July 27, 2021 at 1:15 p.m.

This meeting will be conducted remotely. (See previous page or participation instructions and/or to view the YouTube replay.)

I. Call to Order

II. Roll Call

III. Approval of Agenda

IV. Approval of July 13, 2021 Minutes

V. Public hearing to consider City of Greeley Water and Sewer Department Sanitary Sewer Master Plan and Water Transmission & Distribution Master Plan from 2018 to 2021

Presenters: Adam Prior, Chief Engineer, Water & Sewer
Sean Chambers, Director, Water & Sewer

VI. Public hearing to consider amendments to Title 24 of the 2021 Greeley Municipal Code to adopt Chapters 3-6 and 13

Project: Development Code Update
Case No.: CU2021-0005
Presenter: Carol Kuhn, Chief Planner

VII. Staff Report

VIII. Adjournment

Chair
Justin Yeater

Vice-Chair
Erik Briscoe

Commissioners
Louisa Andersen
Brian Franzen
Larry Modlin
Chelsie Romulo
Christian Schulte

A City Achieving Community Excellence

Greeley promotes a healthy, diverse economy and high quality of life responsive to all its residents and neighborhoods, thoughtfully managing its human and natural resources in a manner that creates and sustains a safe, unique, vibrant and rewarding community in which to live, work, and play.

City of Greeley, Colorado
PLANNING COMMISSION PROCEEDINGS

July 13, 2021

I. Election of Chair Person Pro Tem

Commissioner Franzen moved to elect Louisa Andersen to serve as Chair Pro Tem for this meeting. Commissioner Romulo seconded the motion. Motion carried 4-0.

II. Call to Order

Chair Pro Tem Andersen called the remote meeting to order at 1:17 p.m. via the City's Zoom platform.

III. Roll Call

The hearing clerk called the roll.

PRESENT
Chair Pro Tem Louisa Andersen
Commissioner Franzen
Commissioner Modlin
Commissioner Romulo

ABSENT
Commissioner Erik Briscoe
Commissioner Christian Schulte
Chair Justin Yeater

IV. Approval of Agenda

Commissioner Romulo moved to approve the agenda. Commissioner Franzen seconded the motion. Motion carried 4-0.

V. Approval of June 22, 2021 Minutes

Commissioner Romulo moved to approve the minutes dated June 22, 2021. Commissioner Franzen seconded the motion. Motion carried 4-0.

DRAFT

VI. Public hearing to consider a petition to annex approximately 450.477 acres of unincorporated property into the City of Greeley located generally between County Roads 25 and 27 and north and south of County Road 62

Project: The Cache Annexation
Case No.: ANX2020-0002
Applicant: Ryan Littleton
Location: Generally between County Roads 25 and 27 and north and south of County Road 62
Presenter: Brittany Hathaway, Planner III

VII. Public hearing to consider a request for an establishment of zoning, a rezone from R-L (Residential Low Density) and PUD (Planned Unit Development) to PUD, and a Preliminary PUD Plan for approximately 788 acres of property, known as The Cache, located north of US Highway 34 Business, east and west of 95th Avenue and west of 83rd Avenue

Project: The Cache Preliminary Planned Unit Development Plan
Case No.: PUD2020-0007, ZON 2021-0010, ZON2021-0013
Applicant: Todd Johnson
Location: North of US Highway 34 Business, east and west of 95th Avenue and west of 83rd Avenue
Presenter: Brittany Hathaway, Planner III

A request was made to combine items VI and VII into one presentation. Chair Pro Tem Andersen introduced both items.

Ms. Hathaway addressed the Commission and described the various items that comprised the project and development known as The Cache. The first item was the annexation of approximately 450 acres with an accompanying establishment of zoning. Ms. Hathaway presented a map depicting the area to be annexed. She also pointed out the area requested to be rezoned and reported that the entire area is proposed for a Preliminary PUD plan.

The Preliminary PUD request is for a 788-acre site that includes 450.477 acres currently zoned as Weld County A (agricultural). The Preliminary PUD request contains features that include up to 3,741 residential units, 39.2 acres of commercial mixed use, 239 acres of open space which includes 40.8 acres of bluff preservation dedicated to the City, four pocket parks, two amenity centers, one community/neighborhood park, approximately 7.23 miles of trails, and a school site dedicated for Weld Re-4 School District.

Ms. Hathaway described the master plan that includes open space areas, trails and internal sidewalks that will be determined at the time of subdivision platting. She noted the locations of a future school site and neighborhood and pocket parks throughout the development, adding that commercial will be concentrated along Highway 34 Business. Ms. Hathaway also noted the standards for the subdivision that include lot

sizes, setbacks and architectural standards. She noted that a water-wise landscaping plan is also included in the project.

Ms. Hathaway presented photographs of the site. Notices were mailed to surrounding property owners, signs were posted on the site, and legal notice of the hearing was published in the newspaper. One inquiry was received from a citizen asking about the general location of the project. Staff recommended approval.

Todd Johnson, Terra Forma Solutions, 3465 S. Gaylord Court, Englewood, Colorado, addressed the Commission on behalf of Cache LLC. Mr. Johnson thanked staff and the Commission. He noted the metropolitan district that was approved by City Council last year and stated that this is the next step to move the project forward and begin development. He stated that this is a unique project for Greeley that brings many amenities while preserving the bluff area.

Chair Pro Tem Andersen opened the public hearing at 1:29 p.m.

An email from Jackie Sokol, 669 White Tail Avenue, Greeley, was read into the record. Ms. Sokol also requested to address the Commission and had a few more questions about the location of commercial development, the eastern boundary of the development and noise concerns. Mr. Johnson reported that commercial development would be located mainly along Highway 34 and that the eastern boundary is near 83rd Avenue and Poudre River Road. He added that the developer will work with the City to mitigate any traffic impacts and will address those during the next stage of the development. Mr. Johnson advised that the developer would also work with the City to provide any required noise studies.

Chair Pro Tem Andersen closed the public hearing at 1:38 p.m.

Referring to the notation in the materials that potable and non-potable water would be available, Commissioner Modlin asked whether non-potable water would be made available to individual residents. Mr. Johnson stated that non-potable water would be available throughout the community for major areas of consumption such as parks and pocket parks. He added that there have been no discussions to date about individual use. Ms. Hathaway stated that this could be reviewed more closely during the subdivision phase.

Commissioner Romulo asked where citizens might obtain information about the project. Ms. Hathaway advised that all agendas and packets are available on the City website and stated that citizens are also welcome to call Planning staff at 970-350-9780.

Ms. Sokol requested permission to speak to the Commission. Chair Pro Tem Andersen reopened the public hearing at 1:43 p.m.

Ms. Sokol expressed concerns about the speed of traffic traveling along 83rd Avenue.

Chair Pro Tem Andersen closed the public hearing at 1:45 p.m.

Commissioner Franzen commended the applicant on the project and indicated that it looked like a good addition to the City.

Commissioner Romulo moved that, based on the application received and the preceding analysis, the Planning Commission finds that the proposed annexation meets the required Development Code criteria of Section 24-581(a)(1-5); and recommend approval of the Annexation to the City Council. Commissioner Franzen seconded the motion. Motion carried 4-0.

Commissioner Romulo moved that, based on the application received and the preceding analysis, the Planning Commission finds that the proposed PUD (Planned Unit Development) zone district is in compliance with Development Code Section 24-583(b)(2) regarding the establishment of zoning and therefore recommends approval, contingent upon the City Council's approval of The Cache Annexation petition (ANX2020-0002). Commissioner Modlin seconded the motion. Motion carried 4-0.

Commissioner Romulo moved that, based on the application received and the preceding analysis, the Planning Commission finds that the proposed rezoning from Residential Low Density (R-L) and Planned Unit Development (PUD) to Planned Unit Development (PUD) is in compliance with Development Code Section 24-625(c)(3) a, b, e and g and therefore recommends approval, contingent upon the City Council's approval of The Cache Annexation petition (ANX2020-0002). Commissioner Franzen seconded the motion. Motion carried 4-0.

Commissioner Romulo moved that, based on the application received and the preceding analysis, the Planning Commission finds that the proposed The Cache Preliminary PUD Plan is in compliance with Development Code Section 24-625(c)(3) a, b, e and g and Section 24-663(b) and therefore recommends approval, contingent upon the City Council's approval of The Cache Annexation petition (ANX2020-0002). Commissioner Modlin seconded the motion. Motion carried 4-0.

VIII. Public hearing to consider a Use by Special Review request to allow for a convenience store with gas sales in the I-M (Industrial Medium Intensity) zone district

Project: 225 22nd Street and 2123 2nd Avenue Circle K USR
Case No.: USR2021-0001
Applicant: Corey Stinar, Arris Architecture, Inc., on behalf of Circle K Stores
Location: 225 22nd Street and 2123 2nd Avenue
Presenter: Darrell Gesick, Planner III

Darrell Gesick addressed the Commission and introduced the case, stating that there is a minor subdivision application running currently with the Use by Special Review. He presented a map of the area and stated that the applicant proposes to erect a 5200-square-foot building on a 2.7-acre site that includes passenger car and truck parking, two access points and open space. Mr. Gesick

presented the site plan, landscape plan and building elevations. He briefly described the approval criteria.

Notices were mailed to surrounding property owners, signs were posted on the site, and legal notice of the hearing was published in the newspaper with no inquiries. Staff recommended approval.

Corey Stinar, Arris Architecture, 3436 New Castle Drive, Loveland, Colorado, addressed the Commission on behalf of the applicant and offered to answer questions.

Chair Pro Tem Andersen opened the public hearing at 1:55.

Roxanne (last name not provided) addressed the Commission through the Zoom Q&A and asked about the plan for traffic control since the intersection already experiences a high volume of traffic.

Chair Pro Tem Andersen closed the public hearing at 1:55 p.m.

Mr. Stinar responded that a traffic study had been prepared and that impacts were determined to be within the means of the existing infrastructure.

Chair Pro Tam Andersen observed that the location of 2nd Street to Highway 85 could make it interesting for large trucks to make a turn at the stoplight and asked whether the City had a way to mitigate any issues at the frontage road. Mr. Gesick advised that the City of Greeley and the Colorado Department of Transportation (CDOT) had reviewed the plans and that CDOT accepted the project as presented. Commissioner Romulo noted reference to a traffic impact study and asked whether it was available to the public. Mr. Gesick stated that citizens could contact the Planning office to obtain a copy and that the packet was available online.

Thomas Gilbert, Engineering Development Review, addressed the Commission and stated that the level of service analysis for the intersection for the short and long term determined that everything was within the City of Greeley criteria. He added that 2nd Avenue is owned by CDOT who determined the project was within their criteria.

Commissioner Franzen moved that, based on the application received and the preceding analysis, the Planning Commission finds that the proposed Use by Special Review for a Convenience Store with Gas Sales in the I-M (Industrial Medium Intensity) Zone District is consistent with the Development Code criteria of Section 24-480(a) (Items 1 through 5), and; therefore, approve the Use by Special Review as submitted. Commissioner Modlin seconded the motion. Motion carried 4-0.

DRAFT

IX. Worksession: Code Update, Chapters 3, 4, 5 & 6 (Part II) and Chapter 13

Presenter: Carol Kuhn, Chief Planner

Due to a prior commitment, one of the Commissioners had to leave the meeting, creating lack of a quorum. Commissioner Franzen moved to continue Item IX to the next regular meeting on July 27, 2021. Commissioner Romulo seconded the motion.

Ms. Kuhn addressed the Commission and asked whether they might entertain scheduling a special meeting on July 20, 2021 so that the Development Code update could remain on schedule. Commissioner Franzen moved to approve a special meeting on July 20, 2021 at 1:15 p.m. Commissioner Romulo seconded the motion. The four Commissioners present indicated that they would be able to attend. Motion carried 4-0.

X. Staff Report

Mr. Mueller thanked the Planning Commissioners for their flexibility to schedule a special meeting the following week. Commissioner Modlin asked when the Commission might return to in-person meetings. Mr. Mueller reported that the plan is to return to a hybrid setting allowing both in-person and virtual meetings, adding that the City Clerk's office will be scheduling time to coordinate and train staff and the Commission.

XI. Adjournment

With no further business before the Commission, Chair Pro Tem Andersen adjourned the meeting at 2:09 p.m.

_____
Louisa Andersen, Chair Pro Tem

_____
Brad Mueller, Secretary

DRAFT

Read into the recording during public hearing during The Cache presentation.

Hello,

My name is Jackie Sokol. I live at 669 White Tail Avenue. My home backs up to 83rd Avenue (on the east side of 83rd Avenue across from the Poudre Learning Center).

I am submitting several questions and comments detailed below. I hope you will address as many of these items as you can at the Planning Commission meeting on July 13, 2021. These questions and comments are predicated on the assumption that the proposed annexation and rezoning will be approved and that development of the property will occur at some future date. I realize it is so early in the planning process.that it may be impossible to answer some of these questions at this time, but thought it better to ask these questions sooner than later. My questions/comments are:

1. What type of development is anticipated to occur on the property? Will it be single-family dwellings, multiple-family dwellings, or a mixture of the two? In addition, is any commercial development planned?

2. Is there an anticipated timeframe for development to commence?

3. If residential development does occur, approximately how many single-family and multi-family dwellings would this property accommodate?

4. What streets and roads are expected to provide the primary means of access?

5. Have any traffic studies been done on either 83rd Avenue or 95th Avenue or are such studies planned? At certain times of day, 83rd Avenue already appears to be exceeding capacity and in some locations the roadway is literally falling apart. In addition, a sizable number of drivers disregard the posted speed limits. I see and/or hear a minimum of at least one instance each week where a vehicle locks up its' brakes to avoid striking a pedestrian in the crosswalk or to avoid colliding with a slower-moving vehicle. I rarely drive on 95th Avenue because it has its' own problems that need to be addressed.

6. If widening of 83rd Avenue is planned, will action be taken to mitigate the increased noise?

Any information you can provide to address these questions would be greatly appreciated.

Thank you for your consideration.

Jackie Sokol

PLANNING COMMISSION SUMMARY

ITEM: Amendment to the 2018 Comprehensive Plan to include, by reference, the 2021 Sanitary Sewer Master Plan and the 2021 Water Transmission and Distribution Master Plan

FILE NUMBER: CU2021-0002

PROJECT: Amendment to the 2018 Comprehensive Plan to include, by reference, the 2021 Sanitary Sewer Master Plan and the 2021 Water Transmission and Distribution Master Plan

APPLICANT: City of Greeley, Water & Sewer Department

CASE PLANNER: Adam Prior, Water & Sewer Chief Engineer

PLANNING COMMISSION HEARING DATE: July 27, 2021

PLANNING COMMISSION FUNCTION:
The Planning Commission shall consider the staff report, along with testimony and comments made by staff and the public, and shall then make a recommendation to the City Council regarding the proposed amendments to the 2018 Comprehensive Plan to include, by reference, the enclosed 2021 Sanitary Sewer Master Plan and the 2021 Water Transmission and Distribution Master Plan.

EXECUTIVE SUMMARY

The City of Greeley Water and Sewer Department has developed the Sanitary Sewer Master Plan and Water Transmission & Distribution Master Plan from 2018 to 2021. As the City is growing at a rapid pace, these master plans developed long term infrastructure needs to better prepare and accommodate this growth. These master plans established infrastructure sizing for the entire Greeley Long Range Expected Growth Area. These reports include proposed 5-year, 20-year, and full build-out schedules with estimated costs per project for expanding and improving the systems. This information was used to develop models for each master plan of the existing and future systems, which helped to develop the proposed infrastructure needs for adequate public facilities to support the 2018 Comprehensive Plan.

STAFF RECOMMENDATION

Approval

BACKGROUND

Water and Sewer Department has embarked on the process of completing a Sanitary Sewer Master Plan that was completed in June of 2021. The project started in 2018 with the selection of CDM Smith to complete the engineering services based on past experience with Greeley and extensive master planning qualifications. The project started with monitoring wastewater flows in the entire collection system, which involved 12 temporary flow meters, nine permanent flow meters, two rain gauges,

and 60 days of data collection. This critical step was followed by developing the existing system model for sewer lines 10" and larger. The project then progressed to utilizing the system model to look at existing conditions of the system and planning the expansion of the system in the 5-year, 20-year, and full system build-out time frames. The future land use planning incorporated the actual planned developments within Greeley, the 2018 Comprehensive Plan, planning development reports, 2019 zoning, and coordination with the City's Planning Department staff. This information was incorporated with wastewater flow projections for residential, non-residential, groundwater infiltration, rain dependent infiltration and inflow, and a 5-year storm event system to estimate future demand throughout Greeley. These future demands were integrated into the system expansion model that was utilized to size all sanitary sewer infrastructure out to Greeley's Long Range Expected Growth Area.

The Water Transmission and Distributions Master Plan project started in 2017 with the selection of Bohannan Huston to update the existing 2008 water transmission and distribution model. Then in 2018, the City selected CDM Smith to complete the engineering services for the Master Plan and planning for the expansion of the system. One of the first steps was developing the long term water demands within the Long Term Growth Boundary was utilizing the 2018 Imagine Greeley Land Use Guidance Map, existing zoning, future development projections, and working with the Planning Department. This information was combined to estimate the peak month water demands for full buildout of the system. The next steps were developing the water distribution system that could meet the water demands and pressures required throughout the system. The project then progressed to utilizing the system model for maintaining fire flows, water quality, the expansion of the system in the 5-year, 20-year, and full system build-out time frames.

The final steps included developing CIP projects throughout the system and making sure it was coordinated with the other two Water & Sewer master plan projects and other City Department CIP projects. The final aspects of the project included coordinating outreach efforts to discuss the planned master plans with different community members and groups interested in participating in reviewing the City's draft master plan and providing critical input or comments. This different feedback and input has now been incorporated into the master plan final report completed in June 2021.

KEY ISSUES/STAFF ANALYSIS

Article XIX, Section 19-1(b) of the Greeley Charter describes the Planning Commission's role in providing advice on land use matters to the City Council. The 2018 Comprehensive Plan also requires that the Planning Commission conduct a public hearing on any proposed amendment to the 2018 Comprehensive Plan, which includes a modification to policies contained within other master plans adopted by reference in the plan, and provide a recommendation to City Council on the same.

The updated water and sewer master plans provides the backbone infrastructure required for long term growth of the sanitary sewer system and water transmission and

distributions system. The planning documents are essential to ensure future development in Greeley are served by adequate public facilities and services. These master plans address the City of Greeley Comprehensive Plan Action Plan items: IMP IN-1.2, IMP IN-1.5, IMP IN-1.6, IMP IN-1.7, and IMP-IN-1.8 as shown in Attachment C.

PUBLIC NOTICE AND COMMENT

Staff met with all adjacent communities to develop collaboration and improvement the systems across Northern Colorado. Staff also worked with outside engineers, developers and interested parties to review the master plans and provide insight and comments to the City. These comments have all been addressed and included in the respective master plan. Finally staff presented to the Builders, Realtors, and Developer Roundtable on July 19th, 2021 to discuss the key aspects of all master plans.

The water and sewer department has had many updates to the Water & Sewer Board throughout the project. On July 21, 2021 the Water & Sewer Board approved and recommended the Sanitary Sewer Master Plan and Water Transmission and Distribution Master Plans to City Council.

A formal notice was submitted to the Tribune on July 16, 2021.

PLANNING COMMISSION RECOMMENDED MOTION

A motion that, based on public comment, the Project Summary and accompanying analysis, the Planning Commission recommend to City Council adoption of the enclosed 2021 Wastewater Collections Infrastructure Master Plan and 2021 Water Distribution Infrastructure Master Plan and incorporation of the same by reference as an amendment to the 2018 Comprehensive Plan.

ATTACHMENTS

Attachment A –Sanitary Sewer Master Plan
Attachment B – Water Transmission and Distribution Master Plan
Attachment C – City of Greeley Comprehensive Plan: Action Plan for Infrastructure

City of Greeley Colorado

FINAL

Greeley Sanitary Sewer Master Plan Report

June 2021

CDM Smith

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Appendix G Goals from Comprehensive Plan

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Acronyms and Abbreviations

$/LF	dollars per linear foot
ac	acre
ASCE	American Society of Civil Engineers
ADF	average daily flow
ADWF	average daily wastewater flow
BWF	base wastewater flow
CIP	capital improvement plan or program
CIWEM	Chartered Institution of Water and Environmental Management
C-H	commercial high intensity
C-L	commercial low intensity
CMAR	construction manager at risk
d/D	depth of diameter
DDA	Downtown development area
DWF	dry weather flow
DU	dwelling unit
DU/acre	dwelling unit(s) per acre
ENR-CCI	Engineering News Record Cost Construction Index
EPA	Environmental Protection Agency
EPS	extended period simulation
FEMA	Federal Emergency Management Agency
ft	feet (or foot)
fps	feet per second
gpcd	gallons per capita per day
gpd	gallons per day
gpd/acre	gallons per day per acre
gpm	gallons per minute
GIS	geographic information system
GWI	groundwater infiltration
HP	horsepower
hr	hour
I-H	industrial high intensity
I-L	industrial low intensity
I-M	industrial medium density
I/I	inflow and infiltration
IGA	intergovernmental agreement
LS	lift station
LREGA	long-range expected growth area
MH	manhole
mgd	million gallons per day
NGS	National Geodetic Survey
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
NAVD	North America Vertical Datum

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NFRWQPA	North Front Range Water Quality Planning Association
OPCC	opinion of probable construction cost
PUD	Planned Unit Development
PVC	polyvinyl chloride
RDII	rainfall dependent inflow and infiltration
R-E	residential estate
R-H	residential high density
R-L	residential low density
R-M	residential medium density
R-MH	residential mobile home
SSOAP	Sanitary Sewer Overflow Analysis and Planning
TDH	total dynamic head
UNC	University of Northern Colorado
USACE	United States Army Corps of Engineers
VFD	variable frequency drive
WTRF	Wastewater Treatment and Reclamation Facility
WPCF	Water Pollution Control Facility
WWF	wet weather flow

Definitions

Average annual daily flow – the daily average flow over a one-year period.

Base wastewater flow - the portion of wastewater flow that comes directly from water use and follows a diurnal pattern with a peaking factor.

Buildout – the theoretical point in time where the City has experienced complete development within the LREGA, expected to be sometime after year 2090

Capital improvement - a recommended City construction project to improve or expand the system, summarized in the capital improvement plan

Design storm – theoretical wet weather event with a set duration recurrence frequency that is used to analyze the impacts on the sanitary sewer system. The design storm has a set recurrence frequency.

Diurnal curve - a pattern of peaking factors applied to a base demand (the typical demand for an area) that shows how demands vary by pattern throughout the day; the diurnal curve typically includes the peak hour

Dry weather flow – the wastewater flow within the sewer system that during dry weather periods.

Extended period simulation - a hydraulic modeling methodology that shows how the system performs over a set timescale, during which demands and operating conditions can vary

Firm capacity – capacity of the pump station with one pump (largest) out of service.

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Flow factor - value used to estimate the water demand that a given amount of land will produce once its developed, depending on its land use

Freeboard – difference in elevation between the top of the water in a manhole to the top of the manhole or surface elevation. Freeboard of greater than 10 is desired to avoid potential flooding or basement back-ups.

Groundwater infiltration – groundwater that enters the sewer system through defects in the system that allows groundwater or other dry weather sources to infiltrate the pipe system. This is a constant daily flow that may have seasonal variation.

Infiltration – water that seeps into the sewer system through cracks, holes, joint off-sets and other means Infiltration is typically slow leaking into the pipe.

Inflow – water that enters the sewer system through direct connections such as cross connections, manhole lids or defects, and direct stormwater connections. Inflow is typically rapid.

Long range expected growth area - the limits of the City's expected growth and where it plans to provide water and wastewater services.

Opinion of probable construction cost - the costs borne by the contractor to construct a capital project

Peak day demand – the average demand anticipated during a maximum one-day period for a typical year

Peak day flow – the maximum flow anticipated to occur during a one-day period expressed as the daily average.

Peak hour demand – the average demand anticipated during a maximum one-hour period for a typical year; this is considered to be a conservative value for infrastructure sizing

Peak month demand – the average demand anticipated during a maximum one-month period for a typical year, typically experienced during July

Planning horizon - a timeframe used to estimate expected demands and infrastructure needs

Rainfall dependent I/I – flow that comes from defects in the system or openings in the system that allow water from precipitation to enter the system. This flow varies depending on the wet weather event duration and intensity.

RTK – Three parameters used to characterize the rainfall dependent inflow and infiltration unit hydrographs. R is the fraction of rainfall volume that enters the sanitary sewer. Low R values indicate a sewer system with very little inflow or infiltration. T is the time from the onset of rainfall to the peak of the wet weather hydrograph. K is the ratio of the time of hydrograph recession to the time to hydrograph peak.

Surcharged – pipes with a depth over diameter of greater than 1.

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Tier 1, 2 or 3 – tier of information used to distribute future flow parameters to currently undeveloped areas or areas of redevelopment.

Wet weather flow – the wastewater flow within the sewer system that occurs during of following a rainfall event.

Winter water use – the amount of water used in winter months, defined as December through February.

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Executive Summary

The City of Greeley (City), Colorado is in Weld County approximately 60 miles northeast of Denver close to Fort Collins and Loveland. Greeley is the twelfth largest city in Colorado and has developed into a cultural and academic hub, hosting educational institutions such as the University of Northern Colorado (UNC) and Aims Community College. Greeley offers an affordable cost of living with many options for housing and economic growth. Greeley's population grew from 20,354 in 1950 to an estimated population of 108,175 in 2019. Greeley continues to experience strong growth in population through both infill and expansion of residential and non-residential development within the City's defined service area.

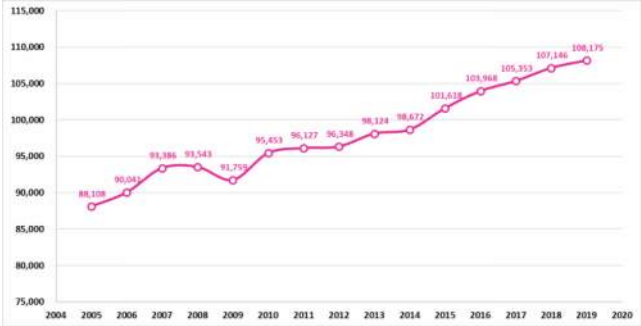

Figure ES-1 Historic Population for the City of Greeley

ES.1 Greeley Master Plan Integration

To address existing and future system needs, the City has updated their 2008 sanitary sewer system master plan and 2014 sewer system model to reflect changes in the system and modify City data. The 2021 Sewer System Master Plan update occurred concurrently with updates to the City's Water Master Plan and Non-Potable Water Master Plan, providing the ability to use consistent data for population and growth; common planning horizons of 5-year, 20-year and buildout; and an integrated planning approach to capital improvement plans (CIP) development. This approach to integrated master planning provides the City with a defensible and coordinated CIP and allows for the scheduling of CIP projects to minimize impacts to citizens. **Figure ES-2** illustrates the critical points of coordination between the three master plans.

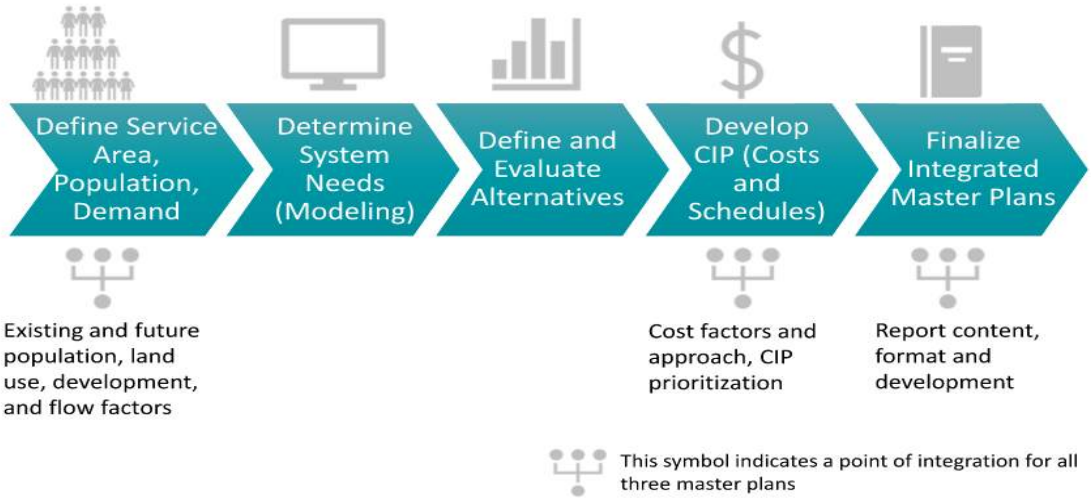

Figure ES-2 Master Plan Approach and Integration with other Master Plans

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ES.2 Conservatism and Uncertainty in Planning

During the development of the master plan, assumptions were made for existing and future conditions. These include factors such as population distribution, flow factors to develop wastewater flow, projections for growth and development, and the response of the system to wet weather impacts. The master planning assumptions trended toward conservative values, which may result in the predicted flows being higher than the actual flows. This master plan provides an analysis of the existing system and defines future needs which should be validated by the City with actual data when available.

The sewer system model is a tool for analyzing the existing system and defining future capacity needs. Care is taken to consider the modeling results and needs for capital improvements or timing of improvements, but this tool has limitations. Knowing the limitations is important in making decisions regarding improvement projects. Limited wet weather flow (WWF) for calibration and simulated flow conditions that vary from observed conditions result in the need to review areas where the model indicates system deficiencies.

Additional uncertainty occurs during the development of the CIP and, as a result, conservative planning assumptions are used. Planning level cost development considers the major categories of capital projects but does not include the finite detail available during the preliminary and final design stages of projects. The CIP was developed based on anticipated growth, modeling results, and planning information and is subject to change if the planning information and forecasts shift over time. Prior to COVID-19, a global pandemic, cost inflation tools provided high confidence for predicting unit prices within a given year. However, during and after COVID-19, these cost inflation tools may not prove to be as accurate.

ES.3 Existing System Information and Model Development

City-provided information was used to inform the development of the master plan update This information included mapping, asset information, planning data, development plans, and physical data like flow metering and winter water billing data. The winter water billing data was used to compare against overall treatment plant flows, distribute population and flow throughout the system and to analyze nonresidential wastewater flow on an acreage basis as a way to inform recommendations for projecting flows in future areas.

Temporary flow metering was conducted between April 18 through June 18, 2019 with the flow data used to supplement information from the City's permanent flow meters. Meter locations are shown in **Figure ES-3**. The collected flow and rainfall data were analyzed using the Sanitary Sewer Overflow Analysis and Planning (SSOAP) tool to determine dry weather and wet weather flow components, which were then used in system modeling.

The City's existing sewer system model (2014) has been updated with new pipelines, updated pump data, and conversion to the North American Vertical Datum of 1988 (NAVD 88). The flow metering data for dry and wet weather conditions was used for model calibration for each meter location.

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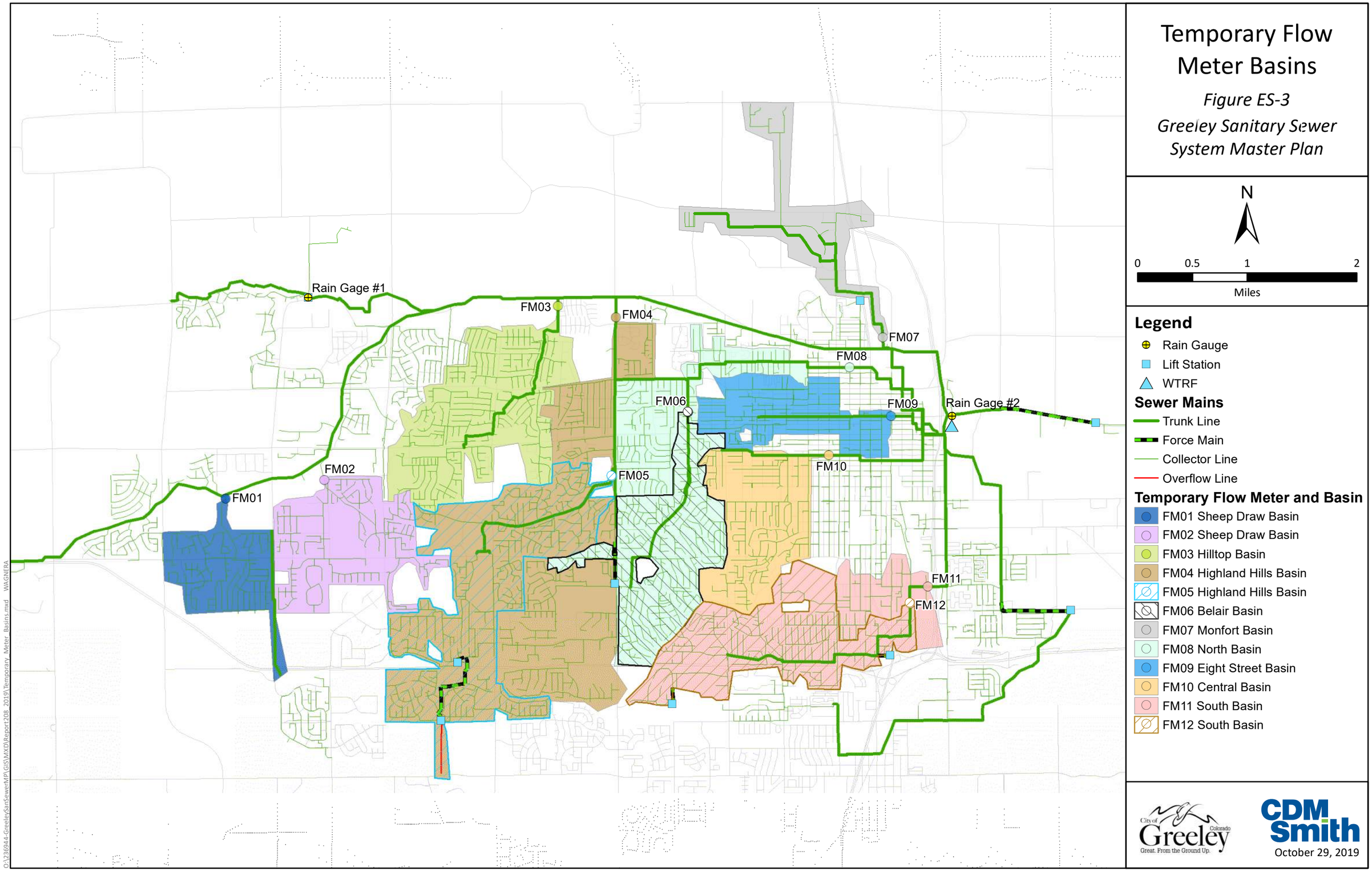
Temporary Flow Meter Basins
Figure ES-3
Greeley Sanitary Sewer System Master Plan
N
0
0.5
1
2
Miles
Legend
Rain Gauge
Lift Station
WTRF
Sewer Mains
Trunk Line
Force Main
Collector Line
Overflow Line
Temporary Flow Meter and Basin
FM01 Sheep Draw Basin
FM02 Sheep Draw Basin
FM03 Hilltop Basin
FM04 Highland Hills Basin
FM05 Highland Hills Basin
FM06 Belair Basin
FM07 Monfort Basin
FM08 North Basin
FM09 Eight Street Basin
FM10 Central Basin
FM11 South Basin
FM12 South Basin
Rain Gage #1
Rain Gage #2
FM01
FM02
FM03
FM04
FM05
FM06
FM07
FM08
FM09
FM10
FM11
FM12
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O:\236944-Greeley\SanSewerMP\GIS\MXD\Report208_2019\Temporary_Meter_Basins.mxd WAGNERA

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ES.4 Service Area and Population Projections

This Sanitary Sewer Masterplan has identified municipal sewer infrastructure requirements to serve the City of Greeley up to the Long-Range Extended Growth Area (LREGA) boundary (**Figure ES-4** on the following page). It should be noted that there is an overlap with Greeley's LREGA and Urban Growth Boundaries and 208 boundaries for both Johnstown and Milliken in the southwest corner of Greeley's growth boundary. The City of Greeley has met with Johnstown and Milliken's staff to understand their interest and future plans for providing sewer service to these areas. From these meetings it is not planned to change growth or 208 boundaries at this time. However, parties generally agreed that at that time that development is being considered in these areas further discussions and assessment would be required to determine how these areas would best be served. In the event that these areas are annexed into the City of Greeley and sewer service is provided by another municipality it would require an Inter-Governmental Agreement to address the service requirements. If annexed into Greeley and Greeley provides municipal sewer service, it will require an amendment of the 208 boundary through the North Front Range Water Quality Planning Association (NFRWQPA).

The future population (and resulting flow) that was distributed over the LREGA for each planning horizon was the 'middle' projection from the *City of Greeley Population and Water Demand Projections* (BBC Research & Consulting, 2018) as shown in **Figure ES-5**. Because the 2075 projection does not represent the buildout year for the City within the LREGA boundary, a buildout population was extrapolated using planning data and factors.

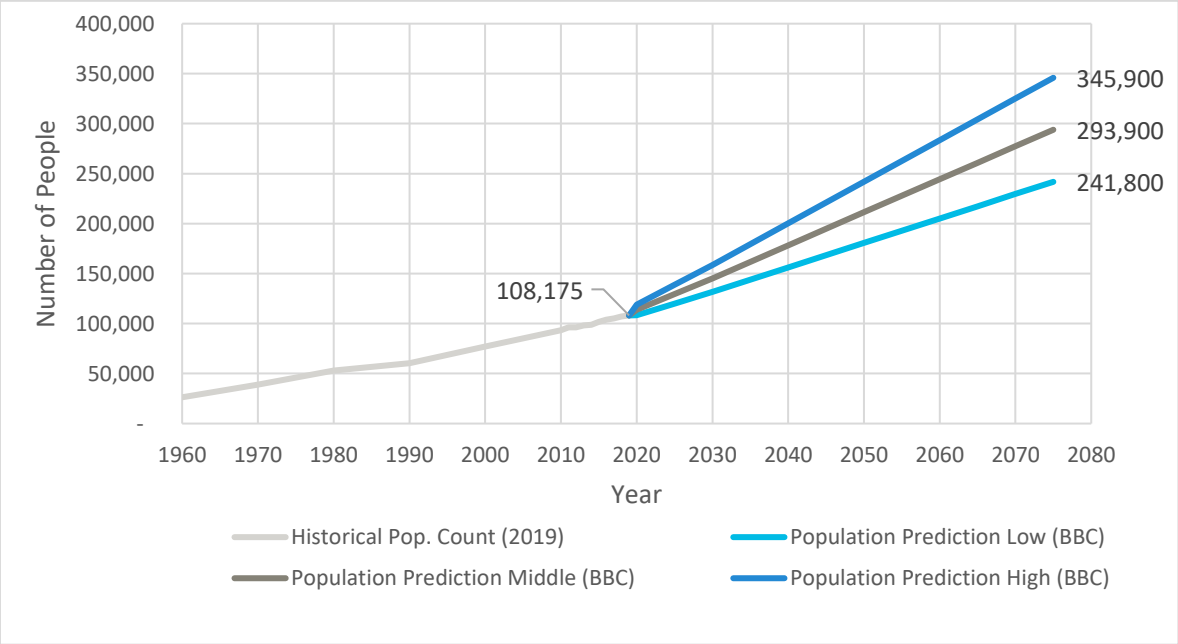

Figure ES-5 Historical and Projected Population

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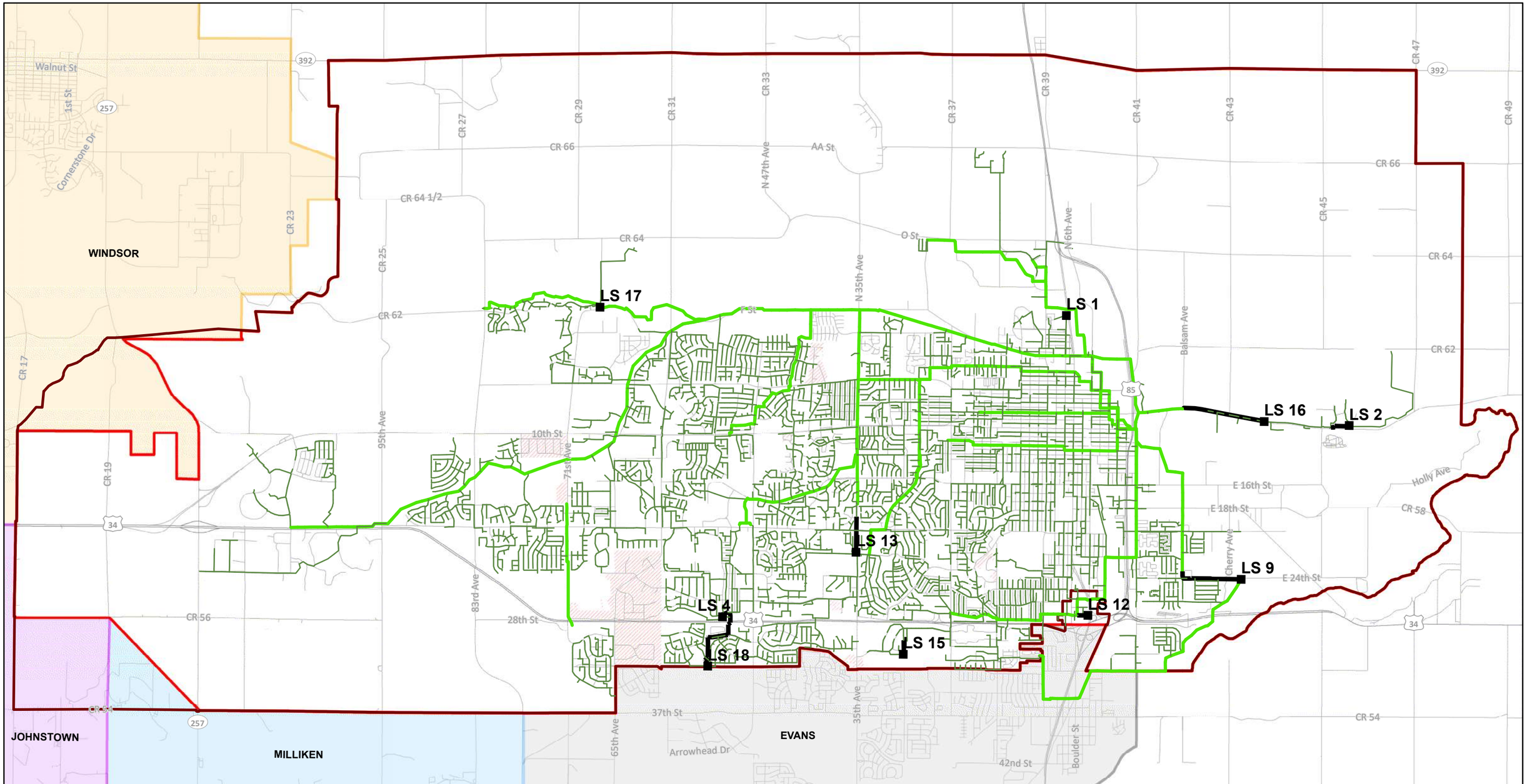

Legend

- Existing Lift Stations

Sewer Mains

- Trunk Line
- Force Main
- Collector Line
- LREGA

Private Septic System Parcels

208 Boundaries

- GREELEY
- EVANS
- JOHNSTOWN
- MILLIKEN
- WINDSOR

N

0 0.5 1 2

Miles

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Wastewater Master Plan Area

Figure ES-4

Greeley Sewer System Master Plan

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Future flow parameters were distributed to currently undeveloped areas, or to areas of redevelopment using a three-tiered approach. To distribute the future flow parameters in the model at each planning horizon, the percent to which each future development tier is built out at the end of each planning horizon was estimated as shown in **Table ES-1**. The percent complete values and development areas included for each Tier were chosen through discussions with the City. **Figures ES-6, ES-7,** and **ES-8** are a visual representation of the information and a depiction of the assumed growth areas for each planning horizon.

Table ES-1 Future Projections Results by Tier

5 Year Planning Horizon	Acres	Population	Nonresidential BWF	Residential BWF	GWI	ADWF
			(gpd)	(gpd)	(gpd)	(mgd)
Existing	10,940	107,146[1]	2,018,478[2]	4,962,559[2]	1,312,438[2]	8.29[2]
Tier 1	1,418	15,072	613,209	921,224	141,842	1.68
Tier 2	195	2,813	38,904	168,789	19,472	0.23
Tier 3	307	3,483	85,713	329,687	31,647	0.45
Total	**12,860**	**128,514**	**2,756,304**	**6,382,259**	**1,505,399**	**10.65**
20 Year Planning Horizon	**Acres**	**Population**	**Nonresidential BWF**	**Residential BWF**	**GWI**	**ADWF**
			(gpd)	(gpd)	(gpd)	(mgd)
Existing	10,940	107,146	2,018,478	4,962,559	1,312,438	8.29
Tier 1	2,243	23,804	695,808	1,427,186	224,209	2.35
Tier 2	1,496	12,577	659,148	760,352	149,576	1.57
Tier 3	3,750	34,159	778,655	2,440,467	375,040	3.59
Total	**18,429**	**177,686**	**4,152,089**	**9,590,564**	**2,061,263**	**15.80**
Buildout	**Acres**	**Population**	**Nonresidential BWF**	**Residential BWF**	**GWI**	**ADWF**
			(gpd)	(gpd)	(gpd)	(mgd)
Existing	10,940	107,146	2,018,478	4,962,559	1,312,438	8.29
Tier 1	2,243	23,804	696,085	1,428,058	224,345	2.35
Tier 2	25,983	247,747	8,376,121	14,873,374	2,598,319	25.85
Tier 3	5,940	49,451	955,631	2,967,037	933,109	4.86
Total	**45,106**	**428,148**	**12,046,315**	**24,231,028**	**5,068,211**	**41.35**

[1] The assumed existing population was taken from the 2018 City of Greeley Population and Water Demand Projections Report.

[2] Flow information for the existing scenario was derived from the 2019 temporary flow metering, permanent flow metering, and lift station flow data. This data was cross checked, and the model was calibrated to wet and dry weather flow. The resulting calibrated flow values are shown in the above table.

The increase in average daily wastewater flow (ADWF) for buildout is calculated at about five times the current ADWF, as compared to population which is calculated to increase by about four times. This discrepancy is due the wastewater flow parameters being on the higher side of the average. A conservancy such as this is needed in master planning to account for inherent unknowns in the spatial distribution of flows so as not to underestimate the infrastructure sizing. **Figure ES-9** illustrates the flow projections over the different planning horizons.

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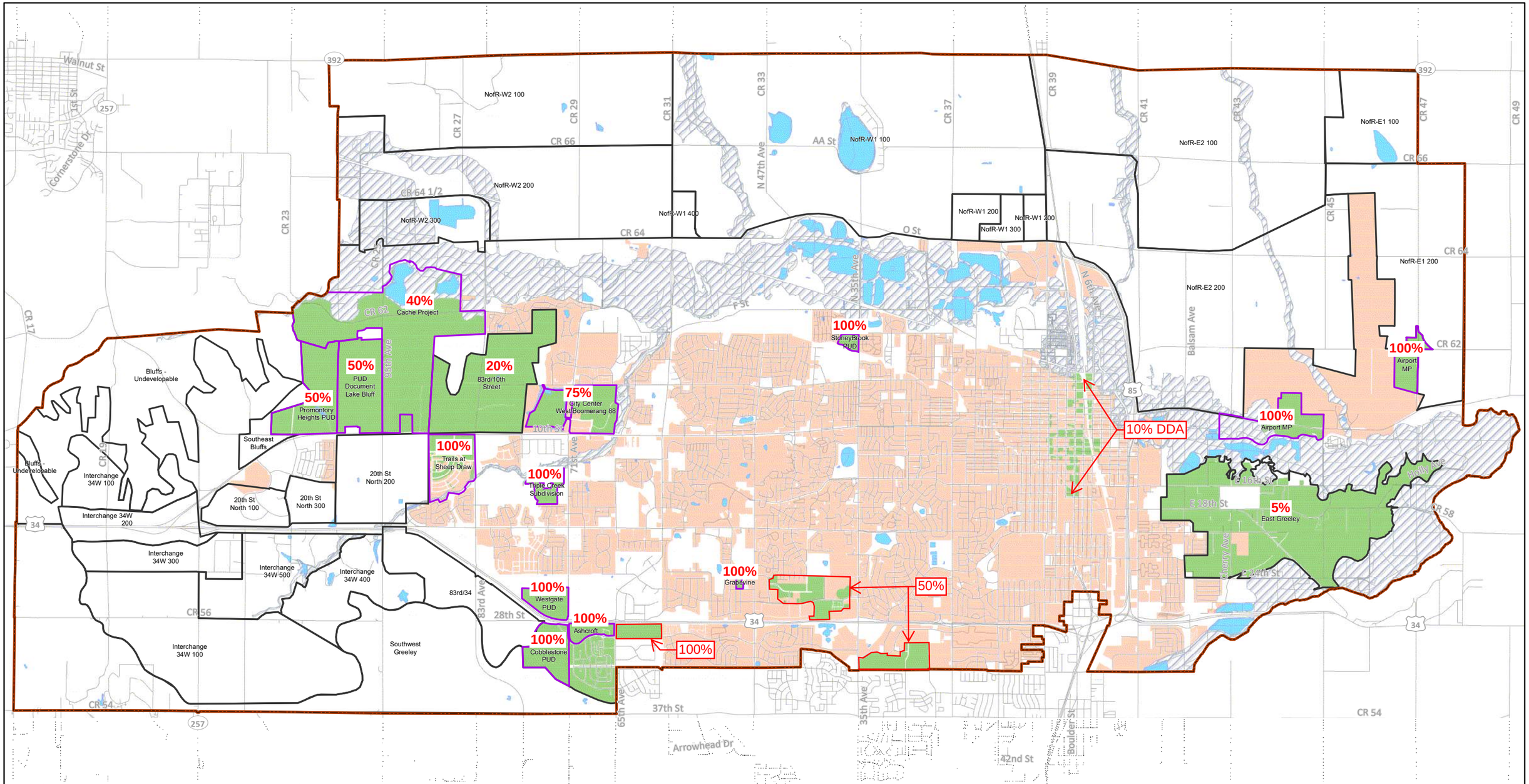

Legend

- LREGA
- Tier 1
- Tier 2
- 100-yr Floodplain
- Future Development
- Existing Service Area
- Lakes and Ponds
- Park

% = Percent Developed

N

0 0.5 1 2

Miles

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Developed Area Projections: 2025

Figure ES-6

Greeley Sewer System Master Plan

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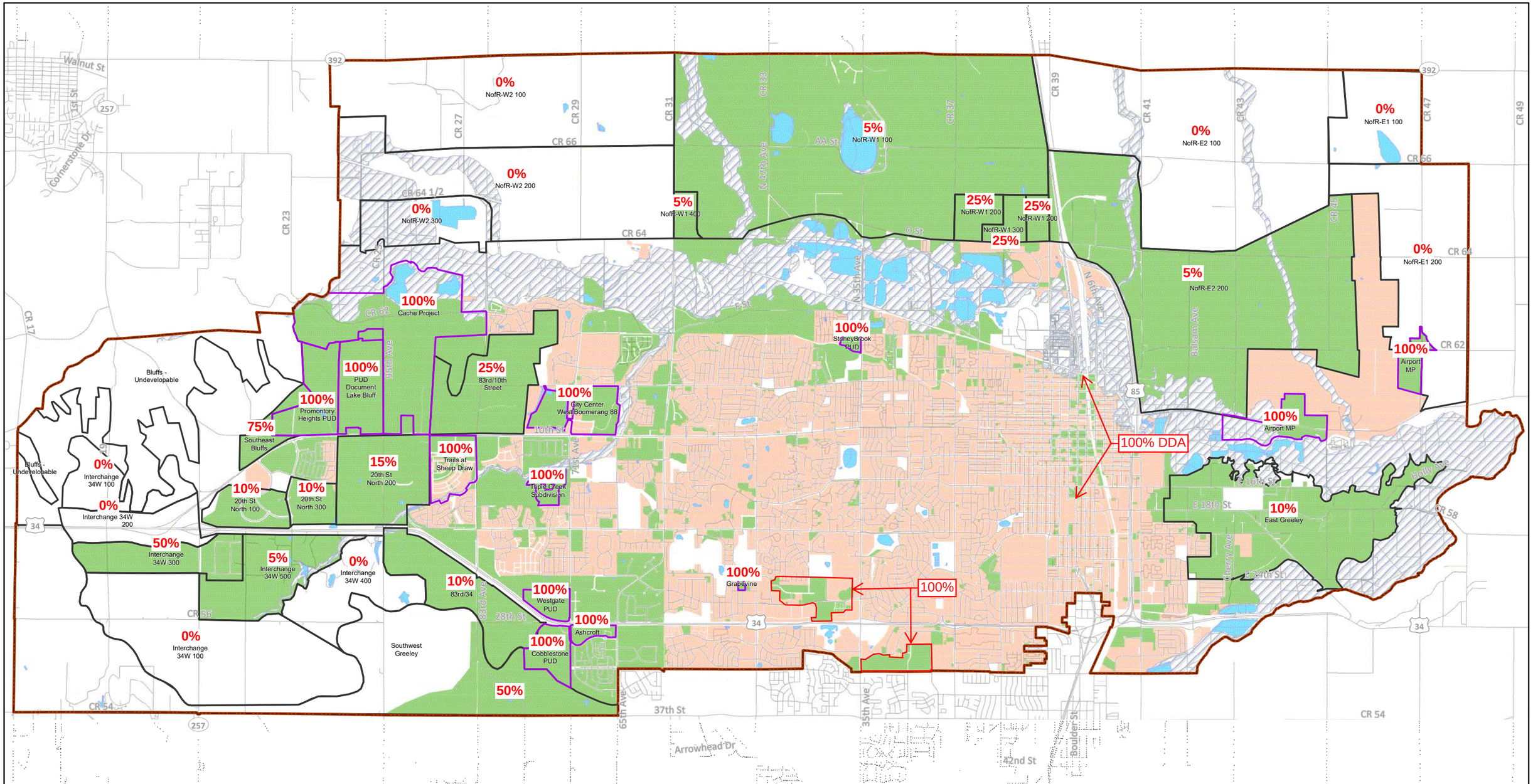

Legend

- LREGA
- Tier 1
- Tier 2
- 100-yr Floodplain
- Future Development
- Existing Service Area
- Lakes and Ponds
- Park

% = Percent Developed

N

0 0.5 1 2

Miles

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Developed Area Projections: 2040

Figure ES-7

Greeley Sewer System Master Plan

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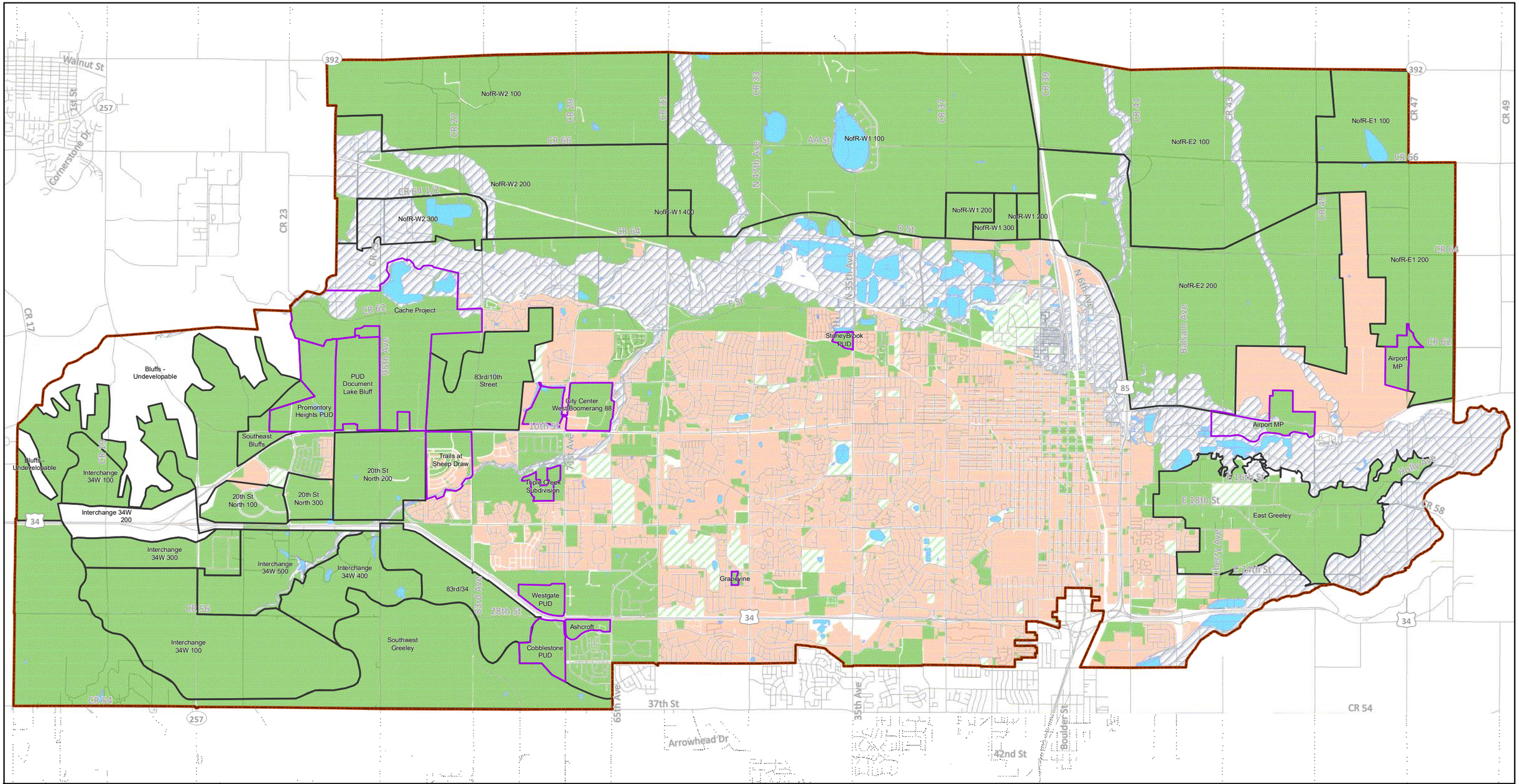

Legend

- LREGA
- Tier 1
- Tier 2
- 100-yr Floodplain
- Future Development
- Existing Service Area
- Lakes and Ponds
- Park

All Areas Assumed 100% Developed

N

0 0.5 1 2

Miles

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Buildout Developed Area

Figure ES-8

Greeley Sewer System Master Plan

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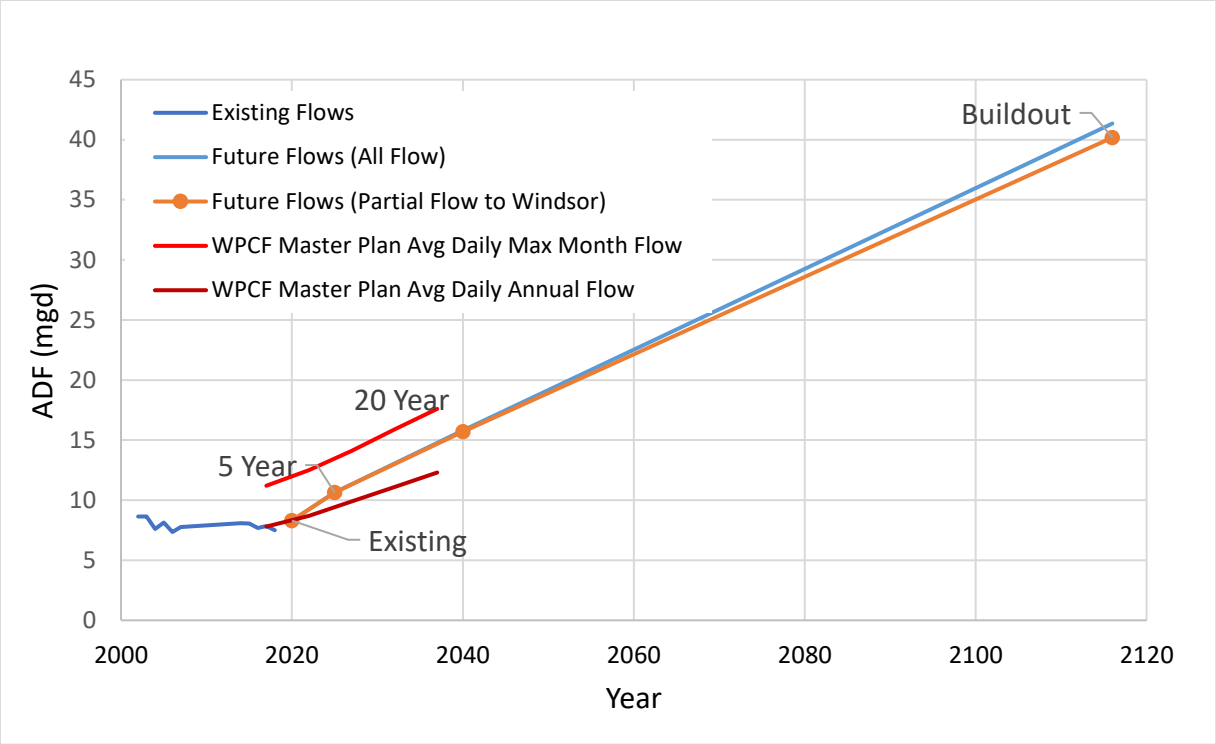

Figure ES-9 Future Flow Projections

ES.5 Model Results and Infrastructure Planning

To accommodate the increase in projected population, the City would need seven (7) new lift stations and about 90 miles of additional gravity sewer by the buildout planning horizon. This expansion allows the City to plan for future growth and development while managing, operating, and maintaining all parts of the sanitary sewer system while providing reliable uninterrupted service to the citizens of Greeley.

The sewer system analysis did not include an assessment of lift station or gravity sewer system condition, nor did it consider any rehabilitation that is not driven by system capacity. Greeley has an asset management program that evaluates existing infrastructure condition and methods of rehabilitation. The asset management program will use this masterplan to inform the rehabilitation methods when addressing sewer system condition. Further assessments of lift stations will determine the lift station condition and consider possible improvements such as the installation of variable frequency drives (VFD) to equalize flow and reduce the hydraulic impact to the receiving gravity sewers.

ES.5.1 Existing System Evaluation

Existing system deficiencies are predicted using the calibrated model with WWF extrapolated for the 5-year design storm event. Recommendations for improvements to the existing system are based on predicted WWF, yet the City's experience with their system and their knowledge of critical areas is what typically drives the prioritization of such projects when developing the capital improvements plan. **Figure ES-10** shows the existing system's dry weather flow (DWF) deficiency locations. The model was also used to analyze the existing system under WWF

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conditions. The results indicate potential deficiencies which are summarized in the following sections. **Figure ES-11** shows an illustrative overview of the wet weather system deficiency locations.

ES.5.2 Future System Evaluation (5 Year and 20 Year Planning Horizon)

The 5-year sewer system deficiency map shown in **Figure ES-12**, includes the future infrastructure that was identified in the existing system evaluation. It also describes the recommended improvements from the existing system analysis. These projects are sized for buildout conditions and many of the capacity improvements are driven by development. It will be the responsibility of individual developers to expand sewer capacity to meet the development capacity needs, while any system improvements to address long term system capacity needs will be met by the City. The 20-year recommended improvements map, shown in **Figure ES-13**, adds the recommended improvements that were identified in the existing and 5-year planning horizon system analysis.

ES.6 CIP Projects and Schedule

The opinion of probable construction cost (OPCC) is considered as the costs that are incurred by the contractor to construct a capital project. The project CIP costs include the OPCC and project implementation costs such as planning and design, administration, and construction management. Assumptions made during project development can add to the variability of final bid project costs when compared to the planning level costs. The assumptions are necessary to capture costs for project elements that cannot be defined at a planning level. Project costs were developed using modeled pipeline quantity estimates and data which were then multiplied by unit cost estimates. During design development, more specific data will be used to inform the design and the resulting project cost estimate. **Table ES-2** provides a breakdown of the different assumptions used for project implementation, including cost contingency.

Table ES-2 Costing Factors for Construction Bid and Total CIP Project Costs

Category	Item	Costing Factor
Construction Bid Cost (includes infrastructure and contractor overhead, profit, bonds, and insurance)	Erosion Control/Stormwater Pollution Prevention[1]	2%
	Mobilization and Demobilization[1]	5%
	Contingency[2]	35%
Project Implementation[3]	Feasibility and Site Studies	9% for OPCC ≤ $1M 6% for OPCC of $1M to $10M 5% for OPCC > $10M
	Preliminary and Final Design	9% for OPCC ≤ $1M 6% for OPCC of $1M to $10M 5% for OPCC > $10M
	Engineering Services During Construction	5%
Additional Project-Related Costs[3]	Outside Construction Management	5%
	Outside Project Management	3%

[1] Construction costing factors for erosion control/stormwater pollution prevention, mobilization and demobilization are added to the subtotal of unit cost items.

[2] Contingency is 35% of the subtotal of the unit cost items and contractor born costs determined by costing factors.

[3] Project Implementation and Additional Project-Related Cost categories are determined as a percentage of the construction cost and part of the total CIP project costs.

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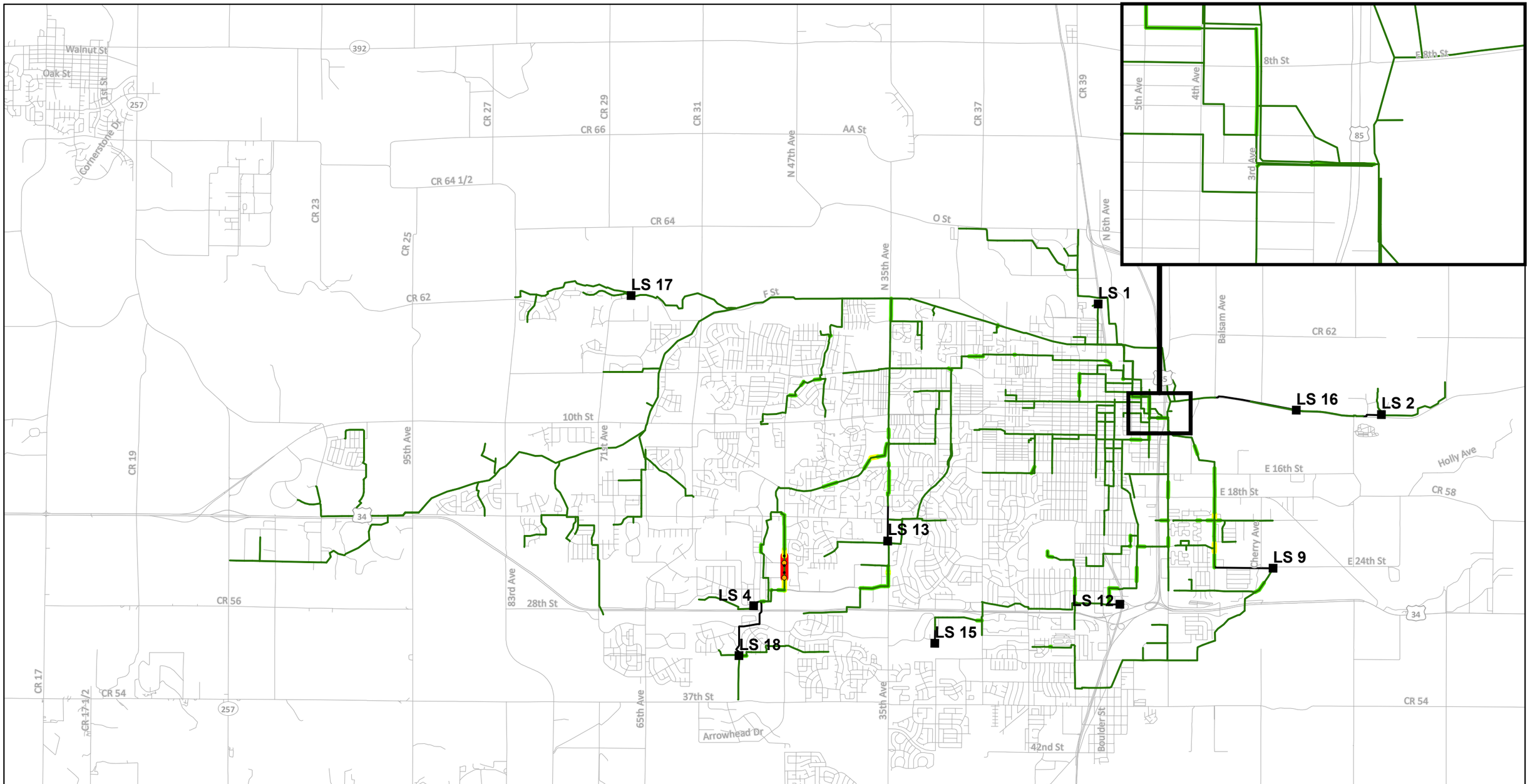

Legend

- Existing Lift Stations
- Existing Interceptors
- Existing Force Mains

Peak DWF d/D

- 0 - 0.5
- 0.5 - 0.8
- 0.8 - 0.99

Surcharged (d/D = 1)

- Backwater
- Capacity Deficiency

Freeboard (Distance from Manhole Rim to HGL)

- <10 ft
- > 10 Ft

N

0 0.5 1 2

Miles

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Predicted Peak Dry Weather Flow Deficiencies- Existing System

Figure ES-10

Greeley Sewer System Master Plan

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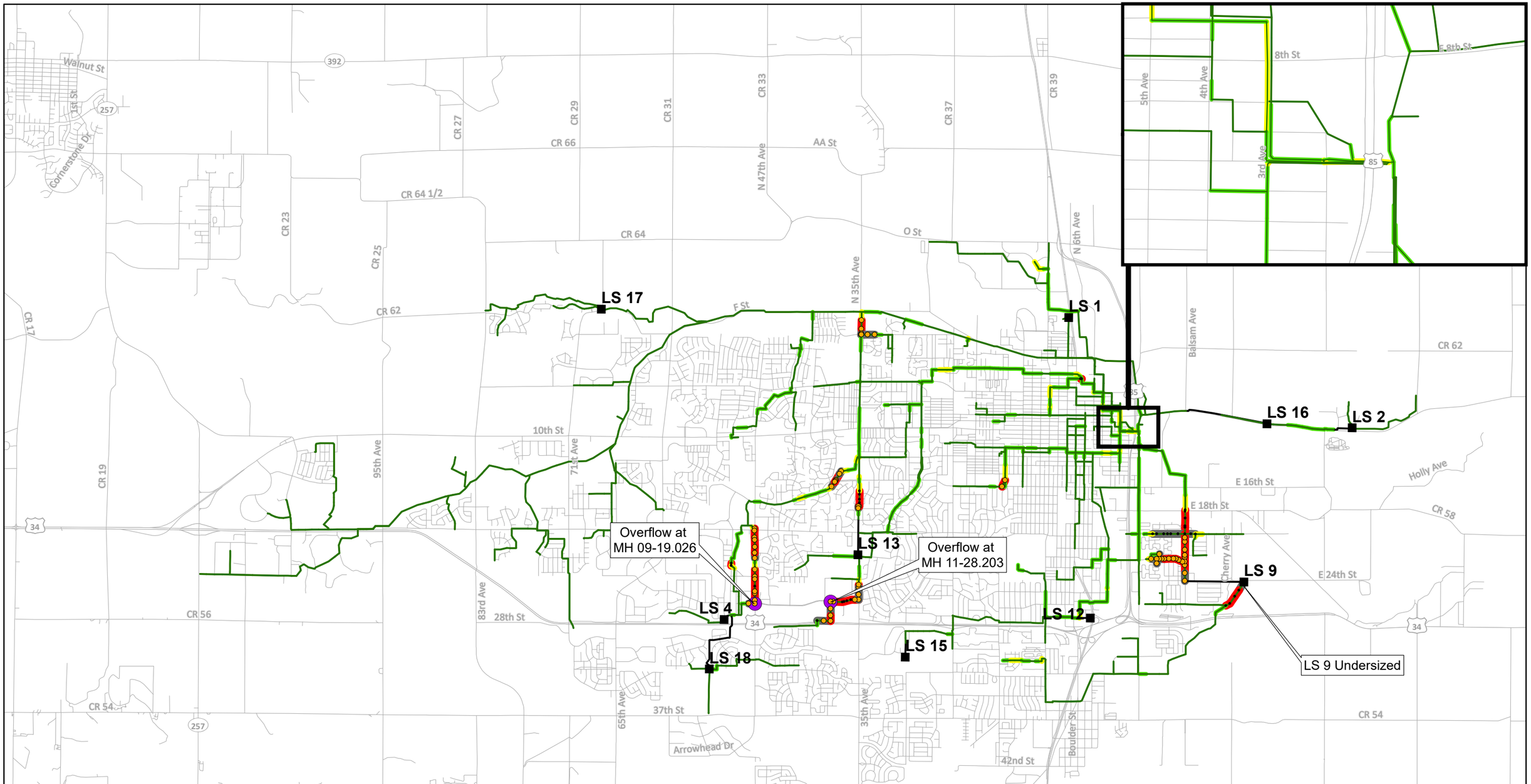

Legend

- Existing Lift Stations
- Existing Force Mains
- Existing Interceptors

Peak WWF d/D

- 0 - 0.5
- 0.5 - 0.8
- 0.8 - 0.99

Surcharged (d/D = 1)

- Backwater
- Capacity Deficiency

Freeboard (Distance from Manhole Rim to HGL)

- <10 ft
- > 10 Ft
- Predicted Manhole Overflows

N

0 0.5 1 2

Miles

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Predicted Peak Wet Weather Flow Deficiencies- Existing System

Figure ES-11

Greeley Sewer System Master Plan

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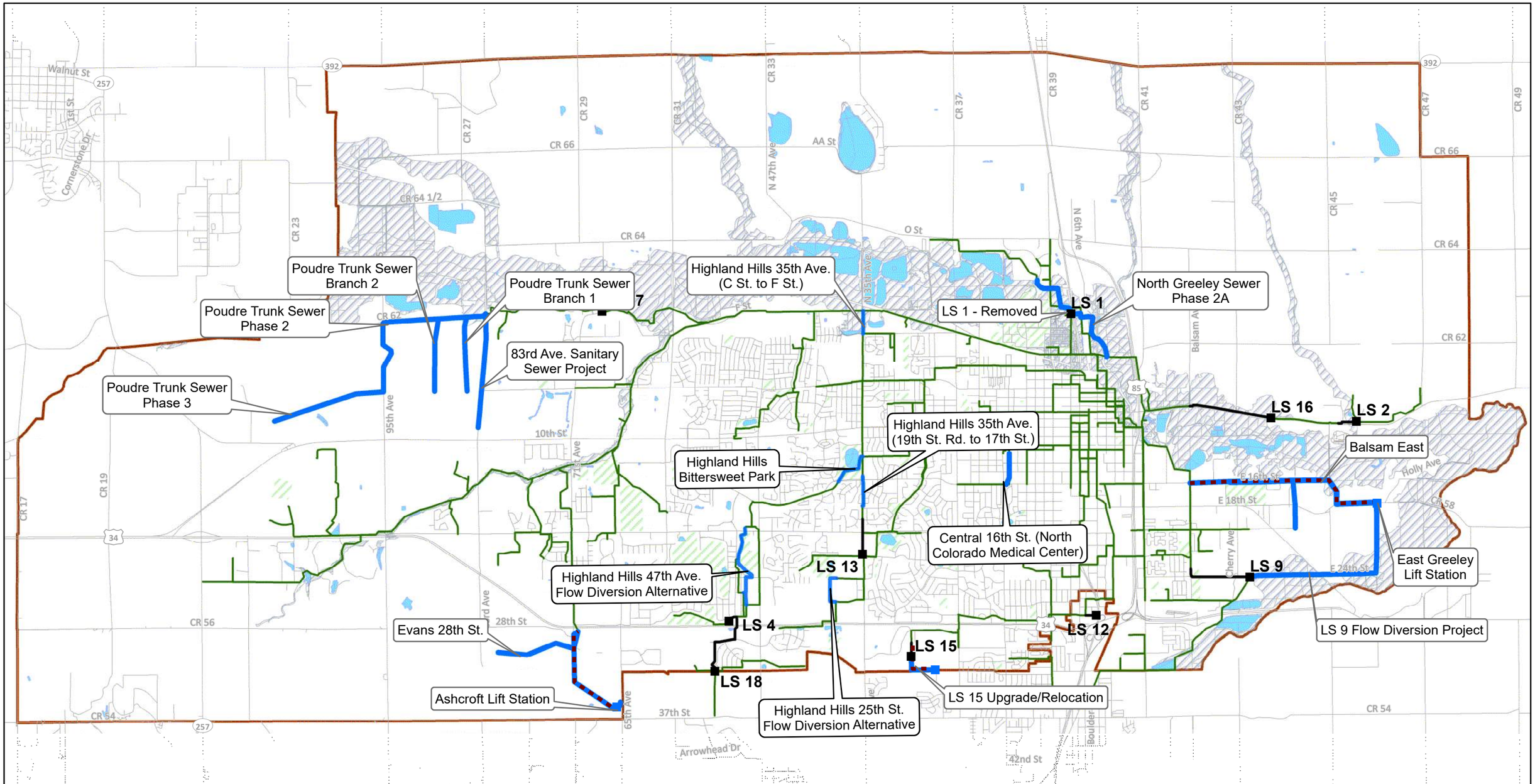

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Legend

- LREGA
- 100-yr Floodplain
- Lakes and Ponds
- Park
- Existing Lift Stations
- Existing Interceptors
- Existing Force Mains
- 5 Year LS Recommendations
- 5 Year Pipe Recommendations
- 5 Year Force Main Recommendations

N

0 0.5 1 2
Miles

Recommended 5 Year Improvements

Figure ES-12

Greeley Sewer System Master Plan

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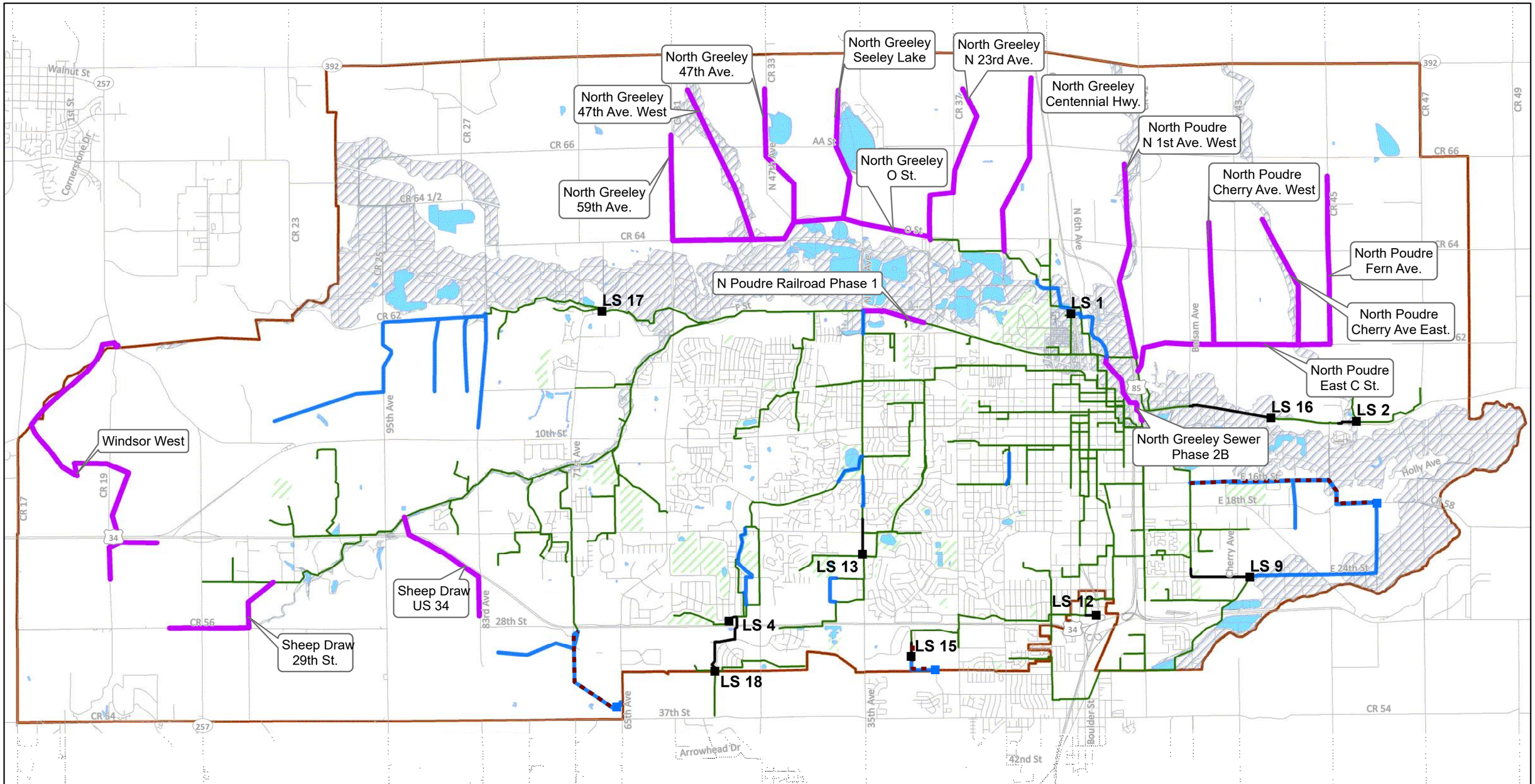

Legend

- LREGA
- 100-yr Floodplain
- Lakes and Ponds
- Park
- Existing Lift Stations
- Existing Interceptors
- Existing Force Mains
- 5 Year LS Recommendations
- 5 Year Pipe Recommendations
- 20 Year Pipe Recommendations
- 5 Year Force Main Recommendations

N

0 0.5 1 2
Miles

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Recommended 20 Year Improvements

Figure ES-13

Greeley Sewer System Master Plan

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ES.6.1 Identified Projects

Table ES-3 provides cost information for the 5-year planning horizon projects and notes the project driver and the party likely responsible for funding each project. **Table ES-4** presents the information for 20-year planning horizon projects. The growth driven projects will be funded by either the City, the developer, or a combination of the two, depending on the project driver.

Table ES-3 5-Year Planning Horizon Project Costs and Drivers

Project	Driver	Responsible Party	OPCC[1] ($M)	Total Cost[2] ($M)
Highland Hills 47th Ave. Flow Diversion	Deficiency	City	$1.4	$1.8
Highland Hills 35th Ave. C. St. to F St.[3]	Deficiency	City	N/A	N/A
Highland Hills 25th St. Flow Diversion Alternative	Deficiency	City	$0.5	$0.7
Highland Hills Bittersweet Park	Deficiency	City	$0.9	$1.1
Highland Hills 35th Ave. (19th St. Rd. to 17th St.	Deficiency	City	$0.8	$1.0
LS 9 Flow Diversion Project[3]	Growth	City	See Footnote 3	
Central 16th St. (North Colorado Medical Center)	Deficiency	City	$0.7	$0.9
North Greeley Sewer Phase 2A	Growth	City	$5.5	$5.8
Ashcroft LS[4]	Growth	City	N/A	N/A
Balsam East	Growth driven development projects. Current model-predicted conditions are not observed so project timing should be evaluated.		$5.1	Not used for development-driven projects.
East Greeley LS			$7.4	
LS 15 Upgrade/Relocation	Growth	Development	$1.2	
Evans 28th St.	Growth	Development	$1.9	
83rd Ave. Sanitary Sewer Project	Growth	Development	$2.3	
Poudre Trunk Phase 2	Growth	Development	$6.2	
Poudre Trunk Sewer Branch 1	Growth	Development	$0.9	
Poudre Trunk Sewer Branch 2	Growth	Development	$1.2	
Poudre Trunk Sewer Phase 3	Growth	Development	$1.7	

[1] The OPCC represents the opinion of cost for construction. The total CIP costs include other factors.

[2] Total costs include the OPCC, land, project implementation and additional project related costs.

[3] This CIP has been identified through modeling but the City has not observed the capacity limitations indicated by the model. Additional investigation is recommended to confirm the need for this project. The project is listed in the 5-year planning horizon for additional investigation and the costs are included in the 20-year planning horizon.

[4] This project is already funded and not included in the total CIP costs.

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Table ES-4 20-Year Planning Horizon Project Costs and Drivers

Project	Driver	Responsible Party	OPCC[1] ($M)	Total Cost[2] ($M)
LS 9 Flow Diversion Project[3]	City	City	$6.4	$8.3
North Poudre Railroad Phase 1	Deficiency	City	$5.7	$7.4
North Greeley Sewer Phase 2B	Deficiency	City	$5.5	$7.2
North Poudre E C Street	Growth	City	$17.1	$21.9
North Greeley O Street	Growth	City	$12.2	$15.6
North Poudre Fern Avenue	Growth	Development	$3.8	Not used for development - driven projects
North Poudre Cherry Avenue East	Growth	Development	$4.1	
North Poudre Cherry Avenue West	Growth	Development	$2.4	
North Poudre North 1st Avenue West	Growth	Development	$6.5	
North Greeley Centennial Highway	Growth	Development	$4.3	
North Greeley North 23rd Avenue	Growth	Development	$4.0	
North Greeley Seeley Lake	Growth	Development	$3.2	
North Greeley 47th Avenue	Growth	Development	$2.6	
North Greeley 47th Avenue West	Growth	Development	$2.9	
North Greeley 59th Avenue	Growth	Development	$2.1	
Sheep Draw 29th Street	Growth	Development	$2.6	
Sheep Draw US 34	Growth	Development	$2.5	
Windsor West	Growth	Development	$7.5	

[1] The OPCC represents the opinion of cost for construction. The total CIP costs include other factors.

[2] Total costs include the OPCC, land, project implementation and additional project related costs.

[3] This CIP has been identified through modeling but the City has not observed the capacity limitations indicated by the model. Additional investigation is recommended to confirm the need for this project. The project is listed in the 5-year planning horizon for additional investigation and the costs are included in the 20-year planning horizon.

ES.6.2 CIP Implementation Schedule

The CIP Planning Tool was used to develop a schedule with consideration of overall costs. Preliminary project planning, design, and construction start dates are subject to change depending on impacts from other projects identified in the water and non-potable water master plans. **Figure ES-14** indicates the proposed implementation schedule for the 5-year and 20-year planning horizons.

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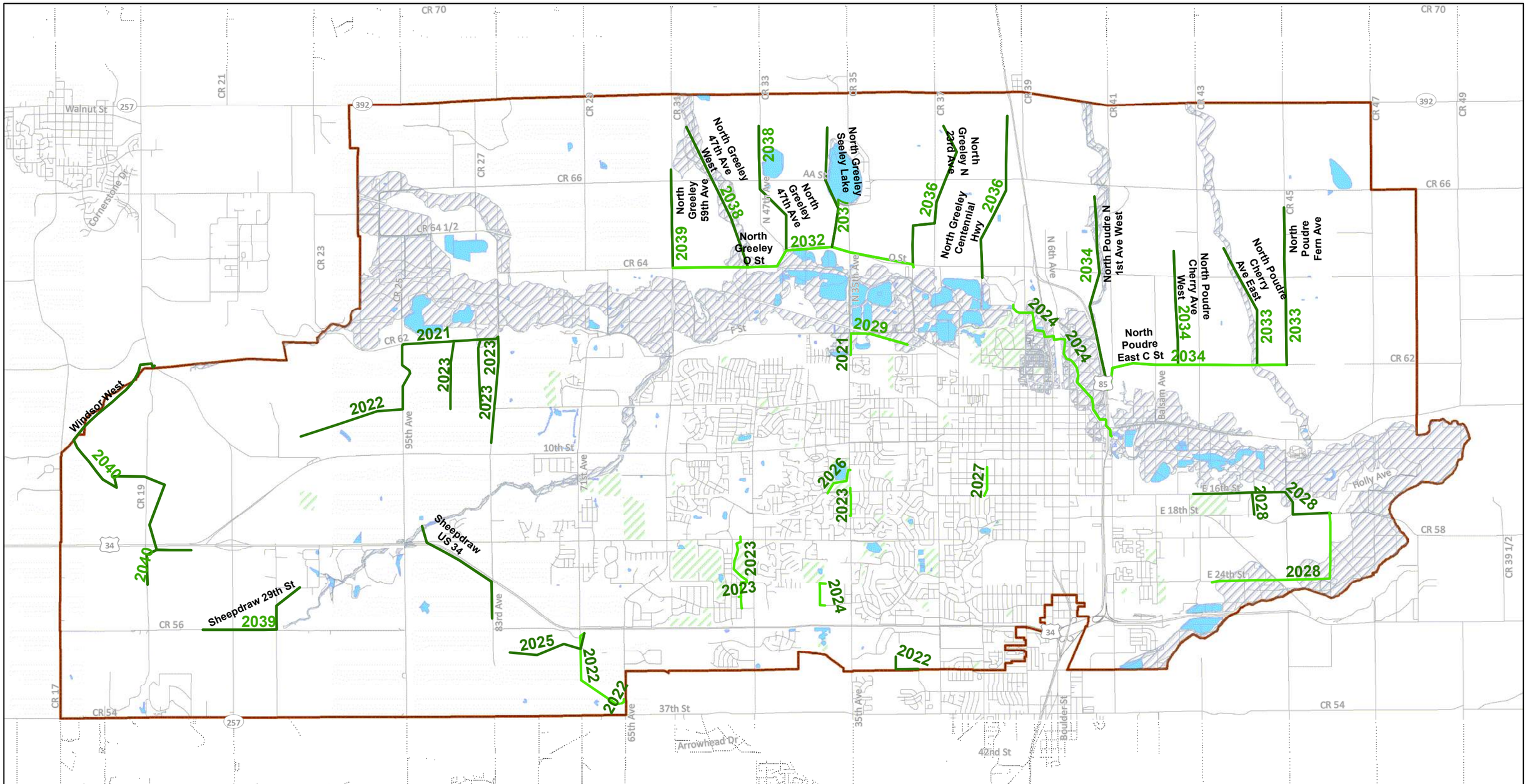

Legend

- LREGA
- Flood Zone
- Lake
- Park
- Sewer 5 Year CIP
- Sewer 20 Year CIP

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March 05, 2021

N

0 0.5 1 2
Miles

20 Year CIP Schedule Coordination

Figure ES-14

Greeley Sewer System Master Plan

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Section 1

Background and Project Purpose

The City of Greeley (City) Colorado's sanitary sewer system has grown by 96 miles in the last 20 years and over 17 miles in the past 10 years. Greeley continues to experience strong growth in population through both infill and the expansion of residential and non-residential development within the City's defined service area. To address existing and future system needs while considering growth, existing system performance, and improvements required to meet their committed level of service to the new growth areas, the City has updated the *2009 Sanitary Sewer Master Plan* (CDM Smith, 2009) and the NFRWQPA *Utility Plan*. This master plan update documents the approach and assumptions used to evaluate the system while defining the capital improvements needed for the long-range CIP for the sanitary sewer system through the year 2040.

1.1 Master Planning Process and Organization

The City's 2021 Sanitary Sewer System Master Plan is being developed in conjunction with its 2021 Water Master Plan and Non-Potable Water Master Plan. Greeley is integrating all three of the master plans so they have a consistent approach to determining the existing and future needs through population and water demand information. By integrating the three master plans, the City made the approach to determining existing and future population, projecting water demands (with resulting wastewater generation) and the defining of capital projects and costs the same across all three master plans.

As a result, the future population projections and associated water demand, the planning horizons, and the approach to capital and project cost development are consistent between the three master plans. This integrated master planning approach is illustrated below in **Figure 1-1**. This figure also shows the critical points of coordination between the three master plans.

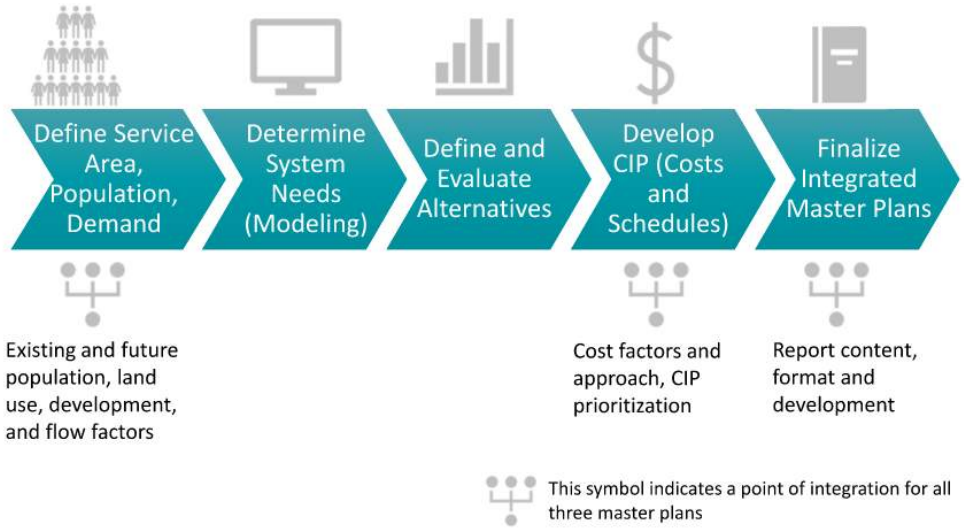

Figure 1-1 Master Plan Approach and Integration with other Master Plans

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1.2 Summary of Previous Master Plans

This master plan builds on the information and analysis completed in the 2008/09 master plan and 2014 model update, which are summarized in the following subsections. Both master plans were limited in wet weather analysis due to insufficient rainfall during the monitoring period. The master plans also identified similar sewer system capacity limitation as described below.

1.2.1 Report Organization

The SSMP is organized into the following sections:

- Section 1 – Background and Project Purpose
- Section 2 – Existing Sewer System and Service Area Data
- Section 3 – Existing and Future Systems Model Development
- Section 4 – Future Flow Projections
- Section 5 – Existing and Future Systems Evaluation
- Section 6 – Capital Improvement Plan

1.2.2 2008/09 Sewer System Master Plan

The 2008/09 master plan provided a CIP for the sanitary sewer system through the year 2028. The plan analyzed the sanitary sewer system including the system's lift stations, sewer lines greater than or equal to 10 inches in diameter, and force mains. Improvements were identified for both reinforcement of the existing system and for expanding services to new locations throughout the City. The hydraulic model was converted from steady-state to a quasi-dynamic extended period simulation (EPS) model to analyze how the system performs over time.

For modeling purposes, equivalent populations were estimated using the historical ratio of commercial and industrial water use to residential use. These populations were then distributed spatially using water billing records and Greeley Community Development Department Planning and Zoning Division documents. Five-year housing unit growth rates were used to forecast the population from 2008 to 2012. The 20-year population was projected assuming a population growth rate of 2.25% per year from 2012 to 2027. The equivalent future employment was estimated by assuming a 20% increase in employment, yielding a future equivalent population of 184,812 people. Future equivalent populations were assigned to undeveloped parcels. The anticipated future equivalent population of 5,000 people associated with the Sheep Draw area was distributed uniformly among undeveloped plots of land within this area.

During the spring 2008 flow monitoring program, there was one substantial rainfall event (June 4, 2008) which resulted in 0.94 inches of precipitation recorded at a single gage, yet the flow meters did not record a significant response to this rainfall event. The 2008 flow data was not considered appropriate for development of wet weather modeling parameters, nor for the calibration of wet weather response. The 2000 flow monitoring data were used to develop system wet weather parameters.

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Evaluation of the sanitary sewer system was based on the capacity of the pipes under DWF and WWF conditions for existing and future scenarios. Each segment identified as deficient was recommended for paralleling, lining, or replacement with a larger diameter pipe based on length of repair and severity of the deficiency. The recommended repairs were grouped into projects.

1.2.3 2014 Existing Sewer System Hydraulic Model

In 2014 the City contracted CDM Smith to update their existing 2008 flow monitoring data and the existing system hydraulic model from the *2009 Sanitary Sewer Master Plan* (CDM Smith). The 2014 report included the transfer and update of their sanitary sewer system model from Innovyze's H20Map Sewer to the geographic information system (GIS) based InfoSWMM sewer model. The model could not be calibrated for WWF because there was not a sufficient wet weather event during the monitoring period but was calibrated to DWF conditions.

Sewer system evaluations were conducted for the existing system using DWF conditions, 10-year WWF conditions, and 25-year WWF conditions. The project conclusions and findings are based on the DWF and 10-year WWF scenarios. A lift station consolidation feasibility review was completed to identify opportunities where two or more existing lift stations could be combined into another existing or proposed new lift station. The key findings for existing conditions were:

- There were no capacity issues under dry weather conditions with approximately 94% of the sewer system (by length) under 50% of its capacity on a typical dry day.
- The existing sewer system did not show any flooding or sewer system overflows observed during both the 10-year and 25-year WWF conditions analysis. There was no significant difference in capacity utilization under 10-year wet weather conditions. As noted above, the existing system was evaluated for the 10-year and 25-year conditions only.
- Approximately 2% of the sewer (by length) was fully utilized under 10-year wet weather conditions.
- Lift station (LS) Consolidation findings:
    - LS4 (Highland Hills) could be removed from service and the flow diverted into LS18 (T-Bone Subdivision) by gravity conveyance.
    - Diversion of LS15 (Auto Plaza) to the LS9 (E. Cherry Avenue) service area was found to be possible with additional capacity improvements to downstream pipes.
    - The influent line for LS13 (Southwest Greeley) could be diverted east and downstream pipes upsized to accommodate additional flow, but the cost may be prohibitive.
    - LS2 (Weld Co. Airport), LS16 (E. 8th Street.), and LS9 (E. Cherry Avenue) could be consolidated into a single new lift station with additional capacity improvements to downstream pipes or diversion of flow to provide adequate capacity.

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1.3 Summary of Available Data

The City-provided information used to inform the development of the master plan update is described in the following sections. This information includes mapping, asset information, planning data, and physical data like metering.

1.3.1 GIS Data

The City provided their current GIS files (November 2019) including planning, flow metering, land use, population, sewer system, and drainage information. **Tables 1-1** through **1-6** summarize the GIS data provided in each category.

Table 1-1 GIS Planning Data

Shapefile	Information Provided
AddressPoints	Geolocations for each address.
Parcels	Parcel Location and Information
Roads	Roadway Polygons
Contours	Elevation information
StreetCenterlines	Roadway Lines
Boundaries_208	208 Boundaries for the City of Greeley and surrounding municipalities
GreeleyCityLimit	City of Greeley City Limits
LREGA	Long Range Expected Growth Area
Boundary_208_2019.gdb	208 Boundary for City of Greeley and surrounding areas
2019_Overlay	Location of roadway restoration projects
Meters_Cust_number	Location and customer number of water meters to help locate billing data
Parks_NatAreas.zip	GIS location of parks and natural areas
Downtown Development Area (DDA) Shapefiles	Shapefiles showing the location of development for the downtown develop project

Table 1-2 GIS Flow Metering Data

Shapefile	Information Provided
Flow_Metering_2019	Location of 2019 flow meters (CDM Smith)
Flow_Metering_2019_RainRauges	Location of 2019 Rain Gauges
Flow_Metering_Historical	Historical flow meter locations
Flow_Metering_Permanent_new2019	Location of permanent flow meters

Table 1-3 GIS Land Use Data

Shapefile	Information Provided
CombinedNeighborhoodUses	Land use type and description for each neighborhood within the City
Employment_and_Industrial_Areas	Location and size of each employment area within the City
MixedUseHighIntensity	Location and size of the mixed use high intensity areas within the City
NorthAnnexationArea	Location of area recently annexed by the City
Open_Lands_fromPTOLLayers	Location of open land
UNCandAIMS	Locations of Colleges
UrbanReserve	Location of Urban Reserve area

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Table 1-4 GIS Population Data

Shapefile	Information Provided
Households_density	Household density information
Median_income_clip	Median income information

Table 1-5 GIS Sewer System Information

Shapefile	Information Provided	Comments
SewerStructuresPublic	Manhole ID, location, depth, diameter, material, liner, construction date, and rehab date	No invert or rim elevations provided in shapefile. Approximately, 1611 sewer structures were included in 2014 model and according with the new sewer system information 326 new structures should be added in the new 2019 SSMP model.
SewerPumpStations	Station name, locations, number, construction date, upgrade date, number of pumps, pump horsepower, pump capacity, head, wetwell size, rim elevation, bottom elevation, and invert elevation	N/A
SewerMainLinesPublic	Gravity sewer locations, upstream manhole, downstream manhole, flow basin, pipe size, material, liner, lining/construction date, and flow type.	No invert elevations provided. Approximately 1,818 of the 8,181 records found in the shapefile were included in 2014 model. 134 new pipes with diameter greater than 8 inches were provided that will be added to the 2019 model and master plan.
Flow_Basins	Flow basin areas	N/A

Table 1-6 GIS Drainage Data

Shapefile	Information Provided
Ditches	Location of drainage ditches
Drainages	Location of rivers and streams
DrainageBasins	Locations of the larger drainage basins within the area
HydroBody	Location of lakes rivers and streams

1.3.2 Flow Data

1.3.2.1 Permanent Flow Meters

The City provided data from seven permanent flow meters from 2016-2019 in 15-minute intervals. The data included depth, velocity, and flow information. **Table 1-7** lists the meters and locations for the data provided.

Table 1-7 Permanent Flow Meters

Flow Meter ID	Location	Main Size	Comments
05-00.003	10th Street, Middle Line	24”	Bad data (1/1/16 – 3/31/16) Blank Data (1/1/19 – 3/6/19)
03-00.042	10th Street, South Line	27”	Bad data (1/1/16 – 3/31/16) Blank Data (1/1/19 – 3/6/19)
07-00.003	10th Street, North Line	24”	Blank Data (1/1/19 – 3/6/19)
13-00.002	1st Ave, West Line	24”	
02-00.002	1st Ave, Middle Line	12”	

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Flow Meter ID	Location	Main Size	Comments
01-00.002	1st Ave, East Line	24”	Zero flow (1/1/17 – 1/9/17)
08-00.011	Highway 85	48”	
08-00.059	F Street and 35th Ave	36”	2019 Data 5 minute
08-00.163	10th Street and 63rd Ave	27”	2019 Data 5 minute

1.3.2.2 Lift Stations

The City provided flow data at their lift stations from 2014 – 2019. After a review of the data, there were a large number records with data outliers or “bad” data. **Figures 1-2 to 1-4** provide a breakdown of the lift station flow data.

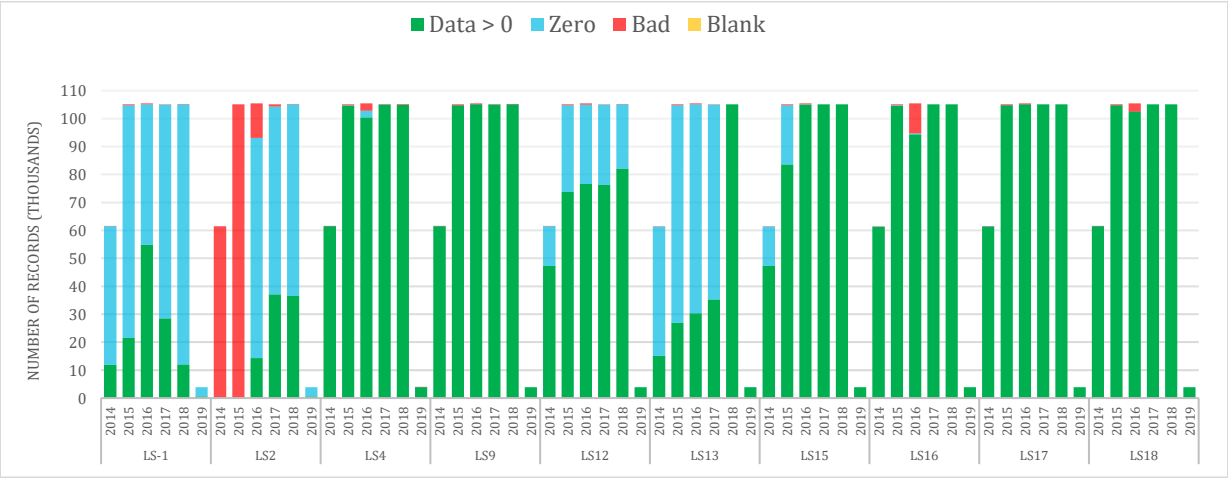

Figure 1-2 Lift Station Outflow Data Records Distribution

LS2 was constructed in 2016. During the reporting period, the data showed very low flow, other than from a water flushing station that occurred late at night.

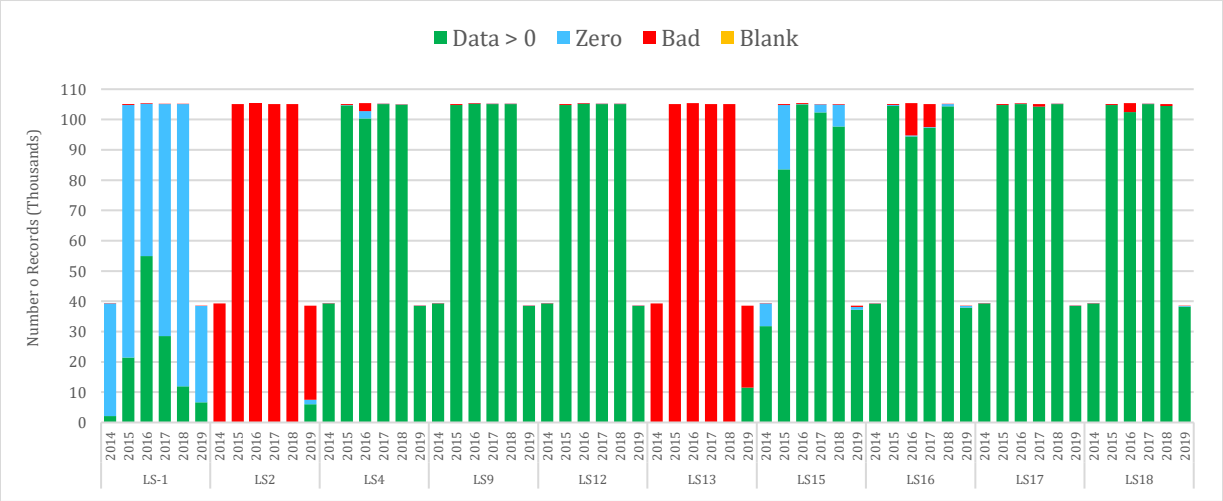

Figure 1-3 Lift Station Inflow Data Records Distribution

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No inflow information from LS2 or LS13 was available due to the data collection method. Historical data is based on a flow meter located on the downstream force main for both lift stations.

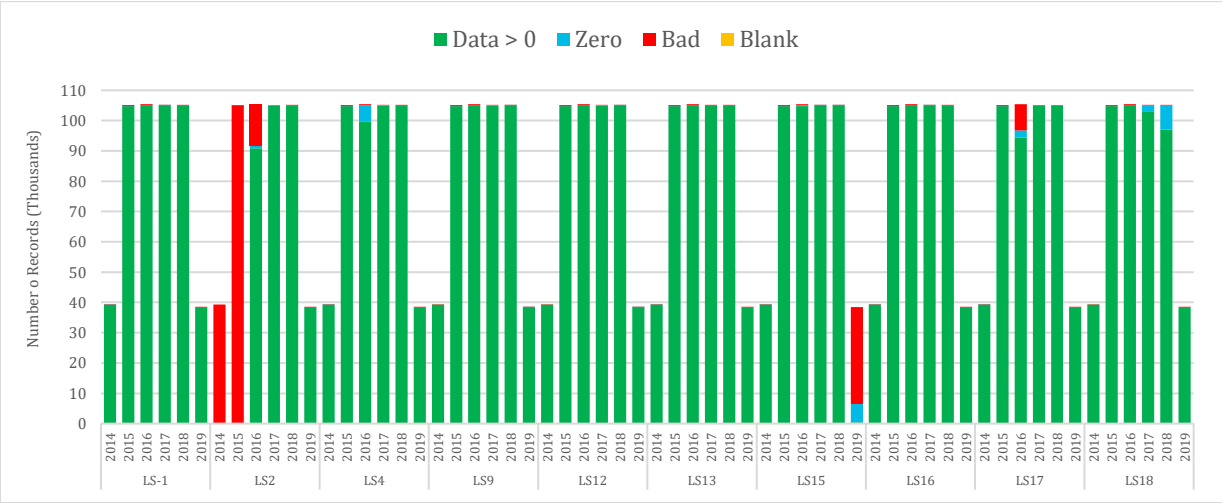

Figure 1-4 Lift Station Level Data Records Distribution

LS2 was constructed in 2016, resulting in the lack of records shown in the above figure.

1.3.2.3 Wastewater Treatment Plant

The City provided flow data at their treatment plant from 2014 – 2020 in 15 minutes intervals, with no major data gaps or issues.

1.3.3 Lift Station Drawings and Curves

Table 1-8 summarizes the lift station information provided by the City.

Table 1-8 Lift Station Information

Lift Station (LS) Number	Station Name	Current Capacity (gpm)	Horse Power (HP)	Approximate Construction Year	Upgrade Year	Pump Curve
LS1	North 9th Avenue	80	3	1959	2000	Yes
LS2	Airport	120	7.5	2016	-	Yes
LS4	Highland Hills	100	7	1992	2015	Yes
LS9	Cherry Avenue	638	21	1989	2013	Yes
LS12	Garden City	80	3	1985	2007	Yes
LS13	35th Avenue	1705	75	1981	2012	Yes
LS15	Auto Plaza	150	10	1980	-	Yes
LS16	East 8th Street	270	13	1985	2013	Yes
LS17	Farmers Spur	560	6.2	1993	2015	Yes
LS18	T Bone	668	54	1998	2013	Yes

HP = horsepower
gpm = gallons per minute

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1.3.4 Sanitary Sewer System Drawings

Table 1-9 below lists the sanitary sewer system drawings that were provided by the City.

Table 1-9 Sanitary Sewer System Drawings

Project Name	Drawing Type	Year	Comments
7th Avenue Improvements	Design	2019	
35th Avenue Preliminary Design Drawings	Design	2020	
83rd Ave – Sanitary Sewer Project	Design	2017	
Ashcroft Draw Basin Sanitary Sewer Phase 1	As-Built	2017	
Ashcroft Draw Basin Sanitary Sewer Phase 2A	Design	2018	Project constructed
Ashcroft Draw Basin Sanitary Sewer Phase 2B	Design	2019	30% Design
City Center West	Design	2014	
College Park Subdivision	Record Drawing	2012	
Greeley Weld County Airport East Side Utilities	Record Drawing	2012	
Greeley Weld Airport Lift Station	As-Built	2015	
Homestead Heights Filing 4	Record Drawing	2008	
North Greeley Sewer Phase 2A	As-Built	2019	Partially Constructed
North Greeley Sewer Phase 2A	Design	2016	
North Greeley Sewer Phase 2B	Design	2018	
Poudre Trunk Sewer Phase 2	Design	2019	100% Design
Poudre Trunk Sewer Phase 2	Design	2019	100% Design
River Run at Poudre River Ranch	Record Drawing	2017	
Sheep Draw Sanitary Sewer Extension	As-Built	2011	
The Trails at Sheep Draw Phase 1A	Record Drawing	2018	
T-Bone Lift Station Emergency Overflow Sewer	Design	2012	
West Greeley Tech Center Phase 1	As-Built	2005	
West Greeley Tech Center Phase 2	As-Built	2015	
East Greeley Sewer Improvements Balsam Avenue Line	As Built	1989	

1.3.5 Planning Information

Tables 1-10 through 1-12 review the previous studies and reports, planning information, and intergovernmental agreements (IGAs) provided by the City. The City of Greeley adopted the Imagine Greeley Comprehensive Plan in 2018, which is a policy guide that provides framework for public and private growth and development decisions made by the City of Greeley over the next ten to twenty years. As a part of the Comprehensive Plan, a list of recommended actions was identified in Chapter 5 to assist in implementation of this plan. A summary of action items addressed with the development of this Sanitary Sewer Masterplan to ensure implementation of the Comprehensive Plan can be found in **Appendix G**.

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Table 1-10 Previous Studies and Reports

Report	Year
Greeley Ashcroft Draw Basin Sanitary Sewer: NFRWQPA Minor Amendment	2017
Imagine Greeley – Comprehensive Plan	2018
Comprehensive Plan Economic Analysis	2017
Comprehensive Plan Appendices	2018
Solids Handling and Treatment Master Plan	2012
Sanitary Sewer Master Plan	2009
North of the River Sewer Facilities Plan	2010
Wastewater Utility Plan – NFRWQPA 208 Plan	2009
Sewer System Model Update and Analysis	2014
Water Pollution Control Facility Treatment and Nutrient Master Plan	2018
City of Greeley Population and Water Demand Projections	2018
Sanitary Sewer Master Plan Volume 1	2003
7th Avenue Storm Drain Improvement Project; Sewer Improvement Modeling Tech Memo	2019
83rd Avenue Sanitary Sewer Main Extension – Sewer Report	2017
Ashcroft Draw Basin Map and Flow Projections	2017
Ashcroft Lift Station and Forcemain Analysis TM	2018
Boomerang 88 Subdivision Sewer System Analysis	2007
Poudre Trunk Sewer Phase II Project-Sub-Basin Master Plan	2018
Final Hydraulic Report – The Trails at Sheep Draw	2018
Industrial Pretreatment Annual Report	2018
Air Emissions and Odor Management Plan	1999
Water Pollution Control Facility Stormwater Management Plan	2017
City of Greeley Strategic Housing Plan	2018
Annual Growth and Development Projections Report	2019
Lakes Bluffs East Area	2013
Promontory Heights Planned Unit Development (PUD)	2019
Lake Bluffs PUD 2019	2019
Lake Bluffs PUD 2020	2020
Flow Information for Eaton	2020
Downtown Redevelopment Plan	2020
Cache Project PUD	2020
Airport Master Plan	2016
AIMS/UNC Reports	2020
City Center West Hydraulics Report	2019
Cobblestone PUD	2019
Grapevine PUD	2019
Stoneybrook PUD	2019
Triple Creek Subdivision PUD	2019
Westgate PUD	2019

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Table 1-11 Planning Information

Data	Request Purpose
City of Greeley Design Criteria and Construction Specifications	Sewer System Master Plan
Current Colorado Discharge Permit for the Wastewater Treatment and Reclamation Facility (WTRF)	208 Report Update
2019 Management Structure for the Water and Sewer Department	208 Report Update
Emergency Power Availability at Wastewater Lift Stations	208 Report Update
WTRF Site Deeds	208 Report Update
Water Billing Data (2014-2019)	Sewer System Master Plan
Emergency Response Protocols	208 Report Update

Table 1-12 Intergovernmental Agreements

Name	Type	Year
Garden City	Wastewater Treatment	2018
Fort Collins, Windsor, Carestream Health, Boxelder Sanitation District, South Fort Collins Sanitation District, Leprino Foods Company	Water Quality Monitoring on the Lower Cache La Poudre River	2019
State of Colorado	Water Resources Monitoring	2018
Evans	Wastewater Treatment	2002
T-Bone (with Evans)	Wastewater Treatment	2011
Windsor	Wastewater Treatment and Lane Use Planning	2008
Fort Collins, Windsor, Boxelder, South Fort Collins, Kodak	Water Quality Monitoring	2007
State of Colorado	Satellite Linked Monitoring	2007
Evans/Ashcroft Lift Station	Wastewater conveyance	Draft

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Section 2

Existing Sewer System and Service Area Data

The City of Greeley is in Weld County approximately 60 miles northeast of Denver, east of the cities of Fort Collins and Loveland. Greeley is accessible from I-25 and adjacent to the intersection of US Highways 85 and 34. It is the twelfth largest city in Colorado and is the county seat and most populous city in Weld County. Greeley has developed into a cultural and academic hub, hosting educational institutions such as UNC and Aims Community College. The City offers an affordable cost of living with many options for housing and economic growth.

2.1 Wastewater Service Area Overview

The City's total land area was approximately 30,730 acres (or 48 square miles) as of 2016, which marked an increase of over 13,000 acres since 1990. The largest period of annexations occurred during the early 2000s. **Figure 2-1** from Imagine Greeley illustrates the City's historical growth.

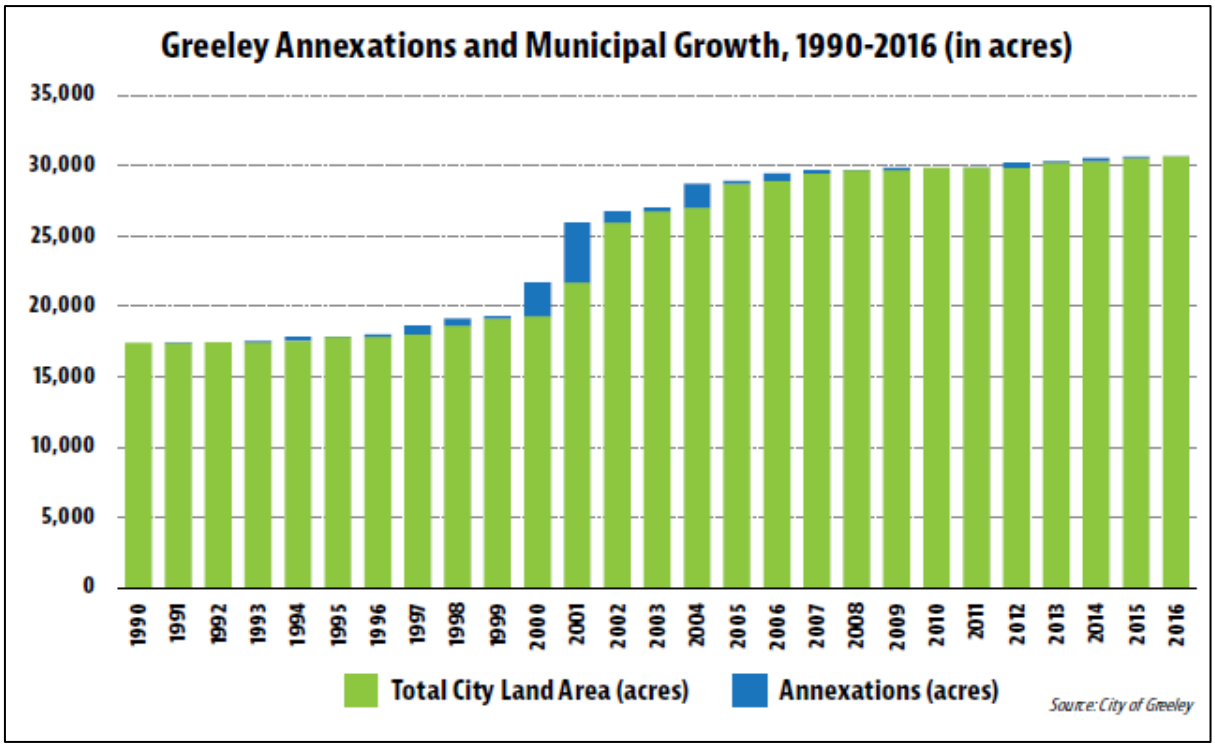

Figure 2-1 Greeley Annexations and Municipal Growth
Source: Imagine Greeley Comprehensive Plan

Of the City's total land area (30,730 acres), 58% was considered to be "developed" in 2017. Within this developed area, the largest land use, as recorded by the Weld County assessor, is rights-of-way (streets, railroads, etc.), followed by residential land uses. The City has a large percentage of land considered property tax exempt/institutional. The remaining 42% of Greeley's land area is considered "undeveloped" and is predominantly used for agriculture. While this land

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is undeveloped today, it may be developed in the future unless preserved in some manner. **Figure 2-2** from Imagine Greeley provides detailed information on Greeley's current land use.

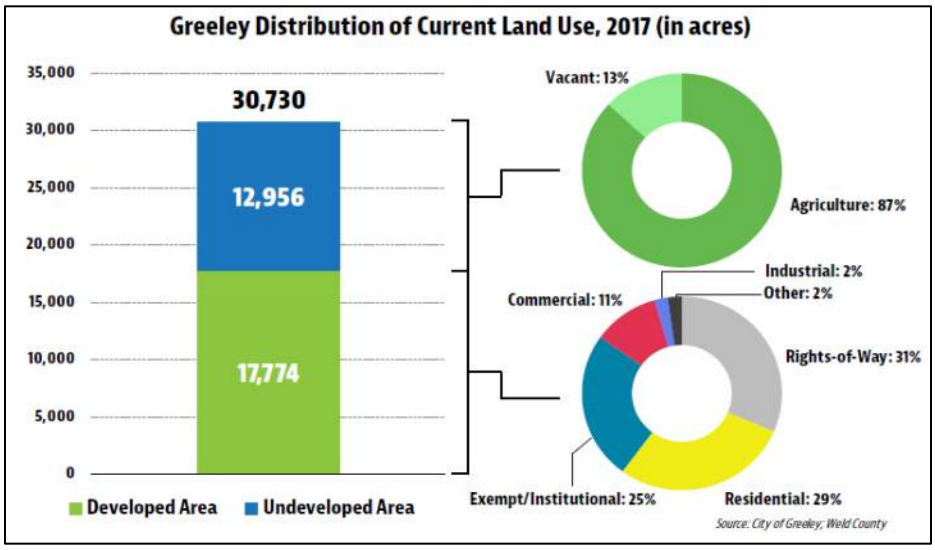

Figure 2-2 Greeley Distribution of Current Land Use, 2017 (in acres)
Source: Imagine Greeley Comprehensive Plan

The City zoning code regulates the types of uses that may occur in specific locations and how such uses may be built. In 2015, most of the land in Greeley was zoned for residential uses, with Agricultural/Holding as the next largest zone type by land area. These categories were the only ones to see decreases in area between 2007 and 2015, likely due to the rezoning that occurred as agricultural lands were developed for other uses. **Figure 2-3** provides a chart detailing the zoning shifts between 2007 and 2015. **Figure 2-4** provides the City's 2019 zoning map.

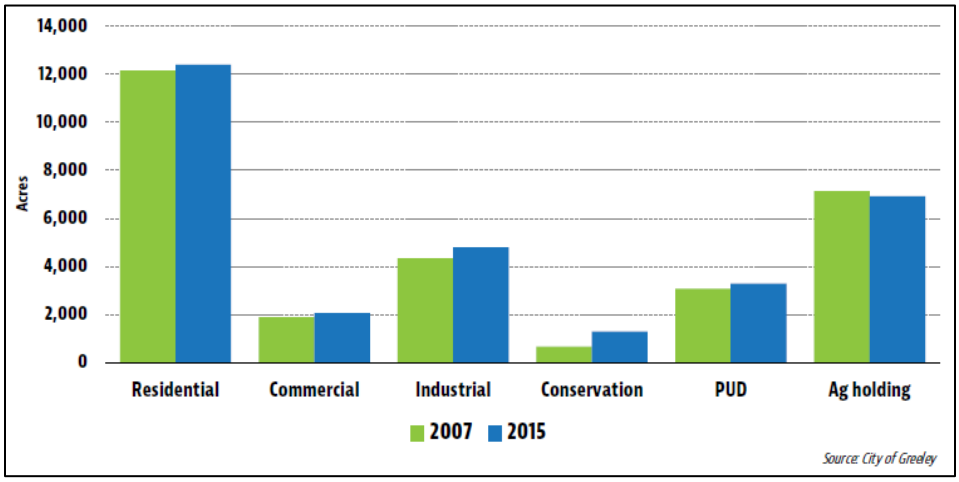

Figure 2-3 Greeley Distribution of Land Uses by Zoning Categories 2007 and 2015
Source: Imagine Greeley Comprehensive Plan

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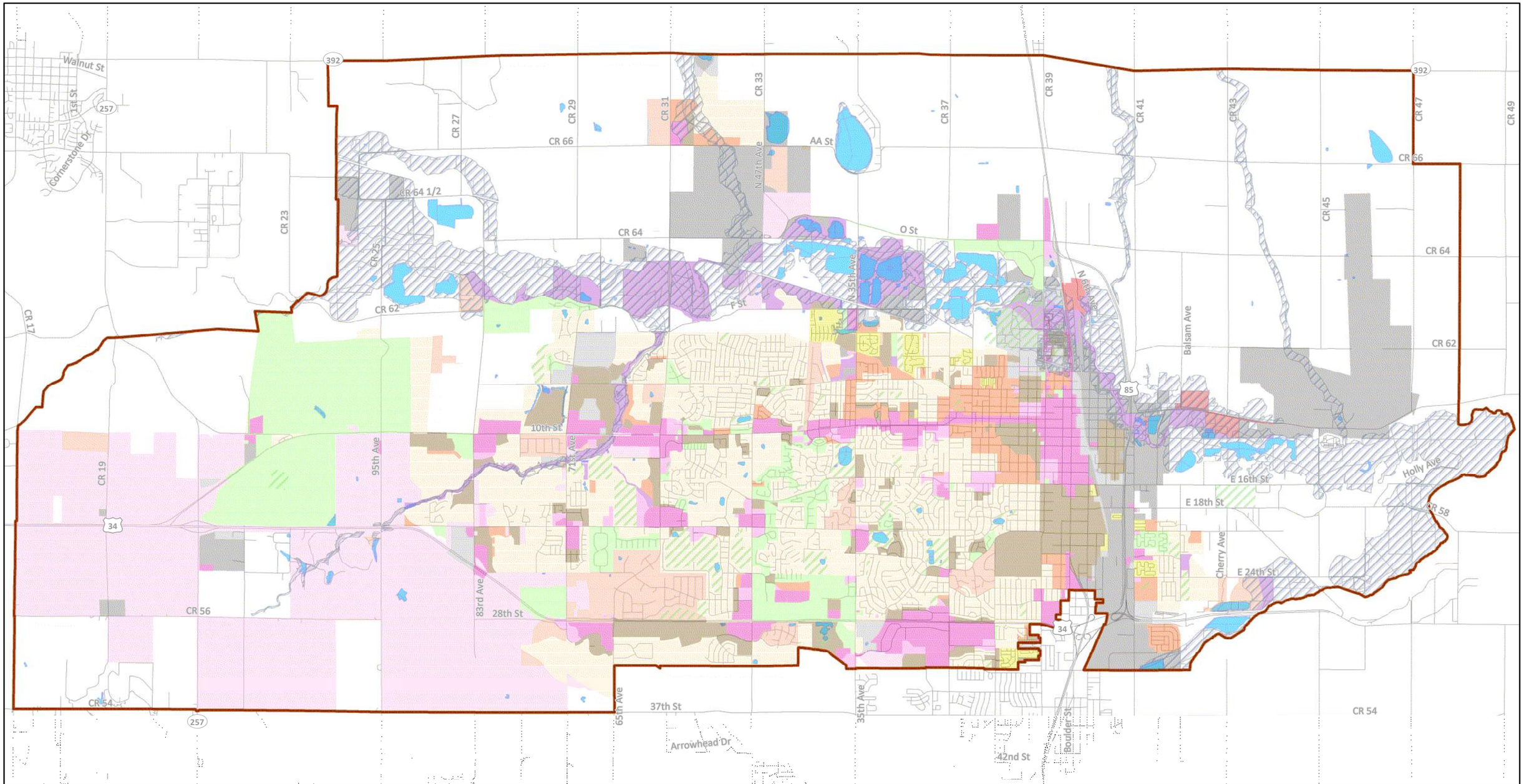

Legend

- LREGA
- 100-yr Floodplain
- Lakes and Ponds
- Park

Greeley 2019 Zoning

- Conservation District (C-D)
- Commercial High Intensity (C-H)
- Commercial Low Intensity (C-L)
- Holding Agriculture (H-A)
- Industrial High Intensity (I-H)
- Industiral Low Intensity (I-L)
- Industrial Medium Intensity (I-M)
- Planned Unit Development (PUD)
- Residential Estate (R-E)
- Residential High Density (R-H)
- Residential Low Density (R-L)
- Residential Medium Density (R-M)
- Residential Mobile Home (R-MH)

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2019 Zoning Map

Figure 2-4

Greeley Sewer System Master Plan

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2.2 Sanitary Sewer System Configuration

2.2.1 Existing Sanitary Sewer System

The City's sanitary sewer system currently consists of approximately 350 miles of sewer pipe which ranges in size from 4" diameter through 21" diameter including approximately 17 miles of interceptor ranging in size from 24" diameter to 48" diameter. The sewer lengths by diameter are shown in **Table 2-1**. The areas that are potentially served by septic systems are shown in **Figure 2-5**.

Table 2-1 Sewer Lengths by Diameter (from GIS information)

Diameter (inches)	Length (ft)
4	4,697
6	88,818
8	1,398,226
10	131,384
12	78,455
15	54,568
16	465
18	51,779
21	38,688
24	17,008
27	10,779
30	19,011
36	38,006
42	1,232
48	5,430

The City's wastewater conveyance system includes 10 lift stations, shown below in **Table 2-2.**

Table 2-2 Existing Lift Station Information

Lift Station Number	Station Name	Current Capacity (gpm)	Horsepower	Approximate Construction Year	Upgrade Year
Lift Station 1	North 9th Avenue	80	3	1959	2000
Lift Station 2	Airport	120	7.5	2016	-
Lift Station 4	Highland Hills	100	7	1992	2015
Lift Station 9	Cherry Avenue	638	21	1989	2013
Lift Station 12	Garden City	80	3	1985	2007
Lift Station 13	35th Avenue	1705	75	1981	2012
Lift Station 15	Auto Plaza	150	10	1980	-
Lift Station 16	East 8th Street	270	13	1985	2013
Lift Station 17	Farmers Spur	560	6.2	1993	2015
Lift Station 18	T Bone	668	54	1998	2013

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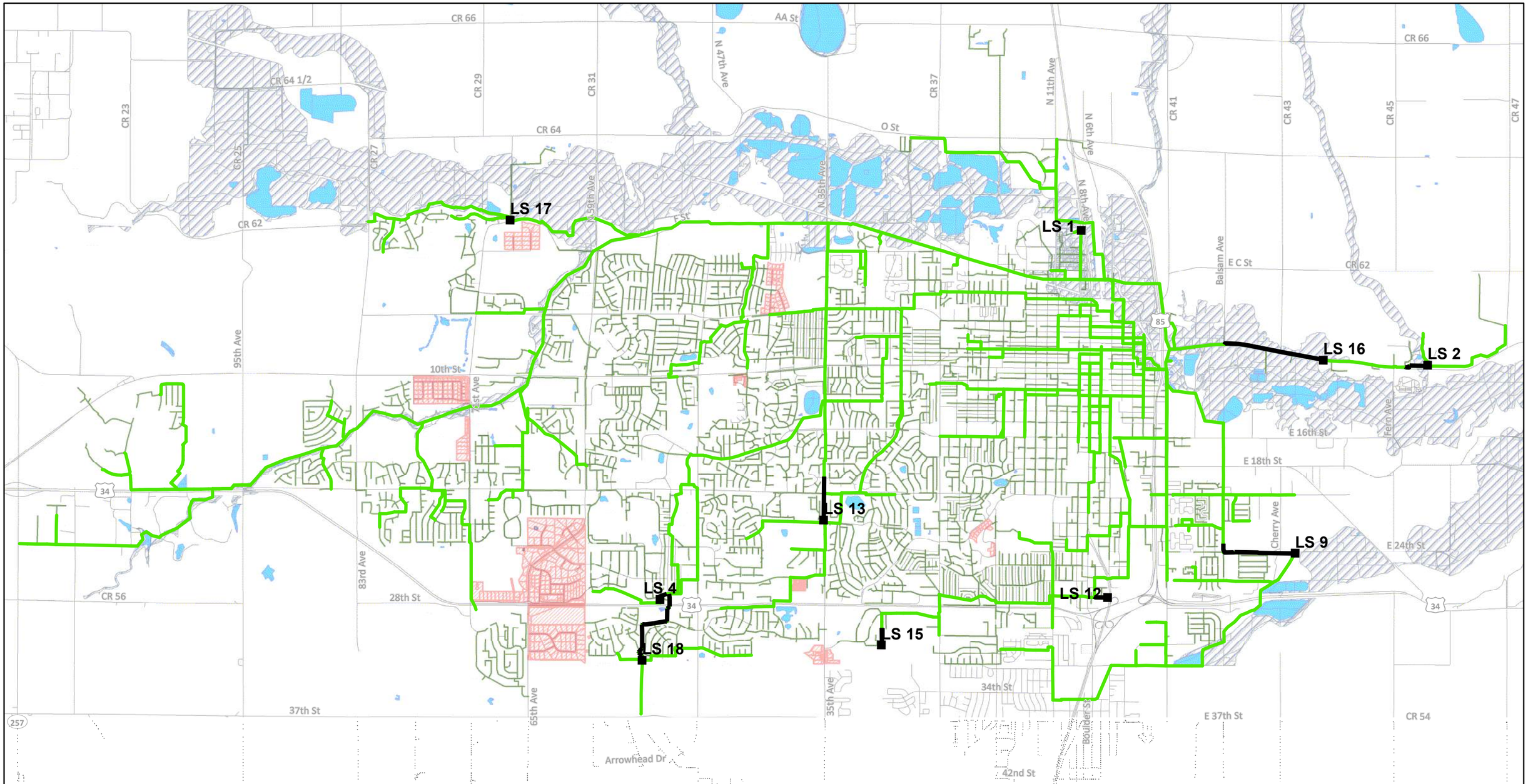

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Legend

- 100-yr Floodplain
- Lakes and Ponds
- Septic Tank Parcels (Assumed)
- Existing Lift Stations
- Existing Trunk Lines
- Force Main
- Existing Collector Sewer

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Existing Sewer System

Figure 2-5

Greeley Sewer System Master Plan

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2.3 Historical Population Data

The City's population grew from a 20,354 in 1950 to an estimated population of 108,175 in 2019. A closer look at the population trends since 2005 reveals that the City's population decreased during 2009 but returned the following year with continued growth ever since that temporary increase. **Figure 2-6** shows the City's population growth from 2005-2017.

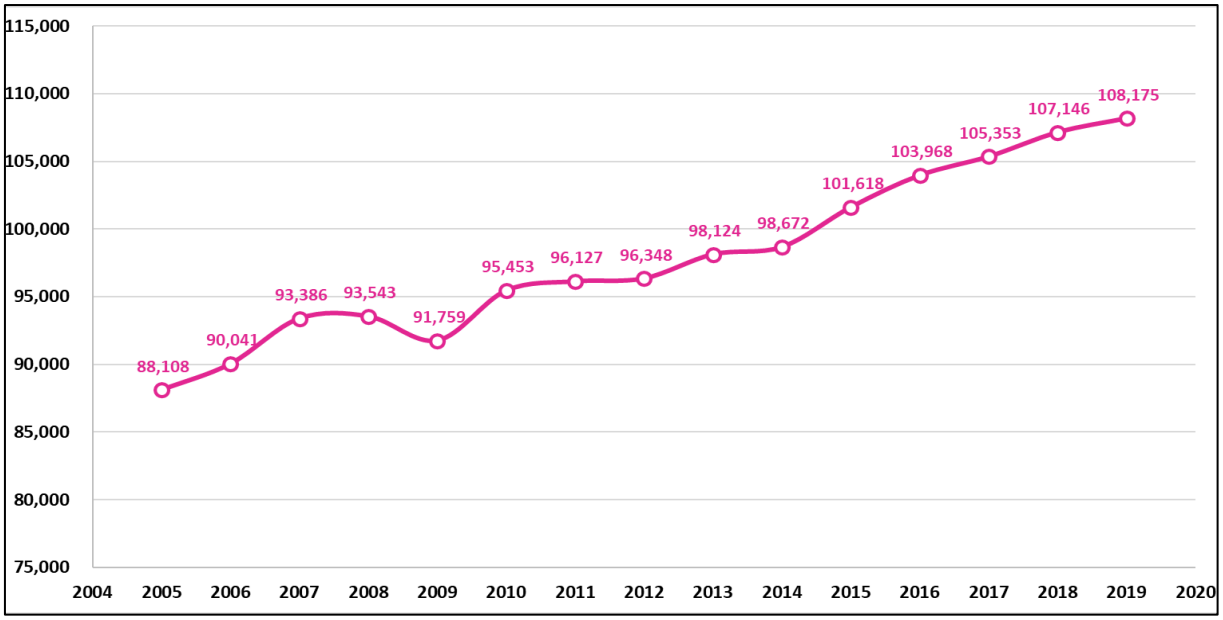

Figure 2-6 Greeley Population 2005 – 2020

2.4 Water Billing Data

The City's sewer flows are not metered and are billed directly for each customer on the wastewater system based on winter water use. Winter water billing data can be used to estimate base wastewater flows (BWF) as this is the portion of wastewater flow that comes directly from water use. During the winter months, water demand is almost exclusively associated with household use, with typically no outside irrigation or other consumptive uses, and is returned as wastewater. Winter water billing data for the City was used to compare to overall treatment plant flows, to distribute population and flow throughout the system and to analyze nonresidential wastewater flow on an acreage basis. This approach was used to inform recommendations for projecting flows in future areas.

The City provided water billing data from 2014 through 2019. This data included a list of the wastewater customers so that any water-only customers would not be accounted for in the estimates of BWF. This data was geolocated using the address information for each account to spatially distribute the information throughout the system. Winter months, or the months of minimum consumptive use, were assumed to be December through February.

The number of customers by type is summarized in **Figure 2-7**, which shows 85% of the accounts as single family residential. Note that customer meter type is different from zoning and land use. Additionally, winter water use by type is summarized in **Figure 2-8**, which shows that

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commercial accounts only represent 7% of accounts, however these commercial accounts represent a much greater percentage of the winter water use. Multi-family units are typically grouped into one account resulting in the large difference shown in that category between count and use.

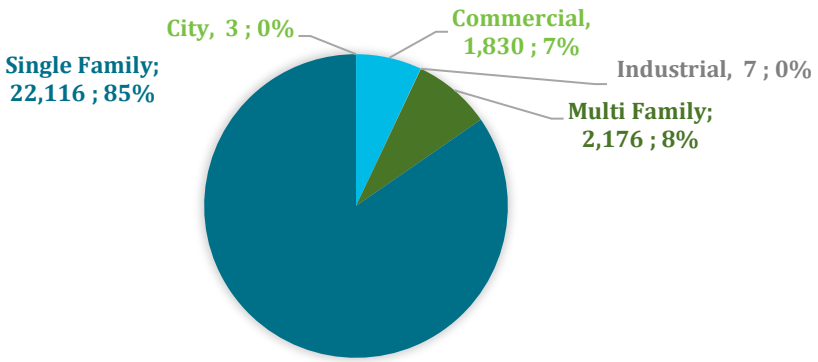

Figure 2-7 Number of Water Billing Accounts by Type

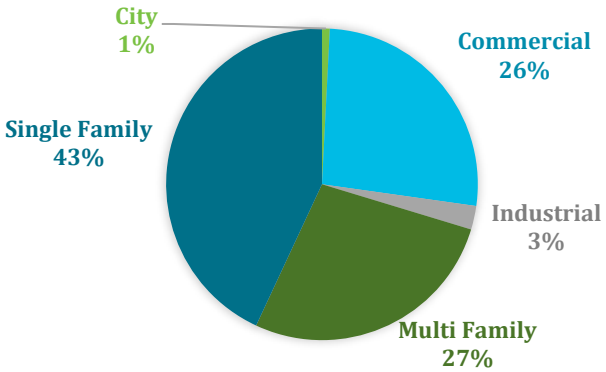

Figure 2-8 Winter Water Use from Billing Data by Type

2.4.1 Spatial Distribution – Residential

As a first step of flow data analysis and model calibration, the 2018/19 winter water billing data associated with their respective geolocated address points were used to spatially distribute population and wastewater flows throughout the system. To calculate existing population from the billing points, the residential billing points were multiplied by the following factors from the City's design criteria:

- Low-density residential (R-L): 3.1 people per unit.
- Medium-density residential (R-M): 2.7 people per unit.
- High-density residential (R-H): 1.7 people per unit.

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To determine which criterion applies to each billing point, residential density information is assumed from the following sources of information:

- Existing land use GIS layer
- Household density GIS layer
- Billing data categories

In the absence of information on residential density in specific areas from the above data sources, 2.7 people per unit was assumed. For multi-family water meters, a population of 2.7 people/meter was assumed with the exception of the UNC. The population of UNC was manually inserted to account for the large value. After the initial population distribution estimate, a small citywide scaling factor was used to ensure the total population matched the projected population. The flow per person after-calibration varied between meter basins as a result of the calibration effort.

2.4.2 Spatial Distribution – Nonresidential

The nonresidential billing data from the same period was joined with zoning data and then converted to gallons per day per acre (gpd/acre) to compare winter water use among various nonresidential zoning categories. This information was used for projecting wastewater flows in future development areas where only zoning information was available. The zoning categories for nonresidential water use include the following:

- C-H: Commercial High Intensity
- C-L: Commercial Low Intensity
- I-L: Industrial Low Intensity
- I-M: Industrial Medium Intensity.

The City provided previously calculated nonresidential winter water use in gpd/acre for the categories of retail, restaurant, office and hotel, which all fall under the zoning category of "C-H". This data set included randomly selected accounts that were examined more closely to understand the likely range of gpd/acre for the commercial zoning. This information was used to remove erroneous gpd/acre calculations or extreme outliers from the 2018/19 winter billing data set.

Figure 2-9 shows box and whisker plots of gpd/acre for the 2018/19 nonresidential winter water use by zoning category**.** These plots include the following statistics:

- The bottom and top of the vertical lines represent the minimum to maximum values excluding outliers. Outliers are defined as any point that lies 1.5 times the interquartile range or the length of the "box" in the plots shown.
- The bottom and top of the box are the 25th and 75th percentiles, respectively.
- The line inside the box is the median.
- The "x" is the average.

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This information guide future conditions flow projections in nonresidential development areas. The 75th percentile values were used in the future land use plans so that the flows were not underestimated.

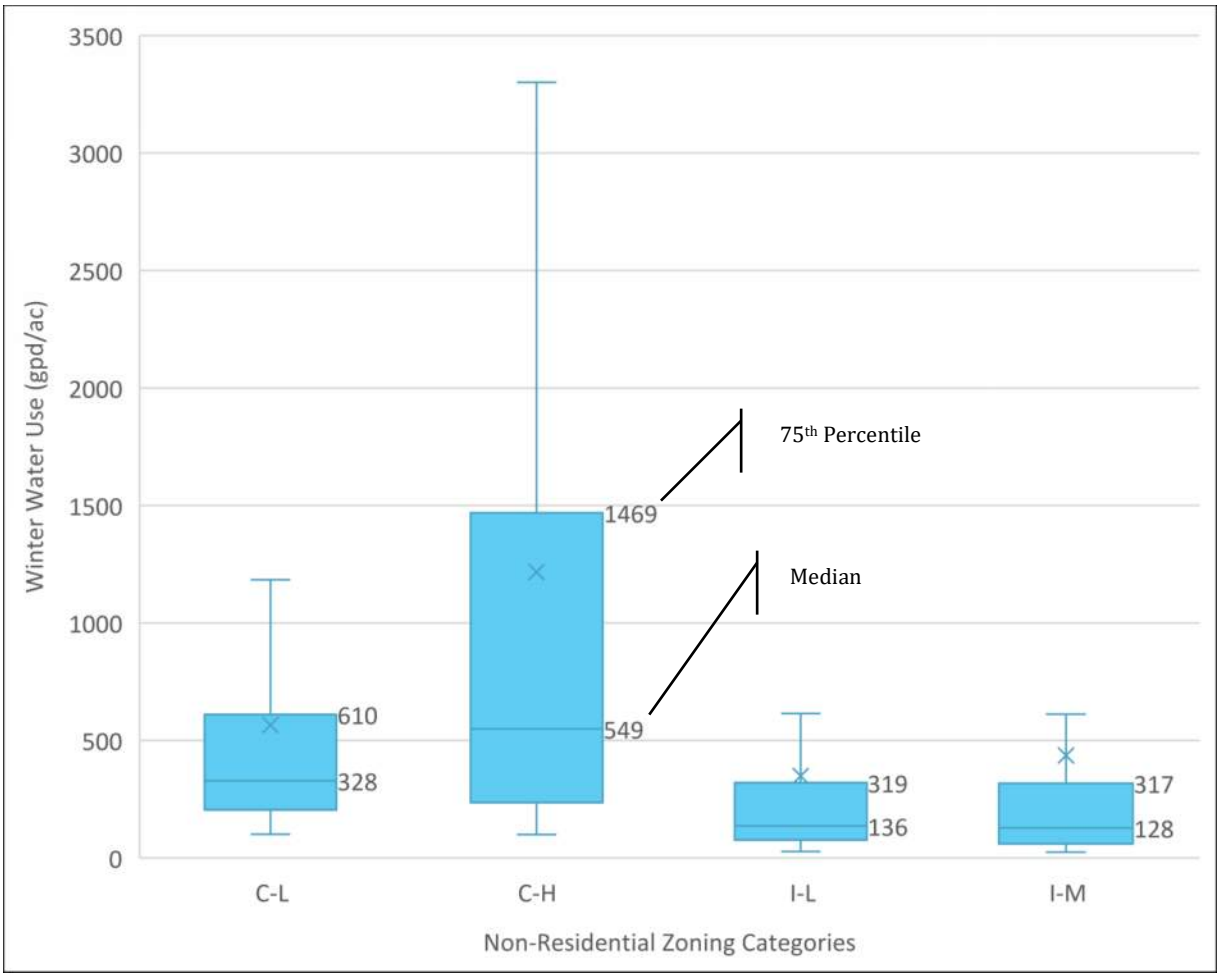

Figure 2-9 Box and Whisker Plot: 2019 Nonresidential Winter Water Use by Commercial Class

Table 2-3 summarizes the median and 75th percentile values for the zoning categories, with the recommended values rounded up from the 75th percentile. This information was used as part of projecting future wastewater flows.

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Table 2-3 Nonresidential Winter Water Billing Data Summary

Nonresidential Zoning Categories	Median (gpd/acre)	75th Percentile (gpd/acre)	Recommended Value for Future Conditions Projections (gpd/acre)
Commercial Low Intensity, C-L	328	610	650
Commercial High Intensity, C-H	549	1469	1500
Industrial Low Intensity, I-L	136	319	500
Industrial Medium Intensity, I-M	128	317	500

Note: At time of planning, there were only 7 industrial meters within the City to approximate industrial flows. To get more data points, all existing water meters within areas zoned as Industrial were selected; the resulting data is shown above. Due to the variability of industrial demands, a higher industrial value was selected to be more conservative. This value more closely aligns with typical values from other municipalities.

2.5 Wastewater Treatment Plant Flow Data

The City provided historical daily wastewater treatment plant flow data in million gallons per day (mgd) from 2014 through 201920, which is used to illustrate trends in average daily flows (ADF) as shown in **Table 2-4**. The ADF divided by total population shows the general trend of a reduction in gallons per capita per day (gpcd). In other words, even though population has increased, ADF has remained steady. This is mainly due to water conservation and improvements that have been made to reduce inflow and infiltration (I/I). The calculated average per capita flow includes residential and nonresidential flow, therefore it does not represent per capita flow for use in future flow projections by land use or zoning type.

Table 2-4 Average and Peak Daily WTRF Influent Flows

Year	Estimated Population[1]	Average Daily Flow (mgd)	Average Per Capita Flow (gpcd)[2]	Peak Day Flow (mgd)
2019	108,175	7.31	68	8.28
2018	107,146	7.49	70	8.82
2017	105,353	7.83	74	11.39
2016	103,968	7.67	74	9.72
2015	101,618	8.06	79	11.49
2014	98,672	8.09	82	15.85

[1] Population estimates from Annual Growth & Development Projections (2019)

[2] Average flow per capita is the ADF divided by the population. The ADF includes residential and nonresidential flow along with GWI attributed to population. The resulting gpcd value was used to illustrate the effects of water conservation on gpcd and was not used for future flow projections.

Peak day flows are presented from 2014 to 2020 and are inclusive of I/I. Monthly rainfall in 2014, 2015 and 2017 was greater than in 2016 and 2018 resulting in higher peaks from I/I in the wetter months. Flow data collected throughout the system on 5 to 15-minute time steps was analyzed to better understand the extent of I/I in the system.

Figure 2-10 shows the average monthly wastewater treatment plant influent flow from 2014 through 2020. This data was used to assess potential seasonal factors in the wastewater flows that may need to be applied in the model. Monthly flows for the month of June in both 2014 and 2015 were significantly higher than in other years due to flooding in those months. Rainfall in the

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City is typically greatest in the month of May. This seasonal increase may indicate an increase in I/I, but later years suggest that this is not a normal occurrence. For all years, the greatest flows were observed in May and June, which coincides with the temporary flow monitoring. However, the flow data for 2019 indicates that flow this year was generally lower than previous years. Starting in June of 2019, the flows increased, but were still lower than typical influent flow.

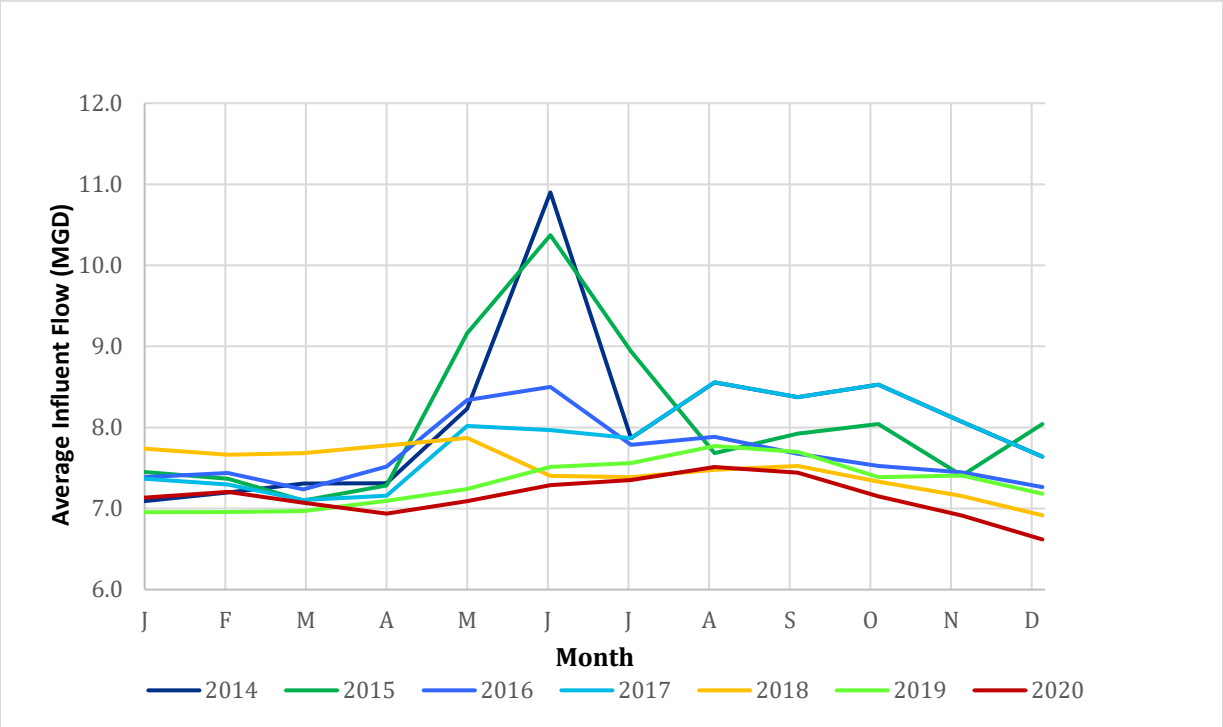

Figure 2-10 ADF Influent Flow Trends by Month

2.6 Available System Flow Data

Available system flow data (obtained upstream of the treatment plant) consists of temporary flow meters and rainfall gages as well as permanent flow meters. Temporary flow meters and rain gauges were installed throughout the wastewater service area by RJN Group from April 18 through June 18, 2019. The data collected was used to analyze the components of wastewater flow within each metered basin. Permanent flow meter data was analyzed in a similar fashion, to assist with model calibration. The parameters developed from the permanent flow meters were used to fill in temporal and spatial gaps in the temporary meter data and to compare parameters across the system.

Temporary wastewater flow monitoring was conducted in 12 locations as shown in **Figure 2-11**. Depth and velocity data were measured from April 18 through June 18, 2019. Rainfall data was collected at two gauges, located on the east and west sides of the City. Permanent meters operated by the City were used to supplement the temporary flow meter data that was collected between April 18, 2019 and June 18, 2019. **Figure 2-12** identified the locations of the City's permanent flow meters.

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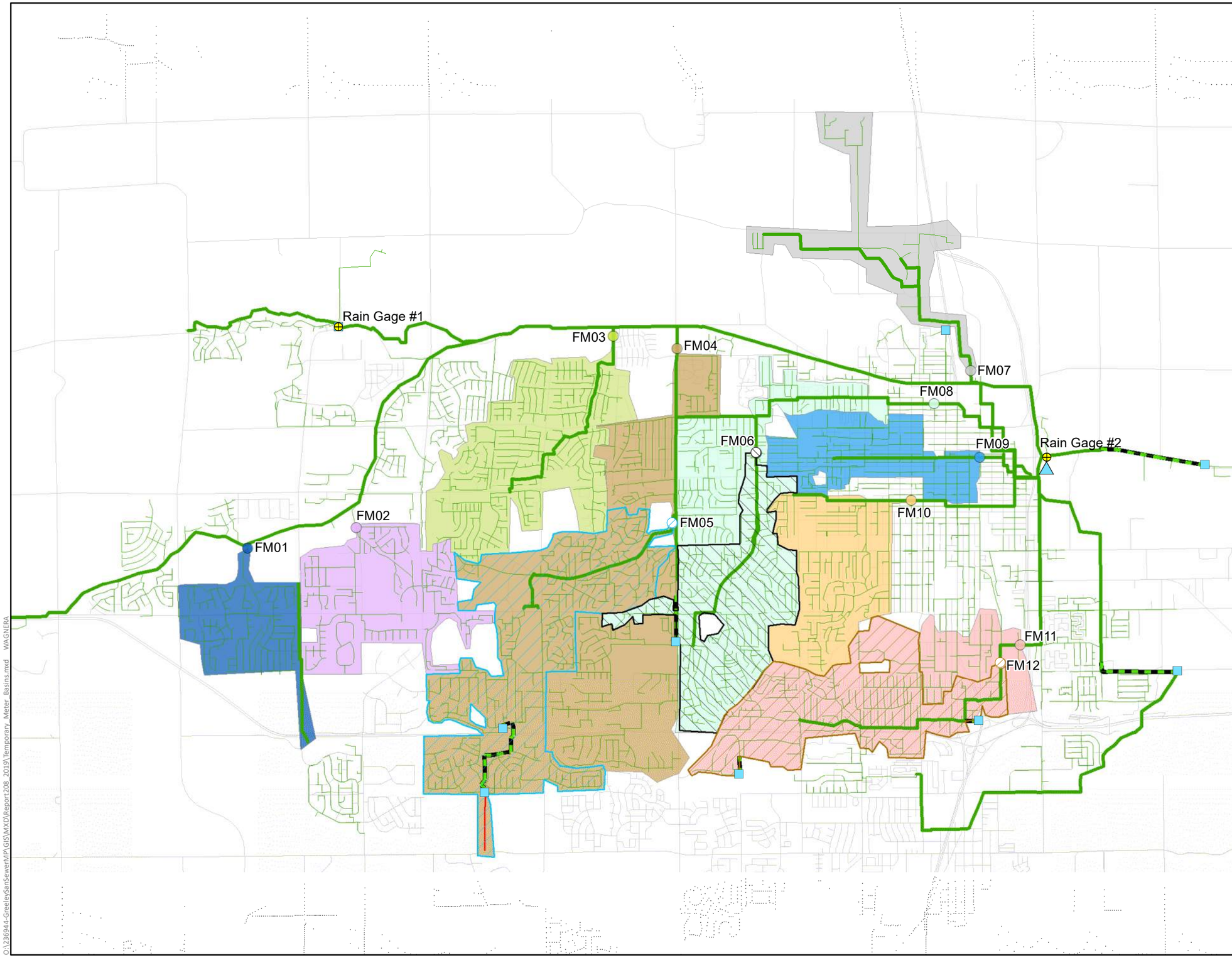
Temporary Flow Meter Basins

Figure 2-12

Greeley Sanitary Sewer System Master Plan



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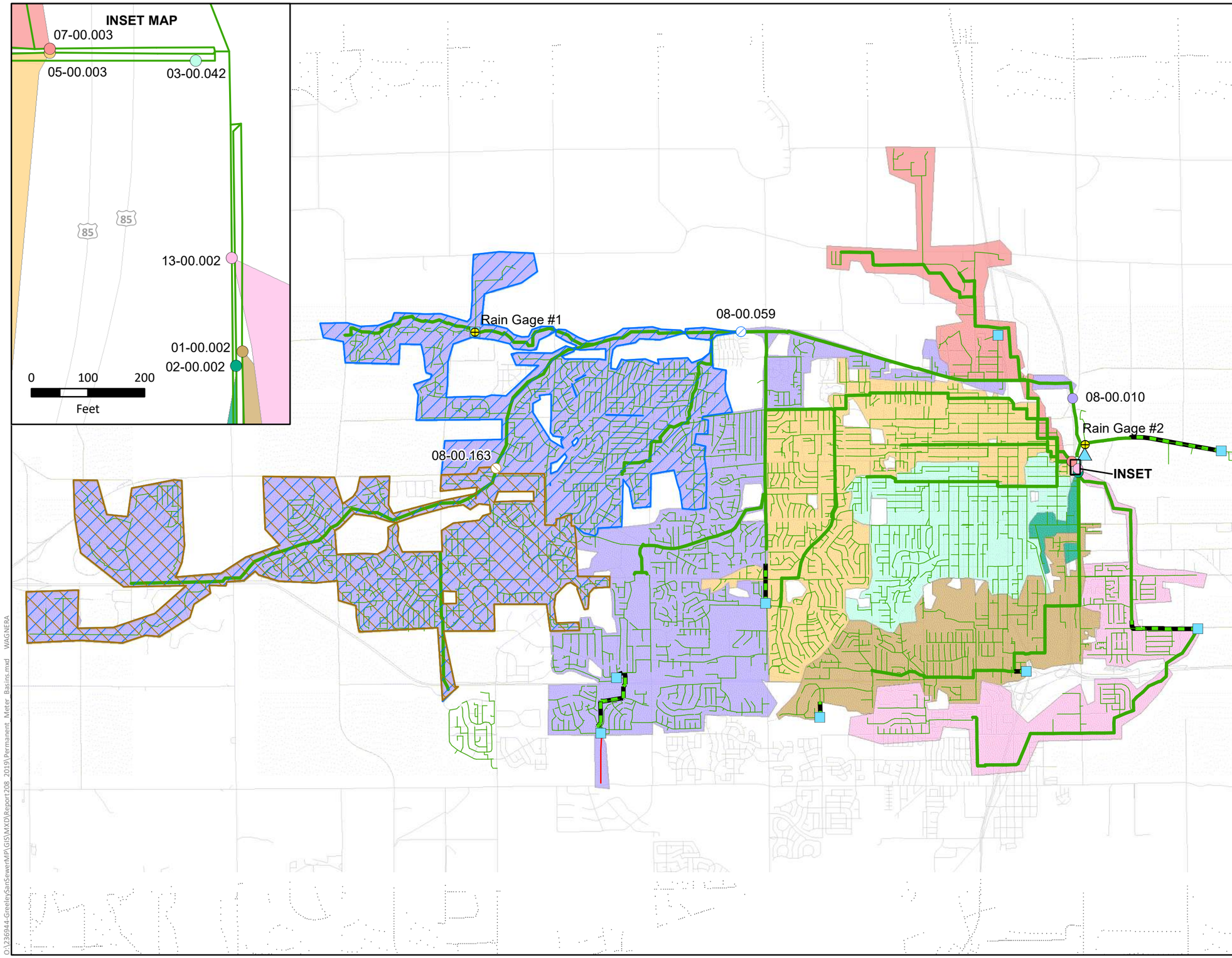

Permanent Flow Meter Basins

Figure 2-13

Greeley Sanitary Sewer System Master Plan

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Legend

- Rain Gauge
- Lift Station
- WTRF

Sewer Mains

- Trunk Line
- Force Main
- Collector Line
- Overflow Line

Permanent Flow Meter and Basin

- 01-00.002
- 02-00.002
- 03-00.042
- 05-00.003
- 07-00.003
- 08-00.010
- 08-00.059
- 08-00.163
- 13-00.002

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October 29, 2019

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2.6.1 Flow Meter Data Analysis

Wastewater flow was divided into three components as shown in **Figure 2-13,** and described below:

- Groundwater Infiltration (GWI), which is a constant flow from groundwater that leaks into the system through cracks in pipes and other structure defects
- BWF is made up of sanitary wastewater flows that are produced by people and businesses, which will vary throughout the day depending on water usage and other factors
- Rainfall Dependent Inflow and Infiltration (RDII), which is peaked based on the peak of the rainfall event simulated

DWF is the sum of GWI and the BWF. WWF is the sum of DWF and RDII. Analysis of the temporary flow meter data is described in the following sections for DWF and RDII.

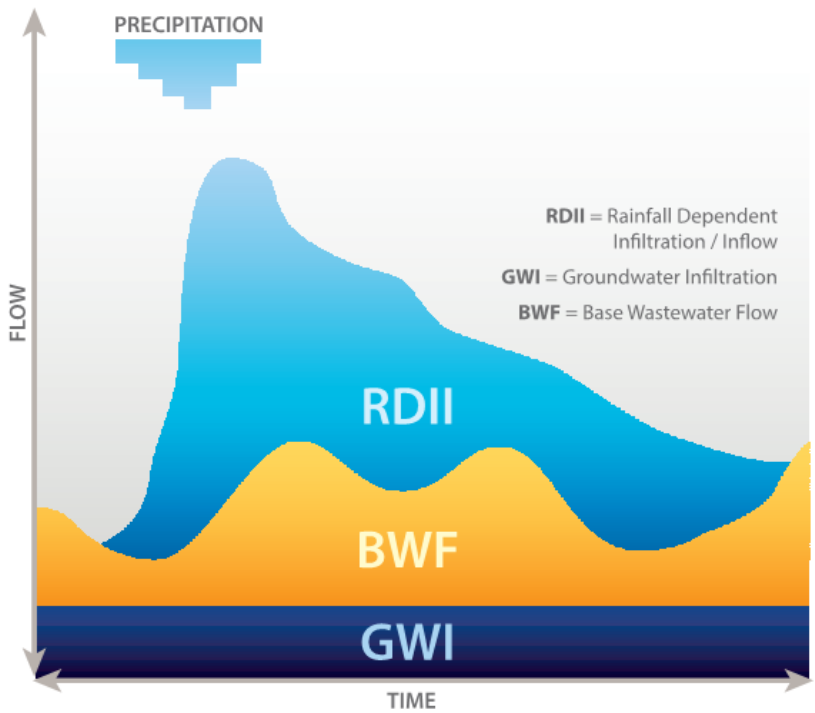

Figure 2-13 Components of Wastewater Flow

2.6.1.1 Dry Weather Flow Analysis

The collected flow and rainfall data were analyzed using the SSOAP toolbox developed by the U.S. Environmental Protection Agency (EPA) and CDM Smith. Using SSOAP, DWF was separated from WWF. DWF statistics were developed by selecting flow from specific DWF days. A day is considered a dry day if no rainfall is observed between the time of the flow and the two days previous. DWF days that were considered statistically different from the rest of the dataset were removed from the analysis. Weekday and weekend DWF statistics were developed separately because of their distinct flow patterns. Once wet days and statistical outliers have been removed,

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the SSOAP toolbox calculates an average flow, average peak, and diurnal flow patterns for each basin organized by weekday and weekends. GWI was estimated as the difference between total DWF measured from the flow meters and the average winter water use from billing data, which was assumed to represent BWF. Initial flow estimates and diurnal patterns calculated from the SSOAP toolbox were loaded into the model, and then adjusted until the flow patterns within the model for each flow basin (both temporary and permanent) matched the measured DWF patterns during the periods used for calibration.

Population and area were used to parameterize the components of wastewater flow. The City estimates that the population currently served by the wastewater system is 107,146. This population was distributed throughout the system based on the geolocated billing data and address points. Understanding the approximate population statistics in each basin allows for the characterization of wastewater flow in terms of per person use. **Tables 2-5** summarizes the calibrated distribution of population, nonresidential flow, residential flow, and GWI within each measured flow basin.

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Table 2-5 Calibrated Modeling Parameters

Flow Metering Basin	Population	Acres	Nonresidential BWF (mgd)	Residential BWF (gpd/person)	GWI (gpd/acre)
FM01 Sheep Draw Basin	3,357	372	0.003	47	43
FM02 Sheep Draw Basin	4,302	686	0.072	35	38
FM03 Hilltop Basin	9,895	1,042	0.043	35	38
FM04 Highland Hills Basin	18,143	2,466	0.283	40	84
FM05 Highland Hills Basin	11,294	1,422	0.05	44	111
FM06 Belair Basin	7,979	911	0.116	67	117
FM07 Monfort Basin	197	458	0.2	51	129
FM08 North Basin	14,997	1,502	0.177	54	188
FM09 Eight Street Basin	4,668	530	0.111	89	140
FM10 Central Basin	5,681	654	0.181	36	38
FM11 South Basin	11,194	1,225	0.362	51	117
FM12 South Basin	8,670	923	0.188	47	92
01-00.002	12,103	1,425	0.441	53	129
02-00.002	375	158	0.01	24	10
03-00.042	13,855	1,340	0.296	38	108
05-00.003	20,935	2,255	0.329	61	162
07-00.003	806	678	0.226	83	139
08-00.010	48,137	6,453	0.532	39	59
13-00.002	8,456	1,004	0.115	66	151
08-00.059	28,933	3,811	0.227	34	39
08-00.163	12,064	1,813	0.125	39	60

[1] Population distribution was estimated from geolocated billing data and address points. These values cannot be summed due to overlapping basins.

2.6.1.2 Calibrated Diurnal Patterns

For each flow meter, SSOAP develops an average diurnal flow pattern for DWF by averaging the flows at each hour in a dry weather day. These patterns were then adjusted specifically for BWF by subtracting the estimated GWI. The BWF flow pattern for each meter was then normalized by dividing the flow in each hour by the overall daily average BWF. These normalized patterns were uploaded into the model and adjusted to match measured flow as part of the calibration process. The normalized patterns are provided in **Appendix A**. For residential water use, the patterns typically peak in the morning and the evening. These peaks diminish with larger area due to sewer system attenuation. For nonresidential areas, the water pattern typically has a plateau of water use from 8 AM to 8 PM.

2.6.1.3 Peaking Factors

Table 2-6 summarizes the average BWF, peak BWF and peaking factor for each temporary flow meter basin by weekend and weekday.

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Table 2-6 Temporary Meter Base Wastewater Flows and Peaking Factors

		Weekday			Weekend		
Basin	Type of Use	BWF (mgd)	BWF Peak (mgd)	Peaking Factor	BWF (mgd)	BWF Peak (mgd)	Peaking Factor
FM01 Sheep Draw Basin	Residential	0.16	0.39	2.46	0.17	0.34	1.96
FM02 Sheep Draw Basin	Mixed	0.23	0.38	1.65	0.23	0.40	1.79
FM03 Hilltop Basin	Residential	0.39	0.66	1.68	0.43	0.72	1.70
FM04 Highland Hills Basin	Residential	1.00	1.38	1.39	1.05	1.68	1.60
FM05 Highland Hills Basin	Residential	0.56	0.90	1.62	0.58	0.99	1.71
FM06 Belair Basin	Mixed	0.61	0.93	1.53	0.65	1.12	1.71
FM07 Monfort Basin	Industrial	0.21	0.32	1.49	0.20	0.32	1.60
FM08 North Basin	Mixed	1.02	1.44	1.42	1.05	1.64	1.55
FM09 Eight Street Basin	Mixed	0.43	0.63	1.47	0.43	0.68	1.58
FM10 Central Basin	Industrial	0.37	0.56	1.50	0.35	0.64	1.86
FM11 South Basin	Industrial	0.64	0.88	1.37	0.58	0.85	1.47
FM12 South Basin	Industrial	0.49	0.71	1.44	0.43	0.66	1.53
01-00.002	Industrial	0.89	1.26	1.42	0.74	1.16	1.57
02-00.002	Industrial	0.02	0.03	1.38	0.02	0.03	1.56
03-00.042	Mixed	0.84	1.15	1.36	0.74	1.20	1.61
05-00.003	Mixed	1.38	1.85	1.34	1.39	2.01	1.45
07-00.003	Industrial	0.43	0.63	1.46	0.43	0.69	1.61
08-00.010	Residential	2.28	3.38	1.49	2.27	3.93	1.73
13-00.002	Mixed	0.58	0.92	1.59	0.61	0.99	1.64
08-00.059	Residential	1.32	2.14	1.62	1.38	2.42	1.76
08-00.163	Residential	0.53	0.89	1.68	0.53	0.96	1.80

The peaking factors for each basin are not intended to be applied city-wide and are appropriate only for the individual basin.

Peaking factors vary based on the type of use (residential versus nonresidential) and the size of the basin. In general, residential areas have a greater peaking factor since most of the water use occurs in the morning and then again in the evening, as compared to nonresidential areas that use water consistently throughout normal business hours. Additionally, as population increases and land use becomes mixed, the peaking factor decreases, as demonstrated by comparing residential and mixed-use diurnal patterns. The increasing size of a basin will result in a lower peaking factor due to the attenuation of peak flows as they move through the collectors and into the interceptors. The peaking factors used in modeling are not intended to be used in smaller areas or for criteria for peaking in development considerations.

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2.6.2 Rainfall Data

Rainfall data was collected along with the flow metering data at two locations. Three events were observed at Rain Gauge 1 (West) and four events were observed at Rain Gauge 2 (East). These events are summarized in **Table 2-7**. Comparing the events to the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 8, Version 2, Point Precipitation Frequency Estimates for Greeley (Atlas 14), the observed events are less than the 1-year return period for the observed durations. Although the observed rainfall was less than the Atlas 14 frequency estimates, there were RDII responses observed that could be characterized using RTKs. RTK is defined as the three parameters used to characterize the rainfall dependent inflow and infiltration unit hydrographs. R is the fraction of rainfall volume that enters the sanitary sewer. Low R values indicate a sewer system with very little inflow or infiltration. T is the time from the onset of rainfall to the peak of the wet weather hydrograph. K is the ratio of the time of hydrograph recession to the time to hydrograph peak. By applying a selected design storm to the RTKs, the RDII response can be extrapolated in the model.

Table 2-7 Rain Events Used for RTK Analysis

Rain Gauge 1 (West)				Rain Gauge 2 (East)			
Start Date/Time	Total Volume (in)	Duration (hr)	Peak Intensity (in/hr)	Start Date/Time	Total Volume (in)	Duration (hr)	Peak Intensity (in/hr)
5/19/2019 9:50	0.75	25.17	0.36	5/20/2019 01:20	0.87	20.83	0.39
(no rainfall observed at this rain gauge)				5/27/2019 17:15	0.31	0.92	0.31
6/2/2019 16:40	0.31	1.58	0.29	6/2/2019 16:20	0.42	1.42	0.41
6/3/2019 16:50	0.21	0.42	0.21	6/3/2019 17:00	0.27	0.42	0.27

hr = hour
in = inches

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Section 3

Existing and Future System Model Development

The City's existing sewer system hydraulic model was most recently updated in 2014 by CDM Smith. This section summarizes the changes made to the 2014 model to represent the 2019 system. These changes included datum conversion, infrastructure updates, database updates, and model pump station updates.

3.1 Datum Conversion

The 2014 Federal Emergency Management Agency (FEMA) Vertical Datum Conversion document supports the nine vertical datum standards adopted by FEMA in the execution of vertical datum conversions from the National Geodetic Vertical Datum of 1929 (NGVD29) to the North American Vertical Datum of 1988 (NAVD 88). This document provides context and supporting guidance for the conversion process. The conversion process used to convert the wastewater model from NGVD 29 to NAVD 88 was based on the above guidance document and is summarized below. To convert from NGVD 29 to NAVD 88, specific conversion software must be used. The National Geodetic Survey (NGS) and the United States Army Corps of Engineers (USACE) have developed software for performing the conversion. USACE CORPSCON software was used for this project.

The primary guiding principle in executing vertical datum conversions is to ensure that no more than a 0.25-foot variance from the average conversion factor exists at any point. **Table 3-1** provides a high-level summary of the different vertical conversion options recommended by the FEMA guidance document.

Table 3-1 Vertical Datum Conversion Options

Option	Name	Description
1	Passive Conversion	This option is used when the difference between NGVD 29 and NAVD 88 is negligible. When this option is used, no changes are made to the elevations.
2	Countywide Conversion	This option uses a single conversion factor for the entire project area. The conversion factor must be determined by setting a grid over the area and taking an unweighted arithmetic average of all the conversion factors at each grid corner. If the maximum offset from this average for all points within the conversion area does not exceed 0.25 feet, then a countywide conversion is acceptable.
3	Smaller Area Based Conversion	This option is used when options 1 and 2 are not possible or when Option 2 is not appropriate due to potential mismatches that could occur in adjacent counties. When this option is used, individual areas may be grouped to carry a common conversion factor, or each area may have its own conversion factor.

The conversion factor must be determined by setting a grid over the area and taking an unweighted arithmetic average of all the conversion factors at each grid corner. If the maximum offset from this average for all points within the conversion area does not exceed 0.25 feet, then a countywide conversion is acceptable.

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A countywide conversion (Option 2 from Table 3-1) was used for the conversion of the 2014 model. **Table 3-2** summarizes the results of the analysis from CORPSCON.

Table 3-2 Greeley Vertical Datum Conversion

Calculation	Value
Average Conversion Factor	2.95 ft
Maximum Conversion Factor	3.068 ft
Minimum Conversion Factor	2.874 ft
Maximum Offset within Project Area	0.12 ft

The maximum offset from the average conversion factor of 0.12 ft was less than the limiting value of 0.25 ft, and therefore the conversion factor of 2.95 ft from NGVD 29 to NAVD 88 was used for the update of the 2014 model.

3.2 Infrastructure Updates

3.2.1 GIS Data

The City provided a comprehensive GIS data set of the existing system and record drawings representing projects completed between 2014 and 2019. The first step in updating the 2014 model was to perform a comprehensive review of all model pipe diameters and confirm that all pipe diameters within the model matched the City GIS pipe diameters. The next step in updating the 2014 model was to add the new infrastructure detailed within the drawings. **Table 3-3** lists the projects that were added to the existing model using record drawing and as-built information from the City.

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Table 3-3 Record Drawings and As-Builts

Project Name	Record Drawing Datum	Datum Conversion	Comments
Ashcroft Draw Basin Sanitary Sewer Phase 1	NAVD 88	N/A	Added new pipes and temporary connection to the model.
Ashcroft Draw Basin Sanitary Sewer Phase 2A	NAVD 88	N/A	Not installed during flow metering. Added to model but only in future scenarios. Existing scenario set to match flow metering period.
Ashcroft Draw Basin Sanitary Sewer Phase 2B	NAVD 88	N/A	Not installed during flow metering. Added to model but only in future scenarios. Existing scenario set to match flow metering period.
College Park Subdivision	NAVD 88	N/A	Updated model, removed pipes that no longer exist.
East Greeley Sewer Improvements, Balsam Avenue Line	City Datum + 0.82 ft	Converted to NAVD 88	Updated pipe diameters and slopes within model.
Greeley-Weld County Airport East Side Utilities	NAVD 88	N/A	Added to model.
Homestead Heights Filing 4	NGVD 29	Converted to NAVD 88	Added 12” section into model.
River Run at Poudre River Ranch Second Filing	NAVD 88	N/A	Added to model.
Sheep Draw Sanitary Sewer Extension	NGVD 29	Converted to NAVD 88	Added to model.
The Trails at Sheep Draw Phase 1A	NAVD 88	N/A	Added to model.
T-Bone Lift Station Overflow Sewer	NAVD 88	N/A	Added to model.
West Greeley Tech Center	NGVD 29	Converted to NAVD 88	Added to model.
West Greeley Tech Center Phase II	NAVD 88	N/A	Added to model.
7th Avenue Improvements	NAVD 88	N/A	Added to model, removed pipes that no longer exist.

3.2.2 2019 Survey Data

Approximately 100 manholes were surveyed to obtain rim and invert information for use within the sanitary sewer model. The 100 manholes selected for survey included flow splitting manholes, areas where the 2014 model had errors in the profile, and areas with no available sources for invert information.

All known flow splits within the model were updated to 2019 survey data. All areas within the model that had profile errors were resolved. The remaining survey data was used to update invert and slope data. All manholes updated with the 2019 survey data were tagged with a 2019 survey data source marker for future model iterations.

3.2.3 Modeled Lift Station Updates

The modeled lift stations were updated with the latest available information including the pump curves provided by the City. Wet well dimensions were confirmed from the GIS data. Lift station

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run data were used to adjust level settings to match field conditions. The design total dynamic head (TDH), HP, and capacity were obtained from the Cy GIS data as shown in **Table 3-4**.

Table 3-4 Lift Station Information

LS #	Location	Service Area	Year Upgraded	Make	Model	HP	Design TDH (ft)	Design Capacity[1] (gpm)
1	601 N 9th Ave	N 9th Ave	2000	Gorman-Rupp	T3A-B	3	20	80
2	660 Ed Beegle Lane	Weld Co. Airport	2016	Gorman-Rupp	T4A-B	7.5	N/A	120
4	5102 27th Street	Highland Hills	2015	Gorman-Rupp	SFV4A	7	35	100
9	1400 E 24th St	E Cherry Ave	2013	Gorman-Rupp	SFV4D	21	57	638
12	600 27th St	Garden City	2007	Gorman-Rupp	T3A-B	3	24	80
13	2100 35th Ave	SW Greeley	2012	Gorman-Rupp	T8A-B	75	94	1700
15	3000 29th St	Auto Plaza	1980	Gorman-Rupp	T3A-B	10	62	150
16	1700 E 8th St	E 8th St	2013	Gorman-Rupp	SFV4D	13	48	270
17	7100 F St	Farmer's Spur	2015	Gorman-Rupp	SFV4A/ JS4A60	6.2	16.5	560
18	3252 52nd Ave	T-Bone Subdivision	2013	Gorman-Rupp	SF4C/ JS6J60	54	153	668

[1] Reported design capacity as of the 2019 flow monitoring effort.

3.3 Dry Weather Flow Calibration

DWF was calibrated in the model using the temporary and permanent flow monitoring data from April 18 to June 18, 2019. Improvements have been completed in the Ashcroft basin (near FM01) since this time.

Observed (metered) DWF was compared to modeled DWF at each meter location. The initial model parameters discussed in Section 2 were adjusted to calibrate simulated flow to observed conditions. Calibration statistics for each flow meter are shown in **Table 3-5**. Volumes are averaged over 7 days for two separate periods of DWF that occurred during the flow monitoring. Peak weekday flows were also compared for each week-long period. The observed and simulated values are within typical calibration standards for DWF of +/- 10% for volume and +20% to -10% for peak flow for at least one of the two calibration weeks for all temporary and permanent flow meter locations. Most of the meter basins calibrated to both weeks.

The model was also calibrated to available lift station flow data as shown in **Table 3-5**. Due to the low flows and small capacity at some lift stations, the Chartered Institution of Water and Environmental Management (CIWEM) criteria could not be applied. Instead, the high, low, and average daily flow from each lift station are shown in comparison to the simulated average daily

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Table 3-5 Model Calibration Results – Dry Weather Flow

Flow Metering Basin	Calibration Dates	Simulated	Observed	% Difference	Simulated	Observed	% Difference
		Average Daily Flow (mgd)			Weekday Peak Hourly Flow (mgd)		
FM01 Sheep Draw Basin	4/22/19 – 4/29/19	0.180	0.178	1%	0.407	0.409	-1%
	5/2/19 – 5/9/19	0.180	0.181	0%	0.400	0.418	-4%
FM02 Sheep Draw Basin	4/22/19 – 4/29/19	0.252	0.248	2%	0.427	0.429	-1%
	5/2/19 – 5/9/19	0.252	0.253	0%	0.423	0.417	2%
FM03 Hilltop Basin	4/22/19 – 4/29/19	0.438	0.434	1%	0.762	0.766	-1%
	5/2/19 – 5/9/19	0.438	0.391	12%	0.762	0.681	12%
FM04 Highland Hills Basin	4/22/19 – 4/29/19	1.164	1.097	6%	1.657	1.581	5%
	5/2/19 – 5/9/19	1.174	1.170	0%	1.657	1.608	3%
FM05 Highland Hills Basin	4/22/19 – 4/29/19	0.698	0.679	3%	1.061	1.068	-1%
	5/2/19 – 5/9/19	0.703	0.708	-1%	1.060	1.045	1%
FM06 Belair Basin	4/22/19 – 4/29/19	0.757	0.755	0%	1.120	1.122	0%
	5/2/19 – 5/9/19	0.759	0.793	-4%	1.121	1.144	-2%
FM07 Monfort Basin	4/22/19 – 4/29/19	0.272	0.268	2%	0.428	0.437	-2%
	5/2/19 – 5/9/19	0.273	0.285	-4%	0.432	0.442	-2%
FM08 North Basin	4/22/19 – 4/29/19	1.270	1.252	1%	1.854	1.913	-3%
	5/2/19 – 5/9/19	1.274	1.364	-7%	1.854	1.836	1%
FM09 Eight Street Basin	4/22/19 – 4/29/19	0.553	0.546	1%	0.777	0.781	0%
	5/2/19 – 5/9/19	0.555	0.549	1%	0.777	0.777	0%
FM10 Central Basin	4/22/19 – 4/29/19	0.370	0.376	-2%	0.597	0.596	0%
	5/2/19 – 5/9/19	0.372	0.399	-7%	0.596	0.609	-2%
FM11 South Basin	4/22/19 – 4/29/19	0.988	0.991	0%	1.461	1.366	7%
	5/2/19 – 5/9/19	0.989	0.979	1%	1.431	1.267	13%
FM12 South Basin	4/22/19 – 4/29/19	0.685	0.681	1%	1.100	1.114	-1%
	5/2/19 – 5/9/19	0.686	0.614	12%	1.061	0.841	26%
01-00.002	4/22/19 – 4/29/19	1.169	1.173	0%	1.656	1.754	-6%
	5/2/19 – 5/9/19	1.171	1.166	0%	1.638	1.548	6%
02-00.002	4/22/19 – 4/29/19	0.023	0.022	1%	0.032	0.034	-6%
	5/2/19 – 5/9/19	0.023	0.023	-2%	0.033	0.035	-8%
03-00.042	4/22/19 – 4/29/19	1.076	1.075	0%	1.420	1.496	-5%
	5/2/19 – 5/9/19	1.079	1.074	0%	1.422	1.427	0%
05-00.003	4/22/19 – 4/29/19	1.804	1.713	5%	2.376	2.363	1%
	5/2/19 – 5/9/19	1.807	1.722	5%	2.377	2.245	6%
07-00.003	4/22/19 – 4/29/19	0.557	0.561	-1%	0.883	0.815	8%
	5/2/19 – 5/9/19	0.560	0.574	-2%	0.883	0.813	9%
08-00.010	4/22/19 – 4/29/19	2.757	2.854	-3%	3.836	4.266	-10%
	5/2/19 – 5/9/19	2.770	2.887	-4%	3.822	4.200	-9%
13-00.002	4/22/19 – 4/29/19	0.907	0.924	-2%	1.258	1.277	-1%
	5/2/19 – 5/9/19	0.905	0.947	-4%	1.257	1.312	-4%
08-00.059	4/22/19 – 4/29/19	1.382	1.332	4%	2.060	1.958	5%
	5/2/19 – 5/9/19	1.386	1.443	-4%	2.054	2.399	-14%
08-00.163	4/22/19 – 4/29/19	0.710	0.682	4%	1.105	1.092	1%
	5/2/19 – 5/9/19	0.710	0.694	2%	1.102	1.068	3%

Lift Station Basin	Calibration Dates	Min Observed	Max Observed	Avg Observed	Avg Simulated	Min Observed	Max Observed	Avg Simulated
		Average Daily Flow (mgd)				Peak Hourly Flow (mgd)		
Lift Station 4	4/22/19 – 4/29/19	0.013	0.017	0.015	0.019	0.029	0.040	0.028
	5/2/19 – 5/9/19	0.013	0.017	0.015	0.020	0.028	0.046	0.030
Lift Station 9[2]	4/22/19 – 4/29/19	0.133	0.359	0.292	0.558	0.367	0.468	0.881
	5/2/19 – 5/9/19	0.328	0.361	0.343	0.558	0.408	0.467	0.878
Lift Station 13	4/22/19 – 4/29/19	0.462	0.482	0.471	0.480	0.640	0.701	0.724
	5/2/19 – 5/9/19	0.455	0.489	0.468	0.484	0.658	0.743	0.724
Lift Station 15	4/22/19 – 4/29/19	0.002	0.006	0.005	0.007	0.004	0.019	0.010
	5/2/19 – 5/9/19	0.002	0.006	0.005	0.007	0.003	0.015	0.010
Lift Station 16	4/22/19 – 4/29/19	0.054	0.070	0.059	0.061	0.187	0.219	0.184
	5/2/19 – 5/9/19	0.054	0.056	0.055	0.061	0.181	0.204	0.180
Lift Station 17	4/22/19 – 4/29/19	0.038	0.097	0.069	0.069	0.065	0.175	0.137
	5/2/19 – 5/9/19	0.041	0.061	0.053	0.070	0.067	0.135	0.135
Lift Station 18	4/22/19 – 4/29/19	0.154	0.281	0.234	0.262	0.397	0.447	0.454
	5/2/19 – 5/9/19	0.254	0.286	0.263	0.264	0.395	0.485	0.461

1. Calibration of the flow meter basins considered as +/- 10% for volume and +20% and -10% for peak hourly flow. Calibration of the lift stations was based on absolute values due to the small basin sizes.
2. Influent flow data at Lift Station 9 was not utilized as part of calibration. The measured flow from the downstream meter 13-00.002 could not be reconciled with the Lift Station flow data. Additionally, flow measurement upstream of Lift Station 9 from the 2014 flow monitoring data agreed with the calibrated DWF levels shown in this table. When reviewed more closely, the lift station inflow data seemed to plateau during high flow periods, indicating a loss of proper flow measurement during those events.

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flow. Additionally, the observed high, low, and average peak hourly flow was provided in comparison to the simulated peak hourly flow.

Simulated DWF was calibrated by adjusting the initial parameters developed for BWF, GWI, and peaking factors described in Section 2. **Table 3-6** shows the calibrated parameters for each flow meter.

Table 3-6 Calibrated Modeling Parameters

Flow Metering Basin	Population	Acres	Nonresidential BWF (mgd)	Residential BWF (gpd/person)	GWI (gpd/acre)
FM01 Sheep Draw Basin	3,357	372	0.003	47	43
FM02 Sheep Draw Basin	4,302	686	0.072	35	38
FM03 Hilltop Basin	9,895	1,042	0.043	35	38
FM04 Highland Hills Basin	18,143	2,466	0.283	40	84
FM05 Highland Hills Basin	11,294	1,422	0.05	44	111
FM06 Belair Basin	7,979	911	0.116	67	117
FM07 Monfort Basin	197	458	0.2	51	129
FM08 North Basin	14,997	1,502	0.177	54	188
FM09 Eight Street Basin	4,668	530	0.111	89	140
FM10 Central Basin	5,681	654	0.181	36	38
FM11 South Basin	11,194	1,225	0.362	51	117
FM12 South Basin	8,670	923	0.188	47	92
01-00.002	12,103	1,425	0.441	53	129
02-00.002	375	158	0.01	24	10
03-00.042	13,855	1,340	0.296	38	108
05-00.003	20,935	2,255	0.329	61	162
07-00.003	806	678	0.226	83	139
08-00.010	48,137	6,453	0.532	39	59
13-00.002	8,456	1,004	0.115	66	151
08-00.059	28,933	3,811	0.227	34	39
08-00.163	12,064	1,813	0.125	39	60

[1] Population distribution was estimated from geolocated billing data and address points. These values cannot be summed due to overlapping basins.

3.4 Wet Weather Flow Calibration

Rainfall data was collected along with the flow metering data at two locations. Three events were observed at Rain Gauge 1 (West) and four events were observed at Rain Gauge 2 (East). The three events that were observed at both rain gauges were used for calibration, and they are summarized in **Table 3-7**. Comparing the events to the *NOAA Atlas 14, Volume 8, Version 2*, Point Precipitation Frequency Estimates for Greeley (Atlas 14), the observed events are less than the 1-year return period for the observed durations.

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Table 3-7 Rain Events Used for RTK Analysis

Rain Gauge 1 (West)				Rain Gauge 2 (East)			
Start Date/Time	Total Volume (in)	Duration (hr)	Peak Intensity (in/hr)	Start Date/Time	Total Volume (in)	Duration (hr)	Peak Intensity (in/hr)
5/19/2019 9:50	0.75	25.17	0.36	5/20/2019 01:20	0.87	20.83	0.39
6/2/2019 16:40	0.31	1.58	0.29	6/2/2019 16:20	0.42	1.42	0.41
6/3/2019 16:50	0.21	0.42	0.21	6/3/2019 17:00	0.27	0.42	0.27

RDII was initially analyzed using SSOAP. SSOAP allows the user to examine the RDII response for selected rainfall events to develop parameters for RDII modeling. The unit hydrograph method was used to develop the hydrographs that represent RDII. This method is based on fitting three triangular unit hydrographs to an actual RDII hydrograph. A unit hydrograph is the flow response that results from one unit of rainfall during one unit of time.

Using the unit hydrograph method, RDII unit hydrographs are characterized by the following three parameters:

- R: The fraction of rainfall volume that enters the sanitary sewer.
- T: The time from the onset of rainfall to the peak of the wet weather hydrograph.
- K: The ratio of the time of hydrograph recession to the time to hydrograph peak.

Three sets of RTKs were developed for the observed rainfall event to represent the fast, medium, and slow responses usually associated with RDII. The initially developed RTKs were adjusted during calibration by comparing observed and simulated WWF hydrographs for each flow meter for the observed rainfall event. The shape of each hydrograph was compared, as was the volume, peak flow, and peak depth.

The evaluation criteria for wet weather calibration are +20% to -10% for flow volume, +25% to -15% for peak flow, and +/- 4 inches for peak depth (CIWEM, 2017). Flow meters that had values within the calibration criteria for two of three storm events were considered calibrated (CIWEM, 2017).

The calibration statistics for wet weather volume, peak flow, and peak depth are shown in **Appendix B** for all flow meters for each storm event. Each flow meter's observed versus modeled values are plotted against the upper and lower CIWEM calibration criteria. Points above or below the calibration lines would be considered outside the criteria limits, while points within the criteria lines are considered calibrated. Meters that are outside the criteria limits for two or more rainfall event are labeled in the figures as these did not meet the overall criterion of calibration to two of the three events.

All flow meters were calibrated for volume and peak flow within the criteria limits except for FM 07 and 08-00.010. Although flow volume during all three wet weather events for FM 07 (Monfort Basin) was within the criteria limits, the peak flows during those events varied widely. The model versus observed peak flow values for the three storm events were +44%, -6%, and -31%. The variation may be due to GWI that was observed during flow metering that would vary based on

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antecedent moisture conditions. There was an observed infiltration leak for FM 07. When reviewing this area for recommendations, the calibration plots and the peak WWF to DWF factor were reviewed when simulating a design storm to check if the peaks were overstated compared to the rest of the system.

Peak flows for permanent meter 08-00.010 were within the acceptable criteria limits, however, flow volume during two of three events was slightly below the criteria limits (-13%, +2%, -13%). Due to a large overlap with other meters within this basin, no further calibration adjustments could be made to bring the volume within the criteria limits without sacrificing the calibration of other meters. These included permanent meter basins 08-00.059 and 08-00.163 and temporary basins 01, 02, 03, 04, 05, and 07. Total volume measured during the wet weather events for all upstream basins were within the acceptable criteria limits. Additionally, the peak flows for all upstream basins (excluding FM 07), were also within the acceptable limits.

During the depth calibration of meter 05-00.003, the peak flow level for Event 3 was taken very slightly outside the peak flow criteria limits. In the interest of maintaining the depth calibration, no further adjustments were made to this basin. All other flow meters besides FM 07, 08-00.010, and 05-00.003 were within the acceptable limits for volume and peak flow. **Table 3-8** and **Table 3-9** show the calibrated RTK parameters.

Table 3-8 Calibrated Temporary Meter Basin RTKs

Flow Metering Basin	Area (ac)	Fast Response			Medium Response			Slow Response			Total R (%)
		R1 (%)	T1 (hr)	K1	R2 (%)	T2 (hr)	K2	R3 (%)	T3 (hr)	K3	
FM01 Sheep Draw	372	0.2	1	1.5	0.1	3	1	0.1	7	3.5	0.4
FM02 Sheep Draw	686	0.1	2	2	0.2	5	5	0.2	10	9	0.5
FM03 Hilltop	1,042	0.1	1	1	0.2	3.5	2	0.3	6	7	0.6
FM04 Highland Hills	1,044	0.4	1	2	0.2	2.5	2.5	0.1	5	3	0.7
FM05 Highland Hills	1,422	0.2	1.5	2	0.3	5	3	0.4	10	5	0.9
FM06 Belair	911	0.2	1	1	0.1	3	3	0.1	6	5	0.4
FM07 Monfort	458	0.3	0.65	1	0.5	2	2	0.1	5	10	0.9
FM08 North	591	0.3	1	1.1	0.1	2.2	2	0.1	2.8	2.5	0.5
FM09 Eight Street	530	0.5	1	1	0.1	2.5	3	0.1	4	4	0.7
FM10 Central	654	0.3	1	1	0.1	2.1	1.8	0.1	2.6	2.2	0.5
FM11 South	302	0.2	1	1	0.1	2.9	1.9	0	4.3	3	0.3
FM12 South	923	0.1	0.7	1	0	1.5	2	0.1	2	3	0.2

Note: Areas shown correspond to areas where RTKs are applied. Due to overlapping basins, the RTK contributing areas will not equal the total basin areas.

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Table 3-9 Calibrated Permanent Meter Basin RTKs

Flow Metering Basin	Area (ac)	Fast Response			Medium Response			Slow Response			Total R (%)
		R1 (%)	T1 (hr)	K1	R2 (%)	T2 (hr)	K2	R3 (%)	T3 (hr)	K3	
01-00.002	200	0.4	0.5	1.7	0.1	3	2	0.1	5	3	0.6
02-00.002	630	0.2	1.25	1.25	0.1	3	3	0.1	7	6	0.4
03-00.042	686	0.2	1	1	0.2	3	2	0.2	5	3	0.6
05-00.003	223	0.1	2	2	0.1	5	3	0.1	10	5	0.3
07-00.003	220	0.1	2.5	2	0.1	5	3	0.1	10	7	0.3
08-00.010	176	0.2	2	1	0.2	5	2	0.2	10	3	0.6
13-00.002	1,004	0.5	1.5	1	0.4	5	2	0.2	10	3	1.1
08-00.059	956	0.4	2.5	2	0.5	5	3	0.6	10	5	1.5
08-00.163	755	0.1	1	1	0	3	2	0	5	3	0.1

Note: Areas shown correspond to areas where RTKs are applied. Due to overlapping basins, the RTK contributing areas will not equal the total basin areas.

The depth calibrations for the flows were all within the range of the CIWEM criteria with the peak depths reasonably close to observed values.

3.5 Model Flow Validation

The model calibration was validated by comparing the simulated flows during the calibration period to the WTRF influent flow and by then comparing the range of calibrated total R to the previously calibrated model. As shown by the ADF at the WTRF by month for 2014 to 2020 (Section 2), the flow in 2019 and 2020 tended to be lower than in previous years. This was considered after model calibration to determine if modeled flows needed to be increased in the model for system evaluation. **Figure 3-1** shows the simulated flows from the calibrated model plotted against the historical data graph. On average from April to May from 2014 to 2020, the modeled influent flow to the WTRF was 9% higher than the influent flow data over those years. Summation of the meters on the seven interceptors that combine at the WTRF indicate that the influent flow should be 8.3 mgd on average from April to May. The simulated DWF was also 8.3 mgd, on average.

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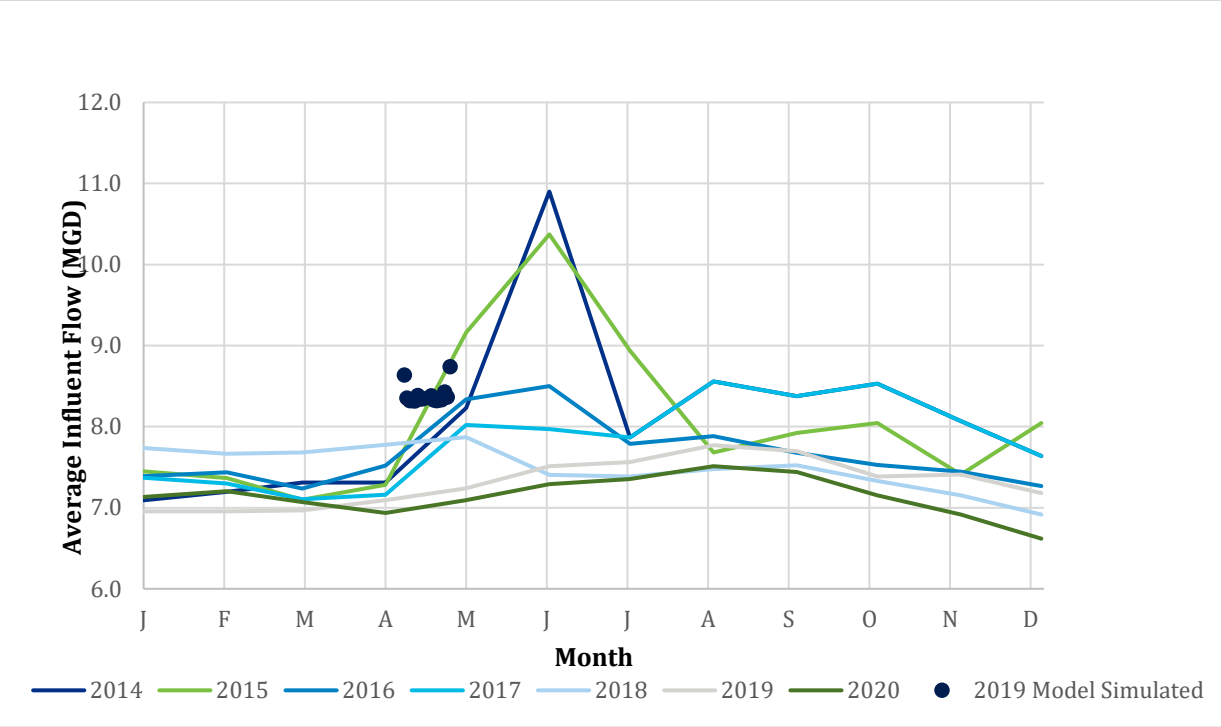

Figure 3-1 Average WTRF Influent Flow Trends Compared to Simulated Influent for 2019

The summed metered flow of all the influent interceptors was inconsistent with the measurements of influent flow at the WTRF. For 2020, the simulated average daily dry weather flow was 16% higher than was observed at the WTRF. The WTRF meter were recently calibrated. Overall, this indicates that it is not necessary to increase the flows in the model to be consistent with the WTRF influent flow data from previous years. The model, as calibrated, is reasonably conservative for the purposes of master planning.

The WTRF 15-minute influent flow data was compared with the simulated flow during the wet weather periods used for calibration to confirm similar peaks in flow. **Figure 3-2** and **Figure 3-3** compare the observed influent flow data to the simulated influent flow for the wet weather events in May and June, respectively. The observed data may be influenced by the WTRF pump station; however, the groups of spikes in the influent flow during wet weather correspond to the simulated wet weather peaks. The simulated flow tends to be higher than the observed flows in May, while the comparison was closer in June.

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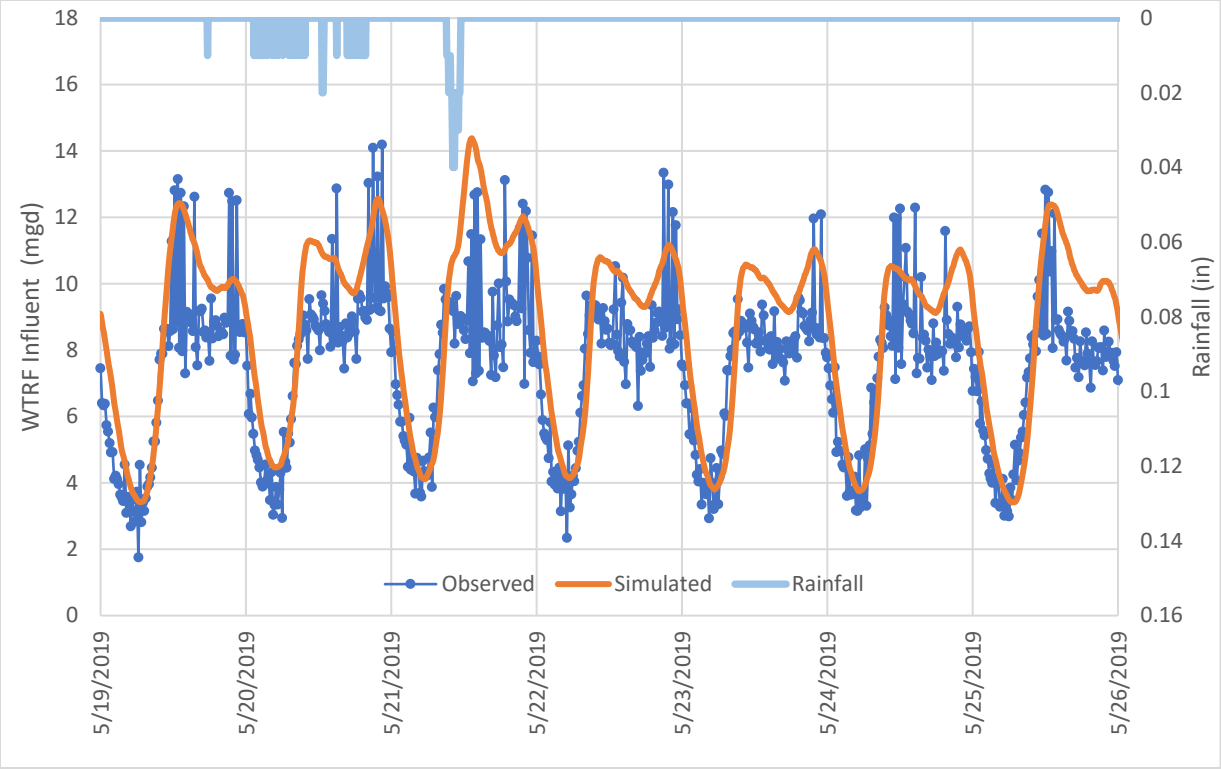

Figure 3-2 Observed Versus Simulated WTRF Influent Flows, May Wet Weather

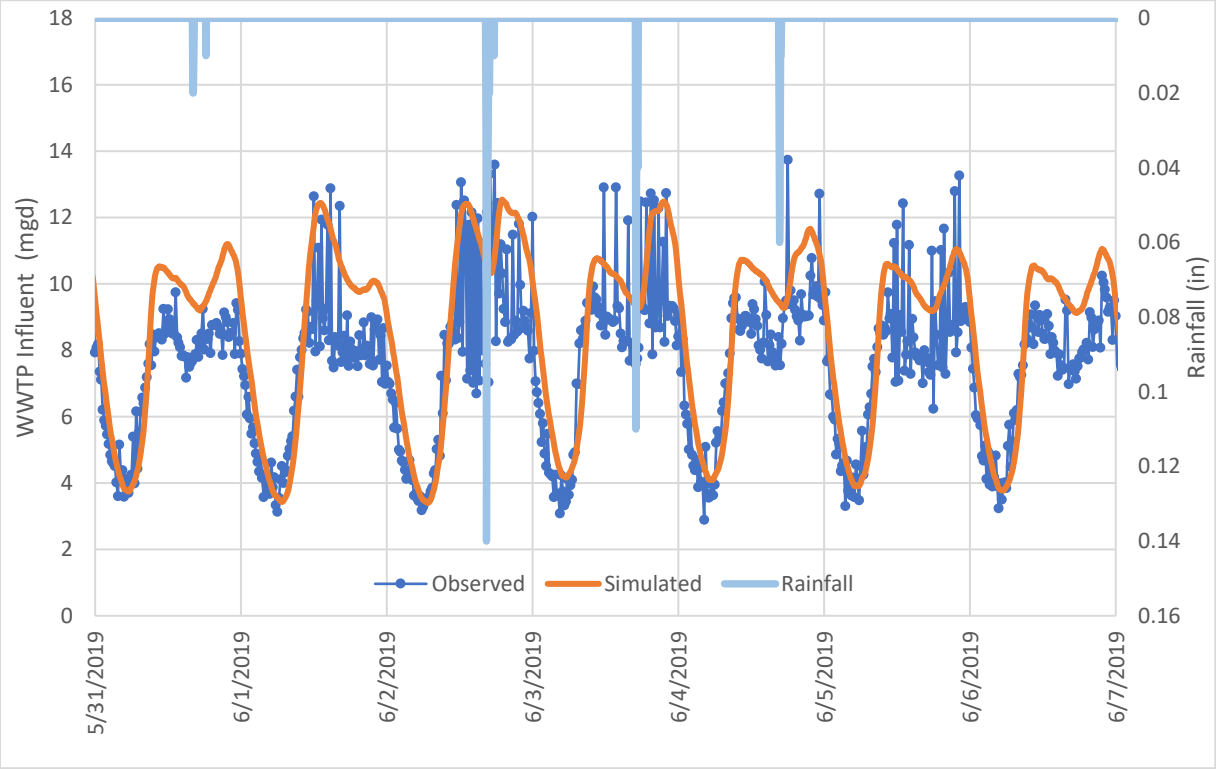

Figure 3-3 Observed Versus Simulated WTRF Influent Flows, June Wet Weather

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Calibrated total R by meter basin was compared to the previously calibrated total R as reported in the *City of Greeley Sewer System Model Update and Analysis* (CDM Smith, 2014). The WWF metering is from the year 2000 but it is the best available information to verify that the methods for developing RDII parameters are consistent. The range of calibrated total R for the year 2019 metering was 0.1% to 1.5%, and the 2014 report contained a range of 0.2% to 1.1%. Only two basins from 2019 were outside the range from the 2014 report. This indicates overall consistency with previous work.

On a basin-by-basin comparison, there were four metered areas from 2019 with a total R that was higher by about 50%, as compared to the 2014 report (08-00.059, 03-00.042, FM03 and FM04). There were also three basins that were lower by about 50% (05-00.003, FM06 and FM08). These areas and their calibration may be reviewed when considering recommendations for improvements; however, these values will vary some since 2000. This does not mean the actual flows were 50% higher or lower, since total R only refers to the percentage of rainfall assumed to enter the sewer system, which is small overall.

Conclusions of the validation include the following:

- The influent flow meter data for 2019 at the WTRF is low as compared to the flow monitored in each of the seven interceptors that combine at the WTRF. However, the simulated influent flow compares well to previous years of higher flows. It was concluded that the higher flows are sufficiently conservative for master planning purposes, and it was not necessary to increase the modeled flows.
- Assuming the average daily influent flow data at the WTRF is low by about 17%, the simulated flows during the wet weather calibration periods are reasonable. A comparison of the simulated influent flow and the 15-minute WTRF metered flow shows that the simulated wet weather peaks are reasonable.
- Calibrate total R is within a similar range as previously calibrated in the model based on 2000 flow monitoring data. Specific metered areas found to be significantly higher or lower than previous calibration will be reviewed when developing recommendations for improvements.

Data from the flow metering is included in **Appendix C**.

3.6 Model Limitations

The model has been updated and calibrated using available data; however, there are limitations as in any model. Knowing those limitations is important in making decisions regarding improvement projects. The limitations and how they will be addressed are outlined below:

- The data collected from the temporary and permanent meters provided sufficient data for good calibration of dry weather flows. For wet weather, although there were some significant rainfall events, the RDII response was limited. Wet weather calibration was an important step in this model update since WWF had not been calibrated since 2000. While the WWF calibration was within the calibration parameters for all but two of the meters, a small RDII response means that most of the flow being calibrated is the dry weather

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portion. The calibration plots were reviewed at locations with existing system deficiencies indicating a need for improvements.

- Depth calibration showed the simulated depths to be higher than observed. The difference was typically two inches or less for all but two meters. The greater simulated depth was considered when examining the system depth of diameter (d/D) criteria for evaluation (see Section 5).
- The WTRF influent data during the flow monitoring period was used as an overall check of the calibrated system response to RDII. The sum of the ADF volumes from each of the metered interceptors suggests that the calculated influent flow is between 8% and 17% higher than what was measured at the WTRF influent meter in 2019. This confirms the calibrated model is sufficiently conservative for master planning.

3.7 Design Storm Development

The previous 2009 and 2014 sewer system studies for the City considered a design storm with a 10-year return period and 24-hour duration for system evaluation. This selection was re-visited as part of this master plan update. The following aspects of design storm selection were considered:

- Design storms used by other municipalities for sanitary sewer system evaluation.
- Updates based on the NOAA Atlas 14 Point Precipitation Frequency Estimates, Volume 8 (NOAA, 2013).
- The shape, or temporal distribution, of the design storm.

In Colorado, there is limited information available on design storm return periods used by other municipalities. Several municipalities apply an overall criterion that does not consider the system's specific response to rainfall. This may be due to the limited time when such data can be collected. Colorado Springs uses a 5-year return period, whereas Boulder cites use of 15-, 20-, and 25-year return periods. Although Boulder considered larger return periods, their method only considers an analysis of flow at their wastewater treatment plant and is not comparable to the more detailed RDII analysis considered for Greeley.

Given the limited number of comparisons and that the Atlas 14 frequency analysis provides regionalization of a design storm, the research was expanded to other areas. A summary of 41 municipalities across the United States developed by CDM Smith shows that about 70% of separate sanitary systems use a design storm of 5 years or less as their level of service for system evaluation.

Updated frequency estimates from Atlas 14 are shown in **Table 3-10**. The total depth for the 10-year 24-hour event in Greeley has increased from 2.4 to 2.73 inches compared to the design storm used in the 2014 report. Given this increase and that most municipalities use a 5-year design storm or less, it is recommended that the City consider a 5-year design storm event in addition to the 10-year event used before.

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Table 3-10 Atlas 14 Precipitation Frequency Estimates (inches)

Return Period (years)	Duration (hr)						
	1	2	3	6	12	24	48
1	0.72	0.86	0.95	1.08	1.27	1.51	1.74
2	0.86	1.02	1.11	1.28	1.51	1.78	2.05
5	1.14	1.34	1.44	1.68	1.97	2.27	2.60
10	1.41	1.66	1.79	2.07	2.41	2.73	3.11
25	1.86	2.21	2.38	2.73	3.09	3.44	3.85
50	2.27	2.71	2.93	3.32	3.69	4.05	4.47
100	2.73	3.27	3.56	3.98	4.34	4.72	5.13

The temporal distribution of the design storm has been updated from the previous studies to an alternating block design storm that captures the depth for each duration of the 5- and 10-year period based on Atlas 14. For example, the 10-year, 1-hour event in Greeley is 1.41 inches; therefore, this is the peak intensity used in the middle of the design storm. The 2-hour depth is 1.66 inches; therefore, the next "block" of rainfall is 0.25 inches, the difference between the 1-hour and 2-hour depth. This is similar to the rainfall distribution described in the Code of Colorado Regulations for the *Rainfall Distribution for NRCS Unit Hydrograph Method.* The design storms for the 5- and 10-year return periods are shown in **Figure 3-4** and **Figure 3-5**, respectively**,** with incremental and cumulative depth. The peak intensity for the 5 and 10-year design storm is considerably greater than the design storm used previously, which was based on an observed rainfall event.

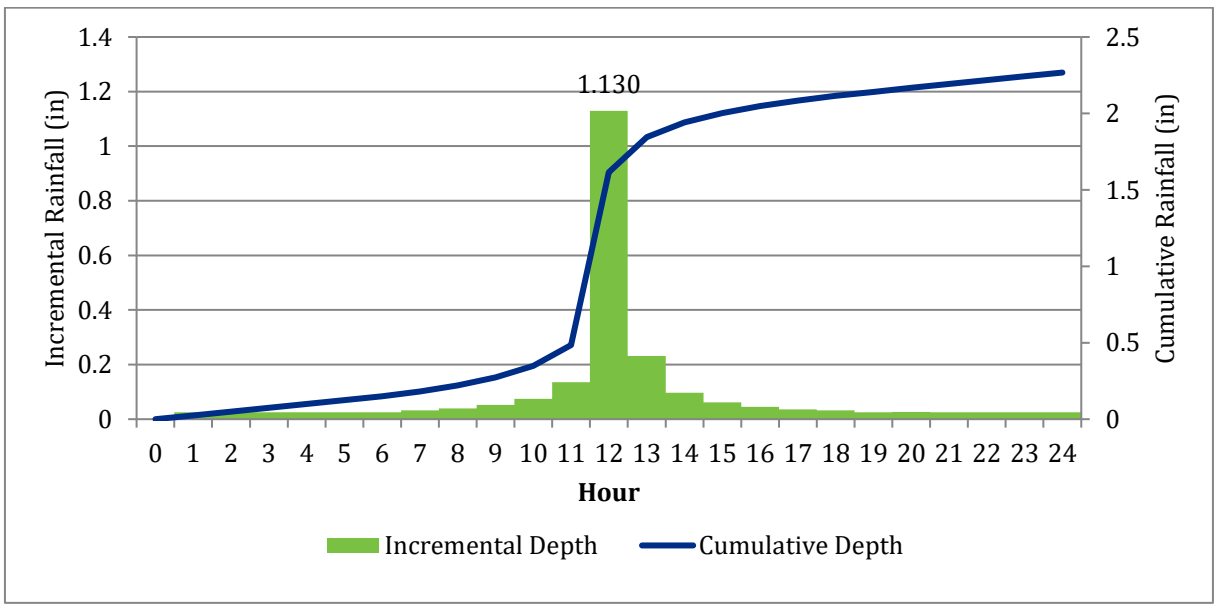

Figure 3-4 Greeley 5-Year, 24-Hour Design Storm

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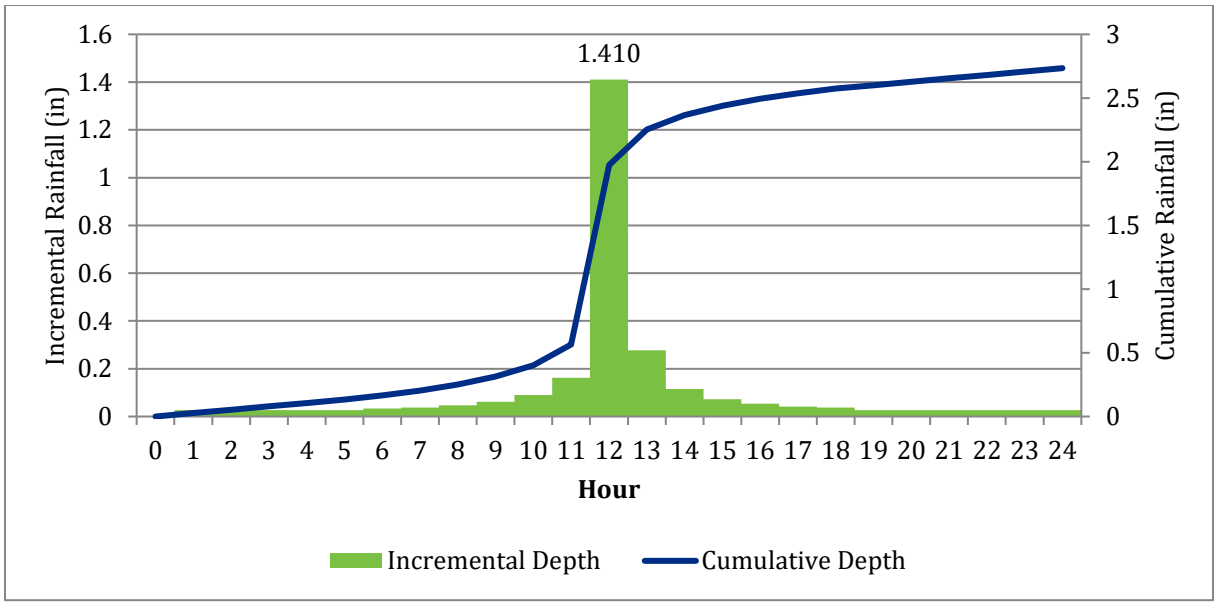

Figure 3-5 Greeley 10-Year, 24-Hour Design Storm

To validate the use of a new design storm peak intensity, historical plant influent data during three large rainfall events and the three calibration events was compared to the simulated flow using the new 5- and 10-year design storms. The peaking factor, which is the peak flow divided by the average annual flow, was calculated for each observed event and a regression analysis was performed on the peaking factor versus the 24-hour rainfall depth. The linear trend with 90% confidence intervals is shown in **Figure 3-6**. Separately, the peaking factor versus rainfall depth was plotted for the two new design storms and the previous design storm. While the design storms simulate a greater peaking factor than the linear trend, they are within the 90% confidence and are therefore more appropriate than using an event that is lower than the trend.

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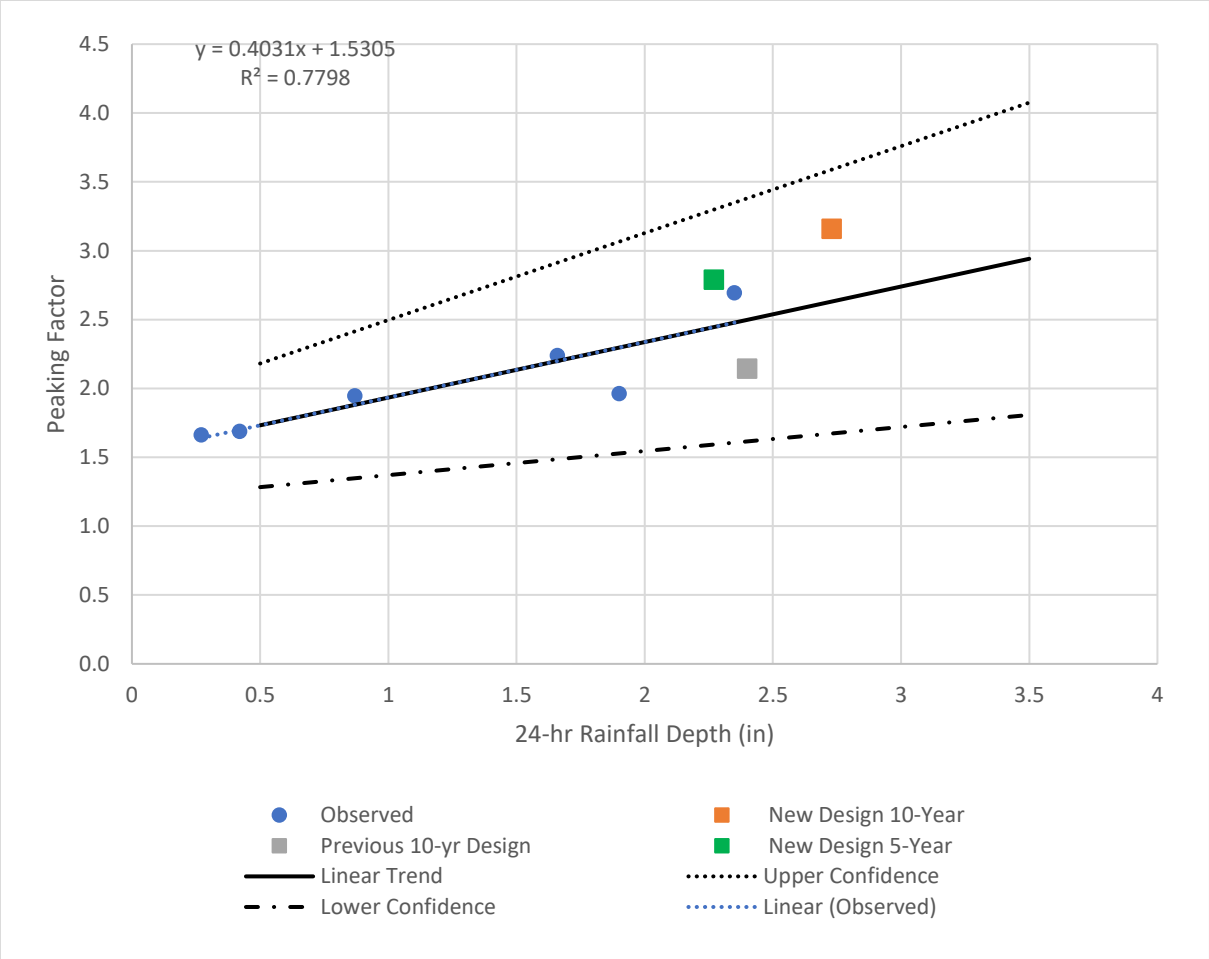

Figure 3-6 Observed Peaking Factor Versus 24-hr Rainfall Depth Compared to Simulated Peaking Factors

To compare the temporal distribution of the hydrographs, the plant influent flow for the three historical events is plotted with the predicted flow using the design storms, shown in **Figure 3-7**. The 24-hr return periods of the three historical events are as follows:

- 2016 Event: between a 1- and 2-year return period.
- 2017 Event: between a 5- and 10-year return period.
- 2018 Event: between a 2- and 5-year return period.

While the design storms produce additional volume when compared to the historical events, the simulated design peaks for the new 5 and 10-year events are similar to the 2017 event. The previous design storm was also simulated and found to simulate a lower peak, as compared to historical events.

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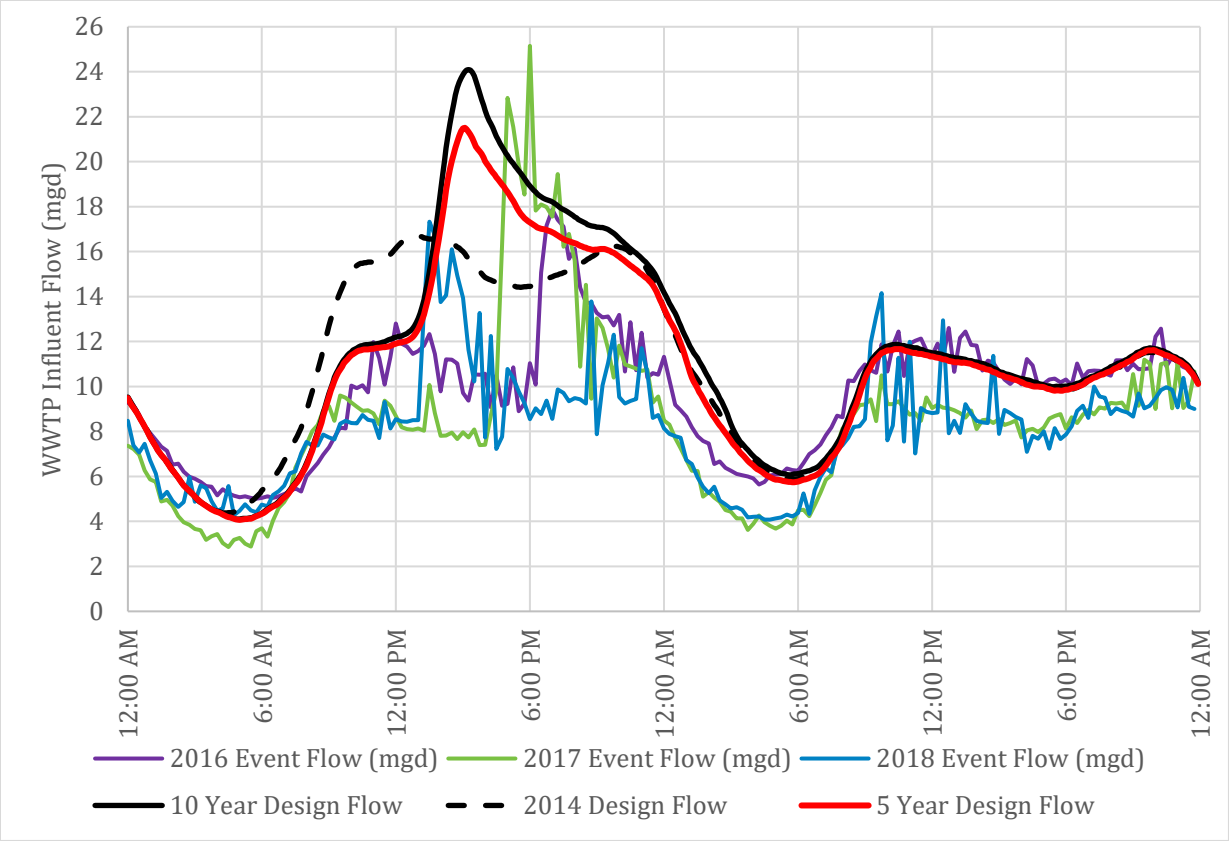

Figure 3-7 Historical WTRF Influent Flows Compared to the Predicted Design Storm Influent Flow

Both the 5-year and 10-year, 24-hour design storms were used to evaluate the existing system; however, only the 5-year event was used in recommending improvements for the following reasons:

- The 5-year event provides sufficient level of service that is comparable or better than other municipalities and therefore this event was used for system evaluation
- Updates from Atlas 14 required that the design storm depth be revisited where it was found that a 10-year event has a greater depth than what was used before.
- Overall peak depth calibration tended to be high in the model; therefore, using a 10-year event may be too conservative.

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Section 4

Future Flow Projections

This section presents the methodology for projecting and distributing future wastewater flows for the Sanitary Sewer Master Plan. This methodology was coordinated with the Water Transmission and Distribution System Master Plan flow projections. It was also extended to project and distribute non-potable water demands should the methods overlap, thereby creating consistency between the sanitary sewer, non-potable water, and water master plans.

The goal of the process described herein is to develop the values and parameters related to modeling wastewater flows for each of the planning horizons, which are defined as existing, 5-year, 20-year, and buildout. An overview of the methodology is outlined below:

- For existing conditions, flows are determined based on existing condition data sets, including winter water use and flow monitoring data. Flow components are calibrated according to the flow monitoring data. Parameters for projecting flow components for future conditions were determined from of this effort.
- The next step is to define the buildout scenario. All areas not currently developed or planned for re-development within the service area boundary were assigned flows based on planned development, zoning, and future land use information provided by the City. Density factors recommended for each land use type to describe residential population or nonresidential flows per acre are applied to the additional acreage to be developed, including new development, re-development and infill.
- The final step is to define and spatially distribute the flows for the 5- and 20-year planning horizons. Planned development progress information from the City was used for this step.

This methodology extends to projecting and distributing water and non-potable demands to the extent that the methods should overlap to be consistent between the wastewater, water, and non-potable master plans.

4.1 Modeling Values and Parameters

Wastewater flow is modeled according to the following three main components:

- BWF: These are the sanitary wastewater flows that come directly from water use and follow a diurnal pattern with a peaking factor.
- GWI: These flows come from defects in the system that allow groundwater or other dry weather sources to infiltrate. This is a constant daily flow that may have seasonal variation.
- RDII: These flows come from defects in the system or openings in the system that allow water from precipitation to enter the system. This flow varies depending on the wet weather event duration and intensity.

BWF is the component derived from the projections methodology and is divided into residential and nonresidential flow components in the model. Winter water billing records are used to initially develop BWF components, which are then calibrated using flow monitoring data. Winter

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water use is an estimate of BWF because water use during the winter months is mostly non-consumptive (i.e., most of the water used is sent back to the sanitary sewer system).

Residential BWF is defined by multiplying the population by gallons per day per person (gpd/person). This is not gpcd due to the fact that residential BWF does not include nonresidential flow contributions. For the existing conditions model, the gpd/person is derived from analysis of flow monitoring data using a population that is spatially distributed in the model from the geolocated water billing records.

Nonresidential BWF was initially defined directly from winter water use and was then adjusted during model calibration. For future conditions, specific design values are used based on this analysis and calibration.

The specific planning information needed to develop future flows in the model include the following:

- Population
- Zoning and Land Use
- Area to be served or currently served

The above information was developed for the following planning horizons: existing (year 2020), 5-year (year 2025), 20-year (year 2040), and buildout. The information developed for each planning horizon will be used for this master plan as well as for the Water Master Plan and Non-Potable Water Master Plan.

The parameters derived from the information available along with the necessary calculations and assumptions needed to distribute that information spatially for each planning horizon are described below. The parameters are presented in terms of how they are used for the wastewater master plan. The water and non-potable master plans use similar parameters as appropriate for determining water demands.

4.2 Service Area and Population Projections

The planning information was spatially distributed to the long-range expected growth area (LREGA) boundary as shown in **Figure 4-1**. This represents the limits of the City's expected growth and where it plans to provide water and wastewater services. It should be noted that there is an overlap with Greeley's LREGA and Urban Growth Boundaries and 208 boundaries for both Johnstown and Milliken in the southwest corner of Greeley's growth boundary. The City of Greeley has met with Johnstown and Milliken's staff to understand their interest and future plans for providing sewer service to these areas. Based on these meetings, it is not planned to change growth or 208 boundaries at this time. However, parties generally agreed that at that time that development is being considered in these areas further discussions and assessment would be required to determine how these areas would best be served. In the event that these areas are annexed into the City of Greeley and sewer service is provided by another municipality it would require an Inter-Governmental Agreement to address the service requirements. If annexed into Greeley and Greeley provides municipal sewer service, it will require an amendment of the 208 boundary through NFRWQPA.

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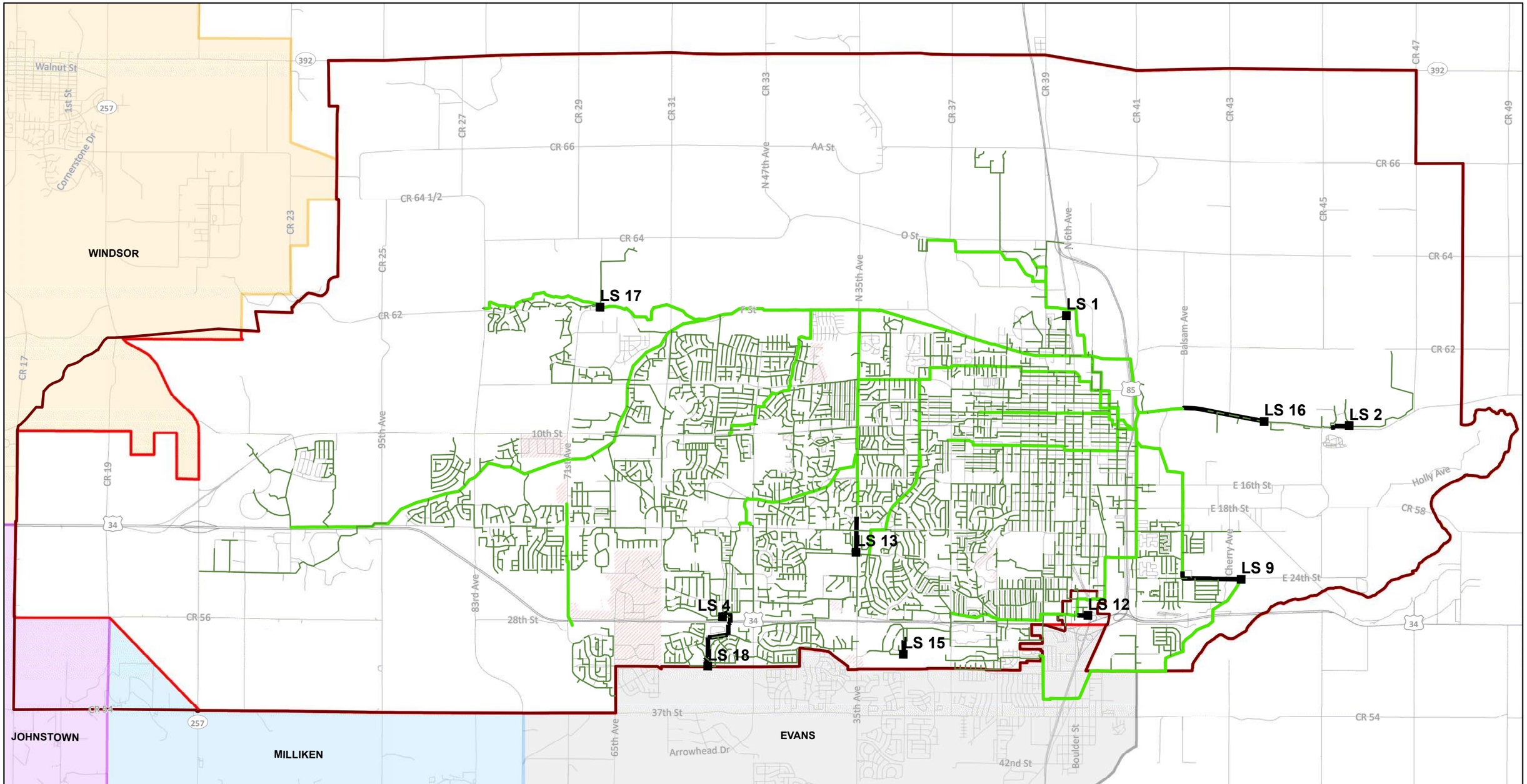

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October 13, 2020

Legend

- Existing Lift Stations

Sewer Mains

- Trunk Line
- Force Main
- Collector Line
- LREGA

Private Septic System Parcels

208 Boundaries

- GREELEY
- EVANS
- JOHNSTOWN
- MILLIKEN
- WINDSOR

N

0 0.5 1 2

Miles

Wastewater Master Plan Area

Figure 4-1

Greeley Sewer System Master Plan

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Population projections represent the timing of population growth to be distributed throughout the LREGA. Various sources of population projections were reviewed and discussed with the City. The most relevant projections come from the *City of Greeley Population and Water Demand Projections*. Historical, low, middle and high population projections are shown in **Figure 4-2**. The three population projections result in a linear annual growth rate of 2.2% for the low scenario, 3.1% for the middle scenario, and 4.0% for the high scenario. The current population and projected 2075 populations are noted. Based on discussions with the City and their knowledge from other studies, it is assumed that 2075 does not represent the buildout year for the City within the LREGA boundary. The BBC report notes that the buildout scenario is likely even later than 2090.

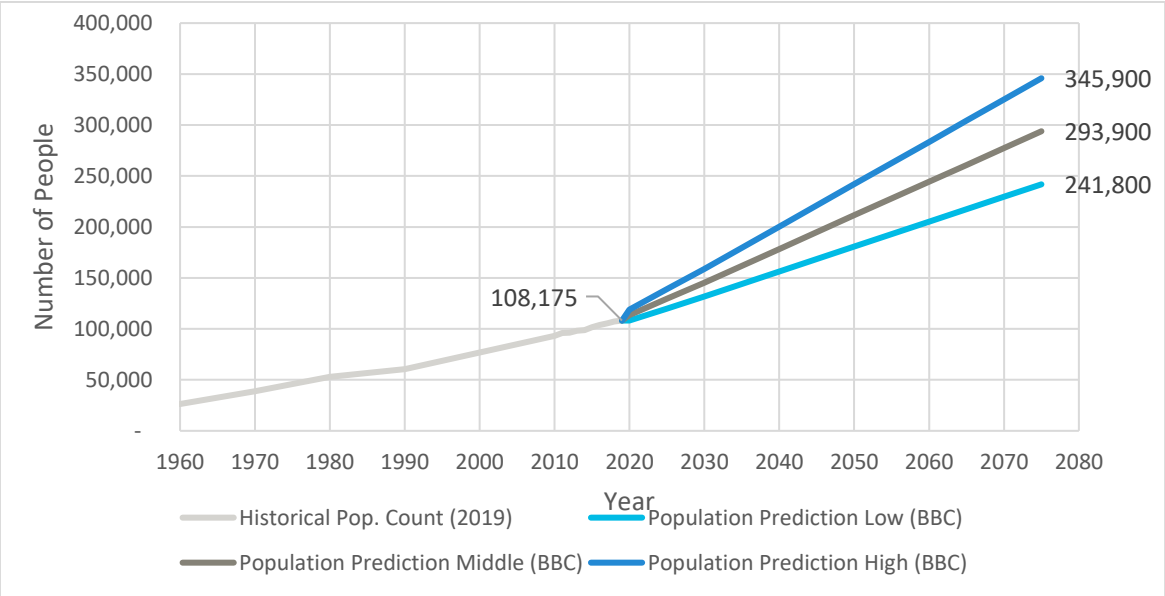

Figure 4-2 Historical and Projected Population

Per the *City of Greeley Population and Water Demand Projections* (BBC) the estimated population served by the wastewater system is 107,146. This population was distributed throughout the system based on the geolocated water billing data and address points. To project future wastewater flow, the proposed population increases from the BBC report are used to spatially distribute flows for each planning horizon. (i.e., the spatially distributed additional population plus the existing population at each planning horizon is set to match the "middle" population projection). The "middle" projection was selected for system analysis and as the basis of the projections methodology. A buildout population is extrapolated beyond 2075 based on the planning data and factors described in the following sections. **Table 4-1** lists the population for each decade and planning horizon year out to buildout.

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Table 4-1 Middle Population Projection

Year	Middle Population Projection
2018	107,146
2020	113,700
5-year, 2025	129,450
2030	145,200
20-year, 2040	178,300
2050	211,400
2060	244,400
2065	260,900
2070	277,400
2075	293,900
Buildout	428,148

Source: City of Greeley Population and Water Demand Projections

4.3 Winter Water Billing

Winter water billing data from 2018 to 2019 is used to distribute existing populations and nonresidential BWF and was then calibrated using flow monitoring data. To determine the distributed existing population, the residential billing points are multiplied by the appropriate factors from the City's design criteria:

- Low-density residential (R-L): 3.1 people per unit.
- Medium-density residential (R-M): 2.7 people per unit.
- High-density residential (R-H): 1.7 people per unit.

To determine which criteria applies to each billing point, residential density information is assumed from the following sources of information:

- Existing land use layer.
- Household density layer.
- Billing data categories.

In the absence of information on residential density from the above data sources in specific areas, 2.7 people per unit is assumed.

Nonresidential BWF was distributed in the existing conditions model using the spatially distributed winter water billing data, which was then adjusted during calibration using the flow monitoring data. This data was also used to analyze typical wastewater flow volume by nonresidential land use types. Flow density by nonresidential land use type was calculated in terms of gpd/acre as shown in **Table 4-2.** The recommended values are rounded up from the 75th percentile of all data within each category. This information was used for projecting flows in future development areas.

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Table 4-2 Nonresidential Winter Water Billing Data Summary

Nonresidential Zoning Categories	Median (gpd/acre)	75th Percentile (gpd/acre)	Recommended Value for Future Conditions Projections (gpd/acre)
Commercial Low Intensity, C-L	328	610	650
Commercial High Intensity, C-H	549	1469	1500
Industrial Low Intensity, I-L	136	319	500
Industrial Medium Intensity, I-M	128	317	500

4.4 Spatial Projections Data and Methodology

Future flow parameters are distributed to currently undeveloped areas or areas of redevelopment based on the best available information for each area. Three tiers of information are described below:

1. Tier 1: Planned Developments.
2. Tier 2: City of Greeley Land Use (Sub-Areas) and Zoning Markup Map (Greeley Markup).
3. Tier 3: Zoning and Comprehensive Plan Information.
    a. Zoning from the *Annual Growth & Development Projections Report* (City of Greeley, 2019).
    b. Land use guidance from the *Imagine Greeley Comprehensive Plan* (City of Greeley Community Development Department, 2018).

4.4.1 Tier 1: Planned Unit Developments (PUDs) and Proposed Developments

Several development plans have been submitted to the City for areas within the LREGA. This information is used to delineate areas and to distribute future populations for modeling future wastewater flows. These various planned developments are described in **Table 4-3** and are shown spatially in **Figure 4-3**.

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Table 4-3 Planned Development Information

Planned Development	Area (acres)	Projected Population (people)	Projected Residential Flow (gallons/day)	Projected Nonresidential Flow (gallons/day)
Airport Master Plan	196	0	0	233,234
Cache Project	800	8,444	506,640	37,343
City Center West/Boomerang 88	214	3,001	180,060	0
Cobblestone PUD	145	3,049	182,940	38,015
Grapevine	6	119	7,140	0
Lake Bluffs PUD	305	2,308	138,480	47,058
Promontory Heights	276	2,936	176,160	73,448
StoneyBrook PUD	20	350	21,000	0
Trails at Sheep Draw	93	2,304	138,240	98,395
Triple Creek Subdivision	51	282	16,920	0
UC Health – Ashcroft	45	0	0	141,120
Westgate PUD	85	1,012	60,720	20,322
Total	2,236	23,804	1,428,240	688,934

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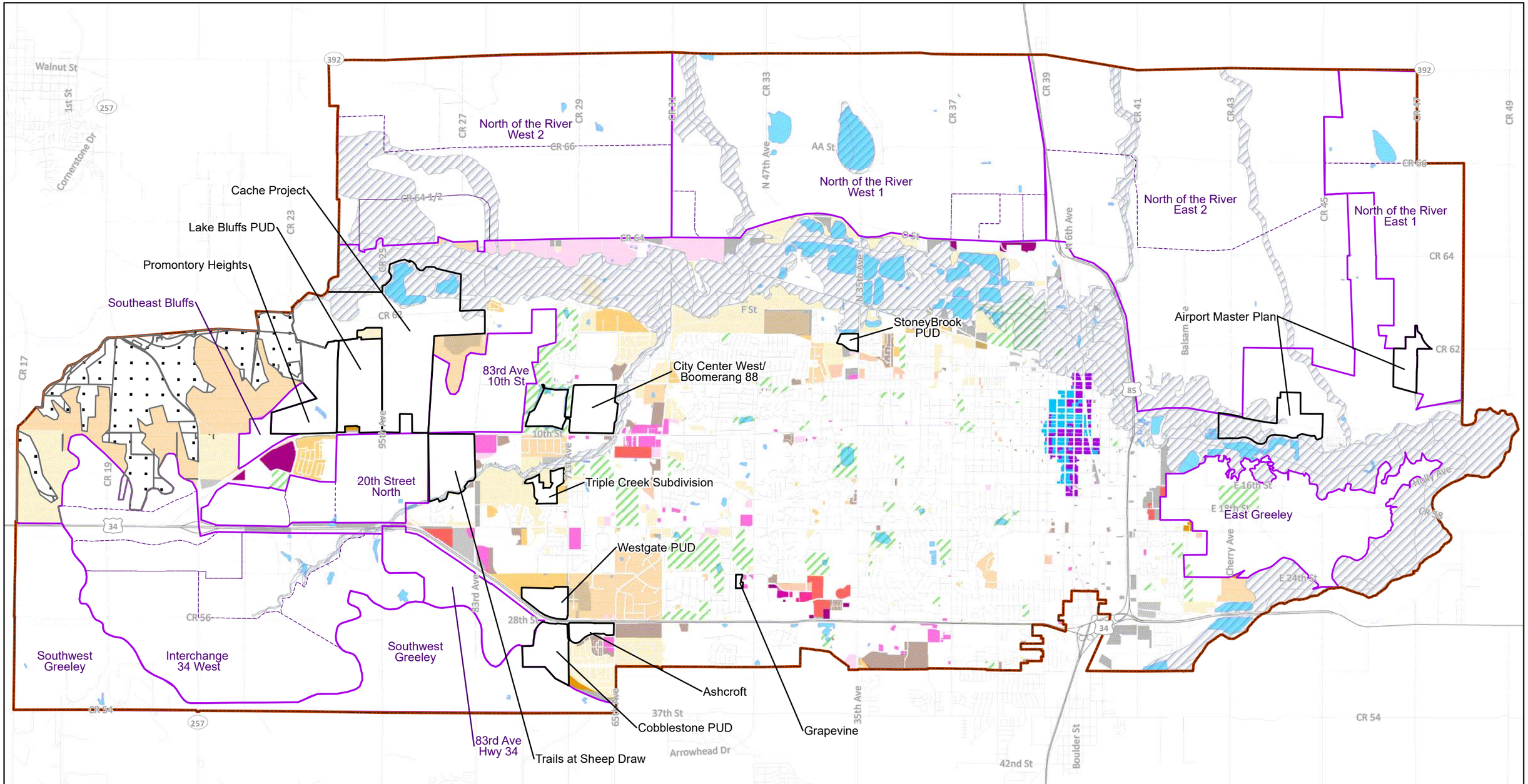

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Legend

- LREGA
- Tier 1 (Planned Developments)
- Tier 2 (Greeley Markup)
- Tier 2 (Sub-Areas)

Tier 3

- C-H
- C-L
- I-L
- I-M
- R-E
- R-H
- R-L
- R-M
- R-MH
- Downtown Development Authority (Existing Flow)
- Downtown Development Authority (Redevelopment)
- Employment, Industrial, and Commercial
- Legacy Urban
- Mixed Use
- Mixed Use High Intensity
- Residential
- Rural
- Bluffs - No Developement
- 100-yr Floodplain
- Lakes and Ponds
- Parks

N

0 0.5 1 2
Miles

Future Projection Areas by Growth Type

Figure 4-3

Greeley Sewer System Master Plan

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4.4.2 Tier 2: City of Greeley Land Use and Zoning Markup Map

Outside of the Tier 1 areas described above, projection data for the remaining available area includes the 2019 Zoning Map and the 2018 *Imagine Greeley Comprehensive Plan*. The City reviewed the data sets and marked off 11 areas to which a specific growth distribution is applied. The City Planning Department assigned percentages of land use type to each growth area. **Table 4-4** describes the distribution of land use projections for each growth area. For example, for the area within the 83rd Ave/Highway 34 boundary, 65% of the total acreage is assumed to be C-H, while 35% of the total acreage is assumed to be R-H at 20 dwelling units per acre (DU/acre).

Table 4-4 City of Greeley Markup Map Summary

Markup Areas	Area	% of Total Area per Nonresidential Land Use Category				% of Total Area per Residential DU/Acre Category				Projected Population Increase	Projected Residential Flow	Projected Nonresidential Flow
	(acres)	C-L	C-H	I-L	(gpd)	1.0	2.5	4.0	20	(people)[1,2]	(gpd)	(gpd)
83rd Avenue/Highway 34	578		65%						35%	6,878	412,680	563,550
83rd Avenue/10th Street	650		15%					45%	40%	12,467	748,020	146,250
20th Street North	883		25%					50%	25%	12,980	778,800	331,125
Southeast Bluffs	123		15%					45%	40%	2,359	141,540	27,675
North of the River – East 1	1,969		10%		80%	10%				610	36,600	1,082,950
North of the River – East 2	5,708		20%		30%			35%	15%	53,884	3,233,040	2,568,600
North of the River – West 1	4,410		15%		10%	10%		50%	15%	51,200	3,072,000	1,212,750
North of the River – West 2	3,783		10%		20%	30%		30%	10%	30,453	1,827,180	945,750
East Greeley	1,292				30%	40%		30%		6,408	384,480	193,800
Southwest Greeley	2,860						100%			22,165	1,329,900	0
Interchange 34 West	3,719		20%		10%			50%	20%	48,347	2,900,820	1,301,650
									Total	**247,751**	**14,865,060**	**8,374,100**

[1] For 20 DU/acre, 1.7 people per DU was assumed. For 1-4 DU/acre, 3.1 people per DU was assumed.

[2] The estimated population increase of 247,751 people is assumed to occur by "buildout", which is estimated to be in approximately 2116.

As determined by the City of Greeley Planning Department, the population for each area is calculated by multiplying the DU/acre by the percentage of the total area marked for residential and then applying the appropriate population factors (people/DU). The nonresidential flow is calculated by multiplying the total area by the percentage of nonresidential use and then applying the appropriate density factor (gpd/ac) that was developed in **Table 4-2** (included earlier in this section).

To spatially distribute the calculated flows within each Tier 2 growth area, the total flow is split into sub areas within each Tier 2 growth area based on direction from the City. The distribution of flow to each sub area is intended to follow the density distribution of the original *Imagine Greeley Comprehensive Plan*. This distribution results in flow densities across each growth area that are similar to densities within the Comprehensive Plan.

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4.4.3 Tier 3: Zoning and Land Use Guidance (Infill Areas)

For the remaining area within the LREGA, zoning and land use information was used to distribute future populations and wastewater flow parameters. The 2019 Zoning Map was used except in areas defined as Planned Unit Development or Holding Agriculture. In these zones and areas outside the 2019 Zoning Map, the Comprehensive Plan land use guidance was used to define future population and wastewater flow parameters.

City design criteria provides a typical range of density (population per acre) within each zoning type. To project future flow, a typical density was chosen for each zoning type. The recommended densities are based on discussions with the City and a review of the following sources:

- Existing winter water billing data for nonresidential areas (in gpd/acre by category).
- *Imagine Greeley Comprehensive Plan* (City of Greeley Community Development Department, 2018).
- Design criteria document which includes zoning district development standards.
- Similar future projection studies.

Table 4-5 summarizes the recommended densities by zoning and land use guidance category used for the projection methodology. Values recommended for nonresidential wastewater flows are based on the values previously presented. **Table 4-6** shows the resulting population and nonresidential flow projections from the Tier 3 areas.

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Table 4-5 Recommended Zoning and Land Use Guidance Densities

Zoning or Land Use Guidance Category	Design Criteria Residential Density[1] (DU/ac)	Recommended Residential Density for Planning (DU/ac)	People Per Unit[2]	Recommended Nonresidential Wastewater Flow Density (gpd/ac)[3]
Residential Estate (R-E)		1	3.1	
Residential Low Density (R-L)	3 to 5	4	3.1	
Residential Medium Density (R-M)	6 to 10	6	2.7	
Residential High Density (R-H)	11 to 20	20	1.7	
Residential Mobile Home (R-MH)		6	2.7	
Commercial Low Intensity (C-L)[5]				650
Commercial High Intensity (C-H)[5]				1,500
Industrial Low Intensity (I-L)[5]				500
Industrial Medium Intensity (I-M)[5]				500
For areas Zoned as - Planned Unit Development (PUD) or Holding Agriculture (H-A) The projection categories from the 2018 *Imagine Greeley Comprehensive Plan* are used. See below:				
Employment, Industrial, and Commercial				883
Mixed Use High Intensity (assume 50% R-H, 50% C-L)	4 to 20	15	1.7	650
Mixed Use (assume 50% R-M, 50% C-L)	4 to 20	10	2.7	650
Suburban	2 to 10	10	2.7	
Residential	3 to 5	4	3.1	
Legacy Urban	4 to 20	10	2.7	
Downtown Development Authority (Redevelopment)	N/A	45	1.7	
Rural	0 to 2	2	3.1	

[1] City of Greeley Design Criteria provided as reference values for the recommended residential zoning densities. Reference values from the Imagine Greeley Comprehensive Plan provided for the Mixed Use, Suburban, Legacy Urban Residential, and Rural areas.

[2] People per unit are based on the City of Greeley design criteria

[3] Recommended Nonresidential Wastewater flow densities per **Table 4-2**.

[4] Recommended density of 45 units/acre within the DDA area is per discussions with City of Greeley.

[5] Commercial and industrial land use categories and their associated intensity designations (C-L, C-M, C-H, I-L, I-M, and I-H) are for zoning purposes only and do not indicate volume of water use.

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Table 4-6 Zoning and Comprehensive Plan Projections for Tier 3 Areas

Zone	Acres	Projected Population	Projected Nonresidential Flow
		(people)	(gpd)
Commercial High Intensity (C-H)	216	0	324,364
Commercial Low Intensity (C-L)	363	0	236,014
Industrial High Intensity (I-H)	0	0	0
Industrial Low Intensity (I-L)	99	0	49,637
Industrial Medium Intensity (I-M)	354	0	176,930
Residential Estate (R-E)	1,491	4,621	0
Residential High Density (R-H)	242	8,214	0
Residential Low Density (R-L)	1,712	21,226	0
Residential Medium Density (R-M)	80	1,300	0
Residential Mobile Home (R-MH)	1	24	0
Comprehensive Plan Area Category	**Acres**	**Projected Population**	**Projected Nonresidential Flow**
		(people)	(gpd)
DDA	94	7,161	0
Employment, Industrial, and Commercial	137	0	121,018
Legacy Urban	10	259	0
Mixed Use	23	186	7,444
Mixed Use High Intensity	123	2,090	39,964
Residential	275	3,405	0
Rural	156	964	0
Total	5,281	49,450	955,371

4.4.3.1 Tier 3: Special Cases

During the development of the projection methodology, certain areas within Tier 3 were adjusted to values outside the Zoning and Comprehensive Plan information. To simplify the projection methodology, these cases were left in Tier 3:

- Downtown Greeley – Future land use for the downtown area was based on a report prepared by the Downtown Development Authority. After discussion with the City, a value of 45 du/acre was assumed for areas marked for development within the report.
- Lift Station 15 Service Area – The City has received interest from developers in this area that has provided a more detailed future projection than the previously available information. All future development area within the LS 15 service area are now projected to develop as R-H.
- West Greeley, Bluffs Area – The Zoning and Comp Plan do not indicate future growth in these areas. After discussion with the City, it was assumed that these areas would develop out as R-E and R-L.

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4.5 Future BWF and GWI Parameters

The total acreage, buildout population and ADWF broken down by flow component were calculated for each tier to show the weight of each tier in the projected flows. Population and nonresidential wastewater flows were calculated using the methodology as presented. To calculate the components of dry weather wastewater flow and overall ADWF, population was converted to BWF in gpd and future GWI was converted from acreage to gpd. These calculations used flow parameters determined from model calibration and flow monitoring data. The averages of the parameters developed by flow metering basin, shown in **Table 4-7**, were reviewed and agreed to with the City.

Table 4-7 Future Projection Parameters

Flow Parameter	Factor
Residential BWF	60 gpd/person
GWI	100 gpd/ac

4.5.1 Future Base Wastewater Flow – Diurnal Patterns

To project future BWF, separate diurnal patterns were developed for residential and nonresidential flow. These patterns were developed through a review of the 2019 flow monitoring data and are intended for use on a systemwide basis. The peaking factors within the proposed patterns are lower than the Greeley Criterion. This difference is intentional. Use of the Greeley Criterion peaking factors for system-wide analysis will result in significantly oversized infrastructure since it is intended to serve as criterion for development specific application. **Figure 4-4** and **Figure 4-5** show the future diurnal patterns used for modeling. Greeley criterion peaking factors include WWF and have additional factors of safety. For modeling and system analysis, wet weather peaks were evaluated separately.

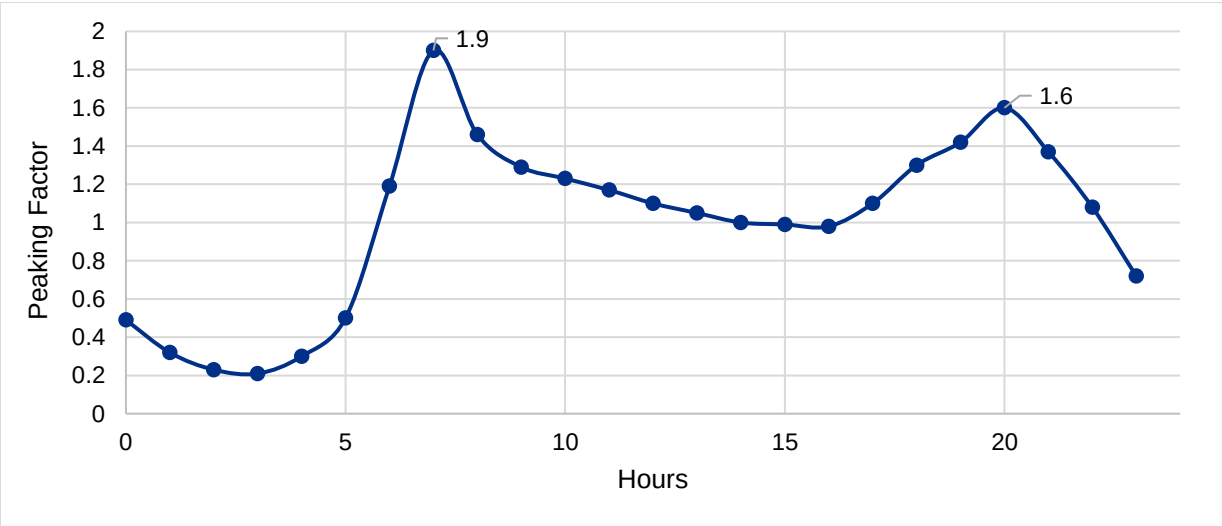

Figure 4-4 Diurnal Curve for Future Residential Flow

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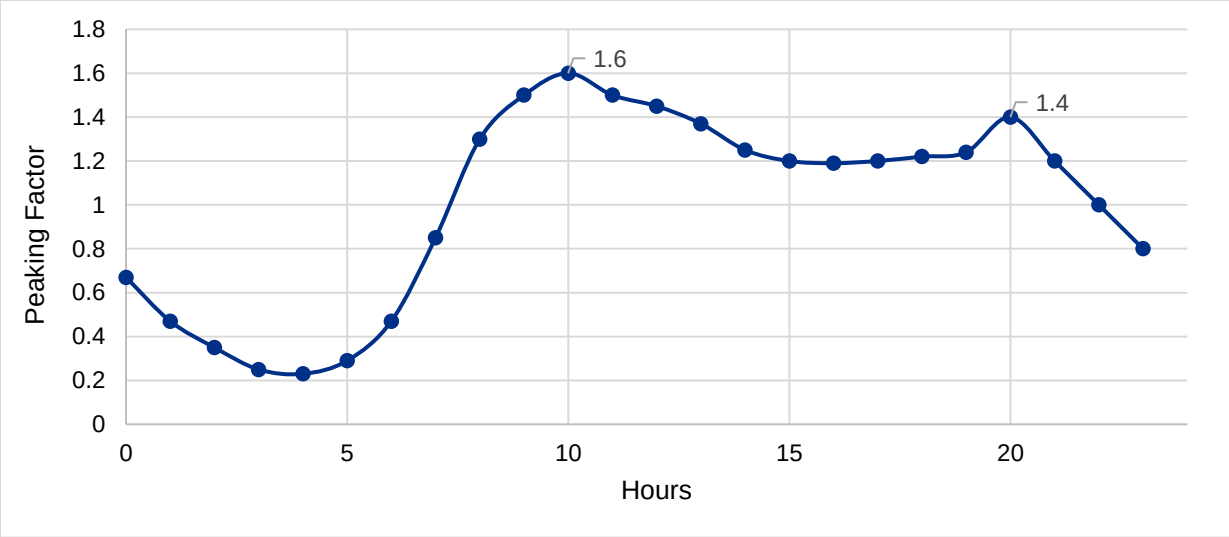

Figure 4-5 Diurnal Curve for Future Nonresidential Flow

4.6 Growth Estimates by Planning Horizon

To distribute the future flow parameters in the model at each planning horizon, the percent to which each future development tier is built out at the end of each planning horizon was estimated (**Table 4-8**) based on the BBC report. At the 2025 and 2040 planning horizons, the calculated population is matched to the BBC report. The overall buildout population was assumed to exceed the 2075 BBC projected population. The total buildout population is projected to be 428,148.

Table 4-8 Planned Development/Markup Area Information

Planned Development – Tier 1	5 Year (% Complete)	20 Year (% Complete)	Buildout (% Complete)
Airport Master Plan	100%	100%	100%
Cache Project	40%	100%	100%
City Center West/Boomerang 88	75%	100%	100%
Cobblestone PUD	100%	100%	100%
Grapevine	100%	100%	100%
Lake Bluffs PUD	50%	100%	100%
Promontory Heights	40%	100%	100%
Stoney Brook PUD	100%	100%	100%
Trails at Sheep Draw	100%	100%	100%
Triple Creek Subdivision	100%	100%	100%
UC Health – Ashcroft	100%	100%	100%
Westgate PUD	100%	100%	100%
Total Population Increase – Tier 1	15,072	23,804	23,804

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Markup Areas – Tier 2	5 Year (% Complete)	20 Year (% Complete)	Buildout (% Complete)
83rd Avenue/Highway 34	0%	10%	100%
83rd Avenue/10th Street	20%	25%	100%
20th Street North (100)	0%	10%	100%
20th Street North (200)	0%	15%	100%
20th Street North (300)	0%	10%	100%
Southeast Bluffs	0%	75%	100%
North of the River – East 1 (100)	0%	0%	100%
North of the River – East 1 (200)	0%	0%	100%
North of the River – East 2 (100)	0%	0%	100%
North of the River – East 2 (200)	0%	5%	100%
North of the River – West 1 (100)	0%	5%	100%
North of the River – West 1 (200)	0%	25%	100%
North of the River – West 1 (300)	0%	25%	100%
North of the River – West 1 (400)	0%	5%	100%
North of the River – West 2 (100)	0%	0%	100%
North of the River – West 2 (200)	0%	0%	100%
North of the River – West 2 (300)	0%	0%	100%
East Greeley	5%	10%	100%
Southwest Greeley	0%	10%	100%
Interchange 34 West (100)	0%	0%	100%
Interchange 34 West (200)	0%	0%	100%
Interchange 34 West (300)	0%	50%	100%
Interchange 34 West (400)	0%	0%	100%
Interchange 34 West (500)	0%	5%	100%
Total Population Increase – Tier 2	2,813	12,577	247,752
Zoning and Land Use Guidance – Tier 3	**5 Year**	**20 Year**	**Buildout**
Tier 3 Areas	7%[1]	69%[1]	100%
Total Population Increase – Tier 3	3,483	34,159	49,451
Summary	**5 Year**	**20 Year**	**Buildout**
Projected Population Increase – Tier 1-3 Total	21,368	70,540	321,007
BBC Report – Population Increase	21,275	70,125	N/A

[1] Percentage increases for the Tier 3 area are relative to total Tier 3 population increase. This increase will occur in specific areas per discussions with City of Greeley.

The percent complete values listed in **Table 4-8**, and development areas included for each Tier were chosen through discussions with the City. **Figures 4-6**, **4-7,** and **4-8** are depictions of the assumed growth areas for each planning horizon and provide visual representations of the information within **Table 4-8.**

It is assumed that the Tier 1 projects will be completed first. For this reason, most of the Tier 1 projects have been assumed to be complete at the 5-year planning horizon, and all of them assumed to be complete at the 20-year planning horizon.

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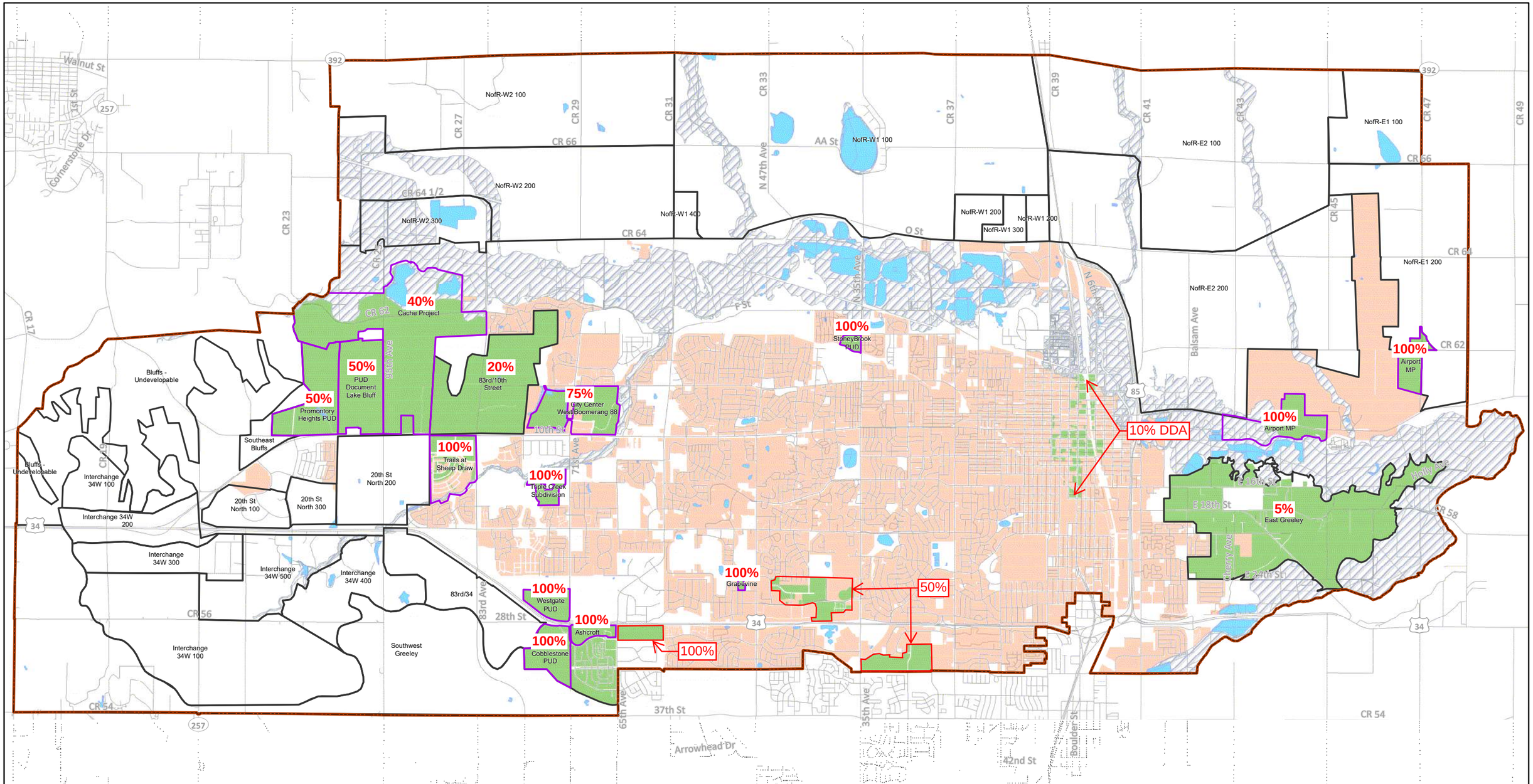

Legend

- LREGA
- Tier 1
- Tier 2
- 100-yr Floodplain
- Future Development
- Existing Service Area
- Lakes and Ponds
- Park

% = Percent Developed

N

0 0.5 1 2

Miles

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Developed Area Projections: 2025

Figure 4-6

Greeley Sewer System Master Plan

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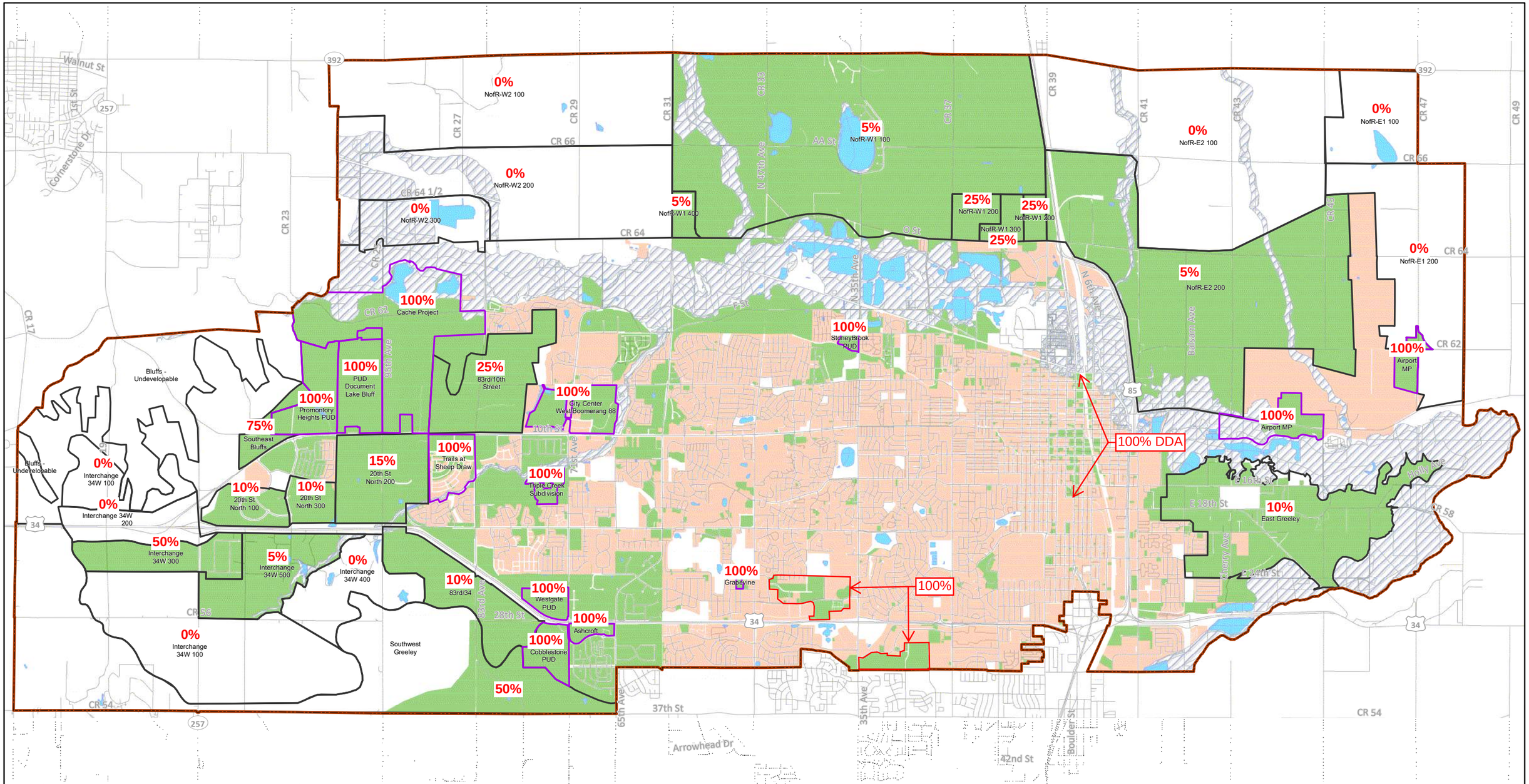

Legend

- LREGA
- Tier 1
- Tier 2
- 100-yr Floodplain
- Future Development
- Existing Service Area
- Lakes and Ponds
- Park

% = Percent Developed

N

0 0.5 1 2

Miles

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Developed Area Projections: 2040

Figure 4-7

Greeley Sewer System Master Plan

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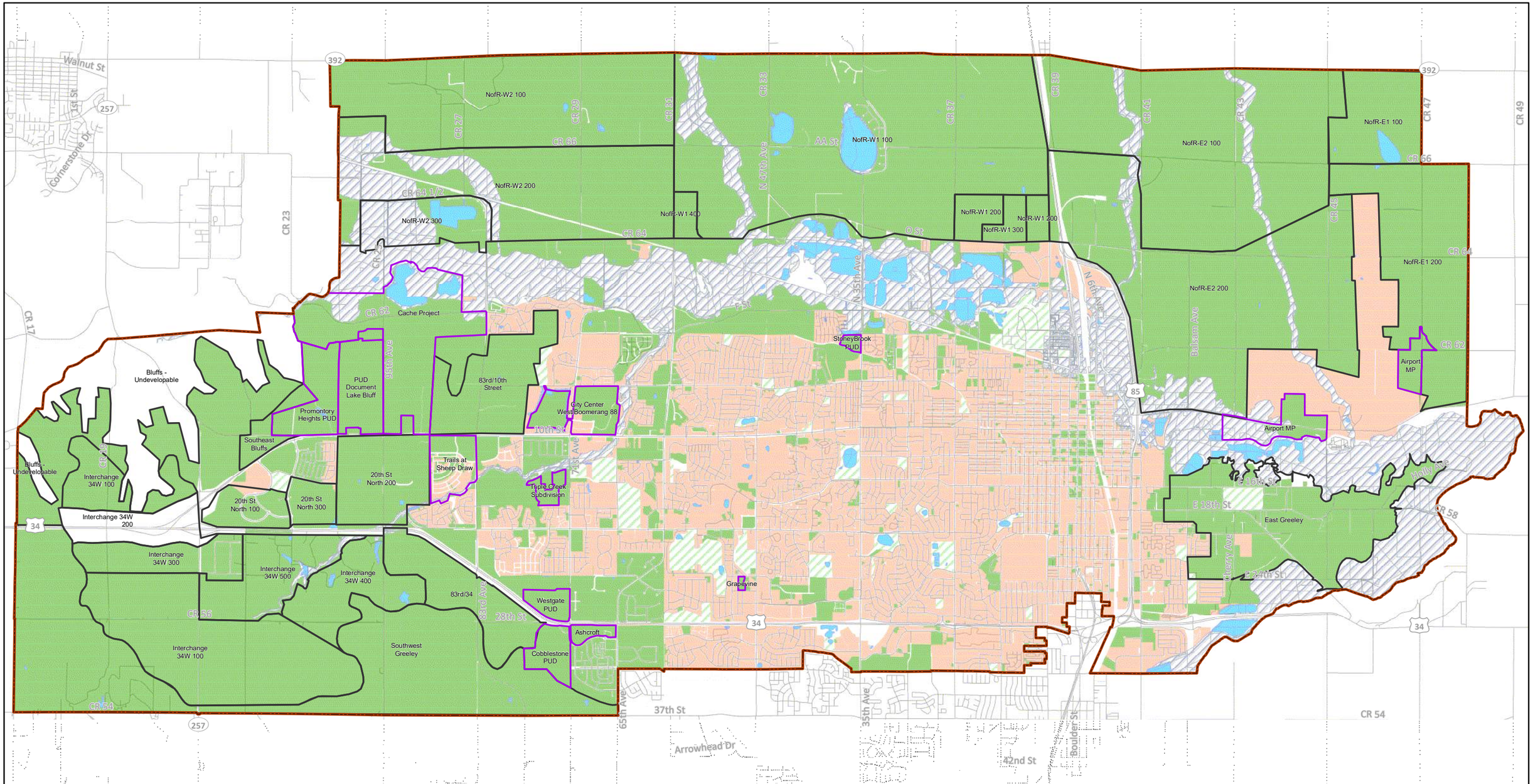

Legend

- LREGA
- Tier 1
- Tier 2
- 100-yr Floodplain
- Future Development
- Existing Service Area
- Lakes and Ponds
- Park

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N

0 0.5 1 2

Miles

Buildout Developed Area

Figure 4-8

Greeley Sewer System Master Plan

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Due to the large areas within the Tier 2 projections category, the Tier 2 percent complete values for the 5-year and 20-year planning horizons have been developed through close discussion with the City. The Tier 2 areas identified for growth at the 5-year/20-year planning horizons are the areas which the City planning department has identified as the most likely growth areas.

The Tier 3 growth identified below for the 5-year planning horizon was chosen through discussions with the City. Tier 3 growth included at the 20-year planning horizon was assumed to include all the infill around the Tier 1 and Tier 2 projected growth areas.

4.7 Overall Methodology Summary

This projections methodology organized the available planning data by tiers to produce the following three components of wastewater flow:

- Residential BWF (gpd)
- Nonresidential BWF (gpd).
- Groundwater Infiltration (gpd).

This information was converted to the components of wastewater flow and spatially distributed in the hydraulic model at each planning horizon. The resulting ADWF by planning horizon and tier is summarized in **Table 4-9**. The calibrated model was used to describe the existing conditions to arrive at the total system flow.

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Table 4-9 Future Projections Results by Tier

5 Year Planning Horizon	Acres	Population	Nonresidential BWF	Residential BWF	GWI	ADWF
			(gpd)	(gpd)	(gpd)	(mgd)
Existing	10,940	107,146 [1]	2,018,478 [2]	4,962,559 [2]	1,312,438[2]	8.29 [2]
Tier 1	1,418	15,072	613,209	921,224	141,842	1.68
Tier 2	195	2,813	38,904	168,789	19,472	0.23
Tier 3	307	3,483	85,713	329,687	31,647	0.45
Total	**12,860**	**128,514**	**2,756,304**	**6,382,259**	**1,505,399**	**10.65**
20 Year Planning Horizon	**Acres**	**Population**	**Nonresidential BWF**	**Residential BWF**	**GWI**	**ADWF**
			(gpd)	(gpd)	(gpd)	(mgd)
Existing	10,940	107,146	2,018,478	4,962,559	1,312,438	8.29
Tier 1	2,243	23,804	695,808	1,427,186	224,209	2.35
Tier 2	1,496	12,577	659,148	760,352	149,576	1.57
Tier 3	3,750	34,159	778,655	2,440,467	375,040	3.59
Total	**18,429**	**177,686**	**4,152,089**	**9,590,564**	**2,061,263**	**15.80**
Buildout	**Acres**	**Population**	**Nonresidential BWF**	**Residential BWF**	**GWI**	**ADWF**
			(gpd)	(gpd)	(gpd)	(mgd)
Existing	10,940	107,146	2,018,478	4,962,559	1,312,438	8.29
Tier 1	2,243	23,804	696,085	1,428,058	224,345	2.35
Tier 2	25,983	247,747	8,376,121	14,873,374	2,598,319	25.85
Tier 3	5,940	49,451	955,631	2,967,037	933,109	4.86
Total	**45,106**	**428,148**	**12,046,315**	**24,231,028**	**5,068,211**	**41.35**

[1] The assumed existing population was taken from the 2018 *City of Greeley Population and Water Demand Projections*.

[2] Flow information for the existing scenario was derived from the 2019 temporary flow metering, permanent flow metering, and lift station flow data. This data was cross checked, and the model was calibrated to wet and dry weather flow. The resulting calibrated flow values are shown in the above table.

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The increase in ADWF for buildout is calculated as about five times the current ADWF. This is different, as compared to population, which is calculated to increase by about four times. This discrepancy is due the wastewater flow parameters being on the higher side of the average. A conservative approach such as this is needed in master planning to account for the inherent unknowns in the spatial distribution of flows so as not to underestimate the infrastructure sizing. **Figure 4-9** illustrates the flow projections over the different planning horizons. For reference comparison, this figure shows future flow projections from the 2018 *Water Pollution Control Facility (WPCF) Treatment and Nutrient Master Plan*.

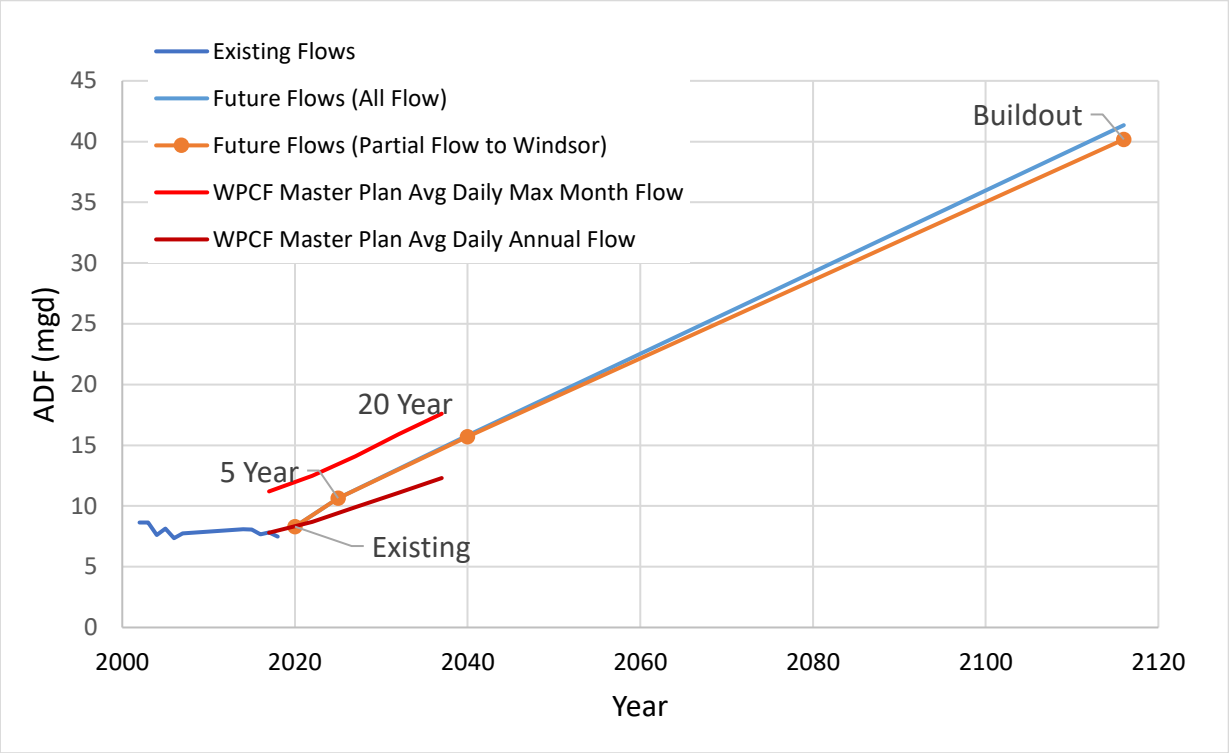

Figure 4-9 Future Flow Projections

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Section 5

Existing and Future Systems Evaluation

Model scenarios representing each of the planning horizons (Existing (2020), 2025, 2040, Buildout) were developed and evaluated to determine the improvements needed to accommodate development and growth. This section describes the evaluation criteria, model results and model deficiencies, followed by recommended improvements for each planning horizon. The existing system was evaluated, and the future system components were sized based on simulated peak WWF using the 5-year design storm event.

Existing system deficiencies were predicted using the calibrated model with WWF extrapolated for the 5-year design storm event. The City may not have observed such deficiencies since the specific duration and shape of the 5-year event has likely not occurred in recent memory. The rainfall and flow monitoring data used for model calibration only captured storm events smaller than a 1-year event. Extrapolation to larger storm events reduces the accuracy of WWF modeling, however, estimates and assumptions are necessary to plan for the desired level of service, which was recommended as the 5-year design storm event. Recommendations for improvements to the existing system are based on these predicted WWF, although the City's experience with their system and knowledge of critical areas is what drives the prioritization of such projects during capital improvements planning.

The improvements recommended to resolve the deficiencies identified at each planning horizon were sized to convey the future buildout conditions during WWF. The planning horizon at which each deficiency was identified is then used to phase the projects during capital improvements planning. The sewer system analysis did not include assessment of lift station or gravity sewer system condition and did not consider rehabilitation that are not driven by system capacity. The City has an asset management program that evaluates existing infrastructure condition and methods of rehabilitation. The asset management program will use this masterplan to inform rehabilitation methods when addressing the sewer system condition. Further assessments of lift stations will determine the lift stations' condition and possible improvements such as the installation of VFDs to equalize flow and reduce the hydraulic impact to the receiving gravity sewers.

Two flow routing alternatives were considered for serving some of the West Greeley areas, defined as those areas west of County Road 19. These flow routing alternatives included the Poudre Alternative and the Windsor Alternative. The Poudre Alternative routes all the flow through the Poudre Trunk line to the WTRF). The Windsor Alternative leverages the overlap of Windsor's sewer service area with the LREGA boundary to route a portion (3.84 mgd) of the West Greeley area flow to Windsor. Modeling analysis predicted that the Windsor alternative would eliminate 11,000 LF of existing 30" sewer interceptor replacement. Additionally, this alternative would also eliminate the need for two lift stations. Based on City discussions and input, the model evaluation scenarios presented in the following sections are based on the Windsor flow routing alternative.

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5.1 Sewer Sub-Basins

Sewer basins are large collection areas that make up the City's sewer system. Sewer sub-basins are the smaller collection areas that are delineated to route flow to their respective downstream sewer manholes. Existing system sub-basins were delineated using collector sewers and parcel boundaries. Each sewer sub basin would include all the collector sewers that are tributary to a manhole but will not include any collector sewer tributary to the upstream or downstream sub-basins. Future sewer system sub-basins were delineated using existing system sub-basins, future planning documents, parcel boundaries, topography, geographic features (rivers, streams, etc.), railroads, and major roads. Note that as developers provide more detailed information, future sewer sub-basin boundaries will need to be revisited.

Future system dry weather and wet weather parameters were applied to each sub-basin and the resulting ADFs were allocated to the nearest manhole for each planning horizon. **Figure 5-1** shows the existing and future sub-basins.

5.2 Evaluation Criteria

The following evaluation criteria were used to evaluate the existing system and future systems under WWF conditions (5-year design storm). The following describes the evaluation and improvement sizing criteria by system component:

- **Lift stations** were evaluated by comparing the simulated wet weather influent flow to the lift station firm capacity, which is the capacity with the largest pump out of service. If the peak wet weather inflow exceeds the firm capacity, then the lift station is flagged as deficient. Deficient lift stations are further evaluated to understand the operation of the station and assess the impacts of the station on the system, such as upstream surcharging. If improvements were determined to be needed, they were sized to match the peak wet weather inflow under buildout conditions.

- **Force mains** were evaluated to check that velocities were within 2.0 and 7.5 feet per second (fps). If peak velocities during WWF were outside of that range, the force main was identified for improvements, which were sized to maintain a peak velocity near 5 fps under buildout conditions.

- **Gravity pipes** were evaluated for capacity utilization by peak d/D under dry and wet weather conditions. Pipes were flagged as deficient if the d/D > 1 and freeboard (depth of flow below manhole rim) < 10 feet. A d/D less than 1.0 indicates the pipe is not flowing full while a d/D of 1.0 or greater is considered surcharged. Surcharged pipes, however, may indicate capacity deficiency in that pipe segment or they may be caused by backwater effects. Improvements are likely to be recommended for existing pipes that are predicted to be surcharged, but improvements may not be necessary if the pipes are sufficiently deep. To assess this, freeboard is considered. A freeboard of 10 feet or more would likely negate the need for improvement of a surcharged pipe.

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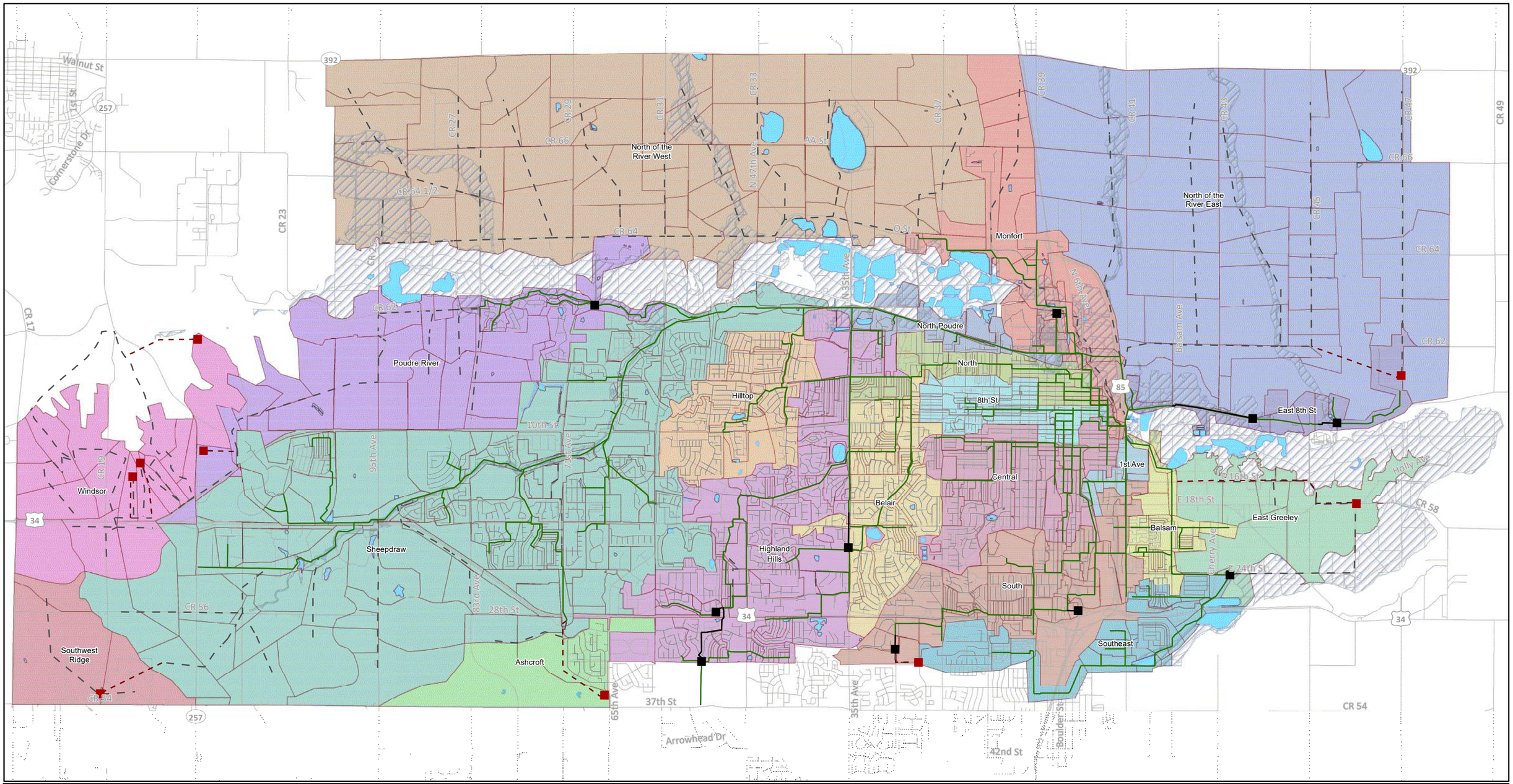

Legend

- Existing Lift Stations
- Future Lift Stations
- Existing Force Mains
- Existing Interceptors
- Existing Collectors
- Future Pipes
- Future Force Main

Sewer Sub-Basins

- 1st Ave
- 8th St
- Ashcroft
- Balsam
- Belair
- Central
- East 8th St
- East Greeley
- Highland Hills
- Hilltop
- Monfort
- North
- North Poudre
- North of the River East
- North of the River West
- Poudre River
- Sheepdraw
- South
- Southeast
- Southwest Ridge
- Windsor

- 100-yr Flood Plain
- Lakes and Ponds

N

0 0.5 1 2

Miles

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Existing and Future Sewer Sub-Basins

Figure 5-1

Greeley Sewer System Master Plan

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- **Existing System Improvements** – Once a portion of the existing system has been identified as requiring improvement, the following criteria are used:
  - Replacement Pipe Size – Replacement pipe size for existing gravity sewer is calculated based on the buildout peak WWF such that the maximum d/D is 0.8. It is assumed that the replacement pipe slope will match the existing pipe slope. It also assumes that replacement pipes will not decrease in diameter at any point along the replacement section (This assumption can potentially lead to lower slope pipe sections driving the replacement pipe sizes).
  - Parallel Pipe Size – Parallel pipe size for existing gravity sewers is calculated based on the buildout peak WWF such that the maximum d/D in the parallel pipe is 0.8, assuming the existing gravity sewer remains in service. The required capacity of the parallel pipe is determined by subtracting the existing pipe capacity from the total buildout peak WWF. It is assumed that the parallel pipe slope will match the existing pipe slope.
- **Future System Gravity Sewer** – New interceptor pipes are sized based on buildout WWF with a maximum d/D of 0.8.

5.2.1 Peak Flow Design Standards Review

The Colorado Department of Health and Safety (CDPHE) and 10 State Standards do not specify design criteria for peak WWF. The requirements for wastewater facilities are that the infrastructure be able to handle "peak flow". The *City of Greeley Design Criteria and Construction Specifications* specify a domestic peaking factor based on population from the American Society of Civil Engineers (ASCE) Peak Flow Curve G. The overall systemwide peaking factor for the City using the ASCE Peak Flow Curve is approximately 2. The ASCE Manual of Practice for Gravity Sewers recommends an overall peaking factor of 2.6 for medium sized utilities.

A 5-Year Design Storm is used for this Master Plan to analyze peak flow. The systemwide peaking factor resulting from this design storm is 2.55 for the existing system scenario, and 2.21 for the buildout system scenario. Within the last 5 years, the City has not had a rain event with the same volume as a 5-year design storm, but there have been storm events with higher peak flows than the proposed design storm. Overall, while the 5-year design storm is a conservative rain event, the resulting peaking factors within the system are not substantially greater than industry standard peaking factors.

5.2.2 5-Year Design Storm

A design criterion of 1000 gpd/acre was simulated for the design storm, using an average of the calibrated RTK parameters that were then adjusted to achieve the design criterion peak. This design criterion is specific to the 5-year design storm and is based on the average results of the calibrated model RTKs which was approximately 895 gpd/acre when simulating the 5-year design storm. Note that the model can be used with a larger design storm to simulate higher RDII rates, but the recommended design criterion of 1000 gpd/acre is specific to a level of service aligned with the 5-year design storm.

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5.3 Existing System Evaluation

The existing conditions model was used to simulate dry and wet weather flow conditions. Under dry weather flow conditions, only 0.25% of the modeled interceptors were predicted to surcharge. **Figure 5-2** shows the existing system dry weather flow deficiency locations.

The location of surcharging during dry weather flow is along 47th Avenue near MH 09-19.010. The model predicted surcharging during dry weather flow at only 4" above the pipe crown, while maintaining 8 feet of freeboard. This area is sensitive to high flow and will be discussed further in this section.

The model was also used to analyze the existing system under WWF conditions (5-year design storm). The results indicate potential deficiencies as summarized in the following sections. **Figure 5-3** shows these wet weather system deficiency locations.

5.3.1 Lift Stations (Existing System)

Lift stations were evaluated based on simulated existing condition influent flows. A summary of this evaluation is presented in **Table 5-1**, which compares the modeled firm capacity to the influent flows under wet and dry conditions. The lift station capacity is considered deficient if the influent flow exceeds the firm capacity. No deficiencies are predicted for DWF conditions. Lift stations 9 and 18 are predicted to be deficient for the simulated peak WWF based on the 5-year design storm.

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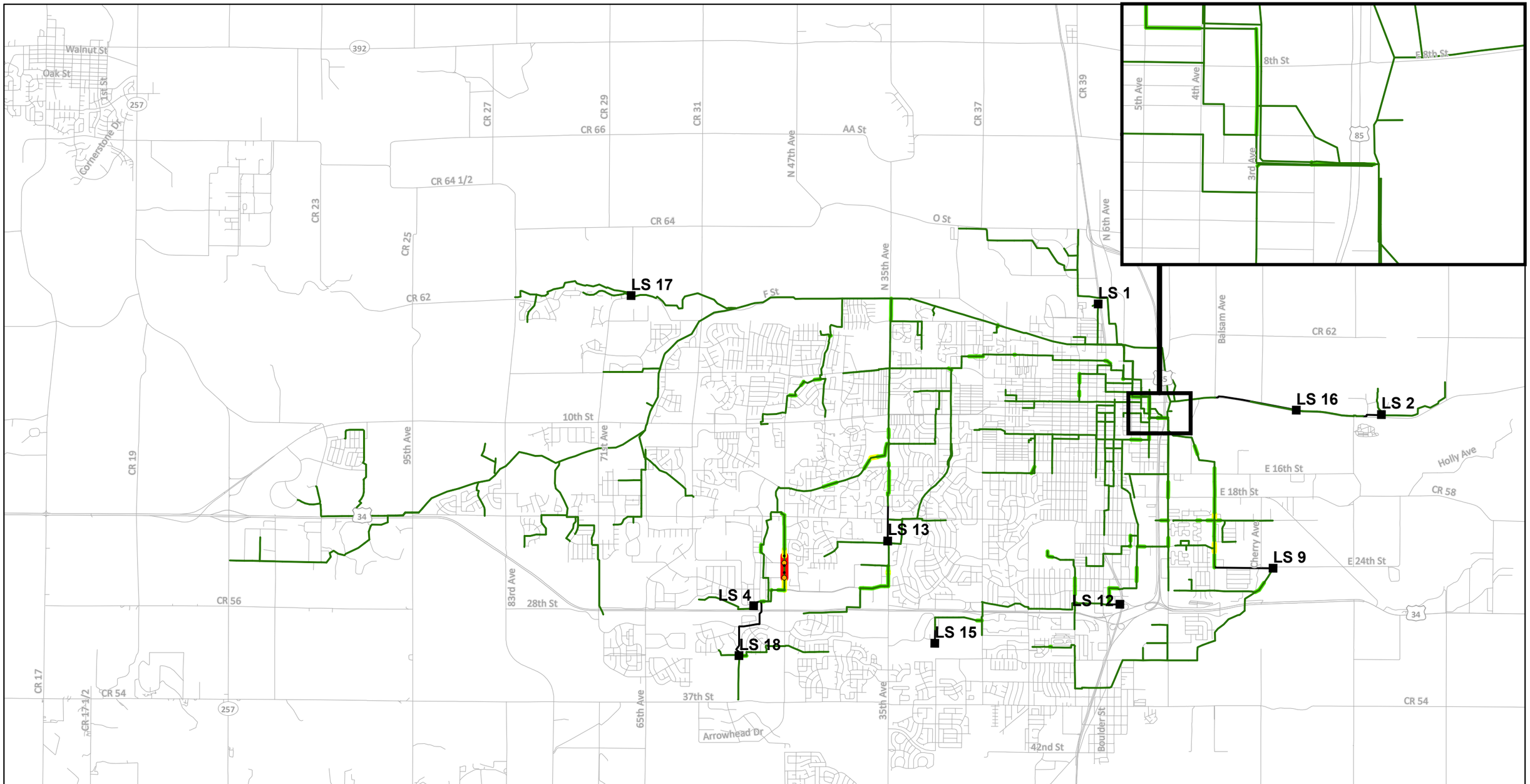

Legend

- Existing Lift Stations
- Existing Interceptors
- Existing Force Mains

Peak DWF d/D

- 0 - 0.5
- 0.5 - 0.8
- 0.8 - 0.99

Surcharged (d/D = 1)

- Backwater
- Capacity Deficiency

Freeboard (Distance from Manhole Rim to HGL)

- <10 ft
- > 10 Ft

N

0 0.5 1 2

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Predicted Peak Dry Weather Flow Deficiencies- Existing System

Figure 5-2

Greeley Sewer System Master Plan

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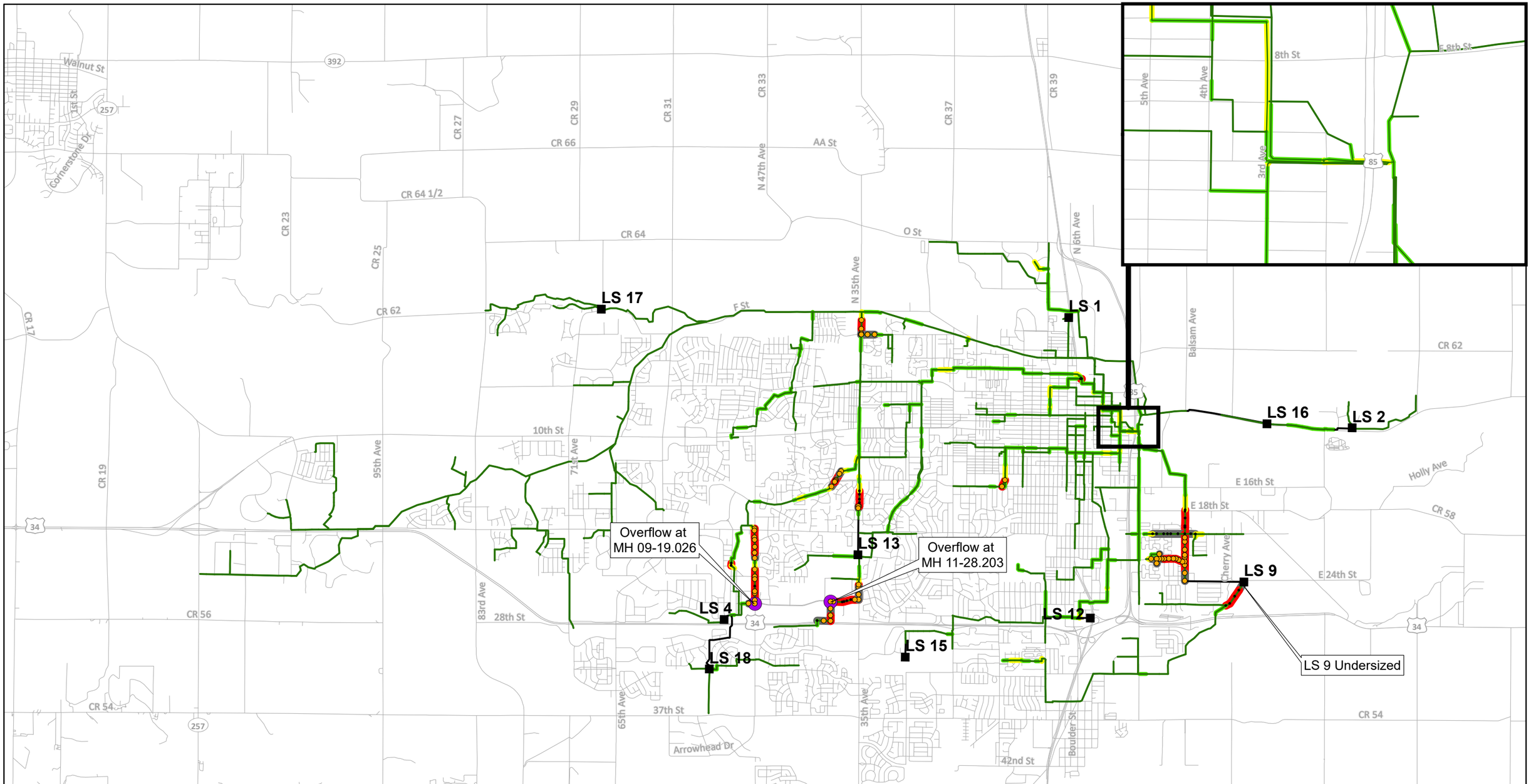

Legend

- Existing Lift Stations
- Existing Force Mains
- Existing Interceptors

Peak WWF d/D

- 0 - 0.5
- 0.5 - 0.8
- 0.8 - 0.99

Surcharged (d/D = 1)

- Backwater
- Capacity Deficiency

Freeboard (Distance from Manhole Rim to HGL)

- <10 ft
- > 10 Ft
- Predicted Manhole Overflows

N

0 0.5 1 2

Miles

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Predicted Peak Wet Weather Flow Deficiencies- Existing System

Figure 5-3

Greeley Sewer System Master Plan

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Table 5-1 Lift Station Evaluation Results (Existing)

LS #	Name	Firm Capacity (One Pump)				Simulated Peak Inflow (gpm)		Deficiency (gpm)	
		Design TDH (ft)	Design Capacity (gpm)[1]	Modeled TDH (ft)[2]	Modeled Capacity (gpm)[3]	DWF	5-Year Storm	DWF	5-Year Storm
1	North 9th Ave	20	80	20	125	12	13	--	--
2	Airport	N/A	120	28	111	6[7]	43[8]	--	--
4	Highland Hills	35	100	38	111	19	51	--	--
9	Cherry Ave	57	638	57	764[4]	486	1,330	--	566
12	Garden City	24	80	24	104	3	23	--	--
13	35th Ave	94	1,700	96	1,680	458	1,071	--	--
15	Auto Plaza	62	150	61	160	7	27	--	--
16	East 8th St	48	270	52	285	25	125[7]	--	--
17	Farmers Spur	16.5	560	20	458[5]	76	211	--	--
18	T-Bone	153	668[6]	140	320[6]	327	417	--	97

[1] Design Capacity information taken from the City of Greeley Lift Station GIS shapefile and is assumed to be firm capacity (1 pump running).

[2] Model TDH was developed by adjusting force main losses to re-create the design TDH within the model.

[3] Model Capacities are firm capacity. Model Capacity is simulated by using pump curves provided by the City with the modeled TDH.

[4] For LS9, the model uses the newer Infinity pump curve provided by the City. The GIS design capacity is likely based on the older J-Series pump curve.

[5] For LS17, different curves are shown for the lead/lag pump. The lead pump is using the older J series curve, while the lag pump is using the new infinity pump curve. This difference between the model and design capacity is due to the small amount of additional head simulated by the model (20 ft TDH vs 16.5 ft TDH).

[6] For LS18, the City indicated the capacity to be approximately 315 gpm. The original pumps at LS18 have been replaced with newer infinity pumps. The model uses the infinity pump curve with an assumed impeller trim of 11.75".

[7] Peak WWF values at LS2/LS 16 exclude an overnight water line flushing up to 80 gpm flowing to LS2. If the flushing were to occur during a peak wet weather event, the total inflow at LS2/LS 16 could reach 123 gpm and 243 gpm //respectively.

For each lift station predicted to be deficient for the simulated wet weather conditions, analysis and recommendations are discussed further below:

LS9 (Cherry Avenue): Peak wet weather influent flows are predicted to exceed the capacity of the existing lift station causing the level in the wet well to rise such that wastewater begins to surcharge upstream of the lift station.

Sensitivity Analysis: The City has not observed capacity issues at LS9 and calibration specific to the LS9 service area was limited to dry weather only due to errors within the lift station SCADA data during wet weather events. Due to the uncertainty in the simulated WWF at LS9 and the City's experience with the lift station, the sensitivity of the simulated peak WWF on predicted system impacts was checked.

If the peak WWF into LS9 were reduced by 25%, the firm capacity (1 pump) and total capacity (2 pumps) would still be exceeded, but the total flow into the lift station would not result in surcharging if both pumps are operating.

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If the peak WWF into LS9 were increased by 25%, the total capacity (2 pumps) would be further exceeded and predicted backwater surcharging would increase; however, the predicted hydraulic grade line is still more than 20 feet below manhole rims.

Assuming the same 25% peak WWF increase, if one pump were out of service, the level in the LS9 wet well is predicted to increase causing further backwater effects upstream. However, the hydraulic grade line upstream of LS9 is still 9 feet below manhole rims.

Recommendations: Additional WWF monitoring and calibration is recommended for the LS9 service area. No immediate improvements are recommended because the sensitivity analysis shows that the lift station deficiency does not result in significant level of surcharging in the upstream gravity pipes even if WWFs are 25% greater than currently simulated.

LS18 (T-Bone): Simulated peak inflow during the 5-year storm event exceeded the capacity of the existing lift station causing the level in the wet well to rise such that the gravity lines upstream of the lift station are predicted to surcharge.

Sensitivity Analysis: After discussions with City, no capacity issues have been observed in the field. Predicted surcharge during wet weather is still more than 10 feet below manhole rims in the upstream, modeled system.

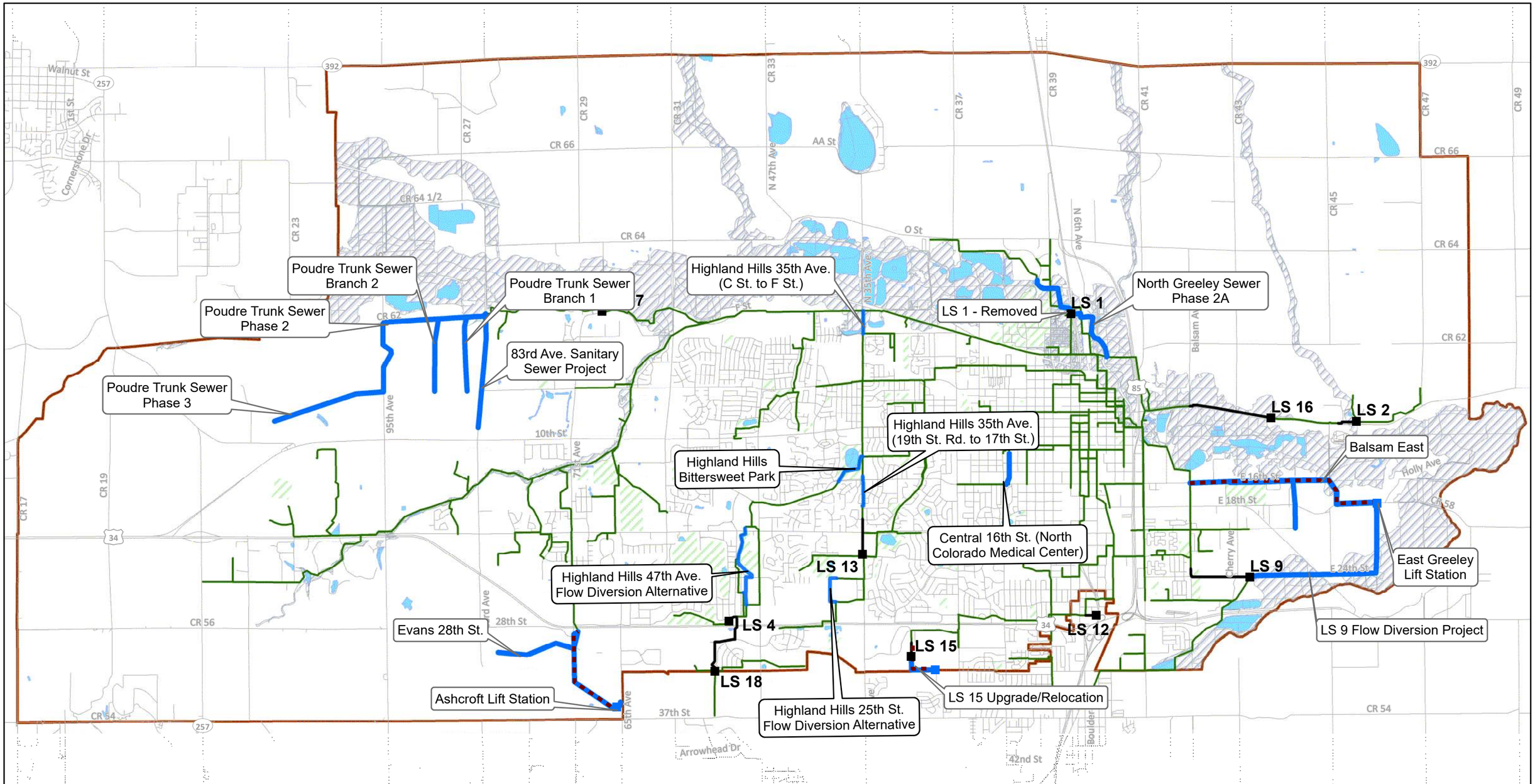
If the levels in LS18 were to being surcharging the upstream system or if LS18 were to go offline for an extended period, excess flow would be directed to the City of Evans through the existing LS18 overflow pipe.

The existing total capacity of LS18 is already greater than the downstream capacity of the existing 8" pipes. Once the lead and lag pump turn on, the downstream system is predicted to surcharge If the lift station firm capacity was upgraded to pump the simulated design storm peak WWF, the City may begin seeing regular surcharging in the downstream system. A CIP project (Highland Hills 47th Avenue Flow Diversion) is planned to address the downstream capacity deficiencies.

Recommendations: No additional improvements are recommended because the deficiency does not result in a significant level of surcharging in the upstream gravity pipes. Any excess flows are directed to Evans through the LS18 overflow pipe.

5.3.2 Gravity Pipe (Existing System)

For gravity pipes, surcharging is predicted in about 5% of the modeled pipes under the simulated WWF conditions. Specific areas of predicted surcharging are identified in **Figure 5-3** (previously shown) and described below. All recommended improvements account for future lift station capacity expansions as well as future buildout peak WWF. **Figure 5-4** details the recommended improvements for the existing system and future infrastructure within the next 5 years.



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April 26, 2021

Legend

- LREGA
- 100-yr Floodplain
- Lakes and Ponds
- Park
- Existing Lift Stations
- Existing Interceptors
- Existing Force Mains
- 5 Year LS Recommendations
- 5 Year Pipe Recommendations
- 5 Year Force Main Recommendations

N

0 0.5 1 2
Miles

Recommended 5 Year Improvements

Figure 5-4

Greeley Sewer System Master Plan

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Balsam - LS9 to 18th St: During dry weather conditions (normal operation) there are no predicted deficiencies for this section of gravity sewer. However, during WWF, the existing 12" pipe and 15" pipe downstream of LS9 are predicted to surcharge. This occurs when 2 pumps at LS9 are operating for a total of 1,070 gpm to pump the upstream flows. The hydraulic grade line is predicted to be within 3-5 feet of manhole rims in the 12" pipe (near 22nd Street) but well below manhole rims in the 15" pipe (12-20 ft). See **Figure 5-5** below for location details.

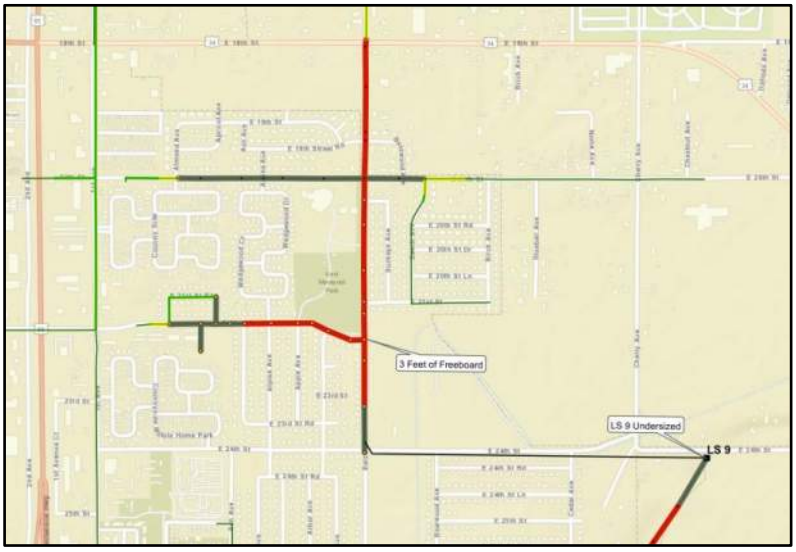

Figure 5-5 Balsam Ave Capacity Deficiency

The existing 10" sewer along 20th Street is predicted to surcharge, but the depth from the hydraulic grade line to manhole rims is greater than 10 ft (12 ft to grade). Surcharging along 20th Street is caused by a backwater effect from the downstream interceptor. If the downstream issues are resolved, there are no capacity deficiencies predicted along 20th Street east of Balsam Avenue.

The existing 8-12" sewer along 22nd Street is predicted to surcharge within 2 feet of manhole rims. Surcharging along 22nd Street is caused by a backwater effect from the downstream interceptor. If the downstream issues are resolved, there are no capacity deficiencies predicted along 22nd Street.

Upstream of LS9, the 15" pipe is predicted to surcharge. The hydraulic grade line is predicted to be 16-20 ft below manhole rims. Surcharging in this pipe is due to a capacity limitation at LS9 that is resulting in a backwater effect. The peak WWF into LS9 exceeds the simulated pump capacity such that the level in the wet well rises above the crown of the influent pipe, resulting in upstream surcharging. If the lift station capacity issue is resolved, the existing 15" pipe is sufficiently sized for the projected flows through buildout.

<u>Recommended Improvements</u>: No immediate improvements are recommended for this section of gravity sewer. Future recommended improvements to the upstream system will eliminate capacity issues within this section of gravity sewer. However, due to the sensitivity of this system with two-pump flow from LS9, the City should monitor this area during wet weather events. If the capacity issues within this section of gravity sewer become critical before the upstream improvements are constructed, improvements to this section of sewer may need to be re-visited.

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Highland Hills - 35th Ave (C Street to F Street): During dry weather conditions (normal operation) there are no predicted deficiencies for this section of gravity sewer. However, during WWF the 18" pipe along 35th Avenue is predicted to surcharge within 4 feet of manhole rims. Additionally, this capacity deficiency results in a backwater effect that causes surcharging within the 12" pipe along C Street. Once the capacity deficiency along 35th Avenue is resolved, there are no predicted capacity deficiencies along C Street.

Recommended Improvements: Replace or parallel the existing 18" gravity sewer as described in **Appendix D**.

Highland Hills - 35th Ave (19th St Rd to 17th Street): During dry weather conditions (normal operation) the existing 12" sewer is predicted to surcharge within 8 feet of manhole rims. Additionally, during wet weather conditions the existing 12" pipe is predicted to surcharge within 3 feet of manhole rims. Surcharging in this 12" pipe is due to a capacity deficiency when the lead pump from LS13 is operating at 1,680 gpm.

Recommended Improvements: Replace or parallel the 12" gravity sewer as described in **Appendix D**. The recommended improvements account for the existing firm pumping capacity from LS13 upstream. LS13 is not deficient in existing or buildout flow conditions; therefore, no improvements are recommended for LS13 and the recommended downstream gravity improvements are appropriately sized for buildout conditions.

Highland Hills - Bittersweet Park: During dry weather conditions (normal operation) there are no predicted deficiencies for this section of gravity sewer. However, during WWF the existing 10" pipe is predicted to surcharge within 4 feet of manhole rims.

Recommended Improvements: Replace or parallel the 10" gravity sewer as described in **Appendix D**.

Highland Hills - 25th Street: During dry weather conditions (normal operation) there are no predicted deficiencies for this section of gravity sewer. However, during WWF the existing 8" pipe along 25th Street is predicted to surcharge with an overflow predicted at MH 11-28.203. This capacity limitation along 25th Street is predicted to cause a backwater effect surcharging the 10" pipes south of 25th Street. The full flow capacity of the existing 8" pipe is approximately 0.5 mgd, while the predicted peak flow during the 5-year design storm is approximately 1.0 mgd. This capacity deficiency in the 8" pipe along 25th Street causes surcharging which results in a predicted overflow at MH 11-28.203.

Alternatives and Sensitivity Analysis: To address the deficiency, alternatives to divert flows from MH 11-28.203 to MH 11-28.061 were evaluated.

- Diversion of Centerplace Drive Only: If only the flows from Centerplace Drive were diverted, the remaining peak WWF through the existing 8" pipe along 25th St is still greater than the pipe capacity (peak flow = 0.51 mgd, pipe capacity = 0.46 mgd). The 8" pipe along 25th Street is still predicted to surcharge within 4 feet of manhole rims. A sensitivity analysis of the simulated WWF along 25th Street found that only a 12% increase in peak WWF will result in a predicted overflow at MH 11-28.203.

- Diversion of All flow Into MH 11-28.203: If all flow into MH 11-28.203 was diverted to MH 11-28.061 (24th Street), the downstream sewer is predicted to surcharge within 5 feet of manhole rims during peak WWF conditions. A sensitivity analysis of the simulated WWF in the 24th Street pipe found that a 30% increase in peak WWF will result in a predicted overflow at MH 11-28.061.

Recommended Improvements: Alternative 1: Divert the flow from Centerplace Drive to MH 11-28.061. Utilizing a flow split, divert 50% of flow upstream of MH 11-28.203 to MH 11-28.061 and 50% of the upstream flow to 25th Street. Install 12" gravity sewer along 38th Avenue as shown in **Appendix D**. This flow split alternative eliminates the capacity issues along both sections of downstream sewer (25th Street and 24th Street). It is possible to construct these improvements in phases, with phase 1 diverting the flow from Centerplace Drive, and phase 2 implementing the flow split for the flow upstream of MH 11-28.203. Alternative 2: Replace or parallel the existing 8" gravity sewer following the same corridor as described in **Appendix D**.

- Alternative 1 is recommended since it addresses the system issues and avoids construction along 35th Avenue.

Highland Hills 47th Ave: During dry weather conditions (normal operation) the existing 8" sewer is predicted to surcharge within 5 feet of manhole rims. During WWF, an overflow is predicted at MH 09-19.026, along with surcharging in the adjacent 8" pipe. This is the result of flow from LS18 with two pumps operating at a combined capacity of 0.58 mgd (400 gpm), which exceeds the capacity of the limiting sections of 8" pipe at about 0.5 mgd (350 gpm). With one pump running, the flow simulated from LS18 is approximately 0.46 mgd (320 gpm), which is below the modeled capacity of the existing 8" pipe. However, during the 5-year design storm event, the predicted peak WWF to LS18 is 0.6 mgd, which triggers the second pump and exceeds the downstream capacity of the system resulting in a predicted overflow at manhole (MH 09-19.026).

Recommended Improvements: To address the deficiency, two alternatives to divert flows from LS18 into a separate downstream gravity sewer were evaluated.

- Alternative 1: Divert all flow from LS18 into the proposed gravity sewer as shown in **Appendix D**. Additionally, divert the flow from LS4 into the proposed diversion sewer to avoid future projected capacity deficiencies along 50th Avenue. It is important to note that this recommended flow diversion includes a section of new pipe and a section of replacement piping along 50th Avenue. This alternative is recommended to avoid construction along 47th Avenue.

- Alternative 2: Replace or parallel the 8" gravity sewer along 47th Avenue as described in **Appendix D**.

5.3.3 Force Main (Existing System)

Force mains were evaluated at the flow rates of the modeled firm capacity of each lift station, the results are summarized in **Table 5-2**. A force main is considered deficient if the velocity based on the pumped flow is less than 2 fps or greater than 7.5 fps. No force mains were identified as deficient.

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Table 5-2 Force Main Evaluation Results

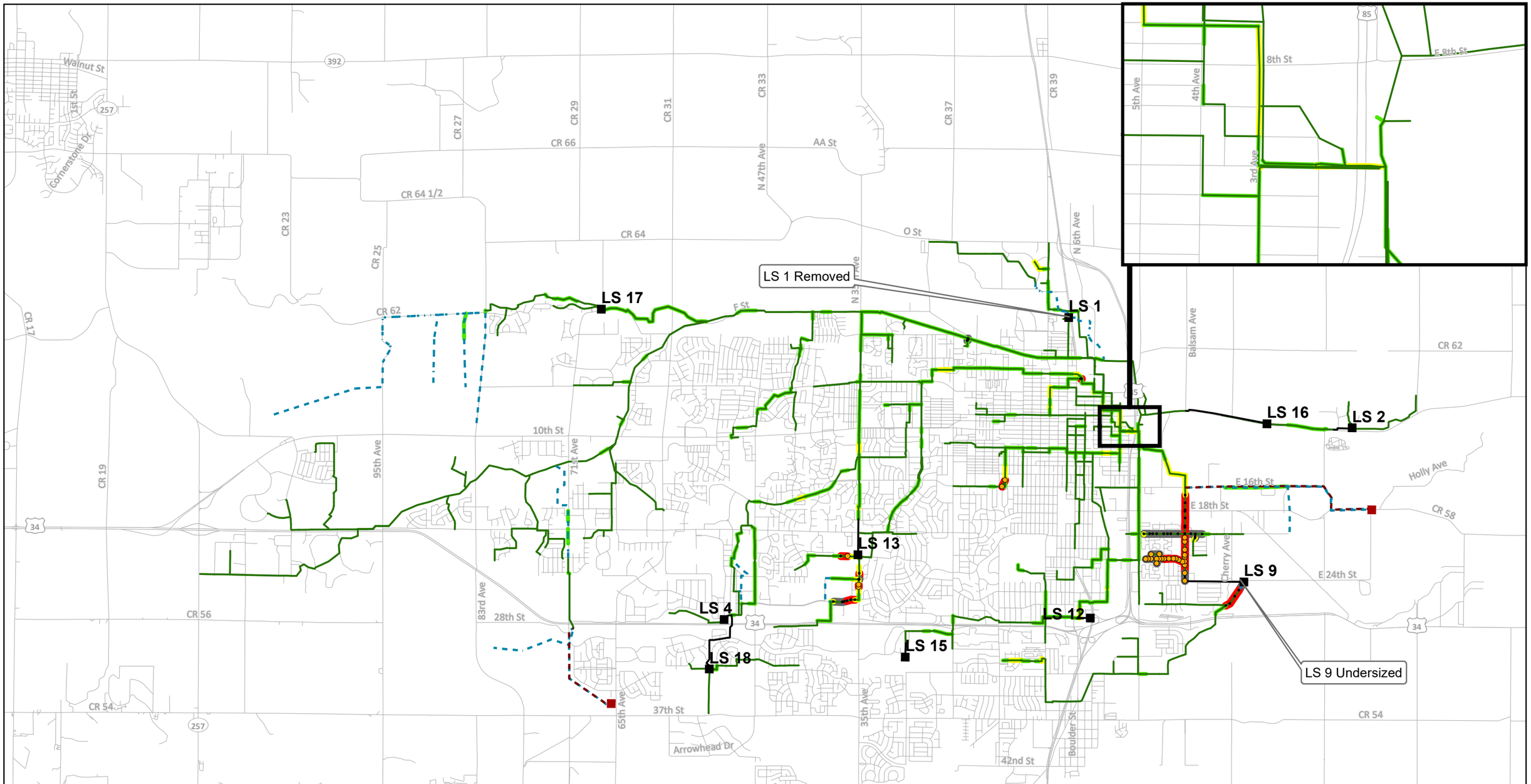
LS #	Name	Force Main Diameter (inches)	Lift Station Firm Capacity (gpm)	Simulated Force Main Velocity (fps)	Deficiency (< 2 or > 7.5 fps)
1	North 9th Ave	4	125	3.14	--
2	Airport	4	111	2.83	--
4	Highland Hills	4	111	2.83	--
9	Cherry Ave	10	764	3.12	--
12	Garden City	4	104	2.65	--
13	35th Ave	10	1,680	6.86	--
15	Auto Plaza	4	160	4.08	--
16	East 8th St	6	285	3.23	--
17	Farmers Spur	6	458	5.20	--
18	T-Bone	8	320	2.04	--

5.4 2025 System Evaluation (5 Year Planning Horizon)

The 2025 planning horizon model simulates the future WWF as determined from the projection methodology and the RDII design criterion. **Figure 5-6** shows the 2025 wastewater system deficiency map which includes the future infrastructure that was identified in **Figure 5-5** (previous figure). It also shows the recommended improvements from the existing system analysis.

Table 5-3 lists the future infrastructure included in the 2025 system model to serve the areas identified in **Section 4**. These projects are sized for buildout conditions. Many of the capacity improvements are driven by development. It will be the responsibility of individual developers to expand sewer capacity to meet the development capacity needs. Any system improvements to address long term master plan needs will be met by the City.

There are 6 planned large industrial water users identified in the Water Master Plan that have not been specifically located or demand allocated. As these locations are determined, they will be evaluated on a case-by-case basis for impacts to determine impacts to the sewer system.



Legend

- Existing Lift Stations
- Future Lift Stations
- Existing Force Mains
- Future Force Main
- Existing Interceptors
- Future Interceptors (2025)

Peak WWF d/D

- 0 - 0.5
- 0.5 - 0.8
- 0.8 - 0.99

Surcharged (d/D = 1)

- Backwater
- Capacity Deficiency

Freeboard (Distance from Manhole Rim to HGL)

- <10 ft
- > 10 Ft
- Predicted Manhole Overflows

N

0 0.5 1 2

Miles

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2025 Predicted Peak Wet Weather Flow Deficiencies

Figure 5-6

Greeley Sewer System Master Plan

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Table 5-3 2025 Projected Future Infrastructure

Project Name	Project Infrastructure
Balsam East	1,693 LF 8” Sewer 4,562 LF 12” Sewer 2,767 LF 15” Sewer 2,987 LF 18” Sewer New East Greeley Lift Station 8,900 LF 8” Force Main
North Greeley Sewer Phase 2A	7,300 LF 36” Sewer
Evans – Ashcroft Lift Station	350 LF 18” Sewer New Ashcroft Lift Station 5,800 LF 8” Force Main
Evans – 28th Street	1,200 LF 8” Sewer 1,750 LF 10” Sewer 2,050 LF 12” Sewer
LS 15 Upgrade and Relocation	New Lift Station 15 2,095 LF 8” Sewer 2,885 LF 6” Force Main
83rd Avenue Sanitary Sewer	2,075 LF 8” Sewer 4,390 LF 10” Sewer
Poudre Trunk Sewer Phase II	10,230 LF 30” Sewer
Poudre Trunk Sewer – Branch 1	4,366 LF 8” Sewer
Poudre Trunk Sewer – Branch 2	916 LF 8” Sewer 3,181 LF 10” Sewer
Poudre Trunk Sewer Phase 3	4,884 LF 10” Sewer 3,865 LF 15” Sewer

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5.4.1 Lift Stations and Force Mains (2025)

Lift Stations 2, 9, 16, and 18 are predicted to be deficient in 2025 based on the simulated WWF for this planning horizon. A summary of the lift station deficiencies is shown in **Table 5-4**.

Table 5-4 Lift Station Evaluation Results (2025)

LS #	Name	Firm Capacity (One Pump)		Simulated Peak Inflow (gpm)		Deficiency (gpm)	
		TDH (ft)	Capacity (gpm)	DWF	5-Year Storm	DWF	5-Year Storm
1	North 9th Ave	Removed per North Greeley Sewer Phase 2A Project					
2	Airport	28	111	132	157	21	46
9	Cherry Ave	57	764	486	1,330	--	566
15	Auto Plaza	61	160	136	180	--	20
16	East 8th St	52	285	299	342	14	57
18	T-Bone	140	320	327	417	7	97
Future Lift Stations							
LS #	**Name**	**Estimated Buildout TDH (ft)**	**Estimated Buildout Wet Weather Flow (gpm)**	**Estimated 2025 Dry Weather Flow (gpm)**		**Estimated 2025 Wet Weather Flow (gpm)**	
Future	LS15	85	310	136		180	
Future	Ashcroft	170	1,974	517		1,206	
Future	East Greeley	61	2,650	31		988	

[1] Buildout peak WWF.

Additional discussion of deficiencies by each individual lift station, along with recommended improvements, are described below.

LS1 (North 9th Avenue): As part of the North Greeley Sewer Phase 2A project, Lift Station 1 is projected to be taken offline by 2025. This is reflected in the 2025 system mode.

LS2 (Airport): Simulated peak inflows exceed the capacity of the existing lift station which cases the level in the wet well to rise such that the gravity lines upstream of the lift station are predicted to surcharge.

Recommended Improvements: No improvements are recommended because the model indicates that the lift station flow deficiency does not result in a deficiency in the upstream gravity pipes.

LS9 (Cherry Avenue): Simulated peak inflows exceed the capacity of the existing lift station which causes the level in the wet well to rise such that wastewater begins to surcharge upstream of the lift station. Additionally, during WWF conditions, the downstream gravity sewer surcharges within 3 feet of existing manhole rims.

Recommended Improvements: To address both the lift station and downstream gravity deficiencies, it is recommended that LS9 be removed, and the flow routed by gravity to the proposed East Greeley Lift Station. The proposed interceptor would serve future development in the East Greeley area. The proposed alignment and profile are feasible given this planning-level

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analysis but will need to be confirmed during design. Simulated peak inflows exceed the capacity of the existing lift station causing the level in the wet well to rise such that wastewater begins to surcharge upstream of the lift station. During WWF conditions, the downstream gravity sewer surcharges within 3 feet of existing manhole rims.

Recommended Improvements: To address both the lift station and downstream gravity deficiencies, it is recommended that LS9 be removed, and the flow routed by gravity to the proposed East Greeley Lift Station. The proposed interceptor would serve future development in the East Greeley area. The proposed alignment and profile are feasible given this planning-level analysis but will need to be confirmed during design.

LS15 (Auto Plaza): Expansion and growth within the lift station service area is predicted to increase the peak WWF to be slightly greater than the lift station capacity. This expansion will be driven by future development. Improvements to the wastewater system will be the responsibility of the developers. To serve the future buildout service area, LS15 will need to be relocated.

Recommended Improvements: Relocate LS15 and expand capacity to meet buildout conditions.

LS16 (East 8th Street): Simulated peak inflows exceed the capacity of the existing lift station which causes the level in the wet well to rise such that the gravity lines upstream of the lift station are predicted to surcharge.

Recommended Improvements: No improvements are recommended because the model indicates that the lift station flow deficiency does not result in a deficiency in the upstream gravity pipes. If LS2 is taken offline and the flow routed by gravity to LS16, no additional improvements would be required at LS16.

Future Ashcroft Lift Station: This lift station is recommended to serve future development per the 2025 planning horizon. The recommended design capacity for the Ashcroft Lift Station is 1,597 gpm. The proposed downstream force main is 5,800 feet of 12” pipe.

Future East Greeley Lift Station: This lift station is recommended for the future East Greeley service area. The recommended design capacity for the East Greely Lift Station is 2,650 gpm. The proposed downstream force main is 11,700 feet of 18” pipe.

5.4.2 Gravity Pipe (2025)

Specific areas of predicted surcharging are described below. All recommended improvements account for future lift station capacity expansions as well as future buildout peak WWF.

Balsam - LS9 to 16th St: Surcharging along Balsam Avenue from LS9 to 16th St remains an issue for the 2025 planning horizon. When 2 pumps at LS9 are operating for a total of 1,070 gpm, the existing 12” pipe and 15” pipe downstream of LS9 are predicted to surcharge. The hydraulic grade line is predicted to be within 3-5 feet of manhole rims in the 12” pipe (near 22nd Street) but well below manhole rims in the 15” pipe (12-20 ft).

Recommended Improvements: With the construction of the East Greeley Lift Station, it is recommended that all flow to LS9 be diverted to the East Greeley Lift Station, and the station be

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removed from service. This diversion of the LS9 flow will eliminate the capacity deficiency detailed above.

Central 16th Ave (North Colorado Medical Center): With the 2025 projected flows, this section of 8" pipe is predicted to be surcharged within 6 feet of manhole rims. The full flow capacity of the existing 8" pipe is approximately 0.75 mgd, while the maximum inflow during the design storm is approximately 0.84 mgd.

Recommended Improvements: Replace or parallel the existing 8" gravity sewer

5.5 2040 System Evaluation (20 Year Planning Horizon)

The 2040 planning horizon model includes future flows determined from the projection methodology and the RDII design criterion. The 2040 wastewater system deficiency map, shown in **Figure 5-7,** includes the future infrastructure identified in **Figure 5-8** and the recommended improvements from the existing and 2025 system analysis.

Table 5-5 (following figures) lists the additional future infrastructure included in the 2040 system model to serve areas identified in **Section 4**. These projects have been sized for buildout conditions. **Figure 5-8** shows the locations of the future infrastructure that has been included in the 2040 system model. Many of the capacity improvements listed below are driven by development and will be the responsibility of individual developers to expand sewer capacity. Any system improvements to address long term master plan needs will be met by the City.

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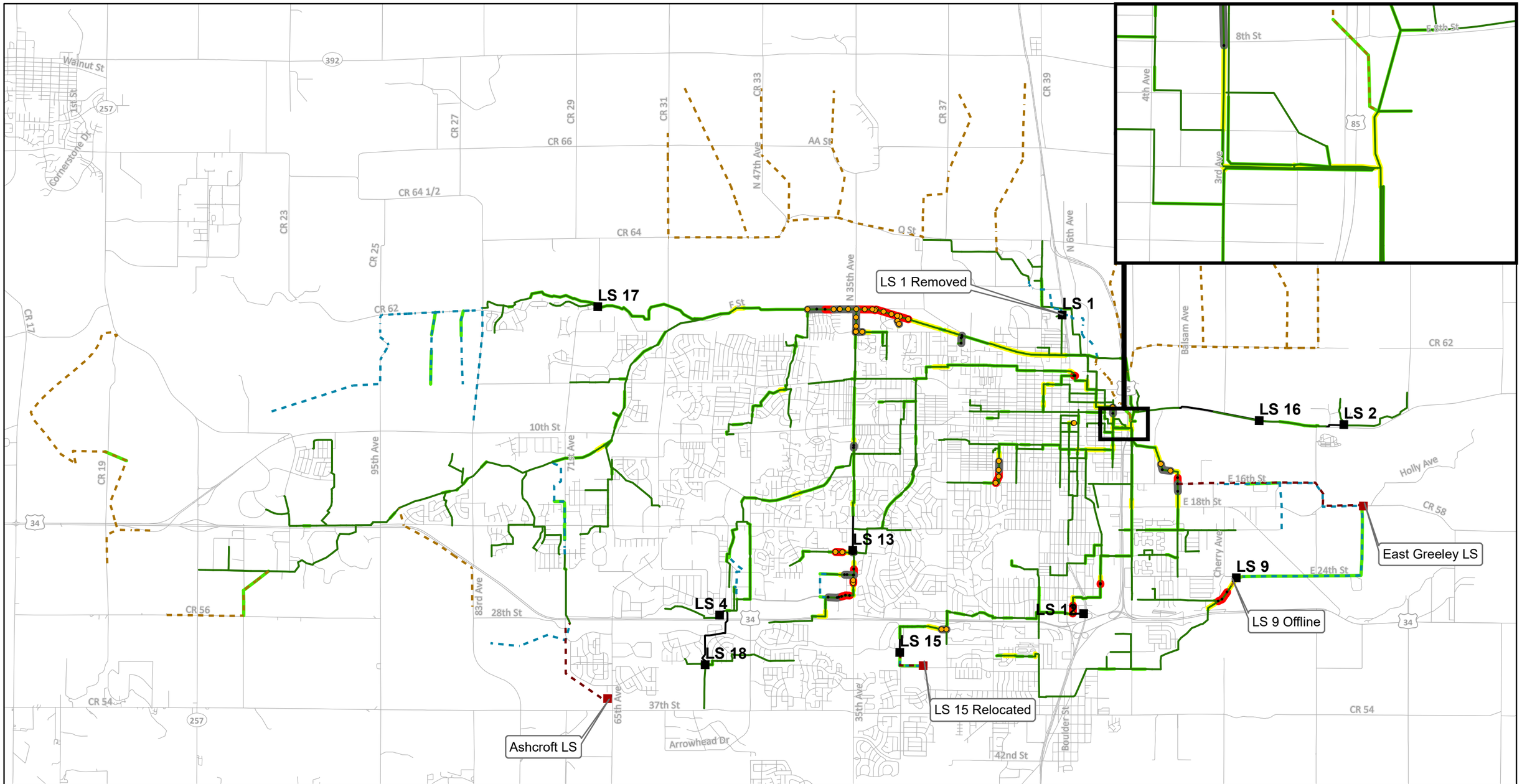

Legend

- Existing Lift Stations
- Future Lift Stations
- Existing Force Mains
- Future Force Main
- Existing Interceptors
- Future Interceptors (2025)
- Future Interceptors (2040)

Peak WWF d/D

- 0 - 0.5
- 0.5 - 0.8
- 0.8 - 0.99

Surcharged (d/D = 1)

- Backwater
- Capacity Deficiency

Freeboard (Distance from Manhole Rim to HGL)

- <10 ft
- > 10 Ft
- Predicted Manhole Overflows

N

0 0.5 1 2

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February 16, 2021

2040 Predicted Peak Wet Weather Flow Deficiencies

Figure 5-7

Greeley Sewer System Master Plan

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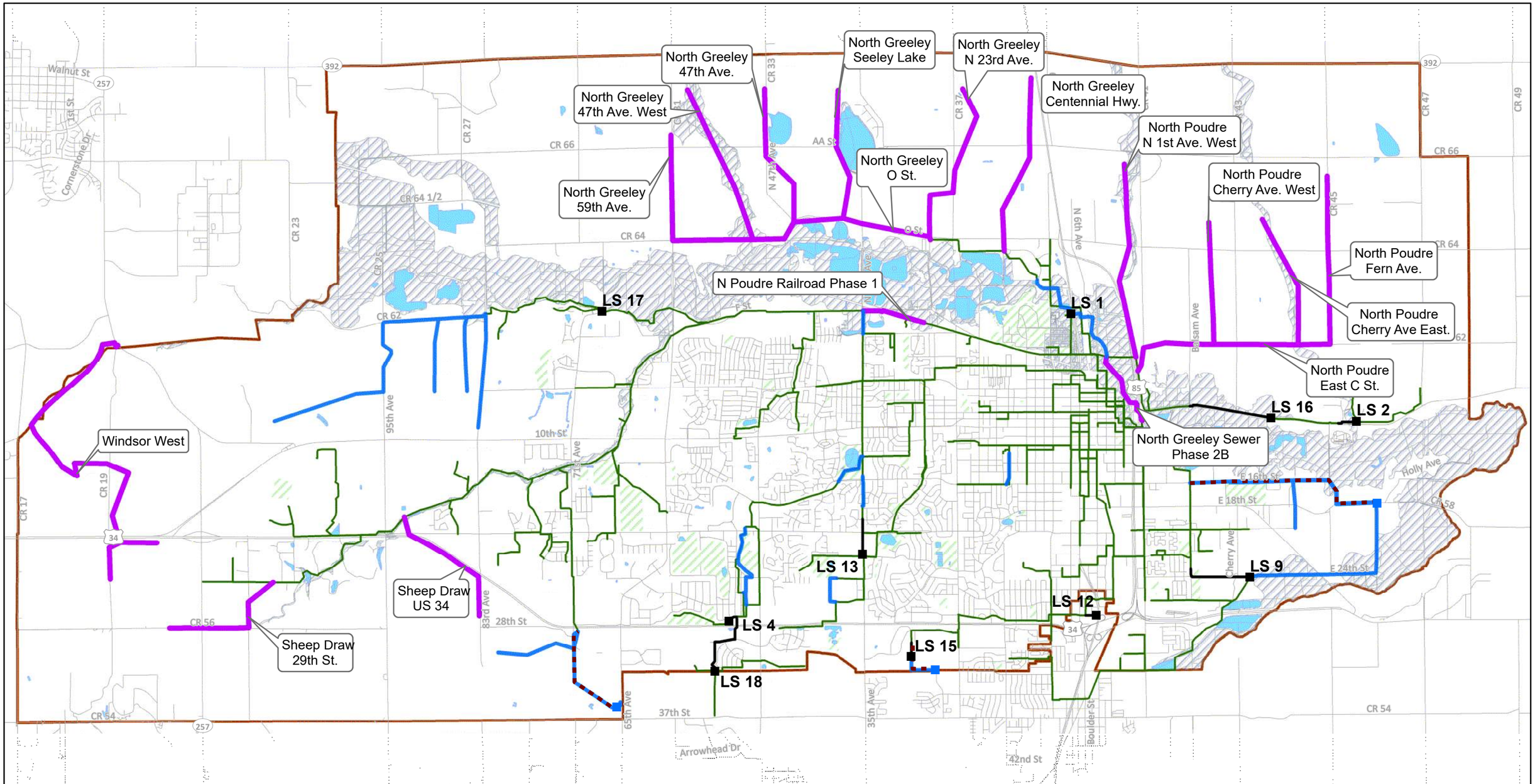

Legend

- LREGA
- 100-yr Floodplain
- Lakes and Ponds
- Park
- Existing Lift Stations
- Existing Interceptors
- Existing Force Mains
- 5 Year LS Recommendations
- 5 Year Pipe Recommendations
- 20 Year Pipe Recommendations
- 5 Year Force Main Recommendations

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Recommended 20 Year Improvements

Figure 5-8

Greeley Sewer System Master Plan

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Table 5-5 2040 Projected Future Infrastructure

Project Name	Project Infrastructure
North Greeley Sewer Phase 2B	4,603 LF 48” Sewer
North Poudre East C Street	1,797 LF 30” Sewer 3,106 LF 36” Sewer 7,073 LF 42” Sewer
North Poudre Fern Ave	5,557 LF 15” Sewer 3,321 LF 18” Sewer 659 LF 21” Sewer
North Poudre Cherry Ave East	4,285 LF 15” Sewer 1,710 LF 21” Sewer 1,623 LF 24” Sewer
North Poudre Cherry Ave West	5,464 LF 18” Sewer 1,447 LF 21” Sewer
North Poudre North 1st Ave West	3,129 LF 15” Sewer 8,017 LF 18” Sewer
North Greeley Centennial Highway	1,376 LF 8” Sewer 3,157 LF 10” Sewer 5,663 LF 12” Sewer
North Greeley West O Street	15,421 LF 36” Sewer
North Greeley North 23rd Ave	1,759 LF 10” Sewer 4,581 LF 12” Sewer 3,672 LF 15” Sewer
North Greely Seeley Lake	1,536 LF 10” Sewer 3,556 LF 12” Sewer 2,376 LF 15” Sewer
North Greeley 47th Ave	1,850 LF 10” Sewer 1,980 LF 12” Sewer 2,228 LF 15” Sewer 2,161 LF 18” Sewer
North Greeley 47th Ave West	1,257 LF 8” Sewer 3,500 LF 10” Sewer 3,410 LF 12” Sewer 1,128 LF 15” Sewer
North Greeley 59th Ave	2,420 LF 8” Sewer 2,227 LF 10” Sewer 1,329 LF 15” Sewer
Sheep Draw US 34	1,172 LF 8” Sewer 4,324 LF 10” Sewer 1,240 LF 12” Sewer
Sheep Draw 24th St South	3,245 LF 27” Sewer
Sheep Draw 29th Street	2,800 LF 8” Sewer 1,690 LF 12” Sewer
Windsor West	3,748 LF 8” Sewer 825 LF 10” Sewer 6,540 LF 12” Sewer 12,633 LF 18” Sewer

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5.5.1 Lift Station and Force Mains (2040)

By 2040, no additional existing lift station improvements are required.

5.5.2 Gravity Pipe (2040)

Specific areas of predicted surcharging are described below. All recommended improvements account for future lift station capacity expansions as well as future buildout peak WWF.

N Poudre Railroad Phase 1 (East of 35th Avenue): The 36" downstream of 35th Ave is predicted to be surcharged within 5 feet of manhole rims due to projected future flows within the Poudre River and Sheep Draw Basins (Completion of the Tier 1 projects – Cache/Lake Bluff/Promontory Heights along with the initial Tier 2 development.). The capacity of the existing 36" pipe is approximately 16.5 mgd. However, the peak wet weather inflow is approximately 20.8 mgd. This capacity deficiency causes a backwater effect upstream along F Street, which compounds the flow capacity issues along 35th Ave (C Street to F Street).

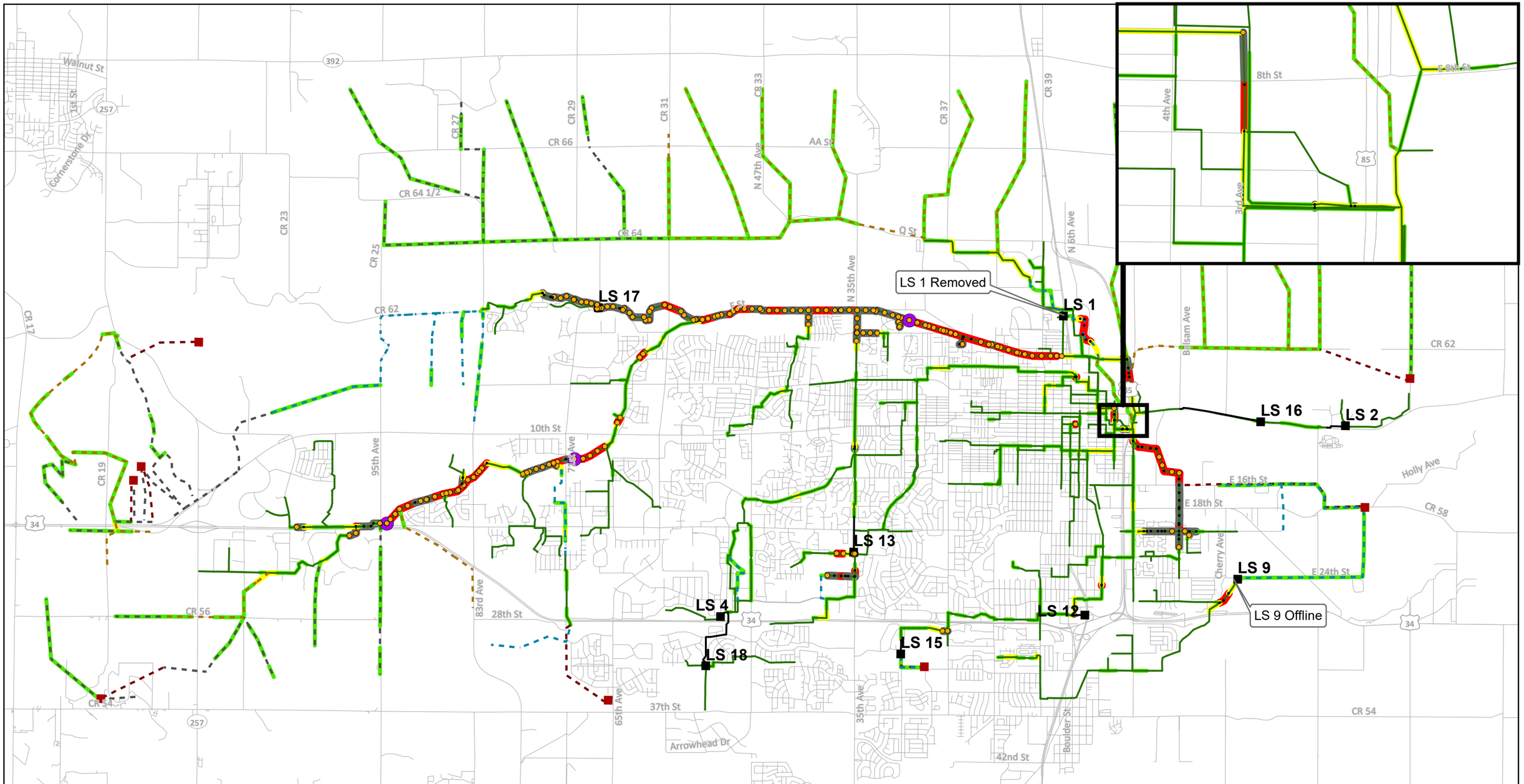
Recommended Improvements: Replace or parallel the existing 36" sewer as described in **Appendix D**.

Balsam 18th St to Ash Avenue: Surcharging along the Balsam Ave trunk line downstream of the East Greeley Lift Station is predicted at the 2040 planning horizon; however, surcharging is still 9 feet below the manhole rims.

Recommended Improvements: No immediate improvements are recommended; however, when the East Greeley service area is built out, improvements to the Balsam Ave trunk line downstream of the East Greeley force main will be required.

5.6 Buildout System Evaluation

The buildout planning horizon model includes future flows as determined from the projection methodology and RDII design criterion. **Figure 5-9** shows the buildout wastewater system deficiency map, including the future infrastructure identified in **Figure 5-10** and the recommended improvements from the existing, 2025, and 2040 system analysis.



Legend

- Existing Lift Stations
- Future Lift Stations
- Existing Force Mains
- Future Force Main
- Existing Interceptors
- Future Interceptors (2025)
- Future Interceptors (2040)
- Future Interceptors (Buildout)

Peak WWF d/D

- 0 - 0.5
- 0.5 - 0.8
- 0.8 - 0.99

Surcharged (d/D = 1)

- Backwater
- Capacity Deficiency

Freeboard (Distance from Manhole Rim to HGL)

- <10 ft
- > 10 Ft
- Predicted Manhole Overflows

N

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December 18, 2020

Buildout Predicted Peak Wet Weather Flow Deficiencies

Figure 5-9

Greeley Sewer System Master Plan

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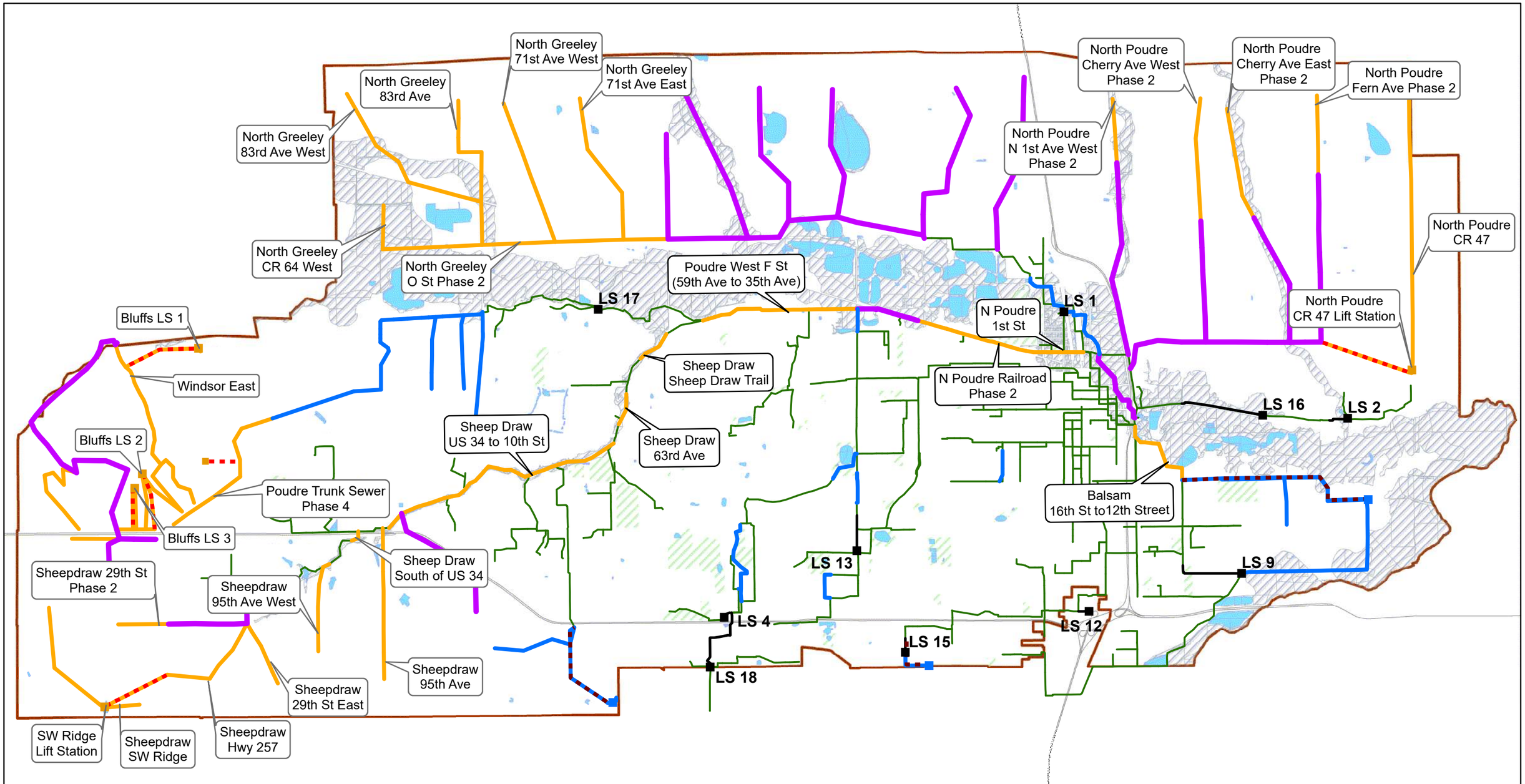

Legend

- LREGA
- 100-yr Floodplain
- Lakes and Ponds
- Park
- Existing Lift Stations
- Existing Interceptors
- Existing Force Mains
- 5 Year LS Recommendations
- Buildout LS Recommendations
- 5 Year Pipe Recommendations
- 20 Year Pipe Recommendations
- Buildout Pipe Recommendations
- 5 Year Force Main Recommendations
- Buildout Force Main Recommendations

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Recommended Capital Improvements

Figure 5-10

Greeley Sewer System Master Plan

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Table 5-6 lists the additional future infrastructure that is included in the buildout system model to the service areas identified in **Section 4**. **Figure 5-10** shows the locations of the future infrastructure that has been included in the buildout system model. Many of the capacity improvements listed below are driven by development and it will be the responsibility of individual developers to expand sewer capacity. Any system improvements to address long term master plan needs will be met by the City.

Table 5-6 Buildout Projected Future Infrastructure

Project Name	Project Infrastructure
North Poudre CR 47	5,481 LF 10" Sewer 7,792 LF 15" Sewer 3,963 LF 18" Sewer N Poudre CR 47 Lift Station 5,460 LF 18" Force Main
North Poudre Fern Ave Phase 2	3,118 LF 10" Sewer 1,411 LF 15" Sewer
North Poudre Cherry Ave East Phase 2	2,942 LF 10" Sewer 3,528 LF 12" Sewer
North Poudre Cherry Ave West Phase 2	2,308 LF 10" Sewer 4,722 LF 15" Sewer
North Poudre North 1st Ave West Phase 2	1,835 LF 12" Sewer 1,826 LF 15" Sewer
North Greeley O Street Phase 2	2,461 LF 21" Sewer 4,170 LF 24" Sewer 6,448 LF 30" Sewer
North Greeley 71st Ave East	672 LF 10" Sewer 1,450 LF 12" Sewer 5,795 LF 15" Sewer 884 LF 21" Sewer
North Greeley 71st Ave West	1,325 LF 8" Sewer 1,600 LF 10" Sewer 1,532 LF 12" Sewer 3,992 LF 15" Sewer
North Greeley 83rd Ave	2,109 LF 8" Sewer 845 LF 12" Sewer 4,155 LF 15" Sewer
North Greeley 83rd Ave West	1,005 LF 8" Sewer 1,119 LF 10" Sewer 1,280 LF 12" Sewer 4,222 LF 15" Sewer 2,805 LF 18" Sewer
North Greeley CR 64	2,502 LF 8" Pipe 5,694 LF 12" Pipe
Sheep Draw 95th Ave	2,774 LF 8" Sewer 3,386 LF 10" Sewer 2,481 LF 18" Sewer
Sheep Draw 95th Ave West	1,315 LF 8" Sewer 2,515 LF 10" Sewer 1,000 LF 12" Sewer

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Project Name	Project Infrastructure
Sheep Draw 29th Street East	2,335 8" Sewer 981 LF 10" Sewer 531 LF 12" Sewer
Sheep Draw 29th Street Phase 2	2,865 LF 8" Sewer
Sheep Draw Highway 257	4,095 LF 12" Sewer 2,296 LF 15" Sewer
Sheep Draw Southwest Ridge	3,454 LF 8" Sewer 6,222 LF 10" Sewer SW Ridge Lift Station 4883 LF 15" Force Main
Poudre Trunk Sewer Phase 4	9,463 LF 8" Sewer
Windsor West Phase 2	11,383 LF 8" Sewer 2,715 LF 10" Sewer 4,077 LF 12" Sewer Bluffs Lift Station 1 Bluffs Lift Station 2 Bluffs Lift Station 3 7,000 LF 4" Force Main
Windsor East	8,053 LF 8" Sewer 6,781 LF 10" Sewer 4,500 LF 4" Force Main

5.6.1 Poudre Flow Routing Alternative

Analysis, maps, and pipe size recommendations described in the previous sections assumed that a portion of the buildout flow will be directed to Windsor for treatment. If an agreement with Windsor cannot be reached for the treatment of the future flows, the City's buildout wastewater system would require additional upgrades. **Figure 5-11** illustrates the Poudre alternative and **Table 5-7** compares the infrastructure needs for the Poudre and Windsor Alternatives at buildout.

An additional lift station may be required to serve an area near the Bluffs (west of US34 across from Promontory Park). During design development, the ability to gravity flow or the requirement for a lift station should be confirmed. For purposes of this master plan, the flow from the area is accounted for in the Poudre gravity pipeline.

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Table 5-7 Poudre and Windsor Alternatives Infrastructure Recommendations for Buildout

Project Name	Poudre Alternative	Windsor Alternative
Poudre Trunk Sewer Phase 3	8,749 LF 21" Sewer	4,884 LF 10" Sewer 3,865 LF 15" Sewer
Poudre Trunk Sewer Phase 4	5,651 LF 18" Sewer 3,812 LF 21" Sewer	9,463 LF 8" Sewer
Bluffs Area[1] (North of US 34/West of CR 257)	22,393 LF 8" Sewer 3,540 LF 10" Sewer 8,267 LF 12" Sewer 410 LF 15" Sewer 3,886 LF 18" Sewer Bluffs Lift Station 1 Bluffs Lift Station 2 Bluffs Lift Station 3 Bluffs Lift Station 4 Bluffs Lift Station 5 14,642 LF 4" Force Main 9,008 LF 12" Force Main	23,184 LF 8" Sewer 10,321 LF 10" Sewer 10,616 LF 12" Sewer 12,769 LF 18" Sewer Bluffs Lift Station 1 Bluffs Lift Station 2 Bluffs Lift Station 3 7,000 LF 4" Force Main 4,500 LF 6" Force Main
Existing Infrastructure Upgrades (78th Ave to West F Street	Replace 11,470 LF of existing 30" sewer with 36" sewer.	N/A

[1] Infrastructure layout for the Poudre and Winsor flow routing alternatives follows the Poudre Trunk Sewer Phase II Project Sub Basin Master Plan (Stantec 2018)

[2] An additional lift station may be required for service to the Bluffs area. This should be evaluated in more detail during design development

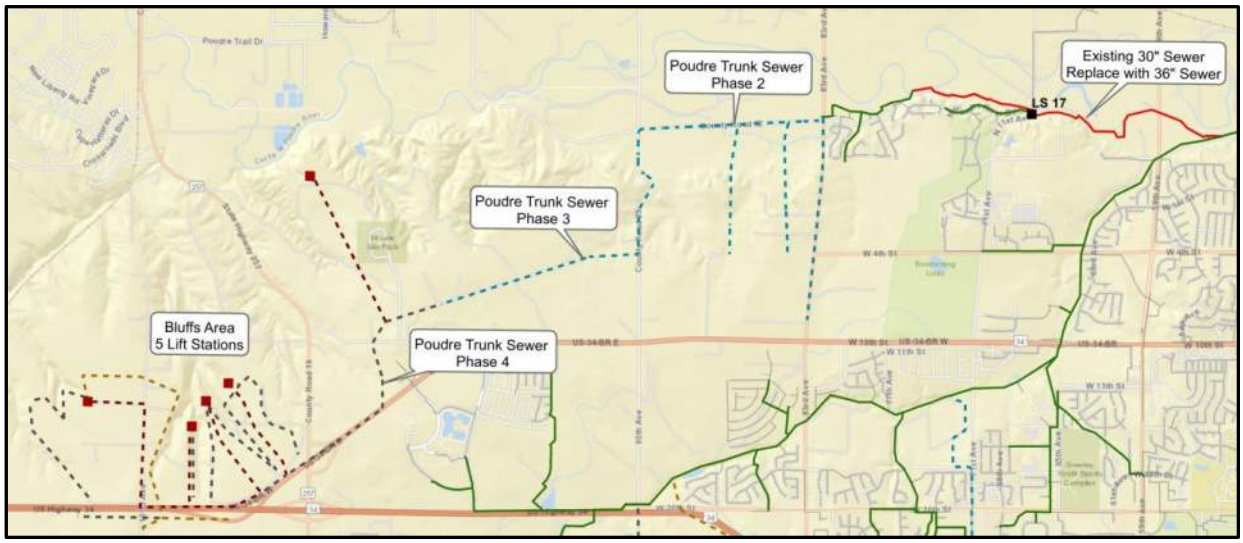

Figure 5-11 Poudre Alternative Infrastructure Review

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5.6.2 Lift Stations and Force Mains

In addition to the lift stations previously discussed, LS4 was found to be deficient at buildout. **Table 5-8** summarizes the model results for the lift stations.

Table 5-8 Lift Station Evaluation Results (Buildout)

LS #	Name	Firm Capacity		Simulated Peak Inflow (gpm)		Deficiency (gpm)	
		Model TDH (ft)	Model Capacity (gpm)	DWF	5-Year Storm	DWF	5-Year Storm
4	Highland Hills	38	111	38	124	--	13
Future	N Poudre CR 47	45	2,222	1,235	2,222	N/A	
Future	SW Ridge	163	1,421	642	1,421		
Future	Bluffs LS1	30	319	101	319		
Future	Bluffs LS2	100	110	3	110		
Future	Bluffs LS3	67	70	17	70		

Additional discussion of deficiencies by each lift station, along with recommended improvements for the lift stations and associated force mains, are described below.

LS4 (Highland Hills): Simulated peak inflow during the design storm event exceeded the capacity of the existing lift station by approximately 13 gpm. The inflows during the design storm simulation were attenuated in the wet well and did not result in surcharging in the upstream gravity system. Projected future growth within the LS4 service area includes the connection of existing homes currently on septic systems east of 65th Avenue.

Recommended Improvements: No improvements are recommended for LS4. The lift station deficiency does not result in surcharging in the upstream gravity pipes.

Future N Poudre CR 47 Lift Station: This lift station is recommended to serve future development at the buildout planning horizon. The recommended design capacity is 2,222 gpm. The proposed downstream force main is 5,460 feet of 18" pipe.

Future SW Ridge Lift Station: This lift station is recommended to serve future development at the buildout planning horizon. The recommended design capacity is 1,421 gpm. The proposed downstream force main is 4,880 feet of 15" pipe.

Future Bluffs Lift Stations: To serve the parcels bluffs area in West Greeley, it is recommended that the Bluffs LS1, LS2, LS3 be installed. It is likely these lift stations will be designed and paid for by developers.

5.6.3 Gravity Pipe (Buildout)

Specific areas of predicted surcharging are described below. All recommended improvements account for future lift station capacity expansions as well as future buildout peak WWF. **Figure 5-10** and **Table 5-9** (at the end of this section) provide details on the recommended improvements at the buildout planning horizon.

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Balsam 16th Street to 12th Street: When the East Greeley and LS9 combined service area reaches buildout flows, the projected WWF event exceeds the capacity of the existing Balsam Avenue trunk line. Surcharging downstream of the East Greeley force main connection at 16th Street is predicted to be within 4 feet of manhole rims. Additionally, this lack of capacity creates a backwater effect that reaches back past 20th Street (refer to **Figure 5-9**).

Recommended Improvements: Replace or parallel the existing pipe.

N Poudre Railroad Phase 2/N Poudre 1st St: The average capacity in these sections of pipe is approximately 17-21 mgd. However, the peak wet weather inflow is approximately 38 mgd. This increase is due to the development assumptions for the Tier 2 areas within the Sheep Draw and Poudre River flow basins.

Recommended Improvements: Replace or parallel the existing pipe.

Poudre West F St (59th Ave to 35th Avenue): The average capacity in this section of pipe is approximately 22 mgd. However, the peak wet weather inflow is approximately 31 mgd, which results in a predicted sanitary sewer overflow at MH 08-00.058. The deficiency is a result of development expected in the 83rd Ave/Highway 34, Interchange 34 West, and 20th Street North Tier 2 growth areas.

Recommended Improvements: Replace or parallel the existing pipe.

Sheep Draw – Sheep Draw Trail: The average capacity in this section of pipe is approximately 15 mgd. However, the peak wet weather inflow is approximately 23.3 mgd. The deficiency is a result of development expected in the 83rd Ave/Highway 34, Interchange 34 West, and 20th Street North Tier 2 growth areas.

Recommended Improvements: Replace or parallel the existing pipe.

Sheep Draw – 63rd Ave: The average capacity in this section of pipe is approximately 17 mgd. However, the peak wet weather inflow is approximately 22.5 mgd. The deficiency is a result of development expected in the 83rd Ave/Highway 34, Interchange 34 West, and 20th Street North Tier 2 growth areas.

Recommended Improvements: Replace or parallel the existing pipe.

Sheep Draw – US 34 to 10th St: The average capacity in this section of pipe is approximately 10 mgd. However, the peak wet weather inflow is approximately 13-21 mgd. It should be noted that the wide range in peak flows are due to the large number of trunk lines that connect to this section of pipe, with the peak flow of 13 mgd near the upstream portion and a peak flow of 21 mgd at the downstream portion. The deficiency is a result of development expected in the 83rd Ave/Highway 34, Interchange 34 West, and 20th Street North Tier 2 growth areas.

Recommended Improvements: Replace or parallel existing 18-24" gravity sewer.

Sheep Draw – South of US 34: Two short segments of gravity sewer are predicted to surcharge within 5 feet of manhole rims during the design storm. The deficiency is a result of development expected in the Interchange 34 West growth area.

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Recommended Improvements: Replace or parallel the existing 15" and 21" gravity sewer.

North Greeley Sewer Phase 2A: The North Greeley Sewer Phase 2A project is projected to surcharge during buildout wet weather conditions. However, surcharging is only predicted to flow within 9 feet of existing manhole rims. It is unlikely that surcharging within this trunk line will cause flooding in connected services. Because this project is already under construction and appears to be adequately sized for the 2040 planning horizon, no further improvements are recommended for buildout conditions. Instead, the area should be revisited as development occurs to confirm adequate capacity remains.

Recommended Improvements: No recommended improvements.

Table 5-9 Buildout Gravity Sewer Projects – Existing System

Project Name	Length	Existing Diameter	Future Diameter[1]	Parallel Diameter[2]	Upstream MH	Downstream MH
Balsam 16th Street to 12th Street	2,927	21"	27"	18"	13-00.014	13-00.007
	2,050	24"	27"	15"	13-00.007	13-00.001
N Poudre Railroad Phase 2	6,852	36"	48"	42"	08-00.047	08-00.028
N Poudre 1st St	2,850	36"	48"	42"	08-00.028	08-00.019
Poudre West F St (59th Ave to 35th Ave)	9,006	36"	48"	27"	08-00.171	08-00.056
Sheep Draw – Sheep Draw Trail	2,108	30"	36"	24"	08-00.089	08-00.084
Sheep Draw – 63rd Ave	1,832	27"	36"	24"	08-00.100	08-00.095
Sheep Draw – US 34 to 10th St	309	18"	30"	24"	08-00.174	08-00.136
	6,598	21"	36"	24"	08-00.136	08-00.120
	4,778	24"	36"	21"	08-00.120	08-00.110
	2,920	24"	36"	36"	08-00.110	08-00.103
Sheep Draw – South of US 34	401	15"	21"	8"	08-33.024	08-33.023
	777	21"	24"	12"	08-33.017	08-33.015

[1] Assumes the existing is replaced at the future diameter at the existing slope.

[2] Assumes the existing line remains in service.

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Section 6

Capital Improvement Plan

6.1 Approach to CIP Development

The identified capital improvements discussed in Sections 4 and 5 were developed with consideration of the City's current and long-range population and projected flows while using currently available information. Conditions will change with time and potential uncertainties will impact the accuracy of each plan in later years. It is important that the City re-evaluates each CIP to better reflect costs as the projects become closer to implementation.

This section provides planning level cost estimates for capital improvements project scheduling. Major capital elements are itemized with unit prices based on the information from past projects and outside resources (both locally and nationwide) for the major capital categories. Project CIPs were developed using modeled pipeline quantity estimates and data. GIS mapping was used to help identify areas of interest, such as utilities and road crossings. The unit prices were then multiplied by the quantity of each element. Project elements that were difficult to estimate during the planning stage are included in the overall cost as either allowances or as a percentage of the total for the itemized project elements. During design development, the more specific data will be used to inform the design and resulting project cost estimate.

Unit priced line items and contractor cost elements were rounded to the nearest whole dollar. Project contingency was rounded to the nearest $10 and then added to the OPCC subtotals, which was then rounded up to the nearest $10,000. Subsequent costing factors were added to the OPCC project totals to determine the CIP estimates used during high-level planning. This approach was also used in the water and non-potable water master plans.

Planning level cost development considers the major categories of capital projects because the detailed field and design information is not available to allow for a more detailed and itemized cost estimate. This information is typically developed during the design and is used similar to that developed during preliminary and final design. Increasing the number of cost elements (and complexity of the estimate) does not increase the project cost accuracy as many of these elements are unknown during the planning phase. Each layer of assumption used to develop more line items adds more uncertainty.

This CIP has been developed based on anticipated growth, modeling results, and planning information. The CIP is subject to change if the planning information and forecasts differ from those used to develop the CIP.

6.2 Cost Development

Unit costs were developed for use in project cost development as described below and in **Appendix D**. Cost estimating is considered Association for the Advancement of Cost Estimating (AACE) Class 5 – Conceptual engineering phase.

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6.2.1 Project Implementation and Additional Project-Related Costs

Project elements considered part of project implementation are difficult to quantify at the planning level. Construction elements include items such as erosion control/stormwater pollution prevention and contractor mobilization and demobilization. These costs are estimated as a percentage of the subtotal for pipe, manholes, and equipment. Contingency is applied to the subtotal of these construction cost elements to account for variations in unit prices or quantity estimates. Programmatic elements include engineering, permitting, legal and administration and are estimated as a percentage of the construction cost. **Table 6-1** provides a breakdown of the different assumptions used for project implementation and contingency.

Table 6-1 Costing Factors for Construction Bid and Total CIP Project Costs

Category	Item	Costing Factor
Construction Bid Cost (includes infrastructure and contractor overhead, profit, bonds, and insurance)	Erosion Control/Stormwater Pollution Prevention[1]	2%
	Mobilization and Demobilization[1]	5%
	Contingency[2]	35%
Project Implementation[3]	Feasibility and Site Studies	9% for OPCC ≤ $1M 6% for OPCC of $1M to $10M 5% for OPCC > $10M
	Preliminary and Final Design	9% for OPCC ≤ $1M 6% for OPCC of $1M to $10M 5% for OPCC > $10M
	Engineering Services During Construction	5%
Additional Project-Related Costs[3]	Outside Construction Management	5%
	Outside Project Management	3%

[1] Construction costing factors for erosion control/stormwater pollution prevention, mobilization and demobilization are added to the subtotal of unit cost items.

[2] Contingency is 35% of the subtotal of the unit cost items and contractor born costs determined by costing factors.

[3] Project Implementation and Additional Project-Related Cost categories are determined as a percentage of the construction cost and part of the total CIP project costs.

6.2.1.1 Project Erosion Control/Stormwater Pollution Prevention

Project erosion control and stormwater pollution prevention includes the contractors cost to manage the stormwater during construction through best management practices. Best management practices include items such as silt fences, rock socks, vehicle tracking, and silt prevention at storm inlets. This category is assumed as 2% of the OPCC subtotal of the items that have unit costs and is based on estimator's judgement and prior reports. This costing factor is added to calculate project OPCC totals.

6.2.1.2 Mobilization and Demobilization

Contractor mobilization and demobilization includes the contractor's start-up and close-out costs. Start-up costs include items such as moving equipment and personnel to the project location, obtaining permits and bonds, etc. Close-out costs include such items as project cleanup, moving equipment and personnel from the project location, etc. The mobilization and demobilization category is assumed as 5% of the OPCC subtotal of the items that have unit costs and is based on

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estimator's judgement and prior reports. This costing factor is added to calculate project OPCC totals.

6.2.1.3 Contingency

During the planning phase, the field work and design have not been completed for the CIPs and therefore the cost development relies on estimated quantities and unit prices for each construction element. Project contingency provides for these uncertainties by adding additional costs to the project total. The contingency at the planning level is typically 35% of the OPCC subtotal after erosion control/stormwater pollution prevention and mobilization and demobilization factors have been included. Project contingency also provides for the costs associated with items that are difficult to itemize at the planning level.

6.2.1.4 Feasibility and Site Studies

This cost element includes the planning and field investigations (geotechnical, survey, ground sampling, subsurface utility engineering (SUE) and locates, etc.) required to implement a project and is estimated as a percentage of the subtotal of the previous elements. The percentage varies based on the OPCC.

6.2.1.5 Preliminary and Final Design

The preliminary and final design cost element includes the cost for engineering services to develop biddable plans and specifications in accordance with applicable standards. This cost is estimated using a percentage of the OPCC.

6.2.1.6 Engineering Service During Construction

Engineering services during construction include review of contractor submittals, requested changes, and design adjustments that may be required during construction. A flat percentage of the OPCC is used to estimate this cost element.

6.2.1.7 Additional Project Related Costs

Outside Construction and Project Management are estimated for projects that are not directly managed by the City. For purposes of this master plan, only projects in excess of $1M were assigned these cost elements.

6.3 Identified CIP Projects

The projects included in the 5-year and 20-year CIPs are defined in Sections 4 and 5 and shown in **Figure 6-1.** Construction and total project costs were developed for the CIP projects for the five-year (2021 through 2025) and 20-year (2026 through 2040) planning horizons and are described in the following subsections.

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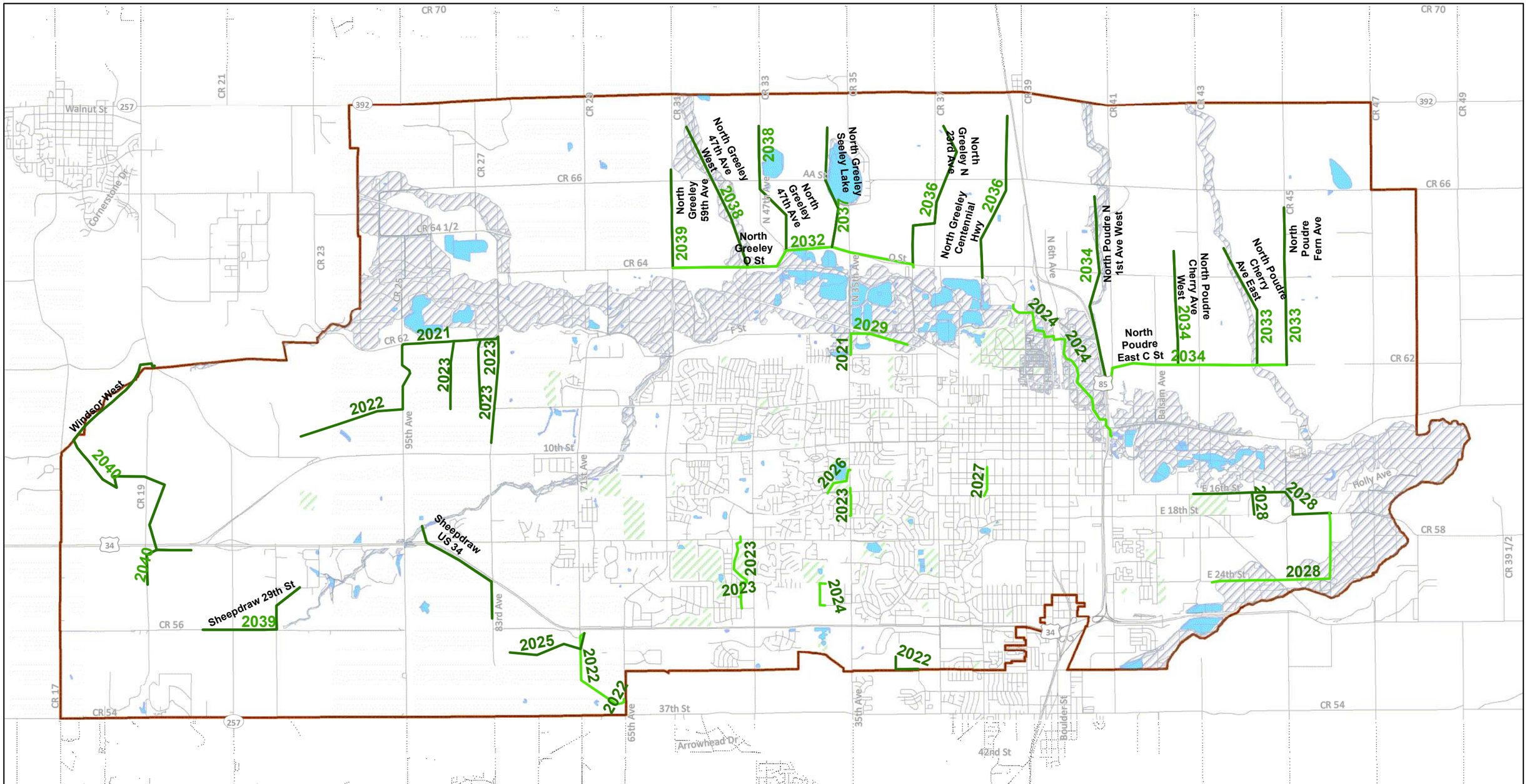

Legend

- LREGA
- Flood Zone
- Lake
- Park
- Sewer 5 Year CIP
- Sewer 20 Year CIP

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CIP PROJECTS

Figure 6-1

Greeley Sewer System Master Plan

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6.3.1 5-Year CIPs

The 5-year CIP includes deficiency driven projects and growth driven projects as summarized below and shown in **Figure 6-2**. Additional details are provided in **Appendix D**. The deficiency driven projects assume pipe removal and replacement; however, during design development, pipe parallel may be considered. The growth driven projects will be funded by either the City or developer (or a combination of the two) depending on the project driver.

- Highland Hills 47th Avenue Flow Diversion Alternative. This project is driven by the lack of capacity downstream of LS18 along 47th Avenue. During dry weather flow, surcharging is predicted within 5 feet of manhole rims. During WWF, with two pumps operating at LS18, an overflow is predicted at MH 09-19.026. The City has not observed any capacity deficiencies within this section of gravity sewer in the field. Therefore, it is recommended the City monitor this area during a high intensity wet weather event before proceeding with design.

- Highland Hills 25th Street Flow Diversion Alternative. This project is driven by a wet weather capacity deficiency where a 10" gravity sewer discharges into an 8" gravity sewer. An overflow is predicted during the 5-year design storm. After discussions with the City, it was determined that this project may be addressed through coordination with a developer of the property West of 38th Avenue. Due to the overflow predicted by the hydraulic model, alleviating the capacity deficiency along 25th Street is critical to the CIP.

- Highland Hills 35th Avenue (C Street to F Street). This project is currently under design by the City and planned to be constructed in the spring of 2021. As the project is already funded, it is included in the 5-year planning horizon but not included in the CIP estimate.

- Highland Hills Bittersweet Park. This project is driven by a wet weather capacity deficiency where a 12" gravity sewer discharges into a 10" gravity sewer. No overflows are predicted during the 5-year design storm, but surcharging is predicted within 4 feet of manhole rims.

- Highland Hills 35th Avenue (19th Street Road to 17th Street). This project is driven by the lack of capacity downstream of LS13 along 35th Avenue. During WWF, surcharging is predicted within 4 feet of manhole rims. This capacity deficiency has been temporarily reduced by the installation of a VFD at LS13. When the pumps at LS13 are operated near full capacity, the downstream surcharging issues are predicted to return.

  LS9 Flow Diversion Project/East Greeley Lift Station/Balsam East. These projects are driven by two factors, growth within the surrounding area, and capacities deficiencies along Balsam Avenue downstream of LS9. During 2 pump operation at LS9, surcharging along Balsam Ave near 22nd Street is predicted to be within 3 feet of manhole rims. These projects when constructed, eliminate this capacity deficiency. The City has not observed capacity deficiencies immediately downstream of LS9. However, due to the surcharge levels predicted, it is recommended the City monitor the pipes downstream of LS9 during high intensity wet weather events. <u>This project timing may be shifted to the 20-year CIP if observed conditions do not match modeled surcharging. The project timing should be adjusted based on actual flow observations or studies in coordination with other projects in the area.</u>

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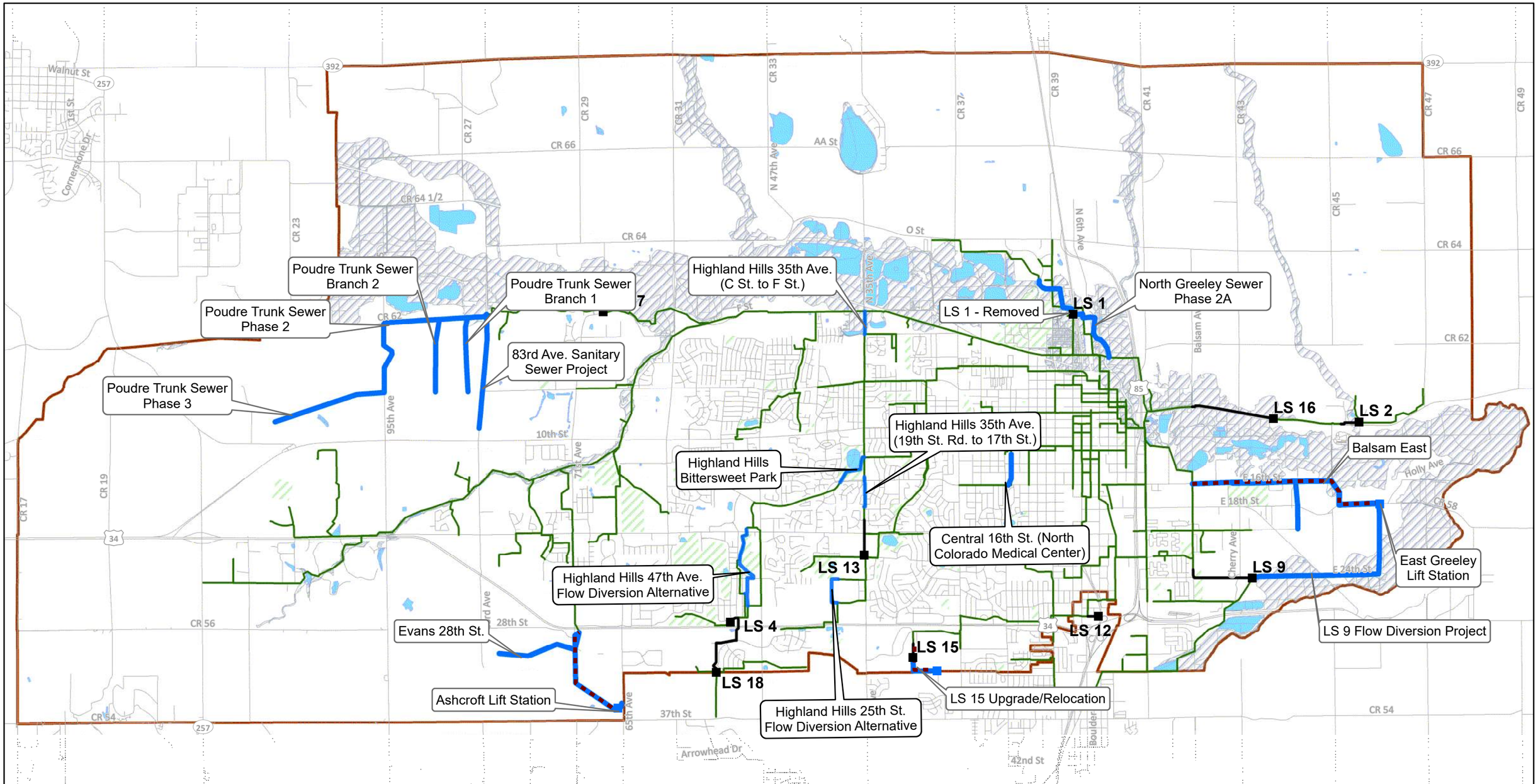

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Legend

- LREGA
- 100-yr Floodplain
- Lakes and Ponds
- Park
- Existing Lift Stations
- Existing Interceptors
- Existing Force Mains
- 5 Year LS Recommendations
- 5 Year Pipe Recommendations
- 5 Year Force Main Recommendations

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Recommended 5 Year Improvements

Figure 6-2

Greeley Sewer System Master Plan

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- LS15 Upgrade and Relocation - This project is driven purely by additional development within the LS15 service area. The existing lift station is nearing the end of its expected useful life and in its current location will not be able to provide service to the entire service area. It is recommended the City work with the developers in the area to relocate and construct a new LS15.

Table 6-2 provides cost information for the 5-year projects and notes the project driver and party likely responsible for funding each project.

Table 6-2 5-Year Planning Horizon Project Costs and Drivers

Project	Project Driver	Responsible Party	OPCC[1] ($M)	Total Cost[2] ($M)
City CIP Projects				
Highland Hills 47th Ave. Flow Diversion Alternative	Deficiency	City	$1.4	$1.8
Highland Hills 35th Ave. C. St. to F St.[3]	Deficiency	City	N/A	N/A
Highland Hills 25th St. Flow Diversion Alternative	Deficiency	City	$0.5	$0.7
Highland Hills Bittersweet Park	Deficiency	City	$0.9	$1.1
Highland Hills 35th Ave. (19th St. Rd. to 17th St.	Deficiency	City	$0.8	$1.0
Central 16th St. (North Colorado Medical Center)	Deficiency	City	$0.7	$0.9
North Greeley Sewer Phase 2A[3]	Growth	City	N/A	N/A
Ashcroft LS[3]	Growth	City	N/A	N/A
LS 9 Flow Diversion Project[4]	Growth	City	Costs are included in the 20-year planning horizon	
Development Driven Projects				
Balsam East	Growth driven development projects. Current model-predicted conditions are not observed so projects timing should be evaluated.		$5.1	Not used for development drive projects
East Greeley LS			$7.4	
LS 15 Upgrade/Relocation	Growth	Development	$1.2	
Evans 28th St.	Growth	Development	$1.9	
83rd Ave. Sanitary Sewer Project	Growth	Development	$2.3	
Poudre Trunk Phase 2	Growth	Development	$6.2	
Poudre Trunk Sewer Branch 1	Growth	Development	$0.9	
Poudre Trunk Sewer Branch 2	Growth	Development	$1.2	
Poudre Trunk Sewer Phase 3	Growth	Development	$1.7	

[1] The OPCC represents the opinion of construction cost only.

[2] Total costs include the OPCC, land, project implementation and additional project related costs (Appendix D).

[3] This project is already funded and not included in the total CIP costs.

[4] This CIP has been identified through modeling but the City has not observed the capacity limitations indicated by the model. Additional investigation is recommended to confirm the need for this project. The project is listed in the 5-year planning horizon for additional investigation and the costs are included in the 20-year planning horizon.

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6.3.2 20-Year Planning Horizon Projects

The 20-year projects include deficiency driven projects and growth driven projects as summarized below. **Figure 6-3** is a visual representation of the recommended 20-year improvements. Additional details are provided in **Appendix D**. The deficiency driven projects assume pipe removal and replacement; however, during design development, pipe parallel may be considered. The growth driven projects will be funded by either the City or developer (or a combination of the two) depending on the project driver.

- North Poudre Railroad Phase 1. This project is driven by two factors, growth within the upstream Poudre and Sheep Draw trunk lines, and low slope within the existing sewer. The flow projections that resulted in this section of pipe being flagged as deficient are conservative, therefore it is recommended the analysis of this pipe section be re-visited before beginning design.
- Remaining 20-year Projects. The remainder of the 20-year projects are development driven and should be implemented and funded on a case-by-case basis.

Table 6-3 provides cost information for the 5-year projects and notes the project driver and party likely responsible for funding each project.

Table 6-3 20-Year Planning Horizon Project Costs and Drivers

Project	Project Driver	Responsible Party	OPCC[1] ($M)	Total Cost ($M)
City CIP Projects				
LS 9 Flow Diversion Project[3]	Growth	City	$6.4	$8.3
North Poudre Railroad Phase 1	Deficiency	City	$5.7	$7.4
North Greeley Sewer Phase 2B	Deficiency	City	$5.5	$7.2
North Poudre East C Street	Growth	City	$17.1	$21.9
North Greeley O Street	Growth	City	$12.2	$15.6
Development Driven Projects				
North Poudre Fern Avenue	Growth	Development	$3.8	Not used for development driven projects
North Poudre Cherry Avenue East	Growth	Development	$4.1	
North Poudre Cherry Avenue West	Growth	Development	$2.4	
North Poudre North 1st Avenue West	Growth	Development	$6.5	
North Greeley Centennial Highway	Growth	Development	$4.3	
North Greeley North 23rd Avenue	Growth	Development	$4.0	
North Greeley Seeley Lake	Growth	Development	$3.2	
North Greeley 47th Avenue	Growth	Development	$2.6	
North Greeley 47th Avenue West	Growth	Development	$2.9	
North Greeley 59th Avenue	Growth	Development	$2.1	
Sheep Draw 29th Street	Growth	Development	$2.6	
Sheep Draw US 34	Growth	Development	$2.5	
Windsor West	Growth	Development	$7.5	

[1] The OPCC represents the opinion of construction cost only.
[2] Total costs include the CIP OPCC, land, project implementation and additional project related costs (Appendix D).
[3] Cost deferred to 20-year planning horizon pending confirmation of project need.

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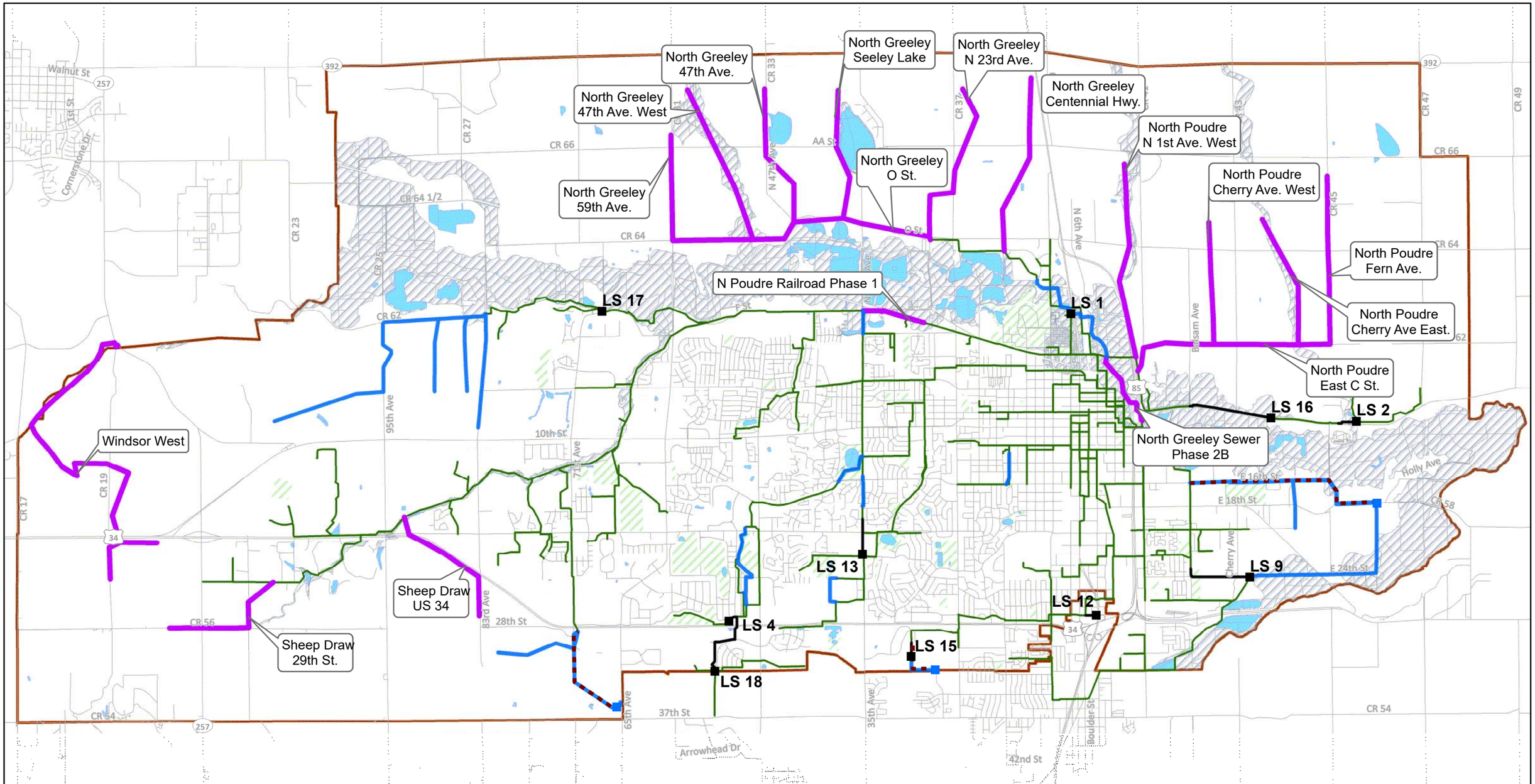

Legend

- LREGA
- 100-yr Floodplain
- Lakes and Ponds
- Park
- Existing Lift Stations
- Existing Interceptors
- Existing Force Mains
- 5 Year LS Recommendations
- 5 Year Pipe Recommendations
- 20 Year Pipe Recommendations
- 5 Year Force Main Recommendations

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Recommended 20 Year Improvements

Figure 6-3

Greeley Sewer System Master Plan

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6.4 CIP Implementation Schedule

The CIP Planning Tool was used to develop a schedule with consideration of overall costs. Preliminary project planning, design, and construction start dates are included in the tool but are subject to change depending on impacts from other projects that were identified in the water and non-potable water master plans. For projects with a total cost over $1M, planning and design were assumed to have a duration of 1 year and construction was assumed to have a duration of 2 years. Projects identified within the 5- and 20-year improvements based on hydraulic evaluations were given projected planning, design, and construction start years. It was assumed that each stage (planning, design, and construction) will take at least 1 year with the construction phase spread out over 2, 3, or 4 years if the total CIP cost for a project was greater than $1 million, $5 million, or $10 million, respectively. For scheduling purposes, 5-year improvements were identified from 2022 through 2027 (start of construction year) while 20-year improvements were identified from 2028 through 2048 (construction start year). Projects will be referred to as 5- and 20-year projects in this section.

Table 6-4 shows the anticipated project schedule along with the total costs for the 5-year and 20-year planning horizons. **Figure 6-4** provides the cumulative cost from planning through construction for the City CIP projects only. Project schedules were confirmed so that financial requirements do not exceed $10M in any given year. Additional annual financial details are provided at the end of **Appendix D**.

Table 6-4 Project Schedule and Cost Summary

Projects	Project Driver	Funding Source	Planning Start Year	Design Start Year	Construction Start Year[1]	OPCC ($M)	Total Cost ($M)
5-year Planning Horizon							
Highland Hills 35th Ave C St. to F St.	Deficiency	City			2021	N/A	N/A
Ashcroft Lift Station	Growth	City			2022	N/A	N/A
Highland Hills 47th Ave Flow Diversion	Deficiency	City		2022	2023	$1.39	$1.81
Highland Hills 35th Ave 19th St. to 17th St.	Deficiency	City		2022	2023	$0.82	$1.01
Highland Hills 25th St Flow Diversion	Deficiency	City	2022	2023	2024	$0.51	$0.66
North Greeley Sewer Phase 2A	Growth	City	2022	2023	2024	$5.5	$5.8
Highland Hills Bittersweet Park	Deficiency	City	2024	2025	2026	$0.84	$1.08
Central 16th Street	Deficiency	City	2025	2026	2027	$0.71	$0.91
Lift Station 9	Growth	City	Moved to 20 year				
20-year Planning Horizon							
Lift Station 9	Growth	City	TBD/2026	TBD/2027	TBD/2028	$6.4	$8.3
N. Poudre RR Phase 1	Deficiency	City	2026	2027	2029	$5.7	$7.4
North Greeley Sewer Phase 2B	Deficiency	City			2029	$5.5	$7.2
North Greeley O St.	Growth	City	2028	2030	2032	$12.2	$15.6
North Poudre East C St.	Growth	City	2030	2032	2034	$17.2	$21.9

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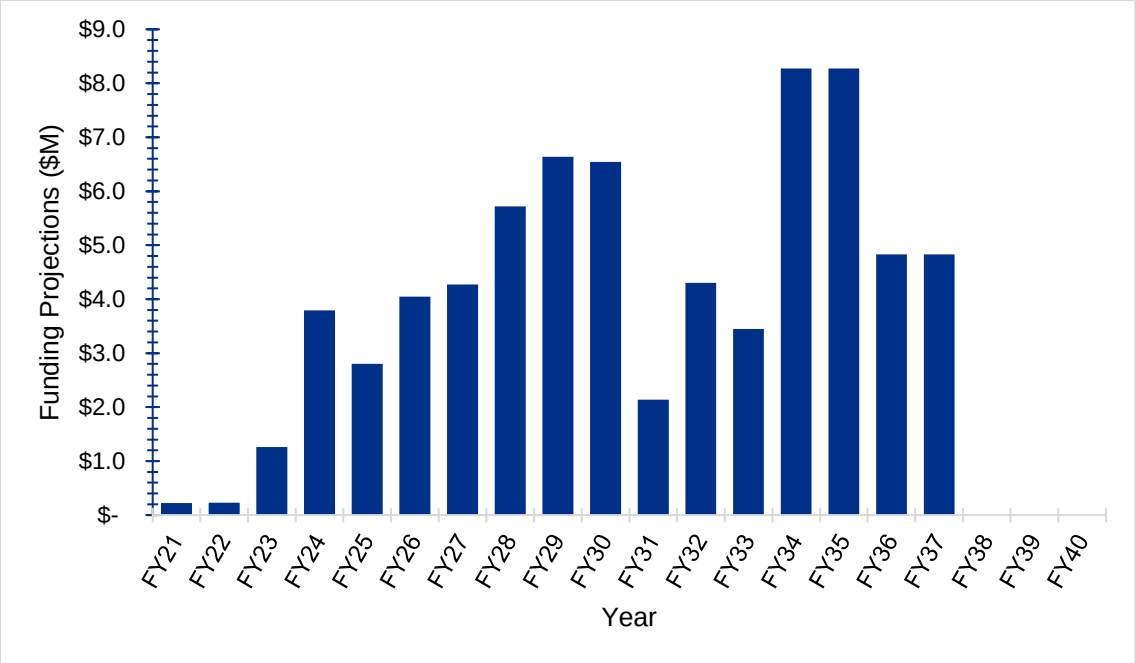

Figure 6-4 Annual Sewer Funding Projections for City CIP Projects

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Section 7

References

Additional information sources are listed in Section 2 of this report. Various design projects (plan drawings) were provided and are references in Section 6.

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Appendix A

Flow Meter Diurnal Patterns (BWF)

For each flow meter, SSOAP develops an average diurnal flow pattern for DWF by averaging the flows at each hour in a dry-weather day. These patterns were then adjusted specifically for BWF by subtracting the estimated GWI. The BWF flow pattern for each meter was then normalized by dividing the flow in each hour by the overall daily average BWF. These normalized patterns will be used in the model. They also provide a peaking factor, which is the maximum daily BWF divided by the average BWF for each basin. This is done for temporary and permanent meters.

Figures A-1, A-2, A-3, A-4, A-5, and A-6 compare the weekday and weekend diurnal patterns developed for each metered area for the dominant uses of residential, mixed and commercial, respectively. The patterns shown in **Figure A-1** and **Figure A-2** are typical of residential use, which peaks in the morning and the evening. These peaks diminish with larger area due to sewer system attenuation. **Figure A-3** and **Figure A-4** present the diurnal pattern for mixed use areas, while **Figure A-5** and **Figure A-6** present patterns showing a typical plateau of water use in predominately nonresidential areas from 8 AM to 8 PM.

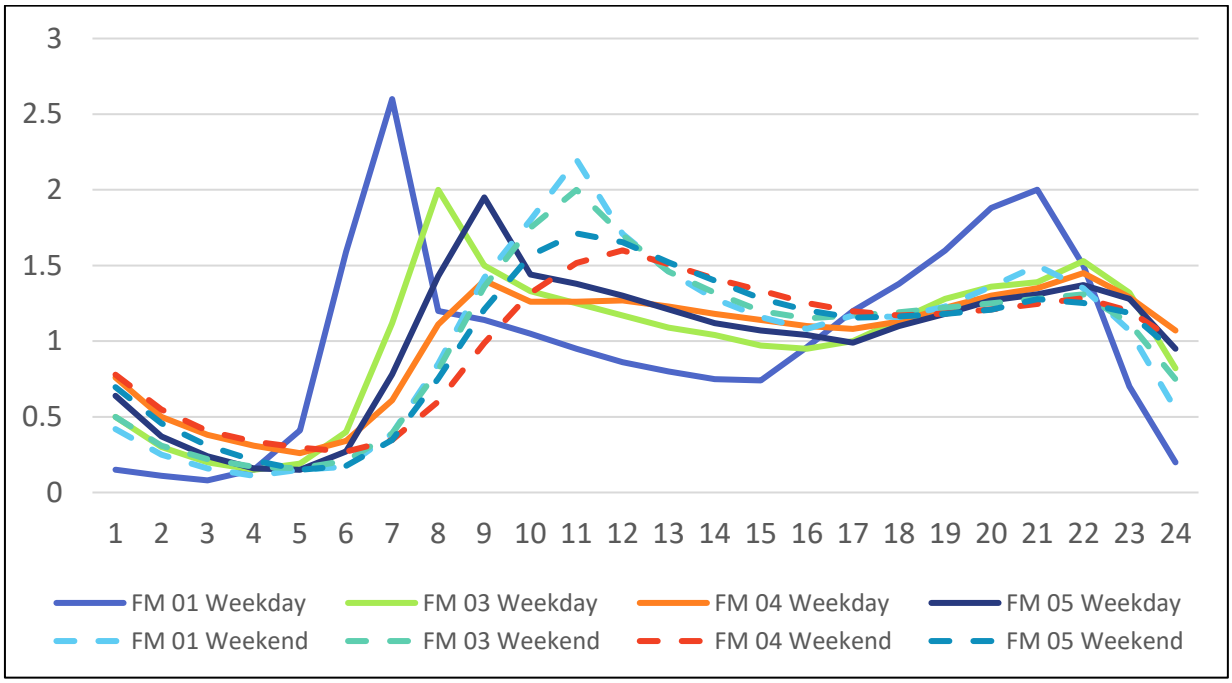

Figure A-1 Temporary Meter Diurnal Patterns of BWF (Residential)

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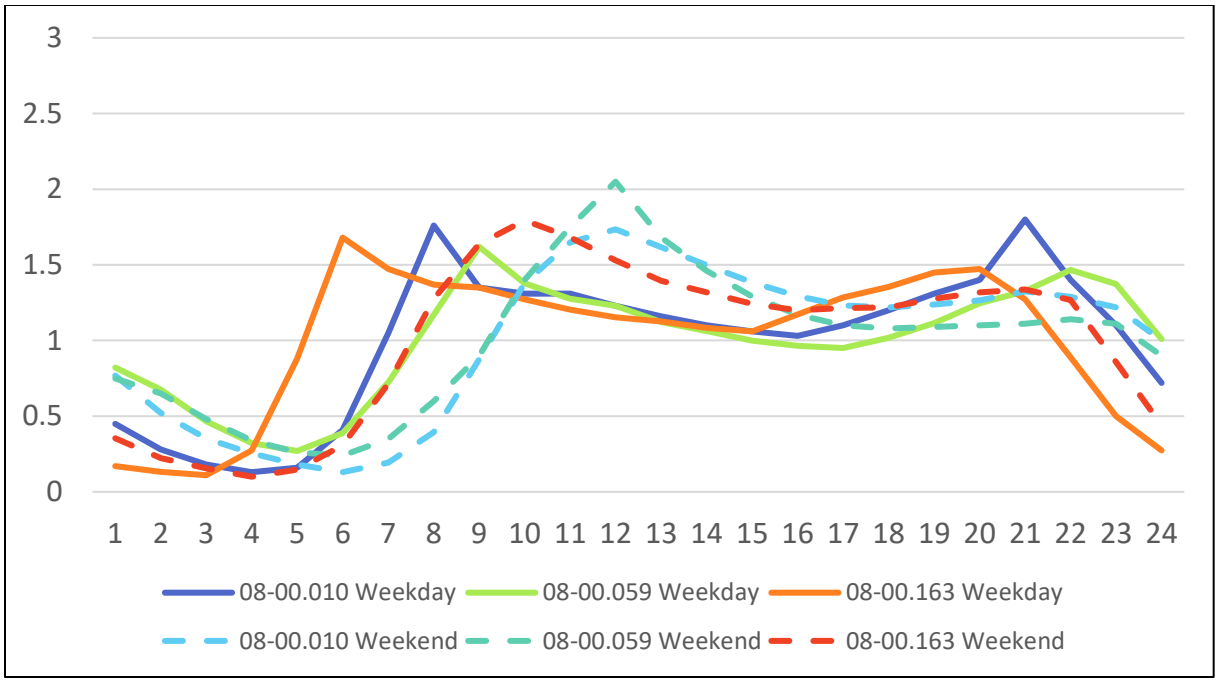

Figure A-2 Permanent Meter Diurnal Patterns of BWF (Residential)

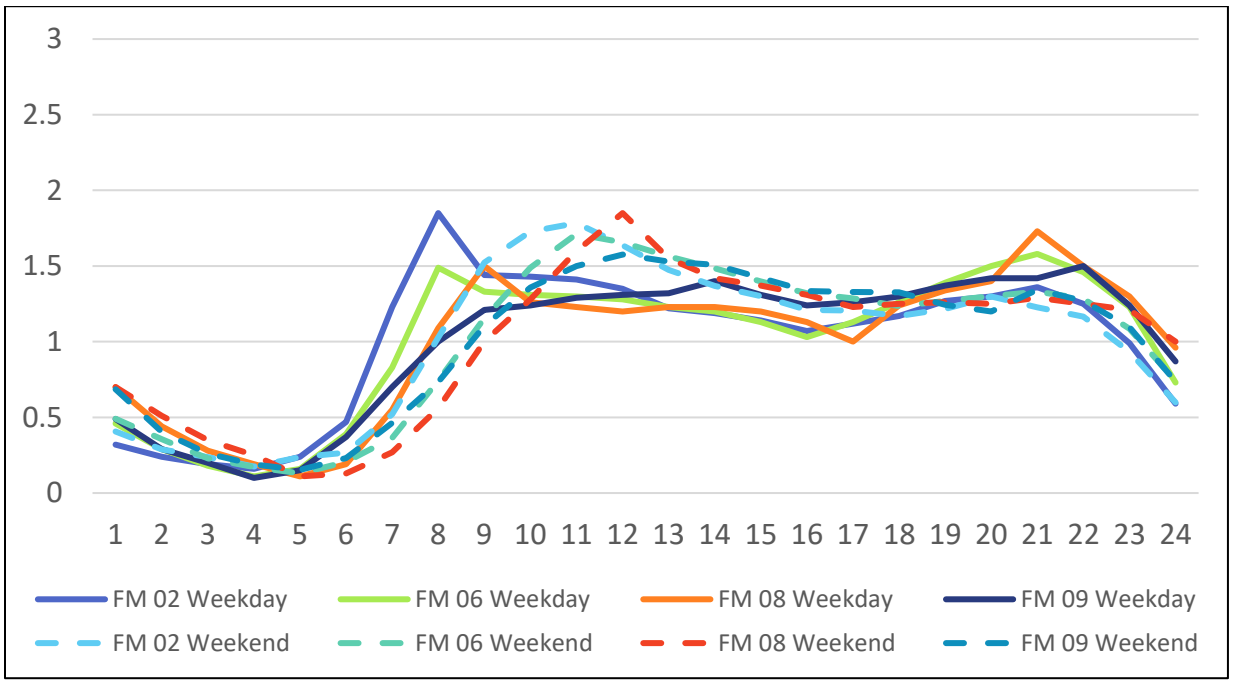

Figure A-3 Temporary Meter Diurnal Patterns of BWF (Mixed Use)

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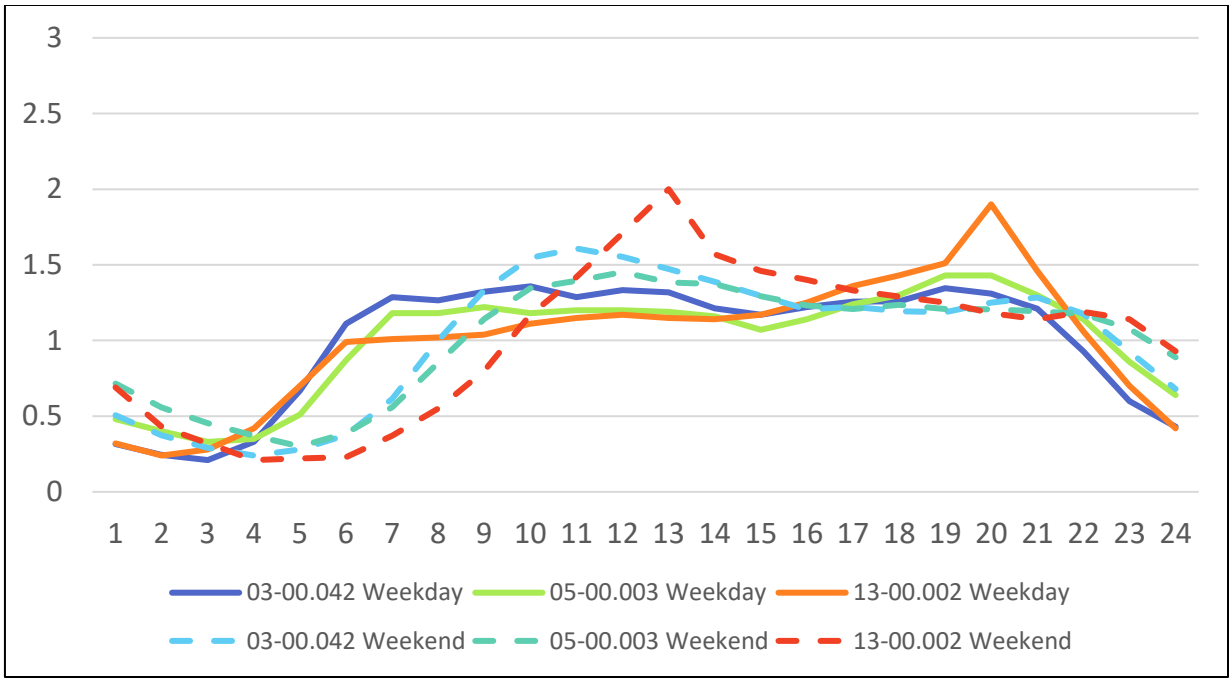

Figure A-4 Permanent Meter Diurnal Patterns of BWF (Mixed Use)

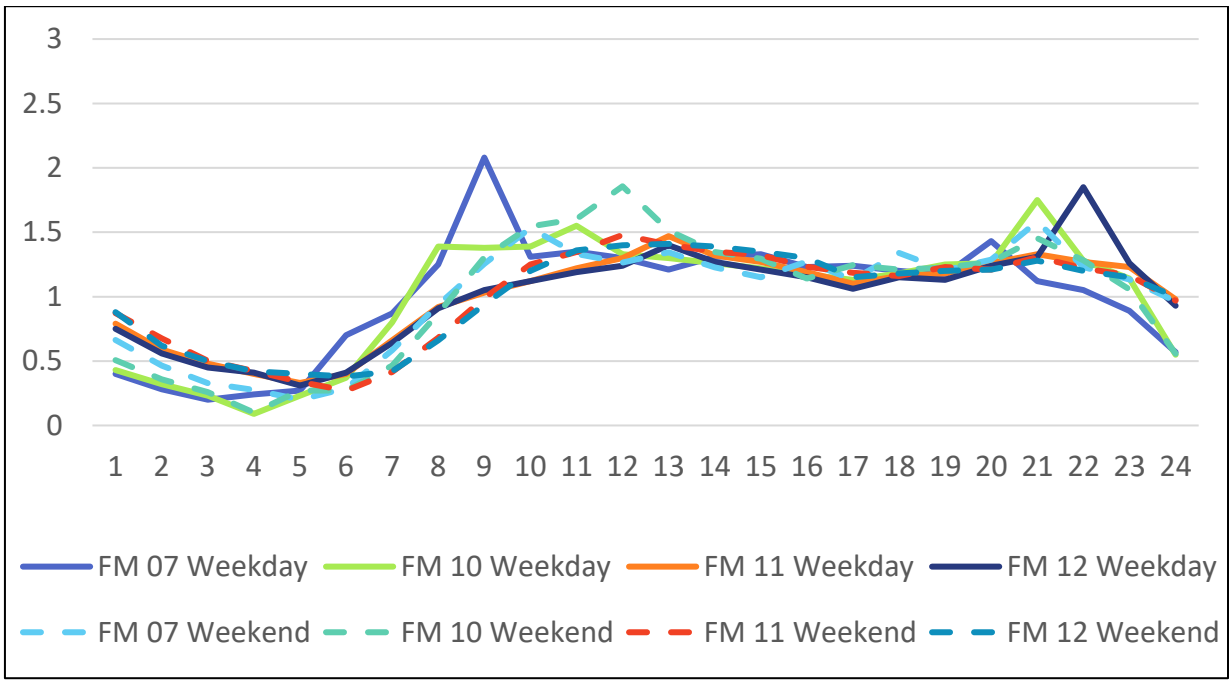

Figure A-5 Temporary Meter Diurnal Patterns of BWF (Commercial/Industrial)

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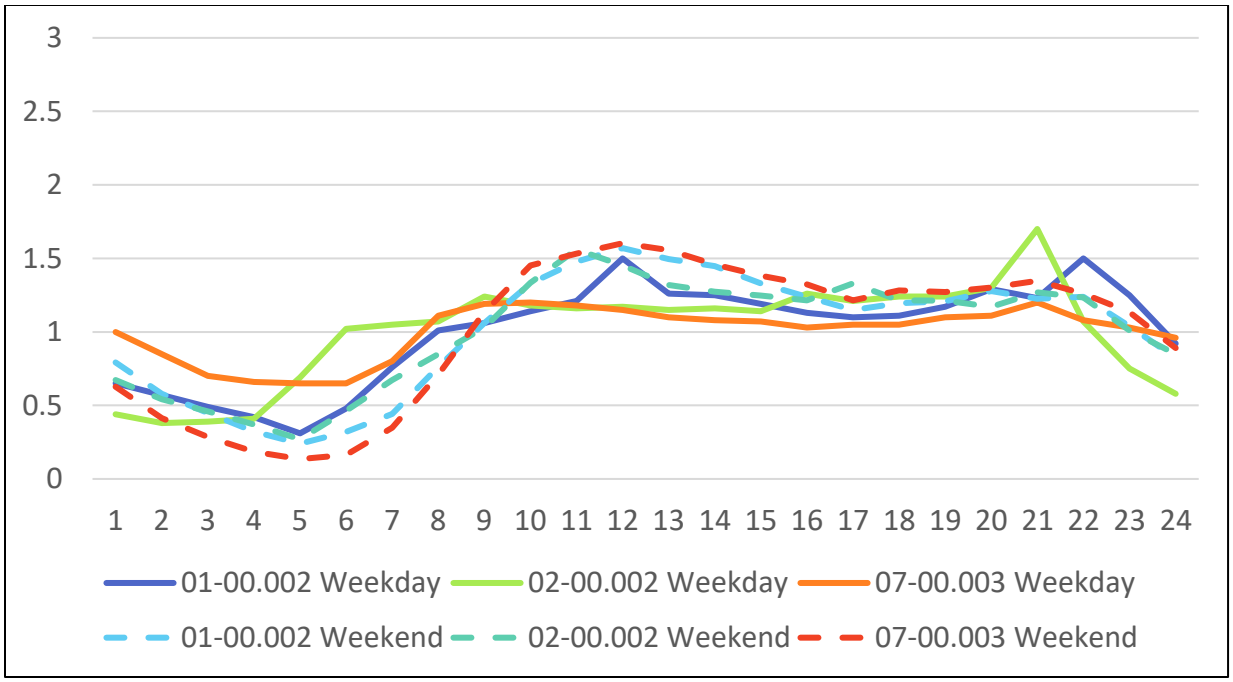

Figure A-6 Permanent Meter Diurnal Patterns of BWF (Commercial/Industrial)

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Appendix B

Calibration Statistics for Wet Weather

The calibration statistics for wet weather volume, peak flow, and peak depth are shown in **Figure B-1** through **Figure B-9**, for all flow meters for each storm event. Each flow meter's observed versus modeled values are plotted against the upper and lower CIWEM calibration criteria. Points above or below the calibration lines would be considered outside the criteria limits, while points within the criteria lines are considered calibrated. Meters that are outside the criteria limits for two or more rainfall event are labeled in the figures as these did not meet the overall criterion of calibration to two of the three events. Calibration plots for the separate meters are provided at the end of this section.

All flow meters were calibrated for volume and peak flow within the criteria limits except for FM 07 and 08-00.010. Although flow volume during all three wet weather events for FM 07 (Monfort Basin) was within the criteria limits, the peak flows during those events varied widely. The model versus observed peak flow values for the three storm events were +44%, -6%, and -31%. The variation may be due to GWI that was observed during flow metering that would vary based on antecedent moisture conditions. When reviewing this area for recommendations, the calibration plots and the peak WWF to dry weather flow factor will be reviewed when simulating a design storm to check if the peaks may be overstated compared to the rest of the system. If this is the case, further investigation may be recommended prior to implementing major improvement projects.

Peak flows for permanent meter 08-00.010 were within the acceptable criteria limits; however, flow volume during two of three events was slightly below the criteria limits (-13%, +2%, -13%). Due to a large overlap with other meters within this basin, no further calibration adjustments could be made to bring the volume within the criteria limits without sacrificing the calibration of other meters including permanent meter basins 08-00.059 and 08-00.163 and temporary basins 01, 02, 03, 04, 05, and 07. Total volume measured during the wet weather events for all upstream basins were within the acceptable criteria limits. Additionally, the peak flows for all upstream basins (excluding FM 07), were also within the acceptable limits.

During depth calibration of meter 05-00.003, the peak flow level for Event 3 was taken very slightly outside the peak flow criteria limits. In the interest of maintaining the depth calibration, no further adjustments were made to this basin.

All other flow meters besides FM 07, 08-00.010, and 05-00.003 were within the acceptable limits for volume and peak flow. Refer to **Table B-1** and **Table B-2** for the calibrated RTK parameters.

The depth calibration for the flow were all within range of the CIWEM criteria.

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Table B-1 Calibrated Temporary Meter Basin RTKs

Flow Metering Basin	Area (ac)	Fast Response			Medium Response			Slow Response			Total R (%)
		R1 (%)	T1 (hr)	K1	R2 (%)	T2 (hr)	K2	R3 (%)	T3 (hr)	K3	
FM01 Sheep Draw	372	0.2	1	1.5	0.1	3	1	0.1	7	3.5	0.4
FM02 Sheep Draw	686	0.1	2	2	0.2	5	5	0.2	10	9	0.5
FM03 Hilltop	1,042	0.1	1	1	0.2	3.5	2	0.3	6	7	0.6
FM04 Highland Hills	1,044	0.4	1	2	0.2	2.5	2.5	0.1	5	3	0.7
FM05 Highland Hills	1,422	0.2	1.5	2	0.3	5	3	0.4	10	5	0.9
FM06 Belair	911	0.2	1	1	0.1	3	3	0.1	6	5	0.4
FM07 Monfort	458	0.3	0.65	1	0.5	2	2	0.1	5	10	0.9
FM08 North	591	0.3	1	1.1	0.1	2.2	2	0.1	2.8	2.5	0.5
FM09 Eight Street	530	0.5	1	1	0.1	2.5	3	0.1	4	4	0.7
FM10 Central	654	0.3	1	1	0.1	2.1	1.8	0.1	2.6	2.2	0.5
FM11 South	302	0.2	1	1	0.1	2.9	1.9	0	4.3	3	0.3
FM12 South	923	0.1	0.7	1	0	1.5	2	0.1	2	3	0.2

Note: Areas shown correspond to areas where RTKs are applied. Due to overlapping basins, the RTK contributing areas will not equal the total basin areas.

Table B-2 Calibrated Permanent Meter Basin RTKs

Flow Metering Basin	Area (ac)	Fast Response			Medium Response			Slow Response			Total R (%)
		R1 (%)	T1 (hr)	K1	R2 (%)	T2 (hr)	K2	R3 (%)	T3 (hr)	K3	
01-00.002	200	0.4	0.5	1.7	0.1	3	2	0.1	5	3	0.6
02-00.002	630	0.2	1.25	1.25	0.1	3	3	0.1	7	6	0.4
03-00.042	686	0.2	1	1	0.2	3	2	0.2	5	3	0.6
05-00.003	223	0.1	2	2	0.1	5	3	0.1	10	5	0.3
07-00.003	220	0.1	2.5	2	0.1	5	3	0.1	10	7	0.3
08-00.010	176	0.2	2	1	0.2	5	2	0.2	10	3	0.6
13-00.002	1,004	0.5	1.5	1	0.4	5	2	0.2	10	3	1.1
08-00.059	956	0.4	2.5	2	0.5	5	3	0.6	10	5	1.5
08-00.163	755	0.1	1	1	0	3	2	0	5	3	0.1

Note: Areas shown correspond to areas where RTKs are applied. Due to overlapping basins, the RTK contributing areas will not equal the total basin areas.

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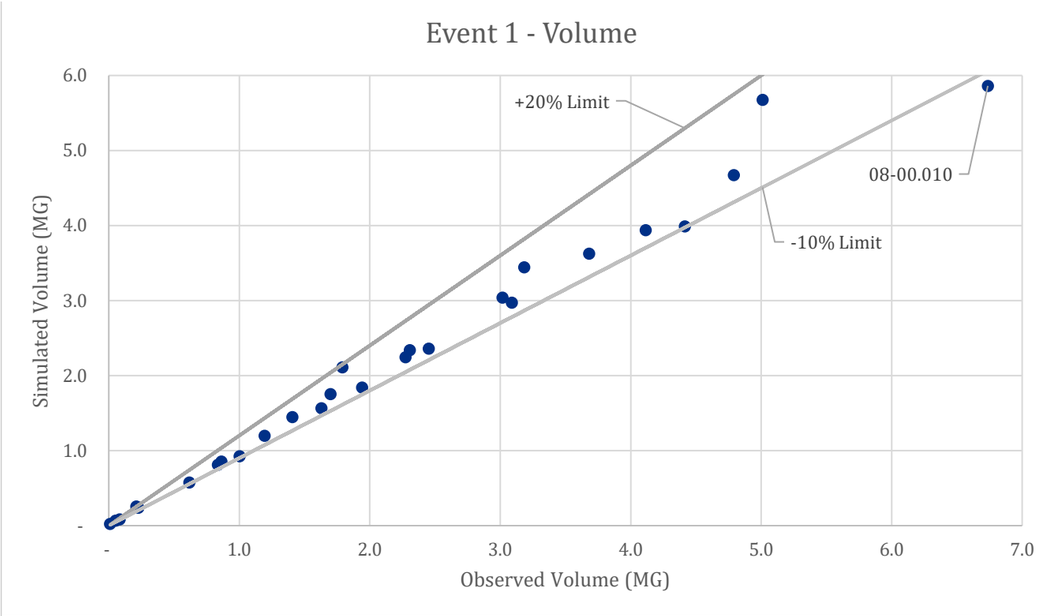

Figure B-1 Event 1 Volume

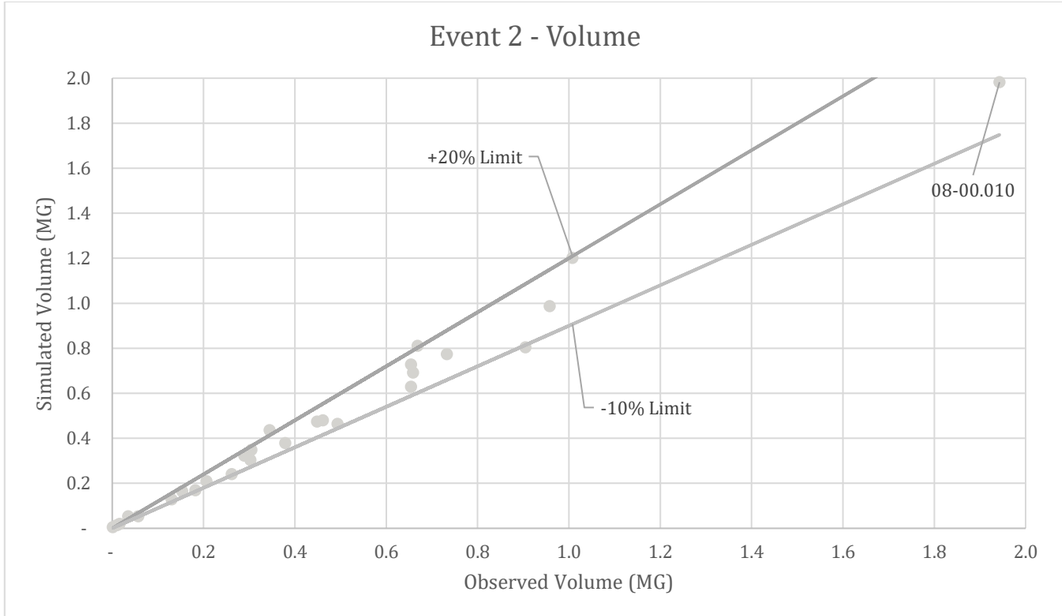

Figure B-2 Event 2 Volume

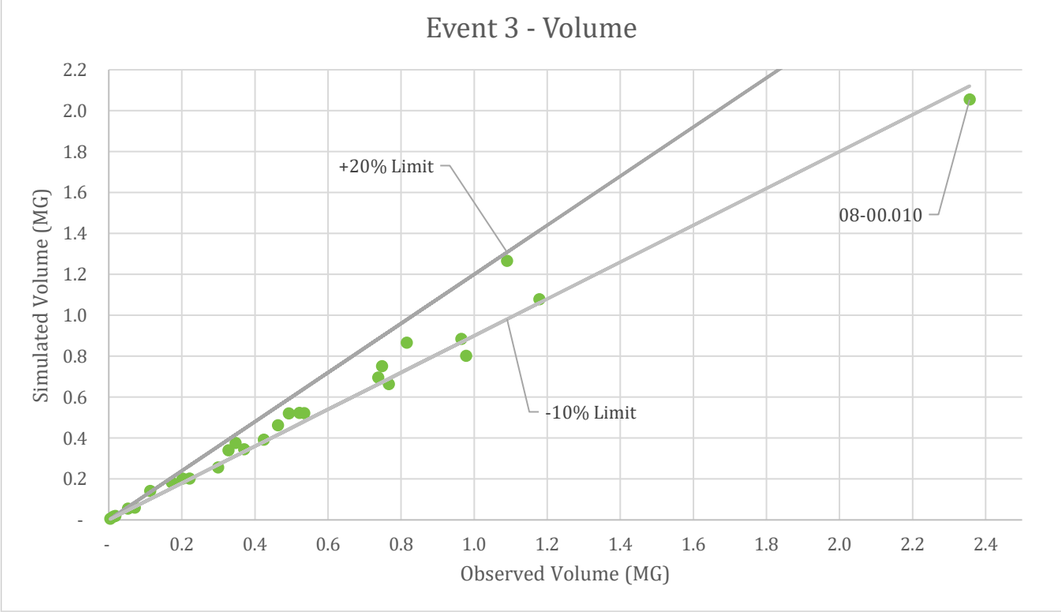

Figure B-3 Event 3 Volume

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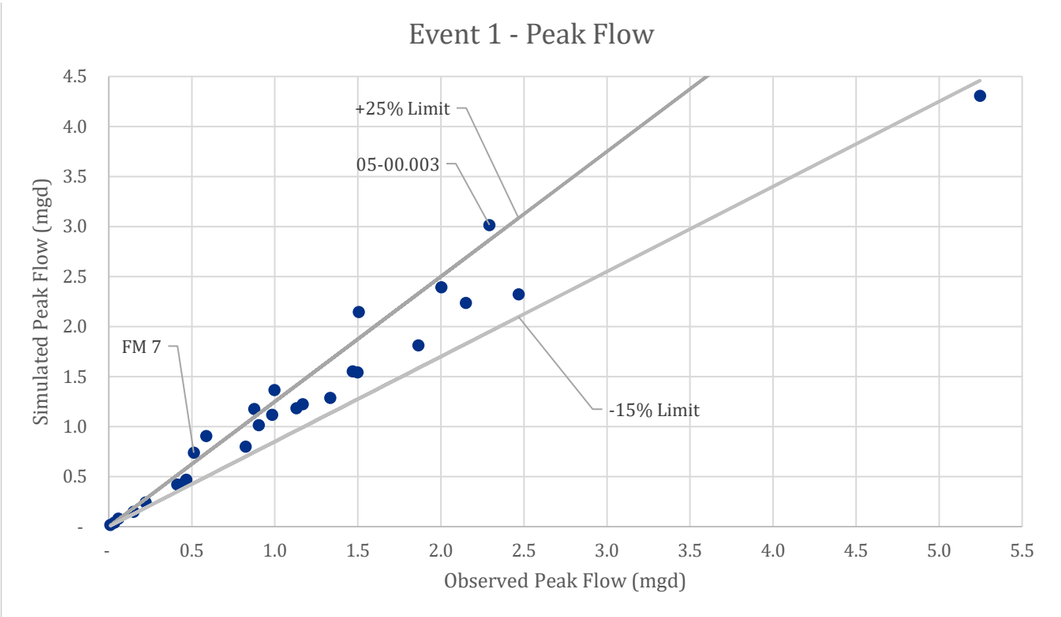

Figure B-4 Event 1 Peak Flow

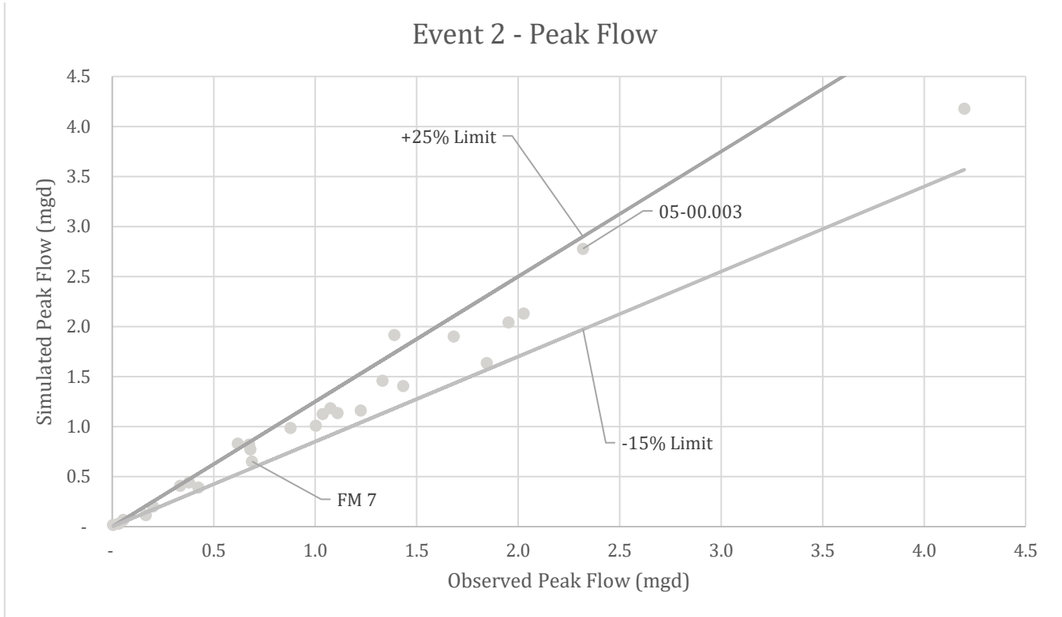

Figure B-5 Event 2 Peak Flow

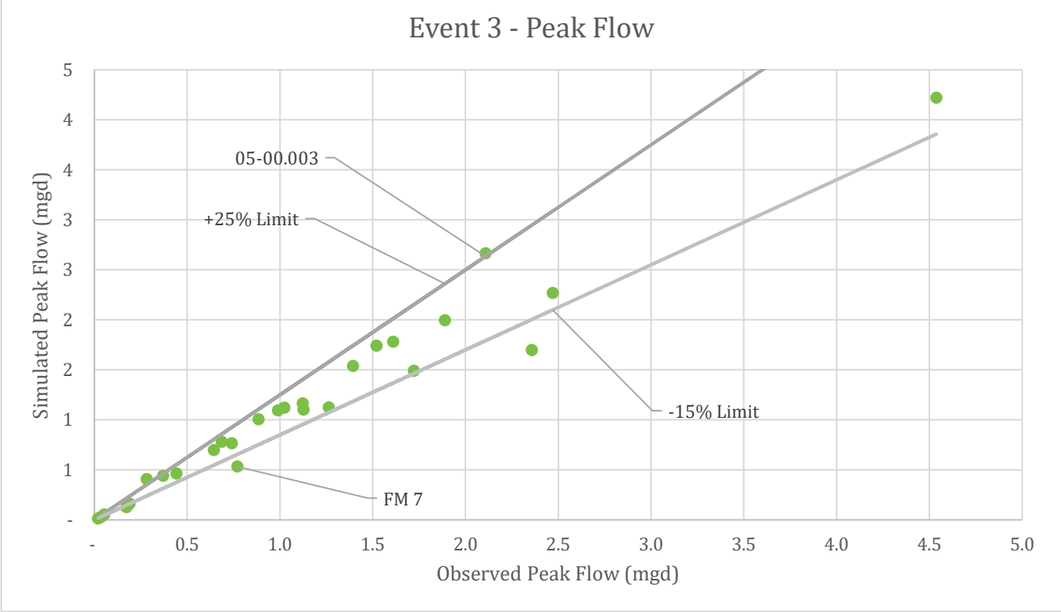

Figure B-6 Event 3 Peak Flow

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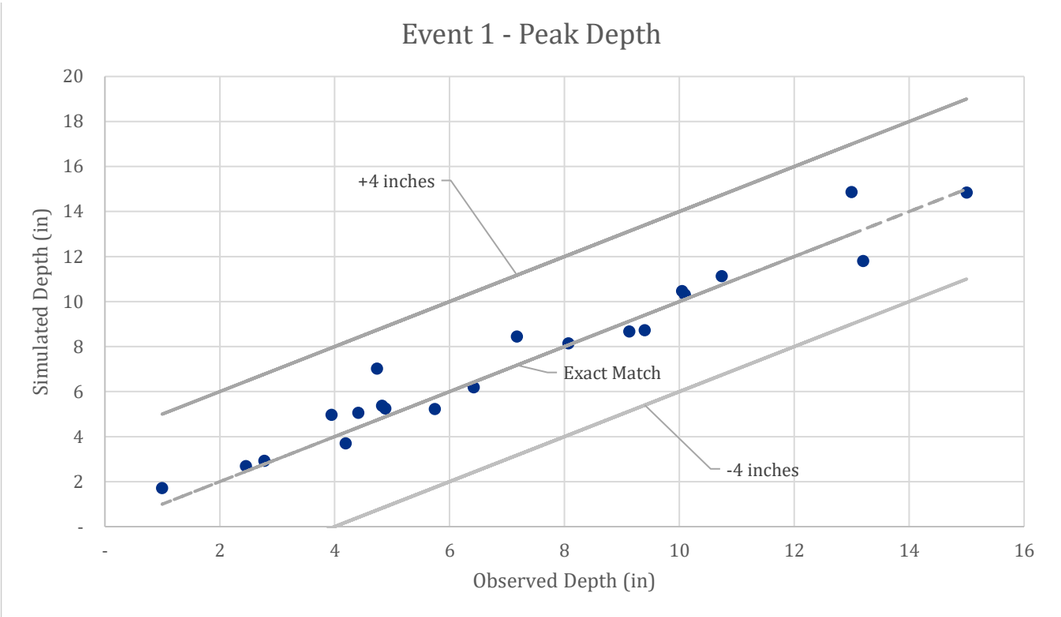

Figure B-7 Event 1 Peak Depth

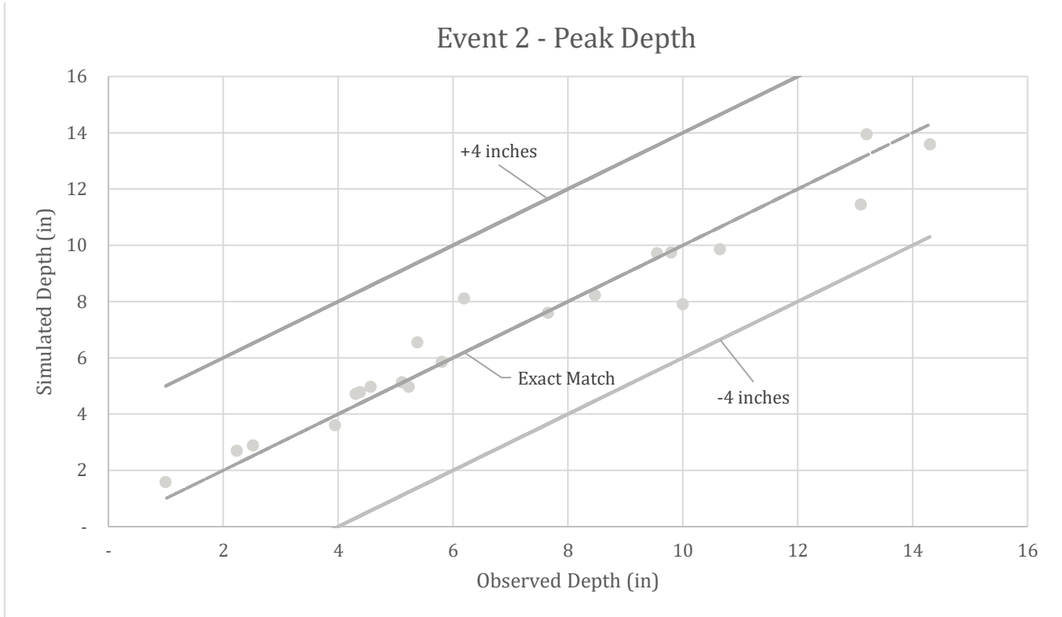

Figure B-8 Event 2 Peak Depth

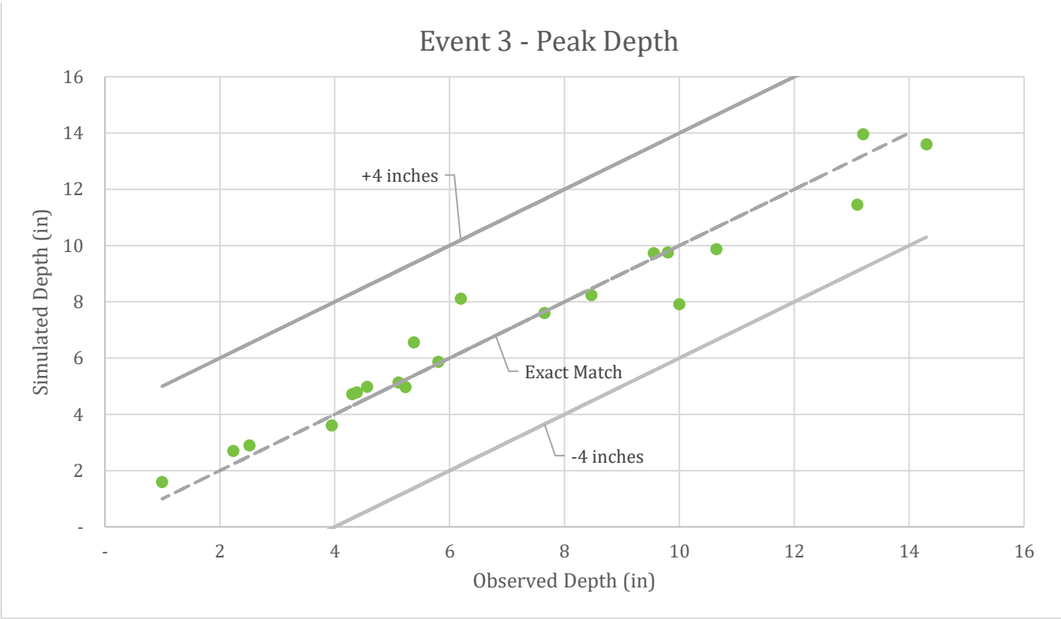

Figure B-9 Event 3 Peak Depth

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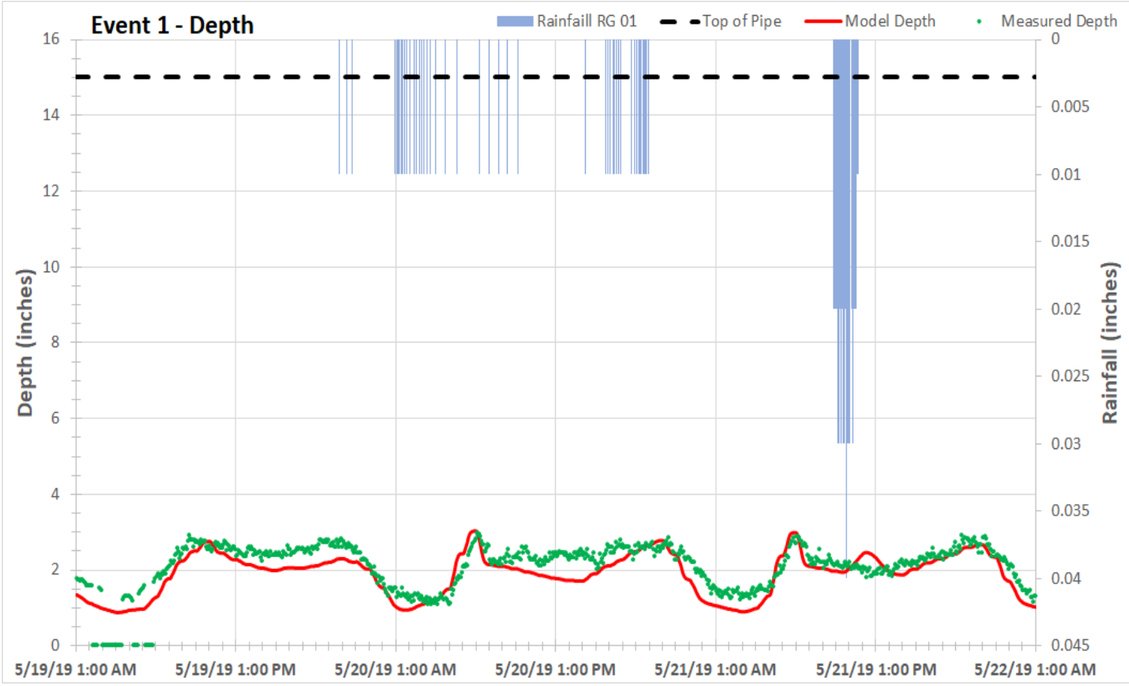
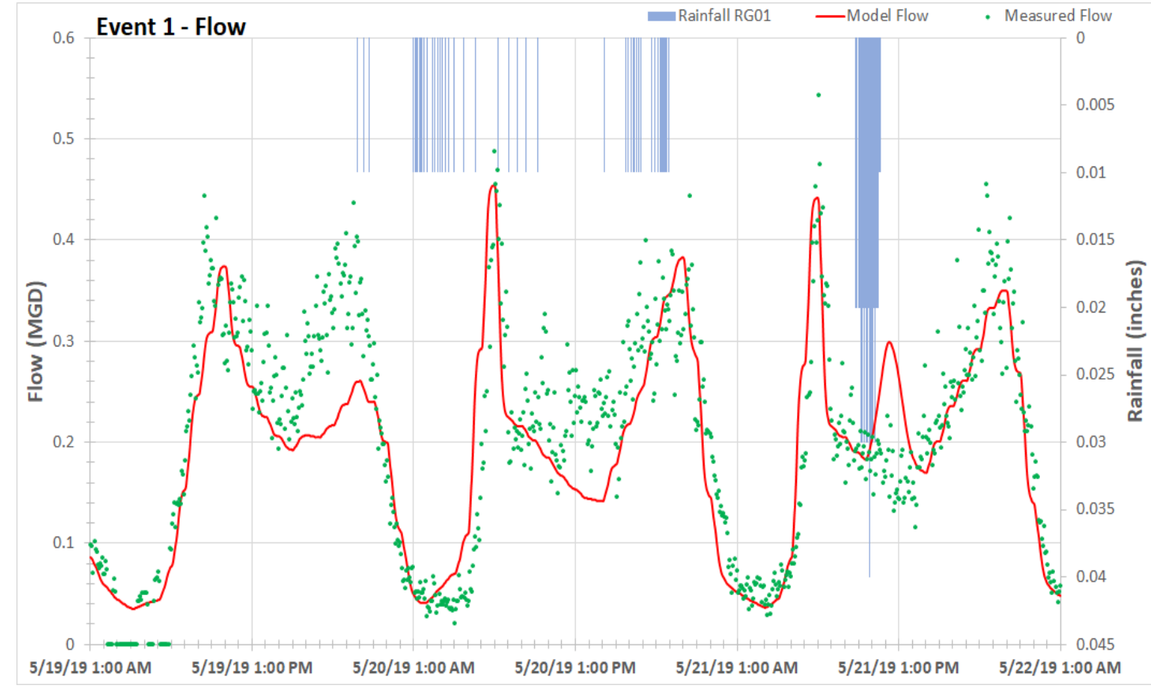
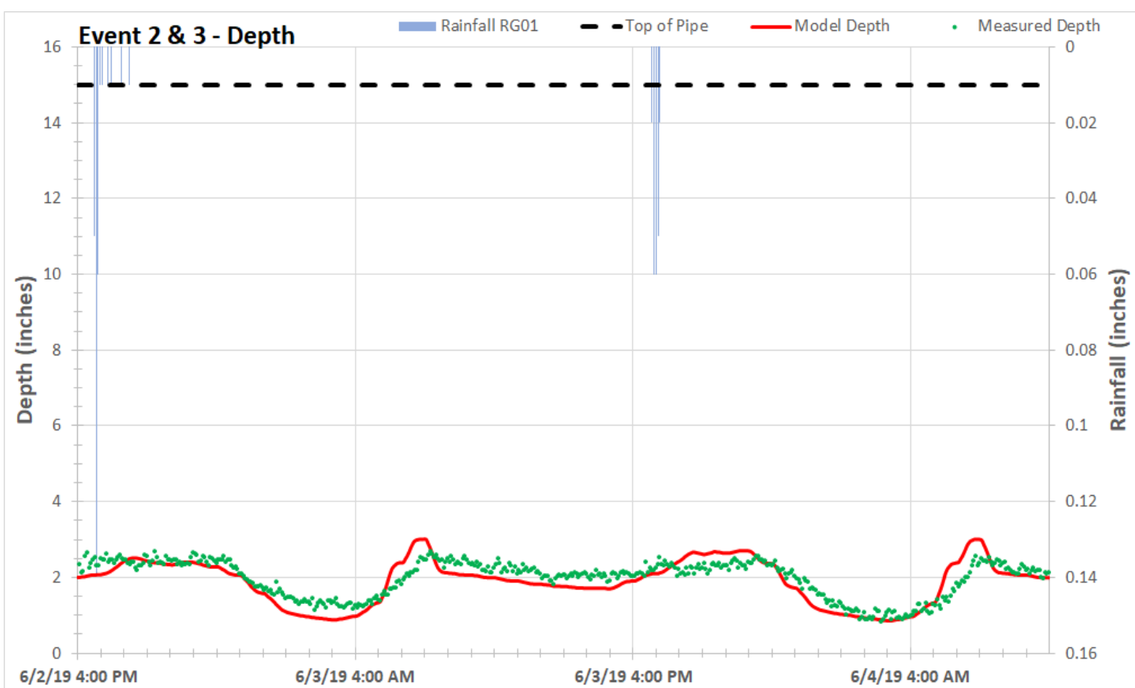
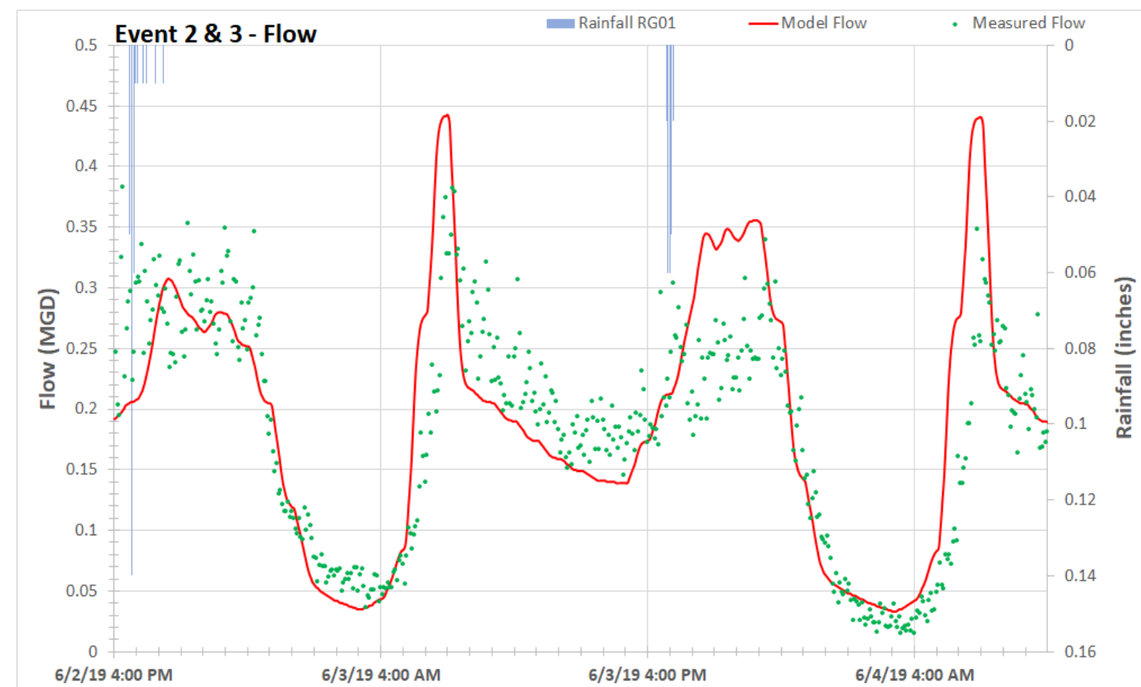
FM 01 - Sheep Draw Basin









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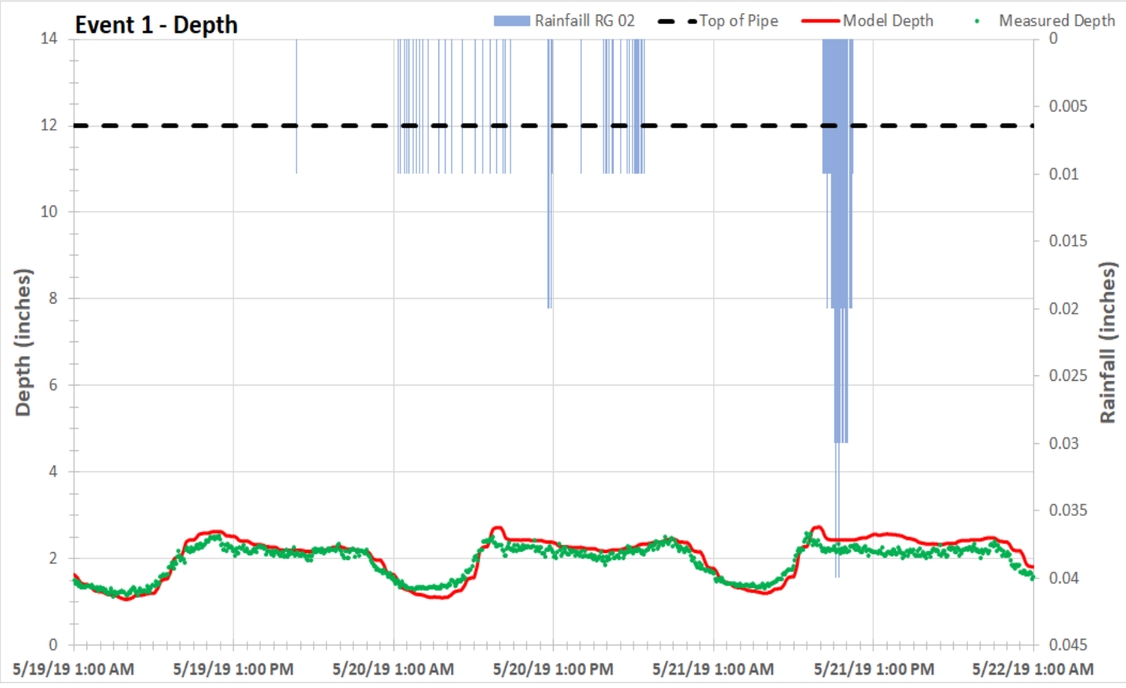
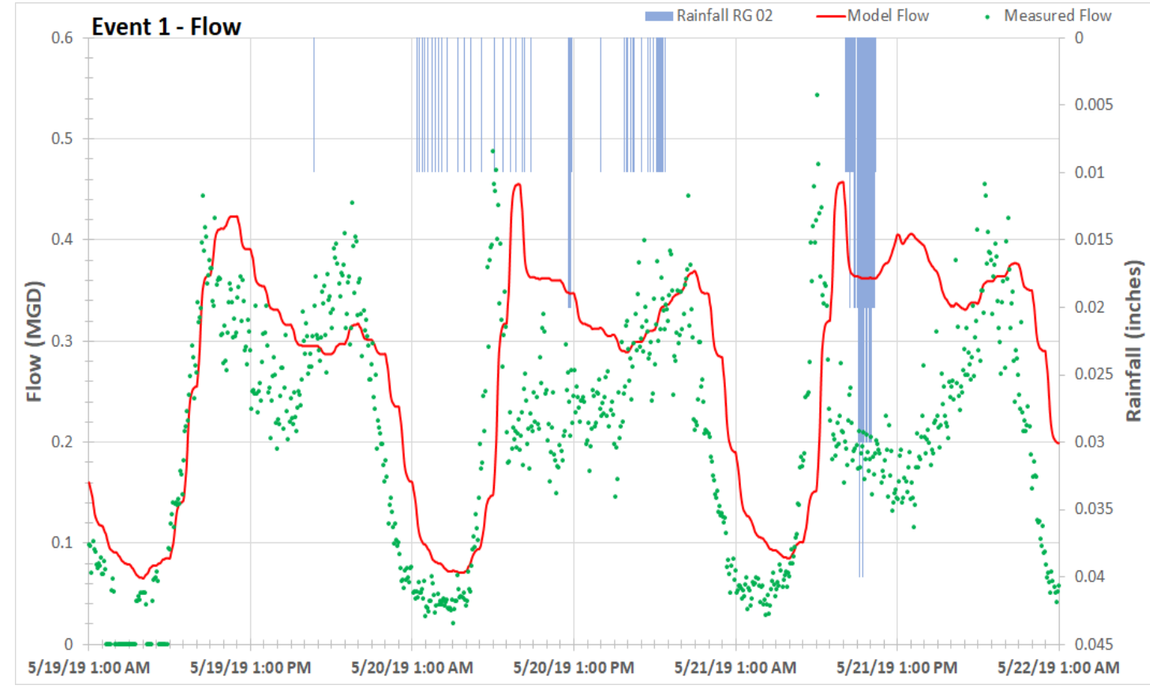
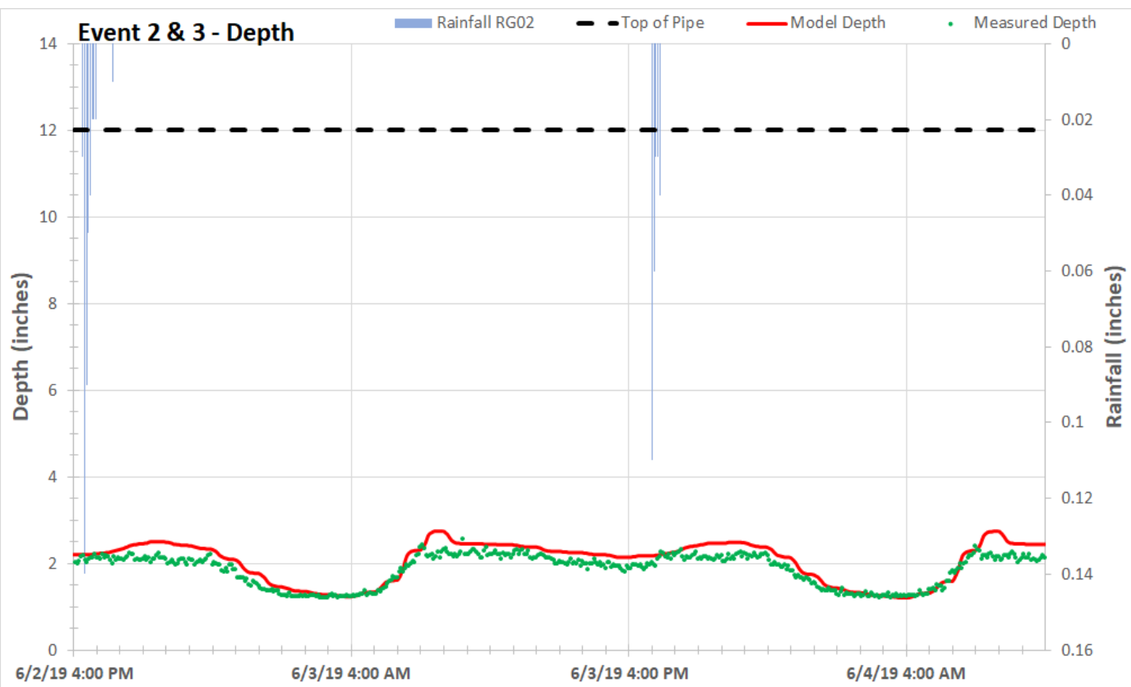
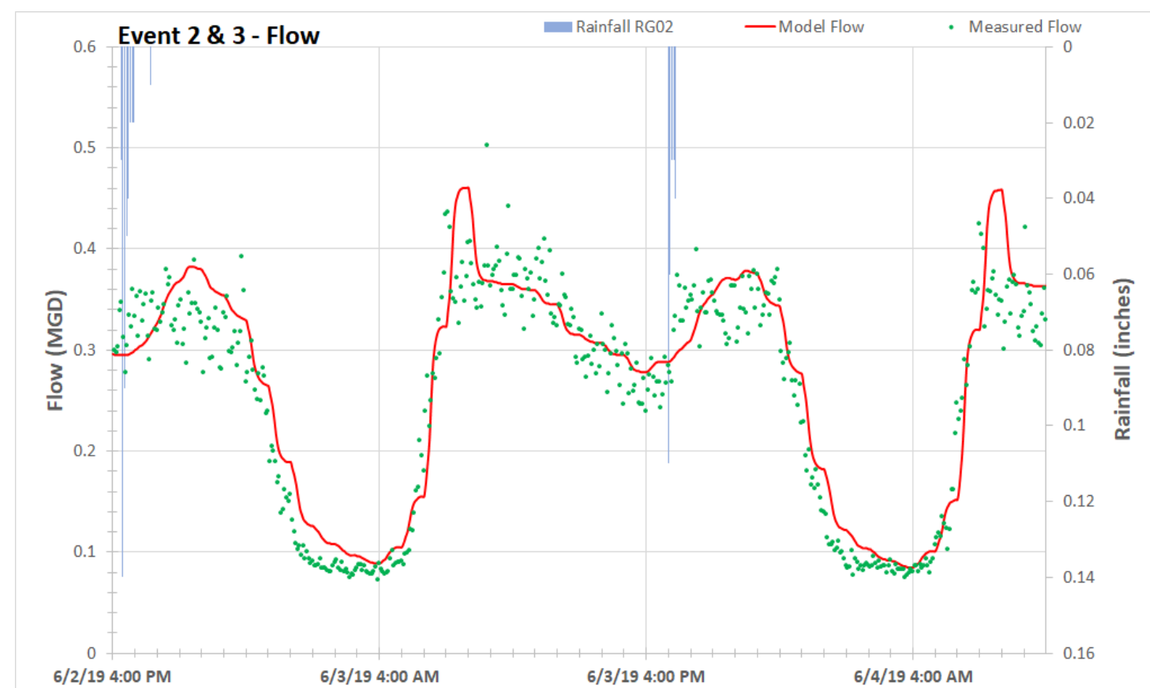
FM 02 - Sheep Draw Basin









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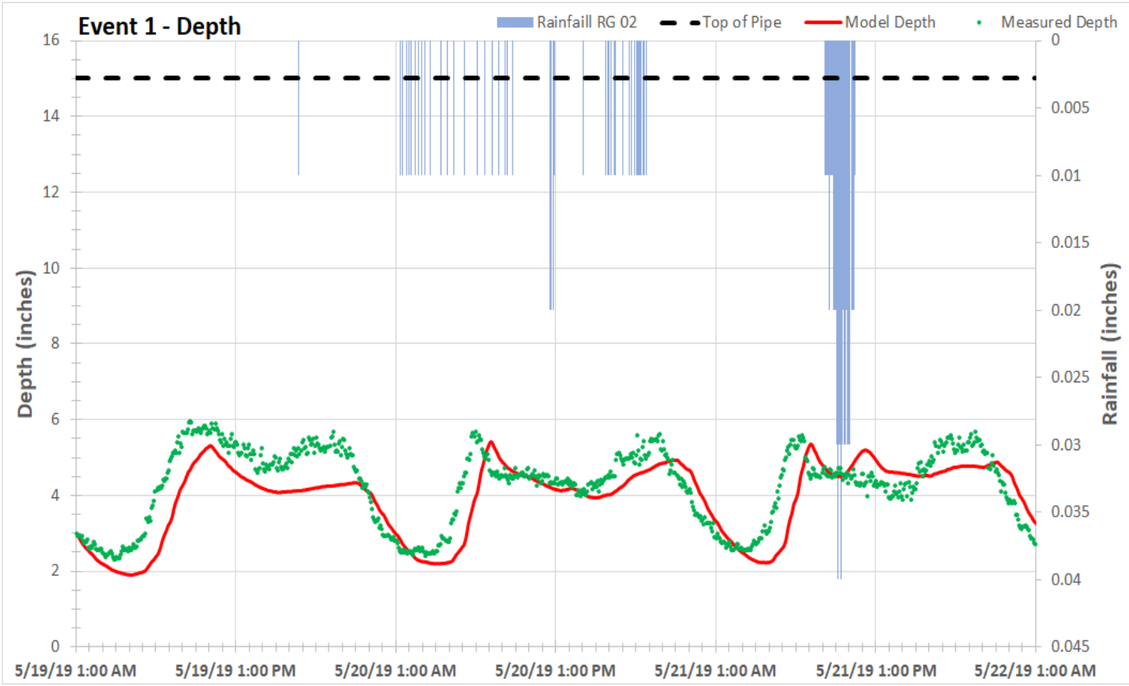
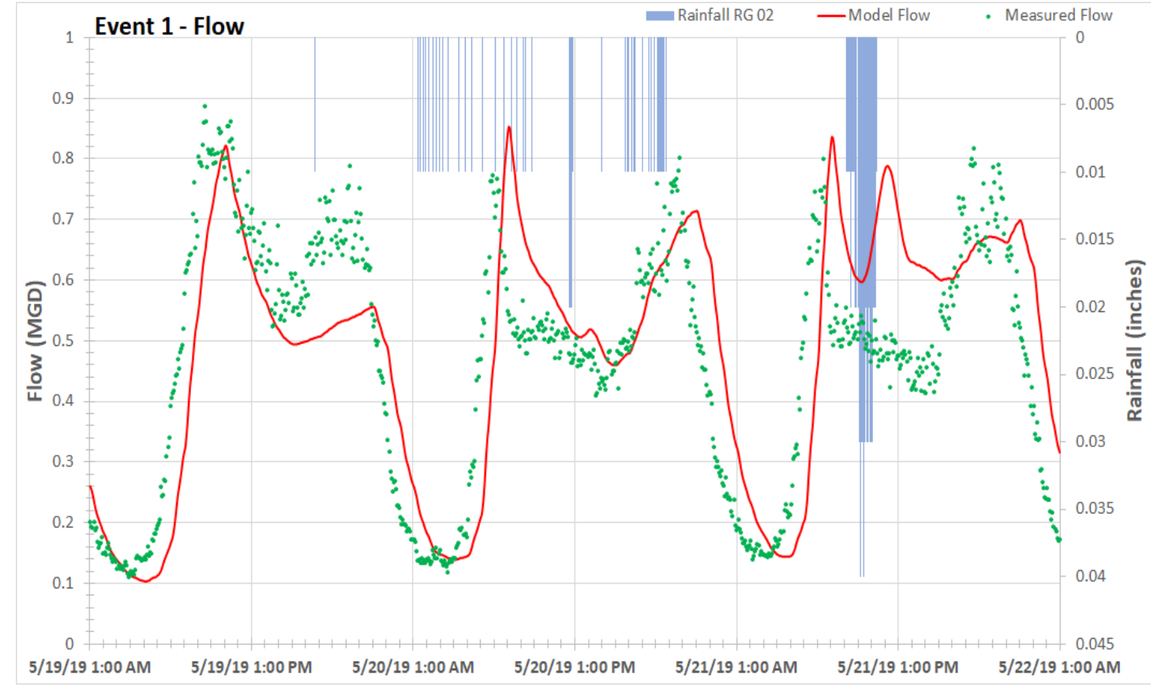
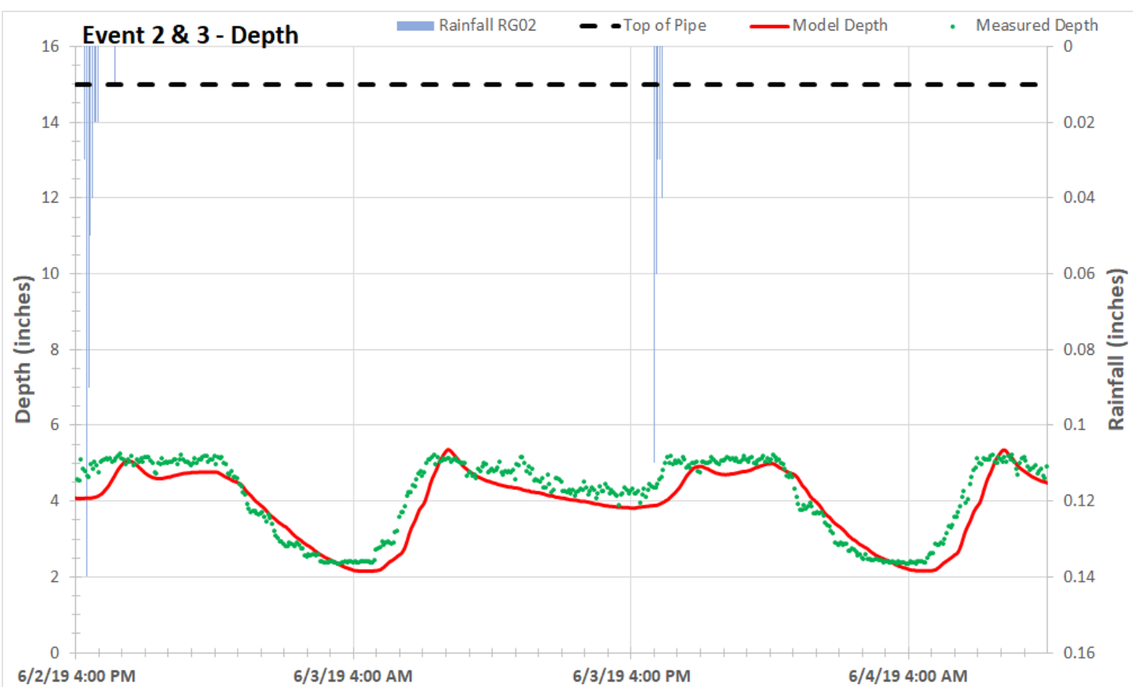
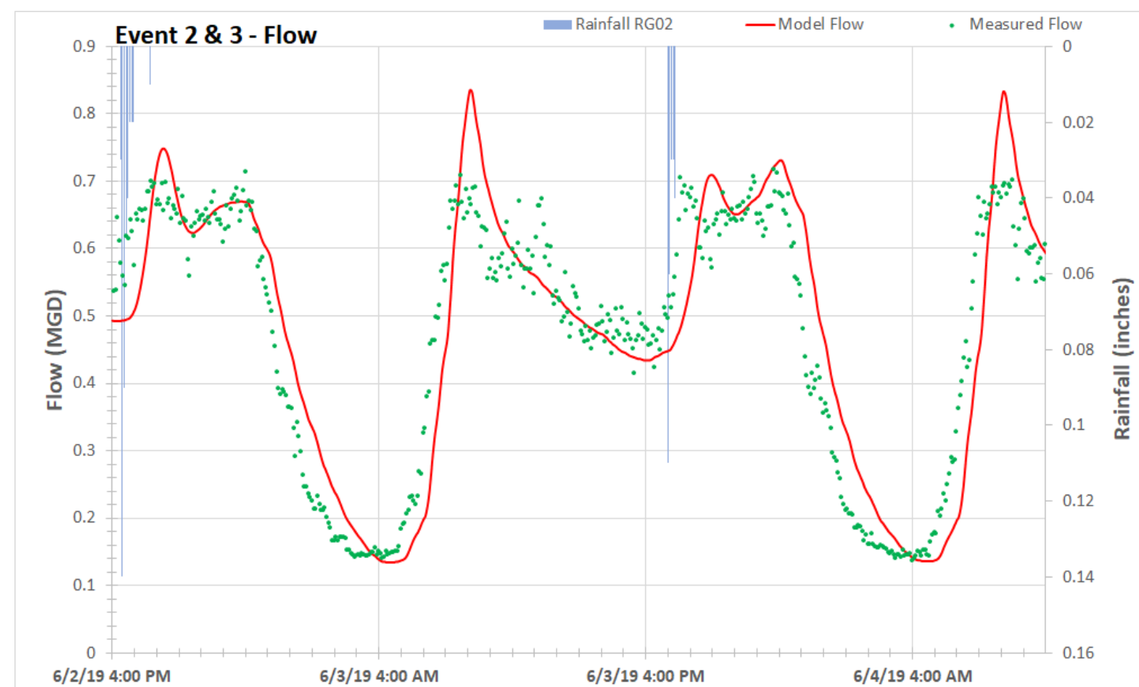
FM 03 - Hilltop Basin









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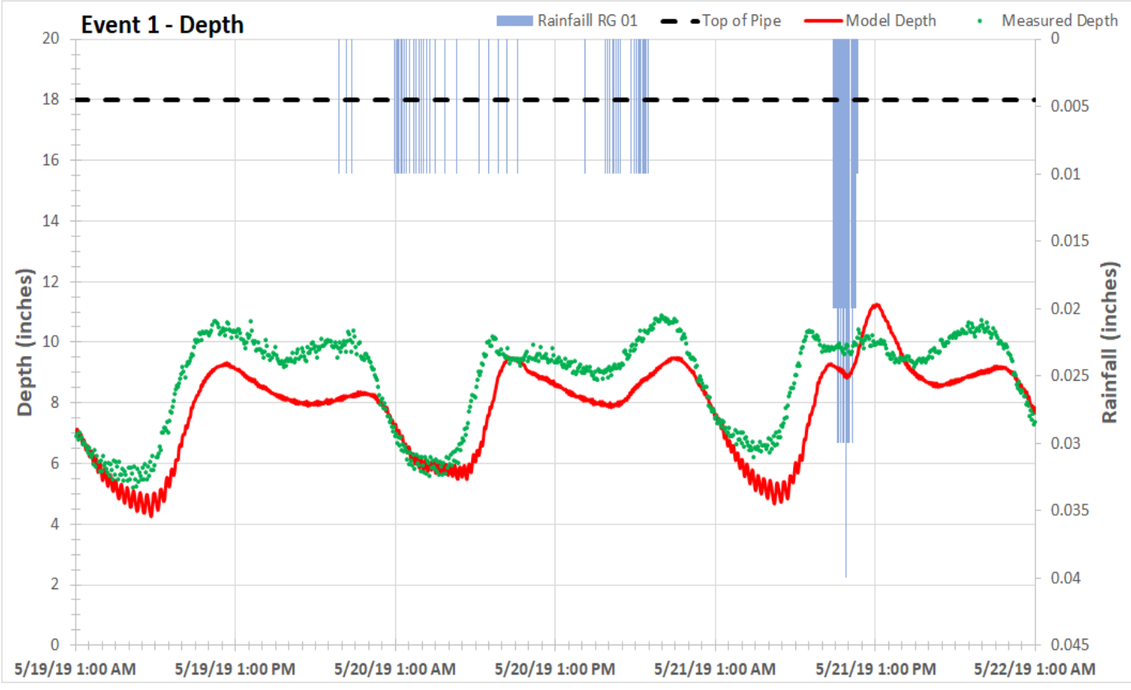
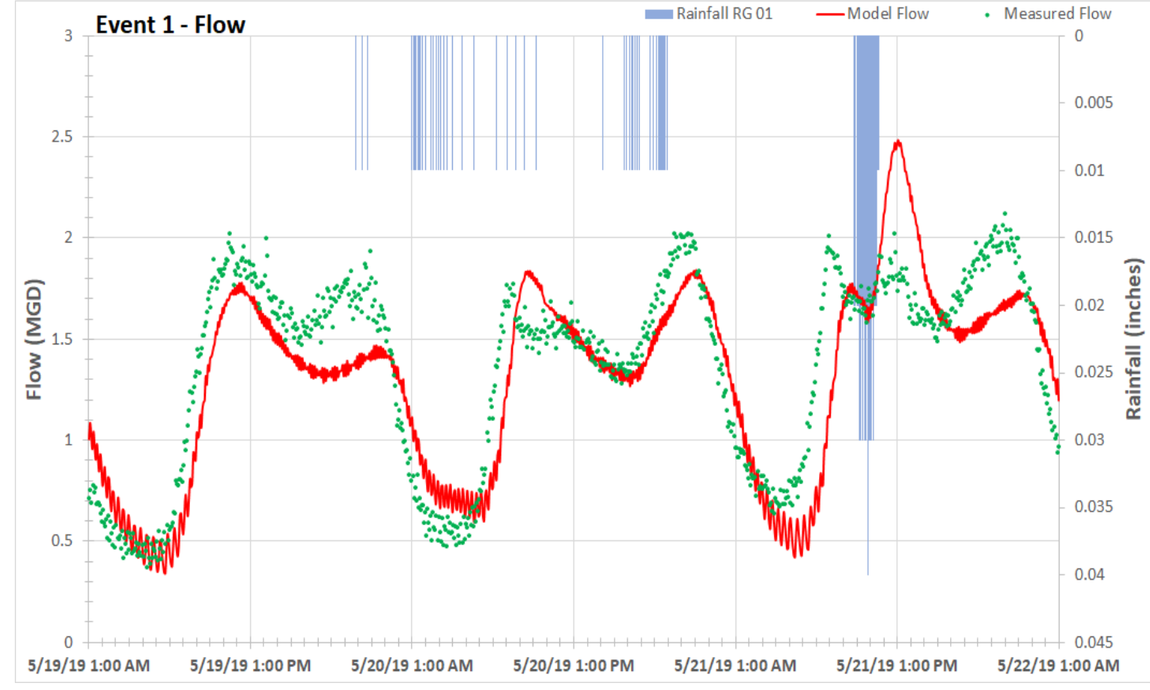
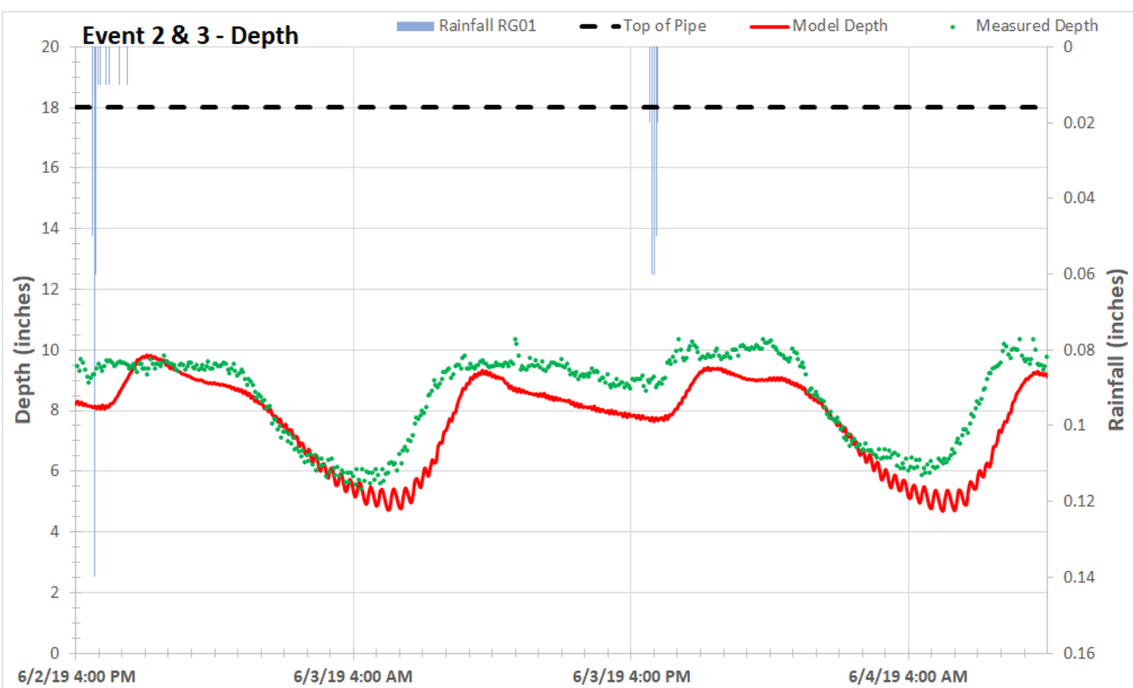
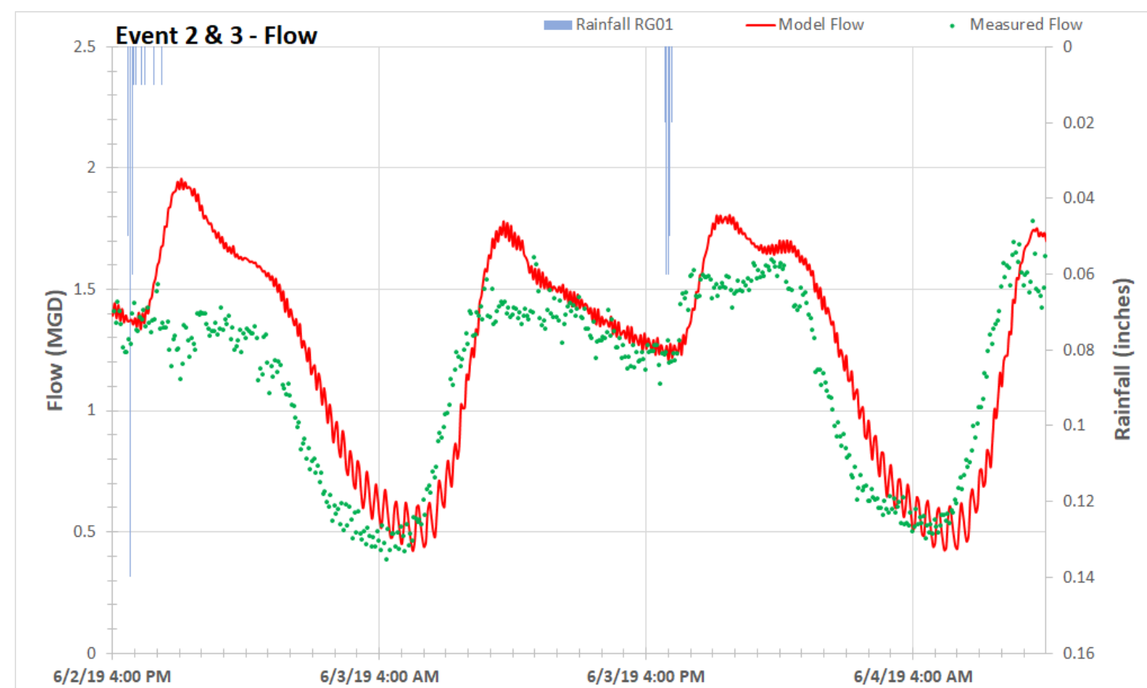
FM 04 - Highland Hills Basin









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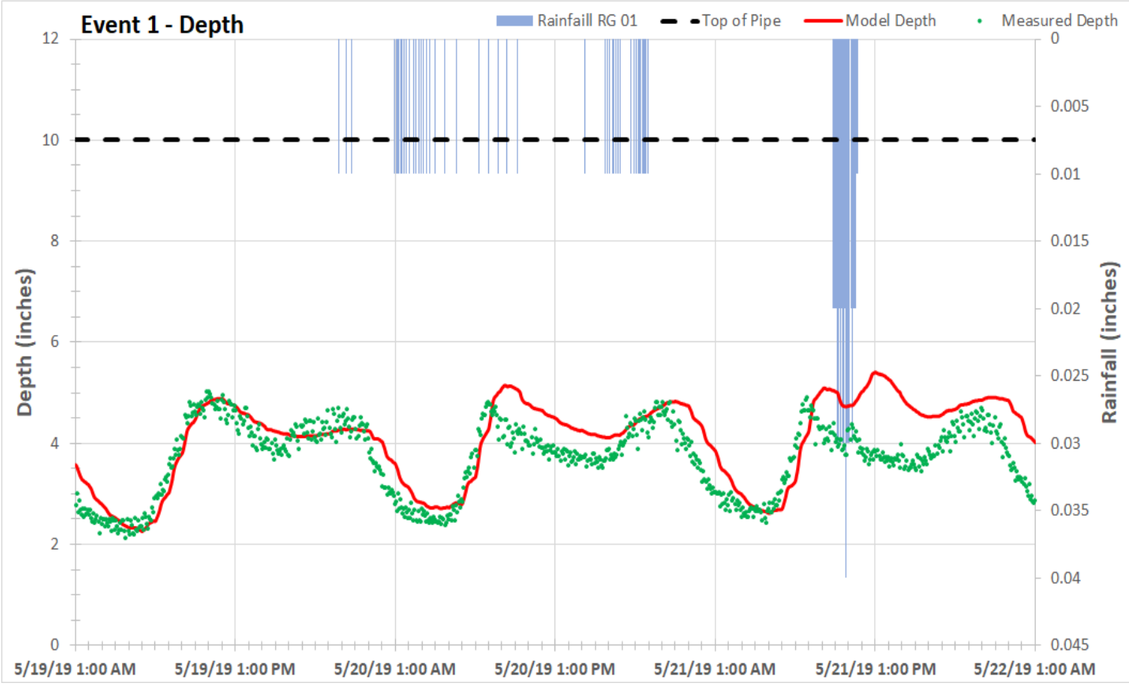
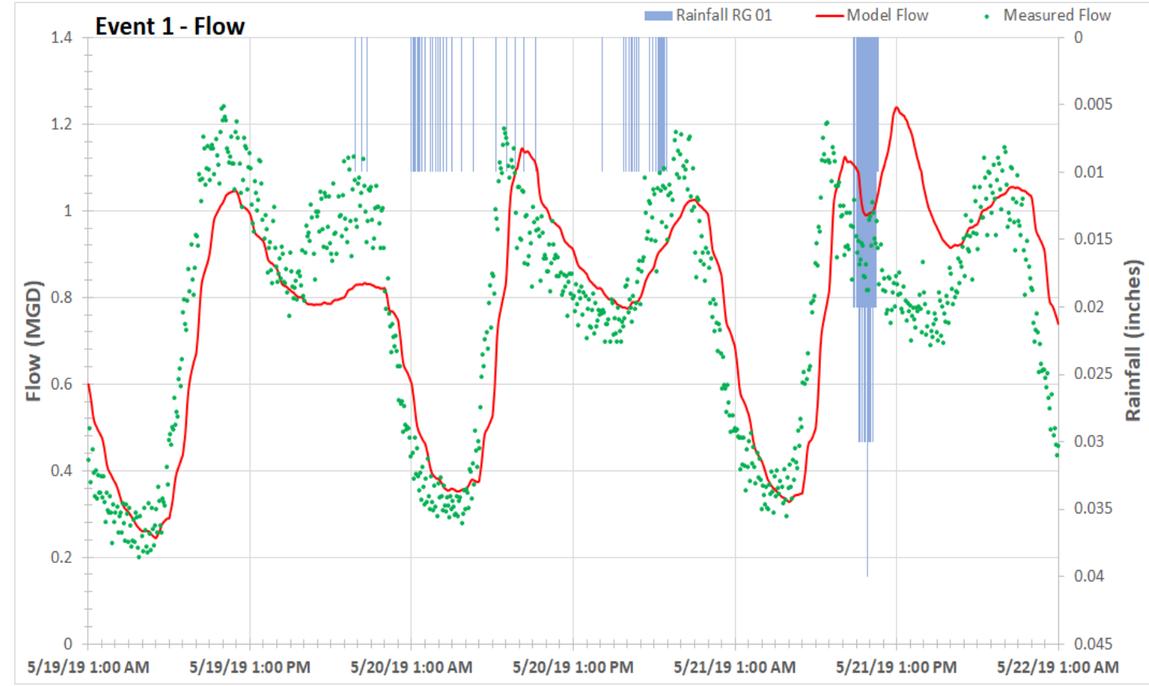
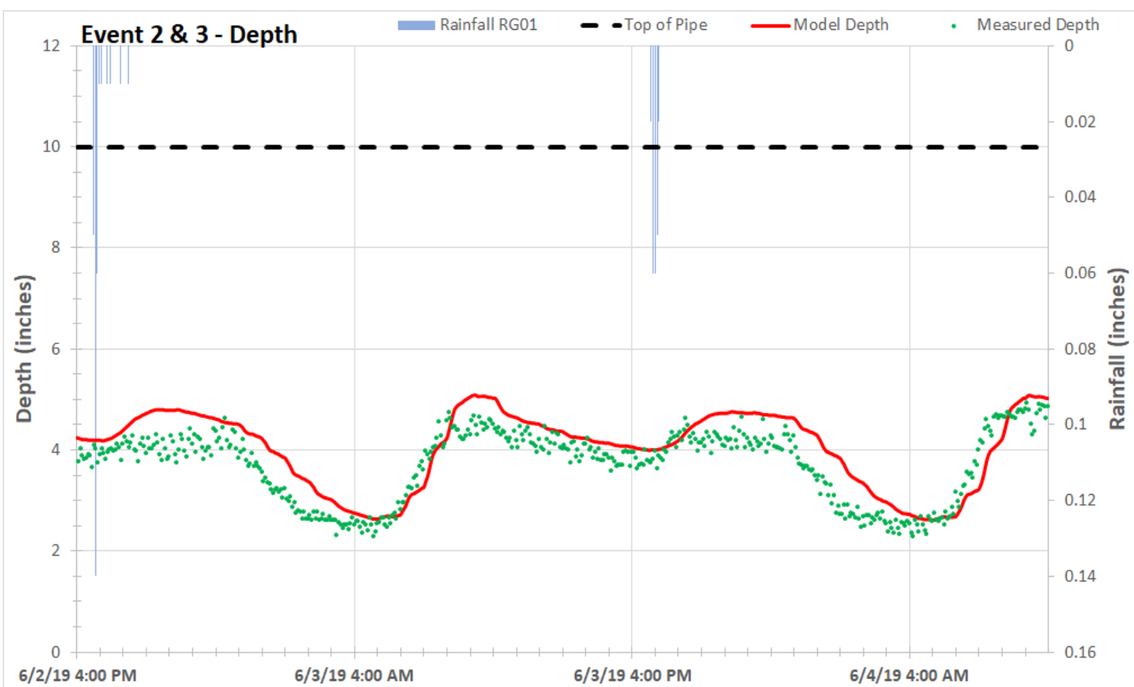
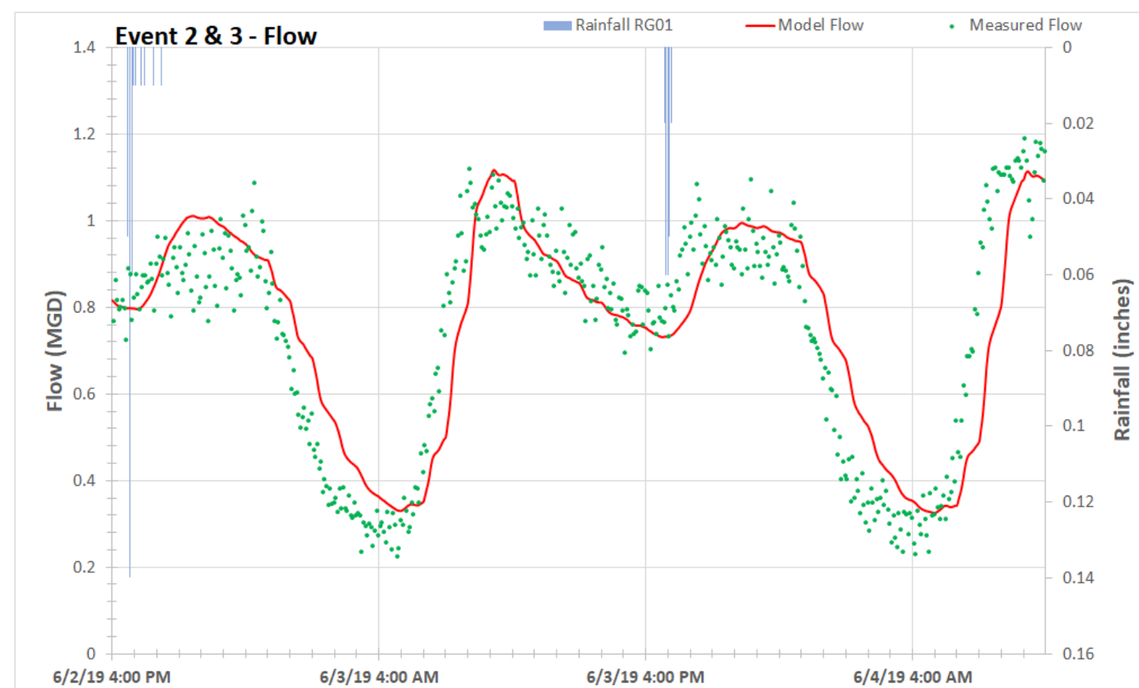
FM 04/05 - Highland Hills Basin









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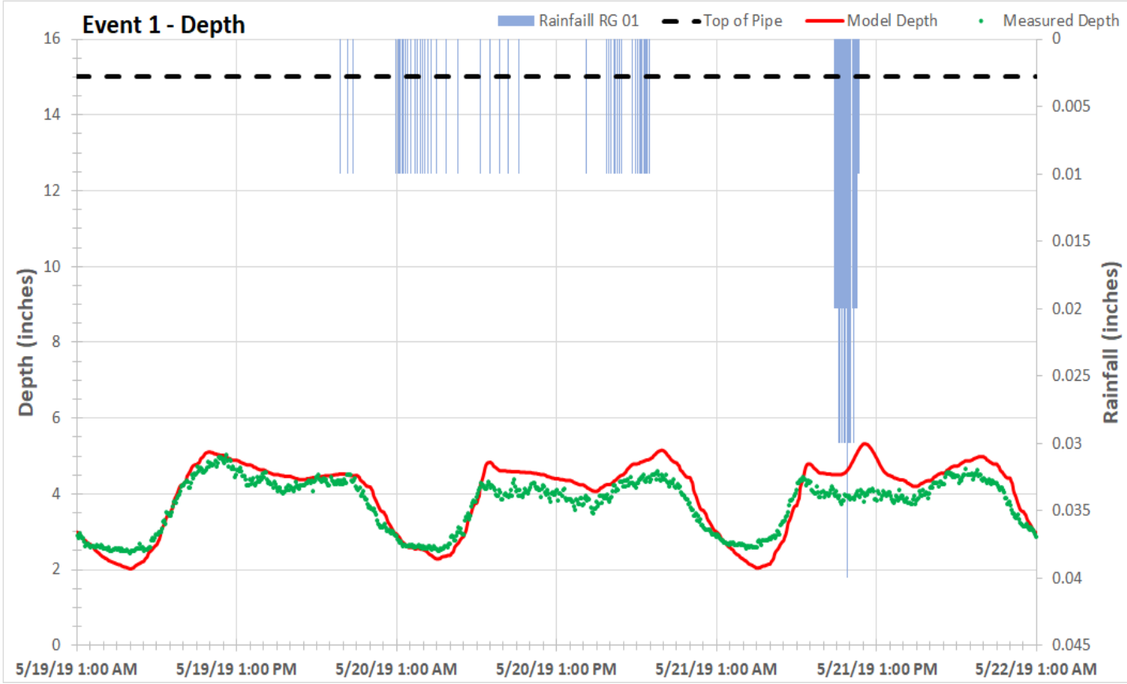
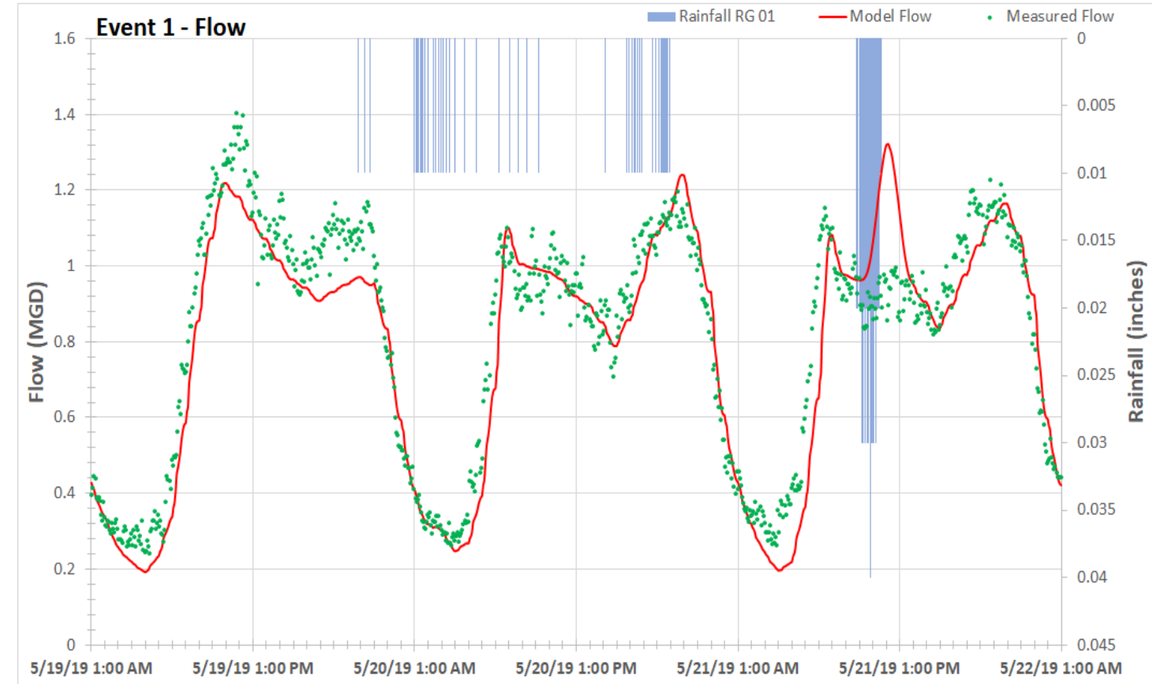
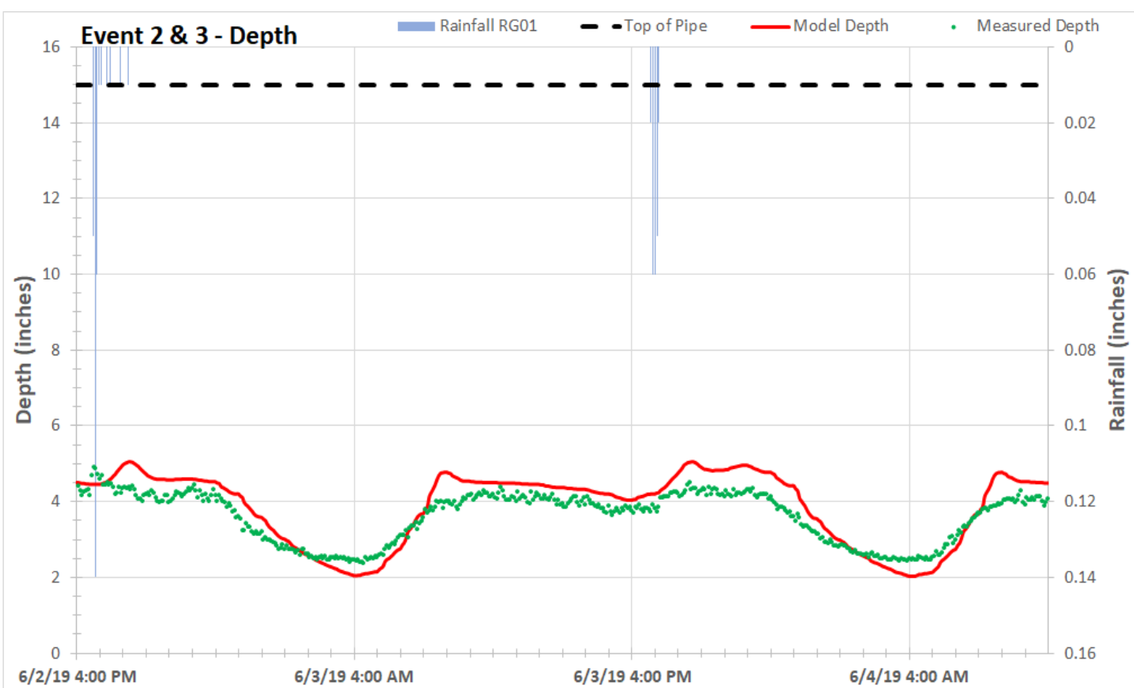
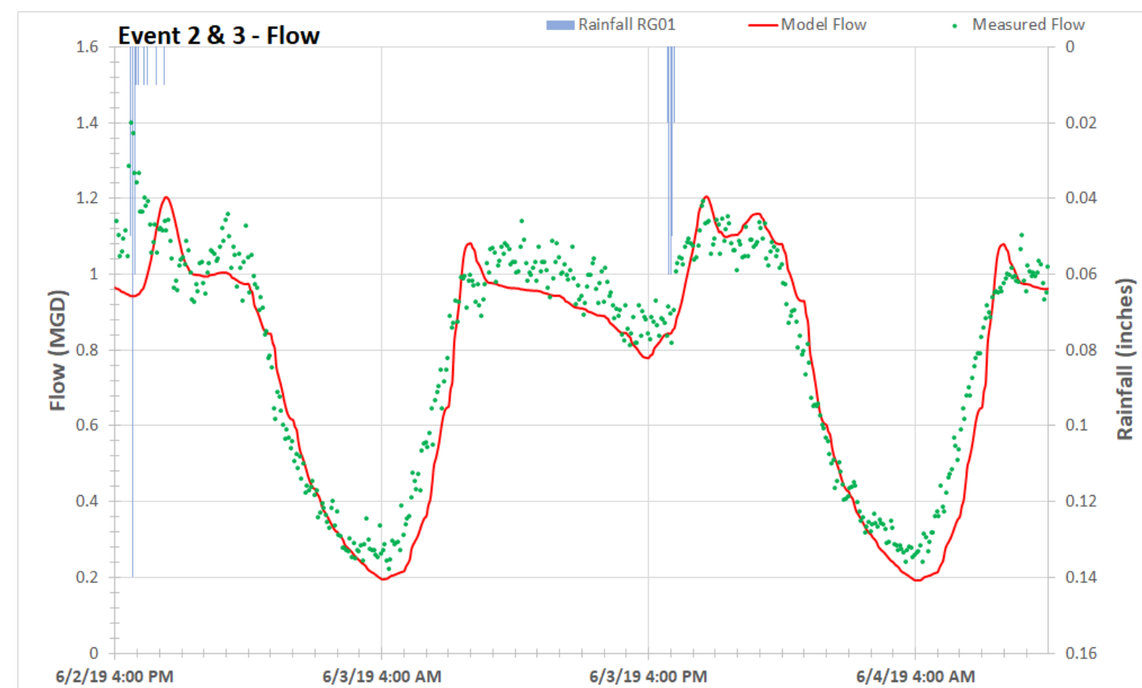
FM 06/08 - North and Belair Basin









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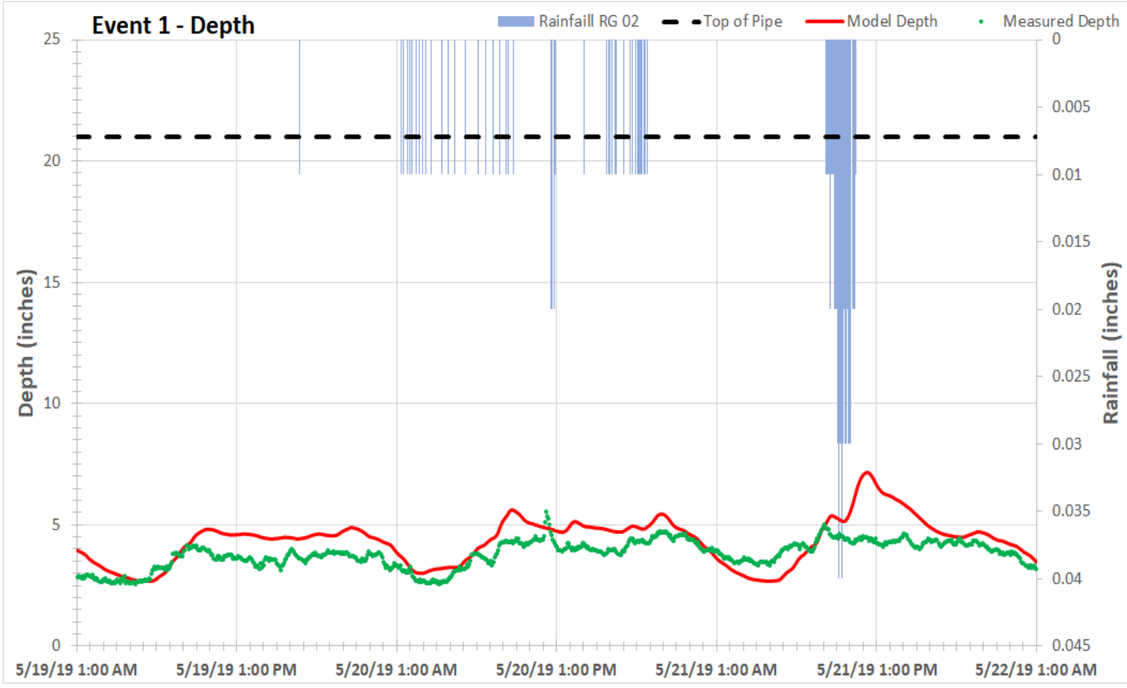
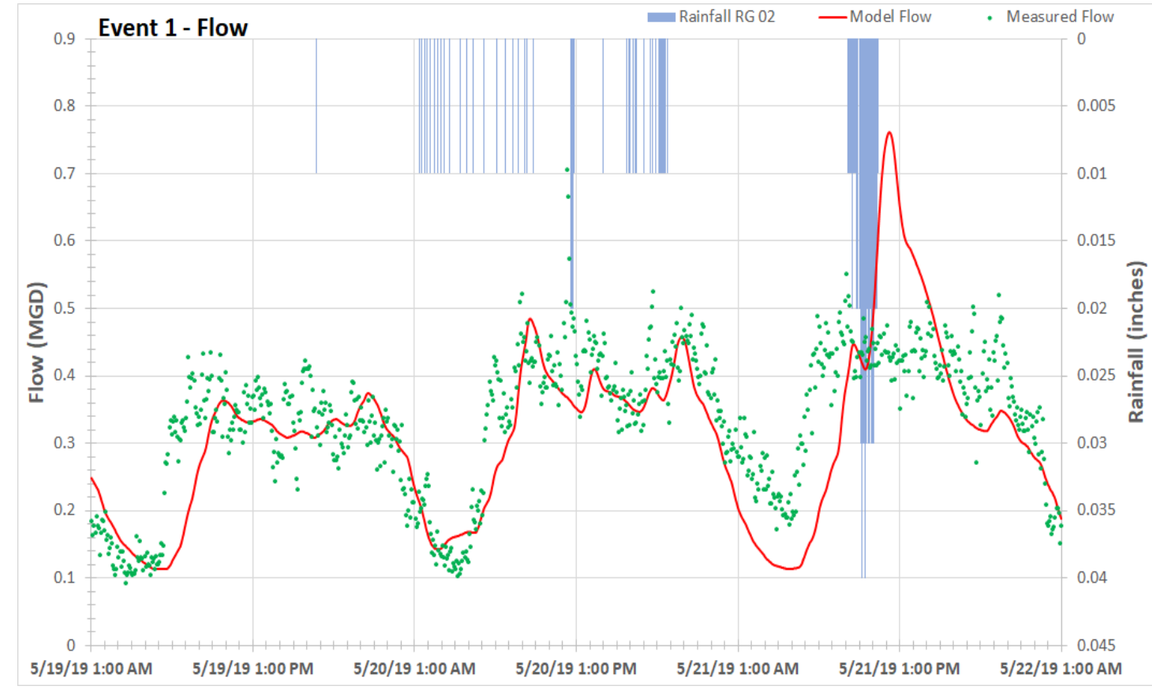
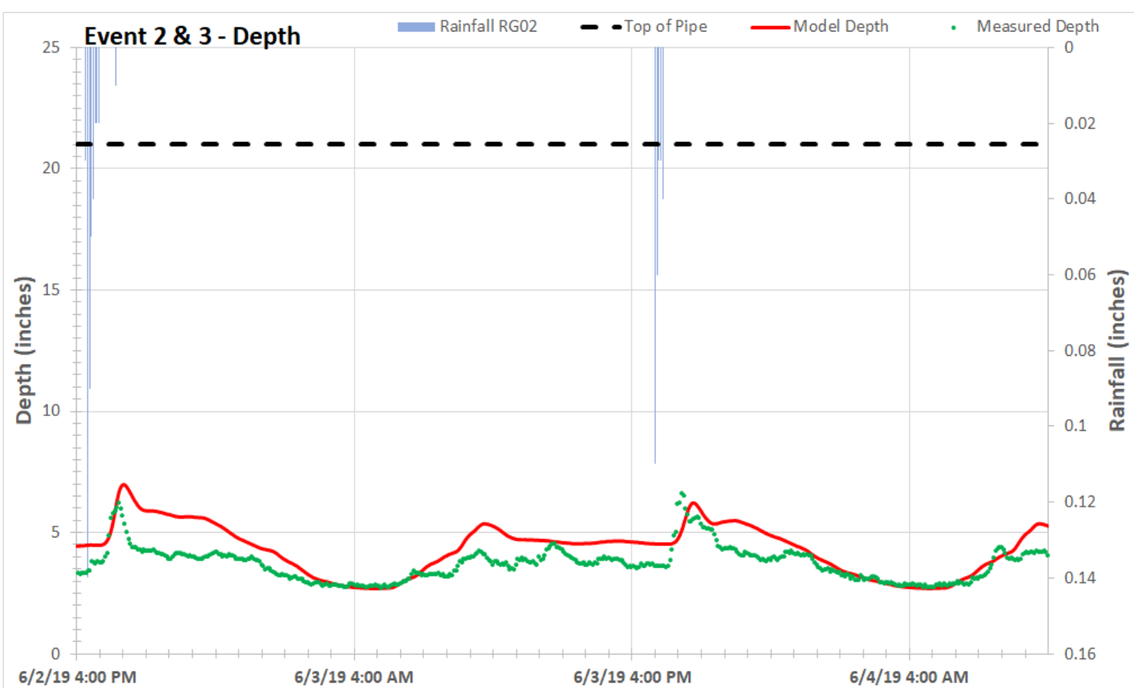
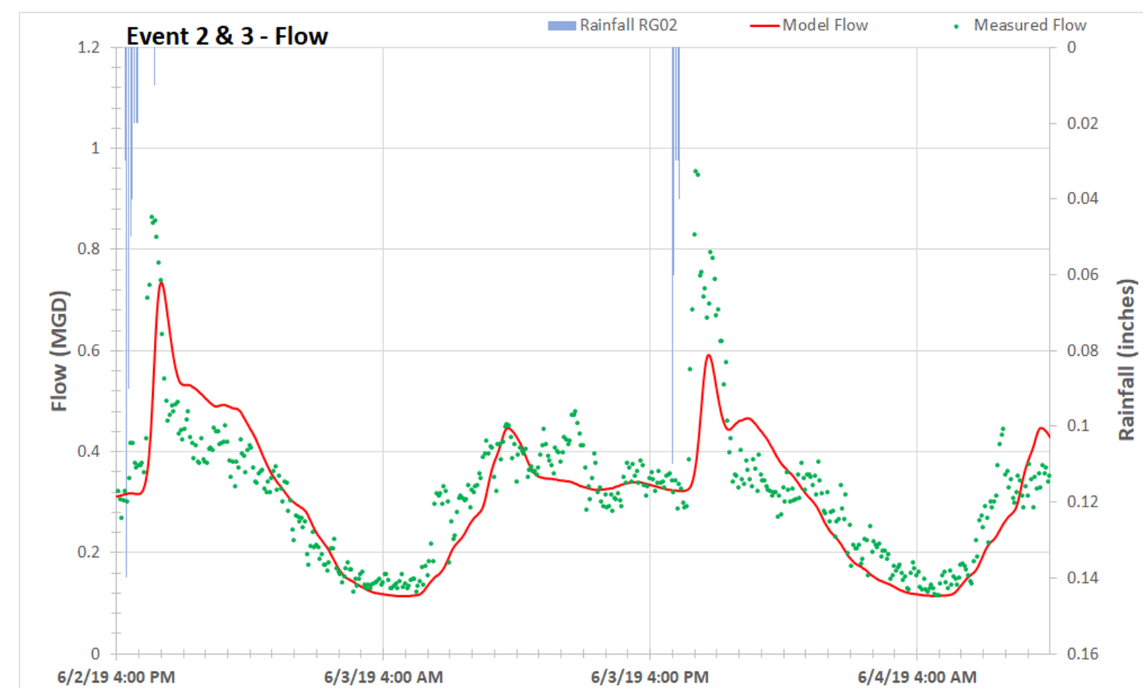
FM 07 - Monfort Basin









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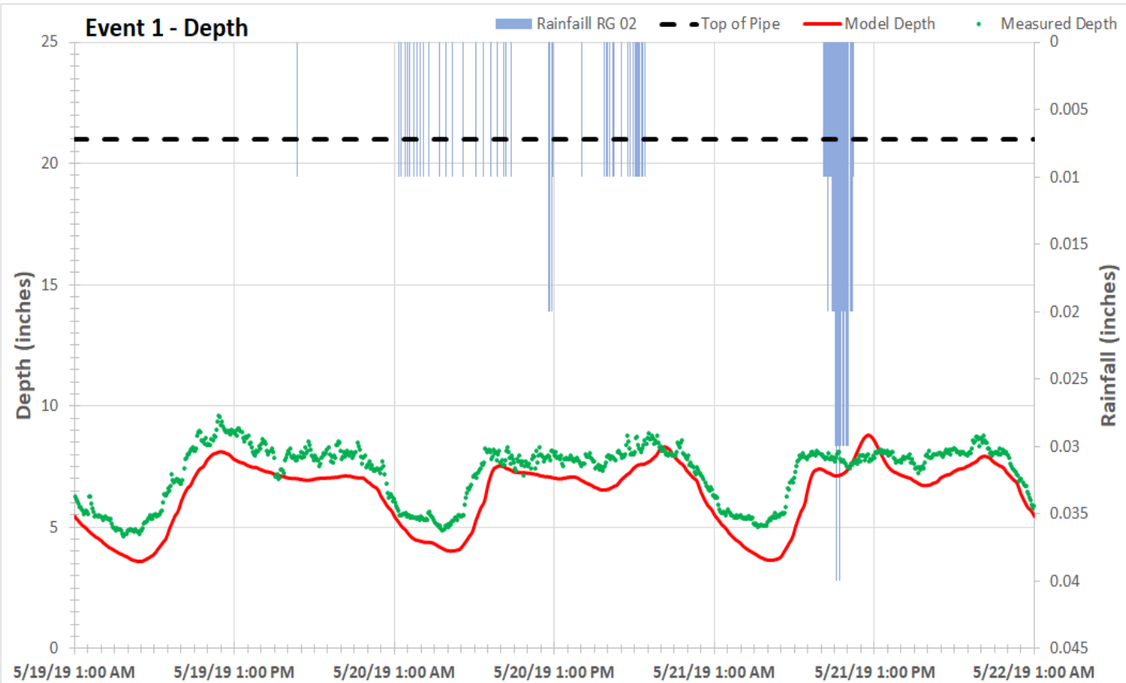
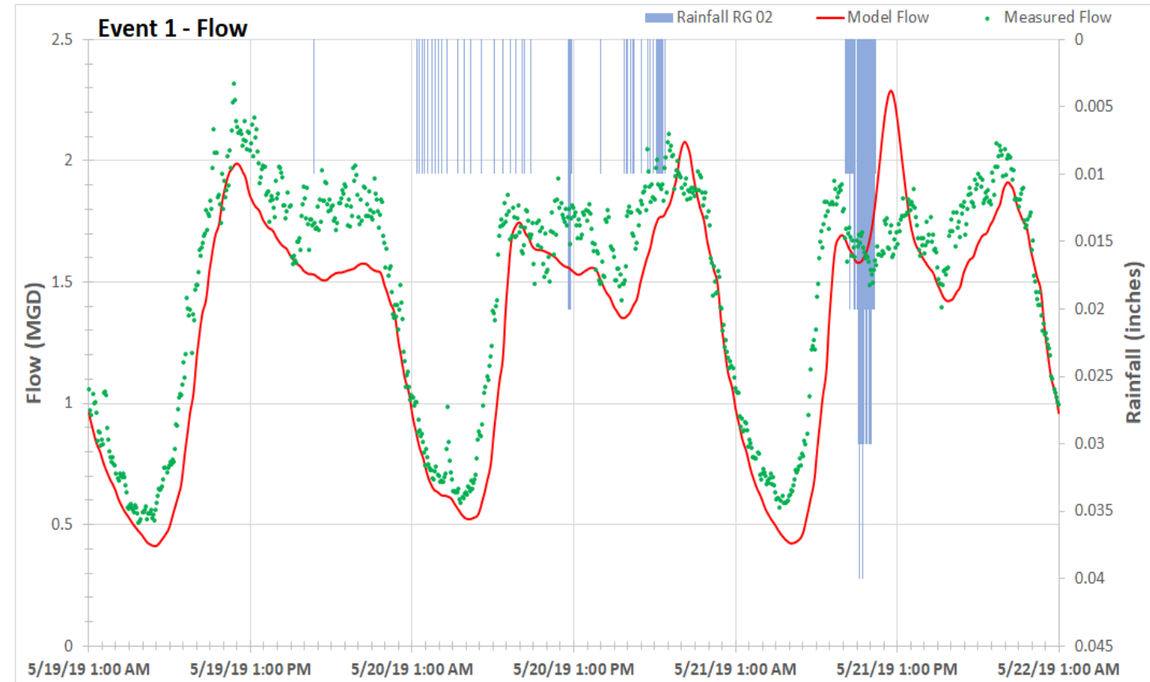
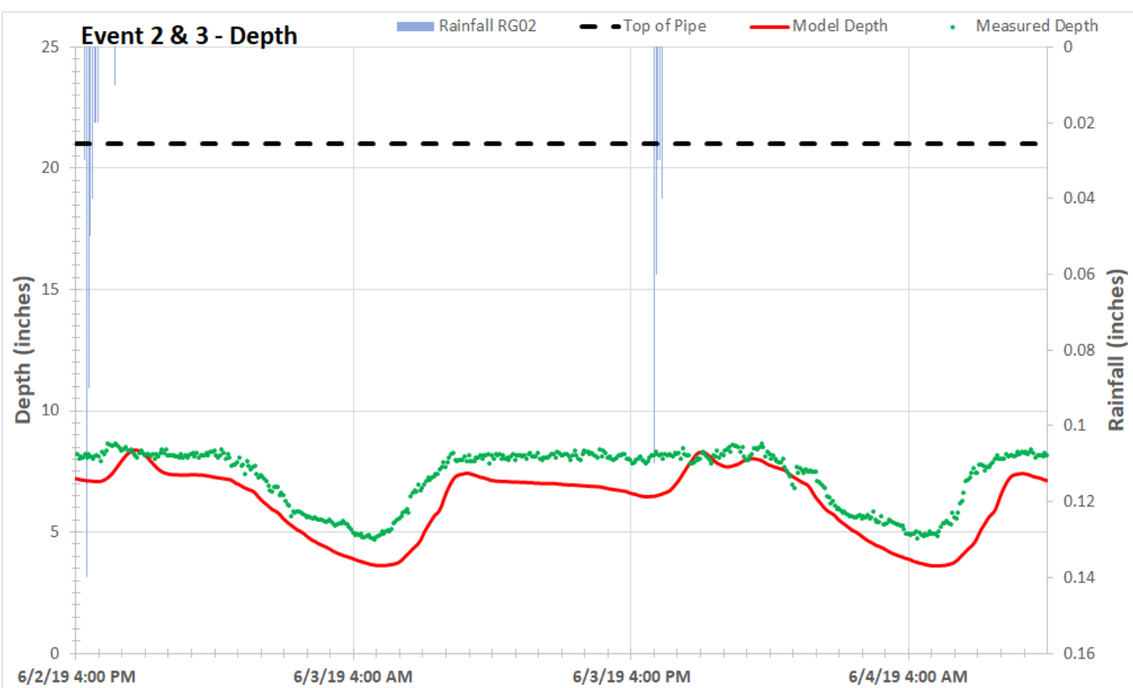
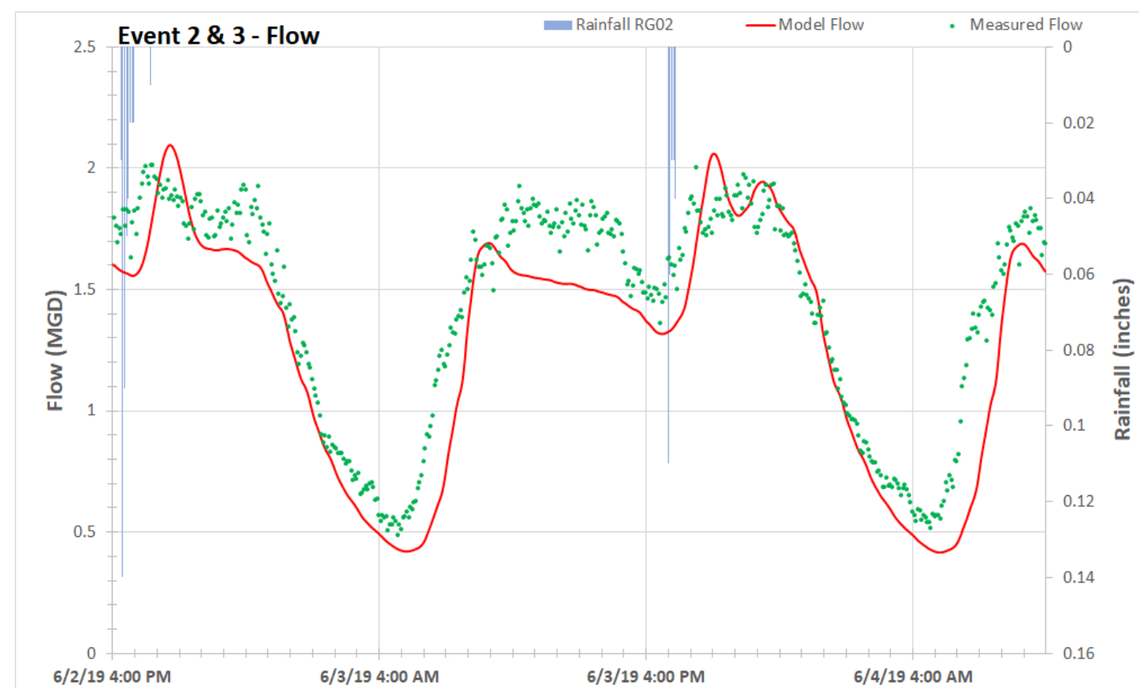
FM 08 - North Basin









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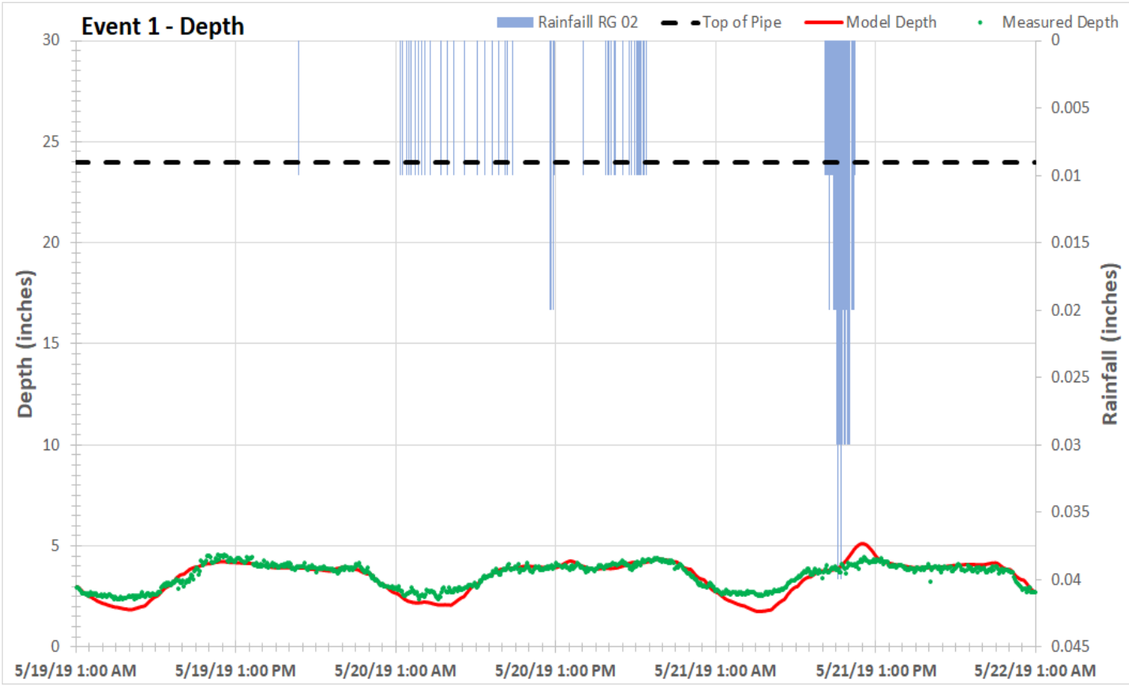
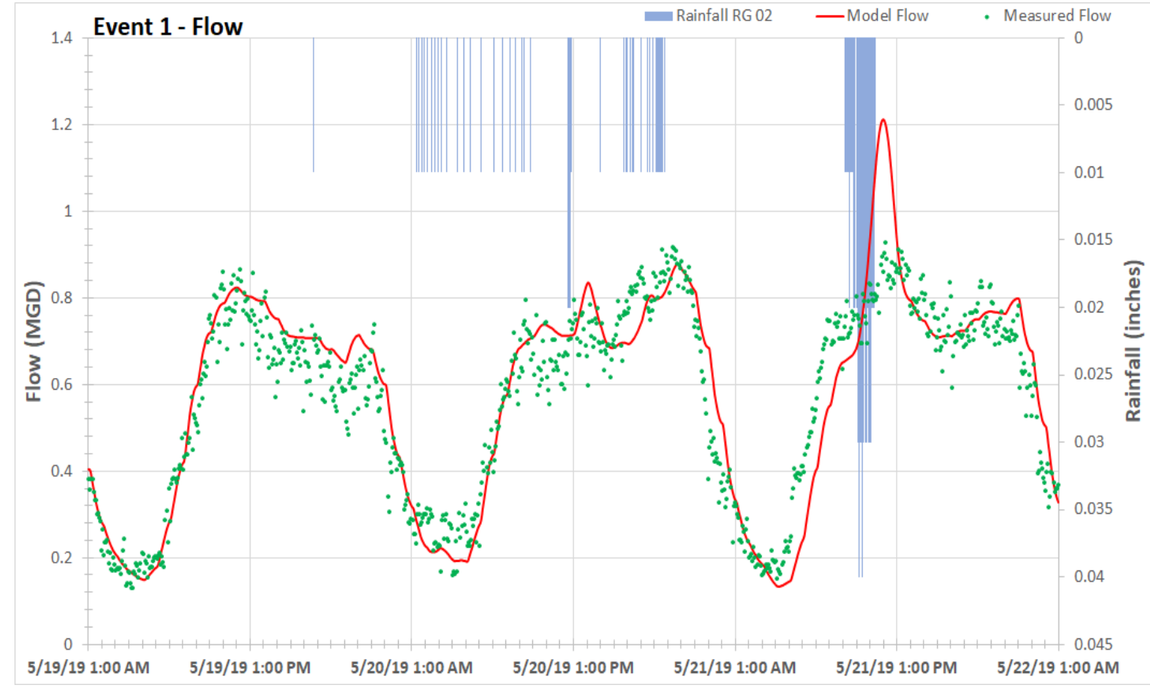
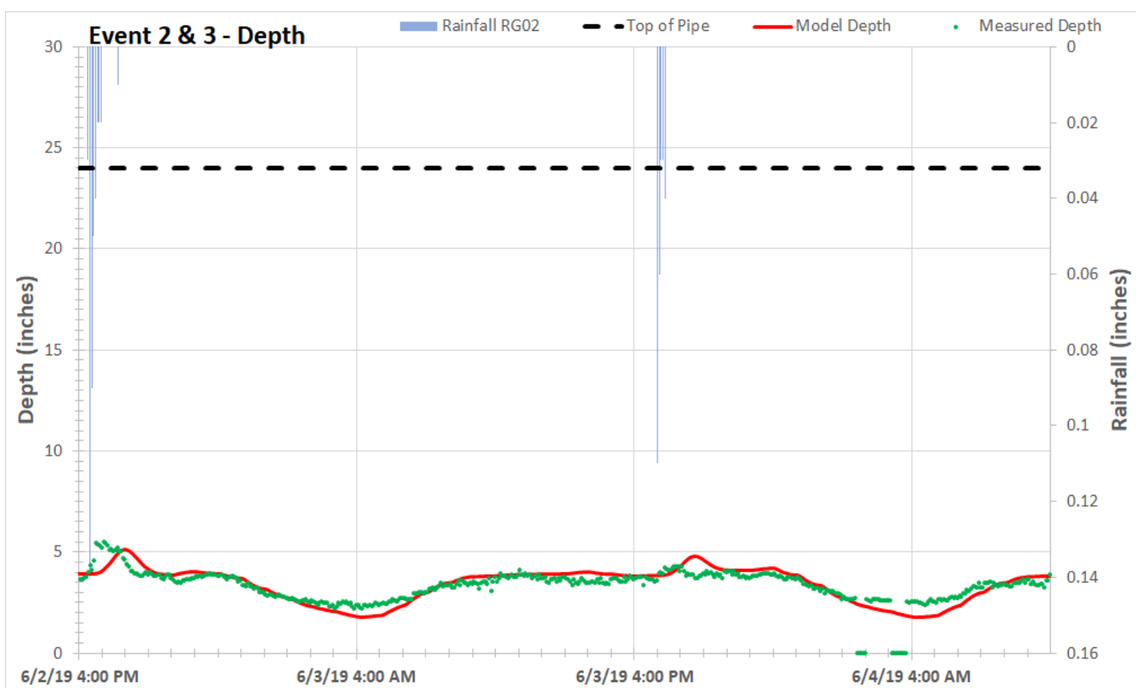
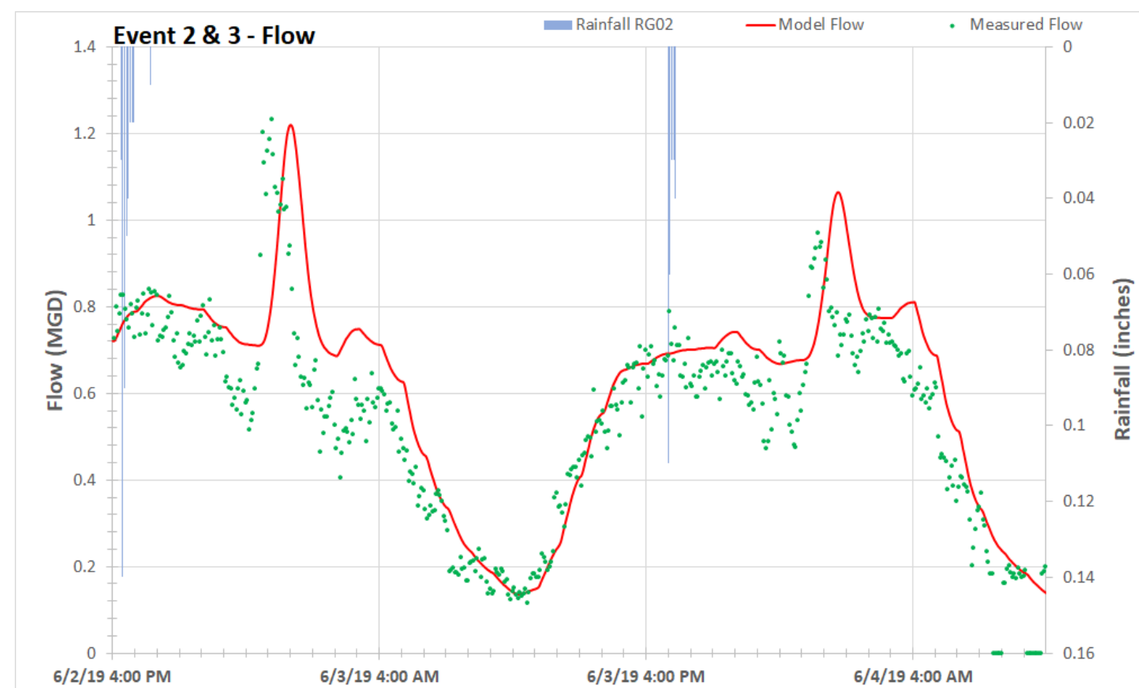
FM 09 - Eight Street Basin









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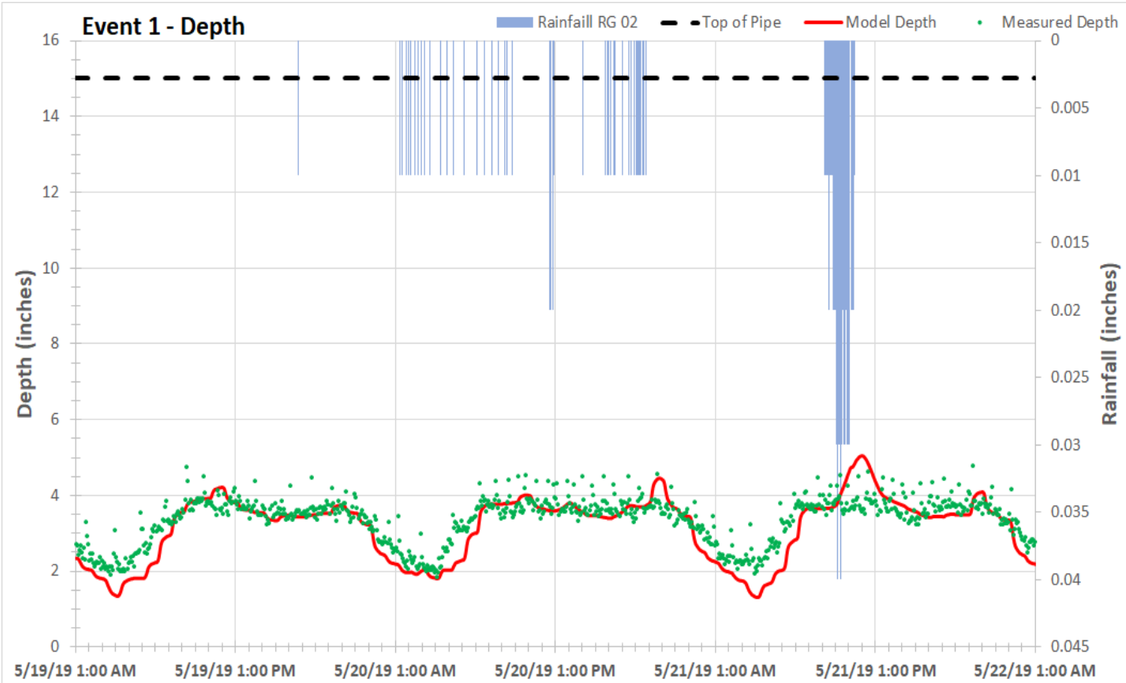
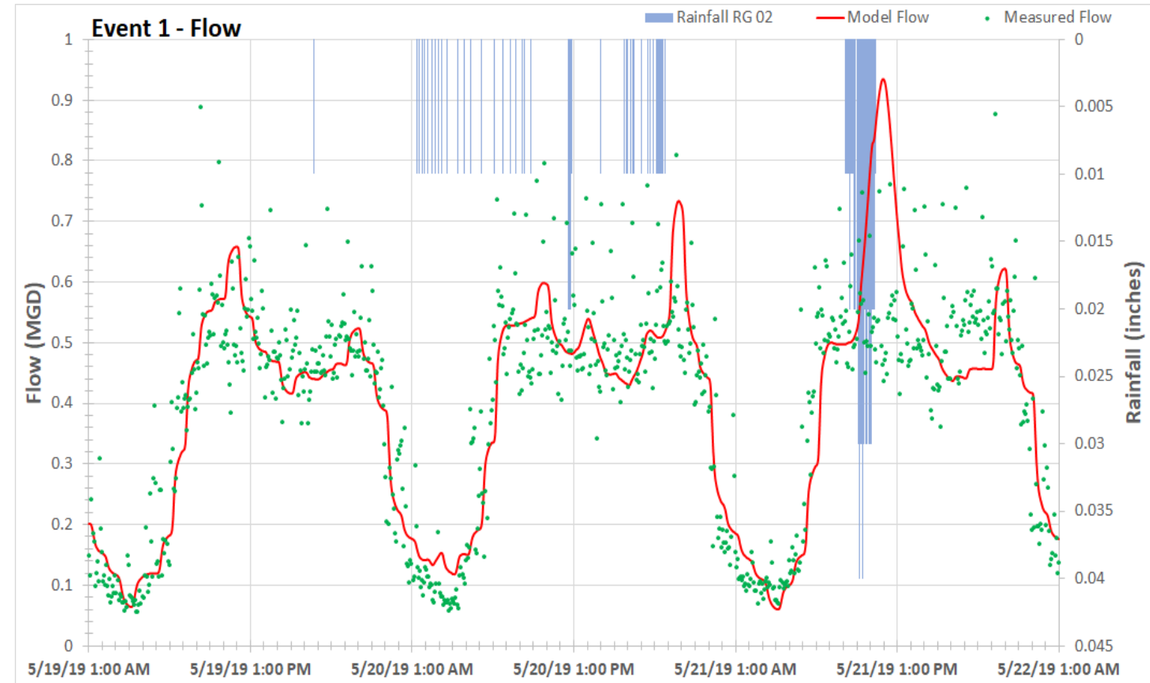
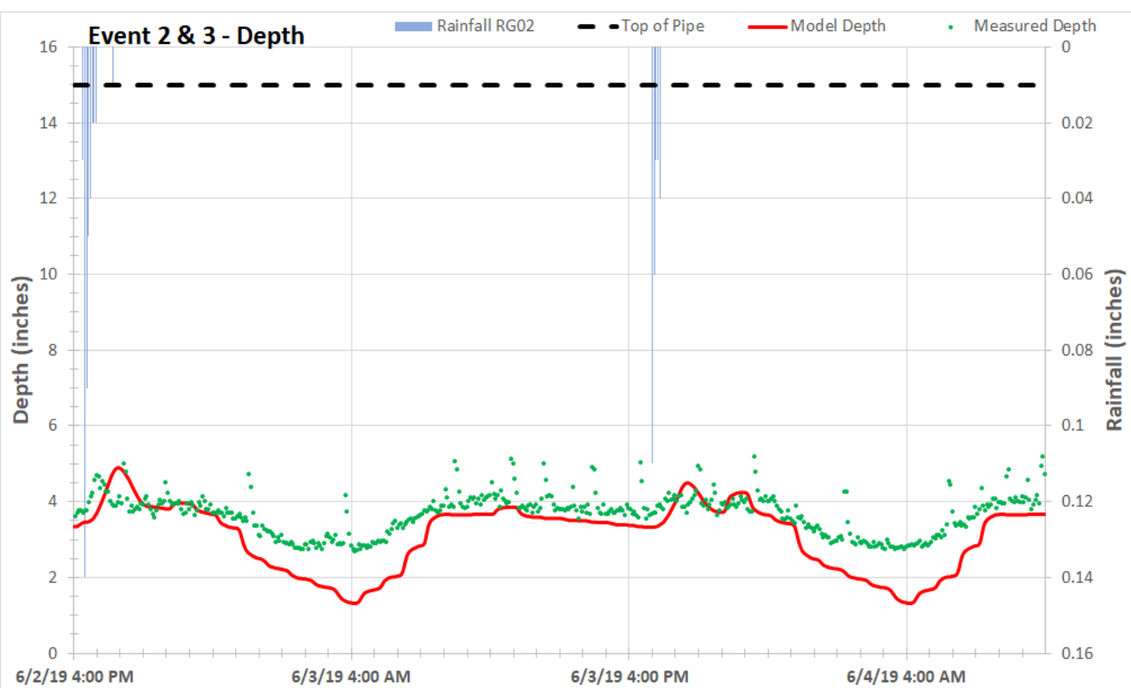
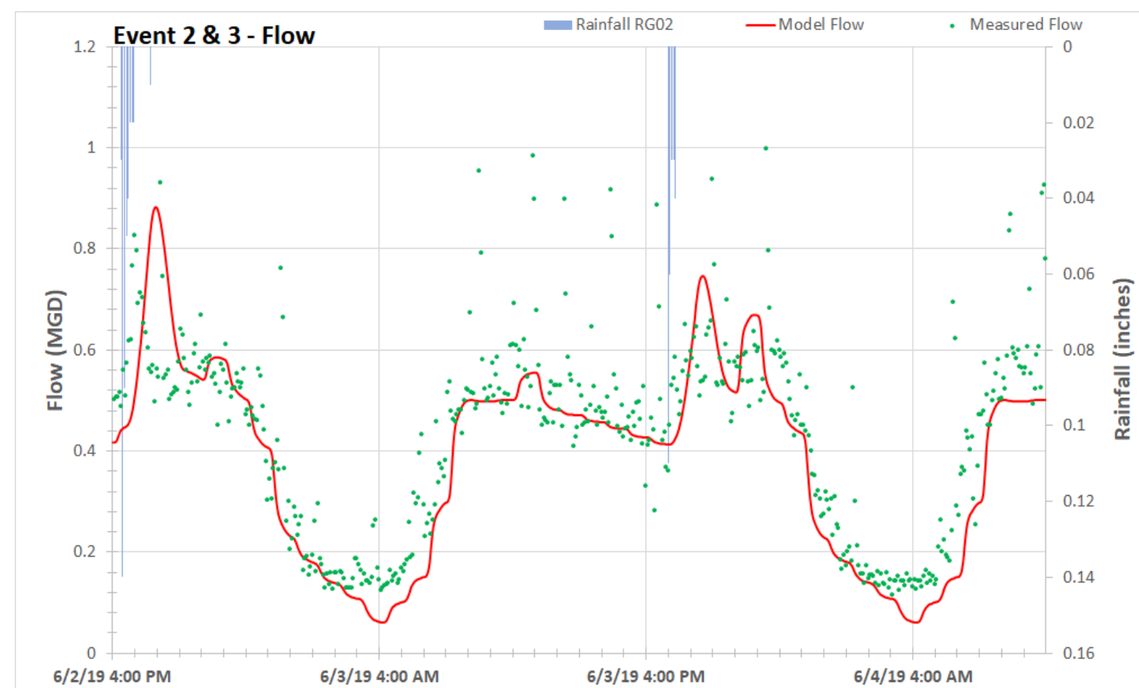
FM 10 - Central Basin









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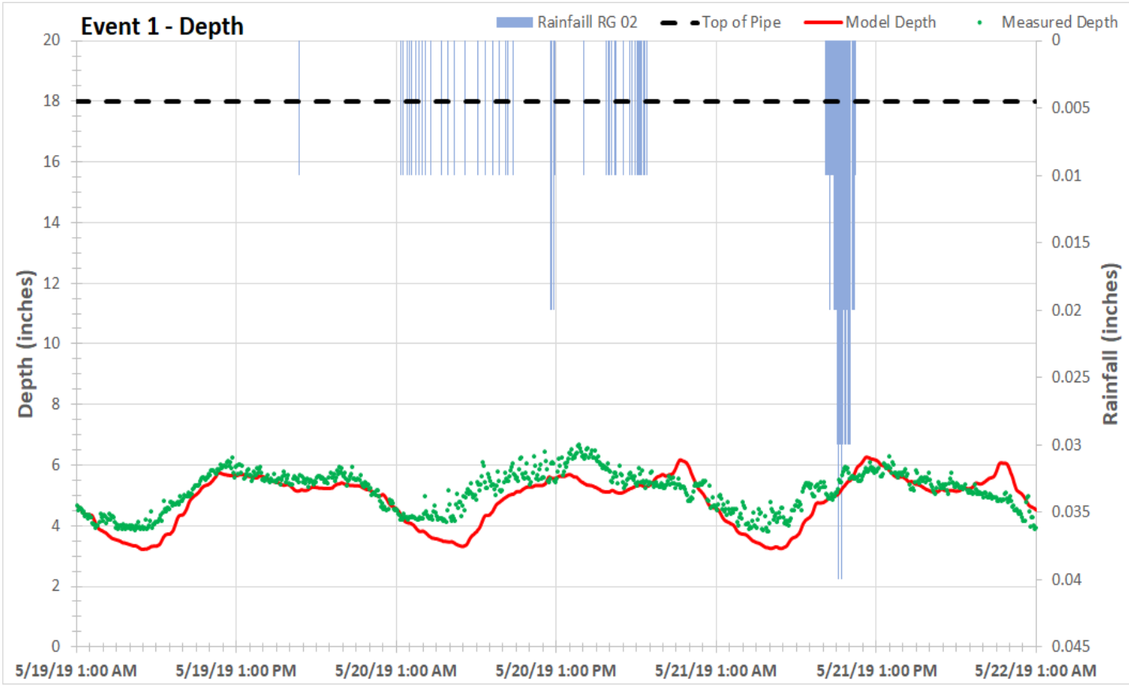
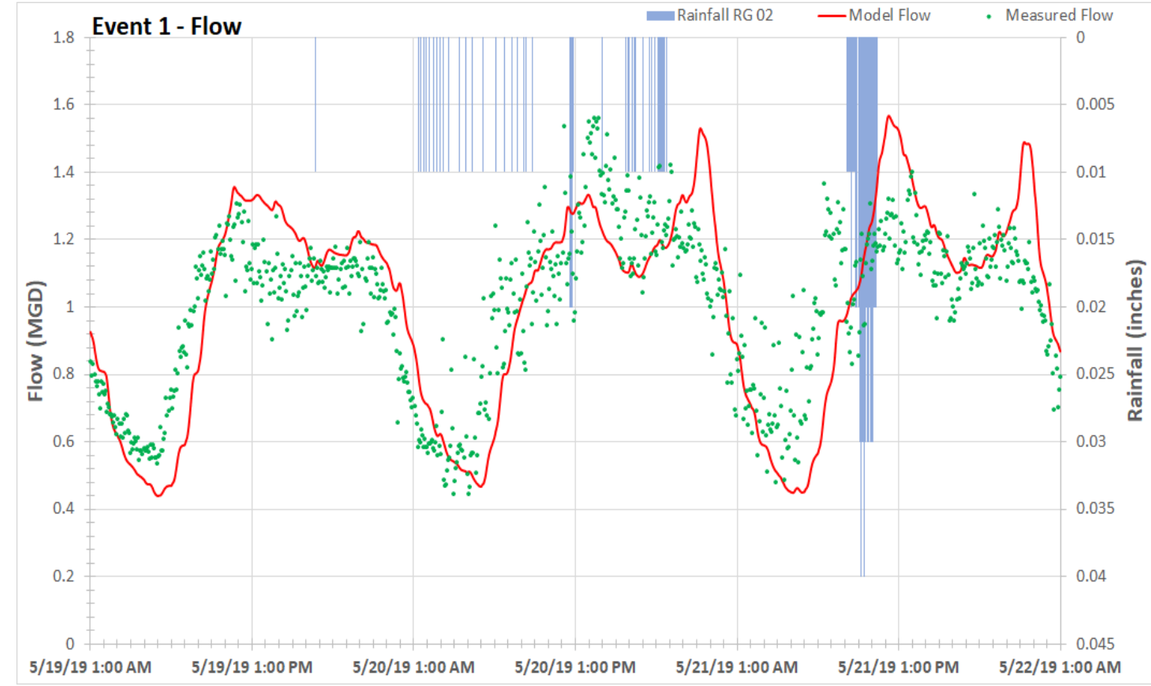
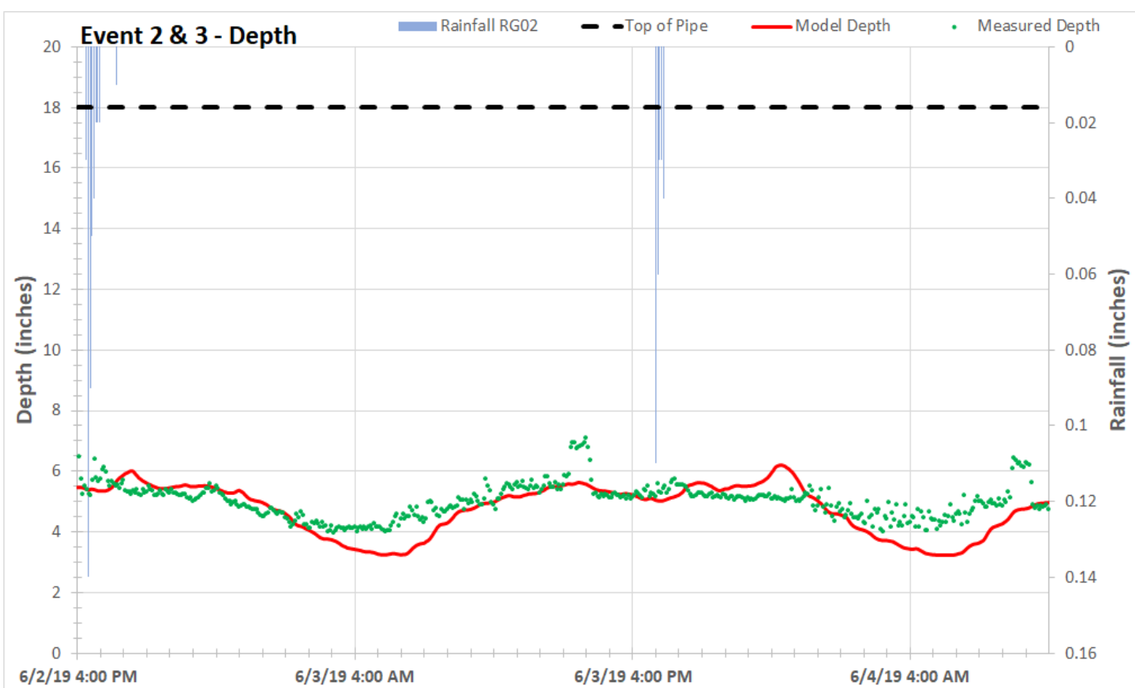
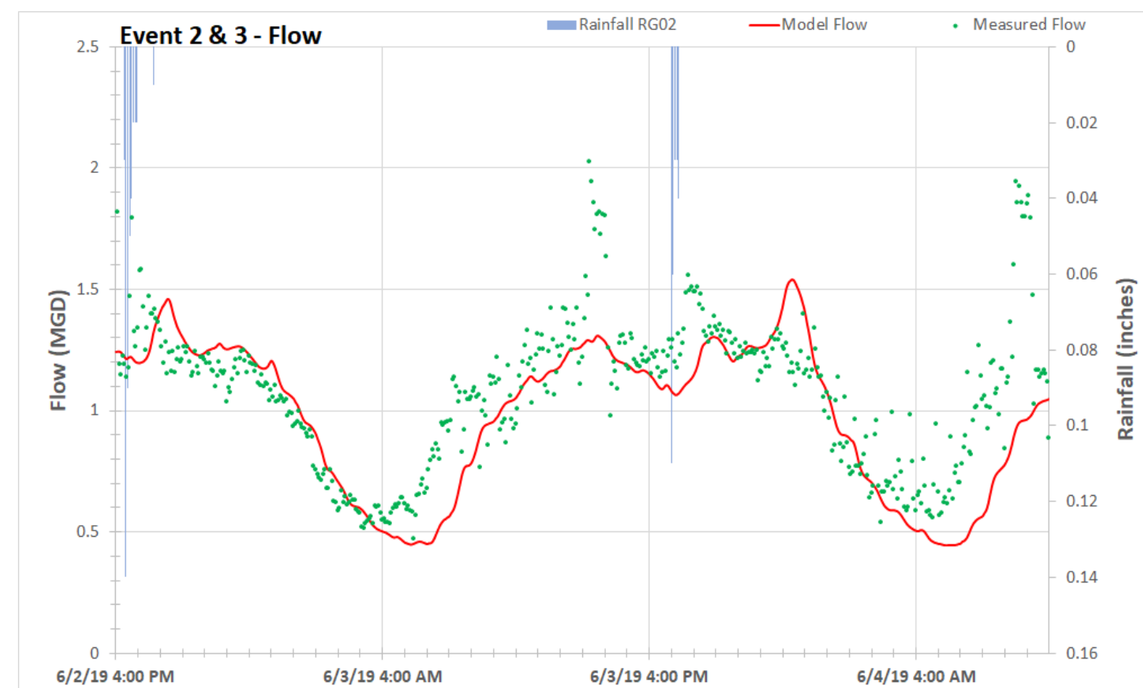
FM 11 - South Basin









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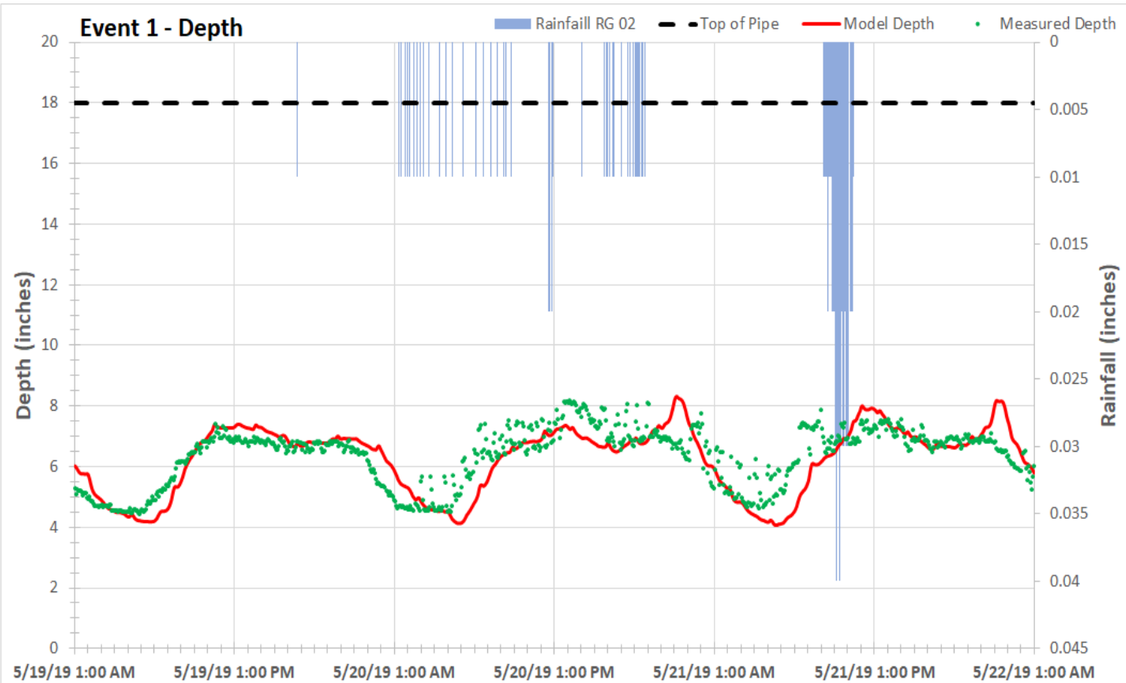
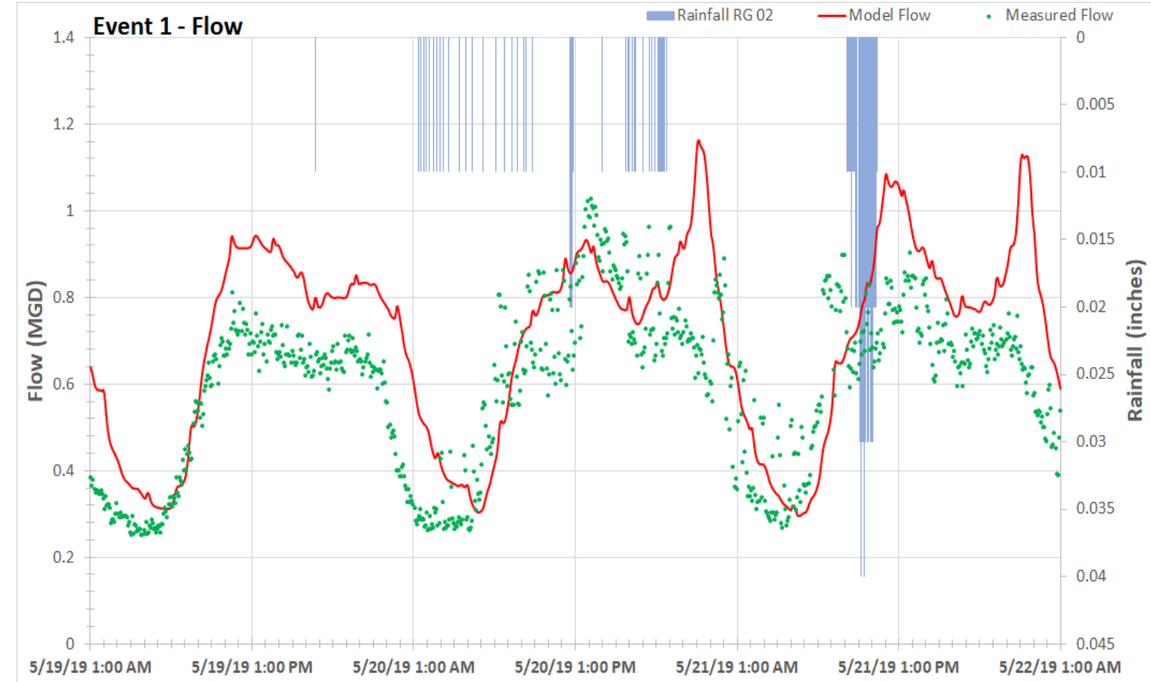
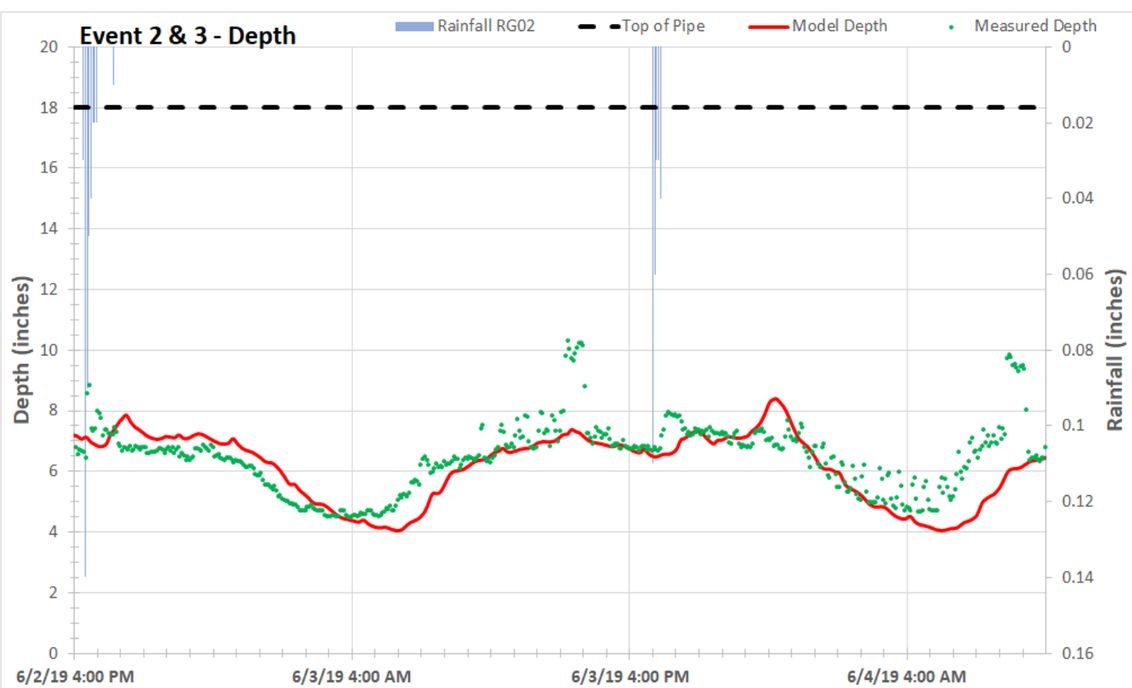
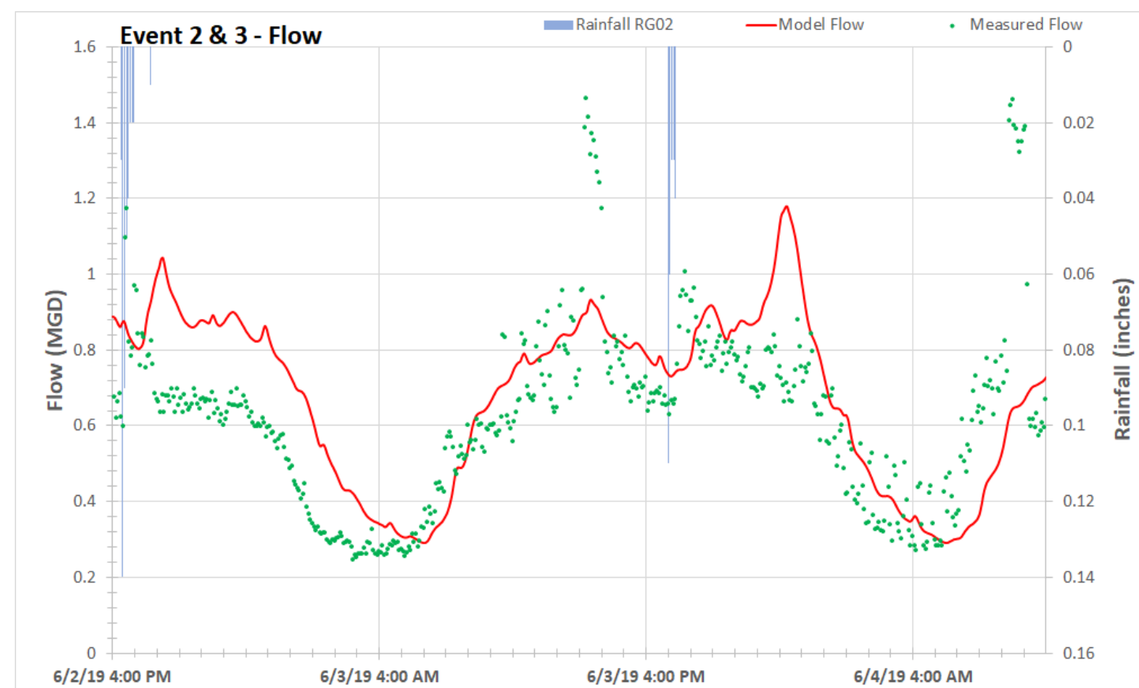
FM 11/12 - South Basin









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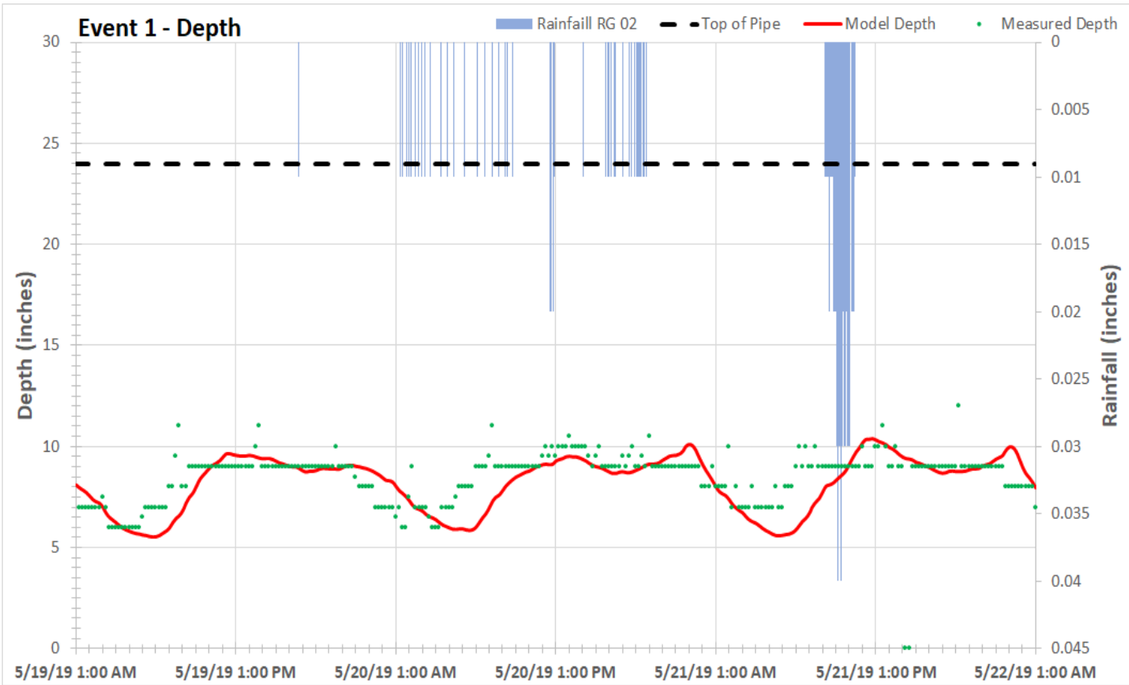
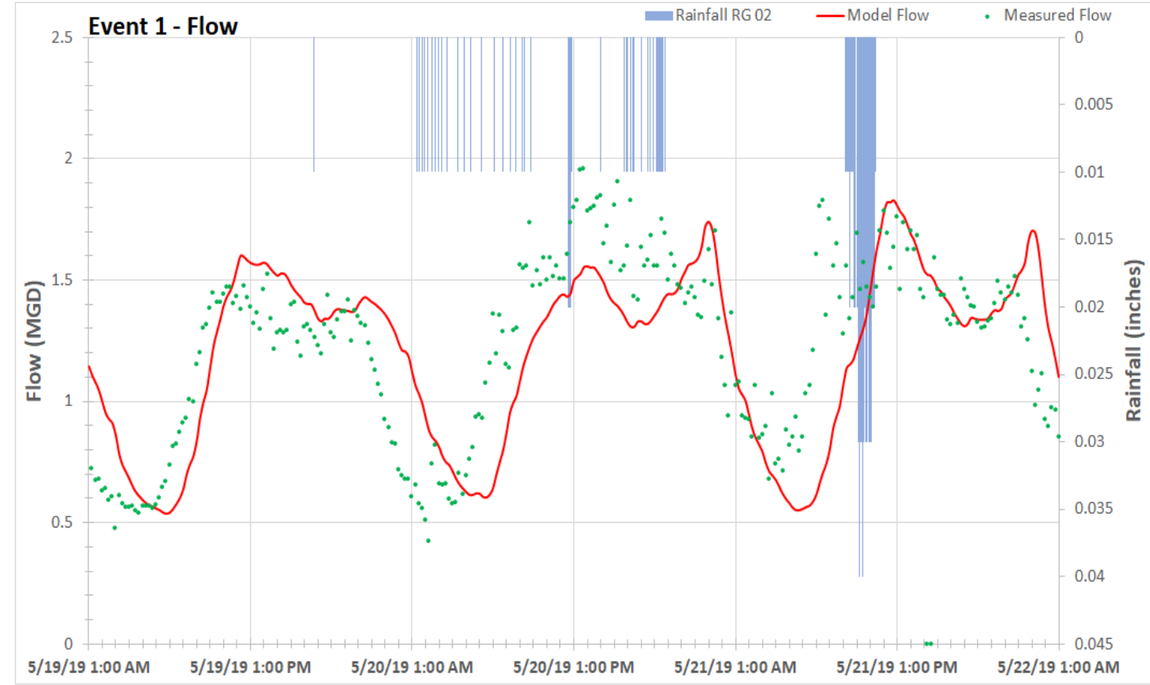
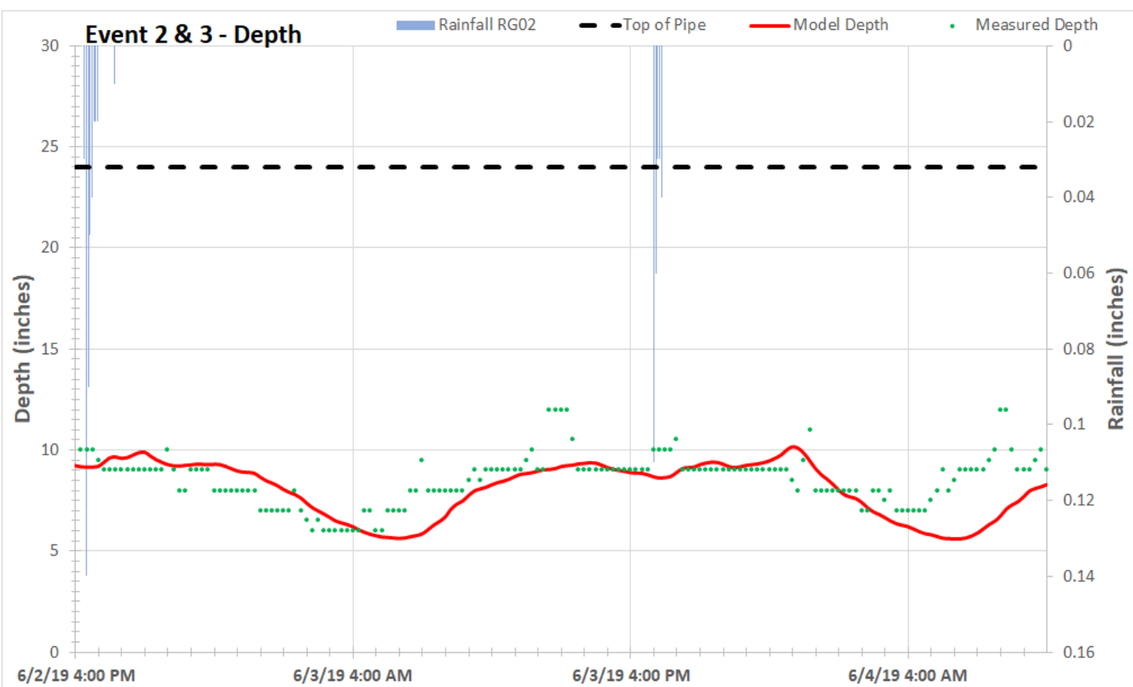
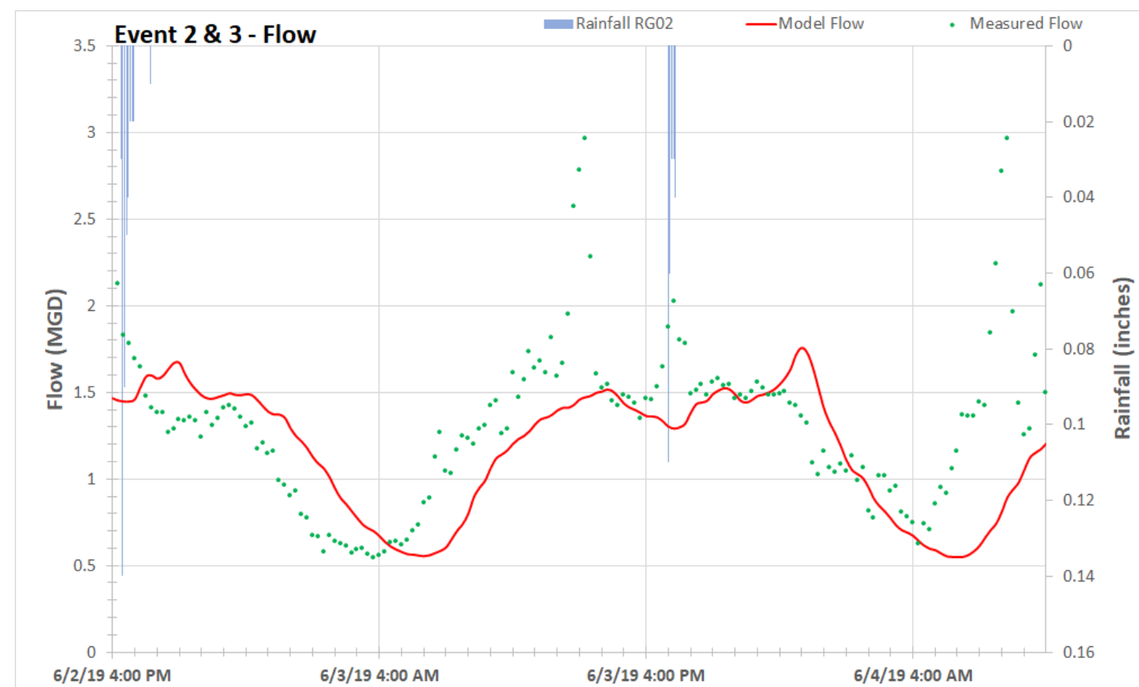
FM 01 - 00.002


Event 1 - Depth
Rainfall RG 02
Top of Pipe
Model Depth
Measured Depth
Depth (inches)
Rainfall (inches)
5/19/19 1:00 AM
5/19/19 1:00 PM
5/20/19 1:00 AM
5/20/19 1:00 PM
5/21/19 1:00 AM
5/21/19 1:00 PM
5/22/19 1:00 AM


Event 1 - Flow
Rainfall RG 02
Model Flow
Measured Flow
Flow (MGD)
Rainfall (inches)
5/19/19 1:00 AM
5/19/19 1:00 PM
5/20/19 1:00 AM
5/20/19 1:00 PM
5/21/19 1:00 AM
5/21/19 1:00 PM
5/22/19 1:00 AM


Event 2 & 3 - Depth
Rainfall RG02
Top of Pipe
Model Depth
Measured Depth
Depth (inches)
Rainfall (inches)
6/2/19 4:00 PM
6/3/19 4:00 AM
6/3/19 4:00 PM
6/4/19 4:00 AM


Event 2 & 3 - Flow
Rainfall RG02
Model Flow
Measured Flow
Flow (MGD)
Rainfall (inches)
6/2/19 4:00 PM
6/3/19 4:00 AM
6/3/19 4:00 PM
6/4/19 4:00 AM

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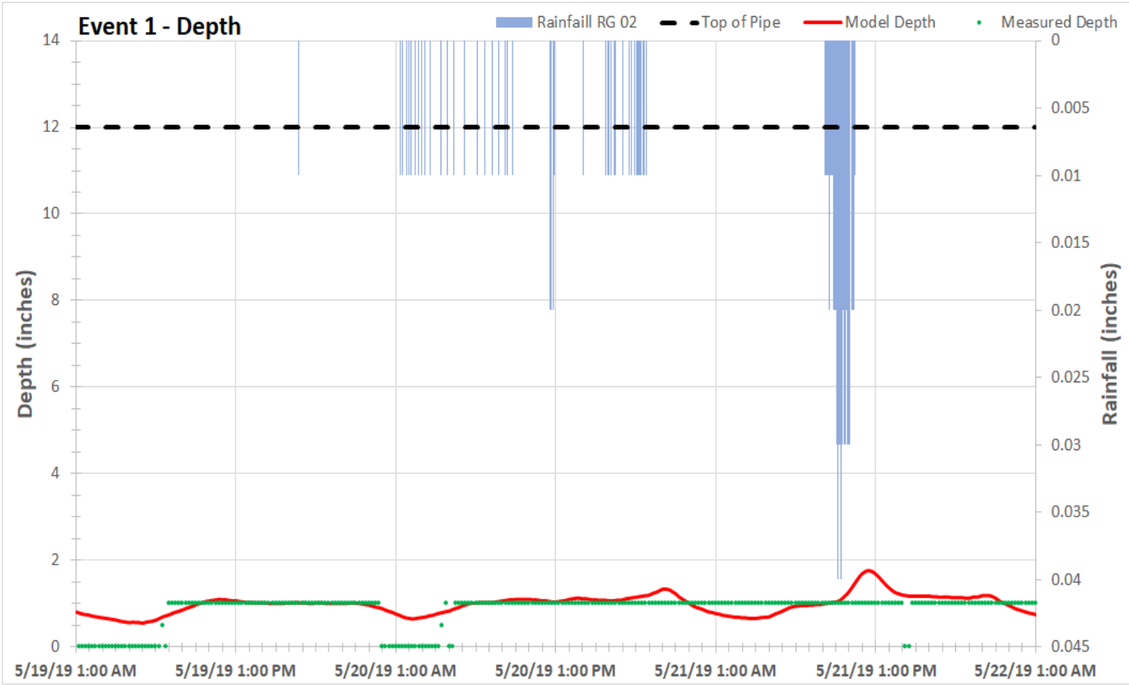
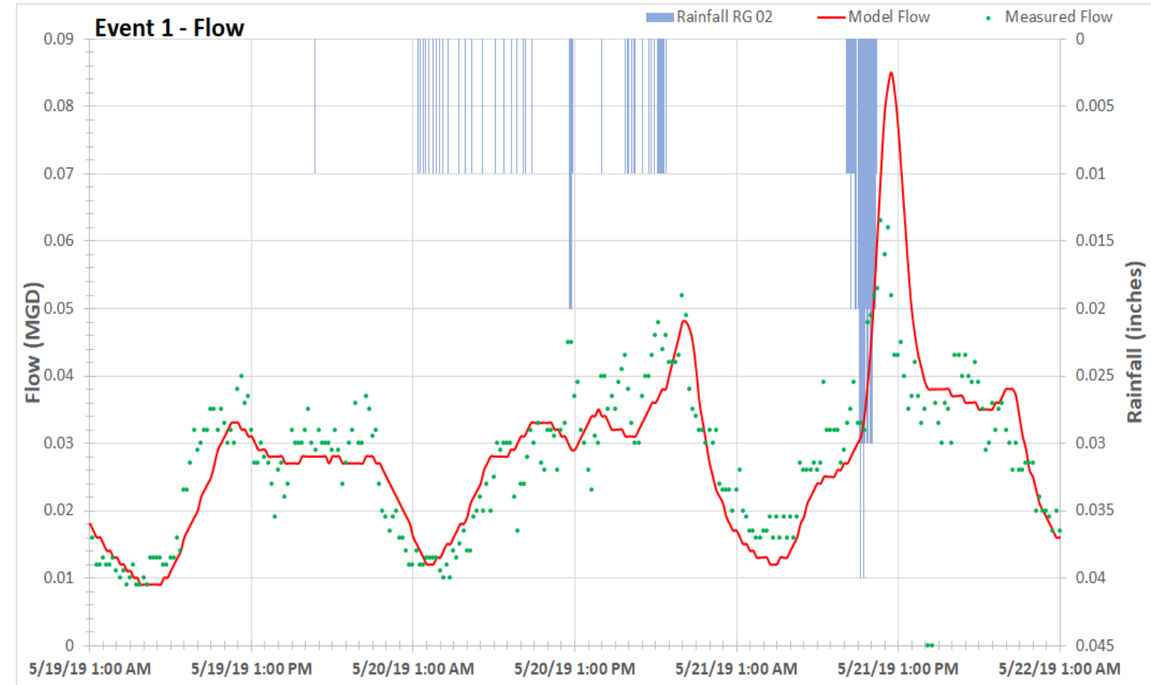
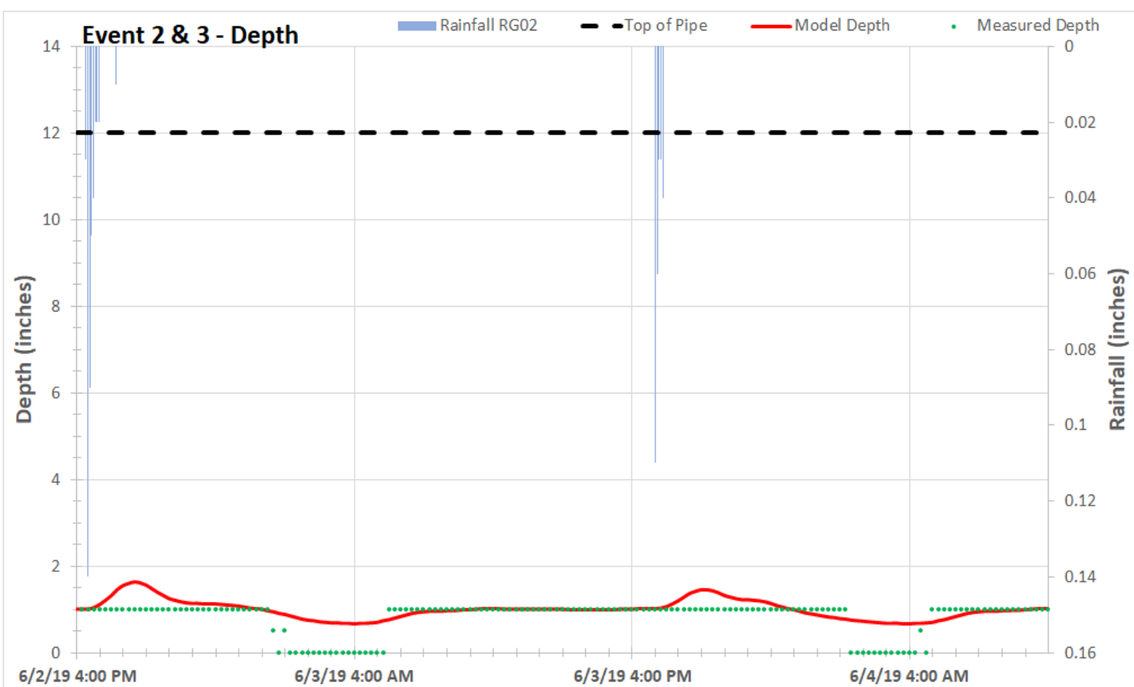
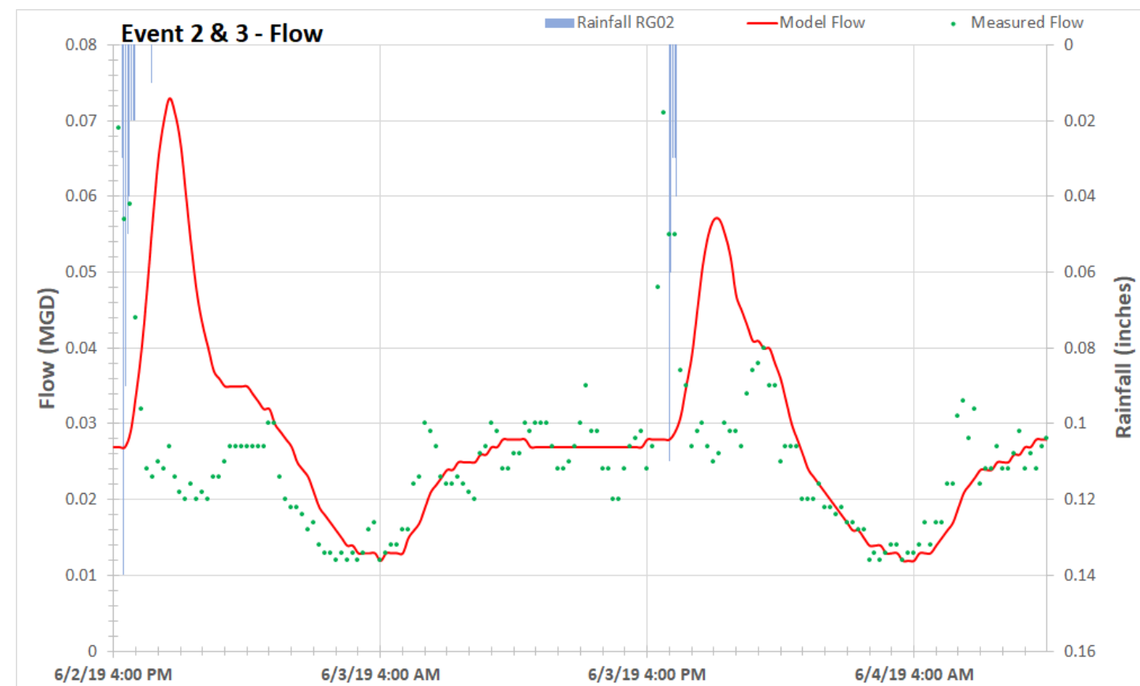
FM 02 - 00.002


Event 1 - Depth
Rainfaill RG 02
Top of Pipe
Model Depth
Measured Depth
Depth (inches)
Rainfall (inches)
5/19/19 1:00 AM
5/19/19 1:00 PM
5/20/19 1:00 AM
5/20/19 1:00 PM
5/21/19 1:00 AM
5/21/19 1:00 PM
5/22/19 1:00 AM


Event 1 - Flow
Rainfall RG 02
Model Flow
Measured Flow
Flow (MGD)
Rainfall (inches)
5/19/19 1:00 AM
5/19/19 1:00 PM
5/20/19 1:00 AM
5/20/19 1:00 PM
5/21/19 1:00 AM
5/21/19 1:00 PM
5/22/19 1:00 AM


Event 2 & 3 - Depth
Rainfall RG02
Top of Pipe
Model Depth
Measured Depth
Depth (inches)
Rainfall (inches)
6/2/19 4:00 PM
6/3/19 4:00 AM
6/3/19 4:00 PM
6/4/19 4:00 AM


Event 2 & 3 - Flow
Rainfall RG02
Model Flow
Measured Flow
Flow (MGD)
Rainfall (inches)
6/2/19 4:00 PM
6/3/19 4:00 AM
6/3/19 4:00 PM
6/4/19 4:00 AM

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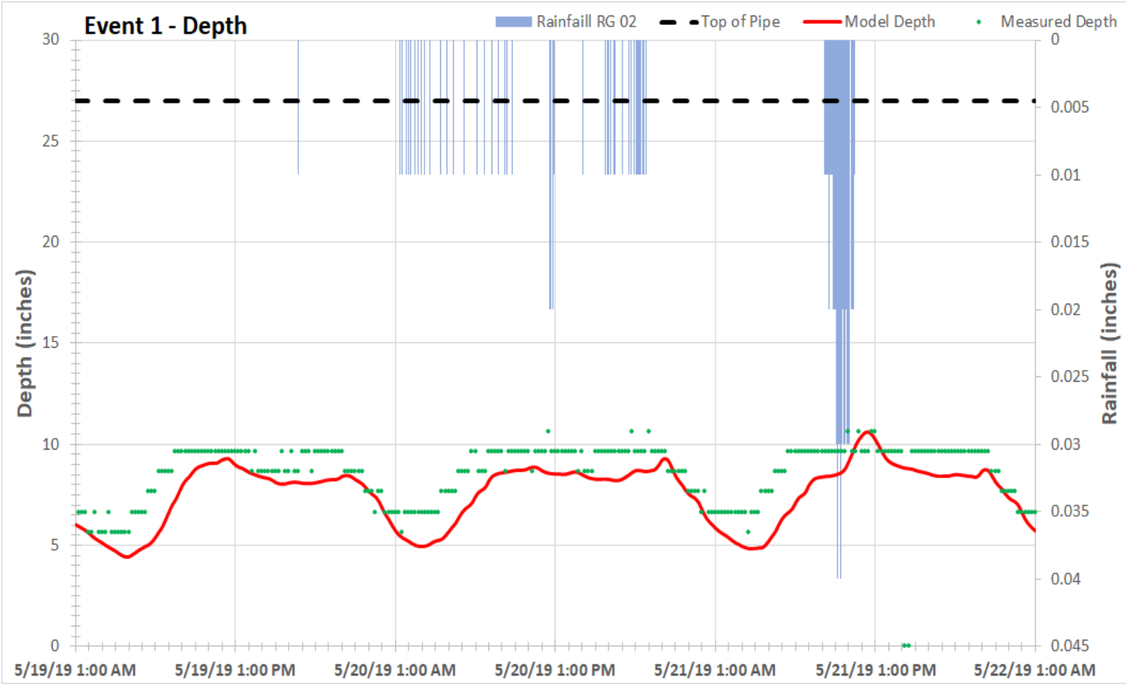
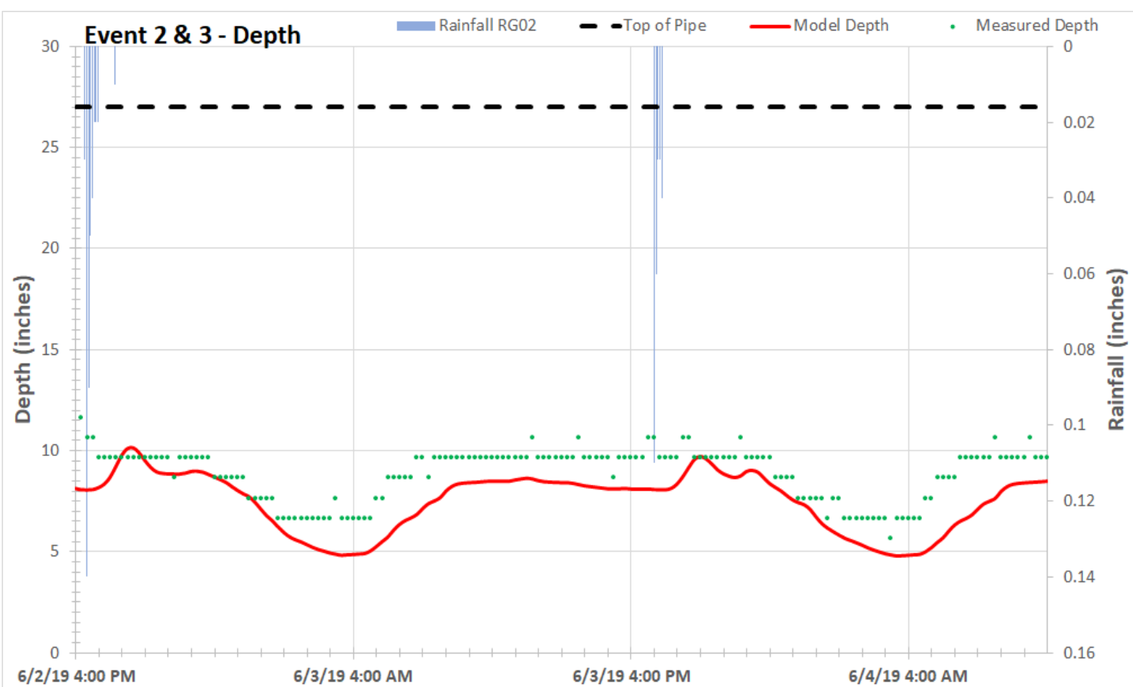
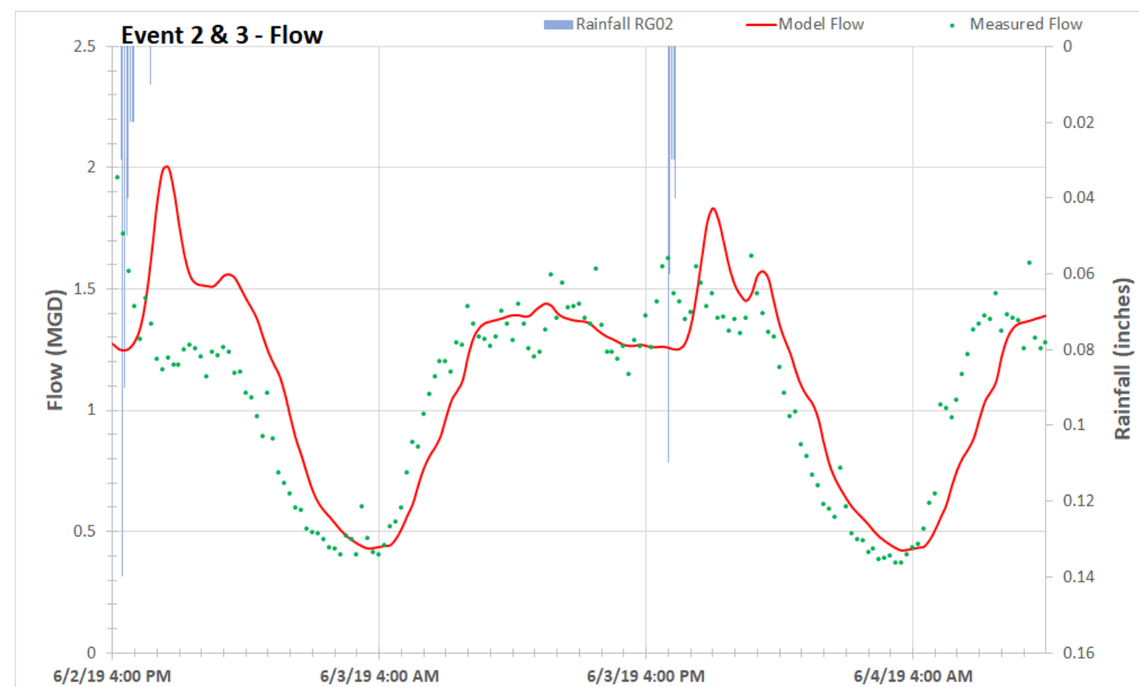
FM 03 - 00.042


Event 1 - Depth
Rainfall RG 02
Top of Pipe
Model Depth
Measured Depth
Depth (inches)
Rainfall (inches)
5/19/19 1:00 AM
5/19/19 1:00 PM
5/20/19 1:00 AM
5/20/19 1:00 PM
5/21/19 1:00 AM
5/21/19 1:00 PM
5/22/19 1:00 AM

Event 1 - Flow
Rainfall RG 02
Model Flow
Measured Flow
Flow (MGD)
Rainfall (inches)
5/19/19 1:00 AM
5/19/19 1:00 PM
5/20/19 1:00 AM
5/20/19 1:00 PM
5/21/19 1:00 AM
5/21/19 1:00 PM
5/22/19 1:00 AM


Event 2 & 3 - Depth
Rainfall RG02
Top of Pipe
Model Depth
Measured Depth
Depth (inches)
Rainfall (inches)
6/2/19 4:00 PM
6/3/19 4:00 AM
6/3/19 4:00 PM
6/4/19 4:00 AM


Event 2 & 3 - Flow
Rainfall RG02
Model Flow
Measured Flow
Flow (MGD)
Rainfall (inches)
6/2/19 4:00 PM
6/3/19 4:00 AM
6/3/19 4:00 PM
6/4/19 4:00 AM

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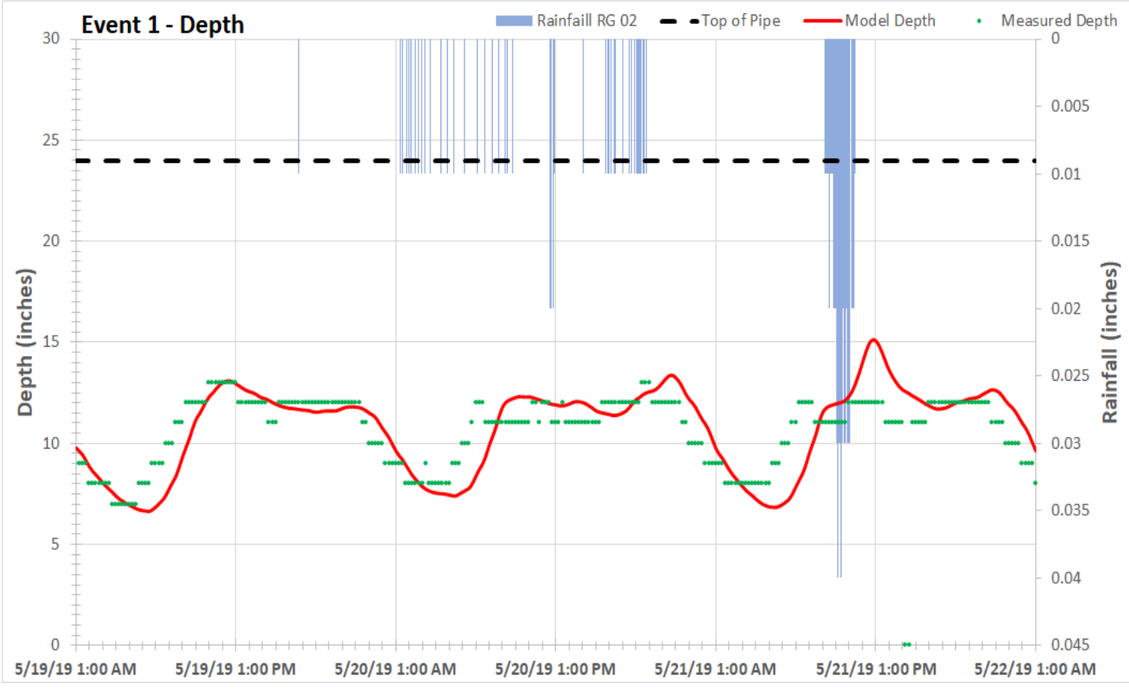
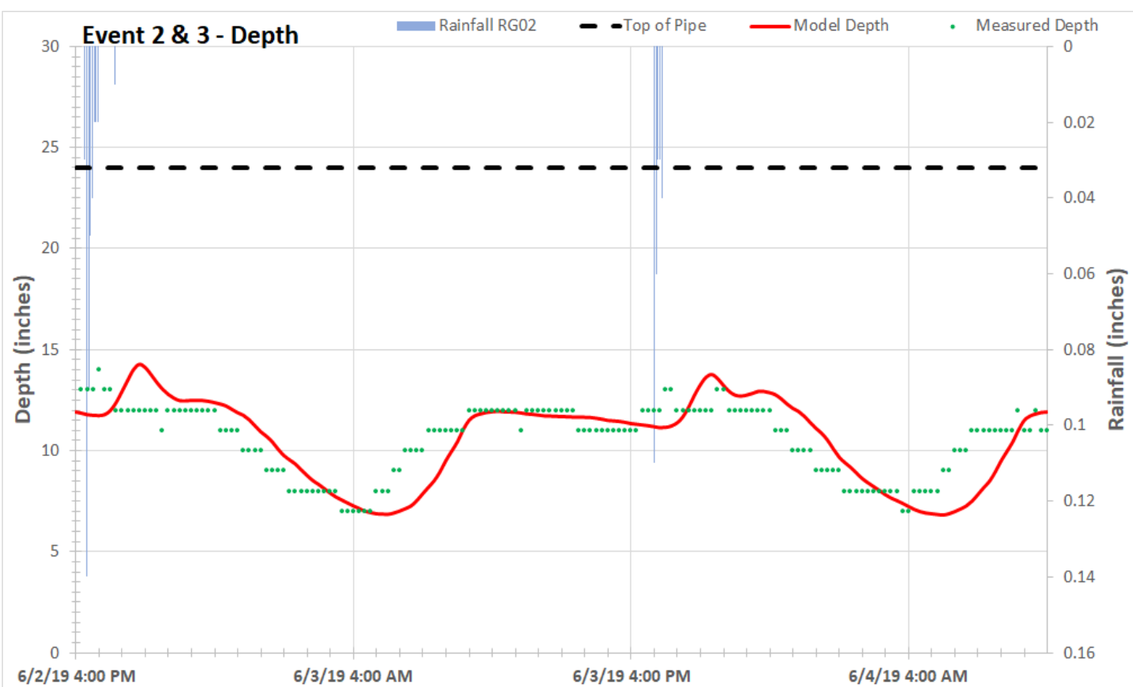
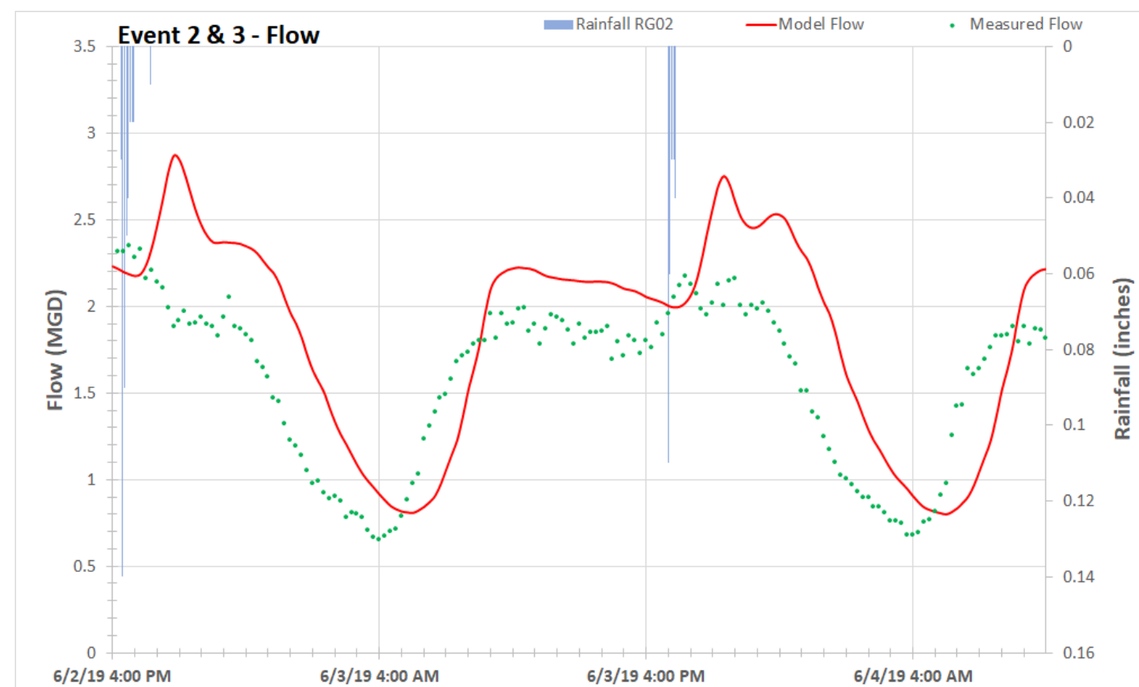
FM 05 - 00.003


Event 1 - Depth
Rainfaill RG 02
Top of Pipe
Model Depth
Measured Depth
Depth (inches)
Rainfall (inches)
5/19/19 1:00 AM
5/19/19 1:00 PM
5/20/19 1:00 AM
5/20/19 1:00 PM
5/21/19 1:00 AM
5/21/19 1:00 PM
5/22/19 1:00 AM

Event 1 - Flow
Rainfall RG 02
Model Flow
Measured Flow
Flow (MGD)
Rainfall (inches)
5/19/19 1:00 AM
5/19/19 1:00 PM
5/20/19 1:00 AM
5/20/19 1:00 PM
5/21/19 1:00 AM
5/21/19 1:00 PM
5/22/19 1:00 AM


Event 2 & 3 - Depth
Rainfall RG02
Top of Pipe
Model Depth
Measured Depth
Depth (inches)
Rainfall (inches)
6/2/19 4:00 PM
6/3/19 4:00 AM
6/3/19 4:00 PM
6/4/19 4:00 AM


Event 2 & 3 - Flow
Rainfall RG02
Model Flow
Measured Flow
Flow (MGD)
Rainfall (inches)
6/2/19 4:00 PM
6/3/19 4:00 AM
6/3/19 4:00 PM
6/4/19 4:00 AM

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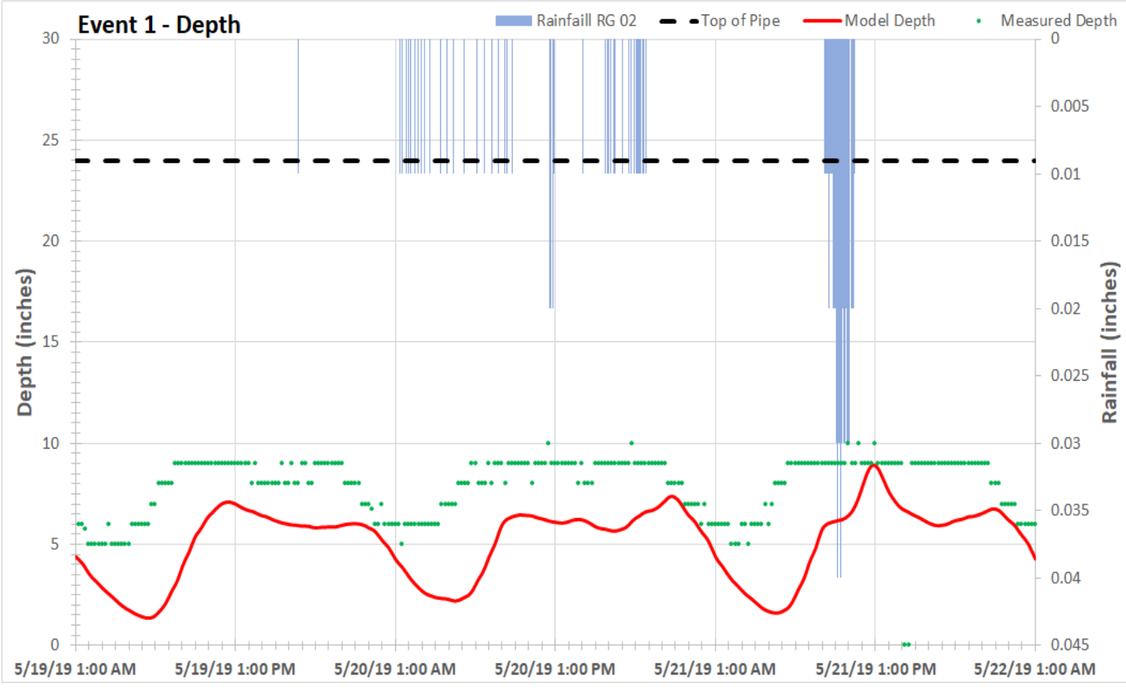
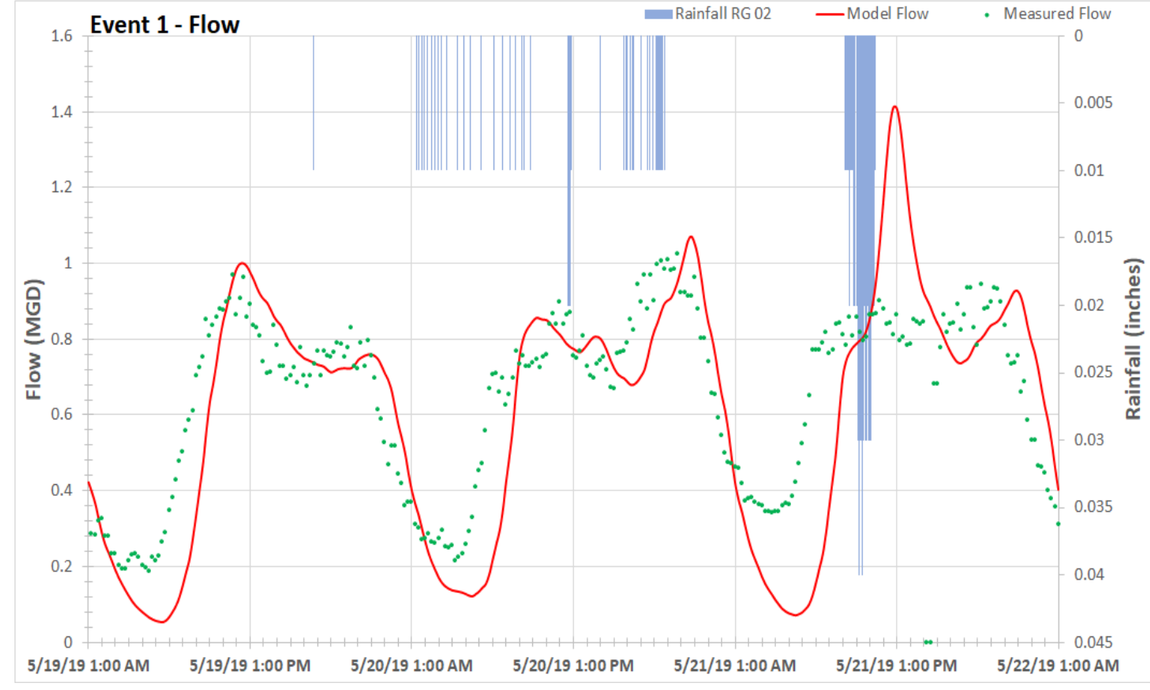
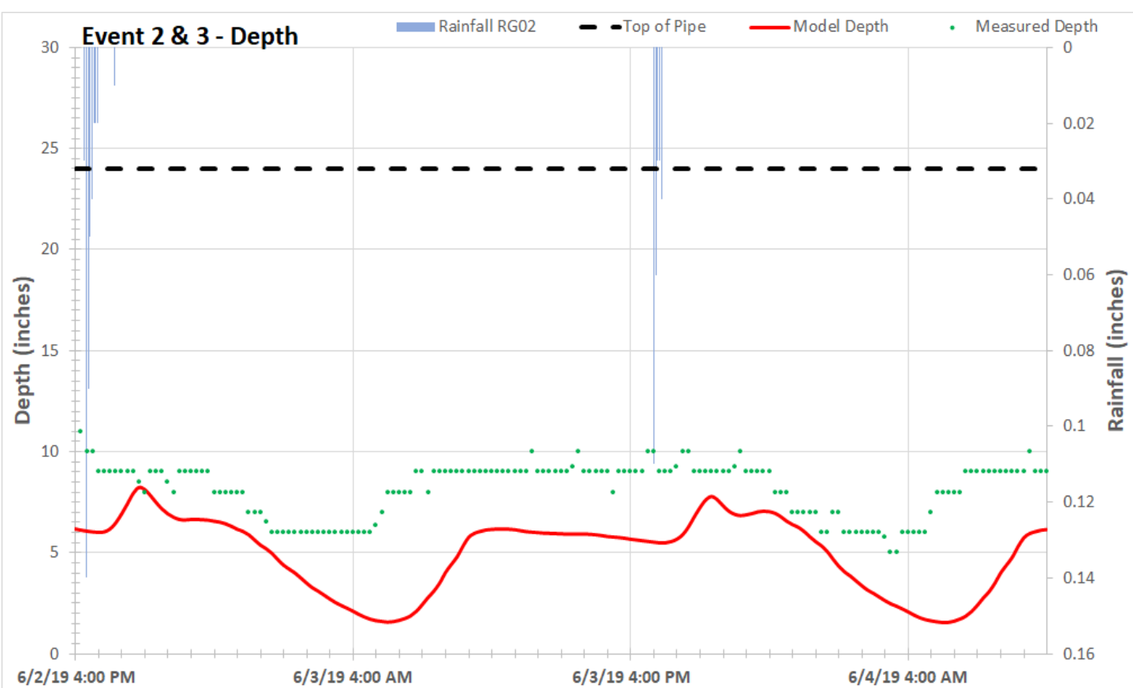
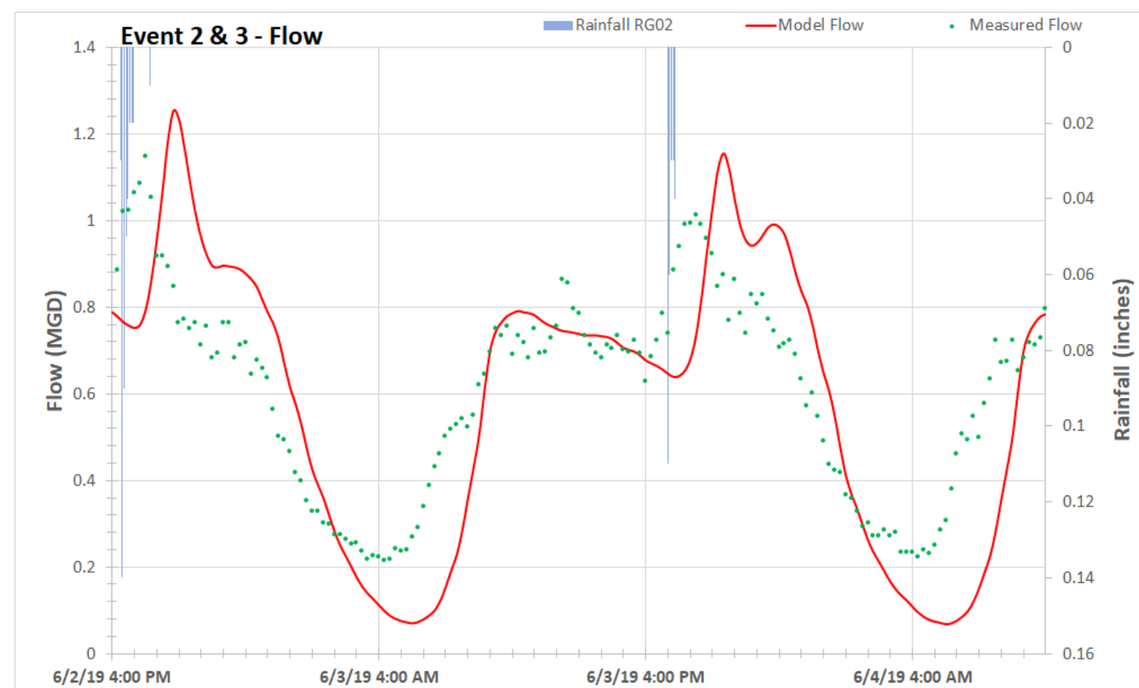
FM 07 - 00.003


Event 1 - Depth
Rainfaill RG 02
Top of Pipe
Model Depth
Measured Depth
Depth (inches)
Rainfall (inches)
5/19/19 1:00 AM
5/19/19 1:00 PM
5/20/19 1:00 AM
5/20/19 1:00 PM
5/21/19 1:00 AM
5/21/19 1:00 PM
5/22/19 1:00 AM


Event 1 - Flow
Rainfall RG 02
Model Flow
Measured Flow
Flow (MGD)
Rainfall (inches)
5/19/19 1:00 AM
5/19/19 1:00 PM
5/20/19 1:00 AM
5/20/19 1:00 PM
5/21/19 1:00 AM
5/21/19 1:00 PM
5/22/19 1:00 AM


Event 2 & 3 - Depth
Rainfall RG02
Top of Pipe
Model Depth
Measured Depth
Depth (inches)
Rainfall (inches)
6/2/19 4:00 PM
6/3/19 4:00 AM
6/3/19 4:00 PM
6/4/19 4:00 AM


Event 2 & 3 - Flow
Rainfall RG02
Model Flow
Measured Flow
Flow (MGD)
Rainfall (inches)
6/2/19 4:00 PM
6/3/19 4:00 AM
6/3/19 4:00 PM
6/4/19 4:00 AM

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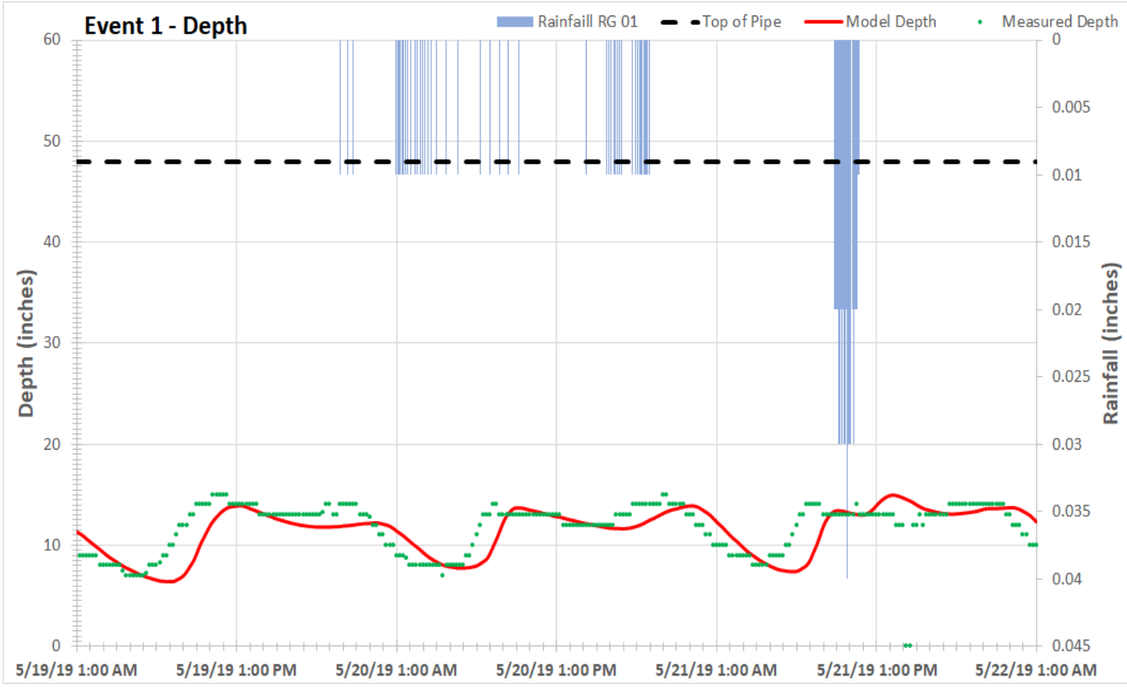
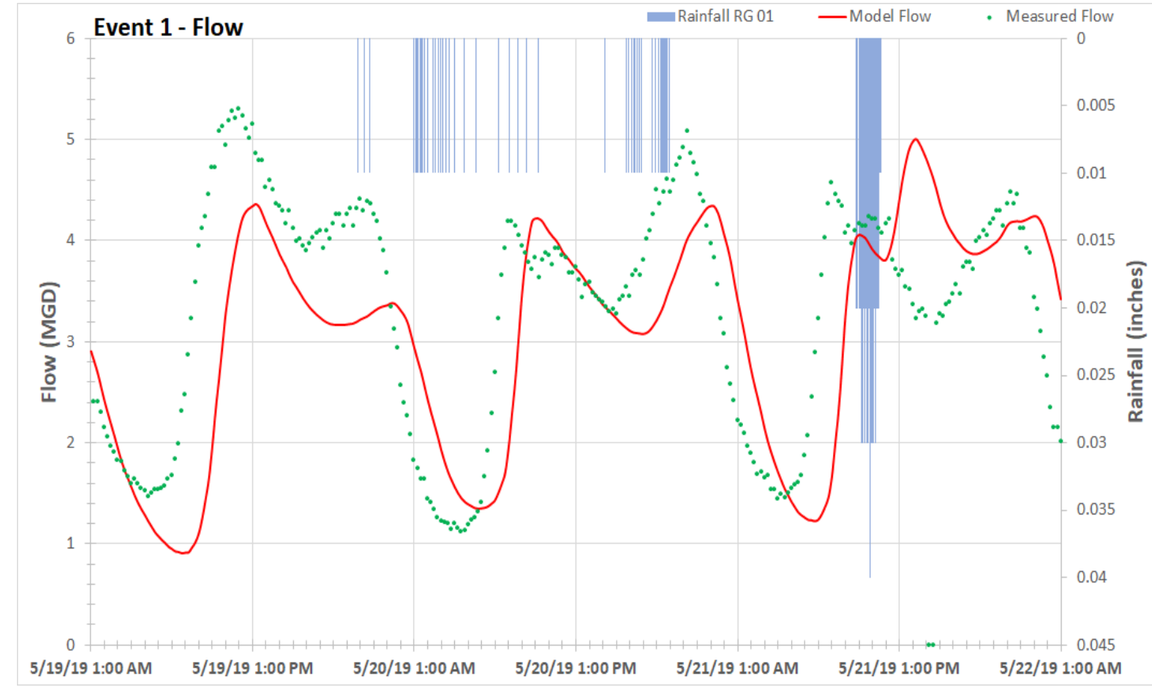
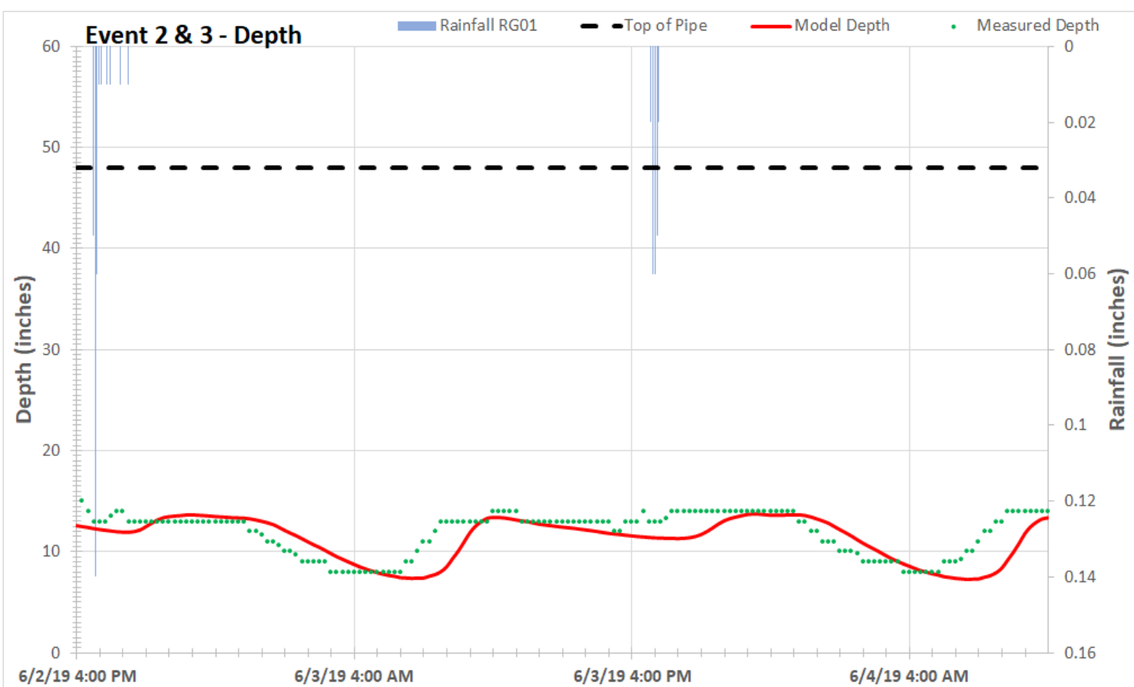
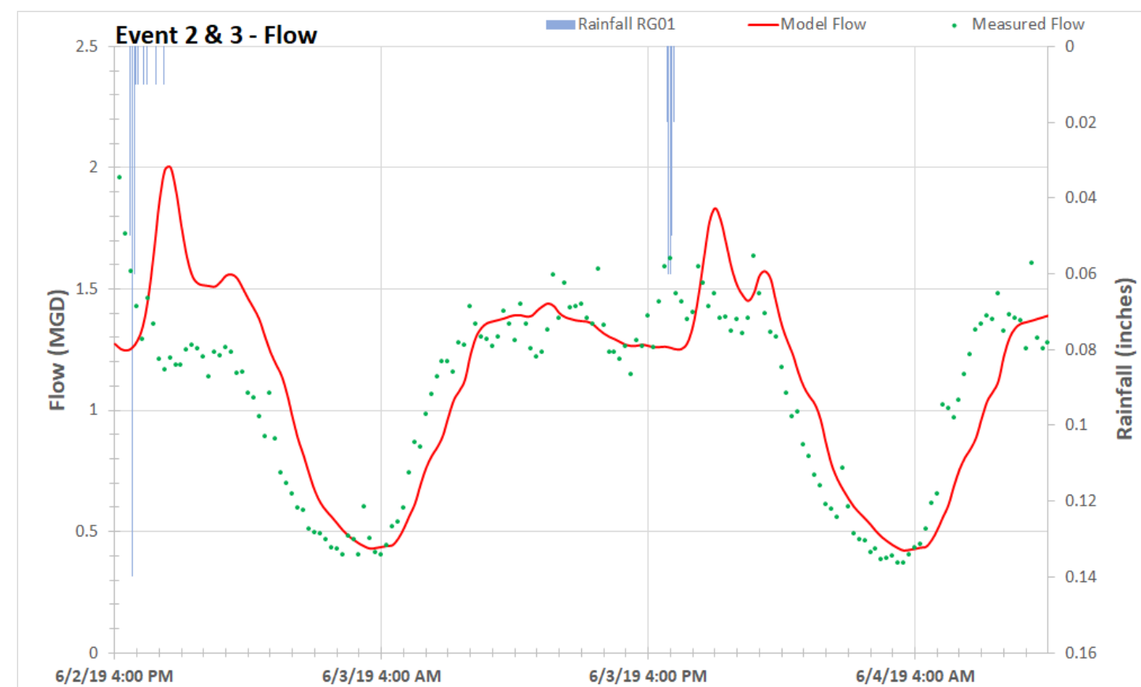
FM 08 - 00.010


Event 1 - Depth
Rainfall RG 01
Top of Pipe
Model Depth
Measured Depth
Depth (inches)
Rainfall (inches)
5/19/19 1:00 AM
5/19/19 1:00 PM
5/20/19 1:00 AM
5/20/19 1:00 PM
5/21/19 1:00 AM
5/21/19 1:00 PM
5/22/19 1:00 AM


Event 1 - Flow
Rainfall RG 01
Model Flow
Measured Flow
Flow (MGD)
Rainfall (inches)
5/19/19 1:00 AM
5/19/19 1:00 PM
5/20/19 1:00 AM
5/20/19 1:00 PM
5/21/19 1:00 AM
5/21/19 1:00 PM
5/22/19 1:00 AM


Event 2 & 3 - Depth
Rainfall RG01
Top of Pipe
Model Depth
Measured Depth
Depth (inches)
Rainfall (inches)
6/2/19 4:00 PM
6/3/19 4:00 AM
6/3/19 4:00 PM
6/4/19 4:00 AM


Event 2 & 3 - Flow
Rainfall RG01
Model Flow
Measured Flow
Flow (MGD)
Rainfall (inches)
6/2/19 4:00 PM
6/3/19 4:00 AM
6/3/19 4:00 PM
6/4/19 4:00 AM

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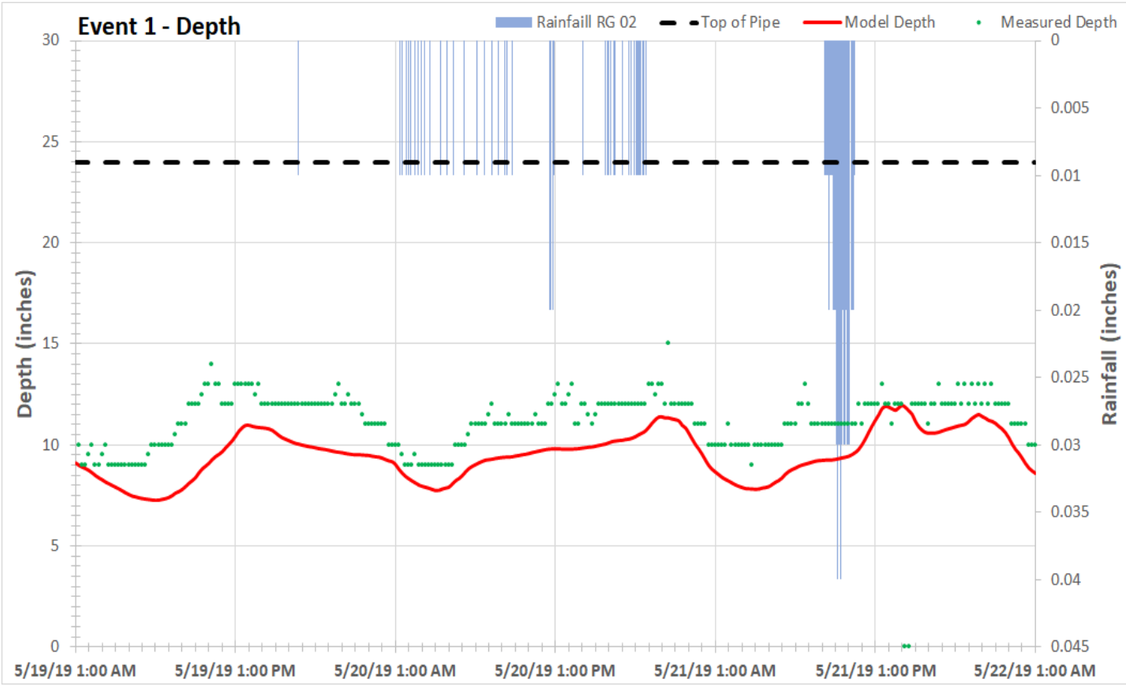
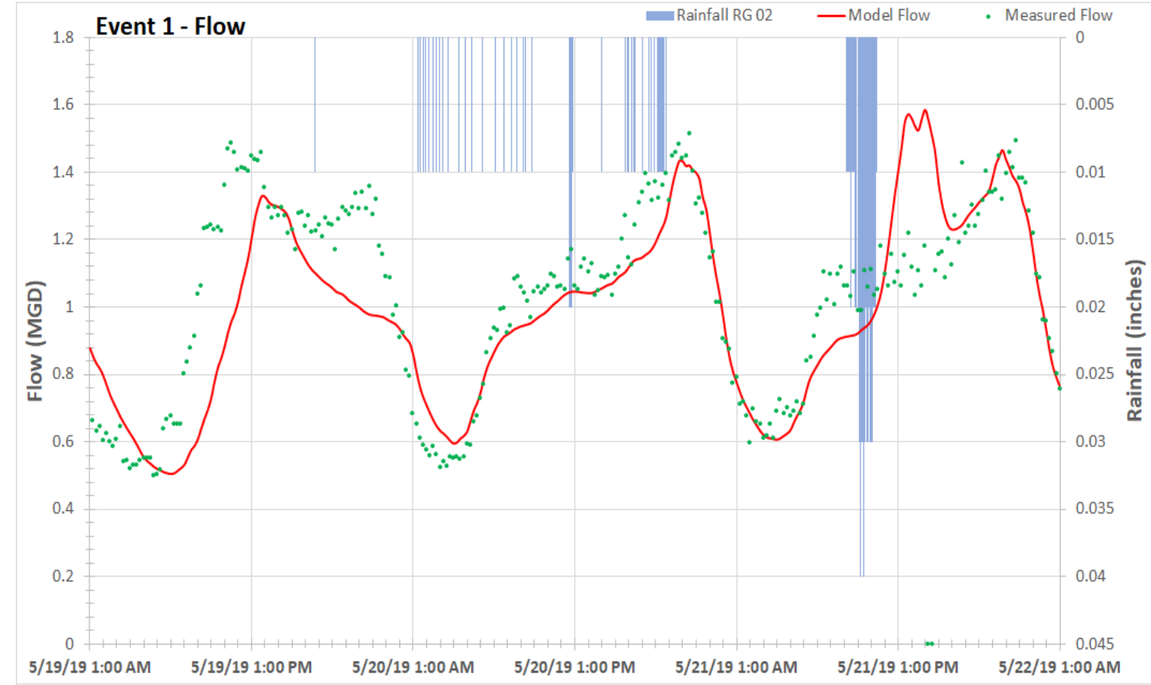
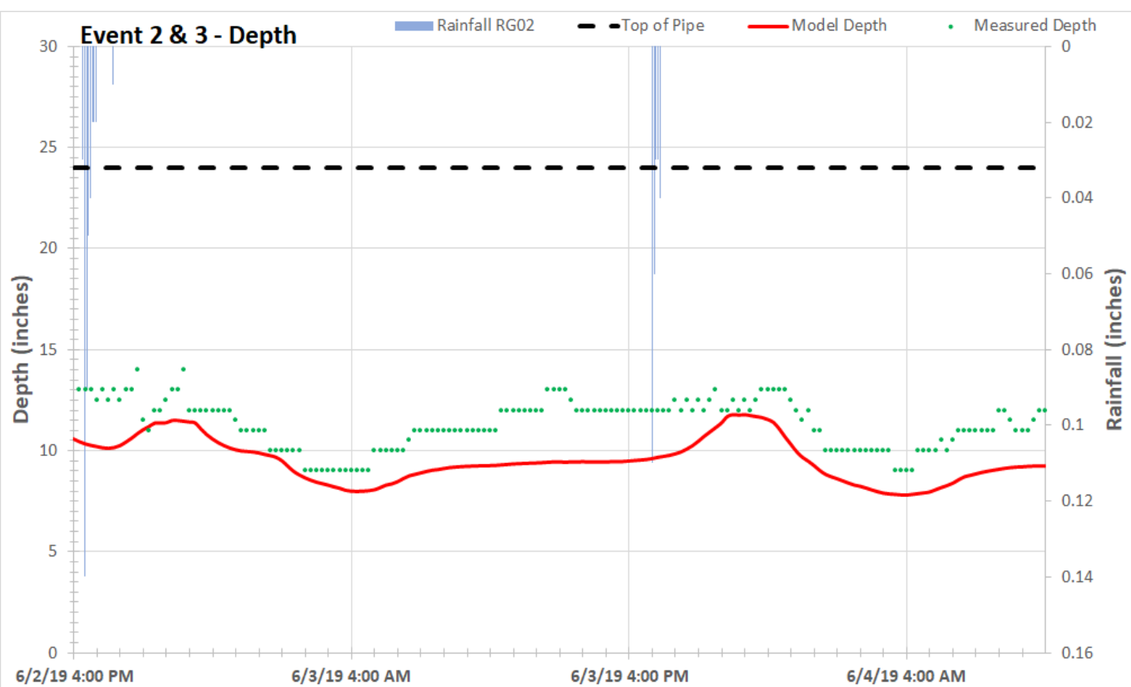
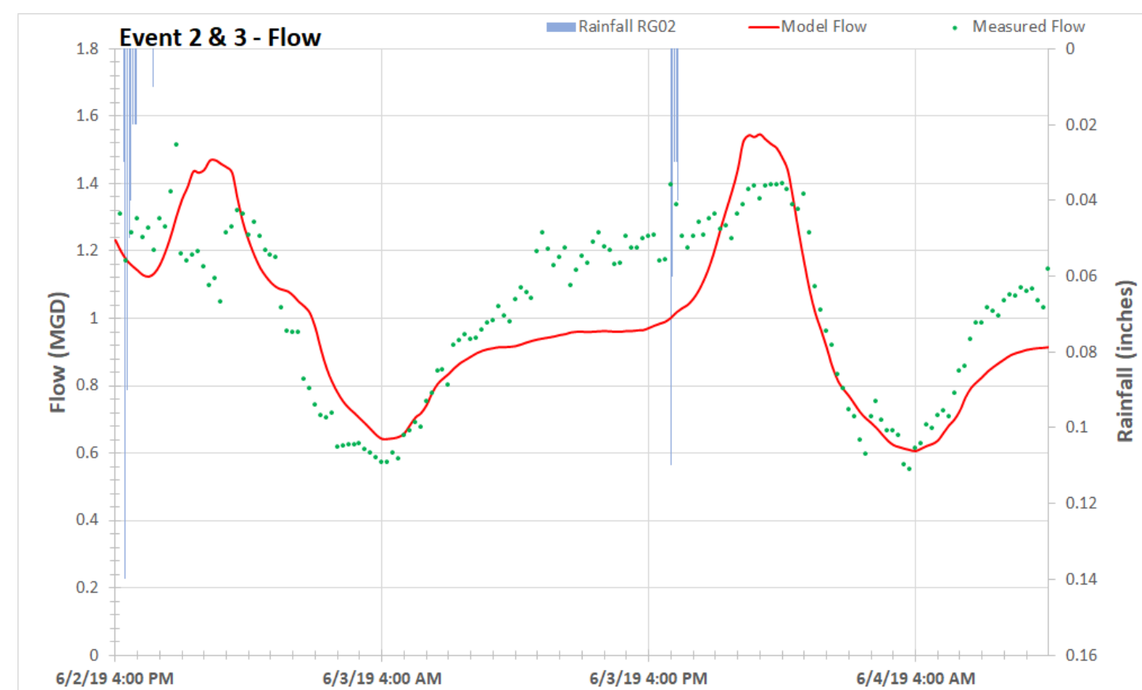
FM 13 - 00.002


Event 1 - Depth
Rainfall RG 02
Top of Pipe
Model Depth
Measured Depth
Depth (inches)
Rainfall (inches)
5/19/19 1:00 AM
5/19/19 1:00 PM
5/20/19 1:00 AM
5/20/19 1:00 PM
5/21/19 1:00 AM
5/21/19 1:00 PM
5/22/19 1:00 AM


Event 1 - Flow
Rainfall RG 02
Model Flow
Measured Flow
Flow (MGD)
Rainfall (inches)
5/19/19 1:00 AM
5/19/19 1:00 PM
5/20/19 1:00 AM
5/20/19 1:00 PM
5/21/19 1:00 AM
5/21/19 1:00 PM
5/22/19 1:00 AM


Event 2 & 3 - Depth
Rainfall RG02
Top of Pipe
Model Depth
Measured Depth
Depth (inches)
Rainfall (inches)
6/2/19 4:00 PM
6/3/19 4:00 AM
6/3/19 4:00 PM
6/4/19 4:00 AM


Event 2 & 3 - Flow
Rainfall RG02
Model Flow
Measured Flow
Flow (MGD)
Rainfall (inches)
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6/3/19 4:00 AM
6/3/19 4:00 PM
6/4/19 4:00 AM

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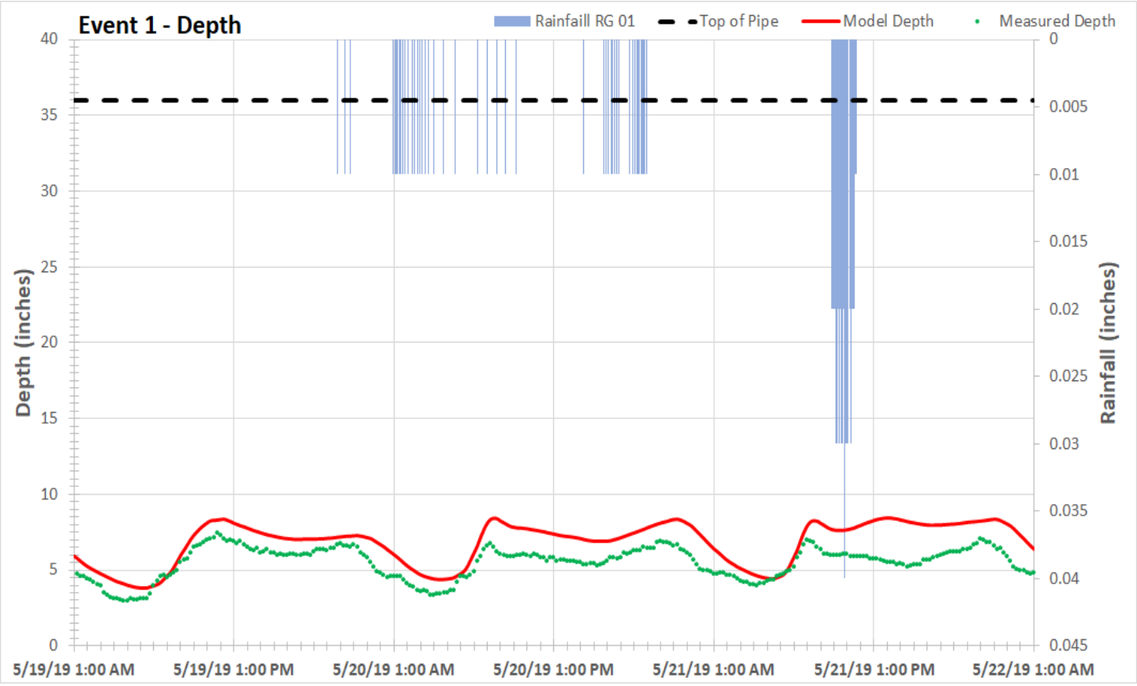
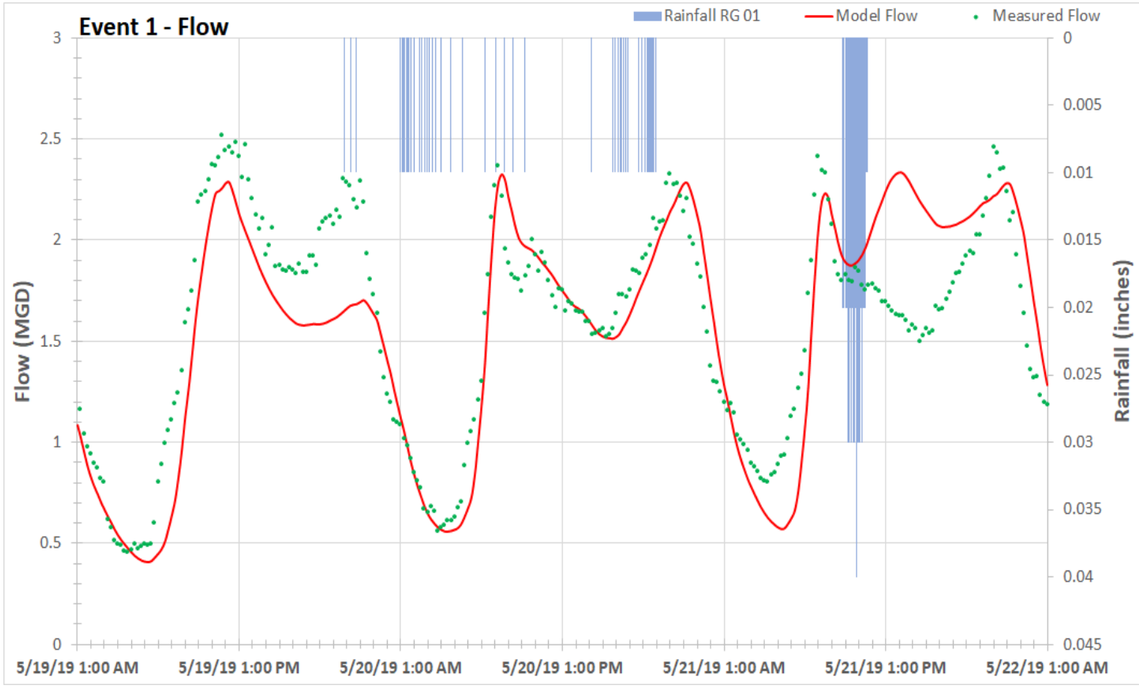
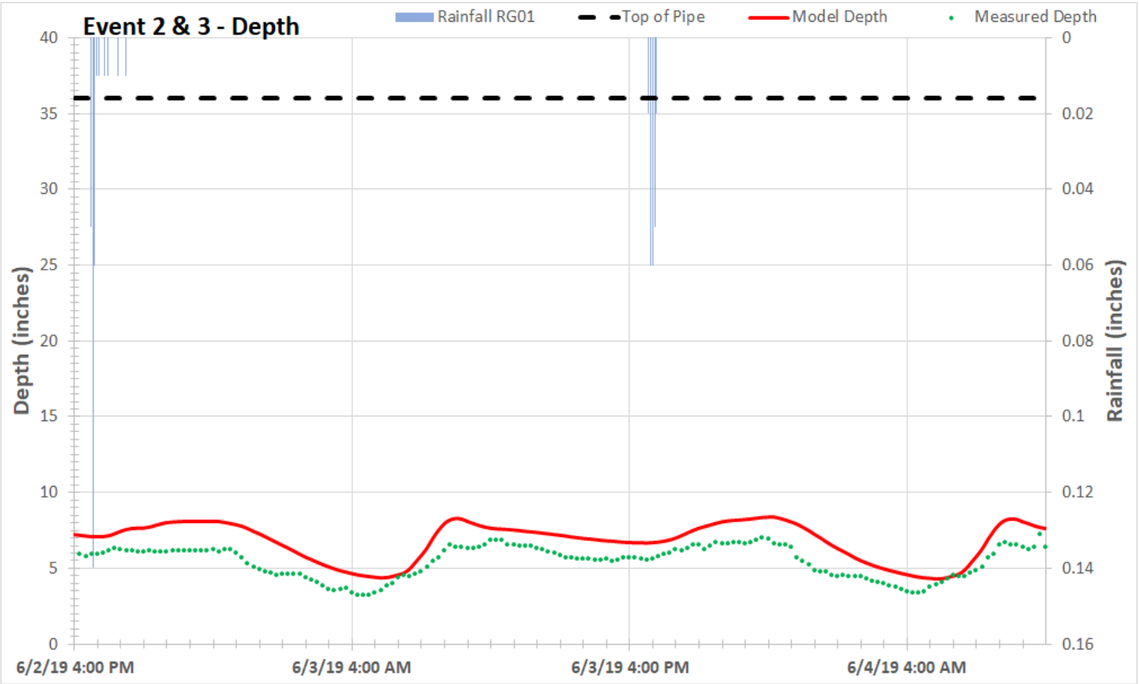
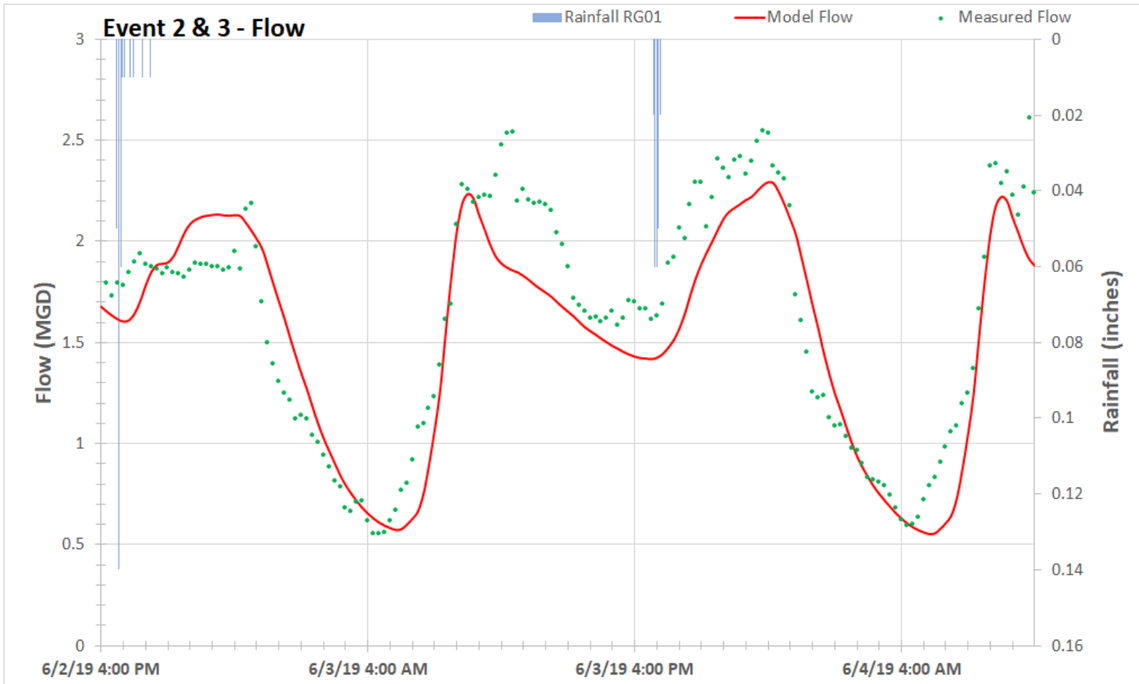
FM 08 - 00.010 and 08 - 00.059









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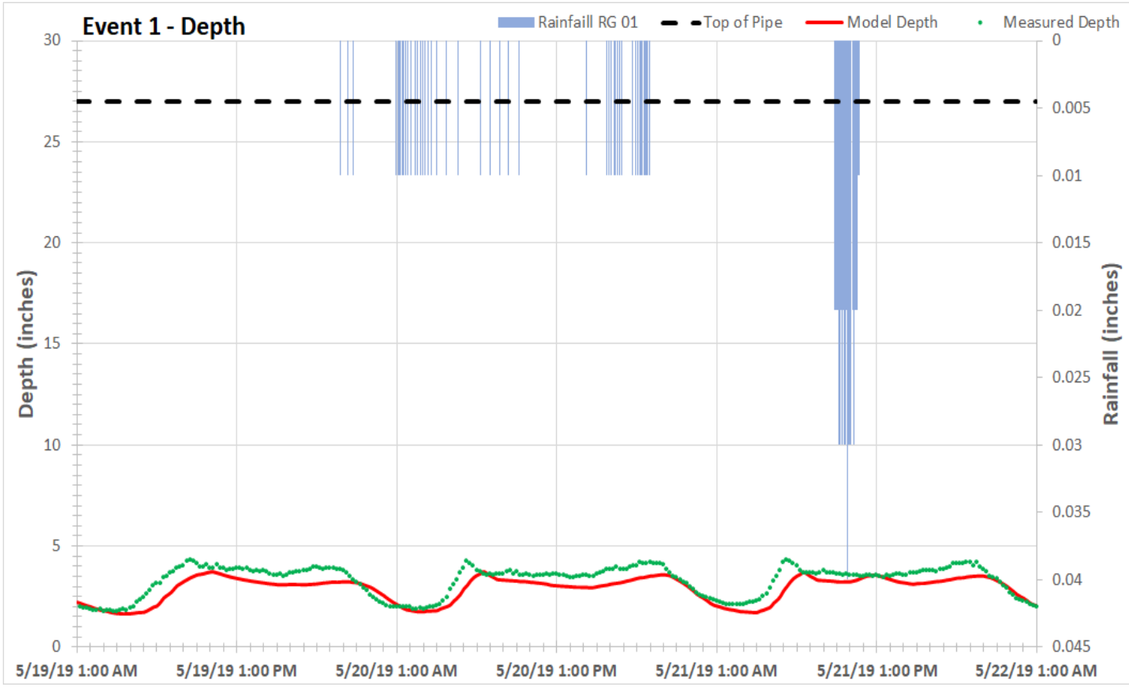

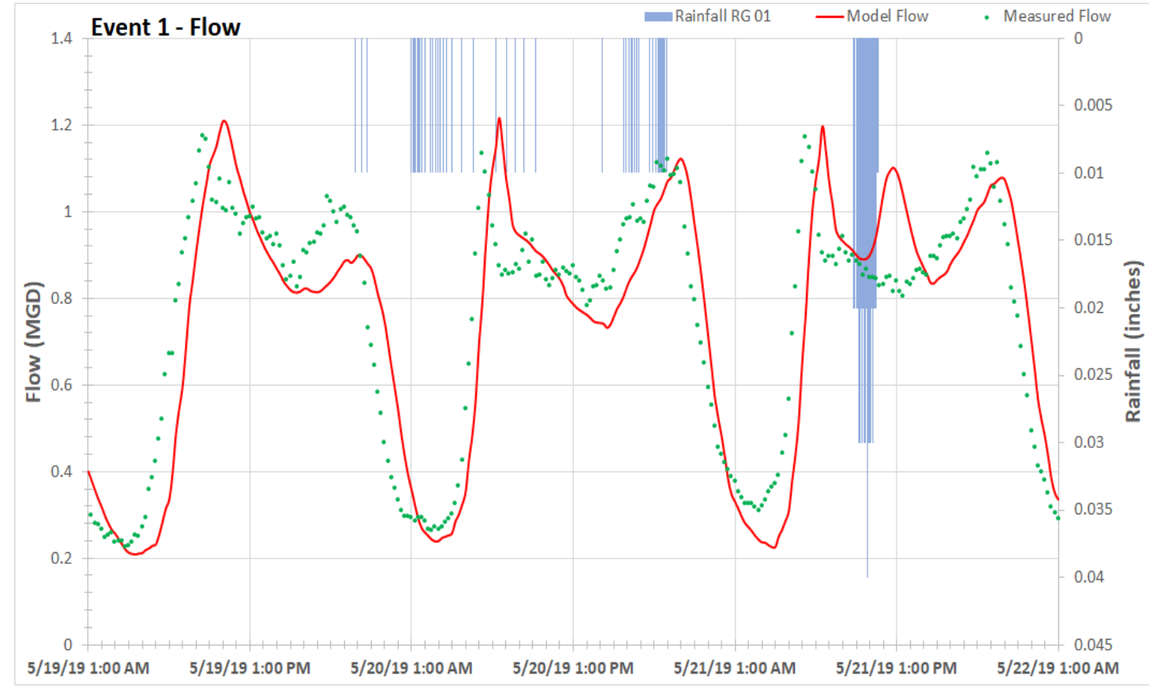

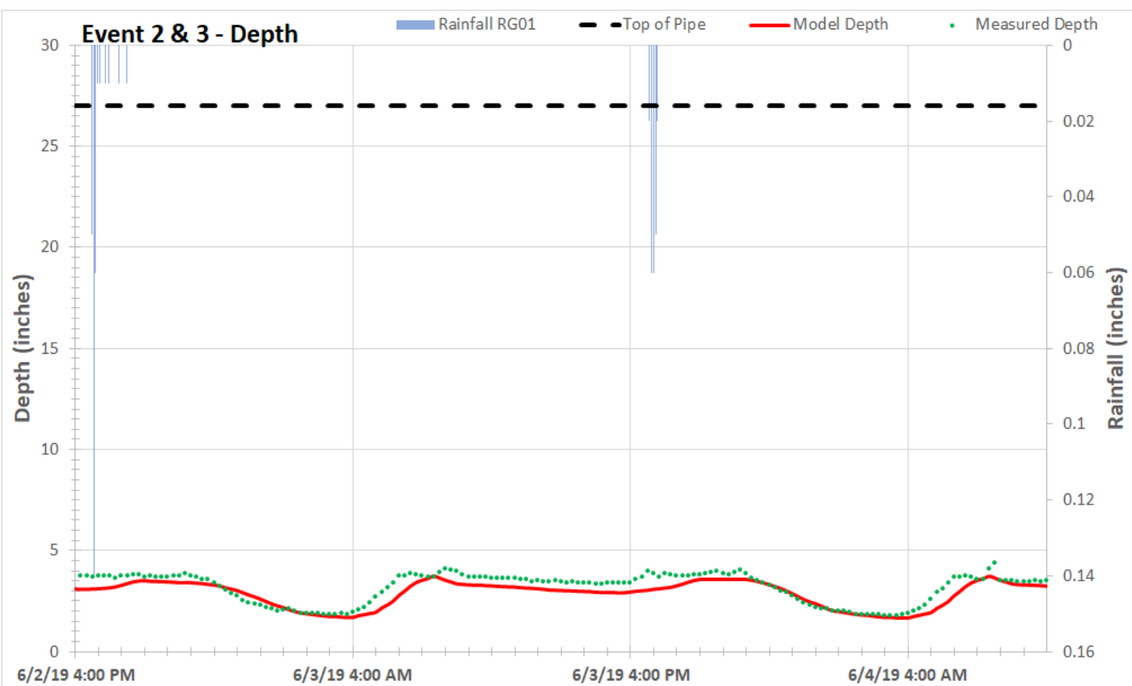

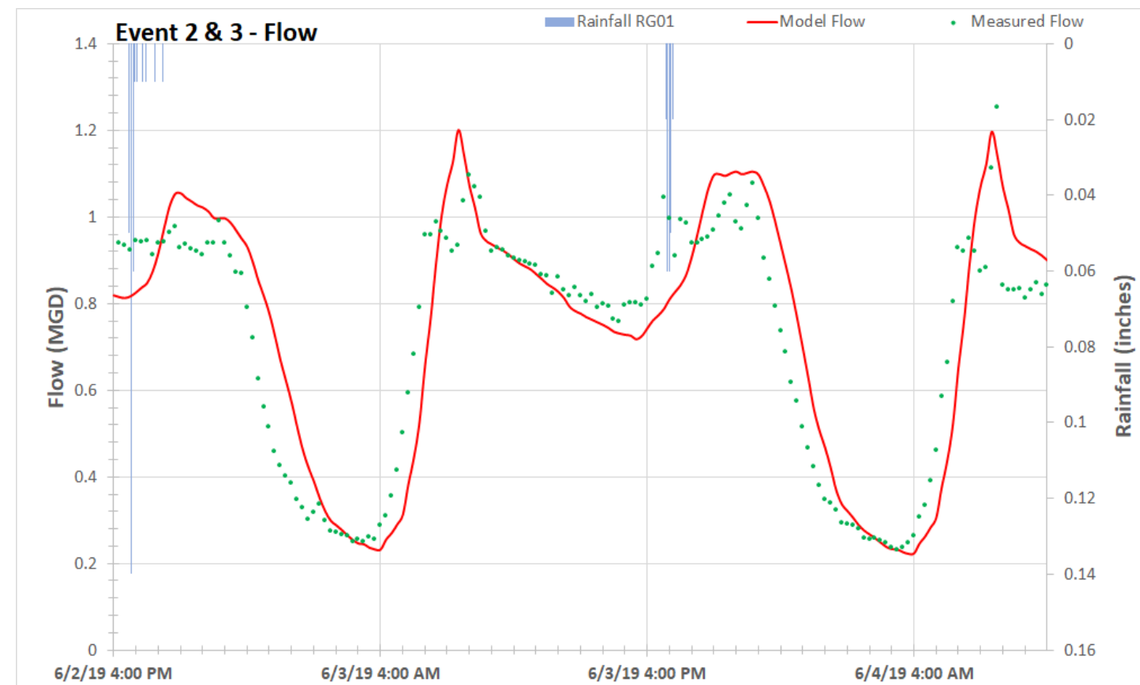

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Appendix C

Sanitary Sewer Master Plan – Flow Monitoring (RJN Group, Inc. September 2019)

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September 2019

City of Greeley, CO Sanitary Sewer Master Plan

Flow Monitoring

Technical Memorandum

prepared for CDM Smith Inc.

prepared by
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APPENDIX D – Daily Flow Summary Tables

1 INTRODUCTION

In April 2019 RJN Group, Inc. was retained by CDM Smith, Inc. (CDM Smith) to perform flow monitoring in the City of Greeley (COG), Colorado. The study consists of using twelve (12) flow monitors and two (2) rain gauges for a monitoring period of 60 days.

The purpose of the flow and rainfall monitoring was to assist with the COG's wastewater collection master plan update. Dry and Wet-weather flows were analyzed to determine dry weather patterns and to identify the contributed excesses flows from wet weather events into the sewer system.

This report addresses the results of the flow monitoring activities.

PROJECT APPROACH

RJN Group, Inc. performed a flow monitoring study between April 18 to June 17, 2019 of COG's wastewater collection system for the purpose of evaluating flow characteristics and to assist CDM Smith's wastewater collection system master plan update efforts.

The project scope consisted of flow and rainfall monitoring for 60 days. Twelve (12) flow meters and two (2) rain gauges were installed between the dates April 2 to April 16, 2019 with the flow monitoring period beginning on April 18. The flow meter and rain gauge locations were provided by CDM Smith. Although the scope requested 30 days of flow monitoring, due to a CDM Smith-requested extension of flow monitoring, meters were pulled after 60 days.

Table 1-A, on the following page provides details of the meter locations used for this monitoring period. The height/width of opening, as indicated on the table, is the measured pipe dimension and does not reflect the nominal pipe size. This is due to deflections that occur at the mouth of a pipe during manhole installation.

The flow meters were used to record depth and velocity of flow at five-minute intervals. Engineering review and input of additional calibration data was used to finalize the metered flow data. Manual depth and velocity readings (velocity profiles) were taken weekly to verify and calibrate the metered data. Average flow rates for one-hour intervals were determined for the monitoring locations. The average hourly flow rates were used to determine daily dry-weather and wet-weather flow rates. Flow data collected during rainfall events was evaluated to determine peak instantaneous inflow rates.

Figure 1.1, on the following page outlines the location of the flow meter.

Table 1-A FLOW MONITORING LOCATIONS				
			Pipe Dimensions	
Meter Site Number	Manhole Number	Site Address	Pipe Height (in)	Pipe Width (in)
FM01	18-16.001	1731 71st Ave.	14.19	14.37
FM02	08-08.003	6350 W 13th St. Rd.	11.50	11.66
FM03	10-00.001	296 Street C	15.31	15.25
FM04	09-00.002	435 N 35th Ave.	18.00	17.75
FM05	09-00.026	35th Ave. & 13th St.	10.18	10.18
FM06	11-00.005	723 26th Ave.	15.25	15.00
FM07	07-00.024	621 A St.	19.75	20.06
FM08	05-00.027	1011 3rd St.	20.18	20.25
FM09	04-00.007	601 8th St.	20.00	20.05
FM10	03-00.018	1203 12th Ave.	15.00	15.00
FM11	01-00.022	222 22st St.	17.00	17.56
FM12	01-00.028	2330 4th Ave.	17.25	17.75

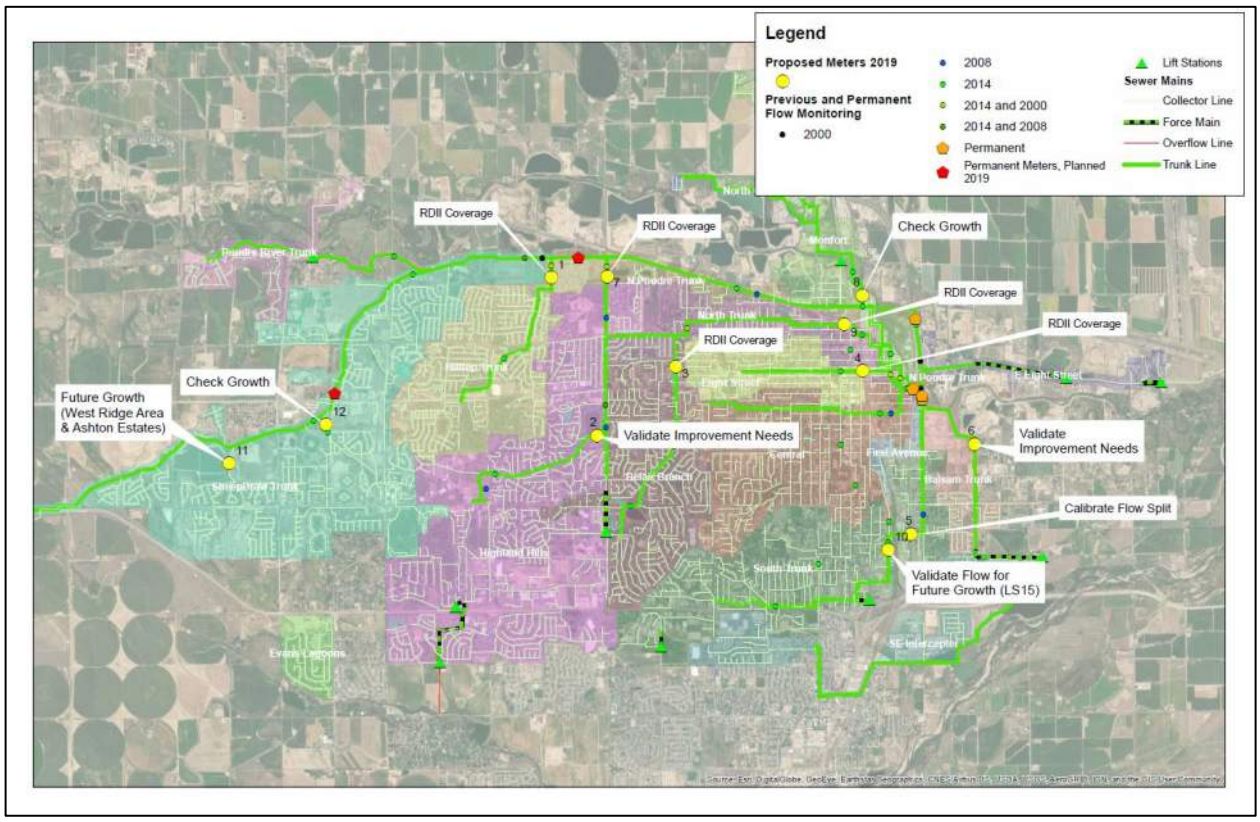


Figure 1.1: Overview of Flow Meter Locations

DEFINITIONS AND ABBREVIATIONS

This section contains definitions and abbreviations commonly used throughout this report.

(1) Infiltration (as defined by USEPA) - the water entering a sewer system and service connections from the ground through such means as, but not limited to, defective pipes, pipe joints, service connections, service laterals, or manhole walls.

(2) Inflow (as defined by USEPA) - the water discharged into a sewer system, including service connections, from such sources as roof leaders; cellar, yard, and area drains; foundation drains; cooling water discharges; drains from springs and swampy areas; manhole covers; cross connections from storm sewers, combined sewers, or catch basins; storm waters; surface runoff; or drainage.

(3) Excessive infiltration and inflow (I/I) - the extraneous clean water that enters the sanitary sewer system, which can be eliminated, on a cost-effective basis.

(4) Base flow - wastewater flow exclusive of infiltration or inflow. Generally determined from water records during months when most of the water consumption is returned to the wastewater collection system.

(5) Permanent Infiltration - extraneous flow that enters the sewer system through the ground during periods of dry-weather/low-groundwater. Generally determined by subtracting base flow during winter months from the average daily dry-weather monitored flow.

(6) Peak Infiltration - the maximum extraneous flow that enters the wastewater collection system during high groundwater conditions after the inflow effects of a rain event have ended. Generally determined by subtracting dry-weather/low-groundwater flow (average daily dry weather monitored flow) from flow recorded during periods of high groundwater.

(7) Average Daily Dry-Weather flow - dry-weather/low-groundwater flow exclusive of dry-weather/high-groundwater (peak infiltration) and wet weather (inflow) flow. Includes base flow and permanent infiltration only.

(8) Average Daily Dry-Weather flow Peaking Factor - the ratio between the peak hourly flow rate and the average daily flow.

(9) 1-Year/60-Minute Storm - a storm event that produces 0.72 inches of rain per hour and is expected to occur once in any given year according to National Oceanic and Atmospheric Administration Atlas 14 Point Precipitation Frequency Estimates.

(10) Design Storm Event - a storm event selected for purposes of analyzing its effect on the wastewater collection system.

(11) gpd - gallons per day.

(12) mgd - million gallons per day.

(13) Surcharge Condition – When the sewer flow depth equals or exceeds the diameter of the discharging sewer lines. (WEF Manual of Practice FD-6)

(14) Sanitary Sewer Overflows (SSOs) (as defined by USEPA) – The discharge of untreated sewage from municipal sanitary sewer systems as a result of broken pipes, equipment failure, or system overload.

(15) Infiltration and Inflow (I/I) – A combination of infiltration and inflow in sanitary sewer.

(16) Rain-Derived Inflow and Infiltration (RD-I/I) – Quantity of rain dependent inflow and infiltration that enters the sanitary sewer system.

2 Data Collection and Equipment

Site Selection

Once the preliminary locations were submitted by CDM Smith a site investigation was performed to determine if the site had good hydraulics for data collection. Generally, it is preferred to have a straight channel where flow is free of turbulence or backwater effects. Listed below are other considerations that were investigated:

- Installation constraints
- Pipe dimensions
- Site accessibility
- Site specific concerns
- Manhole accessibility
- Manhole configuration
- Flow depth range
- Velocity range
- Employee safety
- Surcharging evidence
- Silt deposition
- Maintainability
- Telemetry constraints
- Sensor survival

A copy of the Flow Meter and Rain Gauge Site Installation Form complete with photos and site details of the meter locations, is provided in Appendix A. The photos of the meter site include the site location, inside manhole, and pipe before and after sensor placement.

Flow Meter Type Information

ADS Flowshark meters were selected as the gravity flow meter to complete the flow monitoring program. The average accuracy of the meters for the depth measurement is ±0.15 inches and the average accuracy for velocity is ±0.04 fps.

Some information regarding the selected flow meters is included below and on the following pages:

ADS FLOWSHARK METER PRINCIPLES:

The flow meters are open channel flow meters that utilize Doppler ultrasound technology to sense flow velocity, as well as a redundant depth sensor. The flow meters have five primary components: a logger unit that stores the collected data and houses the RTU, the ultrasonic, pressure and velocity sensors, and the integrated wireless modem. The pressure depth sensor utilizes a pressure transducer which will record level including full pipe and surcharge level. The ultrasonic sensor is a non-instrusive quad-redundant transceiver sensor which will accurately record the depth to within one (1) inch of the sensor's face. The sensors emit signals and receive returned signals from the flow to capture the characteristics of the flow velocity and depth. During surcharged conditions the ultrasonic depth sensors no longer function, and the level is recorded through the pressure sensor.

Flows are calculated using the continuity equation, which is expressed as Q = AV, where Q is flow, A is the cross-sectional area, and V is the average velocity of the flow as illustrated in Figure 2.1. The meter records velocity and depth at five-minute intervals. Also, as redundant checks, during non-surcharged conditions, Qmannings equation was also utilized.

Calibration and Installation:

The ADS FlowShark meter must be calibrated on site by entering physical offsets of the sensors and their positions in the meter as well as comparing the depth and velocity measurements recorded by the meter to manual measurements. Depth and velocity adjustments for the ADS meters are made directly to the meter as necessary.

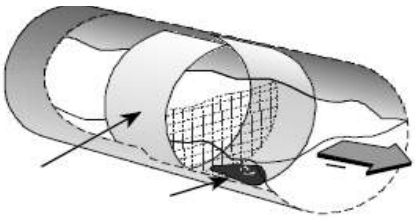


Figure 2.1: Flow is calculated using the Continuity Equation: Flow = Average Velocity x Area of Flow

The meter housing was secured with an eyebolt on the wall of the manhole. A stainless steel, expandable band secured the depth/velocity probe to the channel. The probes were positioned in the flow of the incoming pipe to minimize the effects of flow turbulence and debris buildup that may exist in the manhole.

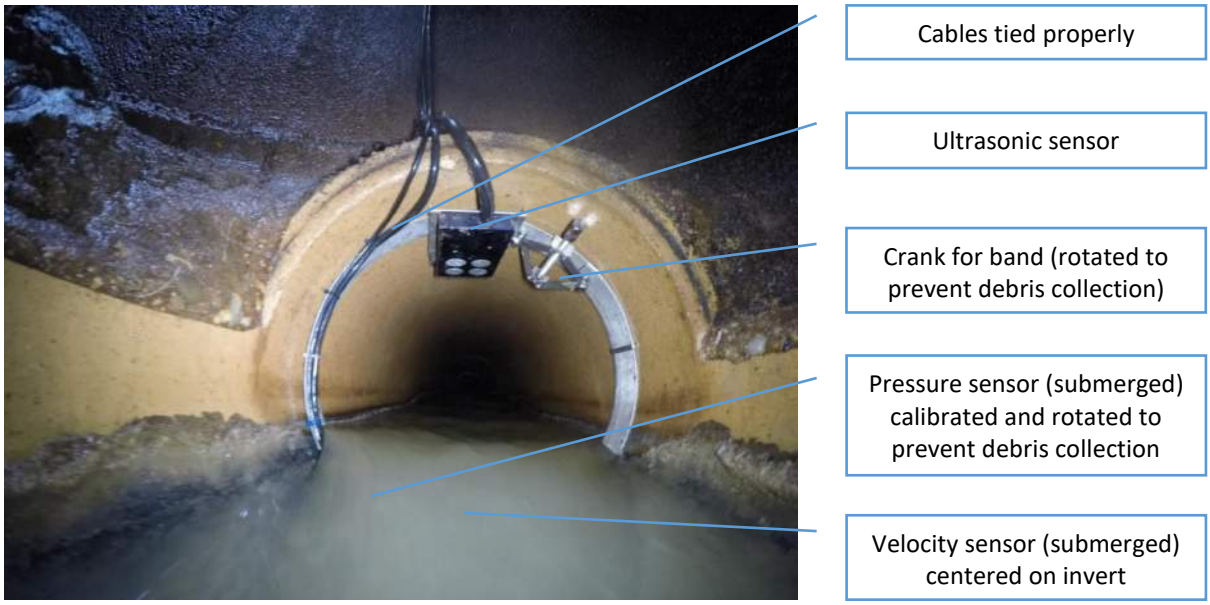


Figure 2.2: FM 03 Flow Meter Installation

TELEMETRY EQUIPMENT

The flow meter called into a central processing location during the project to perform a data dump for data collection and review. This process was performed through a Remote Transmission Unit (RTU) that collects data and sends the collected data by wireless telemetry to

the central processing location. The data was then available for review on the website hosted by RJN.

Each RTU initiated a call into the central location once every 24 hours. The RTU's transmit all the 5-minute data points recorded during that day.

The antennas are typically located just outside the manhole because a cast-iron manhole cover would block the wireless signals otherwise. The antenna was buried just below the existing surface. A typical installation is shown in Figure 2.3.

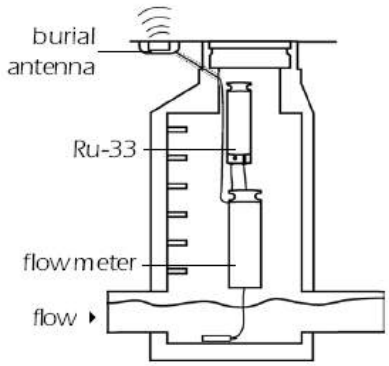


Figure 2.3: Typical meter installation

METER MAINTENANCE

During site visits, data stored in the meter was manually retrieved as a backup to the telemetry download and the meters were inspected to ensure proper operation. The meter depth and velocity readings were taken before and after maintenance/cleaning of the probes. Manual depth and velocity measurements were taken, silt deposit depths were recorded, and the batteries were changed, if necessary. Table 2-A is a list of the maintenance schedule during the monitoring period.

Table 2-A
FLOW METER & RAIN GAUGE MAINTENANCE LOG

Item	Description of Work	Date
1	Site Investigation, Install, & Calibration	4/2 - 4/16/19
2	Maintenance	4/19/19
3	Manual Site Confirmation & Maintenance	4/24 - 4/25/19
4	Maintenance	4/29/19
5	Manual Site Confirmation & Maintenance	5/1 - 5/2/19
6	Maintenance	5/8/19
7	Manual Site Confirmation & Maintenance	5/10/19
8	Manual Site Confirmation & Maintenance	5/15 - 5/16/19
9	Manual Site Confirmation & Maintenance	5/22/19
10	Manual Site Confirmation & Maintenance	5/29/19
11	Manual Site Confirmation & Maintenance	6/5/19
12	Manual Site Confirmation & Maintenance	6/12/19
13	Final Site Confirmation & Removal	6/24 - 6/25/19

RAINFALL MONITORING

Two (2) temporary rain gauges maintained by RJN Group, Inc. were utilized to monitor rainfall during the April 18 through June 17 study period. Rainfall was recorded with a continuously recording rain gauge with an accuracy of 0.01 inches. The rain gauges were equipped with a separate RTU and called in once per day to relay data to the central database.

One rain gauge (RG01) was installed on the west side of City of Greeley at a lift station located near 610 N 71st St. and the other (RG02) was installed on the east side of the City of Greeley on the roof of the administration building of the WWTF located at 300 E 8th St. Rain gauge site sheets can be viewed within Appendix A of this report.

RAINFALL RESULTS:

Both rain gauges recorded one rainfall event of greater or equal than 0.75-inches of rainfall for a 24-hour period. The largest storm event occurred on between May 20 – May 21 for rain gauges RG01 and RG02, where the total rainfall was 0.75 inches and 0.87 inches, with a peak 1-hour intensity of 0.36 inches per hour and 0.39 inches per hour, respectively. The total cumulative rainfall measured from April 18 to June 17 for rain gauges RG01 and RG02 was approximately 3.17 inches and 4.82 inches, respectively. Rain gauge-recorded intensities are listed in Table 2-B and daily summaries are listed in Table 2-C.

Table 2-B
RAINFALL INTENSITIES

Rain Gauge	Observed Peak 60-min Intensity (in)	Observed Peak 60-min Storm Duration	Observed Peak 2-hour Intensity (in)	Observed Peak 2-hour Storm Duration	Observed Peak 24-hour Intensity (in)	Observed Peak 24-hour Storm Duration
RG01	0.36	5/21/2019 10:05:00 AM to 5/21/2019 11:05:00 AM	0.55	5/21/2019 9:40:00 AM to 5/21/2019 11:40:00 AM	0.75	5/20/2019 11:45:00 AM to 5/21/2019 11:45:00 AM
RG02	0.41	5/26/2019 4:05:00 PM to 5/26/2019 5:05:00 PM	0.58	5/21/2019 9:20:00 AM to 5/21/2019 11:20:00 AM	0.87	5/20/2019 11:25:00 AM to 5/21/2019 11:25:00 AM

Table 2-C RAINFALL DAILY SUMMARIES					
Date	RG01 Cumulative Rainfall (in)	RG02 Cumulative Rainfall (in)	Date	RG01 Cumulative Rainfall (in)	RG02 Cumulative Rainfall (in)
4/18/2019	0	0	5/19/2019	0.03	0.01
4/19/2019	0	0	5/20/2019	0.44	0.47
4/20/2019	0	0	5/21/2019	0.55	0.61
4/21/2019	0.15	0.37	5/22/2019	0	0
4/22/2019	0	0	5/23/2019	0.01	0
4/23/2019	0	0	5/24/2019	0	0
4/24/2019	0	0	5/25/2019	0	0
4/25/2019	0	0	5/26/2019	0.01	0.41
4/26/2019	0.03	0.04	5/27/2019	0.05	0.31
4/27/2019	0	0	5/28/2019	0.21	0.21
4/28/2019	0.01	0.01	5/29/2019	0.01	0.02
4/29/2019	0.03	0	5/30/2019	0	0
4/30/2019	0.33	0.25	5/31/2019	0.01	0.06
5/1/2019	0.1	0.1	6/1/2019	0	0
5/2/2019	0	0	6/2/2019	0.31	0.42
5/3/2019	0	0	6/3/2019	0.21	0.27
5/4/2019	0	0	6/4/2019	0.04	0.16
5/5/2019	0	0	6/5/2019	0	0
5/6/2019	0	0	6/6/2019	0	0
5/7/2019	0.05	0.07	6/7/2019	0	0
5/8/2019	0.04	0	6/8/2019	0.02	0
5/9/2019	0.19	0.22	6/9/2019	0.01	0.01
5/10/2019	0	0	6/10/2019	0	0
5/11/2019	0.14	0.12	6/11/2019	0	0
5/12/2019	0	0	6/12/2019	0	0
5/13/2019	0	0	6/13/2019	0	0
5/14/2019	0	0	6/14/2019	0	0
5/15/2019	0	0	6/15/2019	0.01	0.38
5/16/2019	0	0	6/16/2019	0.04	0.01
5/17/2019	0.06	0.24	6/17/2019	0.08	0.05
5/18/2019	0	0	TOTAL:	3.17	4.82

Due to the short term 60-day monitoring period, significant rain events were not recorded. For the rain events during the flow monitoring study compared to the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 8, Version 2, Point Precipitation Frequency Estimates table for the Greeley, CO area, perhaps similar storms as shown below would assist in a more thorough wet weather analysis. For comparison purposes, a 1-year/1-hour, 1-year/2-hour, and 1-year/24-hour NOAA storm is compared to a peak 1-hour, 2-hour, and 24-hour storm as shown below in Table 2-D during the flow monitoring period.

Table 2-D

NOAA vs. RAINFALL INTENSITIES DURING FLOW MONITORING STUDY

Rain Gauge	Observed Peak 60-min Intensity (in)	NOAA 1-year / 1-hour (in)	Observed Peak 2-hour Intensity (in)	NOAA 1-year / 2-hour (in)	Observed Peak 24-hour Intensity (in)	NOAA 1-year / 24-hour
RG01	0.36	0.72	0.55	0.86	0.75	1.51
RG02	0.41	0.72	0.58	0.86	0.87	1.51

FLOW MONITORING

Utilizing a pdf overall exhibit that was provided by CDM Smith, RJN was able to develop a flow network diagram as shown in Figure 2.5, on the following page. Hydrographs and scattergraphs for the monitored sites are included in Appendix B and Appendix C, respectively. Also, a daily flow summary table that includes daily minimum, maximum, and average flows for each monitored site, is included in Appendix D.

OBSERVED INFILTRATION LEAK

During a routine May 29 site confirmation and maintenance visit, and infiltration runner was observed at FM 7 site (MH 07-00.024) located at 621 A St. The infiltration runner was observed during each succeeding site visit up until when the meter was removed. The infiltration runner as shown below in Figure 2.4, was infiltrating through a hole on the side of the manhole channel, above the top of the flow depth.

Figure 2.4: FM 7 site infiltration runner along manhole channel

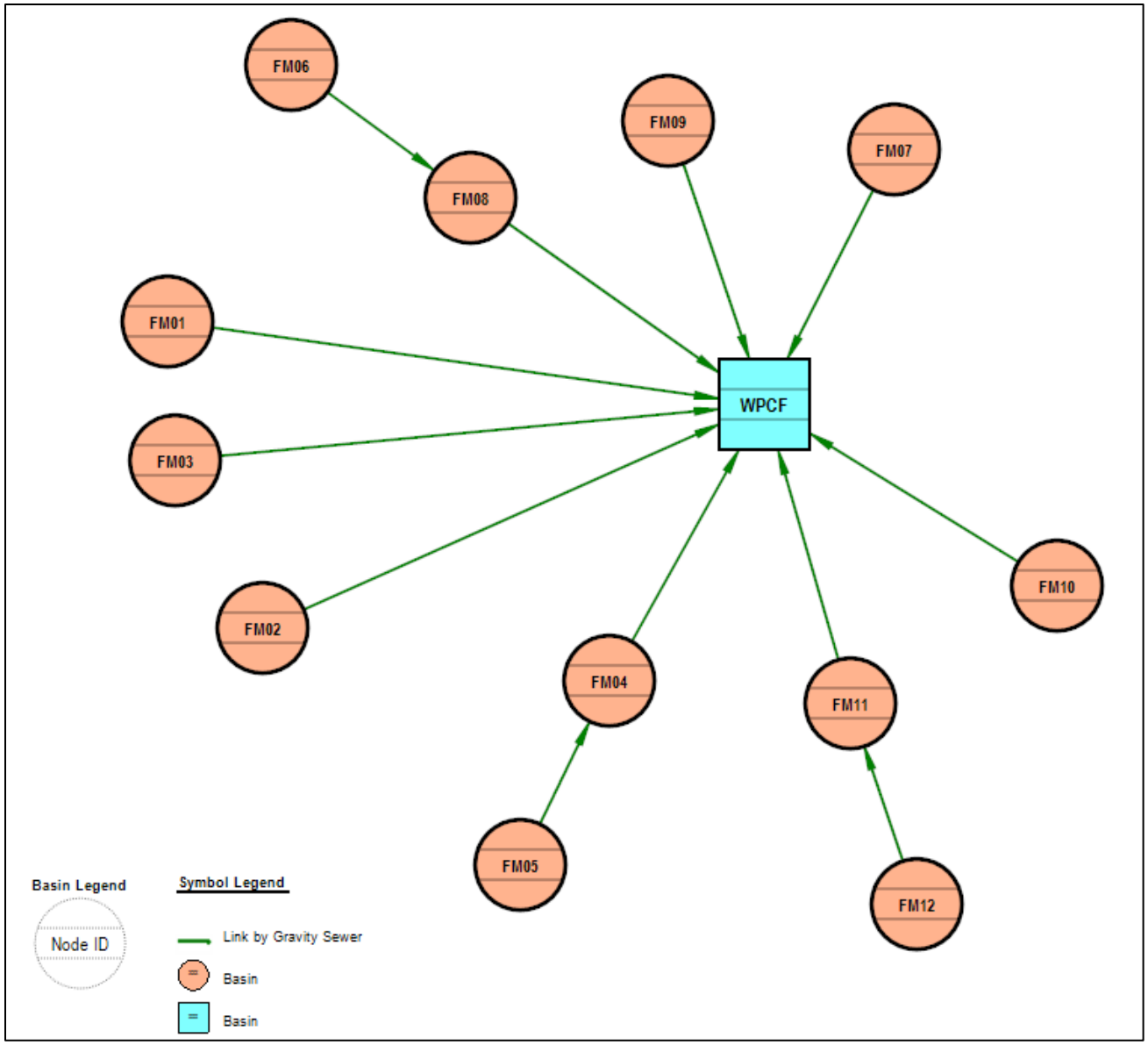


Figure 2.5: Flow network diagram

APPENDIX A

FLOW METER AND RAIN GAUGE SITE REPORTS

rjngroup The Choice for Collection System Solutions	CDM Smith Greeley CO Flow Monitoring	Site Name FM01

Inspected By	ncaris	**Project No.**	**Site Code**
Inspected Date/Time	4/9/2019 12:06 PM	18-3428-00	D-2

System Information

Target Pipe Dia. (in)	15.0
Municipality	
District	Greeley
Assigned Rain Gauge	
Client Manhole #	18-16.001
U/S Connecting MH I.D	08-16.002
System Characteristics:	
Residential - ☐	Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	
Site Access	Off-Road
Longitude	-104.80200000
Latitude	40.41480000
MH Type	Precast Concrete
Manhole Depth (ft)	10.56
Manhole Width (ft)	4.0
Elevated MH	Yes
Height Elevated (ft)	0.3
Structural Integrity	Safe

Site Information

Pipe Height (in)	14.19
Pipe Width (in)	14.37
Pipe Type	Polyvinyl Chloride
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

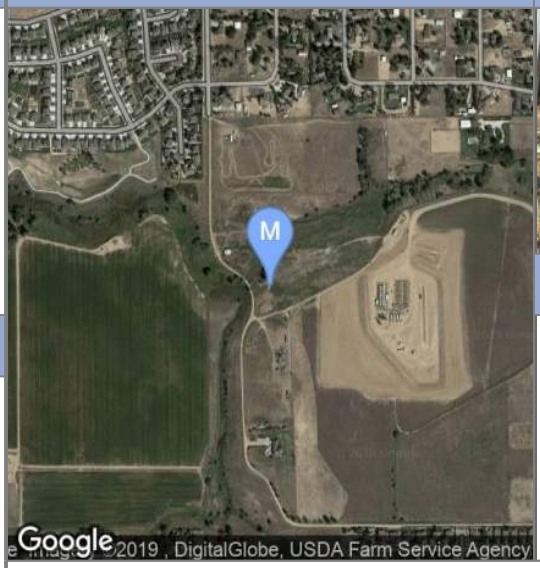
Hydraulic Information

Flow Depth (in)	2.00
Instant Velocity (fps)	3.50
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Slight Bend
Drop Inlet	No
Hydraulic Rating	Fair

Installation Notes

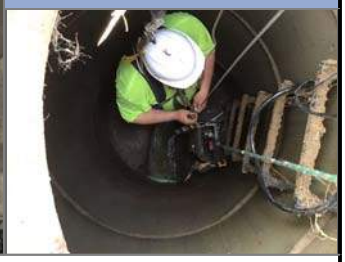
Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	50

Area Location Map



Area View Picture

Top View Picture



Access Notes Off new concrete trail.

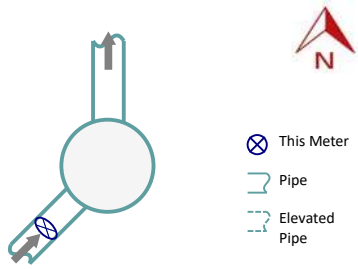
Investigation Photo

Installation Photo

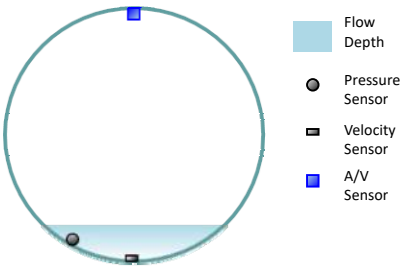
Hydraulic Characteristics

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Pressure Clock Position: 7:00

Velocity Clock Position: 6:00

Post Installation Notes

Meter Type	ADS	5000 AS
Telemetry Type	Telog	
Installation Date	4/9/2019	

Approvals

Recommended by FSP **Client Approval**

rjngroup The Choice for Collection System Solutions	CDM Smith Greeley CO Flow Monitoring	Site Name FM02

Inspected By	ncaris	**Project No.**	**Site Code**
Inspected Date/Time	4/2/2019 3:11 PM	18-3428-00	U-1

System Information

Target Pipe Dia. (in)	12.0
Municipality	
District	Greeley
Assigned Rain Gauge	
Client Manhole #	08-08.003
U/S Connecting MH I.D	08-08.004
System Characteristics:	
Residential - ☐	Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	6350 W 13th St Rd
Site Access	Off-Road
Longitude	-104.78500000
Latitude	40.41710000
MH Type	Precast Concrete
Manhole Depth (ft)	7.96
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	11.50
Pipe Width (in)	11.66
Pipe Type	Polyvinyl Chloride
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

Hydraulic Information

Flow Depth (in)	1.50
Instant Velocity (fps)	4.00
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Fair

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	50

Post Installation Notes

Meter Type	ADS	5000 AS
Telemetry Type	Telog	
Installation Date	4/9/2019	

Area Location Map

Area View Picture

Top View Picture

Access Notes About 50 yards perp to street. Investigated 1 upstream manhole from target because of inaccessibility.

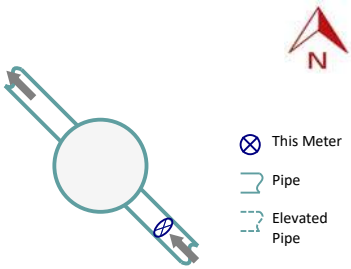
Investigation Photo

Hydraulic Characteristics

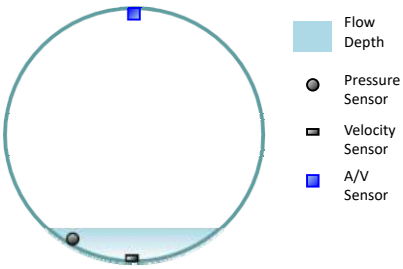
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Pressure Clock Position: 7:00

Velocity Clock Position: 6:00

Approvals

Recommended by FSP **Client Approval**

rjngroup The Choice for Collection System Solutions	CDM Smith Greeley CO Flow Monitoring	Site Name FM03

Inspected By	ncaris	**Project No.**	**Site Code**
Inspected Date/Time	4/2/2019 4:15 PM	18-3428-00	T

System Information

Target Pipe Dia. (in)	15.0
Municipality	
District	Greeley
Assigned Rain Gauge	
Client Manhole #	10-00.001
U/S Connecting MH I.D	10-00.002
System Characteristics:	
Residential - ☐	Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	296 Street C
Site Access	Parkway
Longitude	-104.74469800
Latitude	40.43984100
MH Type	Precast Concrete
Manhole Depth (ft)	9.20
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	15.31
Pipe Width (in)	15.25
Pipe Type	Polyvinyl Chloride
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

Hydraulic Information

Flow Depth (in)	3.00
Instant Velocity (fps)	2.00
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Fair

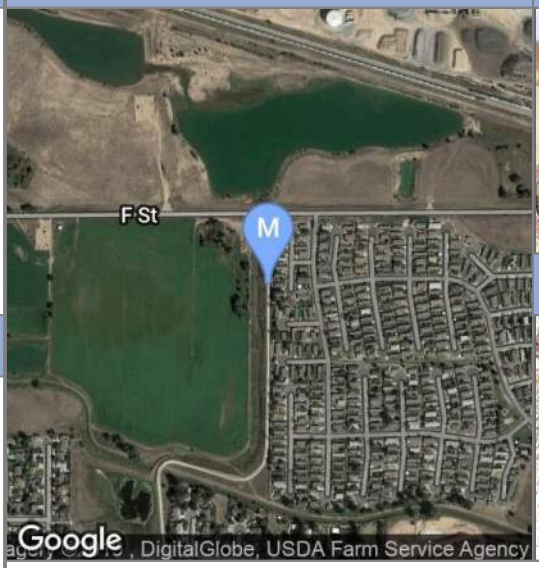
Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	50

Post Installation Notes

Meter Type	ADS	5000 AS
Telemetry Type	Telog	
Installation Date	4/9/2019	

Area Location Map



Area View Picture

Top View Picture

Access Notes On concrete trail

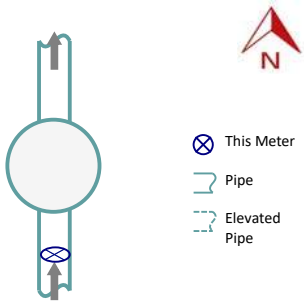
Investigation Photo

Hydraulic Characteristics

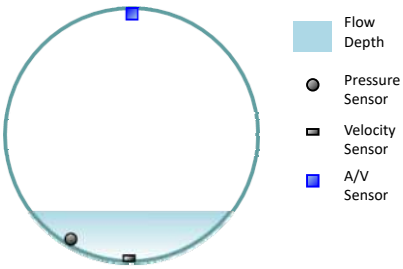
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Pressure Clock Position: 7:00

Velocity Clock Position: 6:00

Approvals

Recommended by FSP **Client Approval**

rjngroup The Choice for Collection System Solutions	CDM Smith Greeley CO Flow Monitoring	Site Name FM04

Inspected By	ncaris	**Project No.**	**Site Code**
Inspected Date/Time	4/3/2019 11:02 AM	18-3428-00	T

System Information

Target Pipe Dia. (in)	18.0
Municipality	
District	Greeley
Assigned Rain Gauge	
Client Manhole #	09-00.002
U/S Connecting MH I.D	09-00.003
System Characteristics:	
Residential - ☐	Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	435 N 35th Ave
Site Access	Fenced In
Longitude	-104.73500000
Latitude	40.43830000
MH Type	Poured Concrete
Manhole Depth (ft)	7.44
Manhole Width (ft)	5.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	18.00
Pipe Width (in)	17.75
Pipe Type	Vitrified Clay
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

Hydraulic Information

Flow Depth (in)	8.40
Instant Velocity (fps)	2.00
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Fair

Installation Notes

Location in Pipe (ft)	2.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	50

Post Installation Notes

Meter Type	ADS	5000 AS
Telemetry Type	Telog	
Installation Date	4/16/2019	

Area Location Map

Area View Picture

Top View Picture

Access Notes Fenced in property off road. Owner granted access during project. No lock on access gate. Gate located at W 35th Ave & W C St.

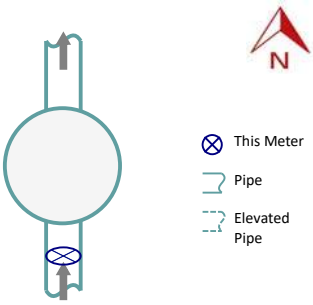
Investigation Photo

Hydraulic Characteristics

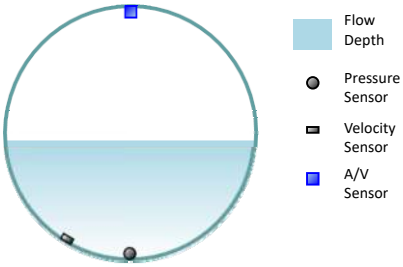
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Pressure Clock Position: 6:00

Velocity Clock Position: 7:00

Approvals

Recommended by FSP **Client Approval**

rjngroup The Choice for Collection System Solutions	CDM Smith Greeley CO Flow Monitoring	Site Name FM05

Inspected By	ncaris	**Project No.**	**Site Code**
Inspected Date/Time	4/3/2019 11:48 AM	18-3428-00	D-1

System Information

Target Pipe Dia. (in)	10.0
Municipality	
District	Greeley
Assigned Rain Gauge	
Client Manhole #	09-00.026
U/S Connecting MH I.D	09-00.027
System Characteristics:	
Residential - ☐	Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	35th Ave & 13th St Greeley
Site Access	Parkway
Longitude	-104.73600000
Latitude	40.41740000
MH Type	Poured Concrete
Manhole Depth (ft)	8.52
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	10.18
Pipe Width (in)	10.18
Pipe Type	Vitrified Clay
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

Hydraulic Information

Flow Depth (in)	2.50
Instant Velocity (fps)	4.00
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Fair

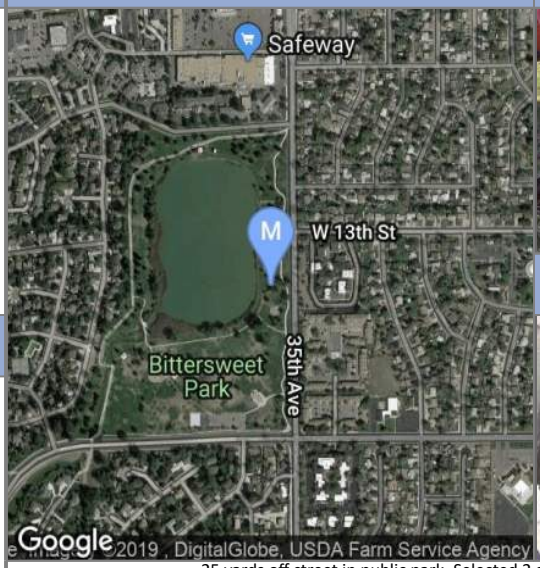
Installation Notes

Location in Pipe (ft)	0.2
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	50

Post Installation Notes

Meter Type	ADS	5000 AS
Telemetry Type	Telog	
Installation Date	4/9/2019	

Area Location Map



Area View Picture

Top View Picture

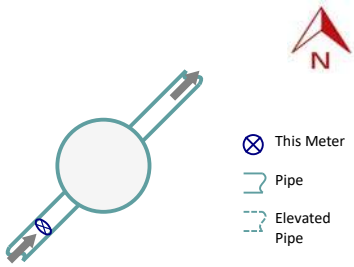
Access Notes	25 yards off street in public park. Selected 2 downstream because target manhole was 1 inch from surcharging and bench flooding at time of site investigation. The next downstream manhole from target site has a significant bend.

Investigation Photo

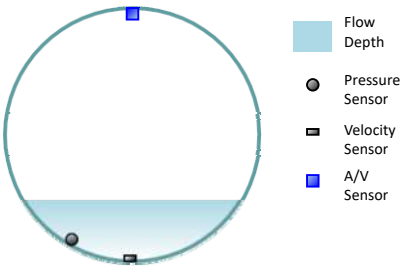
Installation Photo

Hydraulic Characteristics	
Installation Notes	Band near mouth of pipe. Was unable to go further up pipe due to slight deformity.

Install Plan Sketch



Install Cross-Section Sketch



Pressure Clock Position: 7:00

Velocity Clock Position: 6:00

Approvals

Recommended by FSP	Client Approval

rjngroup The Choice for Collection System Solutions	CDM Smith Greeley CO Flow Monitoring	Site Name FM06

Inspected By	ncaris	**Project No.**	**Site Code**
Inspected Date/Time	4/3/2019 12:23 PM	18-3428-00	T

System Information

Target Pipe Dia. (in)	15.0
Municipality	
District	Greeley
Assigned Rain Gauge	
Client Manhole #	11-00.005
U/S Connecting MH I.D	11-00.006
System Characteristics:	
Residential - ☐	Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	723 26th Ave
Site Access	Roadway, Low Traffic
Longitude	-104.72200000
Latitude	40.42580000
MH Type	Precast Concrete
Manhole Depth (ft)	10.82
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	15.25
Pipe Width (in)	15.00
Pipe Type	Vitrified Clay
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

Hydraulic Information

Flow Depth (in)	3.00
Instant Velocity (fps)	2.00
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Fair

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	50

Post Installation Notes

Meter Type	ADS	5000 AS
Telemetry Type	Telog	
Installation Date	4/16/2019	

Area Location Map

Area View Picture

Top View Picture

Access Notes

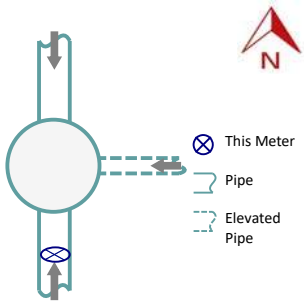
Investigation Photo

Installation Photo

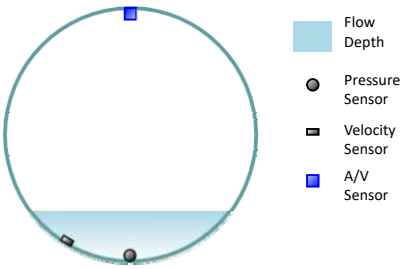
Hydraulic Characteristics Incoming 6" dia. line from east had no flow during site investigation & installation vis

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Pressure Clock Position: 6:00

Velocity Clock Position: 7:00

Approvals

Recommended by FSP **Client Approval**

rjngroup The Choice for Collection System Solutions	CDM Smith Greeley CO Flow Monitoring	Site Name FM07

Inspected By	ncaris	**Project No.**	**Site Code**
Inspected Date/Time	4/3/2019 2:13 PM	18-3428-00	T

System Information

Target Pipe Dia. (in)	21.0
Municipality	
District	Greeley
Assigned Rain Gauge	
Client Manhole #	07-00.024
U/S Connecting MH I.D	07-00.023
System Characteristics:	
Residential - ☐	Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	621 A St
Site Access	Other
Longitude	-104.68900000
Latitude	40.43540000
MH Type	Poured Concrete
Manhole Depth (ft)	10.04
Manhole Width (ft)	4.0
Elevated MH	Yes
Height Elevated (ft)	0.4
Structural Integrity	Safe

Site Information

Pipe Height (in)	19.75
Pipe Width (in)	20.06
Pipe Type	Polyvinyl Chloride
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

Hydraulic Information

Flow Depth (in)	4.25
Instant Velocity (fps)	2.00
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Fair

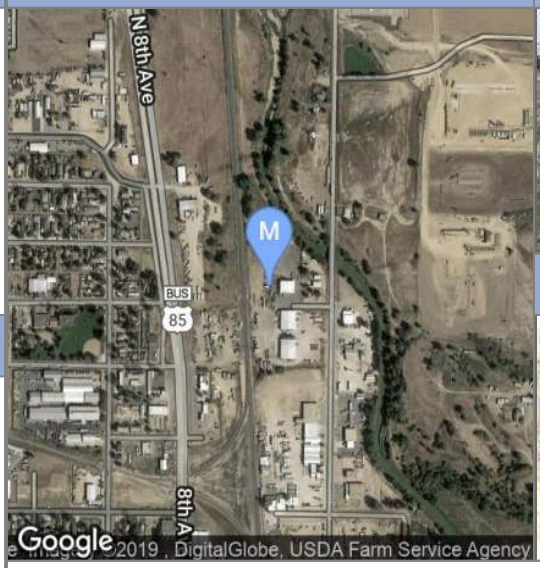
Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Non-Paved Surface
Signal Strength	50

Post Installation Notes

Meter Type	ADS	5000 AS
Telemetry Type	Telog	
Installation Date	4/9/2019	

Area Location Map



Area View Picture

Top View Picture

Access Notes Inside bay yard. Spoke to owner and he is ok with access throughout project. Not gated.

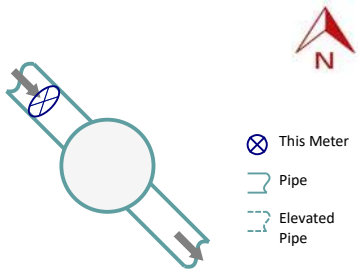
Investigation Photo

Hydraulic Characteristics

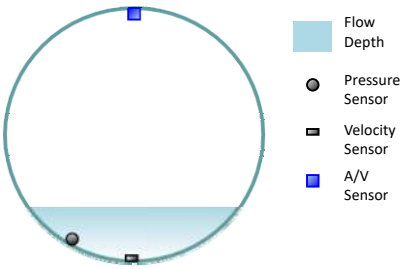
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Pressure Clock Position: 7:00

Velocity Clock Position: 6:00

Approvals

Recommended by FSP **Client Approval**

rjngroup The Choice for Collection System Solutions	CDM Smith Greeley CO Flow Monitoring	Site Name FM08

Inspected By	ncaris	**Project No.**	**Site Code**
Inspected Date/Time	4/3/2019 2:45 PM	18-3428-00	U-1

System Information

Target Pipe Dia. (in)	21.0
Municipality	
District	Greeley
Assigned Rain Gauge	RG02
Client Manhole #	05-00.027
U/S Connecting MH I.D	05-00.028
System Characteristics:	
Residential - ☐	Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	1011 3rd St
Site Access	Roadway, High Traffic
Longitude	-104.69400000
Latitude	40.43140000
MH Type	Poured Concrete
Manhole Depth (ft)	6.66
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	20.18
Pipe Width (in)	20.25
Pipe Type	Vitrified Clay
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

Hydraulic Information

Flow Depth (in)	4.00
Instant Velocity (fps)	2.50
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Fair

Installation Notes

Location in Pipe (ft)	1.5
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	50

Post Installation Notes

Meter Type	ADS	5000 AS
Telemetry Type	Telog	
Installation Date	4/15/2019	

Area Location Map

Area View Picture

Top View Picture

Access Notes Picked 1 upstream because of lower risk traffic accident.

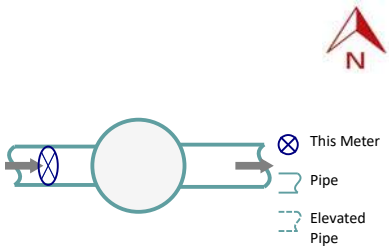
Investigation Photo

Hydraulic Characteristics

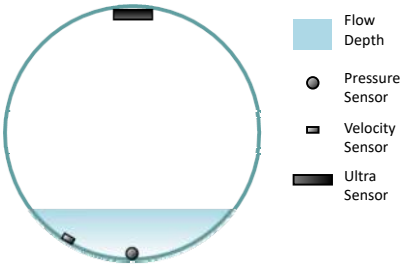
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Pressure Clock Position: 6:00

Velocity Clock Position: 7:00

Approvals

Recommended by FSP **Client Approval**

rjngroup The Choice for Collection System Solutions	CDM Smith Greeley CO Flow Monitoring	Site Name FM09

Inspected By	ncaris	**Project No.**	**Site Code**
Inspected Date/Time	4/3/2019 3:35 PM	18-3428-00	T

System Information

Target Pipe Dia. (in)	24.0
Municipality	
District	Greeley
Assigned Rain Gauge	
Client Manhole #	04-00.007
U/S Connecting MH I.D	04-00.008
System Characteristics:	
Residential - ☐	Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	601 8th St
Site Access	Roadway, High Traffic
Longitude	-104.68700000
Latitude	40.42490000
MH Type	Precast Concrete
Manhole Depth (ft)	9.30
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	20.00
Pipe Width (in)	20.05
Pipe Type	Other
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

Hydraulic Information

Flow Depth (in)	4.00
Instant Velocity (fps)	2.00
Surcharge Evidence (ft)	1.83
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Fair

Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	50

Post Installation Notes

Meter Type	ADS	5000 AS
Telemetry Type	Telog	
Installation Date	4/15/2019	

Area Location Map

Area View Picture

Top View Picture

Access Notes Cones setup south bound lane 6th ave & west bound 8th St. to redirect traffic around manhole site

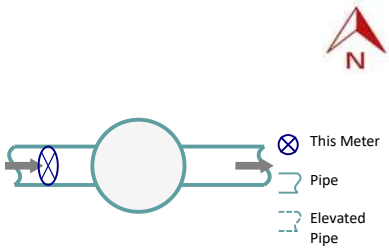
Investigation Photo

Hydraulic Characteristics

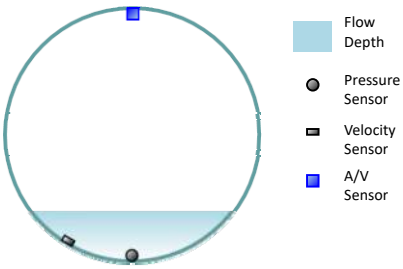
Installation Photo

Installation Notes Pipe material is HDPE

Install Plan Sketch



Install Cross-Section Sketch



Pressure Clock Position: 6:00

Velocity Clock Position: 7:00

Approvals

Recommended by FSP **Client Approval**

rjngroup The Choice for Collection System Solutions	CDM Smith Greeley CO Flow Monitoring	Site Name FM10

Inspected By	ncaris	**Project No.**	**Site Code**
Inspected Date/Time	4/16/2019 5:57 PM	18-3428-00	U-3

System Information

Target Pipe Dia. (in)	18.0
Municipality	
District	Greeley
Assigned Rain Gauge	
Client Manhole #	03-00.018
U/S Connecting MH I.D	03-00.019
System Characteristics:	
Residential - ☐	Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	1203 12th Ave
Site Access	Roadway, High Traffic
Longitude	-104.69800000
Latitude	40.41990000
MH Type	Poured Concrete
Manhole Depth (ft)	14.34
Manhole Width (ft)	4.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	15.00
Pipe Width (in)	15.00
Pipe Type	Vitrified Clay
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

Hydraulic Information

Flow Depth (in)	4.50
Instant Velocity (fps)	2.50
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Fair

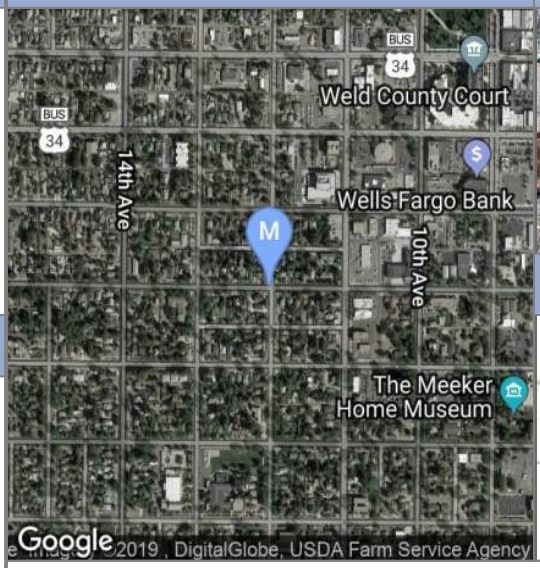
Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	75

Post Installation Notes

Meter Type	ADS	5000 AS
Telemetry Type	Telog	
Installation Date	4/16/2019	

Area Location Map



Area View Picture

Top View Picture

Access Notes

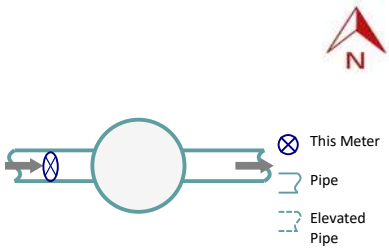
Investigation Photo

Hydraulic Characteristics

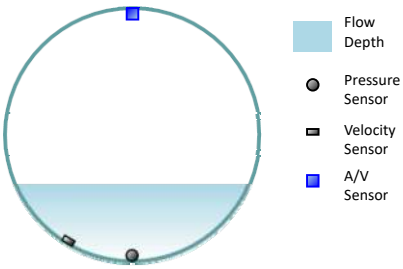
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Pressure Clock Position: 6:00

Velocity Clock Position: 7:00

Approvals

Recommended by FSP	Client Approval

rjngroup The Choice for Collection System Solutions	CDM Smith Greeley CO Flow Monitoring	Site Name FM11

Inspected By	ncaris	**Project No.**	**Site Code**
Inspected Date/Time	4/3/2019 4:48 PM	18-3428-00	T

System Information

Target Pipe Dia. (in)	18.0
Municipality	
District	Greeley
Assigned Rain Gauge	
Client Manhole #	01-00.022
U/S Connecting MH I.D	01-00.023
System Characteristics:	
Residential - ☐	Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	222 22nd St
Site Access	Roadway, High Traffic
Longitude	-104.68100000
Latitude	40.40240000
MH Type	Poured Concrete
Manhole Depth (ft)	11.78
Manhole Width (ft)	5.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	17.00
Pipe Width (in)	17.56
Pipe Type	Vitrified Clay
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

Hydraulic Information

Flow Depth (in)	4.00
Instant Velocity (fps)	4.00
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Fair

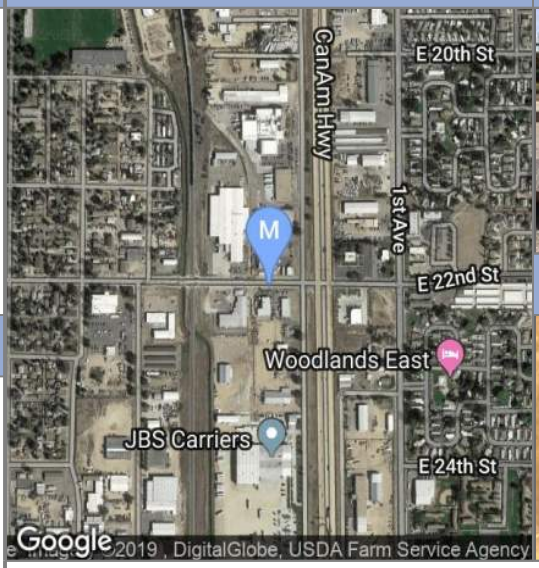
Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	50

Post Installation Notes

Meter Type	ADS	5000 AS
Telemetry Type	Telog	
Installation Date	4/16/2019	

Area Location Map



Area View Picture

Top View Picture

Access Notes Eastbound lane 22nd st in bike lane.

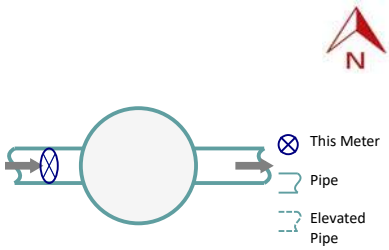
Investigation Photo

Hydraulic Characteristics

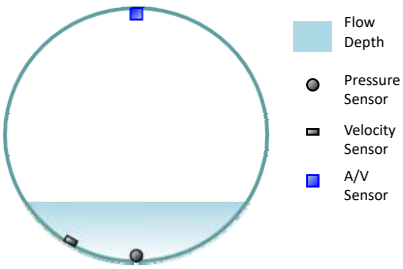
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Pressure Clock Position: 6:00

Velocity Clock Position: 7:00

Approvals

Recommended by FSP **Client Approval**

rjngroup The Choice for Collection System Solutions	CDM Smith Greeley CO Flow Monitoring	Site Name FM12

Inspected By	ncaris	**Project No.**	**Site Code**
Inspected Date/Time	4/3/2019 5:08 PM	18-3428-00	T

System Information

Target Pipe Dia. (in)	18.0
Municipality	
District	Greeley
Assigned Rain Gauge	
Client Manhole #	01-00.028
U/S Connecting MH I.D	01-00.029
System Characteristics:	
Residential - ☐	Commercial - ☐ Industrial - ☐
P/S Influence	No
WWTP Influence	No

Location Information

Site Address	2330 4th Ave
Site Access	Roadway, Low Traffic
Longitude	-104.68400000
Latitude	40.40020000
MH Type	Lined
Manhole Depth (ft)	11.30
Manhole Width (ft)	5.0
Elevated MH	No
Height Elevated (ft)	
Structural Integrity	Safe

Site Information

Pipe Height (in)	17.25
Pipe Width (in)	17.75
Pipe Type	Vitrified Clay
Pipe Shape	Circular
O2	**LEL %**
H2S	**CO**

Hydraulic Information

Flow Depth (in)	6.00
Instant Velocity (fps)	4.00
Surcharge Evidence (ft)	
Silt Type	None
Silt Depth (in)	0.00
Needs Cleaning	No
Backwater	No
Flow Path	Straight
Drop Inlet	No
Hydraulic Rating	Fair

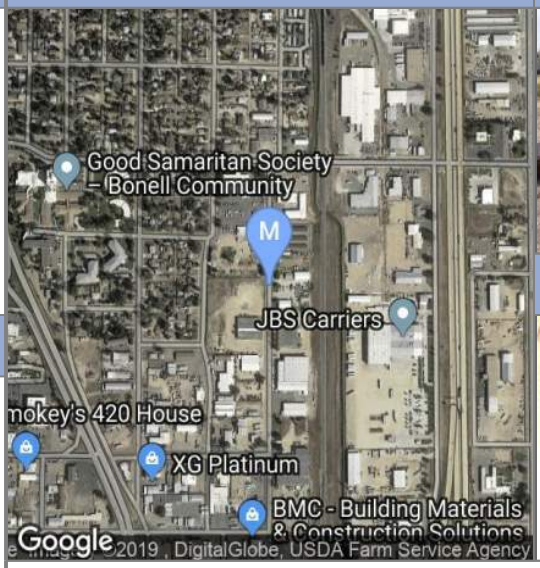
Installation Notes

Location in Pipe (ft)	1.0
Location from Manhole	
Sensors	Pressure, Velocity, and Ultra
Antenna Surface	Paved Surface
Signal Strength	50

Post Installation Notes

Meter Type	ADS	5000 AS
Telemetry Type	Telog	
Installation Date	4/15/2019	

Area Location Map



Area View Picture

Top View Picture

Access Notes North bound lane along 4th ave. Manhole closer to edge of street.

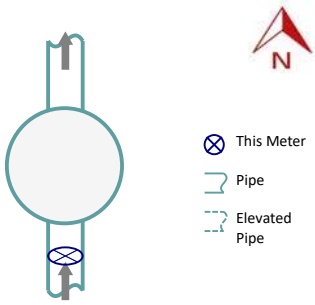
Investigation Photo

Hydraulic Characteristics

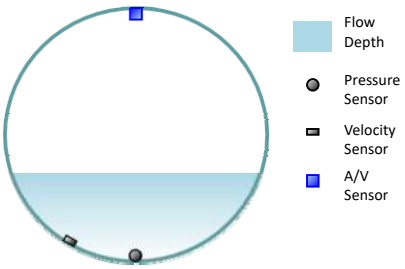
Installation Photo

Installation Notes

Install Plan Sketch



Install Cross-Section Sketch



Pressure Clock Position: 6:00

Velocity Clock Position: 7:00

Approvals

Recommended by FSP **Client Approval**

rjngroup	CDM Smith Greeley CO Flow Monitoring	RG Site Name RG01

Project	Project No.	Inspection Date/Time	Facility Name
Greeley CO Flow Monitoring	*18-3428-00*	*4/9/2019 9:22 AM*	*Pump Ststion*
		Inspected By	**Access Instructions**
		kbelk	
Site Address:	*610 N 71st Ave*		
Latitude / Longitude	40.44120000	-104.78800000	

Contact Info	
Name	*Cory Fuller*
Title	*City of Greeley*
Phone #	*970-415-2166*

Tipping Bucket Serial #

Logger Serial #

Rain Gauge Manufacturer

Telog RG32

Recommended for Installation ☑

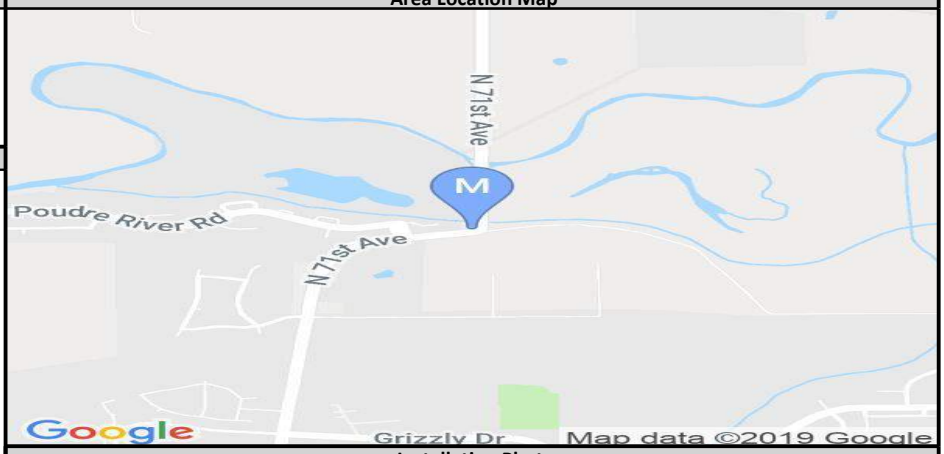
Installation Instructions

Building Photo

Ladder Location Photo

Location Diagram of Rain Gauge

Area Location Map



Installation Photo

rjngroup	CDM Smith Greeley CO Flow Monitoring	RG Site Name RG02

Project	Project No.	Inspection Date/Time	Facility Name
Greeley CO Flow Monitoring	*18-3428-00*	*4/10/2019 9:43 AM*	*Water Treatment Plant*
		Inspected By	**Access Instructions**
		kbelk	*Buzz at front gate, pull to main building, go inside, and gain access to stairs to roof.*
Site Address:	*300 E 8th St*		
Latitude / Longitude	40.42460000	-104.67700000	

Contact Info	
Name	*Cory Fuller*
Title	*City of Greeley*
Phone #	*970-415-2166*

Tipping Bucket Serial #

Logger Serial #

Rain Gauge Manufacturer

Telog RG32

Recommended for Installation ☑

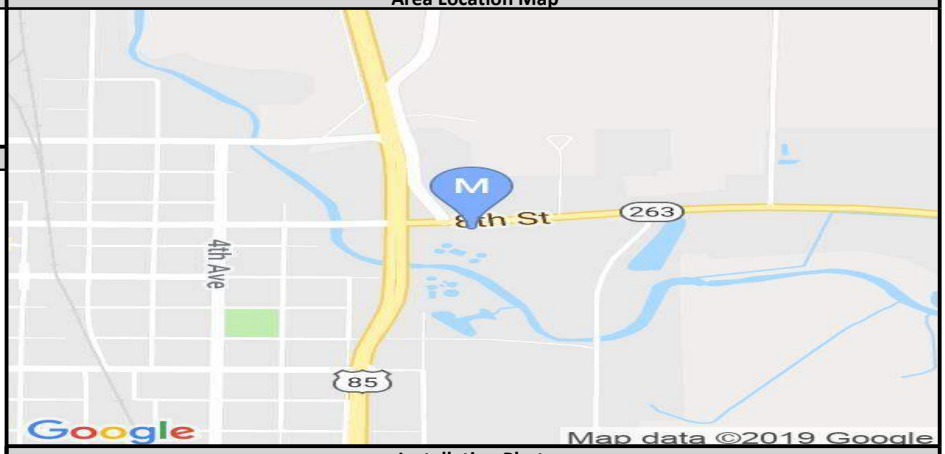
Installation Instructions

Building Photo

Ladder Location Photo

Location Diagram of Rain Gauge

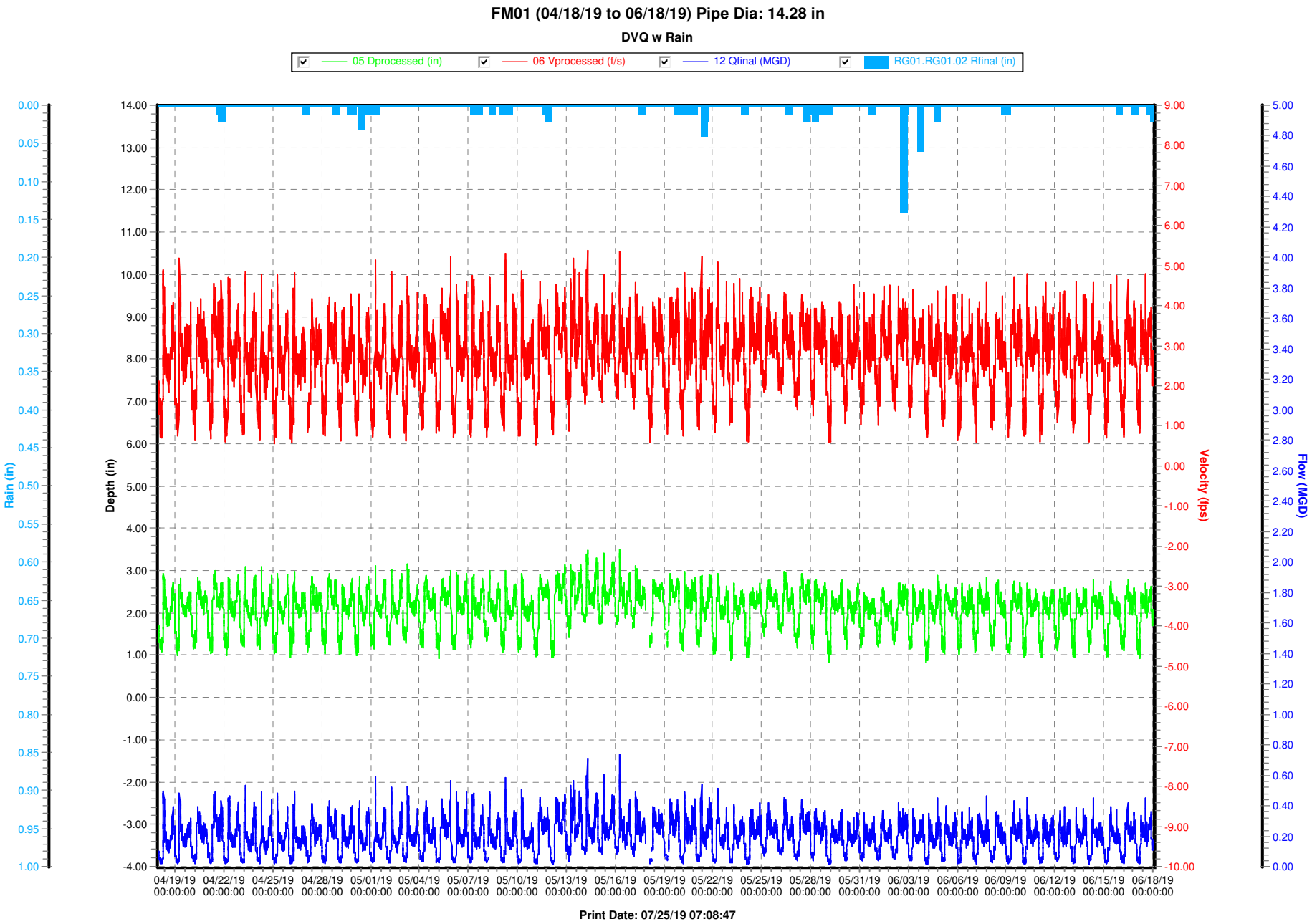
Area Location Map



Installation Photo

APPENDIX B

HYDROGRAPHS


FM01 (04/18/19 to 06/18/19) Pipe Dia: 14.28 in
DVQ w Rain
05 Dprocessed (in)
06 Vprocessed (f/s)
12 Qfinal (MGD)
RG01.RG01.02 Rfinal (in)
Rain (in)
Depth (in)
Velocity (fps)
Flow (MGD)
04/19/19 00:00:00
04/22/19 00:00:00
04/25/19 00:00:00
04/28/19 00:00:00
05/01/19 00:00:00
05/04/19 00:00:00
05/07/19 00:00:00
05/10/19 00:00:00
05/13/19 00:00:00
05/16/19 00:00:00
05/19/19 00:00:00
05/22/19 00:00:00
05/25/19 00:00:00
05/28/19 00:00:00
05/31/19 00:00:00
06/03/19 00:00:00
06/06/19 00:00:00
06/09/19 00:00:00
06/12/19 00:00:00
06/15/19 00:00:00
06/18/19 00:00:00
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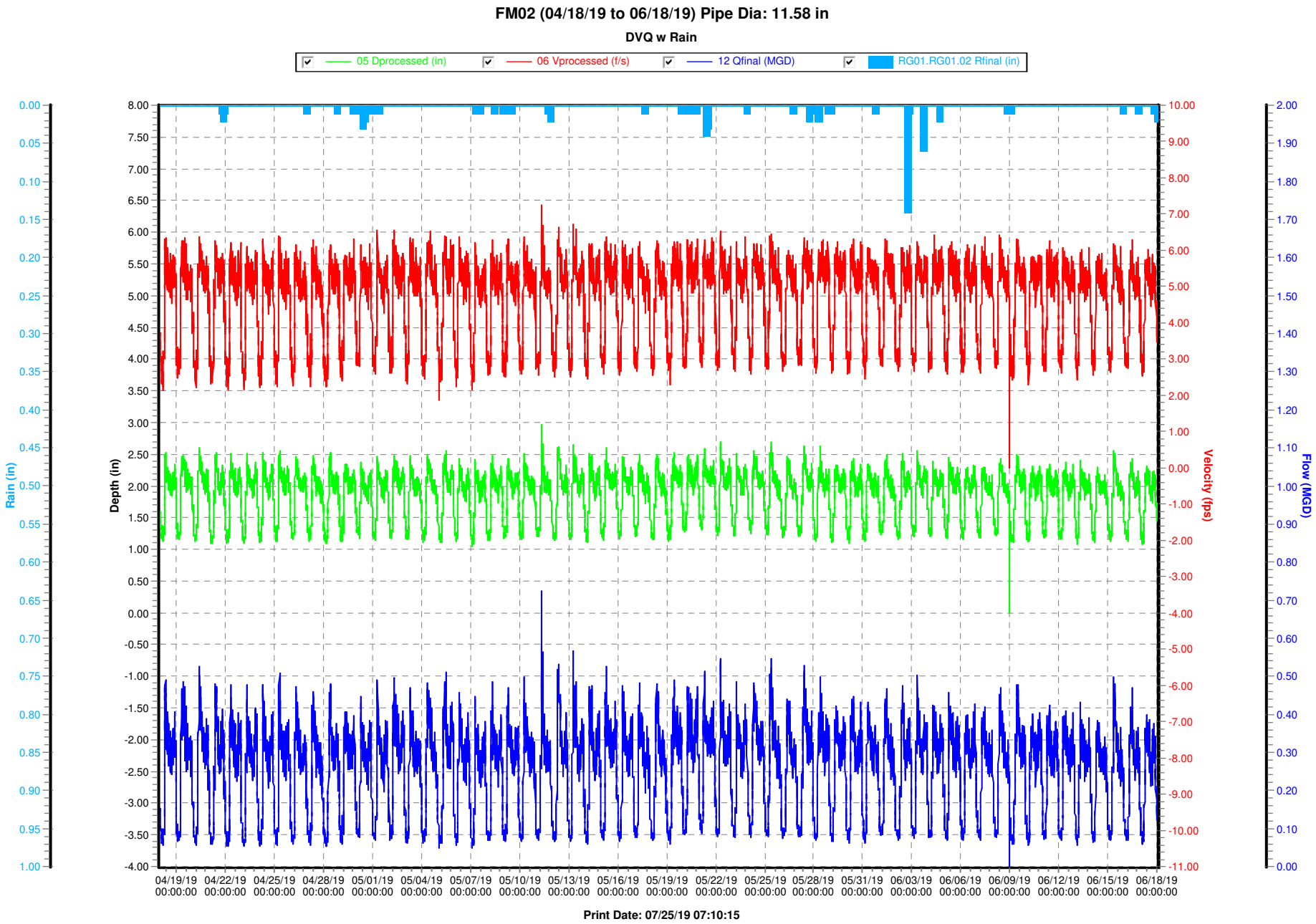
FM02 (04/18/19 to 06/18/19) Pipe Dia: 11.58 in
DVQ w Rain
05 Dprocessed (in)
06 Vprocessed (f/s)
12 Qfinal (MGD)
RG01.RG01.02 Rfinal (in)
Rain (in)
Depth (in)
Velocity (fps)
Flow (MGD)
04/19/19 00:00:00
04/22/19 00:00:00
04/25/19 00:00:00
04/28/19 00:00:00
05/01/19 00:00:00
05/04/19 00:00:00
05/07/19 00:00:00
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06/06/19 00:00:00
06/09/19 00:00:00
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06/15/19 00:00:00
06/18/19 00:00:00
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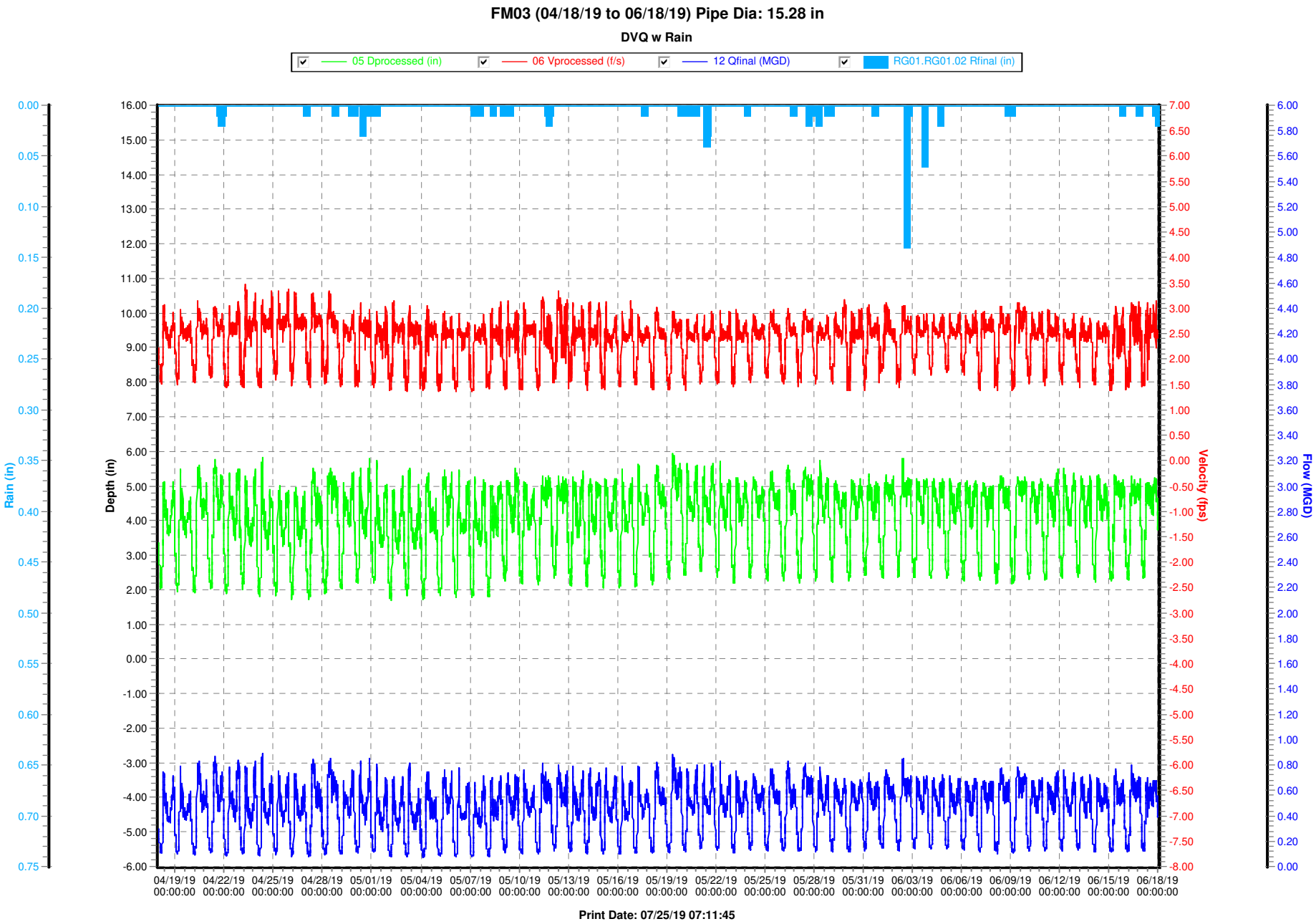
FM03 (04/18/19 to 06/18/19) Pipe Dia: 15.28 in
DVQ w Rain
05 Dprocessed (in)
06 Vprocessed (f/s)
12 Qfinal (MGD)
RG01.RG01.02 Rfinal (in)
Rain (in)
Depth (in)
Velocity (fps)
Flow (MGD)
04/19/19 00:00:00
04/22/19 00:00:00
04/25/19 00:00:00
04/28/19 00:00:00
05/01/19 00:00:00
05/04/19 00:00:00
05/07/19 00:00:00
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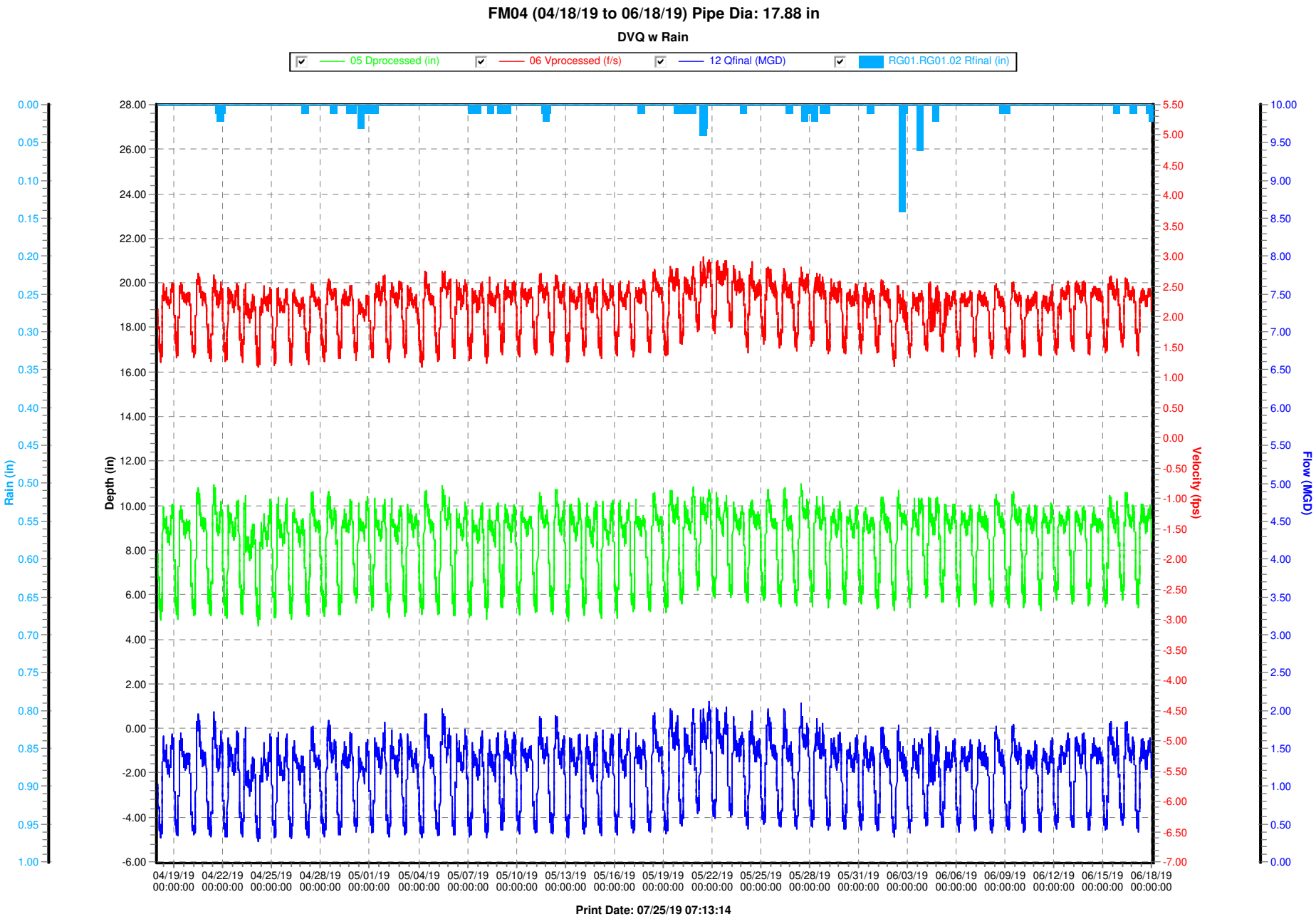
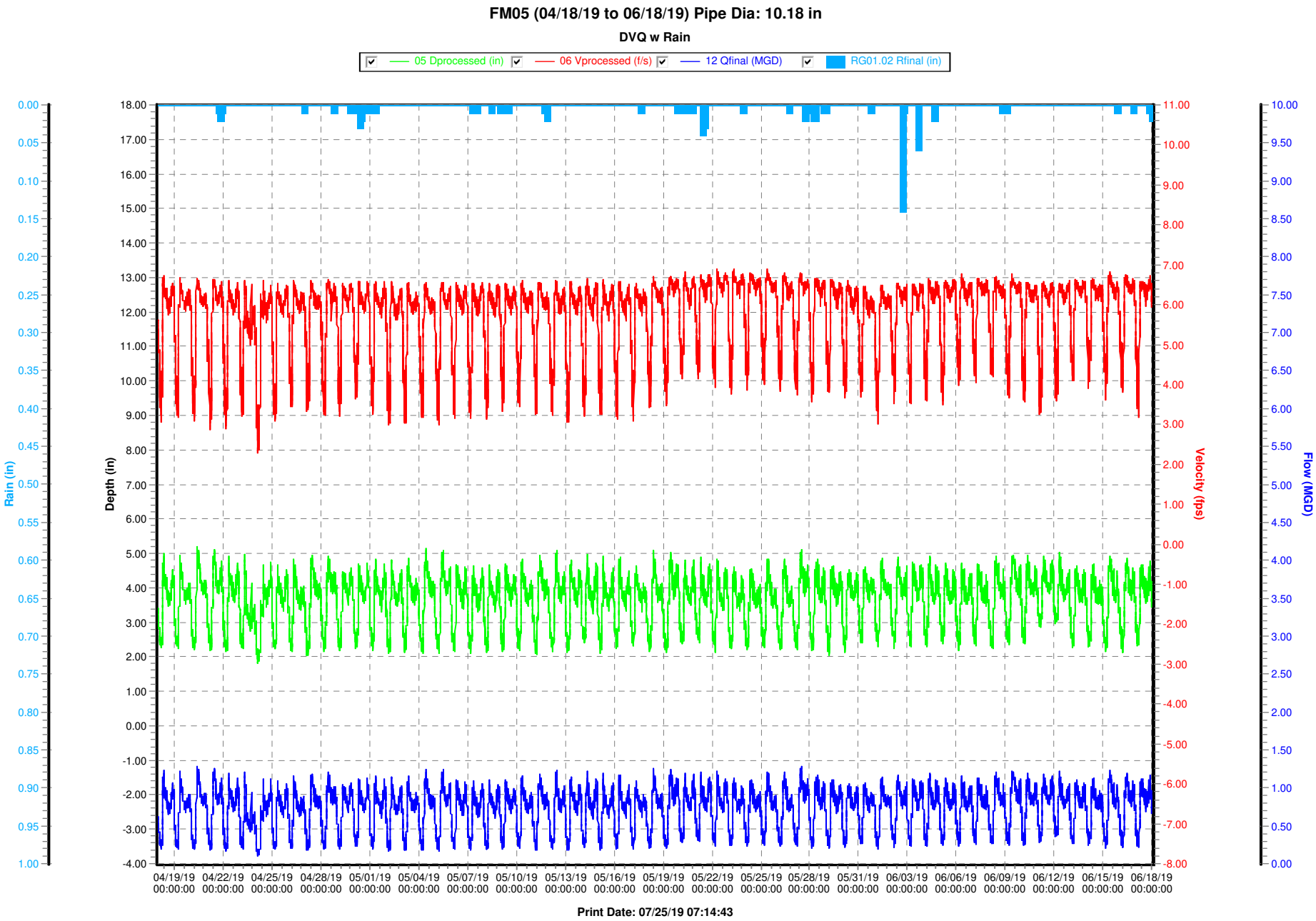

FM04 (04/18/19 to 06/18/19) Pipe Dia: 17.88 in
DVQ w Rain
05 Dprocessed (in)
06 Vprocessed (f/s)
12 Qfinal (MGD)
RG01.RG01.02 Rfinal (in)
Depth (in)
Velocity (fps)
Flow (MGD)
Rain (in)
Print Date: 07/25/19 07:13:14


FM05 (04/18/19 to 06/18/19) Pipe Dia: 10.18 in
DVQ w Rain
05 Dprocessed (in)
06 Vprocessed (f/s)
12 Qfinal (MGD)
RG01.02 Rfinal (in)
Rain (in)
Depth (in)
Velocity (fps)
Flow (MGD)
04/19/19 00:00:00
04/22/19 00:00:00
04/25/19 00:00:00
04/28/19 00:00:00
05/01/19 00:00:00
05/04/19 00:00:00
05/07/19 00:00:00
05/10/19 00:00:00
05/13/19 00:00:00
05/16/19 00:00:00
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05/22/19 00:00:00
05/25/19 00:00:00
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06/06/19 00:00:00
06/09/19 00:00:00
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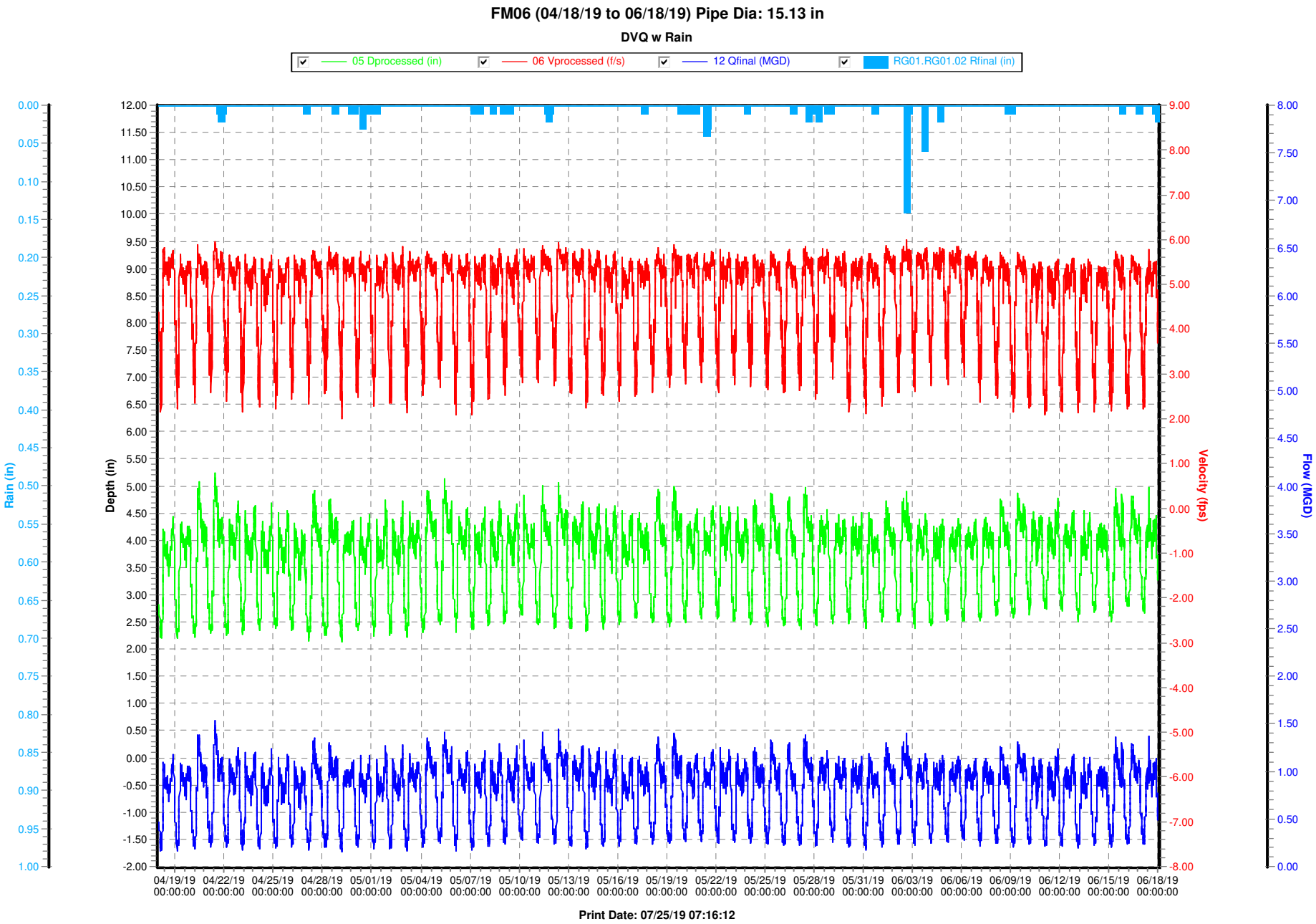
FM06 (04/18/19 to 06/18/19) Pipe Dia: 15.13 in
DVQ w Rain
05 Dprocessed (in)
06 Vprocessed (f/s)
12 Qfinal (MGD)
RG01.RG01.02 Rfinal (in)
Rain (in)
Depth (in)
Velocity (fps)
Flow (MGD)
04/19/19 00:00:00
04/22/19 00:00:00
04/25/19 00:00:00
04/28/19 00:00:00
05/01/19 00:00:00
05/04/19 00:00:00
05/07/19 00:00:00
05/10/19 00:00:00
05/13/19 00:00:00
05/16/19 00:00:00
05/19/19 00:00:00
05/22/19 00:00:00
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06/06/19 00:00:00
06/09/19 00:00:00
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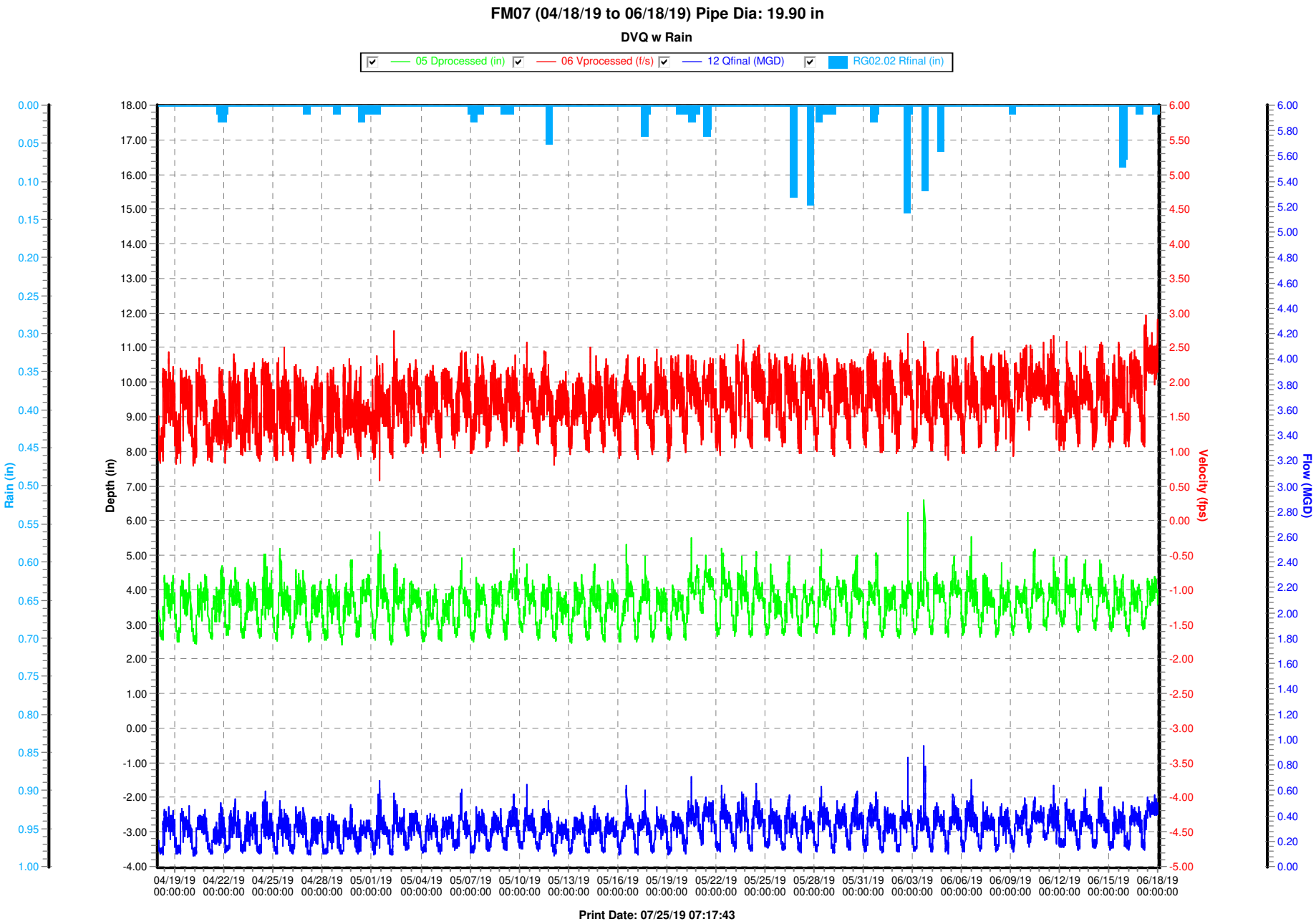
FM07 (04/18/19 to 06/18/19) Pipe Dia: 19.90 in
DVQ w Rain
05 Dprocessed (in)
06 Vprocessed (f/s)
12 Qfinal (MGD)
RG02.02 Rfinal (in)
Rain (in)
Depth (in)
Velocity (fps)
Flow (MGD)
04/19/19 00:00:00
04/22/19 00:00:00
04/25/19 00:00:00
04/28/19 00:00:00
05/01/19 00:00:00
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06/09/19 00:00:00
06/12/19 00:00:00
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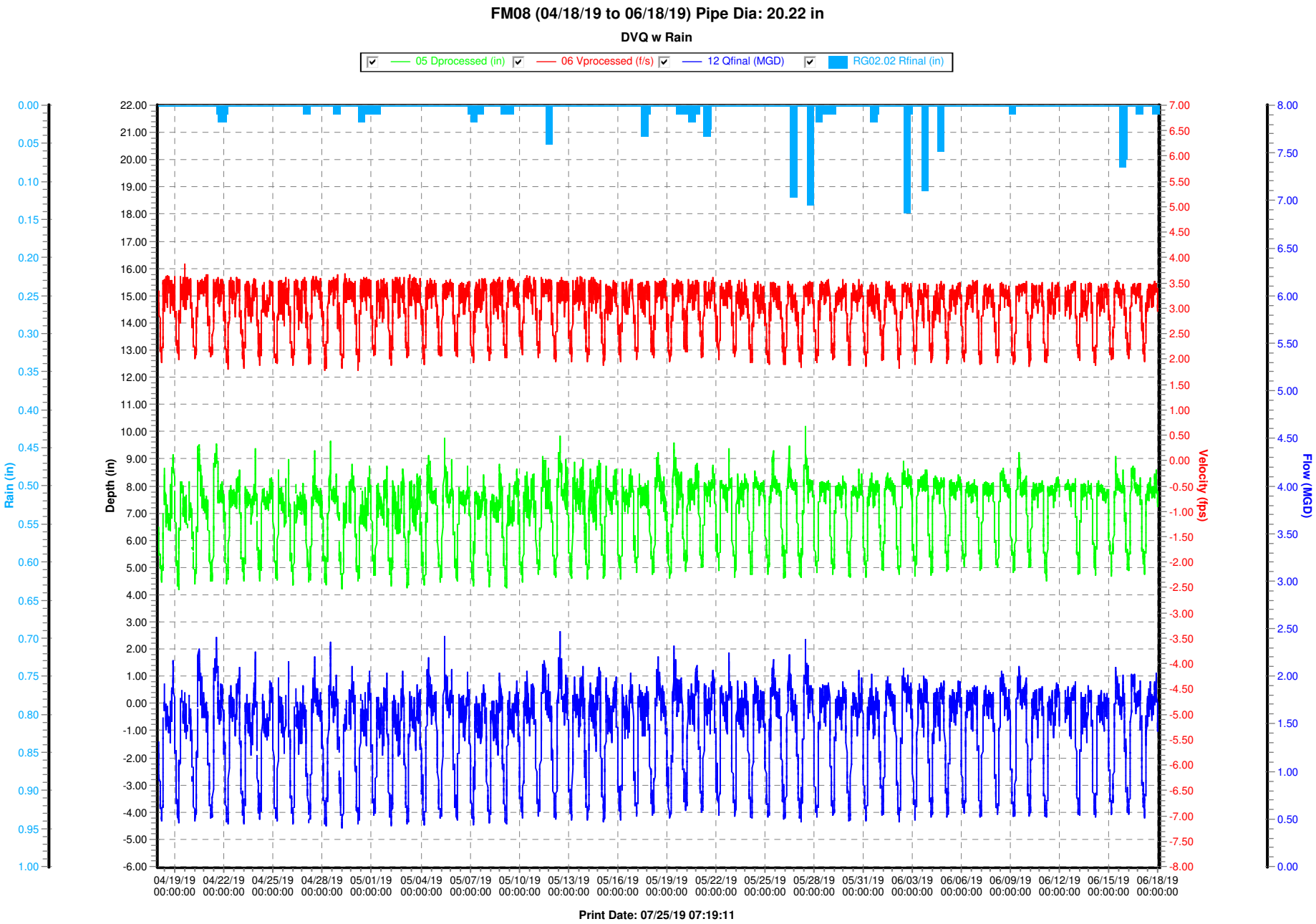
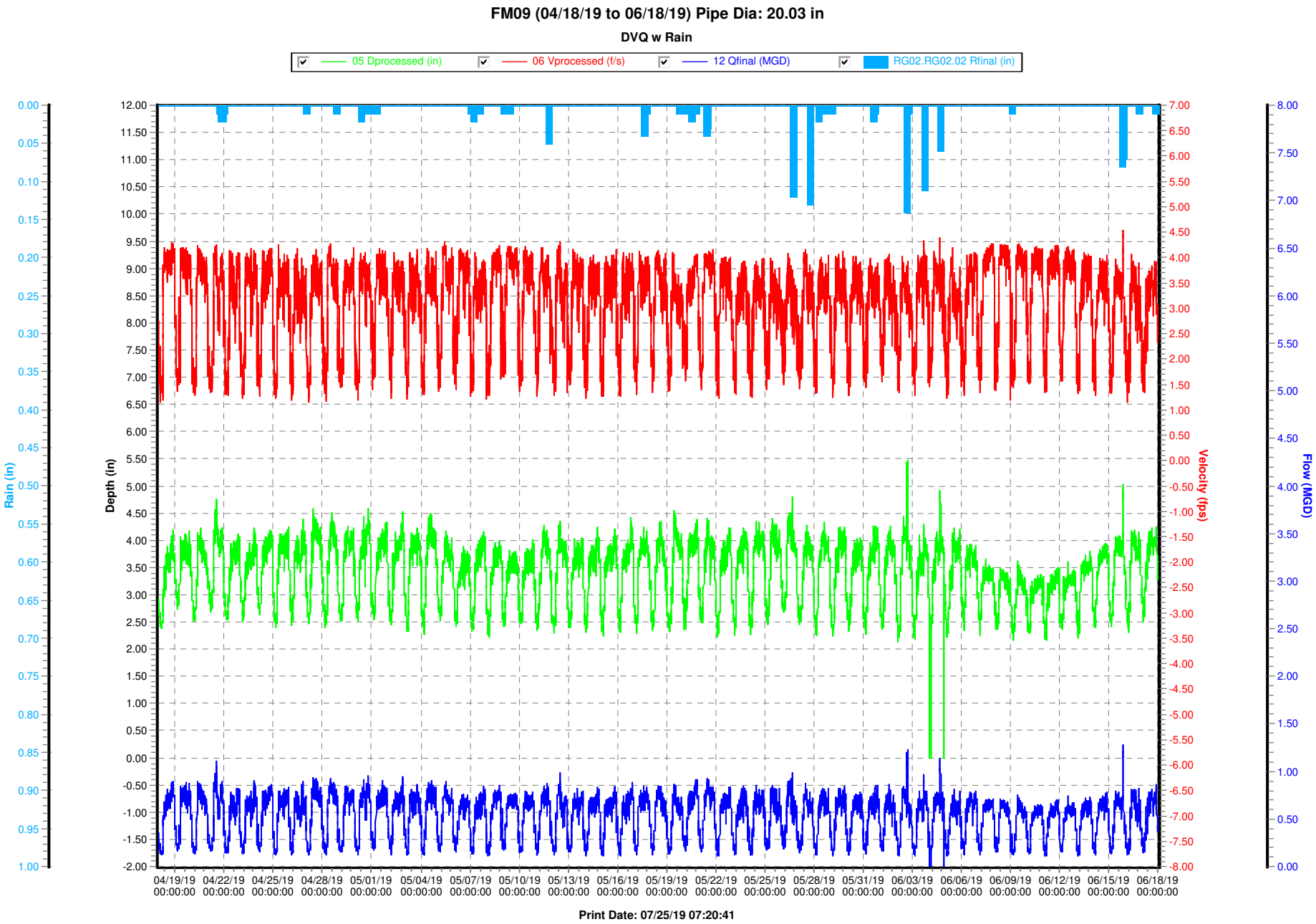
Print Date: 07/25/19 07:17:43


FM08 (04/18/19 to 06/18/19) Pipe Dia: 20.22 in
DVQ w Rain
05 Dprocessed (in)
06 Vprocessed (f/s)
12 Qfinal (MGD)
RG02.02 Rfinal (in)
Rain (in)
Depth (in)
Velocity (fps)
Flow (MGD)
04/19/19 00:00:00
04/22/19 00:00:00
04/25/19 00:00:00
04/28/19 00:00:00
05/01/19 00:00:00
05/04/19 00:00:00
05/07/19 00:00:00
05/10/19 00:00:00
05/13/19 00:00:00
05/16/19 00:00:00
05/19/19 00:00:00
05/22/19 00:00:00
05/25/19 00:00:00
05/28/19 00:00:00
05/31/19 00:00:00
06/03/19 00:00:00
06/06/19 00:00:00
06/09/19 00:00:00
06/12/19 00:00:00
06/15/19 00:00:00
06/18/19 00:00:00
Print Date: 07/25/19 07:19:11


FM09 (04/18/19 to 06/18/19) Pipe Dia: 20.03 in
DVQ w Rain
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06 Vprocessed (f/s)
12 Qfinal (MGD)
RG02.RG02.02 Rfinal (in)
Rain (in)
Depth (in)
Velocity (fps)
Flow (MGD)
04/19/19 00:00:00
04/22/19 00:00:00
04/25/19 00:00:00
04/28/19 00:00:00
05/01/19 00:00:00
05/04/19 00:00:00
05/07/19 00:00:00
05/10/19 00:00:00
05/13/19 00:00:00
05/16/19 00:00:00
05/19/19 00:00:00
05/22/19 00:00:00
05/25/19 00:00:00
05/28/19 00:00:00
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06/06/19 00:00:00
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06/18/19 00:00:00
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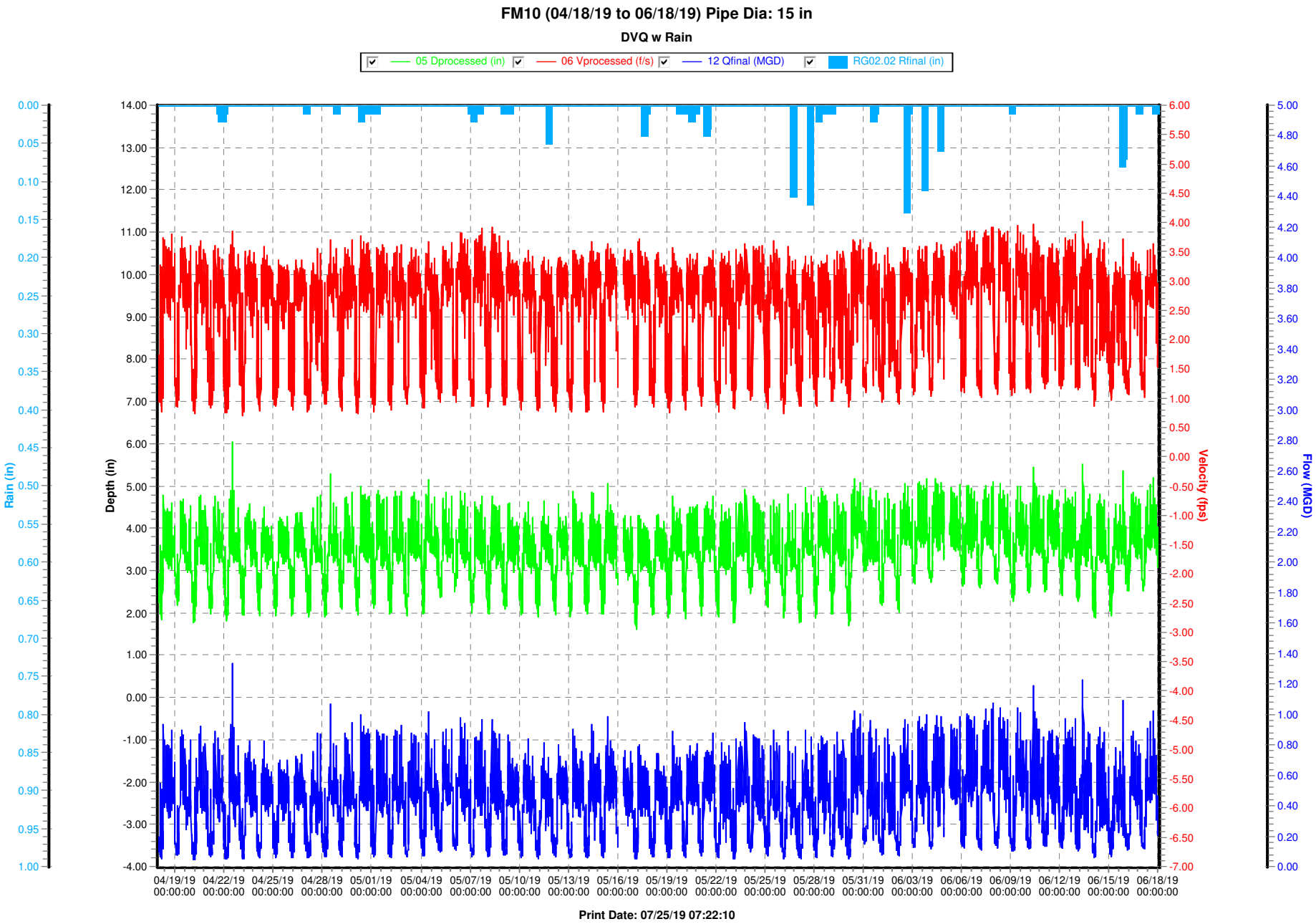
FM10 (04/18/19 to 06/18/19) Pipe Dia: 15 in
DVQ w Rain
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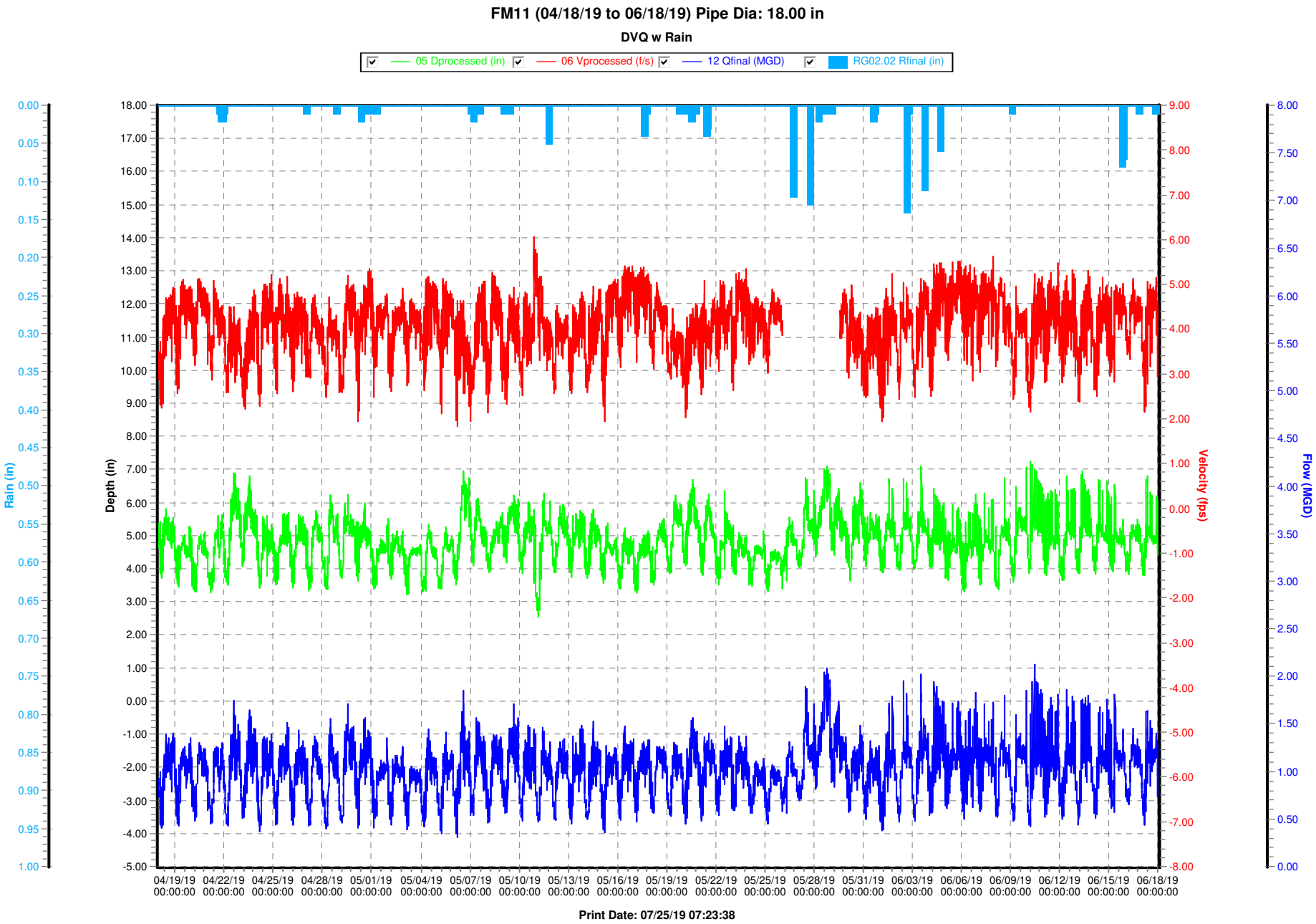
06 Vprocessed (f/s)
12 Qfinal (MGD)
RG02.02 Rfinal (in)
Rain (in)
Depth (in)
Velocity (fps)
Flow (MGD)
04/19/19 00:00:00
04/22/19 00:00:00
04/25/19 00:00:00
04/28/19 00:00:00
05/01/19 00:00:00
05/04/19 00:00:00
05/07/19 00:00:00
05/10/19 00:00:00
05/13/19 00:00:00
05/16/19 00:00:00
05/19/19 00:00:00
05/22/19 00:00:00
05/25/19 00:00:00
05/28/19 00:00:00
05/31/19 00:00:00
06/03/19 00:00:00
06/06/19 00:00:00
06/09/19 00:00:00
06/12/19 00:00:00
06/15/19 00:00:00
06/18/19 00:00:00
Print Date: 07/25/19 07:22:10


FM11 (04/18/19 to 06/18/19) Pipe Dia: 18.00 in
DVQ w Rain
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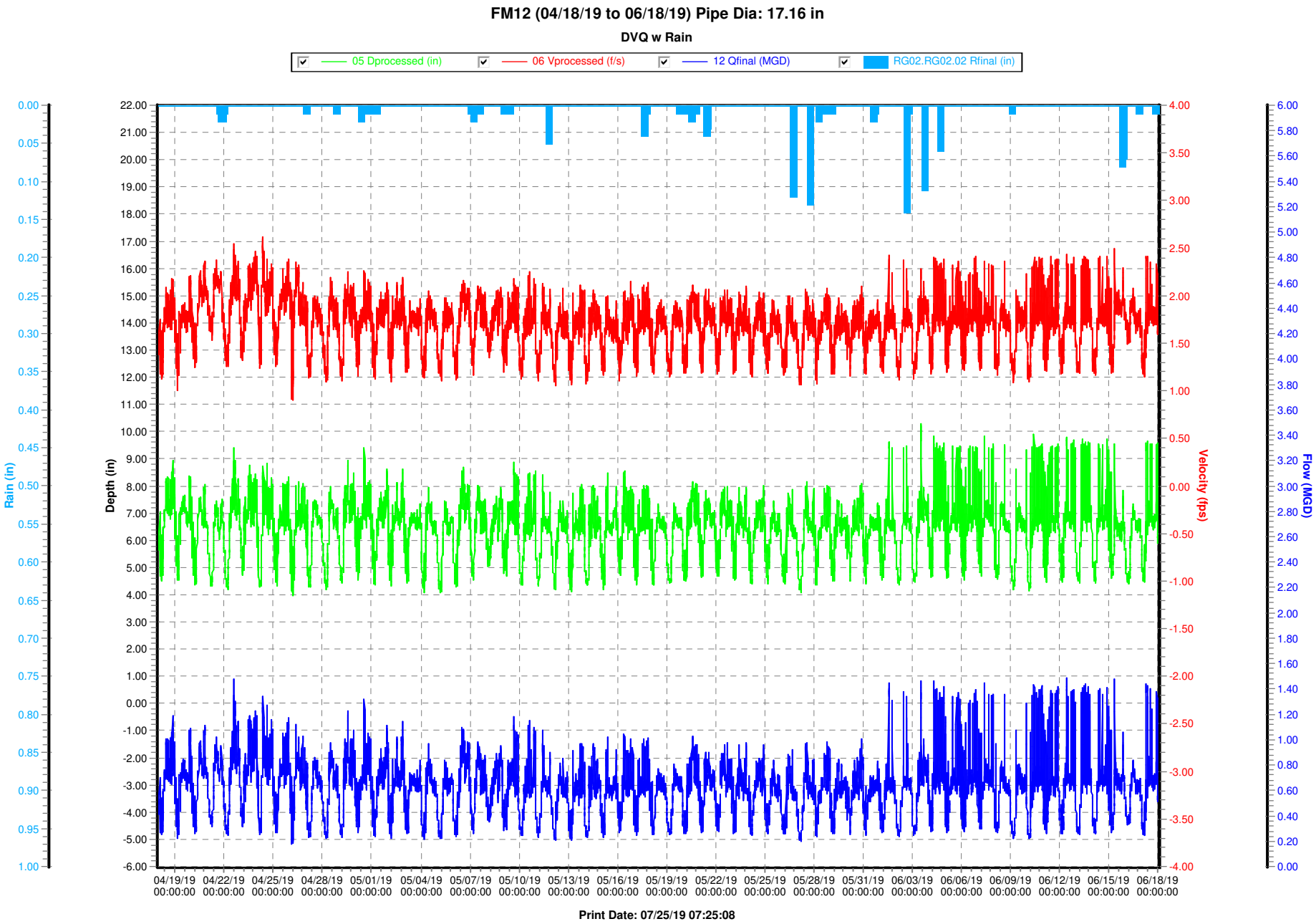
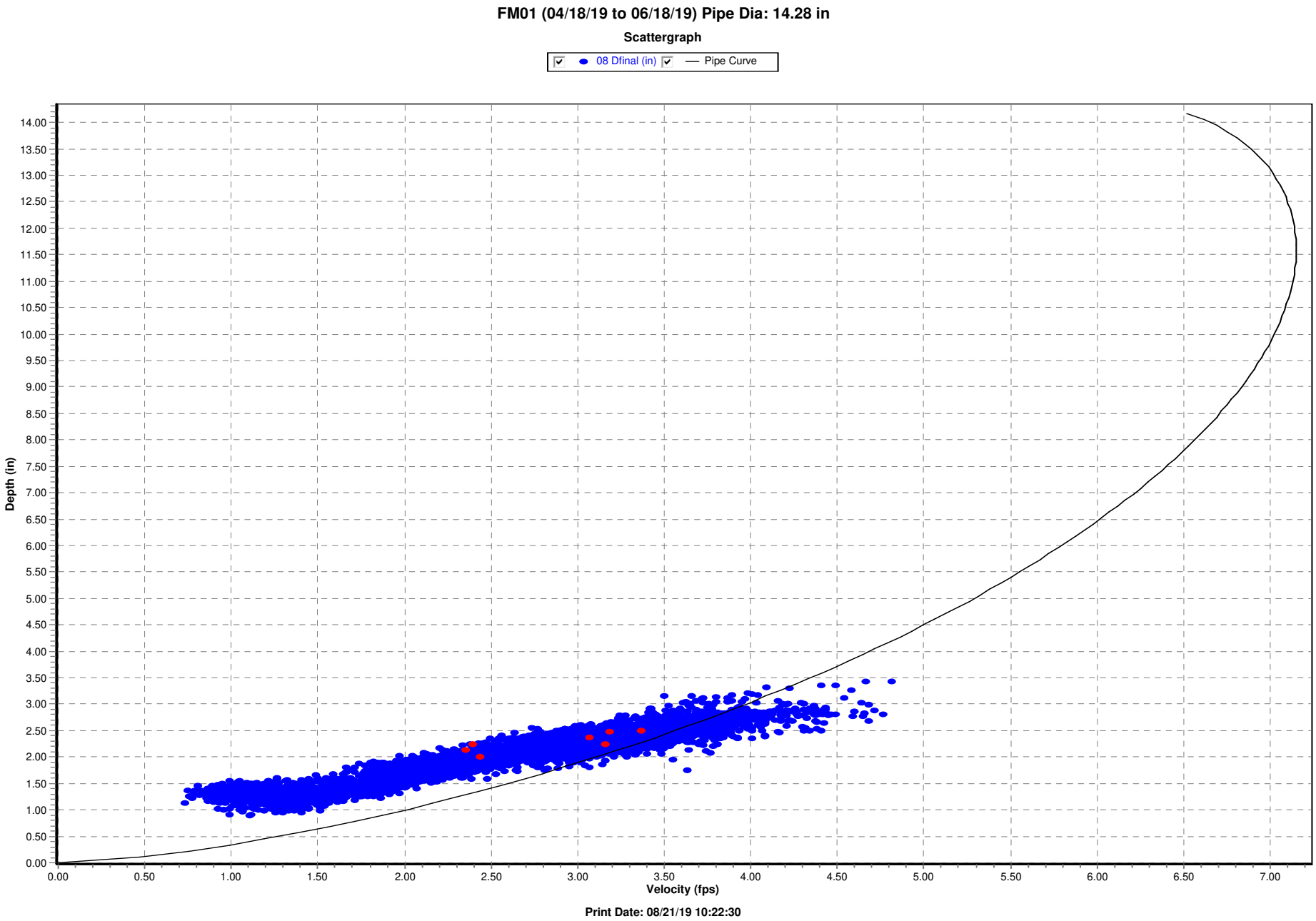
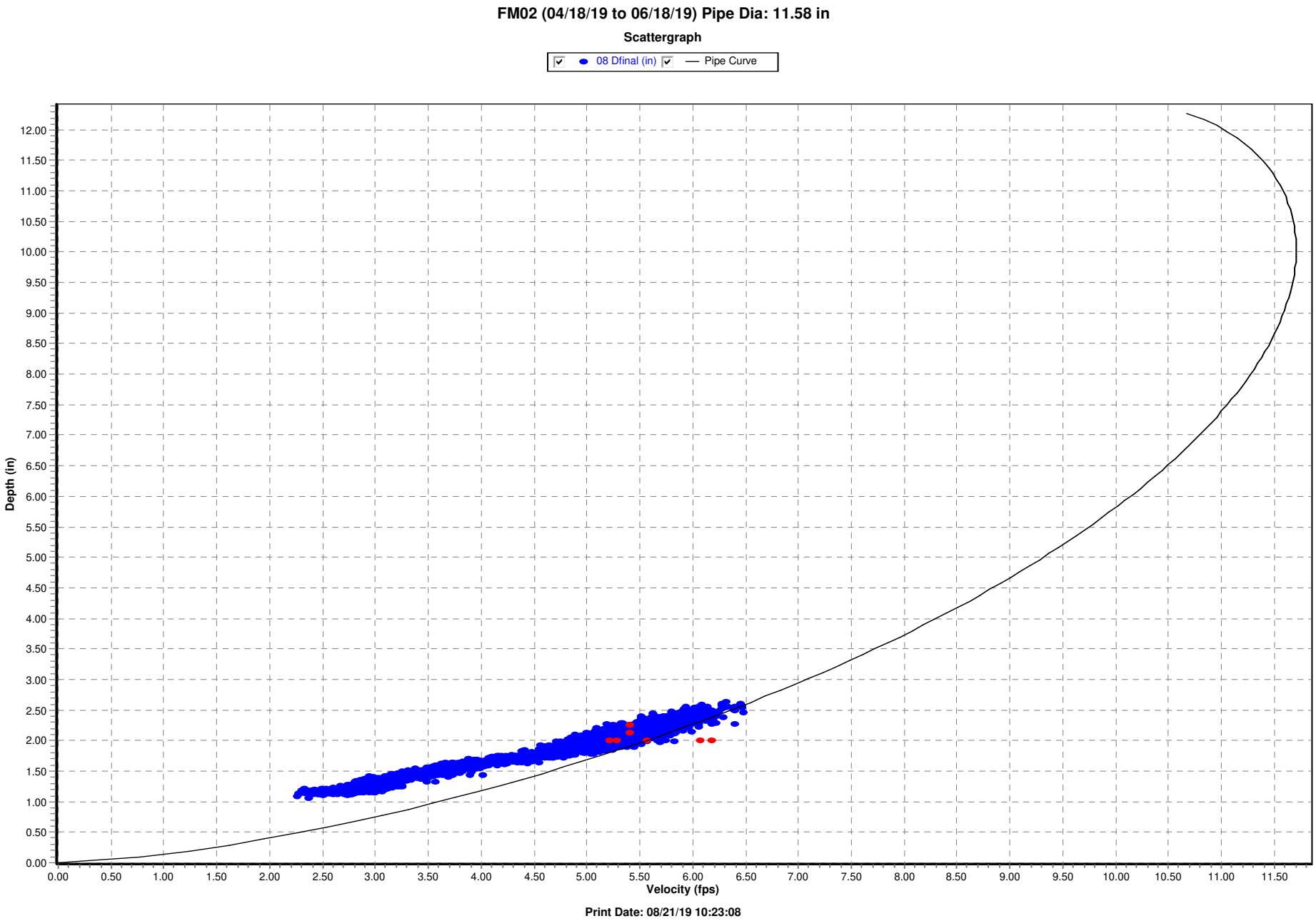
06 Vprocessed (f/s)
12 Qfinal (MGD)
RG02.02 Rfinal (in)
Rain (in)
Depth (in)
Velocity (fps)
Flow (MGD)
04/19/19 00:00:00
04/22/19 00:00:00
04/25/19 00:00:00
04/28/19 00:00:00
05/01/19 00:00:00
05/04/19 00:00:00
05/07/19 00:00:00
05/10/19 00:00:00
05/13/19 00:00:00
05/16/19 00:00:00
05/19/19 00:00:00
05/22/19 00:00:00
05/25/19 00:00:00
05/28/19 00:00:00
05/31/19 00:00:00
06/03/19 00:00:00
06/06/19 00:00:00
06/09/19 00:00:00
06/12/19 00:00:00
06/15/19 00:00:00
06/18/19 00:00:00
Print Date: 07/25/19 07:23:38


FM12 (04/18/19 to 06/18/19) Pipe Dia: 17.16 in
DVQ w Rain
05 Dprocessed (in)
06 Vprocessed (f/s)
12 Qfinal (MGD)
RG02.RG02.02 Rfinal (in)
Rain (in)
Depth (in)
Velocity (fps)
Flow (MGD)
04/19/19 00:00:00
04/22/19 00:00:00
04/25/19 00:00:00
04/28/19 00:00:00
05/01/19 00:00:00
05/04/19 00:00:00
05/07/19 00:00:00
05/10/19 00:00:00
05/13/19 00:00:00
05/16/19 00:00:00
05/19/19 00:00:00
05/22/19 00:00:00
05/25/19 00:00:00
05/28/19 00:00:00
05/31/19 00:00:00
06/03/19 00:00:00
06/06/19 00:00:00
06/09/19 00:00:00
06/12/19 00:00:00
06/15/19 00:00:00
06/18/19 00:00:00
Print Date: 07/25/19 07:25:08

APPENDIX C

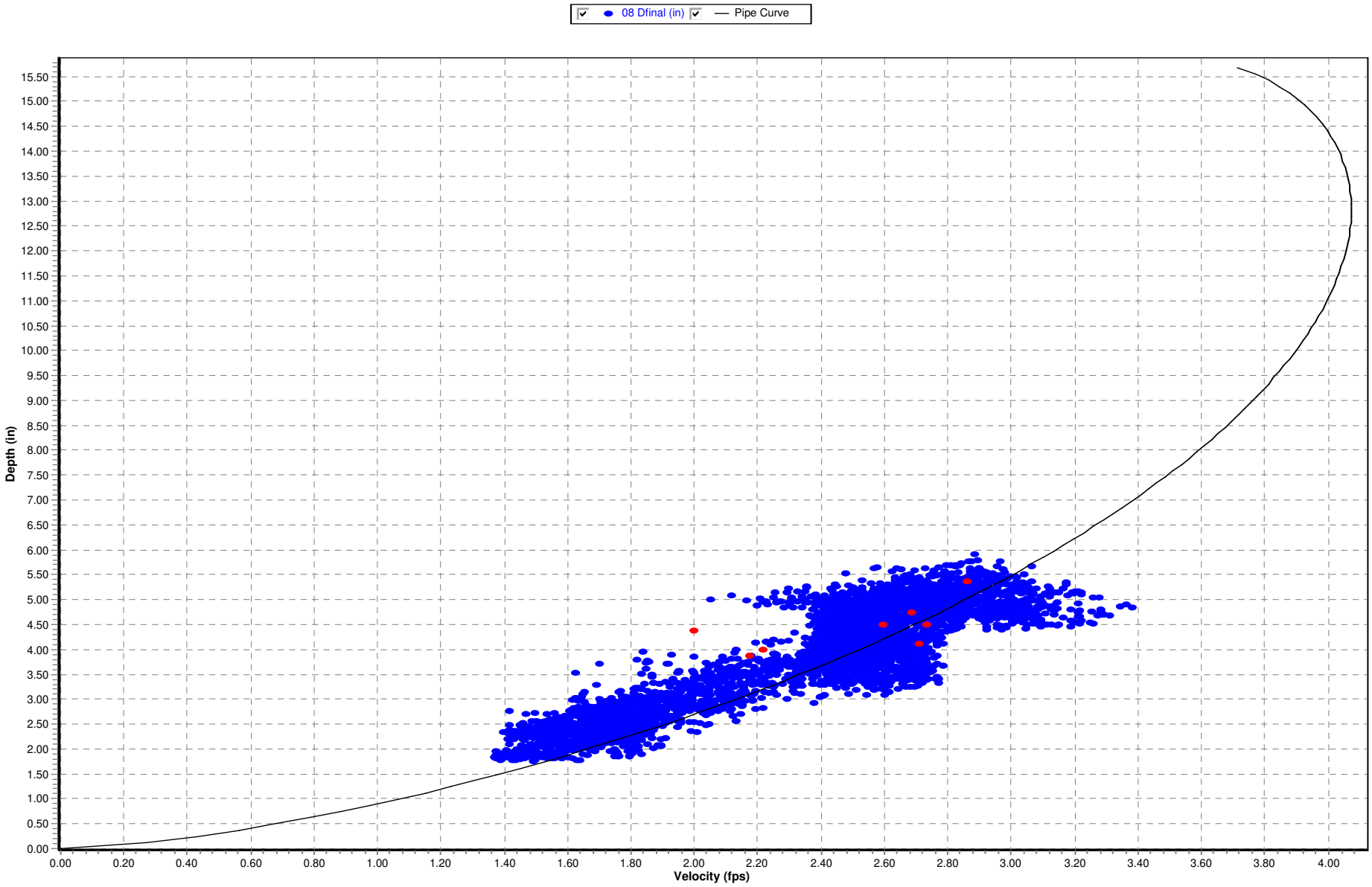
SCATTERGRAPHS


FM01 (04/18/19 to 06/18/19) Pipe Dia: 14.28 in
Scattergraph
08 Dfinal (in)
Pipe Curve
Depth (in)
Velocity (fps)
Print Date: 08/21/19 10:22:30

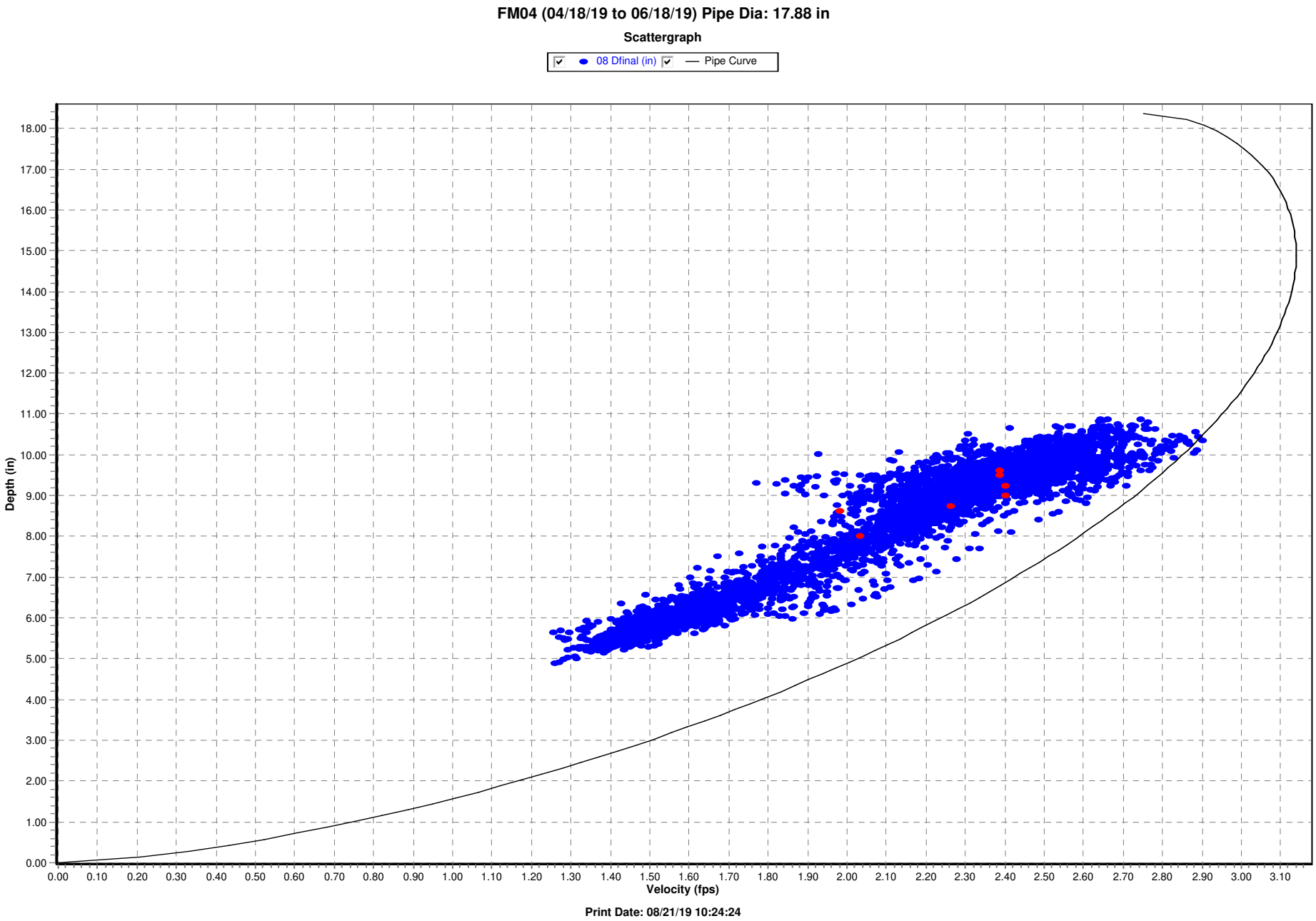

FM02 (04/18/19 to 06/18/19) Pipe Dia: 11.58 in
Scattergraph
08 Dfinal (in)
Pipe Curve
Depth (in)
Velocity (fps)
Print Date: 08/21/19 10:23:08

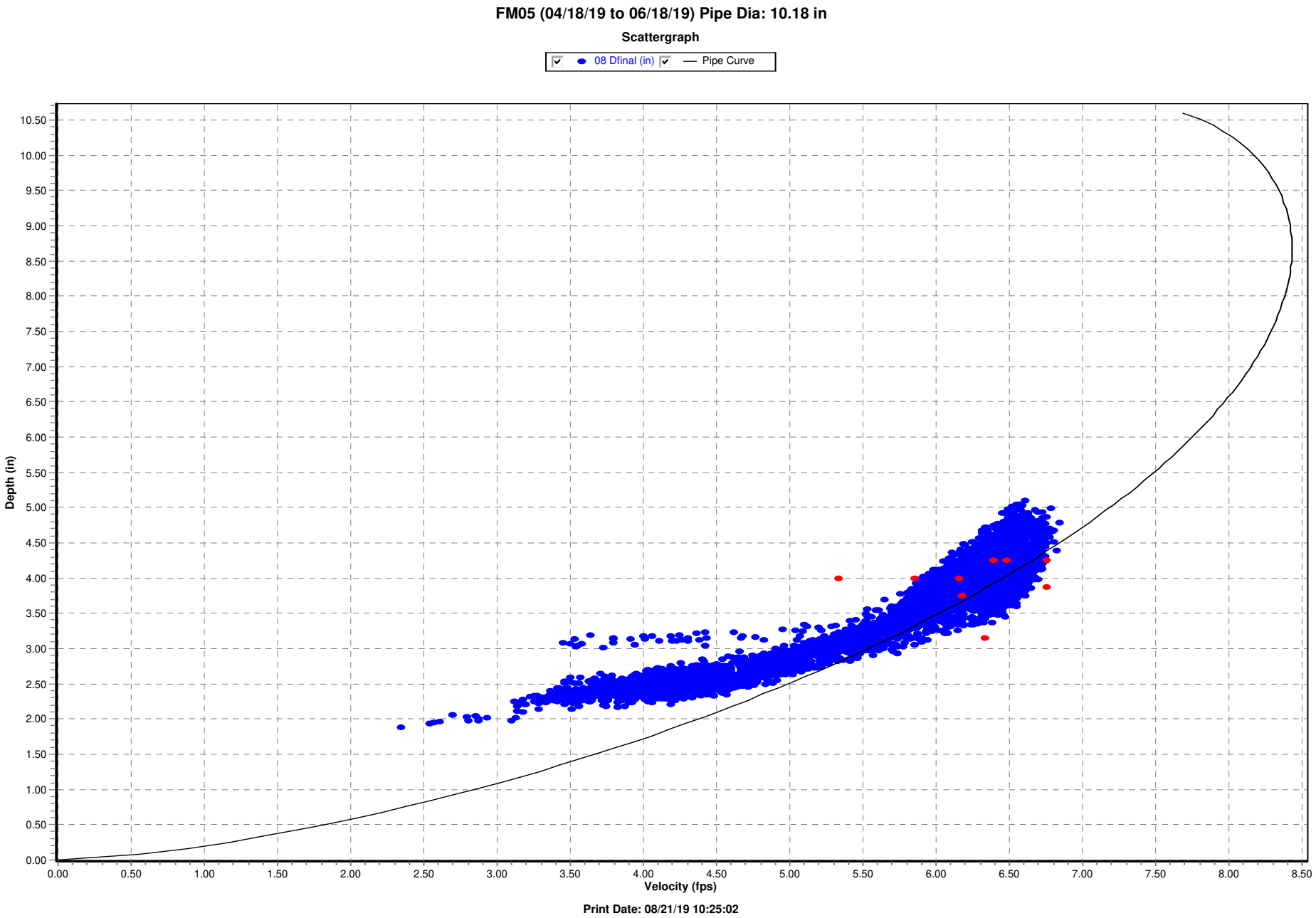
FM03 (04/18/19 to 06/18/19) Pipe Dia: 15.28 in

Scattergraph



Print Date: 08/21/19 10:23:46


FM04 (04/18/19 to 06/18/19) Pipe Dia: 17.88 in
Scattergraph
08 Dfinal (in)
Pipe Curve
Depth (in)
Velocity (fps)
Print Date: 08/21/19 10:24:24


FM05 (04/18/19 to 06/18/19) Pipe Dia: 10.18 in
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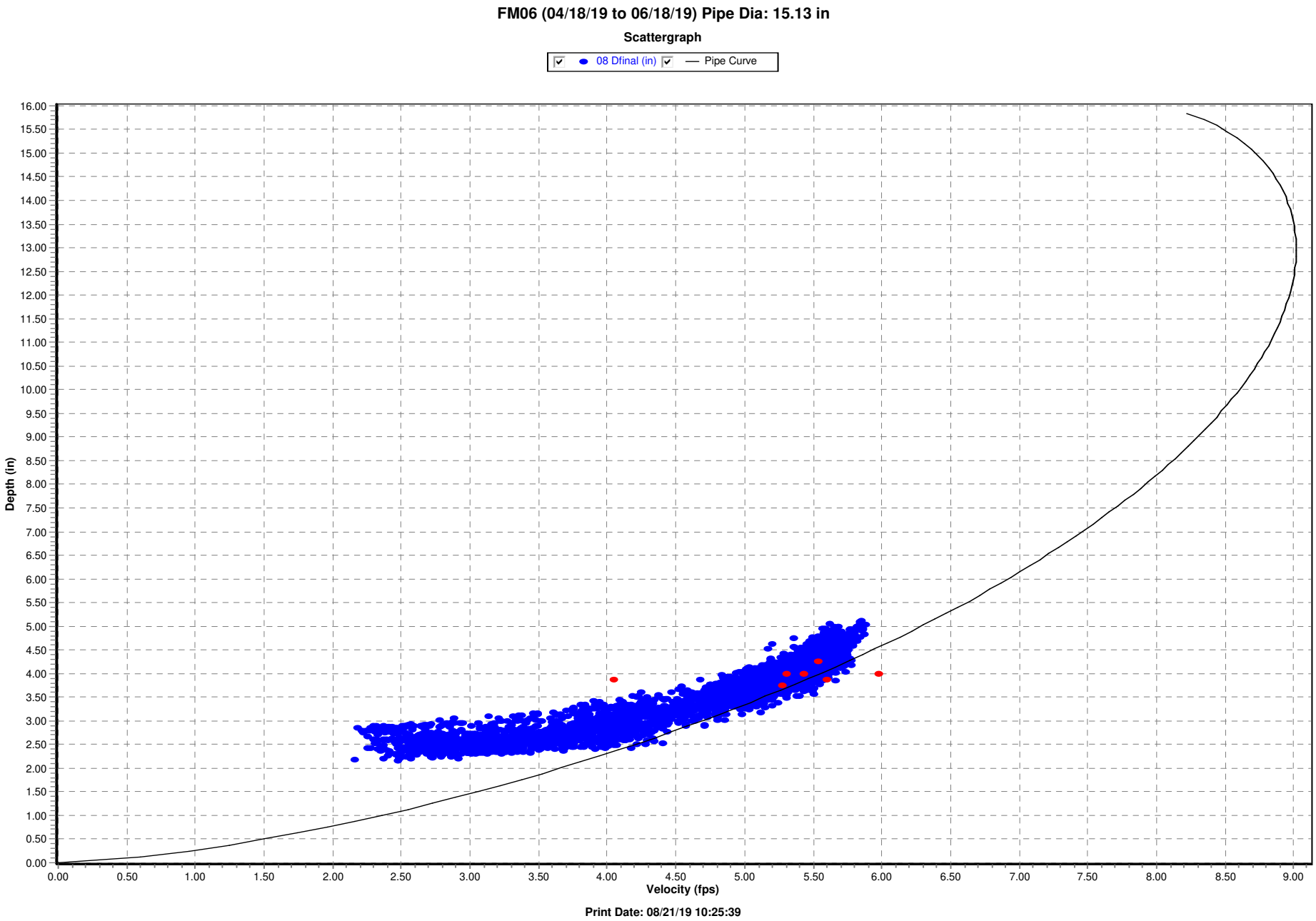
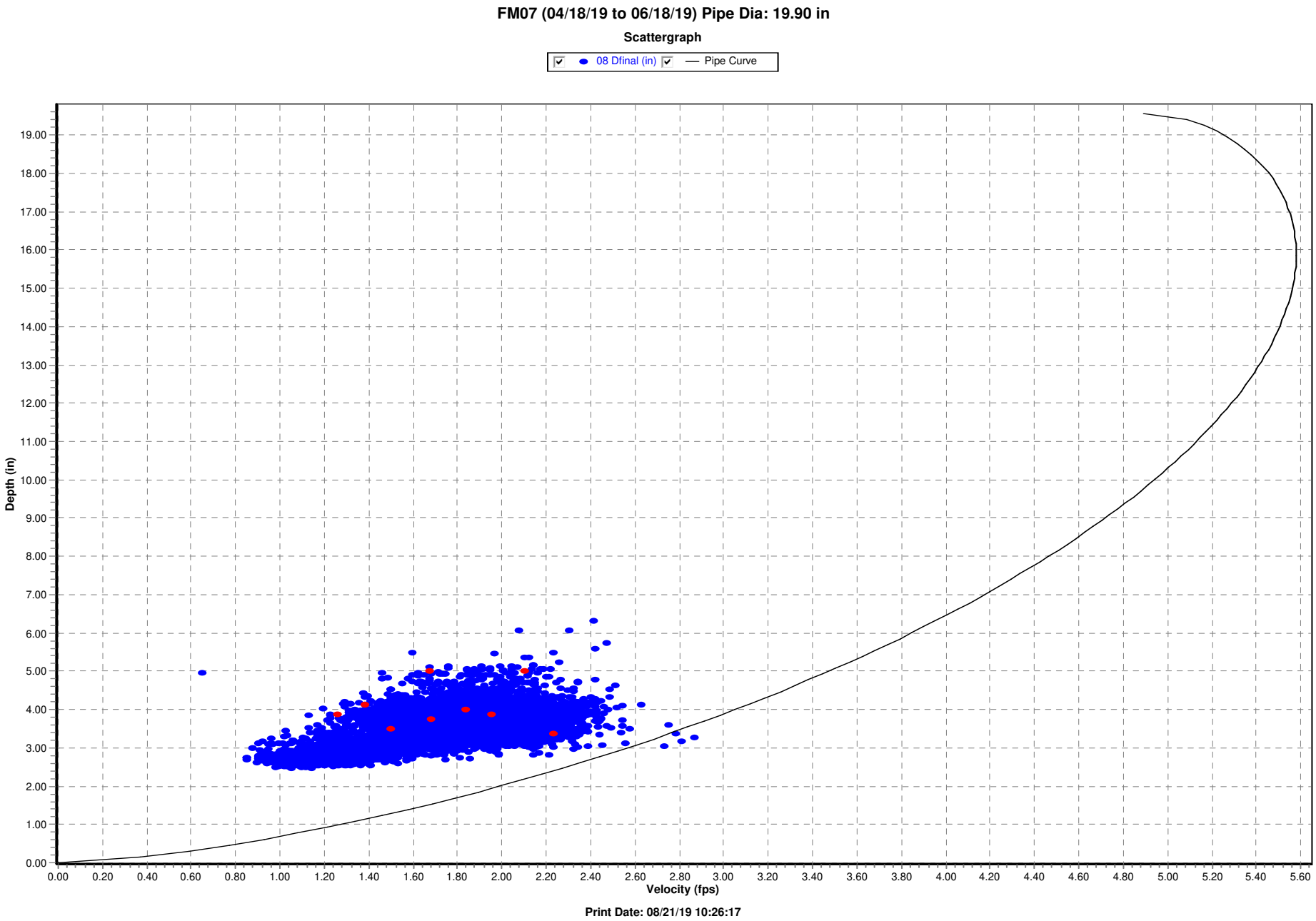
Pipe Curve
Depth (in)
Velocity (fps)
Print Date: 08/21/19 10:25:02


FM06 (04/18/19 to 06/18/19) Pipe Dia: 15.13 in
Scattergraph
08 Dfinal (in)
Pipe Curve
Depth (in)
Velocity (fps)
Print Date: 08/21/19 10:25:39


FM07 (04/18/19 to 06/18/19) Pipe Dia: 19.90 in
Scattergraph
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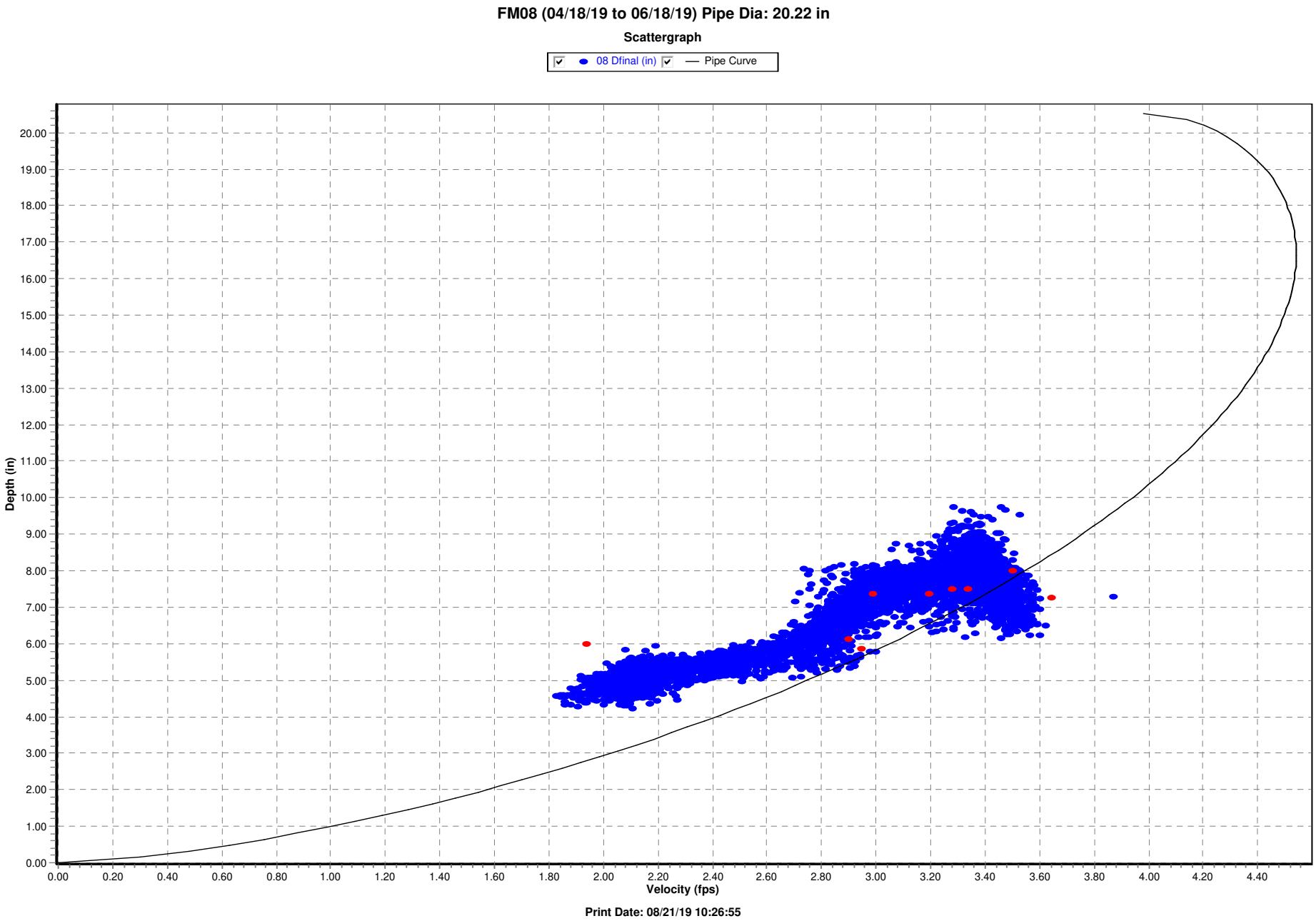
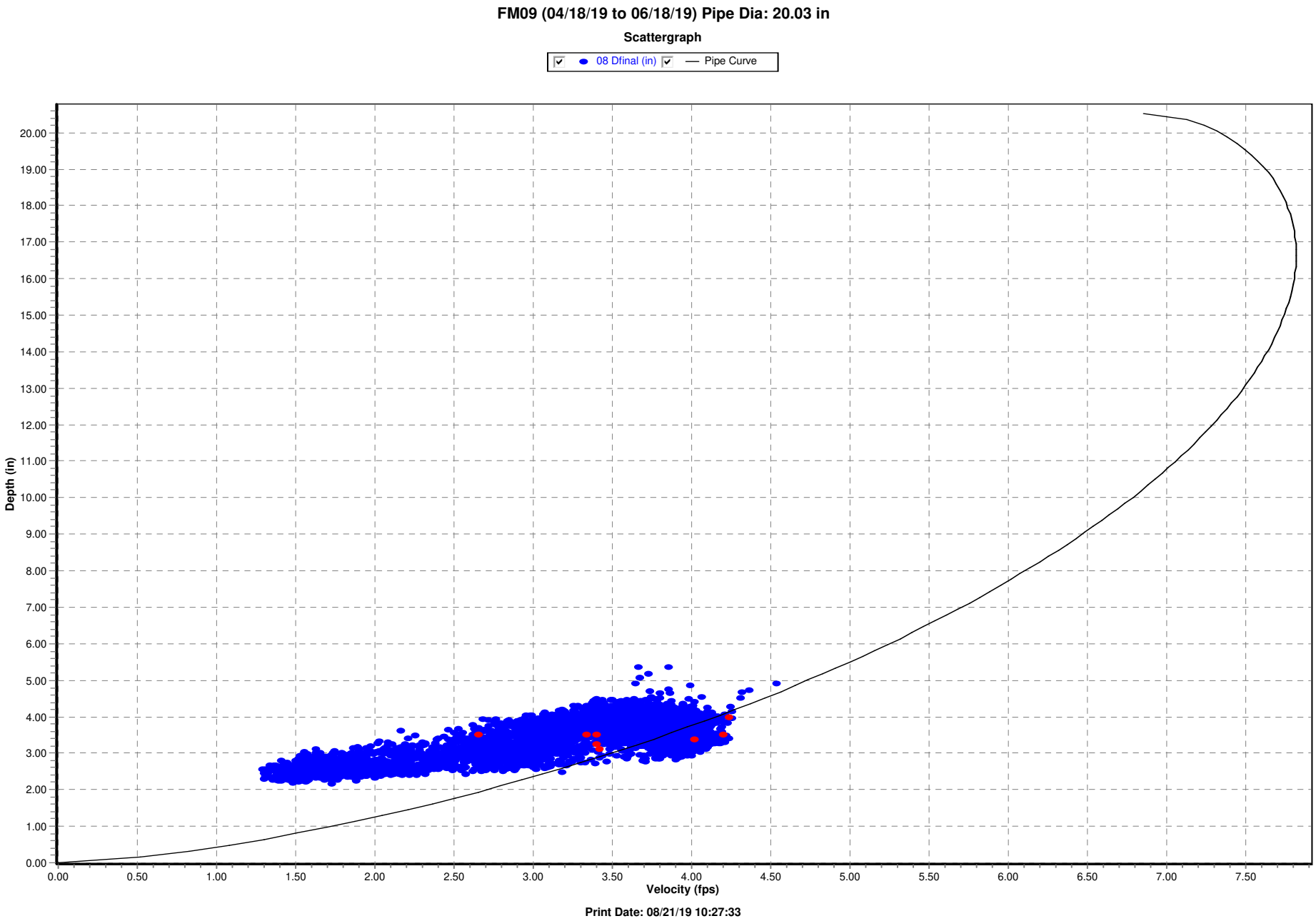
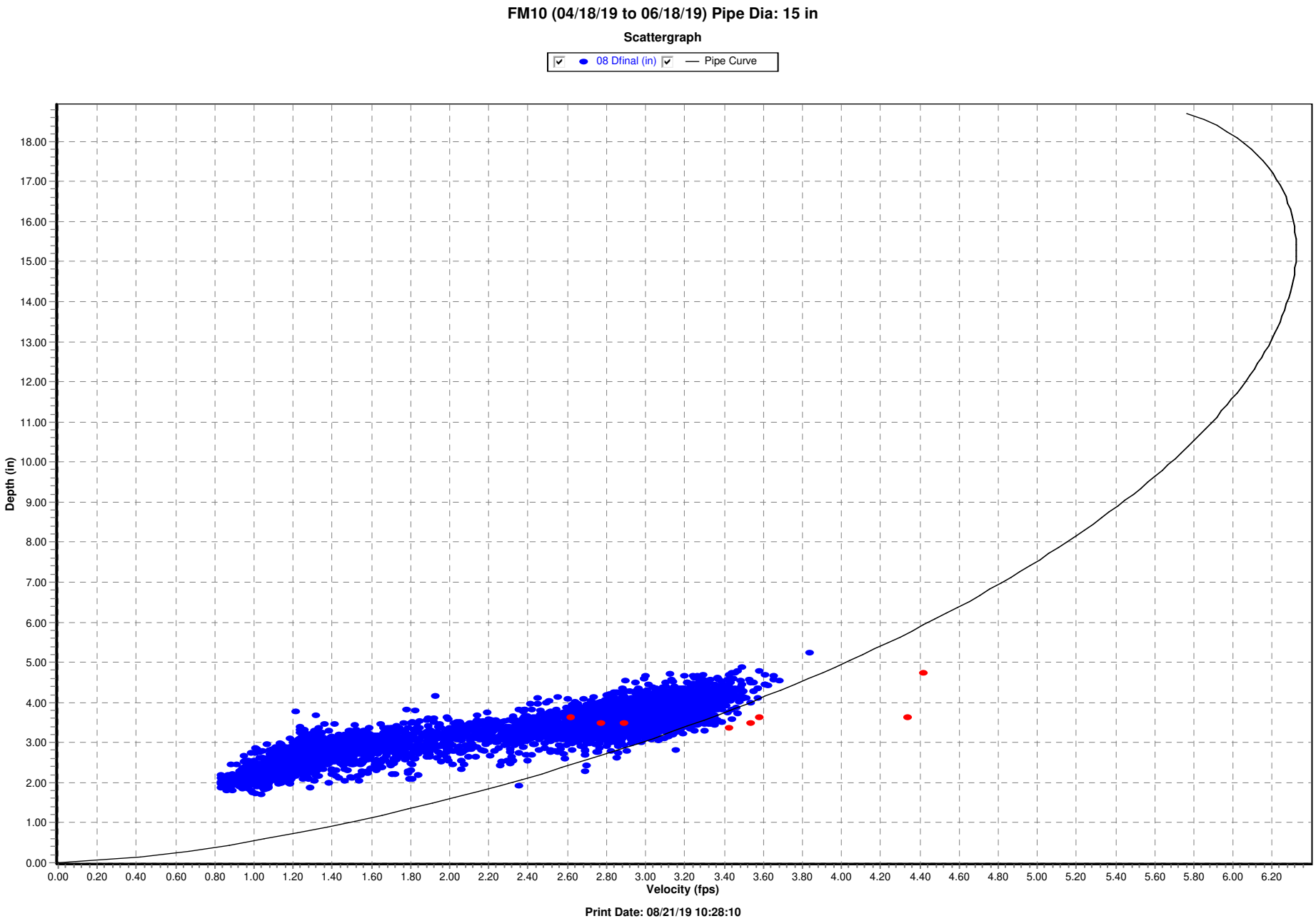
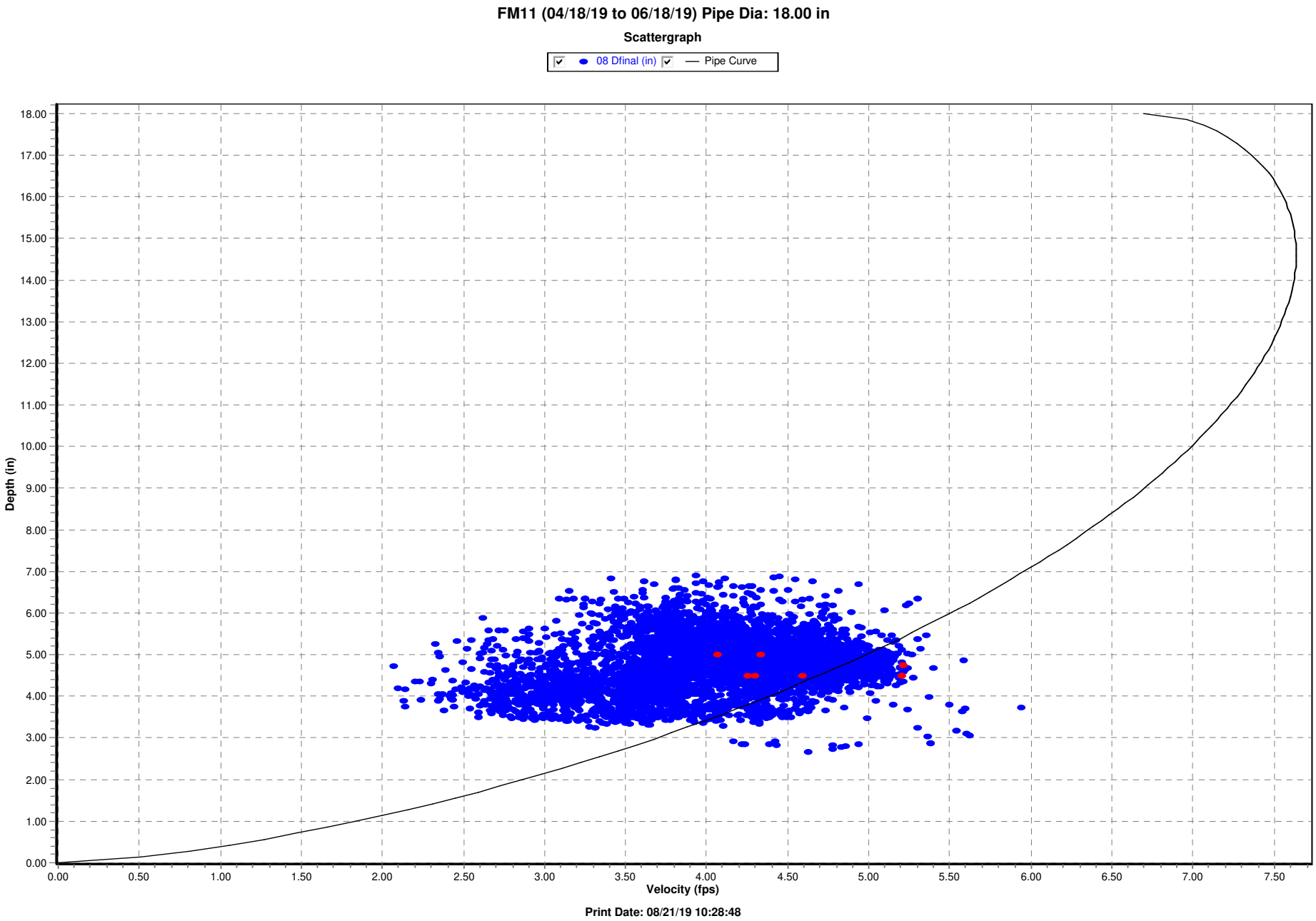
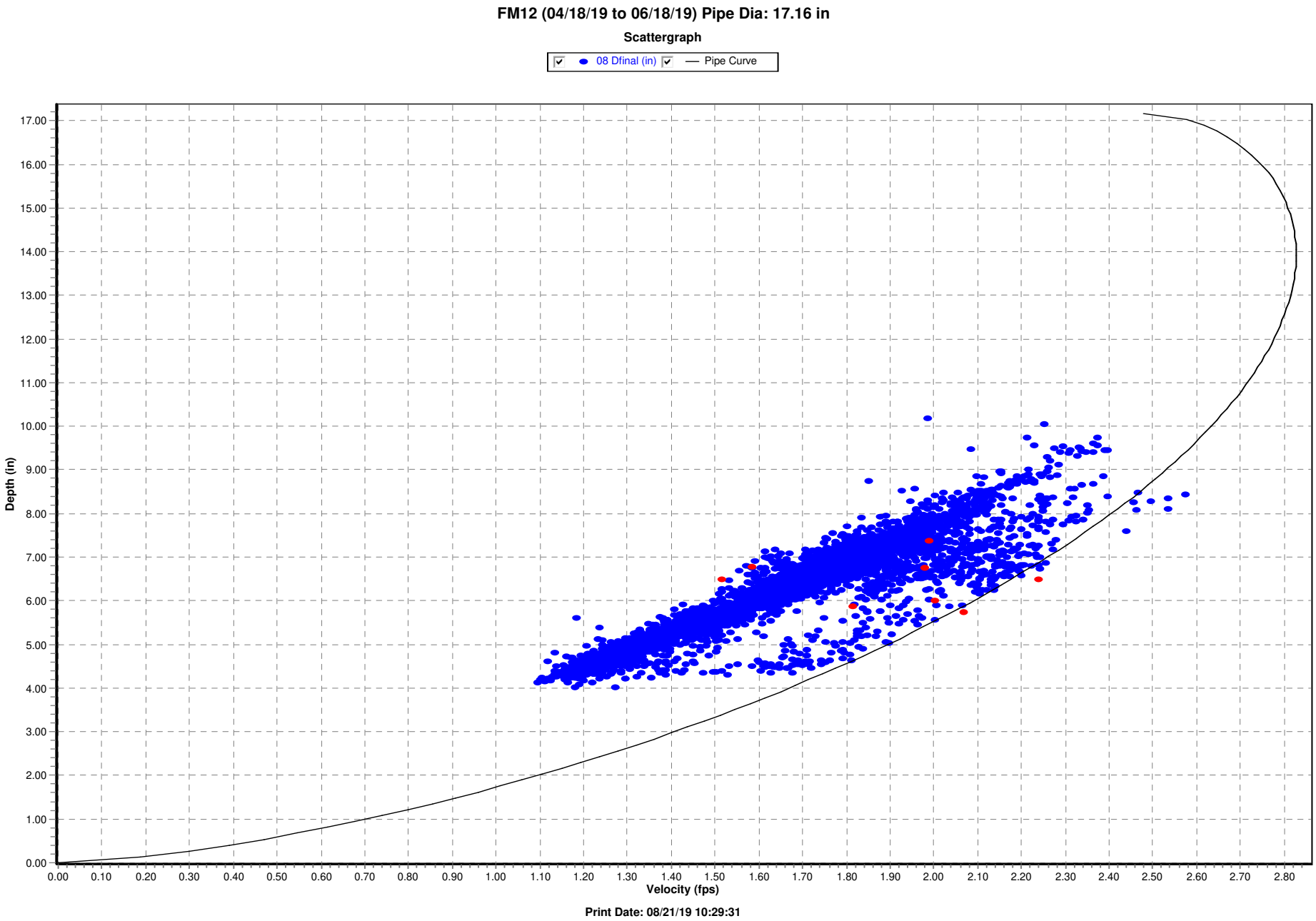
Pipe Curve
Depth (in)
Velocity (fps)
Print Date: 08/21/19 10:26:17


FM08 (04/18/19 to 06/18/19) Pipe Dia: 20.22 in
Scattergraph
08 Dfinal (in)
Pipe Curve
Depth (in)
Velocity (fps)
Print Date: 08/21/19 10:26:55


FM09 (04/18/19 to 06/18/19) Pipe Dia: 20.03 in
Scattergraph
08 Dfinal (in)
Pipe Curve
Depth (in)
Velocity (fps)
Print Date: 08/21/19 10:27:33


FM10 (04/18/19 to 06/18/19) Pipe Dia: 15 in
Scattergraph
08 Dfinal (in)
Pipe Curve
Depth (in)
Velocity (fps)
Print Date: 08/21/19 10:28:10


FM11 (04/18/19 to 06/18/19) Pipe Dia: 18.00 in
Scattergraph
08 Dfinal (in)
Pipe Curve
Depth (in)
18.00
17.00
16.00
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
4.50
5.00
5.50
6.00
6.50
7.00
7.50
Velocity (fps)
Print Date: 08/21/19 10:28:48


FM12 (04/18/19 to 06/18/19) Pipe Dia: 17.16 in
Scattergraph
08 Dfinal (in)
Pipe Curve
Depth (in)
Velocity (fps)
Print Date: 08/21/19 10:29:31

APPENDIX D

DAILY FLOW SUMMARY TABLES

FM01 DAILY MIN, MAX, & AVERAGE FLOW, AND RAINFALL - 4/18/19 to 6/17/19 - Flow values extracted from 5-minute data				
Date	Minimum Flow (MGD)	Maximum Flow (MGD)	Average Flow (MGD)	RG01 Precipitation (inches)
4/18/2019	0.02	0.49	0.16	0.00
4/19/2019	0.02	0.48	0.17	0.00
4/20/2019	0.02	0.40	0.19	0.00
4/21/2019	0.02	0.49	0.21	0.15
4/22/2019	0.02	0.46	0.18	0.00
4/23/2019	0.02	0.53	0.17	0.00
4/24/2019	0.02	0.49	0.17	0.00
4/25/2019	0.02	0.48	0.17	0.00
4/26/2019	0.02	0.50	0.17	0.03
4/27/2019	0.03	0.42	0.19	0.00
4/28/2019	0.02	0.43	0.20	0.01
4/29/2019	0.02	0.40	0.18	0.03
4/30/2019	0.03	0.43	0.18	0.33
5/1/2019	0.03	0.59	0.18	0.10
5/2/2019	0.02	0.52	0.18	0.00
5/3/2019	0.02	0.53	0.17	0.00
5/4/2019	0.03	0.43	0.19	0.00
5/5/2019	0.02	0.56	0.21	0.00
5/6/2019	0.03	0.49	0.19	0.00
5/7/2019	0.02	0.48	0.18	0.05
5/8/2019	0.03	0.49	0.18	0.04
5/9/2019	0.03	0.58	0.17	0.19
5/10/2019	0.02	0.51	0.16	0.00
5/11/2019	0.02	0.46	0.21	0.14
5/12/2019	0.02	0.48	0.23	0.00
5/13/2019	0.03	0.56	0.25	0.00
5/14/2019	0.08	0.71	0.25	0.00
5/15/2019	0.08	0.60	0.25	0.00
5/16/2019	0.08	0.74	0.23	0.00
5/17/2019	0.07	0.49	0.22	0.06
5/18/2019	0.02	0.39	0.23	0.00
5/19/2019	0.04	0.44	0.24	0.03
5/20/2019	0.02	0.49	0.21	0.44
5/21/2019	0.03	0.54	0.20	0.55
5/22/2019	0.03	0.51	0.18	0.00
5/23/2019	0.02	0.41	0.18	0.01

Table (*cont.*)				
Date	**Minimum Flow (MGD)**	**Maximum Flow (MGD)**	**Average Flow (MGD)**	**Precipitation (inches)**
5/24/2019	0.01	0.42	0.19	0.00
5/25/2019	0.07	0.42	0.21	0.00
5/26/2019	0.07	0.46	0.21	0.01
5/27/2019	0.04	0.44	0.22	0.05
5/28/2019	0.04	0.38	0.21	0.21
5/29/2019	0.02	0.37	0.18	0.01
5/30/2019	0.04	0.35	0.18	0.00
5/31/2019	0.04	0.36	0.17	0.01
6/1/2019	0.04	0.37	0.18	0.00
6/2/2019	0.05	0.42	0.21	0.31
6/3/2019	0.04	0.38	0.18	0.21
6/4/2019	0.02	0.45	0.17	0.04
6/5/2019	0.03	0.40	0.18	0.00
6/6/2019	0.02	0.39	0.17	0.00
6/7/2019	0.02	0.46	0.18	0.00
6/8/2019	0.03	0.36	0.17	0.02
6/9/2019	0.02	0.43	0.19	0.01
6/10/2019	0.02	0.46	0.18	0.00
6/11/2019	0.02	0.34	0.18	0.00
6/12/2019	0.03	0.39	0.18	0.00
6/13/2019	0.02	0.39	0.17	0.00
6/14/2019	0.02	0.45	0.17	0.00
6/15/2019	0.02	0.39	0.17	0.01
6/16/2019	0.02	0.42	0.19	0.04
6/17/2019	0.02	0.45	0.18	0.08

FM02

DAILY MIN, MAX, & AVERAGE FLOW, AND RAINFALL - 4/18/19 to 6/17/19 - Flow values extracted from 5-minute data

Date	Minimum Flow (MGD)	Maximum Flow (MGD)	Average Flow (MGD)	RG01 Precipitation (inches)
4/18/2019	0.06	0.49	0.26	0.00
4/19/2019	0.07	0.49	0.27	0.00
4/20/2019	0.06	0.53	0.26	0.00
4/21/2019	0.06	0.48	0.25	0.15
4/22/2019	0.05	0.48	0.25	0.00
4/23/2019	0.05	0.48	0.25	0.00
4/24/2019	0.06	0.48	0.25	0.00
4/25/2019	0.06	0.51	0.26	0.00
4/26/2019	0.06	0.47	0.25	0.03
4/27/2019	0.06	0.46	0.24	0.00
4/28/2019	0.05	0.48	0.24	0.01
4/29/2019	0.06	0.41	0.25	0.03
4/30/2019	0.08	0.45	0.25	0.33
5/1/2019	0.07	0.49	0.25	0.10
5/2/2019	0.07	0.50	0.27	0.00
5/3/2019	0.06	0.47	0.25	0.00
5/4/2019	0.06	0.48	0.26	0.00
5/5/2019	0.05	0.51	0.26	0.00
5/6/2019	0.06	0.46	0.25	0.00
5/7/2019	0.05	0.45	0.24	0.05
5/8/2019	0.07	0.48	0.24	0.04
5/9/2019	0.07	0.47	0.25	0.19
5/10/2019	0.07	0.50	0.26	0.00
5/11/2019	0.07	0.72	0.26	0.14
5/12/2019	0.07	0.53	0.26	0.00
5/13/2019	0.07	0.57	0.27	0.00
5/14/2019	0.06	0.48	0.26	0.00
5/15/2019	0.07	0.53	0.28	0.00
5/16/2019	0.07	0.48	0.26	0.00
5/17/2019	0.08	0.48	0.25	0.06
5/18/2019	0.07	0.48	0.25	0.00
5/19/2019	0.06	0.49	0.26	0.03
5/20/2019	0.08	0.47	0.29	0.44
5/21/2019	0.09	0.51	0.28	0.55
5/22/2019	0.08	0.55	0.28	0.00
5/23/2019	0.08	0.49	0.27	0.01

Table (*cont.*)				
Date	**Minimum Flow (MGD)**	**Maximum Flow (MGD)**	**Average Flow (MGD)**	**Precipitation (inches)**
5/24/2019	0.08	0.48	0.28	0.00
5/25/2019	0.08	0.55	0.27	0.00
5/26/2019	0.07	0.44	0.24	0.01
5/27/2019	0.08	0.53	0.27	0.05
5/28/2019	0.07	0.50	0.26	0.21
5/29/2019	0.07	0.42	0.26	0.01
5/30/2019	0.06	0.45	0.26	0.00
5/31/2019	0.06	0.43	0.26	0.01
6/1/2019	0.08	0.47	0.25	0.00
6/2/2019	0.07	0.48	0.25	0.31
6/3/2019	0.07	0.50	0.27	0.21
6/4/2019	0.08	0.43	0.26	0.04
6/5/2019	0.07	0.46	0.26	0.00
6/6/2019	0.07	0.43	0.26	0.00
6/7/2019	0.07	0.42	0.25	0.00
6/8/2019	0.08	0.47	0.25	0.02
6/9/2019	0.06	0.48	0.25	0.01
6/10/2019	0.06	0.41	0.26	0.00
6/11/2019	0.07	0.43	0.25	0.00
6/12/2019	0.07	0.41	0.25	0.00
6/13/2019	0.06	0.43	0.24	0.00
6/14/2019	0.06	0.38	0.24	0.00
6/15/2019	0.07	0.50	0.24	0.01
6/16/2019	0.07	0.47	0.24	0.04
6/17/2019	0.06	0.40	0.25	0.08

FM03

DAILY MIN, MAX, & AVERAGE FLOW, AND RAINFALL - 4/18/19 to 6/17/19 - Flow values extracted from 5-minute data

Date	Minimum Flow (MGD)	Maximum Flow (MGD)	Average Flow (MGD)	RG01 Precipitation (inches)
4/18/2019	0.10	0.75	0.40	0.00
4/19/2019	0.10	0.79	0.39	0.00
4/20/2019	0.09	0.83	0.45	0.00
4/21/2019	0.11	0.87	0.47	0.15
4/22/2019	0.09	0.84	0.44	0.00
4/23/2019	0.10	0.83	0.43	0.00
4/24/2019	0.08	0.90	0.42	0.00
4/25/2019	0.09	0.76	0.42	0.00
4/26/2019	0.08	0.73	0.41	0.03
4/27/2019	0.08	0.85	0.45	0.00
4/28/2019	0.09	0.85	0.48	0.01
4/29/2019	0.10	0.76	0.42	0.03
4/30/2019	0.11	0.86	0.44	0.33
5/1/2019	0.11	0.81	0.39	0.10
5/2/2019	0.08	0.71	0.38	0.00
5/3/2019	0.08	0.82	0.36	0.00
5/4/2019	0.07	0.74	0.39	0.00
5/5/2019	0.08	0.76	0.42	0.00
5/6/2019	0.07	0.78	0.37	0.00
5/7/2019	0.08	0.72	0.37	0.05
5/8/2019	0.08	0.71	0.40	0.04
5/9/2019	0.11	0.74	0.45	0.19
5/10/2019	0.10	0.76	0.43	0.00
5/11/2019	0.10	0.82	0.47	0.14
5/12/2019	0.13	0.80	0.48	0.00
5/13/2019	0.11	0.80	0.44	0.00
5/14/2019	0.10	0.77	0.44	0.00
5/15/2019	0.10	0.78	0.42	0.00
5/16/2019	0.10	0.79	0.42	0.00
5/17/2019	0.10	0.79	0.43	0.06
5/18/2019	0.10	0.83	0.46	0.00
5/19/2019	0.11	0.89	0.50	0.03
5/20/2019	0.12	0.80	0.45	0.44
5/21/2019	0.14	0.82	0.46	0.55
5/22/2019	0.13	0.83	0.45	0.00
5/23/2019	0.11	0.76	0.45	0.01

Table (*cont.*)				
Date	**Minimum Flow (MGD)**	**Maximum Flow (MGD)**	**Average Flow (MGD)**	**Precipitation (inches)**
5/24/2019	0.13	0.73	0.47	0.00
5/25/2019	0.13	0.77	0.47	0.00
5/26/2019	0.12	0.83	0.46	0.01
5/27/2019	0.12	0.82	0.49	0.05
5/28/2019	0.12	0.79	0.45	0.21
5/29/2019	0.11	0.70	0.46	0.01
5/30/2019	0.11	0.69	0.46	0.00
5/31/2019	0.12	0.74	0.47	0.01
6/1/2019	0.15	0.76	0.48	0.00
6/2/2019	0.12	0.85	0.51	0.31
6/3/2019	0.14	0.72	0.47	0.21
6/4/2019	0.14	0.73	0.46	0.04
6/5/2019	0.14	0.71	0.46	0.00
6/6/2019	0.13	0.69	0.46	0.00
6/7/2019	0.11	0.68	0.47	0.00
6/8/2019	0.10	0.78	0.49	0.02
6/9/2019	0.11	0.79	0.50	0.01
6/10/2019	0.12	0.70	0.47	0.00
6/11/2019	0.12	0.75	0.47	0.00
6/12/2019	0.12	0.76	0.45	0.00
6/13/2019	0.13	0.72	0.45	0.00
6/14/2019	0.11	0.70	0.44	0.00
6/15/2019	0.11	0.77	0.47	0.01
6/16/2019	0.12	0.80	0.48	0.04
6/17/2019	0.12	0.70	0.48	0.08

FM04

DAILY MIN, MAX, & AVERAGE FLOW, AND RAINFALL - 4/18/19 to 6/17/19 - Flow values extracted from 5-minute data

Date	Minimum Flow (MGD)	Maximum Flow (MGD)	Average Flow (MGD)	RG01 Precipitation (inches)
4/18/2019	0.32	1.69	1.14	0.00
4/19/2019	0.34	1.70	1.15	0.00
4/20/2019	0.36	1.96	1.18	0.00
4/21/2019	0.34	1.99	1.17	0.15
4/22/2019	0.33	1.72	1.14	0.00
4/23/2019	0.34	1.78	0.99	0.00
4/24/2019	0.27	1.69	1.04	0.00
4/25/2019	0.31	1.72	1.10	0.00
4/26/2019	0.31	1.60	1.07	0.03
4/27/2019	0.32	1.80	1.12	0.00
4/28/2019	0.33	1.87	1.17	0.01
4/29/2019	0.35	1.71	1.15	0.03
4/30/2019	0.39	1.62	1.10	0.33
5/1/2019	0.38	1.85	1.19	0.10
5/2/2019	0.33	1.74	1.16	0.00
5/3/2019	0.36	1.69	1.14	0.00
5/4/2019	0.32	1.96	1.17	0.00
5/5/2019	0.34	2.02	1.24	0.00
5/6/2019	0.35	1.76	1.18	0.00
5/7/2019	0.33	1.73	1.12	0.05
5/8/2019	0.31	1.70	1.13	0.04
5/9/2019	0.42	1.73	1.22	0.19
5/10/2019	0.36	1.64	1.18	0.00
5/11/2019	0.39	1.92	1.22	0.14
5/12/2019	0.37	1.93	1.22	0.00
5/13/2019	0.32	1.69	1.16	0.00
5/14/2019	0.37	1.72	1.16	0.00
5/15/2019	0.35	1.74	1.16	0.00
5/16/2019	0.35	1.77	1.17	0.00
5/17/2019	0.38	1.70	1.17	0.06
5/18/2019	0.39	1.97	1.24	0.00
5/19/2019	0.37	2.02	1.29	0.03
5/20/2019	0.47	2.02	1.32	0.44
5/21/2019	0.63	2.12	1.49	0.55
5/22/2019	0.57	2.04	1.43	0.00
5/23/2019	0.60	1.91	1.34	0.01

Table (*cont.*)				
Date	**Minimum Flow (MGD)**	**Maximum Flow (MGD)**	**Average Flow (MGD)**	**Precipitation (inches)**
5/24/2019	0.43	1.99	1.30	0.00
5/25/2019	0.49	2.02	1.32	0.00
5/26/2019	0.45	2.02	1.22	0.01
5/27/2019	0.44	2.09	1.31	0.05
5/28/2019	0.46	1.89	1.29	0.21
5/29/2019	0.42	1.72	1.22	0.01
5/30/2019	0.43	1.67	1.17	0.00
5/31/2019	0.42	1.66	1.18	0.01
6/1/2019	0.41	1.78	1.18	0.00
6/2/2019	0.33	1.80	1.09	0.31
6/3/2019	0.39	1.63	1.16	0.21
6/4/2019	0.47	1.78	1.16	0.04
6/5/2019	0.45	1.62	1.16	0.00
6/6/2019	0.39	1.61	1.16	0.00
6/7/2019	0.41	1.62	1.16	0.00
6/8/2019	0.38	1.79	1.17	0.02
6/9/2019	0.41	1.82	1.19	0.01
6/10/2019	0.39	1.60	1.15	0.00
6/11/2019	0.40	1.65	1.14	0.00
6/12/2019	0.44	1.71	1.20	0.00
6/13/2019	0.45	1.70	1.23	0.00
6/14/2019	0.42	1.64	1.19	0.00
6/15/2019	0.42	1.85	1.24	0.01
6/16/2019	0.48	1.86	1.26	0.04
6/17/2019	0.39	1.65	1.21	0.08

FM05

DAILY MIN, MAX, & AVERAGE FLOW, AND RAINFALL - 4/18/19 to 6/17/19 - Flow values extracted from 5-minute data

Date	Minimum Flow (MGD)	Maximum Flow (MGD)	Average Flow (MGD)	RG01 Precipitation (inches)
4/18/2019	0.19	1.23	0.72	0.00
4/19/2019	0.20	1.22	0.71	0.00
4/20/2019	0.19	1.29	0.74	0.00
4/21/2019	0.17	1.25	0.75	0.15
4/22/2019	0.17	1.19	0.72	0.00
4/23/2019	0.20	1.21	0.54	0.00
4/24/2019	0.11	1.12	0.61	0.00
4/25/2019	0.19	1.10	0.70	0.00
4/26/2019	0.20	1.16	0.69	0.03
4/27/2019	0.18	1.19	0.72	0.00
4/28/2019	0.20	1.20	0.74	0.01
4/29/2019	0.19	1.07	0.73	0.03
4/30/2019	0.22	1.13	0.73	0.33
5/1/2019	0.19	1.16	0.72	0.10
5/2/2019	0.17	1.15	0.70	0.00
5/3/2019	0.17	1.16	0.70	0.00
5/4/2019	0.18	1.25	0.73	0.00
5/5/2019	0.17	1.24	0.74	0.00
5/6/2019	0.19	1.10	0.71	0.00
5/7/2019	0.18	1.09	0.69	0.05
5/8/2019	0.19	1.10	0.69	0.04
5/9/2019	0.19	1.11	0.72	0.19
5/10/2019	0.20	1.16	0.71	0.00
5/11/2019	0.18	1.18	0.72	0.14
5/12/2019	0.20	1.24	0.72	0.00
5/13/2019	0.17	1.15	0.71	0.00
5/14/2019	0.22	1.22	0.72	0.00
5/15/2019	0.18	1.19	0.70	0.00
5/16/2019	0.20	1.18	0.71	0.00
5/17/2019	0.20	1.09	0.70	0.06
5/18/2019	0.21	1.26	0.72	0.00
5/19/2019	0.20	1.24	0.77	0.03
5/20/2019	0.28	1.19	0.76	0.44
5/21/2019	0.29	1.20	0.77	0.55
5/22/2019	0.23	1.22	0.76	0.00
5/23/2019	0.24	1.13	0.73	0.01

Table (*cont.*)				
Date	**Minimum Flow (MGD)**	**Maximum Flow (MGD)**	**Average Flow (MGD)**	**Precipitation (inches)**
5/24/2019	0.23	1.11	0.73	0.00
5/25/2019	0.25	1.21	0.74	0.00
5/26/2019	0.24	1.20	0.71	0.01
5/27/2019	0.23	1.29	0.78	0.05
5/28/2019	0.21	1.17	0.76	0.21
5/29/2019	0.21	1.10	0.74	0.01
5/30/2019	0.22	1.05	0.72	0.00
5/31/2019	0.26	1.07	0.72	0.01
6/1/2019	0.19	1.15	0.73	0.00
6/2/2019	0.21	1.16	0.75	0.31
6/3/2019	0.22	1.12	0.76	0.21
6/4/2019	0.23	1.19	0.76	0.04
6/5/2019	0.24	1.14	0.74	0.00
6/6/2019	0.23	1.15	0.75	0.00
6/7/2019	0.26	1.13	0.74	0.00
6/8/2019	0.26	1.21	0.76	0.02
6/9/2019	0.24	1.23	0.80	0.01
6/10/2019	0.25	1.19	0.78	0.00
6/11/2019	0.28	1.19	0.81	0.00
6/12/2019	0.36	1.22	0.80	0.00
6/13/2019	0.26	1.10	0.76	0.00
6/14/2019	0.25	1.13	0.72	0.00
6/15/2019	0.21	1.24	0.75	0.01
6/16/2019	0.22	1.19	0.77	0.04
6/17/2019	0.22	1.17	0.77	0.08

FM06

DAILY MIN, MAX, & AVERAGE FLOW, AND RAINFALL - 4/18/19 to 6/17/19 - Flow values extracted from 5-minute data

Date	Minimum Flow (MGD)	Maximum Flow (MGD)	Average Flow (MGD)	RG01 Precipitation (inches)
4/18/2019	0.16	1.18	0.74	0.00
4/19/2019	0.17	1.09	0.75	0.00
4/20/2019	0.19	1.39	0.80	0.00
4/21/2019	0.21	1.53	0.84	0.15
4/22/2019	0.20	1.25	0.78	0.00
4/23/2019	0.18	1.20	0.75	0.00
4/24/2019	0.19	1.24	0.72	0.00
4/25/2019	0.19	1.18	0.74	0.00
4/26/2019	0.20	1.10	0.71	0.03
4/27/2019	0.17	1.35	0.79	0.00
4/28/2019	0.21	1.30	0.78	0.01
4/29/2019	0.15	1.12	0.75	0.03
4/30/2019	0.21	1.17	0.74	0.33
5/1/2019	0.18	1.27	0.75	0.10
5/2/2019	0.19	1.28	0.75	0.00
5/3/2019	0.16	1.19	0.78	0.00
5/4/2019	0.20	1.35	0.84	0.00
5/5/2019	0.24	1.41	0.86	0.00
5/6/2019	0.17	1.22	0.78	0.00
5/7/2019	0.18	1.22	0.77	0.05
5/8/2019	0.21	1.29	0.77	0.04
5/9/2019	0.23	1.27	0.79	0.19
5/10/2019	0.27	1.33	0.81	0.00
5/11/2019	0.25	1.41	0.83	0.14
5/12/2019	0.24	1.44	0.87	0.00
5/13/2019	0.22	1.27	0.82	0.00
5/14/2019	0.19	1.26	0.80	0.00
5/15/2019	0.21	1.23	0.77	0.00
5/16/2019	0.21	1.17	0.75	0.00
5/17/2019	0.24	1.16	0.77	0.06
5/18/2019	0.23	1.36	0.81	0.00
5/19/2019	0.24	1.40	0.83	0.03
5/20/2019	0.26	1.19	0.80	0.44
5/21/2019	0.26	1.23	0.82	0.55
5/22/2019	0.25	1.25	0.82	0.00
5/23/2019	0.25	1.19	0.78	0.01

Table (*cont.*)				
Date	**Minimum Flow (MGD)**	**Maximum Flow (MGD)**	**Average Flow (MGD)**	**Precipitation (inches)**
5/24/2019	0.24	1.25	0.81	0.00
5/25/2019	0.24	1.33	0.81	0.00
5/26/2019	0.22	1.30	0.76	0.01
5/27/2019	0.23	1.39	0.82	0.05
5/28/2019	0.22	1.22	0.80	0.21
5/29/2019	0.26	1.16	0.80	0.01
5/30/2019	0.20	1.16	0.77	0.00
5/31/2019	0.18	1.19	0.75	0.01
6/1/2019	0.21	1.30	0.80	0.00
6/2/2019	0.23	1.40	0.84	0.31
6/3/2019	0.22	1.19	0.80	0.21
6/4/2019	0.24	1.17	0.80	0.04
6/5/2019	0.26	1.16	0.81	0.00
6/6/2019	0.27	1.14	0.80	0.00
6/7/2019	0.21	1.14	0.78	0.00
6/8/2019	0.24	1.26	0.80	0.02
6/9/2019	0.21	1.31	0.83	0.01
6/10/2019	0.23	1.15	0.77	0.00
6/11/2019	0.22	1.24	0.76	0.00
6/12/2019	0.22	1.18	0.76	0.00
6/13/2019	0.19	1.15	0.73	0.00
6/14/2019	0.22	1.06	0.73	0.00
6/15/2019	0.20	1.37	0.80	0.01
6/16/2019	0.23	1.29	0.80	0.04
6/17/2019	0.23	1.38	0.77	0.08

FM07

DAILY MIN, MAX, & AVERAGE FLOW, AND RAINFALL - 4/18/19 to 6/17/19 - Flow values extracted from 5-minute data

Date	Minimum Flow (MGD)	Maximum Flow (MGD)	Average Flow (MGD)	RG02 Precipitation (inches)
4/18/2019	0.09	0.47	0.28	0.00
4/19/2019	0.10	0.48	0.26	0.00
4/20/2019	0.08	0.45	0.26	0.00
4/21/2019	0.10	0.50	0.24	0.37
4/22/2019	0.11	0.53	0.29	0.00
4/23/2019	0.11	0.44	0.27	0.00
4/24/2019	0.10	0.60	0.28	0.00
4/25/2019	0.10	0.52	0.28	0.00
4/26/2019	0.10	0.48	0.28	0.04
4/27/2019	0.09	0.40	0.26	0.00
4/28/2019	0.10	0.42	0.24	0.01
4/29/2019	0.10	0.49	0.25	0.00
4/30/2019	0.10	0.37	0.25	0.25
5/1/2019	0.10	0.68	0.28	0.10
5/2/2019	0.09	0.58	0.29	0.00
5/3/2019	0.13	0.44	0.29	0.00
5/4/2019	0.11	0.42	0.26	0.00
5/5/2019	0.10	0.41	0.27	0.00
5/6/2019	0.13	0.61	0.30	0.00
5/7/2019	0.11	0.47	0.27	0.07
5/8/2019	0.12	0.45	0.28	0.00
5/9/2019	0.13	0.57	0.31	0.22
5/10/2019	0.14	0.65	0.30	0.00
5/11/2019	0.12	0.52	0.29	0.12
5/12/2019	0.09	0.39	0.25	0.00
5/13/2019	0.10	0.43	0.27	0.00
5/14/2019	0.11	0.48	0.27	0.00
5/15/2019	0.11	0.42	0.27	0.00
5/16/2019	0.09	0.64	0.28	0.00
5/17/2019	0.09	0.60	0.29	0.24
5/18/2019	0.11	0.47	0.28	0.00
5/19/2019	0.09	0.43	0.29	0.01
5/20/2019	0.10	0.71	0.35	0.47
5/21/2019	0.17	0.55	0.37	0.61
5/22/2019	0.12	0.64	0.34	0.00
5/23/2019	0.12	0.59	0.35	0.00

Table (*cont.*)				
Date	**Minimum Flow (MGD)**	**Maximum Flow (MGD)**	**Average Flow (MGD)**	**Precipitation (inches)**
5/24/2019	0.12	0.65	0.34	0.00
5/25/2019	0.15	0.53	0.31	0.00
5/26/2019	0.13	0.56	0.31	0.41
5/27/2019	0.11	0.48	0.30	0.31
5/28/2019	0.12	0.63	0.34	0.21
5/29/2019	0.11	0.52	0.32	0.02
5/30/2019	0.13	0.59	0.33	0.00
5/31/2019	0.12	0.59	0.34	0.06
6/1/2019	0.11	0.47	0.29	0.00
6/2/2019	0.11	0.86	0.32	0.42
6/3/2019	0.12	0.95	0.33	0.27
6/4/2019	0.11	0.51	0.31	0.16
6/5/2019	0.10	0.57	0.32	0.00
6/6/2019	0.11	0.69	0.33	0.00
6/7/2019	0.12	0.51	0.31	0.00
6/8/2019	0.12	0.50	0.31	0.00
6/9/2019	0.11	0.55	0.33	0.01
6/10/2019	0.16	0.55	0.35	0.00
6/11/2019	0.18	0.64	0.35	0.00
6/12/2019	0.15	0.54	0.31	0.00
6/13/2019	0.13	0.61	0.33	0.00
6/14/2019	0.14	0.63	0.32	0.00
6/15/2019	0.13	0.51	0.31	0.38
6/16/2019	0.13	0.48	0.32	0.01
6/17/2019	0.13	0.57	0.39	0.05

FM08

DAILY MIN, MAX, & AVERAGE FLOW, AND RAINFALL - 4/18/19 to 6/17/19 - Flow values extracted from 5-minute data

Date	Minimum Flow (MGD)	Maximum Flow (MGD)	Average Flow (MGD)	RG02 Precipitation (inches)
4/18/2019	0.48	2.17	1.31	0.00
4/19/2019	0.45	1.85	1.24	0.00
4/20/2019	0.48	2.29	1.43	0.00
4/21/2019	0.51	2.41	1.44	0.37
4/22/2019	0.45	2.10	1.39	0.00
4/23/2019	0.45	2.25	1.35	0.00
4/24/2019	0.49	1.95	1.35	0.00
4/25/2019	0.47	2.15	1.28	0.00
4/26/2019	0.45	1.90	1.29	0.04
4/27/2019	0.46	2.21	1.44	0.00
4/28/2019	0.43	2.36	1.39	0.01
4/29/2019	0.41	2.10	1.31	0.00
4/30/2019	0.45	2.05	1.34	0.25
5/1/2019	0.54	2.04	1.34	0.10
5/2/2019	0.43	2.06	1.32	0.00
5/3/2019	0.45	1.91	1.33	0.00
5/4/2019	0.43	2.19	1.40	0.00
5/5/2019	0.51	2.42	1.43	0.00
5/6/2019	0.49	2.05	1.38	0.00
5/7/2019	0.44	1.91	1.35	0.07
5/8/2019	0.46	2.03	1.34	0.00
5/9/2019	0.45	1.96	1.36	0.22
5/10/2019	0.51	2.05	1.39	0.00
5/11/2019	0.53	2.17	1.44	0.12
5/12/2019	0.50	2.47	1.49	0.00
5/13/2019	0.49	2.10	1.45	0.00
5/14/2019	0.49	2.09	1.43	0.00
5/15/2019	0.46	1.99	1.41	0.00
5/16/2019	0.48	2.03	1.40	0.00
5/17/2019	0.53	1.91	1.41	0.24
5/18/2019	0.54	2.21	1.43	0.00
5/19/2019	0.51	2.32	1.46	0.01
5/20/2019	0.59	2.11	1.48	0.47
5/21/2019	0.57	2.07	1.47	0.61
5/22/2019	0.54	2.25	1.49	0.00
5/23/2019	0.53	1.95	1.42	0.00

Table (*cont.*)				
Date	**Minimum Flow (MGD)**	**Maximum Flow (MGD)**	**Average Flow (MGD)**	**Precipitation (inches)**
5/24/2019	0.51	1.99	1.44	0.00
5/25/2019	0.52	2.17	1.45	0.00
5/26/2019	0.50	2.23	1.39	0.41
5/27/2019	0.47	2.39	1.46	0.31
5/28/2019	0.52	1.93	1.43	0.21
5/29/2019	0.53	1.94	1.42	0.02
5/30/2019	0.48	2.06	1.42	0.00
5/31/2019	0.47	2.03	1.41	0.06
6/1/2019	0.54	2.00	1.45	0.00
6/2/2019	0.47	2.08	1.48	0.42
6/3/2019	0.49	2.00	1.45	0.27
6/4/2019	0.52	1.95	1.46	0.16
6/5/2019	0.52	1.95	1.48	0.00
6/6/2019	0.56	1.90	1.46	0.00
6/7/2019	0.52	1.90	1.44	0.00
6/8/2019	0.55	2.05	1.46	0.00
6/9/2019	0.53	2.11	1.46	0.01
6/10/2019	0.53	1.89	1.45	0.00
6/11/2019	0.52	1.93	1.42	0.00
6/12/2019	1.35	1.94	1.70	0.00
6/13/2019	0.54	1.90	1.41	0.00
6/14/2019	0.52	1.85	1.40	0.00
6/15/2019	0.55	2.09	1.44	0.38
6/16/2019	0.55	2.02	1.48	0.01
6/17/2019	0.51	2.03	1.45	0.05

FM09

DAILY MIN, MAX, & AVERAGE FLOW, AND RAINFALL - 4/18/19 to 6/17/19 - Flow values extracted from 5-minute data

Date	Minimum Flow (MGD)	Maximum Flow (MGD)	Average Flow (MGD)	RG02 Precipitation (inches)
4/18/2019	0.13	0.89	0.54	0.00
4/19/2019	0.16	0.88	0.59	0.00
4/20/2019	0.14	0.89	0.54	0.00
4/21/2019	0.16	1.11	0.56	0.37
4/22/2019	0.14	0.82	0.50	0.00
4/23/2019	0.14	0.90	0.52	0.00
4/24/2019	0.15	0.86	0.57	0.00
4/25/2019	0.12	0.83	0.56	0.00
4/26/2019	0.13	0.89	0.51	0.04
4/27/2019	0.12	0.93	0.58	0.00
4/28/2019	0.12	0.93	0.56	0.01
4/29/2019	0.15	0.84	0.55	0.00
4/30/2019	0.13	0.95	0.57	0.25
5/1/2019	0.18	0.91	0.59	0.10
5/2/2019	0.13	0.94	0.57	0.00
5/3/2019	0.12	0.86	0.56	0.00
5/4/2019	0.12	0.90	0.58	0.00
5/5/2019	0.16	0.90	0.56	0.00
5/6/2019	0.15	0.76	0.52	0.00
5/7/2019	0.13	0.85	0.51	0.07
5/8/2019	0.12	0.85	0.53	0.00
5/9/2019	0.18	0.77	0.56	0.22
5/10/2019	0.14	0.79	0.53	0.00
5/11/2019	0.12	0.88	0.54	0.12
5/12/2019	0.12	0.99	0.52	0.00
5/13/2019	0.16	0.82	0.53	0.00
5/14/2019	0.11	0.83	0.53	0.00
5/15/2019	0.12	0.84	0.55	0.00
5/16/2019	0.12	0.88	0.54	0.00
5/17/2019	0.12	0.84	0.56	0.24
5/18/2019	0.13	0.85	0.55	0.00
5/19/2019	0.13	0.86	0.52	0.01
5/20/2019	0.16	0.92	0.58	0.47
5/21/2019	0.15	0.93	0.60	0.61
5/22/2019	0.11	0.83	0.55	0.00
5/23/2019	0.12	0.84	0.51	0.00

Table (*cont.*)				
Date	**Minimum Flow (MGD)**	**Maximum Flow (MGD)**	**Average Flow (MGD)**	**Precipitation (inches)**
5/24/2019	0.12	0.86	0.54	0.00
5/25/2019	0.17	0.86	0.54	0.00
5/26/2019	0.18	0.99	0.57	0.41
5/27/2019	0.15	0.88	0.52	0.31
5/28/2019	0.12	0.83	0.54	0.21
5/29/2019	0.12	0.84	0.53	0.02
5/30/2019	0.12	0.78	0.51	0.00
5/31/2019	0.13	0.86	0.52	0.06
6/1/2019	0.16	0.87	0.52	0.00
6/2/2019	0.12	1.23	0.53	0.42
6/3/2019	0.12	0.97	0.52	0.27
6/4/2019	0.16	1.14	0.58	0.16
6/5/2019	0.11	0.82	0.49	0.00
6/6/2019	0.13	0.80	0.53	0.00
6/7/2019	0.12	0.71	0.51	0.00
6/8/2019	0.15	0.71	0.49	0.00
6/9/2019	0.12	0.75	0.46	0.01
6/10/2019	0.14	0.66	0.47	0.00
6/11/2019	0.12	0.70	0.47	0.00
6/12/2019	0.15	0.74	0.49	0.00
6/13/2019	0.11	0.73	0.49	0.00
6/14/2019	0.13	0.79	0.52	0.00
6/15/2019	0.14	1.28	0.54	0.38
6/16/2019	0.12	0.82	0.50	0.01
6/17/2019	0.14	0.87	0.53	0.05

FM10

DAILY MIN, MAX, & AVERAGE FLOW, AND RAINFALL - 4/18/19 to 6/17/19 - Flow values extracted from 5-minute data

Date	Minimum Flow (MGD)	Maximum Flow (MGD)	Average Flow (MGD)	RG02 Precipitation (inches)
4/18/2019	0.05	0.94	0.37	0.00
4/19/2019	0.07	0.90	0.38	0.00
4/20/2019	0.05	0.92	0.36	0.00
4/21/2019	0.07	0.89	0.36	0.37
4/22/2019	0.05	1.34	0.37	0.00
4/23/2019	0.05	0.83	0.40	0.00
4/24/2019	0.06	0.83	0.38	0.00
4/25/2019	0.06	0.70	0.37	0.00
4/26/2019	0.06	0.74	0.38	0.04
4/27/2019	0.05	0.88	0.35	0.00
4/28/2019	0.06	1.07	0.37	0.01
4/29/2019	0.06	0.94	0.39	0.00
4/30/2019	0.05	1.00	0.39	0.25
5/1/2019	0.06	0.90	0.40	0.10
5/2/2019	0.06	0.93	0.39	0.00
5/3/2019	0.07	0.88	0.40	0.00
5/4/2019	0.07	1.02	0.41	0.00
5/5/2019	0.09	0.90	0.41	0.00
5/6/2019	0.11	0.98	0.43	0.00
5/7/2019	0.07	0.97	0.39	0.07
5/8/2019	0.06	0.97	0.40	0.00
5/9/2019	0.08	0.87	0.38	0.22
5/10/2019	0.06	0.84	0.37	0.00
5/11/2019	0.05	0.82	0.36	0.12
5/12/2019	0.06	0.80	0.38	0.00
5/13/2019	0.06	0.90	0.38	0.00
5/14/2019	0.06	0.93	0.39	0.00
5/15/2019	0.06	0.98	0.41	0.00
5/16/2019	0.12	0.76	0.44	0.00
5/17/2019	0.05	0.80	0.36	0.24
5/18/2019	0.06	0.75	0.35	0.00
5/19/2019	0.06	0.89	0.38	0.01
5/20/2019	0.06	0.81	0.41	0.47
5/21/2019	0.07	0.88	0.41	0.61
5/22/2019	0.06	0.81	0.36	0.00
5/23/2019	0.05	0.95	0.39	0.00

Table (*cont.*)				
Date	**Minimum Flow (MGD)**	**Maximum Flow (MGD)**	**Average Flow (MGD)**	**Precipitation (inches)**
5/24/2019	0.10	0.87	0.39	0.00
5/25/2019	0.07	0.89	0.36	0.00
5/26/2019	0.05	0.89	0.32	0.41
5/27/2019	0.05	0.90	0.35	0.31
5/28/2019	0.06	0.86	0.38	0.21
5/29/2019	0.07	0.88	0.35	0.02
5/30/2019	0.05	1.02	0.45	0.00
5/31/2019	0.15	0.96	0.38	0.06
6/1/2019	0.08	0.90	0.34	0.00
6/2/2019	0.07	0.97	0.41	0.42
6/3/2019	0.13	1.00	0.44	0.27
6/4/2019	0.12	0.99	0.46	0.16
6/5/2019	0.16	0.99	0.54	0.00
6/6/2019	0.12	1.01	0.47	0.00
6/7/2019	0.11	1.08	0.50	0.00
6/8/2019	0.12	1.04	0.46	0.00
6/9/2019	0.10	1.05	0.43	0.01
6/10/2019	0.12	1.19	0.43	0.00
6/11/2019	0.13	0.89	0.46	0.00
6/12/2019	0.12	0.97	0.42	0.00
6/13/2019	0.10	1.23	0.41	0.00
6/14/2019	0.06	0.91	0.36	0.00
6/15/2019	0.06	1.09	0.37	0.38
6/16/2019	0.11	0.89	0.40	0.01
6/17/2019	0.12	1.02	0.43	0.05

FM11

DAILY MIN, MAX, & AVERAGE FLOW, AND RAINFALL - 4/18/19 to 6/17/19 - Flow values extracted from 5-minute data

Date	Minimum Flow (MGD)	Maximum Flow (MGD)	Average Flow (MGD)	RG02 Precipitation (inches)
4/18/2019	0.41	1.40	0.99	0.00
4/19/2019	0.43	1.35	0.96	0.00
4/20/2019	0.48	1.30	0.96	0.00
4/21/2019	0.45	1.30	0.93	0.37
4/22/2019	0.43	1.75	1.02	0.00
4/23/2019	0.50	1.65	1.03	0.00
4/24/2019	0.37	1.39	0.98	0.00
4/25/2019	0.44	1.52	1.00	0.00
4/26/2019	0.43	1.43	0.97	0.04
4/27/2019	0.43	1.38	0.94	0.00
4/28/2019	0.40	1.56	0.93	0.01
4/29/2019	0.45	1.71	1.05	0.00
4/30/2019	0.41	1.56	1.06	0.25
5/1/2019	0.40	1.35	0.90	0.10
5/2/2019	0.43	1.26	0.91	0.00
5/3/2019	0.39	1.06	0.86	0.00
5/4/2019	0.41	1.44	0.95	0.00
5/5/2019	0.35	1.41	0.94	0.00
5/6/2019	0.30	1.86	1.02	0.00
5/7/2019	0.54	1.57	1.04	0.07
5/8/2019	0.46	1.39	1.02	0.00
5/9/2019	0.56	1.71	1.09	0.22
5/10/2019	0.48	1.48	1.00	0.00
5/11/2019	0.47	1.46	0.97	0.12
5/12/2019	0.49	1.35	0.98	0.00
5/13/2019	0.44	1.49	1.00	0.00
5/14/2019	0.50	1.53	0.96	0.00
5/15/2019	0.36	1.27	0.94	0.00
5/16/2019	0.49	1.47	1.02	0.00
5/17/2019	0.47	1.33	1.00	0.24
5/18/2019	0.56	1.26	1.00	0.00
5/19/2019	0.53	1.31	0.96	0.01
5/20/2019	0.44	1.56	1.03	0.47
5/21/2019	0.48	1.40	1.03	0.61
5/22/2019	0.54	1.48	1.02	0.00
5/23/2019	0.59	1.37	1.01	0.00

Table (*cont.*)				
Date	**Minimum Flow (MGD)**	**Maximum Flow (MGD)**	**Average Flow (MGD)**	**Precipitation (inches)**
5/24/2019	0.56	1.14	0.89	0.00
5/25/2019	0.45	1.07	0.85	0.00
5/26/2019	0.56	1.32	0.94	0.41
5/27/2019	0.69	1.89	1.15	0.31
5/28/2019	0.82	2.09	1.50	0.21
5/29/2019	0.84	1.74	1.25	0.02
5/30/2019	0.57	1.48	1.03	0.00
5/31/2019	0.50	1.32	0.97	0.06
6/1/2019	0.38	1.79	1.00	0.00
6/2/2019	0.47	1.95	1.04	0.42
6/3/2019	0.47	2.02	1.08	0.27
6/4/2019	0.54	1.95	1.12	0.16
6/5/2019	0.61	1.74	1.07	0.00
6/6/2019	0.49	1.83	1.04	0.00
6/7/2019	0.58	1.73	1.10	0.00
6/8/2019	0.52	1.80	1.04	0.00
6/9/2019	0.48	1.85	1.03	0.01
6/10/2019	0.42	2.13	1.08	0.00
6/11/2019	0.52	1.81	1.07	0.00
6/12/2019	0.50	1.86	1.05	0.00
6/13/2019	0.44	1.80	1.09	0.00
6/14/2019	0.51	1.76	1.05	0.00
6/15/2019	0.57	1.81	1.05	0.38
6/16/2019	0.65	1.46	1.05	0.01
6/17/2019	0.43	1.64	1.05	0.05

FM12

DAILY MIN, MAX, & AVERAGE FLOW, AND RAINFALL - 4/18/19 to 6/17/19 - Flow values extracted from 5-minute data

Date	Minimum Flow (MGD)	Maximum Flow (MGD)	Average Flow (MGD)	RG02 Precipitation (inches)
4/18/2019	0.25	1.19	0.68	0.00
4/19/2019	0.22	1.09	0.65	0.00
4/20/2019	0.26	1.12	0.67	0.00
4/21/2019	0.32	1.02	0.66	0.37
4/22/2019	0.24	1.48	0.73	0.00
4/23/2019	0.31	1.23	0.77	0.00
4/24/2019	0.25	1.34	0.76	0.00
4/25/2019	0.26	1.18	0.68	0.00
4/26/2019	0.18	1.12	0.67	0.04
4/27/2019	0.23	0.86	0.58	0.00
4/28/2019	0.22	0.97	0.58	0.01
4/29/2019	0.23	1.23	0.67	0.00
4/30/2019	0.27	1.32	0.70	0.25
5/1/2019	0.24	1.11	0.64	0.10
5/2/2019	0.22	1.15	0.64	0.00
5/3/2019	0.26	0.84	0.60	0.00
5/4/2019	0.22	0.97	0.56	0.00
5/5/2019	0.22	0.84	0.53	0.00
5/6/2019	0.24	1.09	0.67	0.00
5/7/2019	0.26	0.98	0.64	0.07
5/8/2019	0.35	0.96	0.64	0.00
5/9/2019	0.28	1.18	0.63	0.22
5/10/2019	0.24	1.15	0.59	0.00
5/11/2019	0.23	1.07	0.56	0.12
5/12/2019	0.21	0.85	0.54	0.00
5/13/2019	0.20	0.97	0.58	0.00
5/14/2019	0.23	0.97	0.57	0.00
5/15/2019	0.23	1.02	0.57	0.00
5/16/2019	0.27	1.04	0.62	0.00
5/17/2019	0.25	1.02	0.60	0.24
5/18/2019	0.25	0.77	0.55	0.00
5/19/2019	0.25	0.81	0.53	0.01
5/20/2019	0.26	1.03	0.63	0.47
5/21/2019	0.27	0.90	0.62	0.61
5/22/2019	0.28	0.97	0.64	0.00
5/23/2019	0.26	0.98	0.61	0.00

Table (*cont.*)				
Date	**Minimum Flow (MGD)**	**Maximum Flow (MGD)**	**Average Flow (MGD)**	**Precipitation (inches)**
5/24/2019	0.24	0.96	0.60	0.00
5/25/2019	0.26	0.84	0.55	0.00
5/26/2019	0.26	0.92	0.51	0.41
5/27/2019	0.20	0.98	0.55	0.31
5/28/2019	0.24	0.99	0.62	0.21
5/29/2019	0.26	0.85	0.56	0.02
5/30/2019	0.25	1.01	0.61	0.00
5/31/2019	0.25	0.83	0.56	0.06
6/1/2019	0.26	1.45	0.59	0.00
6/2/2019	0.24	1.38	0.56	0.42
6/3/2019	0.25	1.46	0.63	0.27
6/4/2019	0.27	1.46	0.70	0.16
6/5/2019	0.27	1.37	0.63	0.00
6/6/2019	0.27	1.40	0.63	0.00
6/7/2019	0.30	1.45	0.66	0.00
6/8/2019	0.27	1.36	0.57	0.00
6/9/2019	0.22	1.29	0.55	0.01
6/10/2019	0.22	1.44	0.62	0.00
6/11/2019	0.26	1.42	0.63	0.00
6/12/2019	0.26	1.49	0.64	0.00
6/13/2019	0.25	1.44	0.64	0.00
6/14/2019	0.26	1.41	0.63	0.00
6/15/2019	0.27	1.48	0.60	0.38
6/16/2019	0.33	0.84	0.57	0.01
6/17/2019	0.25	1.44	0.63	0.05

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Appendix D

Cost Development and CIP Information

D.1 Cost Development

D.1.1 Variability in Data

Data was obtained from past contractor bidding information provided by the City and by other Front Range communities as well as national sources which included unit costs for various, potential capital expenditures on wastewater, water, and non-potable projects. The data varied in the level of detail and in the definition of each cost element. For example, pipeline costs may or may not include dewatering, restoration, or paving project sites. Pipe cost data from the different sources also varied by construction depth, ground conditions, and method of installation for pipeline. For example, one data source may have identified unit price for a given pipe diameter size at a given depth while another data source provided unit costs for given pipe diameter sizes of various depths within developed or undeveloped land areas. Both data sources provide information regarding pipe installation costs, but the data needs to be considered based on the level of detail that is desired for project CIP development.

D.1.2 Unknown Elements and Assumptions

Assumptions made during CIP development can add to the variability of final bid project costs when compared to the planning level costs. The assumptions are necessary to capture costs for project elements that cannot be defined at a planning level. Examples of undefinable costs include dewatering project areas, utility pipeline crossings, permitting for project implementation, final contractor bid quantities, seasonal soil and ground conditions, and stormwater management of project sites. Assumptions are also made for method of pipe installation, timing of projects, and materials of construction. During design development, additional field information including survey, geotechnical data, groundwater levels, traffic control requirements, and final pipe alignment of project areas will be available to help refine the project elements and construction methods.

Trendlines and linear interpolation are used to develop costs for project elements for which the data was incomplete. For example, cost data was obtained for the installation of gravity sanitary sewer pipe for 8” through 48” diameter pipe, however, there was limited cost information for 15”, 30”, and 54” pipe. Trend line equations for linear, power, exponential, polynomial and their respective R2 values were compared to identify the most probable estimation equation. In this case, the trendline equation with an R2 value closest to 1 was selected as the most probable estimation equation. Because the trendline with the most pertinent R2 value may not reflect the true data trend, the City should readjust cost data throughout the planning horizon, which is defined as the length of time into the future for which projects are planned.

Figure D-1 shows an example of comparing different trend line equations and their respective R2 values for approximating missing data for the trenchless installation of the gravity sanitary sewer line item. In this example, the linear trend line (shown by the purple dotted line below) has the closest R2 value to 1 compared to the exponential and logarithmic trend lines (shown by the blue

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and green dotted lines below, respectively) based on available data. As a result, without additional industry knowledge and experience, the linear trend line would be assumed to best approximate unit costs for trenchless pipe installation for pipe diameter sizes not available from the given data set. This assumption may conflict with actual trenchless pipe installation data trends known in the industry which may better be approximated by exponential or logarithmic trend lines. This is especially true when predicting trenchless pipe installations for large pipe diameter sizes (i.e., greater than 30" diameter) where predictions of data points of the trend lines begin to greatly diverge. At a planning level, this limitation is acceptable when a cushion of construction cost contingency (i.e., 35%) is added to help absorb this unit cost uncertainty. However, at an engineering design level, where construction cost contingency is lowered or removed, the chosen trend line that best reflects industry data trends should be used regardless of if the chosen trend line has an R2 value closest to 1 to avoid unnecessary error.

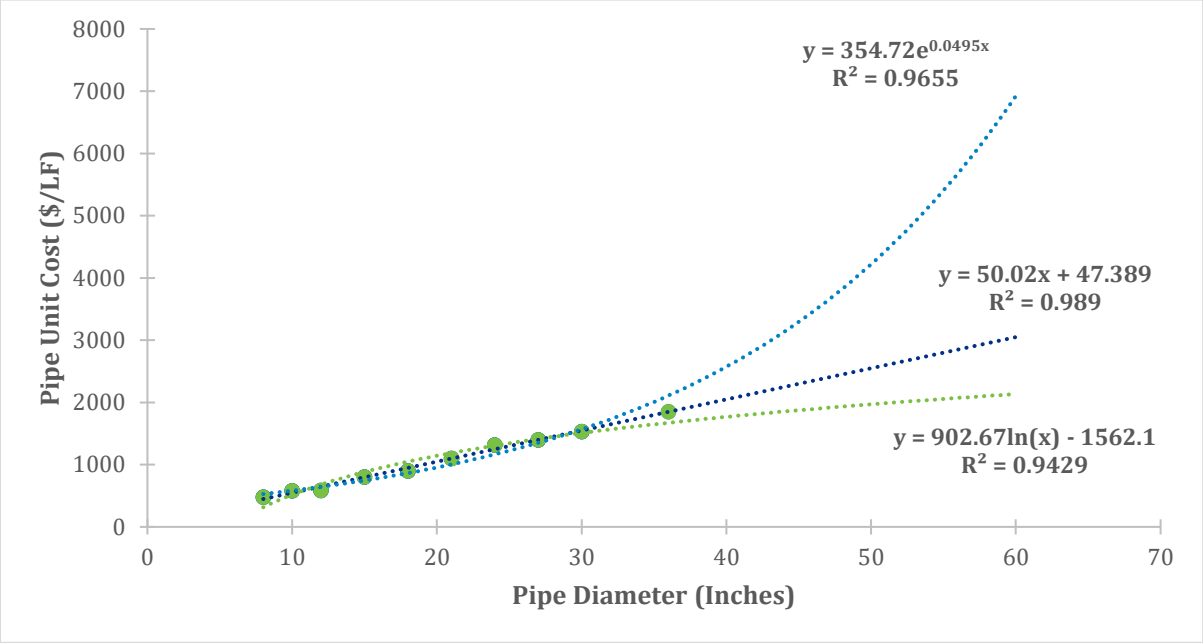

Figure D-1 Example of Different Trendlines for Finding Missing Data of a Line Item

D.1.3 Unpredictability

There is unpredictability to consider during CIP development, which is captured in the cost range provided for the overall CIP. Examples of unpredictability include future economic trends and inflation rates of CIPs. Prior to COVID-19, a global pandemic, cost inflation tools provided high confidence for predicting unit prices within a given year. However, after COVID-19, these cost inflation tools may not prove to be as accurate.

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D.2 Cost Development

D.2.1 Data Sources

Major data sources for the cost factors included the following: water, non-potable, and wastewater master plans; past project and contractor construction bid tabs; CDM Smith's estimator group unit prices; vendor quotes for project components; and City data bases. A list of external sources used to develop unit costs for the City's CIP wastewater cost estimations is included below.

- 7th Avenue. Storm Drain, Sanitary Sewer – GMP (City of Greeley, 2019).
- 71st Avenue Bridge/Road Widening/Phase 2 of Ashcroft Draw Basin Sanitary Sewer (City of Greeley, 2018).
- Ashcroft Draw Sanitary Sewer Project Guaranteed Maximum Price (City of Greeley, 2016).
- City of Aurora Wastewater Master Plan (AECOM, 2017).
- City of Greeley Pipe Rehabilitation Cost Estimating Template (City of Greeley, 2019).
- Collection, Distributions, Transmission Projects Phase I – (Construction Manager at Risk or CMAR) (City of Greeley, 2019).
- Lift Station 15 (Auto Plaza) Upgrade Quotes (Canyon Systems, Inc. 2020).
- North Greeley Sewer Phase IIA (City of Greeley, 2016).
- Weld County Assessor's Website (Weld County Government, 2020).

The data was compiled in an Excel spreadsheet with line item data reflected as unit costs (e.g., dollars per linear foot, dollars per each, etc.). When needed, unit costs for specific line items were calculated using trend line equations. Line items that were not specific and/or harder to estimate using specific unit cost quantity were reflected as a percentage addition to project costs (e.g., mobilization and demobilization, erosion control/stormwater pollution prevention, etc.).

The costs estimated in the project CIPs are in August 2020 dollars. Historical data was adjusted to the equivalent August 2020 data by using Engineering News Record's Construction Cost Index (ENR-CCI). ENR estimates a project each month in 20 different cities around the U.S. and calculates the composite index. Costs are adjusted by multiplying a cost element with the ratio of the current day ENR-CCI and date of data.

$$\text{Construction Unit Cost (T2)} = \text{Construction Cost (T1)} \times \frac{\text{CCI(T2)}}{\text{CCI(T1)}}$$

T2 and T1 reflect the desired projected year and month desired and the originally year and month of unit costs, respectively.

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D.2.2 Major Cost Elements

The OPCC is considered the costs incurred by the contractor to construct a capital project. The project CIP costs include the OPCC and project implementation costs such as planning and design, administration, and construction management. The CIP costs were developed using five general cost element categories as described below and in the following subsections:

- Pipeline and Manholes: Quantities are from bid tabs, past reports, and model results as described in **Sections 4 and 5**. Costs are developed by multiplying the estimated quantity by a unit price for that quantity.
- Lift Stations: Quantities for new lift stations are estimated using typical pump station costs based on flow rate capacity required for each station. Quantities for upgrades and rehabilitation of existing lift stations (e.g., flow rate increases) are estimated using price quotes from a local pump supplier familiar with the City's lift station preferences and using the desired head and flow rate capacity.
- Land Considerations (easements): Land considerations provide for permanent easements acquired outside of city right-of-way. Permanent easements ensure that there will be reserved land space for future project pipelines that do not follow City roadways. The easement acquisition was estimated as an allowance (5%) of the total OPCC for each project.
- Dewatering: Dewatering is the removal of water from soil by pumping where pipeline will be placed/replaced. Dewatering requirements are site specific and depend on ground water levels and soil conditions. No field data was obtained during the CIP development so dewatering costs have been estimated using a tiered approach based on proximity of the project to water and the depth of the excavation. The estimated cost for dewatering is subject to considerable variance.
- Project Implementation and Contingency: These cost elements are the most subjective of the five primary categories and are based on percentages of the subtotal for the first four elements. Project implementation and contingency factor in requirements to begin projects and uncertainty/risks associated with projects.

D.2.3 Pipeline and Manholes

D.2.3.1 Installation of Pipe

Gravity sewer pipe and force mains were generally assumed to be installed using open cut construction. Open cut construction is defined as when contractors remove surface soils to insert pipe, except for when pipe installation depth was greater than 20 feet, or for arterial roadway and highway, railroad, and irrigation ditch crossings. In such instances, trenchless pipe installation was assumed which inserts pipe through tunneling and boring methods. Open cut pipeline installation unit costs (in dollars per linear foot of pipe) include the pipe and bedding, excavation, by-pass pumping, installation including traffic control, tie-ins for service laterals, backfill, restoration, and removal of old pipe.

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The open cut installation was divided into developed and undeveloped categories. The developed category includes pipe installed in developed areas such as in neighborhoods, along major city streets, across two lane roads, through developed commercial property, and designated agricultural land and around city boundaries. The undeveloped category was assigned to pipe installed on permanently open space such as city parks. For both categories, the pipe installation was further segregated by depth categories: (1) from 0-foot to 10-foot depth and (2) greater than 10-foot to 20-foot depth. Where depth of pipe was greater than 20 feet, trenchless pipe installation was assumed.

Trenchless installation costs (in dollars per liner foot of pipe) include the casing and carrier pipe, supports and contact grouting of the interstitial space, launching and receiving pits, and ground monitoring using jack and bore drilling. Unit prices were developed using bid tabs and CDM Smith's construction cost data base. Alternative methods of trenchless installation will be defined during project design development and based on field conditions.

Table D-1 provides the unit cost breakdown for installation and removal of polyvinyl chloride (PVC) gravity sewer pipe and force mains.

Table D-1 Unit Costs for PVC Gravity Sewer and Force Main installation and removal

Pipe Diameter Size (in.)	Unit Cost ($/LF of Pipe)				
	Developed Land Designation		Undeveloped Land Designation		Trenchless (Crossings and >20 ft Depth)
	0 ft – 10 ft Depth	>10 ft – 20 ft Depth	0 ft – 10 ft Depth	>10 ft – 20 ft Depth	
8	88	188	45	78	478
10	95	196	50	83	581
12	105	206	59	92	584
15	119	220	68	10268	798
18	133	235	Not Used		897
21	152	254			1,098
24	179	268			1,314
27	194	299			1,398
30	240	347			1,531
36	286	397			1,848
42	372	488			2,148
48	446	566			2,448
54	588	712			2,748

D.2.3.2 Manholes

Four-foot diameter manholes were assumed for 8" and 12" diameter sanitary sewer pipe and five-foot diameter manholes were assumed for 15" to 27" diameter sanitary sewer based on the City's construction standards (City of Greeley, 2008). Six-foot diameter manholes were assumed for pipeline greater than 27" diameter up to and including 48" diameter sanitary sewers. Eight-foot diameter manholes were assumed for any sanitary sewer greater than 48" diameter. The unit cost per manhole was estimated assuming installation of new manholes across the entire pipe length of a given project. This conservative estimate accounts for removal and replacement of

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existing manholes that are at the end of their service lifetime or would need to be upsized given their connection to pipe of increased diameter size. Manhole spacing was estimated at 250-foot between manholes. The following equation was used to estimate the number of manholes required as a function of total gravity sanitary sewer pipe length. One additional manhole was added per project for a conservative estimate.

$$\textbf{Total Manhole No.} = \frac{\textbf{Total Project Pipe Length}}{\textbf{250}} + \textbf{1}$$

To determine the number of manholes in each depth category, the percentage of the total pipe in each depth class was multiplied by the total number of manholes as shown in the below equation:

$$\textbf{Manhole No.}_{\textbf{By Pipe Depth Class}} = \textbf{Total Manhole No.} \times \frac{\textbf{Total Pipe Length Per Depth Class}}{\textbf{Total Project Pipe Length}}$$

Table D-2 shows the unit costs used for estimating installation of new manhole installation.

Table D-2 Unit Costs of 4-foot Diameter and 5-foot Diameter Manholes by Pipe Depth Class

Manhole Diameter (In.)	Unit Cost ($/Each Manhole)		
	0 ft – 10 ft Pipe Depth	10 ft – 20 ft Pipe Depth	>20 ft Pipe Depth
4	4,118	5,777	7,937
5	6,543	9,540	13,302
6	15,998	22,839	29,359
8	31,896	48,162	64,429

D.2.4 Lift Stations

The construction costs of new lift stations were estimated using existing bid information and master planning information from the nearby community of Aurora. Aurora considered both high and low trend line estimates, which were escalated to August 2020 equivalents for the new East Greeley and Ashcroft lift stations. The cost estimates include construction of new lift station infrastructure including enclosures, wet wells, instrumentation, electrical, and pumps. The 2006 high, low, and averaged lift station equations are shown below:

$$\textbf{Low Limit New LS Cost}(\$) = \$\textbf{1,583} \times \textbf{LS Flow Rate (gpm)}^{\textbf{0.77}}$$

$$\textbf{High Limit New LS Cost}(\$) = \$\textbf{22,500} \times \textbf{LS Flow Rate (gpm)}^{\textbf{0.62}}$$

$$\textbf{Averaged Limit New LS Cost}(\$) = \$\textbf{10,594} \times \textbf{LS Flow Rate (gpm)}^{\textbf{0.66}}$$

Figure D-2 depicts the comparison of the three equations used for new lift station construction estimations.

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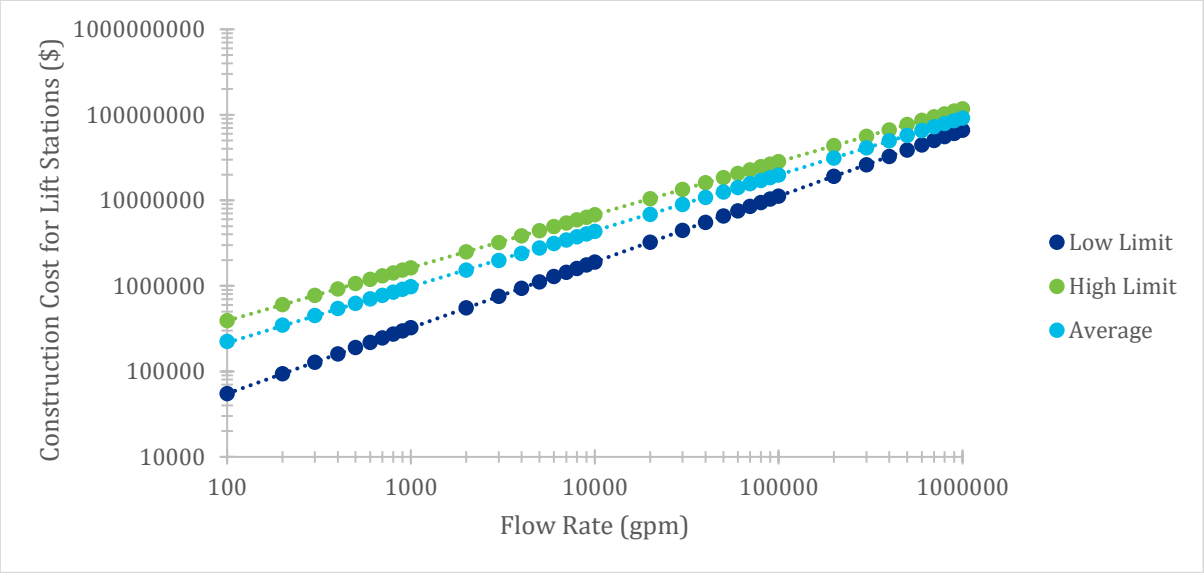

Figure D-2 Pumping Station High, Low, and Averaged Estimated Construction Costs (Jones et al. 2006).

Upgrades to existing lift stations were estimated using pump vendor quotes recommended by the City. The City uses Gorman-Rupp pumps at its lift stations and has also worked with Canyon Systems, Inc. in the past. Lift station rehabilitation includes the replacement of existing pumps, valves and piping; new wet wells and pads; and a new enclosure. (Canyon Systems, Inc., 2020).

D.2.5 Crossings and Land Considerations

D.2.5.1 Irrigation Ditch Crossings

ArcMap GIS and city-provided information was used to identify irrigation ditch locations. Irrigation ditch crossings were assumed as 100-feet in length and approximated by trenchless pipe installation regardless of pipe depth.

D.2.5.2 Utility, Roadway, and Railway Crossings

ArcMap GIS, the City's online GIS, and Google Maps were used to identify road, utility, and railroad crossings. Unit prices were developed assuming installation by jack and bore, where applicable, using the following assumptions:

- Roads were separated into typical (defined as two to three lane roads located on side streets and in neighborhoods), arterial (defined as major roadways of four lanes or more assumed at 200-foot wide), and highways (defined as major roadways with Colorado Department of Transportation right-of-way requirements at 250-foot wide). Widths were based on the U.S. Department of Transportation Federal Highway Administration (USDOT, 2014). Typical road crossings were included as part of overall open cut installation while arterial road and highway crossings were accounted as a part of trenchless pipe installation costs.

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- Railway crossings were estimated as 150 feet in length and included in trenchless installation costs. The actual length of the railway crossings will depend on specific railway and buffer requirements.
- All City and non-city utilities were not included as individual unit cost items, but rather assumed as part of project contingency.

D.2.5.3 Easements

Easement acquisition was assumed to be required for all pipeline not in a city right-of-way or on city-owned property. Easement acquisition was assumed as 5% of the OPCC.

D.2.6 Dewatering

A three-tiered approach was used to determine projected dewatering costs. The three tiers used for unit cost estimations was developed considering land elevations in and around the City (between 4,596 feet to 5,059 feet), flood plain maps, and proximity to irrigation ditches and water bodies. Tier 1 includes pipe construction within the 100-year flood plain and/or within 50 feet of an irrigation ditch, pond, or lake. Tier 2 includes pipe that is not in Tier 1 and in locations where the ground elevation is below the median elevation of Greeley (4,828 feet). Tier 2 costs are assumed as 50% of the Tier 1 costs. Tier 3 includes pipe in areas where the ground elevation is above the median elevation of the City. Dewatering costs for Tier 3 are assumed as captured in the project contingency, since dewatering will be minimal. For pipe sections installed at average depths below 15 feet using open cut installation, the dewatering tier is reduced by one level. For example, if a gravity sewer pipe section is being installed in a Tier 3 area but is at 16-foot average depth, the pipeline section will be considered as Tier 2 classification for dewatering. Likewise, if a pipe section is within the Tier 2 category but is greater than 15 feet deep, that section would be moved to the Tier 1 category.

Figure D-3 illustrates the three-tiered dewatering profile for the five-year and 20-year planning horizons. **Table D-3** provides the unit costs of the three-tiered dewatering categories in dollars per linear foot of sanitary sewer pipe.

Table D-3 Unit Costs for Dewatering by Tier

Tier	Unit Cost ($/LF of Pipe)
1	105
2	52.50
3	0

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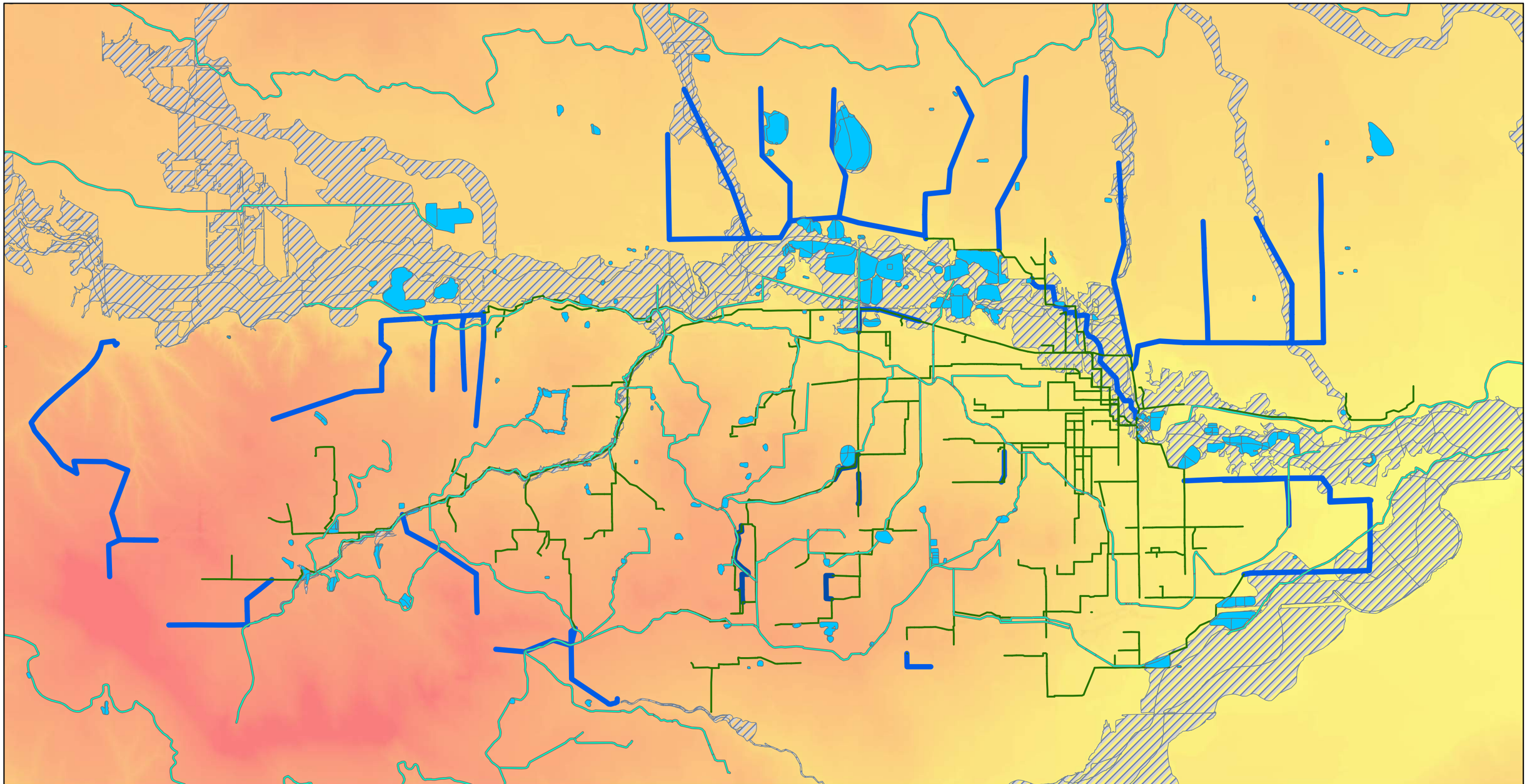

Legend

Tier 1

- 100 Yr Flood Plain
- Lakes 50ft Buffer
- Ditch 50ft Buffer

Tier 2

- 4828 ft
- 4596 ft

Tier 3

- 5059 ft
- 4828 ft

- Future Pipe
- Existing Interceptors

N

0 0.5 1 2

Miles

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November 02, 2020

Dewatering Profile

Greeley Wastewater System Master Plan

Figure 6-4

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D.3 Current/5 Year Planning Horizon Cost Development

For each City project, a project location map is provided following the cost development information.

D.3.1 City CIP Projects

D.3.1.1 Highland Hills 47th Avenue Flow Diversion

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 10” *Depth 0–10ft*	786	$95	$75,035	$75,035
PVC Gravity Sewer 10” *Depth 10–20ft*	1,313	$196	$257,209	$257,209
PVC Gravity Sewer 10” (Undeveloped) *Depth 0–10ft*	1,256	$49	$61,547	$61,547
PVC Gravity Sewer 12” *Depth 0–10ft*	395	$105	$41,561	$41,561
PVC Gravity Sewer 12” (Undeveloped) *Depth 0–10ft*	1,405	$58	$82,153	$82,153
PVC Sewer Trenchless 10”	100	$581	$58,148	$58,148
PVC Sewer Trenchless 12”	200	$584	$116,856	$116,856
Manhole 4ft *Depth 0-10ft*	16	$4,118	$65,894	$65,894
Manhole 4ft *Depth 10-20ft*	8	$5,777	$46,217	$46,217
Manhole 4ft *Depth >20ft*	1	$7,937	$7,937	$7,937
Tier 1 Dewatering	1,351	$105	$141,855	$141,855
Tier 2 Dewatering	135	$52.50	$7,088	$7,088
Unit Cost Subtotal				$961,500
Erosion Control/Stormwater Pollution Prevention			2%	$19,230
Mobilization & Demobilization			5%	$48,075
Subtotal				$1,028,805
Contingency			35%	$360,000
Opinion of Probable Construction Cost (rounded)				**$1,390,000**
Easement			5% of OPCC	$70,000
Feasibility and Site Studies			6% of OPCC	$84,000
Preliminary and Final Design			6% of OPCC	$84,000
Engineering Services During Construction			5% of OPCC	$69,500
Outside Construction Management - not used if OPCC is < $1M				$70,000
Outside Project Management - not used if OPCC is <$1M				$42,000
Capital Improvement Plan Total (rounded)				**$1,810,000**

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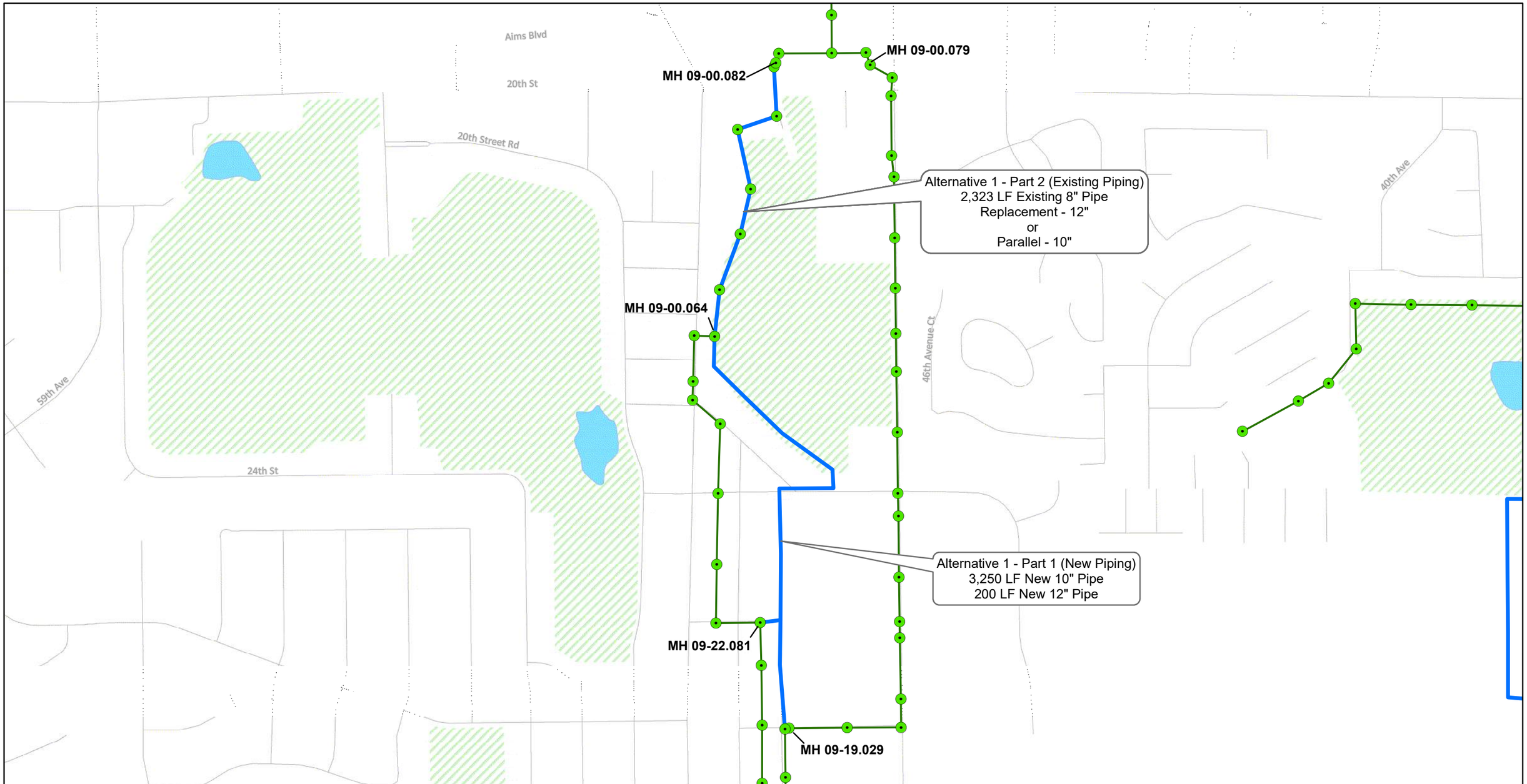

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April 26, 2021

Legend

- LREGA
- 100-yr Floodplain
- Lakes and Ponds
- Park
- Existing Manholes
- Existing Lift Stations
- Existing Interceptors
- Existing Force Mains
- 5 Year LS Recommendations
- Buildout LS Recommendations
- 5 Year Pipe Recommendations
- 20 Year Pipe Recommendations
- Buildout Pipe Recommendations
- 5 Year Force Main Recommendations
- Buildout Force Main Recommendations

N

0 370 740 1,480 Feet

Highland Hills 47th Ave

Appendix D-1.1.1

Greeley Sewer System Master Plan

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D.3.1.2 Highland Hills 25th Street Flow Diversion

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 12” *Depth 0–10ft*	1,793	$105	$188,601	$188,601
PVC Sewer Trenchless 12”	200	$584	$116,856	$116,856
Manhole 4ft *Depth 0-10ft*	8	$4,118	$32,947	$32,947
Manhole 4ft *Depth >20ft*	1	$7,937	$7,937	$7,937
Unit Cost Subtotal				$346,342
Erosion Control/Stormwater Pollution Prevention			2%	$6,927
Mobilization & Demobilization			5%	$17,317
Subtotal				$370,586
Contingency			35%	$129,710
Opinion of Probable Construction Cost (rounded)				**$510,000**
Easement			5% of OPCC	$25,500
Feasibility and Site Studies			9% of OPCC	$46,000
Preliminary and Final Design			9% of OPCC	$46,000
Engineering Services During Construction			5% of OPCC	$26,000
Outside Construction Management - not used if OPCC is < $1M				$0
Outside Project Management - not used if OPCC is <$1M				$0
Capital Improvement Plan Total (rounded)				**$660,000**

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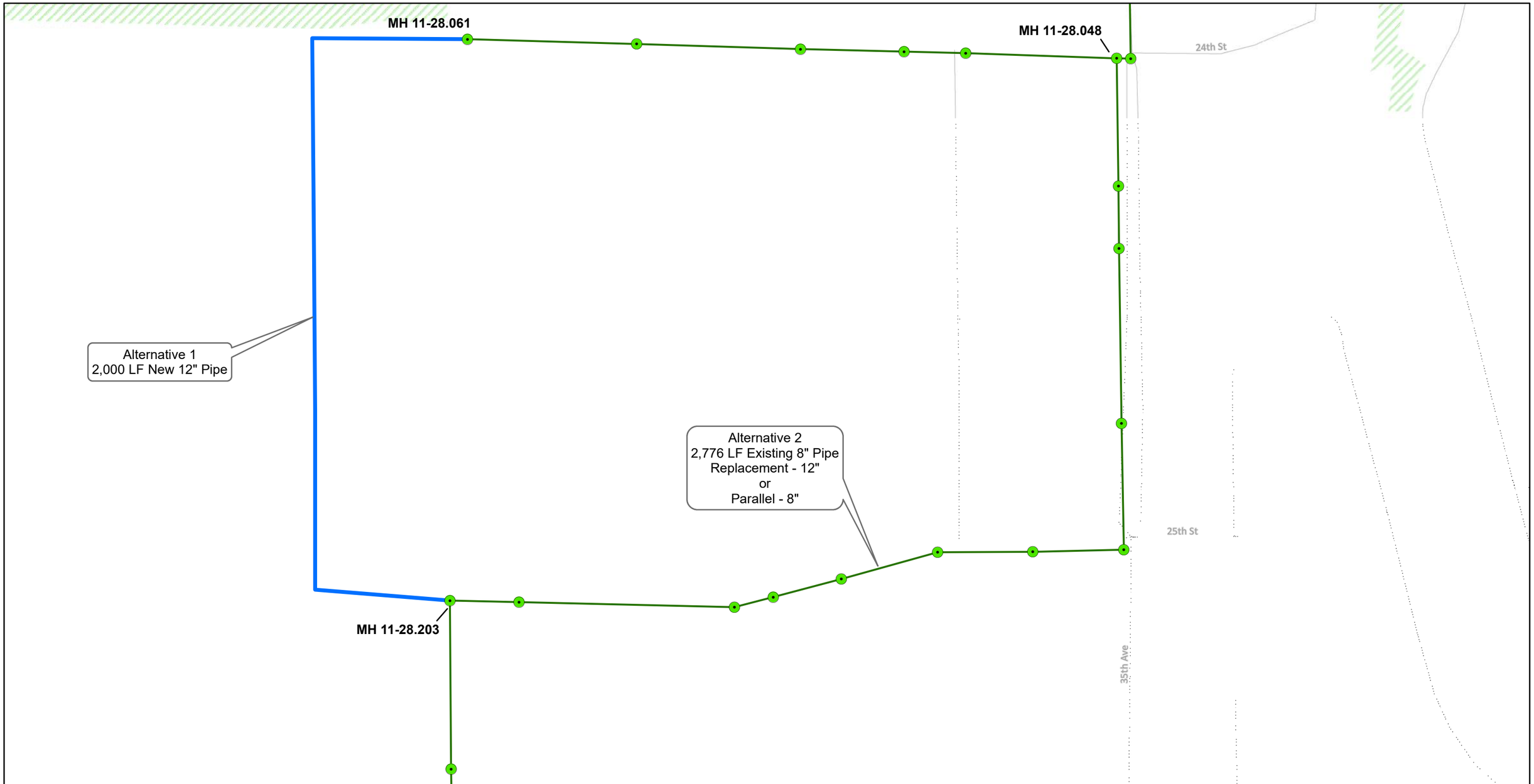

Legend

- LREGA
- 100-yr Floodplain
- Lakes and Ponds
- Park
- Existing Manholes
- Existing Lift Stations
- Existing Interceptors
- Existing Force Mains
- 5 Year LS Recommendations
- Buildout LS Recommendations
- 5 Year Pipe Recommendations
- 20 Year Pipe Recommendations
- Buildout Pipe Recommendations
- 5 Year Force Main Recommendations
- Buildout Force Main Recommendations

N

0 130 260 520 Feet

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Highland Hills 25th St

Appendix D-1.1.2

Greeley Sewer

System Master Plan

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D.3.1.3 Highland Hills Bittersweet Park

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 15” *Depth 0–10ft*	126	$119	$14,975	$14,975
PVC Gravity Sewer 15” *Depth 10–20ft*	103	$220	$22,733	$22,733
PVC Gravity Sewer 15” (Undeveloped) *Depth 0–10ft*	785	$68	$53,376	$53,376
PVC Gravity Sewer 15” (Undeveloped) *Depth 10–20ft*	1,084	$103	$111,334	$111,334
PVC Sewer Trenchless 15”	200	$798	$159,538	$159,538
Manhole 5ft *Depth 0-10ft*	4	$6,543	$26,171	$26,171
Manhole 5ft *Depth 10-20ft*	6	$9,540	$57,240	$57,240
Manhole 5ft Depth >20ft	1	$13,302	$13,302	$13,302
Tier 2 Dewatering	2298	$52.50	$120,654	$120,654
Unit Cost Subtotal				$579,322
Erosion Control/Stormwater Pollution Prevention			2%	$11,586
Mobilization & Demobilization			5%	$28,966
Subtotal				$619,875
Contingency			35%	$216,960
Opinion of Probable Construction Cost (rounded)				**$840,000**
Easement			5% of OPCC	$42,000
Feasibility and Site Studies			9% of OPCC	$76,000
Preliminary and Final Design			9% of OPCC	$76,000
Engineering Services During Construction			5% of OPCC	$42,000
Outside Construction Management - not used if OPCC is < $1M				$0
Outside Project Management - not used if OPCC is <$1M				$0
Capital Improvement Plan Total (rounded)				**$1,080,000**

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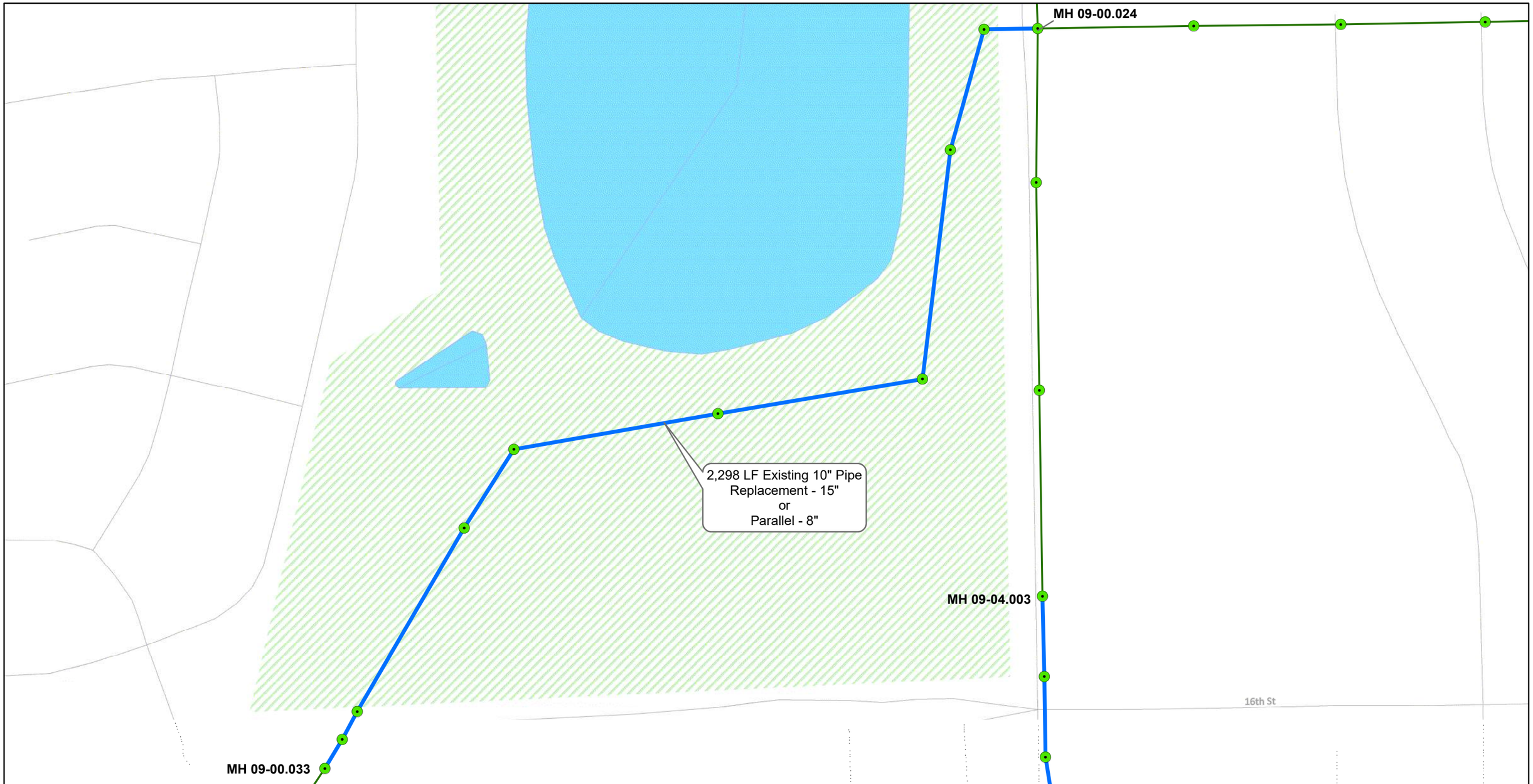

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April 26, 2021

Legend

- LREGA
- 100-yr Floodplain
- Lakes and Ponds
- Park
- Existing Manholes
- Existing Lift Stations
- Existing Interceptors
- Existing Force Mains
- 5 Year LS Recommendations
- Buildout LS Recommendations
- 5 Year Pipe Recommendations
- 20 Year Pipe Recommendations
- Buildout Pipe Recommendations
- 5 Year Force Main Recommendations
- Buildout Force Main Recommendations

N

0 105 210 420 Feet

Highland Hills Bittersweet Park

Appendix D-1.1.3

Greeley Sewer

System Master Plan

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D.3.1.4 Highland Hills 35th Avenue 19th Street to 17th Street

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 18” *Depth 0–10ft*	634	$133	$84,398	$84,398
PVC Gravity Sewer 18” *Depth 10–20ft*	923	$235	$217,066	$217,066
PVC Trenchless 18”	200	$897	$179,454	$179,454
Manhole 5ft *Depth 0-10ft*	3	$6,543	$19,628	$19,628
Manhole 5ft *Depth 10-20ft*	5	$9,540	$47,700	$47,700
Manhole 5ft *Depth >20ft*	1	$13,302	$13,302	$13,302
Unit Cost Subtotal				$561,547
Erosion Control/Stormwater Pollution Prevention			2%	$11,231
Mobilization & Demobilization			5%	$28,077
Subtotal				$600,856
Contingency			35%	$210,300
Opinion of Probable Construction Cost (rounded)				**$820,000**
Feasibility and Site Studies			5% of OPCC	$41,000
Feasibility and Site Studies			9% of OPCC	$74,000
Preliminary and Final Design			9% of OPCC	$74,000
Engineering Services During Construction			5% of OPCC	$41,000
Outside Construction Management - not used if OPCC is < $1M				$0
Outside Project Management - not used if OPCC is <$1M				$0
Capital Improvement Plan Total				**$1,010,000**

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Legend

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- 5 Year LS Recommendations
- Buildout LS Recommendations
- 5 Year Pipe Recommendations
- 20 Year Pipe Recommendations
- Buildout Pipe Recommendations
- 5 Year Force Main Recommendations
- Buildout Force Main Recommendations

N

0 140 280 560 Feet

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Highland Hills 35th Ave
(19th St Rd to 17th St)

Appendix D-1.1.4

Greeley Sewer System Master Plan

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D.3.1.5 Central 16th Avenue

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 10” *Depth 0–10ft*	717	$95	$68,471	$68,471
PVC Gravity Sewer 10” (Undeveloped) *Depth 10–20ft*	670	$82	$55,073	$55,073
PVC Sewer Trenchless 10”	400	$581	$232,590	$232,590
Manhole 4ft *Depth 0-10ft*	7	$4118	$28,829	$28,829
Manhole 4ft Depth 10-20	2	$5777	$11,554	$11,554
Tier 2 Dewatering	1,787	$52.50	$93,818	$93,818
Unit Cost Subtotal				$490,336
Erosion Control/Stormwater Pollution Prevention			2%	$9,807
Mobilization & Demobilization			5%	$24,517
Subtotal				$524,659
Contingency			35%	$183,640
Opinion of Probable Construction Cost (rounded)				**$710,000**
Easement			5% of OPCC	$36,000
Feasibility and Site Studies			9% of OPCC	$64,000
Preliminary and Final Design			9% of OPCC	$64,000
Engineering Services During Construction			5% of OPCC	$36,000
Outside Construction Management - not used if OPCC is < $1M			5% of OPCC	$0
Outside Project Management - not used if OPCC is <$1M			3% of OPCC	$0
Capital Improvement Plan Total (rounded)				**$910,000**

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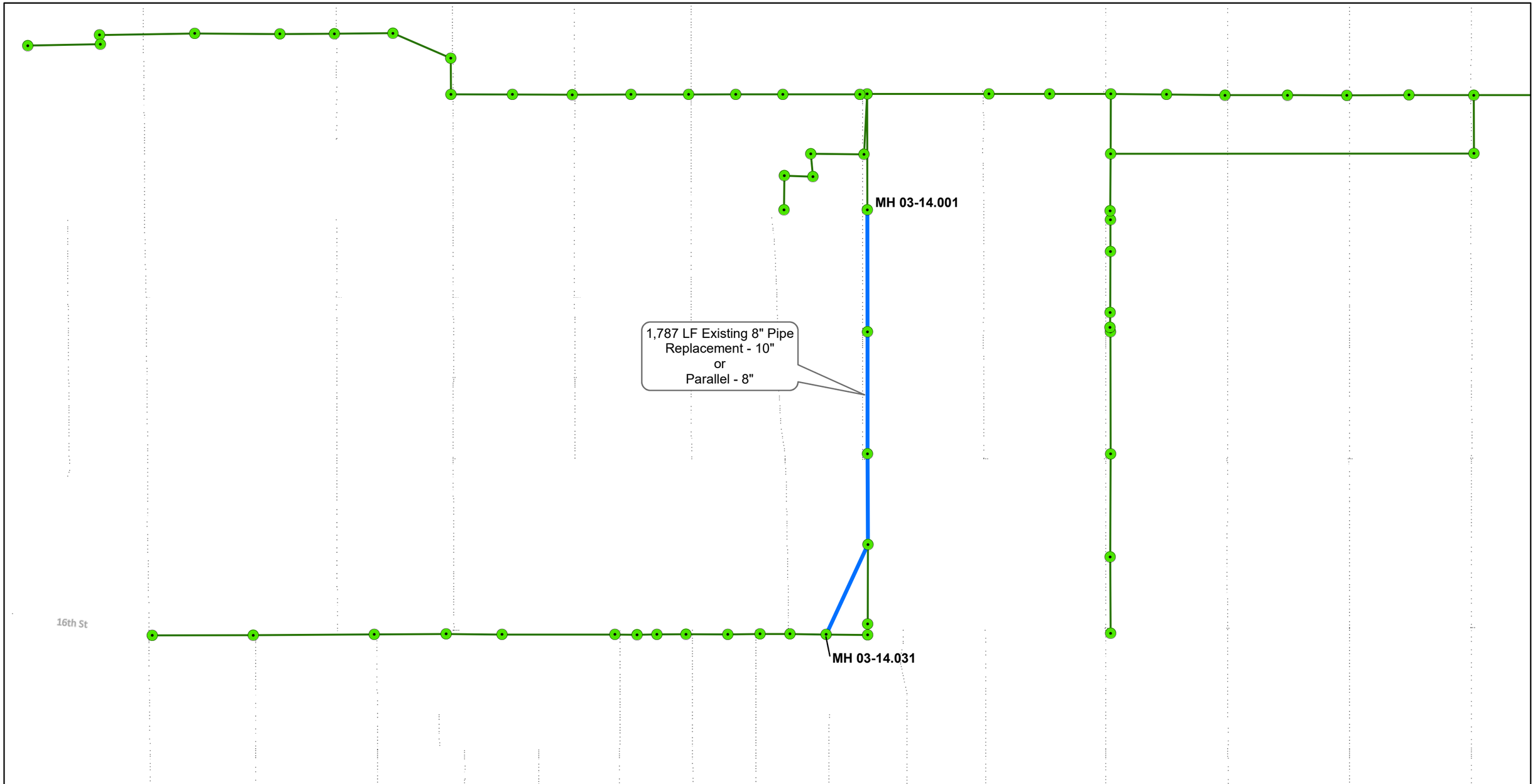

Legend

- LREGA
- 100-yr Floodplain
- Lakes and Ponds
- Park
- Existing Manholes
- Existing Lift Stations
- Existing Interceptors
- Existing Force Mains
- 5 Year LS Recommendations
- Buildout LS Recommendations
- 5 Year Pipe Recommendations
- 20 Year Pipe Recommendations
- Buildout Pipe Recommendations
- 5 Year Force Main Recommendations
- Buildout Force Main Recommendations

N

0 250 500 1,000 Feet

City of Greeley Colorado
Great. From the Ground Up.

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April 26, 2021

Central 16th Ave (North Colorado Medical Center)

Appendix D-1.1.5

Greeley Sewer System Master Plan

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D.3.2 Development Projects

D.3.2.1 East Greeley Lift Station

Item	Quantity	Unit Cost	Extended Cost	Total Cost
East Greeley Lift Station	LS	—	$2,765,157	$2,765,157
PVC Force main 18”	11,670	$133	$1,554,647	$1,554,647
PVC Trenchless 18”	100	$897	$89,727	$89,727
Tier 1 Dewatering	1,505	$105	$158,025	$158,025
Tier 2 Dewatering	10,265	$52.50	$538,913	$538,913
Unit Cost Subtotal				$5,106,469
Erosion Control/Stormwater Pollution Prevention			2%	$102,129
Mobilization & Demobilization			5%	$255,323
Subtotal				$5,463,922
Contingency			35%	$1,912,380
Opinion of Probable Construction Cost (rounded)				**$7,380,000**

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D.3.2.2 LS15 Expansion

Item	Quantity	Unit Cost	Extended Cost	Total Cost
LS15 Expansion	1	LS	$400,000	$400,000
PVC Force main 6”	2,884	$66	$191,494	$191,494
PVC Gravity Sewer 8” *Depth 0-10ft*	2,096	$88	$184,448	$184,448
Manhole 4ft *Depth 0-10ft*	10	$4118	$41,184	$41,184
Unit Cost Subtotal				$817,125
Erosion Control/Stormwater Pollution Prevention			2%	$16,343
Mobilization & Demobilization			5%	$40,856
Subtotal				$874,324
Contingency			35%	$306,020
Opinion of Probable Construction Cost (rounded)				**$1,190,000**

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D.3.2.3 83rd Avenue Sanitary Sewer Project

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 8” *Depth 10-20ft*	2,075	$188	$390,928	$390,928
PVC Gravity Sewer 10” *Depth 0-10ft*	202	$95	$19,338	$19,338
PVC Gravity Sewer 10” *Depth 10-20ft*	3,607	$196	$706,418	$706,418
PVC Trenchless 10”	325	$581	$189,023	$189,023
Manhole 4ft *Depth 0-10ft*	1	$4118	$4,118	$4,118
Manhole 4ft *Depth 10-20ft*	25	$5777	$144,428	$144,428
Manhole 4ft *Depth >20ft*	1	$7937	$7,937	$7,937
Tier 1 Dewatering	905	$105	$95,025	$95,025
Tier 2 Dewatering	1,095	$52.50	$57,488	$57,488
Unit Cost Subtotal				$1,614,703
Erosion Control/Stormwater Pollution Prevention			2%	$32,294
Mobilization & Demobilization			5%	$80,735
Subtotal				$1,727,732
Contingency			35%	$604,710
Opinion of Probable Construction Cost (rounded)				**$2,340,000**

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D.3.2.4 Poudre Trunk Phase 2

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 30” *Depth 0-10ft*	2,607	$240	$624,663	$624,663
PVC Gravity Sewer 30” *Depth 10-20ft*	7,522	$347	$2,606,607	$2,606,607
PVC Trenchless 30”	100	$1531	$153,129	$153,129
Manhole 5ft *Depth 0-10ft*	11	$6543	$71,969	$71,969
Manhole 5ft *Depth 10-20ft*	31	$9540	$295,738	$295,738
Tier 1 Dewatering	2,860	$105	$300,300	$300,300
Tier 2 Dewatering	4,818	$52.50	$252,945	$252,945
Unit Cost Subtotal				$4,305,352
Erosion Control/Stormwater Pollution Prevention			2%	$86,107
Mobilization & Demobilization			5%	$215,268
Subtotal				$4,606,727
Contingency			35%	$1,612,360
Opinion of Probable Construction Cost (rounded)				**$6,220,000**
Easement			5% of OPCC	$311,000

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D.3.2.5 Poudre Trunk Branch 1

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 8” *Depth 0-10ft*	3,558	$88	$314,679	$314,679
PVC Gravity Sewer 10” *Depth 0-10ft*	678	$95	$64,782	$64,782
PVC Trenchless 8”	100	$478	$47,808	$47,808
Manhole 4ft *Depth 0-10ft*	19	$4118	$78,249	$78,249
Tier 1 Dewatering	533	$105	$55,965	$55,965
Tier 2 Dewatering	913	$52.50	$47,933	$47,933
Unit Cost Subtotal				$609,416
Erosion Control/Stormwater Pollution Prevention			2%	$12,188
Mobilization & Demobilization			5%	$30,471
Subtotal				$652,076
Contingency			35%	$228,230
Opinion of Probable Construction Cost (rounded)				**$890,000**
Easement			5% of OPCC	$45,000

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D.3.2.6 Poudre Trunk Branch 2

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 8” *Depth 0-10ft*	916	$88	$80,980	$80,980
PVC Gravity Sewer 10” *Depth 0-10ft*	1,215	$95	$116,029	$116,029
PVC Gravity Sewer 10” *Depth 10-20ft*	1,896	$196	$371,319	$371,319
PVC Trenchless 10”	100	$581	$58,148	$58,148
Manhole 4ft *Depth 0-10ft*	9	$4118	$37,066	$37,066
Manhole 4ft *Depth 10-20ft*	8	$5777	$46,217	$46,217
Manhole 4ft Depth >20 ft	1	$7937	$7,937	$7,937
Tier 1 Dewatering	100	$105	$10,500	$10,500
Tier 2 Dewatering	1,483	$52.50	$77,858	$77,858
Unit Cost Subtotal				$806,052
Erosion Control/Stormwater Pollution Prevention			2%	$16,121
Mobilization & Demobilization			5%	$40,303
Subtotal				$862,476
Contingency			35%	$301,870
Opinion of Probable Construction Cost (rounded)				**$1,170,000**
Easement			5% of OPCC	$59,000

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D.3.2.7 Poudre Trunk Phase 3

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 10” *Depth 0-10ft*	4,884	$95	$466,425	$466,425
PVC Gravity Sewer 15” *Depth 0-10ft*	2,964	$119	$352,015	$352,015
PVC Gravity Sewer 15” *Depth 10-20ft*	756	$220	$166,490	$166,490
Manhole 4ft *Depth 0-10ft*	21	$4118	$86,486	$86,486
Manhole 5ft *Depth 0-10ft*	12	$6543	$78,512	$78,512
Manhole 5ft *Depth 10-20ft*	3	$9540	$28,620	$28,620
Unit Cost Subtotal				$1,178,547
Erosion Control/Stormwater Pollution Prevention			2%	$23,571
Mobilization & Demobilization			5%	$58,927
Subtotal				$1,261,045
Contingency			35%	$441,370
Opinion of Probable Construction Cost (rounded)				**$1,710,000**
Easement			5% of OPCC	$86,000

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D.3.2.8 Evans 28th Street

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 8” *Depth 0-10ft*	1,547	$88	$136,830	$136,830
PVC Gravity Sewer 10” *Depth 10-20ft*	1,351	$196	$264,556	$264,556
PVC Gravity Sewer 12” *Depth 10-20ft*	1,956	$206	$402,795	$402,795
PVC Trenchless 8”	100	$478	$47,808	$47,808
PVC Trenchless 10”	400	$581	$232,590	$232,590
PVC Trenchless 12”	100	$584	$58,428	$58,428
Manhole 4ft *Depth 0-10ft*	7	$4118	$28,829	$28,829
Manhole 4ft *Depth 10-20ft*	14	$5777	$80,880	$80,880
Manhole 4ft *Depth >20ft*	2	$7937	$15,875	$15,875
Tier 1 Dewatering	600	$105	$63,000	$63,000
Unit Cost Subtotal				$1,331,591
Erosion Control/Stormwater Pollution Prevention			2%	$26,632
Mobilization & Demobilization			5%	$66,580
Subtotal				$1,424,802
Contingency			35%	$498,690
Opinion of Probable Construction Cost (rounded)				**$1,930,000**
Easement			5% of OPCC	$97,000

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D.3.2.9 Balsam East

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 8” *Depth 0-10ft*	1,693	$88	$149,735	$149,735
PVC Gravity Sewer 12” *Depth 0-10ft*	3,214	$105	$338,026	$338,026
PVC Gravity Sewer 12” *Depth 10-20ft*	13	$206	$2,737	$2,737
PVC Gravity Sewer 15” *Depth 0-10ft*	2,767	$119	$328,720	$328,720
PVC Gravity Sewer 18” *Depth 10-20ft*	2,988	$235	$702,574	$702,574
PVC Gravity Sewer 21” *Depth 10-20ft*	78	$254	$19,807	$19,807
PVC Trenchless 12”	1,335	$584	$780,015	$780,015
Manhole 4ft *Depth 0-10ft*	32	$4118	$131,788	$131,788
Manhole 4ft *Depth 10-20ft*	1	$5777	$5,777	$5,777
Manhole 4ft *Depth >20ft*	5	$7937	$39,687	$39,687
Manhole 5ft *Depth 0-10ft*	12	$6543	$78,512	$78,512
Manhole 5ft *Depth 10-20ft*	12	$9540	$114,479	$114,479
Tier 1 Dewatering	3,445	$105	$361,725	$361,725
Tier 2 Dewatering	8,643	$52.50	$453,766	$453,766
Unit Cost Subtotal				$3,507,347
Erosion Control/Stormwater Pollution Prevention			2%	$70,147
Mobilization & Demobilization			5%	$175,367
Subtotal				$3,752,862
Contingency			35%	$1,313,510
Opinion of Probable Construction Cost (rounded)				**$5,070,000**
Easement			5% of OPCC	$254,000

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D.4 20 Year Planning Horizon Project Cost Development

D.4.1 City CIP Projects

For each City project, a project location map is provided following the cost development information.

D.4.1.1 LS9 Diversion

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 21” *Depth 10–20ft*	10,930	$254	$2,778,999	$2,778,999
PVC Sewer Trenchless 21”	200	$1098	$219,562	$219,562
Manhole 5ft *Depth 10-20ft*	45	$9540	$429,297	$429,297
Tier 1 Dewatering	7,992	$105	$839,160	$839,160
Tier 2 Dewatering	3,138	$52.50	$164,745	$164,745
Unit Cost Subtotal				$4,431,763
Erosion Control/Stormwater Pollution Prevention			2%	$88,635
Mobilization & Demobilization			5%	$221,588
Subtotal				$4,742,000
Contingency			35%	$1,659,700
Opinion of Probable Construction Cost (rounded)				**$6,410,000**
Easement			5% of OPCC	$321,000
Feasibility and Site Studies			6% of OPCC	$385,000
Preliminary and Final Design			6% of OPCC	$385,000
Engineering Services During Construction			5% of OPCC	$321,000
Outside Construction Management - not used if OPCC is < $1M			5% of OPCC	$321,000
Outside Project Management - not used if OPCC is <$1M			3% of OPCC	$193,000
Capital Improvement Plan Total (rounded)				**$8,340,000**

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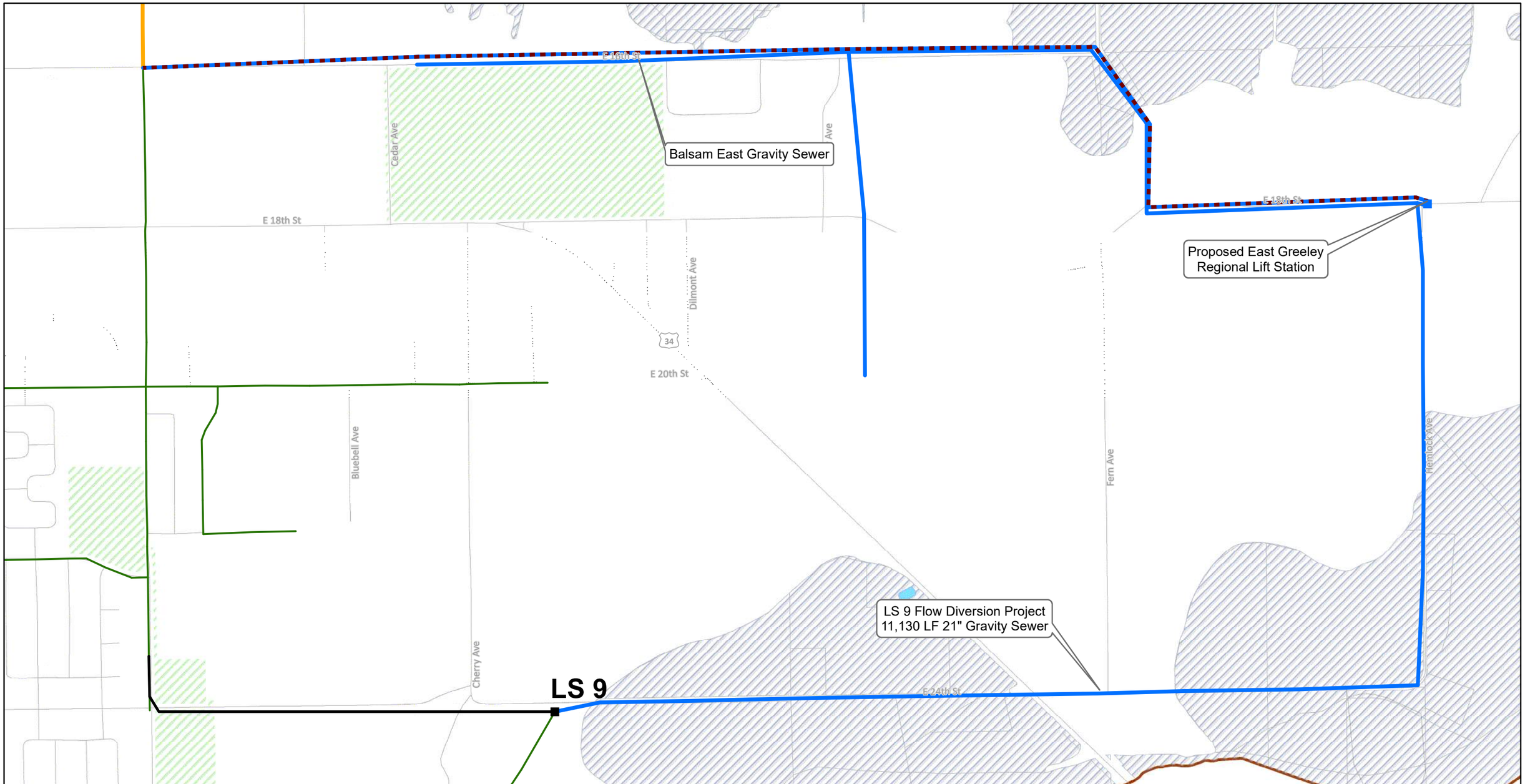

Legend

- LREGA
- 100-yr Floodplain
- Lakes and Ponds
- Park
- Existing Manholes
- Existing Lift Stations
- Existing Interceptors
- Existing Force Mains
- 5 Year LS Recommendations
- Buildout LS Recommendations
- 5 Year Pipe Recommendations
- 20 Year Pipe Recommendations
- Buildout Pipe Recommendations
- 5 Year Force Main Recommendations
- Buildout Force Main Recommendations

N

0 375 750 1,500 Feet

City of Greeley Colorado
Great. From the Ground Up.

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April 26, 2021

LS 9 Flow Diversion

Appendix D-3.1.1

Greeley Sewer

System Master Plan

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D.4.1.2 N. Poudre RR Phase 1

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 54" *Depth 0–10ft*	225	$588	$132,439	$132,439
PVC Gravity Sewer 54" *Depth 10–20ft*	3,185	$712	$2,267,980	$2,267,980
PVC Sewer Trenchless 54"	150	$2748	$412,271	$412,271
Manhole 8ft *Depth 0-10ft*	1	$31896	$31,896	$31,896
Manhole 8ft *Depth 10-20ft*	14	$48162	$674,268	$674,268
Manhole 8ft *Depth >20ft*	1	$64429	$64,429	$64,429
Tier 1 Dewatering	2,979	$105	$312,795	$312,795
Tier 2 Dewatering	582	$52.50	$30,555	$30,555
Unit Cost Subtotal				$3,926,633
Erosion Control/Stormwater Pollution Prevention			2%	$78,533
Mobilization & Demobilization			5%	$196,332
Subtotal				$4,201,497
Contingency			35%	$1,470,530
Opinion of Probable Construction Cost (rounded)				**$5,680,000**
Easement			5% of OPCC	$284,000
Feasibility and Site Studies			6% of OPCC	$341,000
Preliminary and Final Design			6% of OPCC	$341,000
Engineering Services During Construction			5% of OPCC	$284,000
Outside Construction Management - not used if OPCC is < $1M			5% of OPCC	$284,000
Outside Project Management - not used if OPCC is <$1M			3% of OPCC	$171,000
Capital Improvement Plan Total (rounded)				**$7,390,000**

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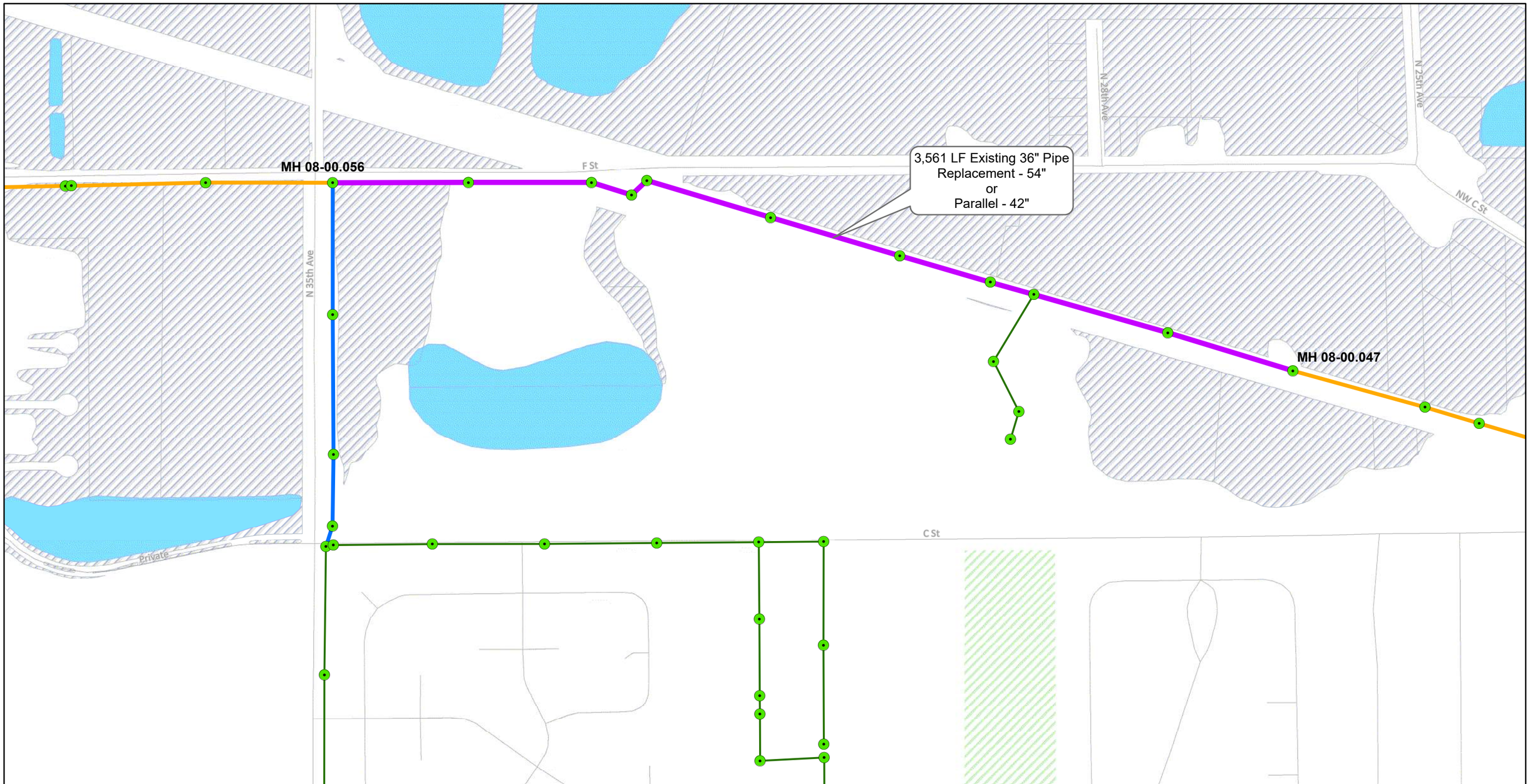

Legend

- LREGA
- 100-yr Floodplain
- Lakes and Ponds
- Park
- Existing Manholes
- Existing Lift Stations
- Existing Interceptors
- Existing Force Mains
- 5 Year LS Recommendations
- Buildout LS Recommendations
- 5 Year Pipe Recommendations
- 20 Year Pipe Recommendations
- Buildout Pipe Recommendations
- 5 Year Force Main Recommendations
- Buildout Force Main Recommendations

N

0 200 400 800 Feet

City of Greeley Colorado
Great. From the Ground Up.

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April 26, 2021

N Poudre Railroad
Phase 1 (East of 35th Ave)

Appendix D-3.1.2

Greeley Sewer System Master Plan

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D.4.1.3 N Poudre East C Street

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 30” *Depth 0-10ft*	1,797	$240	$430,554	$430,554
PVC Gravity Sewer 36” *Depth 10-20ft*	3,006	$397	$1,194,691	$1,194,691
PVC Gravity Sewer 42” *Depth 0-10ft*	1,373	$372	$511,412	$511,412
PVC Gravity Sewer 42” *Depth 10-20ft*	2,948	$488	$1,438,743	$1,438,743
PVC Trenchless 36”	100	$1848	$184,811	$184,811
PVC Trenchless 42”	2,751	$2148	$5,910,747	$5,910,747
Manhole 6ft *Depth 0-10ft*	13	$15998	$207,974	$207,974
Manhole 6ft *Depth 10-20ft*	24	$22839	$548,136	$548,136
Manhole 6ft *Depth >20ft*	12	$29359	$352,308	$352,308
Tier 1 Dewatering	7,926	$105	$832,230	$832,230
Tier 2 Dewatering	4,051	$52.50	$212,657	$212,657
Unit Cost Subtotal				$11,824,264
Erosion Control/Stormwater Pollution Prevention			2%	$236,485
Mobilization & Demobilization			5%	$591,213
Subtotal				$12,651,963
Contingency			35%	$4,428,190
Opinion of Probable Construction Cost (rounded)				**$17,090,000**
Easement			5% of OPCC	$855,000
Feasibility and Site Studies			5% of OPCC	$855,000
Preliminary and Final Design			5% of OPCC	$855,000
Engineering Services During Construction			5% of OPCC	$855,000
Outside Construction Management - not used of OPCC <$1M			5% of OPCC	$855,000
Outside Project Management - not used if OPCC <$1M			3% of OPCC	$513,000
Capital Improvement Plan Total (rounded)				**$21,880,000**

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D.4.1.4 N. Greeley O Street

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 36” *Depth 0-10ft*	1,963	$286	$561,629	$561,629
PVC Gravity Sewer 36” *Depth 10-20ft*	13,458	$397	$5,348,291	$5,348,291
Manhole 6ft *Depth 0-10ft*	8	$15998	$127,984	$127,984
Manhole 6ft *Depth 10-20ft*	55	$22839	$1,256,145	$1,256,145
Tier 1 Dewatering	6,387	$105	$670,635	$670,635
Tier 2 Dewatering	9,034	$52.50	$474,273	$474,273
Unit Cost Subtotal				$8,438,957
Erosion Control/Stormwater Pollution Prevention			2%	$168,779
Mobilization & Demobilization			5%	$421,948
Subtotal				$9,029,684
Contingency			35%	$3,160,390
Opinion of Probable Construction Cost (rounded)				**$12,200,000**
Easement			5% of OPCC	$610,000
Feasibility and Site Studies			5% of OPCC	$610,000
Preliminary and Final Design			5% of OPCC	$610,000
Engineering Services During Construction			5% of OPCC	$610,000
Outside Construction Management- not used if OPCC <$1M			5% of OPCC	$610,000
Outside Project Management- not used if OPCC <$1M			3% of OPCC	$366,000
Capital Improvement Plan Total (rounded)				**$15,620,000**

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D.4.2 Development Projects

D.4.2.1 N. Poudre Fern Avenue

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 15” *Depth 10-20ft*	5,557	$220	$1,223,292	$1,223,292
PVC Gravity Sewer 18” *Depth 0-10ft*	3,321	$133	$442,362	$442,362
PVC Gravity Sewer 21” *Depth 0-10ft*	659	$152	$99,977	$99,977
Manhole 5ft *Depth 0-10ft*	17	$6543	$111,225	$111,225
Manhole 5ft *Depth 10-20ft*	23	$9540	$219,419	$219,419
Tier 2 Dewatering	9,537	$52.50	$500,687	$500,687
Unit Cost Subtotal				$2,596,962
Erosion Control/Stormwater Pollution Prevention			2%	$51,939
Mobilization & Demobilization			5%	$129,848
Subtotal				$2,778,749
Contingency			35%	$972,570
Opinion of Probable Construction Cost (rounded)				**$3,760,000**
Feasibility and Site Studies			6% of OPCC	$226,000
Preliminary and Final Design			6% of OPCC	$226,000
Engineering Services During Construction			5% of OPCC	$188,000
Outside Construction Management - not used if OPCC <$1M			5% of OPCC	$188,000
Outside Project Management - not used if OPCC <$1M			3% of OPCC	$113,000
Capital Improvement Plan Total (rounded)				**$4,710,000**

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D.4.2.2 N Poudre Cherry Avenue E

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 15” *Depth 10-20ft*	4,185	$220	$921,182	$921,182
PVC Gravity Sewer 21” *Depth 10-20ft*	1,710	$254	$434,865	$434,865
PVC Gravity Sewer 24” *Depth 10-20ft*	1,623	$268	$435,624	$435,624
PVC Sewer Trenchless 15”	100	$798	$79,769	$79,769
Manhole 5ft *Depth 10-20ft*	32	$9540	$305,278	$305,278
Tier 1 Dewatering	4,962	$105	$521,010	$521,010
Tier 2 Dewatering	2,656	$52.50	$139,452	$139,452
Unit Cost Subtotal				$2,837,181
Erosion Control/Stormwater Pollution Prevention			2%	$56,744
Mobilization & Demobilization			5%	$141,859
Subtotal				$3,035,783
Contingency			35%	$1,062,530
Opinion of Probable Construction Cost (rounded)				**$4,100,000**
Easement			5% of OPCC	$205,000

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D.4.2.3 N. Poudre Cherry Avenue W

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 18” *Depth 0-10ft*	5,464	$133	$727,938	$727,938
PVC Gravity Sewer 21” *Depth 10-20ft*	1,447	$254	$367,861	$367,861
Manhole 5ft *Depth 0-10ft*	23	$6543	$150,481	$150,481
Manhole 5ft *Depth 10-20ft*	6	$9540	$57,240	$57,240
Tier 2 Dewatering	6,911	$52.50	$362,836	$362,836
Unit Cost Subtotal				$1,666,356
Erosion Control/Stormwater Pollution Prevention			2%	$33,327
Mobilization & Demobilization			5%	$83,318
Subtotal				$1,783,000
Contingency			35%	$624,060
Opinion of Probable Construction Cost (rounded)				**$2,410,000**
Easement			5% of OPCC	$121,000

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D.4.2.4 N Poudre N 1st Ave W

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 15” *Depth 0-10ft*	1,589	$119	$188,790	$188,790
PVC Gravity Sewer 15” *Depth 10-20ft*	1,540	$220	$338,983	$338,983
PVC Gravity Sewer 18” *Depth 0-10ft*	1,821	$133	$242,581	$242,581
PVC Gravity Sewer 18” *Depth 10-20ft*	1,038	$235	$244,120	$244,120
PVC Trenchless 18”	2,579	$897	$2,314,061	$2,314,061
Manhole 5ft *Depth 0-10ft*	14	$6543	$91,597	$91,597
Manhole 5ft *Depth 10-20ft*	11	$9540	$104,939	$104,939
Manhole 5ft *Depth >20ft*	11	$13302	$146,319	$146,319
Tier 1 Dewatering	4,208	$105	$441,840	$441,840
Tier 2 Dewatering	6,938	$52.50	$364,245	$364,245
Unit Cost Subtotal				$4,477,475
Erosion Control/Stormwater Pollution Prevention			2%	$89,550
Mobilization & Demobilization			5%	$223,874
Subtotal				$4,790,898
Contingency			35%	$1,676,820
Opinion of Probable Construction Cost (rounded)				**$6,470,000**
Easement			5% of OPCC	$324,000

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D.4.2.5 N Greeley Centennial Hwy

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 8” *Depth 0-10ft*	1,376	$88	$121,673	$121,673
PVC Gravity Sewer 10” *Depth 10-20ft*	3,157	$196	$618,241	$618,241
PVC Gravity Sewer 12” *Depth 10-20ft*	5,463	$206	$1,125,033	$1,125,033
PVC Sewer Trenchless 12”	200	$584	$116,856	$116,856
Manhole 4ft *Depth 0-10ft*	6	$4118	$24,710	$24,710
Manhole 4ft *Depth 10-20ft*	36	$5777	$207,976	$207,976
Tier 1 Dewatering	4,348	$105	$456,540	$456,540
Tier 2 Dewatering	5,848	$52.50	$306,998	$306,998
Unit Cost Subtotal				$2,978,028
Erosion Control/Stormwater Pollution Prevention			2%	$59,561
Mobilization & Demobilization			5%	$148,901
Subtotal				$3,186,490
		Contingency	35%	$1,115,280
Opinion of Probable Construction Cost (rounded)				**$4,310,000**
Easement			5% of OPCC	$216,000

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D.4.2.6 N. Greeley N. 23rd Avenue

	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 10” *Depth 0-10ft*	1,759	$95	$167,953	$167,953
PVC Gravity Sewer 12” *Depth 10-20ft*	4,581	$206	$943,406	$943,406
PVC Gravity Sewer 15” *Depth 0-10ft*	1,181	$119	$140,333	$140,333
PVC Gravity Sewer 15” *Depth 10-20ft*	2,490	$220	$548,143	$548,143
Manhole 4ft *Depth 0-10ft*	8	$4118	$32,947	$32,947
Manhole 4ft *Depth 10-20ft*	19	$5777	$109,765	$109,765
Manhole 5ft *Depth 0-10ft*	4	$6543	$26,171	$26,171
Manhole 5ft *Depth 10-20ft*	11	$9540	$104,939	$104,939
Tier 1 Dewatering	2,607	$105	$273,735	$273,735
Tier 2 Dewatering	7,405	$52.50	$388,742	$388,742
Unit Cost Subtotal				$2,736,134
Erosion Control/Stormwater Pollution Prevention			2%	$54,723
Mobilization & Demobilization			5%	$136,807
Subtotal				$2,927,663
Contingency			35%	$1,024,690
Opinion of Probable Construction Cost (rounded)				**$3,960,000**
Easement			5% of OPCC	$198,000

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D.4.2.7 N. Greeley Seeley Lake

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 10” *Depth 0-10ft*	1,536	$95	$146,675	$146,675
PVC Gravity Sewer 12” *Depth 10-20ft*	3,556	$206	$732,375	$732,375
PVC Gravity Sewer 15” *Depth 10-20ft*	2,376	$220	$523,045	$523,045
Manhole 4ft *Depth 0-10ft*	6	$4118	$24,710	$24,710
Manhole 4ft *Depth 10-20ft*	15	$5777	$86,657	$86,657
Manhole 5ft *Depth 10-20ft*	10	$9540	$95,399	$95,399
Tier 1 Dewatering	3,556	$105	$373,380	$373,380
Tier 2 Dewatering	3,913	$52.50	$205,409	$205,409
Unit Cost Subtotal				$2,187,650
Erosion Control/Stormwater Pollution Prevention			2%	$43,753
Mobilization & Demobilization			5%	$109,382
Subtotal				$2,340,785
Contingency			35%	$819,280
Opinion of Probable Construction Cost (rounded)				**$3,170,000**
Easement			5% of OPCC	$159,000

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D.4.2.8 N. Greeley 47th Avenue

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 10” *Depth 0-10ft*	1,849	$95	$176,594	$176,594
PVC Gravity Sewer 12” *Depth 0-10ft*	1,980	$105	$208,238	$208,238
PVC Gravity Sewer 15” *Depth 0-10ft*	2,228	$119	$264,668	$264,668
PVC Gravity Sewer 18” *Depth 10-20ft*	2,161	$235	$508,263	$508,263
Manhole 4ft *Depth 0-10ft*	15	$4118	$61,776	$61,776
Manhole 5ft *Depth 0-10ft*	10	$6543	$65,426	$65,426
Manhole 5ft *Depth 10-20ft*	9	$9540	$85,859	$85,859
Tier 2 Dewatering	8,219	$52.50	$431,482	$431,482
Unit Cost Subtotal				$1,802,306
Erosion Control/Stormwater Pollution Prevention			2%	$36,046
Mobilization & Demobilization			5%	$90,115
Subtotal				$1,928,467
Contingency			35%	$674,970
Opinion of Probable Construction Cost (rounded)				**$2,610,000**
Easement			5% of OPCC	$131,000

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D.4.2.9 N. Greeley 47th Avenue W

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 8” *Depth 0-10ft*	1,257	$88	$111,184	$111,184
PVC Gravity Sewer 10” *Depth 0-10ft*	3,500	$95	$334,239	$334,239
PVC Gravity Sewer 12” *Depth 0-10ft*	3,410	$105	$358,704	$358,704
PVC Gravity Sewer 15” *Depth 0-10ft*	1,128	$119	$133,958	$133,958
Manhole 4ft *Depth 0-10ft*	34	$4118	$140,025	$140,025
Manhole 5ft *Depth 0-10ft*	5	$6543	$32,713	$32,713
Tier 1 Dewatering	7,317	$105	$768,285	$768,285
Tier 2 Dewatering	1,978	$52.50	$103,845	$103,845
Unit Cost Subtotal				$1,982,954
Erosion Control/Stormwater Pollution Prevention			2%	$39,659
Mobilization & Demobilization			5%	$99,148
Subtotal				$2,121,760
Contingency			35%	$742,620
Opinion of Probable Construction Cost (rounded)				**$2,870,000**
Easement			5% of OPCC	$144,000

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D.4.2.10 N. Greeley N 59th Avenue

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 8” *Depth 0-10ft*	2,420	88	$214,044	$214,044
PVC Gravity Sewer 10” *Depth 0-10ft*	2,227	95	$212,664	$212,664
PVC Gravity Sewer 15” *Depth 10-20ft*	1,329	220	$292,623	$292,623
Manhole 4ft *Depth 0-10ft*	19	4118	$78,249	$78,249
Manhole 5ft *Depth 10-20ft*	6	9540	$57,240	$57,240
Tier 2 Dewatering	5,976	53	$313,754	$313,754
Unit Cost Subtotal				$1,168,574
Erosion Control/Stormwater Pollution Prevention			2%	$23,371
Mobilization & Demobilization			5%	$58,429
Subtotal				$1,250,374
Contingency			35%	$437,640
Opinion of Probable Construction Cost (rounded)				**$1,690,000**

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D.4.2.11 Sheep Draw 29th Street

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 8” *Depth 0-10ft*	2,550	$88	$225,508	$225,508
PVC Gravity Sewer 12” *Depth 0-10ft*	1,590	$105	$167,277	$167,277
PVC Gravity Sewer 27” *Depth 0-10ft*	778	$194	$150,732	$150,732
PVC Gravity Sewer 27” *Depth 10-20ft*	2,367	$299	$706,550	$706,550
PVC Sewer Trenchless 8”	250	$478	$119,521	$119,521
PVC Sewer Trenchless 12”	100	$584	$58,428	$58,428
PVC Sewer Trenchless 27”	100	$1,398	$139,793	$139,793
Manhole 4ft *Depth 0-10ft*	19	$4118	$78,249	$78,249
Manhole 5ft *Depth 0-10ft*	3	$6543	$19,628	$19,628
Manhole 5ft *Depth 10-20ft*	10	$9540	$95,399	$95,399
Tier 1 Dewatering	200	$105	$2,446	$21,000
Unit Cost Subtotal				$1,782,085
Erosion Control/Stormwater Pollution Prevention			2%	$35,642
Mobilization & Demobilization			5%	$89,104
Subtotal				$1,906,831
Contingency			35%	$667,400
Opinion of Probable Construction Cost (rounded)				**$2,580,000**
Easement			5% of OPCC	$129,000

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D.4.2.12 Sheep Draw US34

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 8” *Depth 10-20ft*	1,172	$188	$220,843	$220,843
PVC Gravity Sewer 10” *Depth 0-10ft*	1,892	$95	$180,706	$180,706
PVC Gravity Sewer 10” *Depth 10-20ft*	1,982	$196	$388,195	$388,195
PVC Gravity Sewer 12” *Depth 10-20ft*	2,364	$206	$486,870	$486,870
PVC Sewer Trenchless 10 In.	450	$581	$261,664	$261,664
Manhole 4ft *Depth 0-10ft*	8	$4,118	$32,947	$32,947
Manhole 4ft *Depth 10-20ft*	23	$5777	$132,874	$132,874
Tier 1 Dewatering	396	$105	$41,580	$41,580
Unit Cost Subtotal				$1,745,679
Erosion Control/Stormwater Pollution Prevention			2%	$34,914
Mobilization & Demobilization			5%	$87,284
Subtotal				$1,867,876
Contingency			35%	$653,760
Opinion of Probable Construction Cost (rounded)				**$2,530,000**
Easement			5% of OPCC	$127,000

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D.4.2.13 Windsor W

Item	Quantity	Unit Cost	Extended Cost	Total Cost
PVC Gravity Sewer 8” *Depth 0-10ft*	3,748	$88	$331,510	$331,510
PVC Gravity Sewer 10” *Depth 0-10ft*	825	$95	$78,821	$78,821
PVC Gravity Sewer 12” *Depth 0-10ft*	4,191	$105	$440,759	$440,759
PVC Gravity Sewer 12” *Depth 10-20ft*	2,099	$206	$432,239	$432,239
PVC Gravity Sewer 18” *Depth 0-10ft*	2,932	$133	$390,620	$390,620
PVC Gravity Sewer 18” *Depth 10-20ft*	9,101	$235	$2,139,992	$2,139,992
PVC Sewer Trenchless 12”	250	$584	$146,070	$146,070
PVC Sewer Trenchless 18”	600	$897	$538,362	$538,362
Manhole 4ft *Depth 0-10ft*	36	$4118	$148,262	$148,262
Manhole 4ft *Depth 10-20ft*	9	$5777	$51,994	$51,994
Manhole 4ft *Depth >20ft*	1	$7937	$7,937	$7,937
Manhole 5ft *Depth 0-10ft*	11	$6543	$71,969	$71,969
Manhole 5ft *Depth 10-20ft*	36	$9540	$343,438	$343,438
Manhole 5ft *Depth >20ft*	2	$13302	$26,603	$26,603
Tier 2 Dewatering	501	$52.50	$26,303	$26,303
Unit Cost Subtotal				$5,174,880
Erosion Control/Stormwater Pollution Prevention			2%	$103,498
Mobilization & Demobilization			5%	$258,744
Subtotal				$5,537,122
Contingency			35%	$1,938,000
Opinion of Probable Construction Cost (rounded)				**$7,480,000**
Easement			5% of OPCC	$374,000

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Appendix E

Coordination and Engagement with Adjacent Communities

E.1 Goals of the Stakeholder Engagement Plan

The stakeholder engagement process was incorporated to involve local communities in the City's sewer system master plan and to seek regional options that benefit the area in planning for future growth. The stakeholder engagement process allowed the City to share information and consider future opportunities in which various stakeholders can support planned growth and development in the region. This stakeholder process was intended to help form a collaborative environment with the identified stakeholders.

E.2 Key Stakeholders

The key stakeholders were identified based on their current system connections with the City, proximity to City boundaries, and historical interest in opportunities for shared service. For many of the stakeholders, the City has an intergovernmental agreement (IGA) in place. The list of key stakeholders and IGA summary are presented in **Table E-1**.

Table E-1. Stakeholders for Sewer System Master Plan

Stakeholder	IGA Status and Summary
Evans	The current IGA calls for Evans to treat wastewater from the Ashcroft Basin at the Hill-N-Park wastewater plant (except for the T-Bone Ranch subdivision, which has a separate IGA wherein Evans only provides treatment in an emergency). The wastewater delivery system is operated and maintained by Greeley. However, due to proposed development that would exceed the capacity of the Hill-N-Park plant, Greeley plans to renegotiate the Ashcroft IGA by October 1st, 2022 and construct sewer lines and a lift station to serve the entire Ashcroft Basin themselves.
Windsor	The existing IGA establishes terms and conditions for land use, site and building standards and utility services within the Cooperative Planning, Land Use and Utility Areas (CPUA). Greeley agrees to deliver sewage originating within the CPUA to the Windsor sewer system for treatment by Windsor.
Eaton	The City does not have an IGA with Eaton as Eaton is north of the City where little population growth has occurred; however, both parties are in continued communication for opportunities of IGA development as the City's population is projected to expand northward across the Cache la Poudre River where shared wastewater treatment and services may be required.
Kersey	The City does not have an IGA with Kersey as Kersey has a much smaller population than the City and Kersey is separated from the City by the South Platte River; however, there has been communication between the City and Kersey for future IGA opportunities.
Milliken	The City does not have an IGA with Milliken as Milliken is south of the City where little population growth has occurred; however, there has been communication between the City and Milliken for future IGA opportunities.
Johnstown	The City will coordinate separately with Johnstown

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E.3 Level of Stakeholder Engagement

Stakeholder engagement in a project will vary depending on the interest of the stakeholders, potential impact on their customers and systems, and ability to contribute to the project. **Figure E-1** illustrates various levels of stakeholder engagement that can be achieved depending upon overall goals and objectives ranging from simply being informed to being fully a part of the decision-making process.

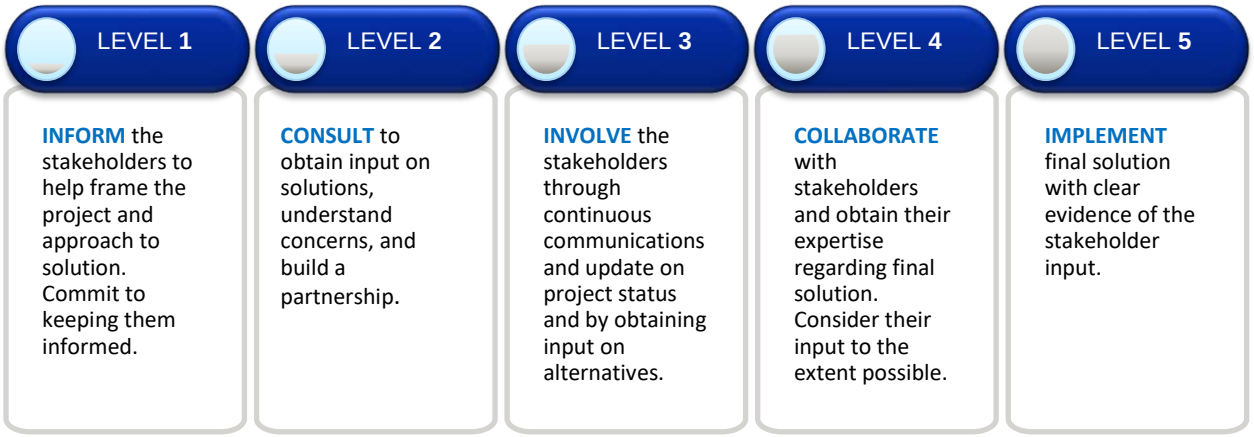

Figure E-1 Stakeholder Engagement Levels

Stakeholder planning defines the existing level of engagement for each stakeholder then develops a plan to reach the desired level of engagement. The existing level of engagement is subjectively determined by considering how active and informed each stakeholder is about the WWMP and associated infrastructure and how much interest they have historically shown in partnering with the City for services. Stakeholders who have an existing IGA tend to be more informed than those who do not have an existing agreement in place. The perceived existing level of engagement and the City's desired level of engagement for each stakeholder is shown in **Table E-2**.

Table E-2 Stakeholder Existing and Desired Level of Engagement

	Level of Engagement	
Stakeholder	Existing	Desired
Evans	2: Consult	5: Implement
Kersey	1: Inform	2: Consult
Eaton	1: Inform	4: Collaborate
Windsor	2: Consult	5: Implement
Milliken	1: Inform	4: Collaborate

E.4 Collaboration Opportunities

The City's stakeholder goal is to involve participants to the desired level through outreach and engagement in the City's overall planning process. This includes identifying opportunities for collaboration between stakeholders. Through a series of one-on-one and group meetings between the City and their regional neighbors, several collaboration opportunities were identified as summarized below and shown on **Figure E-2** (provided at the end of this section).

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E.4.1 Individual Collaboration Opportunities

E.4.1.1 Greeley

The City has one WWTP that is adequately sized for current demand (rated at 14.7 mgd with an ADF of 7.8 mgd). The City's most recent wastewater master plan outlines the following four-phased approach to treatment improvements to meet regulatory and capacity requirements: (1) WWTP process upgrades to meet Regulation 85, (2) renewal of existing assets (replacement), (3) flow and loading increases, and (4) improvements to meet Regulation 31 discharge limits. Addressing the four-phased approach, the City is concerned with expanding its assets (infrastructure such as pipelines, tanks, and pump stations) and how it will achieve full lifecycle value of its existing assets.

E.4.1.2 Milliken

Milliken's 208 Boundary overlaps the City's LREGA and Milliken would need a lift station to serve this area. A portion of wastewater from Milliken's 208 boundary area is directed toward the City's Sheep Draw sewer system in the City of Greeley's wastewater planning. The City suggested Milliken revise their 208 boundary to match the City's LREGA boundary and provide a schedule for changes moving forward.

The initial feedback from the City's discussion with Milliken was that the area may be best served by Greeley due to limitations of the existing infrastructure and future wastewater plant needs and capacity limitations. However, Milliken staff needed to engage their City Management to further discuss. Their current plant is rated for 0.7 mgd with plans to expand to 0.95 mgd. They are also evaluating replacement of the existing lift station #5 with a 0.5 mgd plant but are in preliminary stages of assessment as there are other locations where a second treatment plant may be warranted depending on development. The existing sewer infrastructure has not been sized to serve this area and would require upsizing in addition to significant new infrastructure to serve this area.

Opportunity for Collaboration:

- Adjustment to area of overlap between the City's LREGA and Milliken's 208 boundary

E.4.1.3 Kersey

Kersey wants to maintain a natural buffer between the City and Kersey's service area by defining Kersey Road as the actual boundary rather than the South Platte River. Kersey's population growth will result in the need for additional treatment capacity or connection to the East Greeley lift station.

Opportunity for Collaboration:

- Additional service to western side of Kersey (connection to East Greeley LS or regional treatment plant)

E.4.1.4 Windsor

The IGA between the City and Windsor has a conflict in language on service for the Greeley Annexation Area indicated both entities will provide treatment to this area. Windsor has indicated they may not have treatment capacity to serve the Greeley Annexation area. The City can maintain the gravity sewer pipelines and keep the effluent water rights with Windsor treating

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the wastewater from the Annexation area. Windsor's current plant is rated for 2.8 mgd maximum month daily flow and they are current at approximately 60% of the rated capacity. They anticipate starting planning for expansion in 2023, at which point they will be at approximately 80%. The estimated 5 mgd future capacity was not intended to include development within Greeley being treated by Windsor. If Greeley were to send flows to Windsor it would need to be evaluated and the treatment plant capacity adjusted. Any flows from Greeley to Windsor are subject to the terms of the IGA.

Opportunity for Collaboration:

- Wastewater service to the Greeley Annexation Area (provided by Windsor)

E.4.1.5 Eaton

Eaton's WWTP is located on the east side of their service area, is at approximately 25% capacity (rated at 0.75 mgd) and can be expanded to approximately 1.75 mgd. Eaton's growth is projected to occur south and west of the town making gravity flow of wastewater to their plant difficult. Eaton has one plant operator for its water and wastewater treatment facilities, limiting ability to expand without additional staff. Eaton has submitted a boundary update to the county.

Eaton provided information for future development resulted in ADF of 9.86 mgd from the Eaton development area. Greeley and Eaton will evaluate in the future if the flow estimate is realistic and requirements for service to this area. The anticipated gravity sewer pipe size for this flow is conceptually estimated at 36" and would require a separate detailed evaluation including routing to the plant. These flow projections were not included in the master plan infrastructure analysis. A summary of the information provided by Eaton and resulting infrastructure sizing is show on **Figure E-3.**

Opportunity for Collaboration:

- Wastewater service to Eaton's growth area provided by the City

E.4.1.6 Evans

Evans has expressed interest in working with the City and Eaton to develop a regional solution to providing wastewater services and meet more stringent discharge regulations. Evans' single lift station has a maximum daily flow capacity of 2.07 mgd or 1.8 mgd when the T-Bone section of its lift station is not included. Their wastewater treatment plant is rated at 2.88 mgd but is currently operating at approximately 2.65 mgd with BOD loading at 80% of capacity. Their service area is experience high rates of infill.

The City's IGA with Evans states the Ashcroft subdivision will be served by the City once its constructs the Ashcroft LS. The Evans sewer system near LS15 (Auto Plaza) is at capacity and Evans is unlikely to accommodate additional wastewater flows projected by future population growth. LS15 will need to be relocated or replaced with expanded wastewater flow capacity.

Opportunity for Collaboration:

- Wastewater service in the area of LS15
- Regional treatment or capacity sharing

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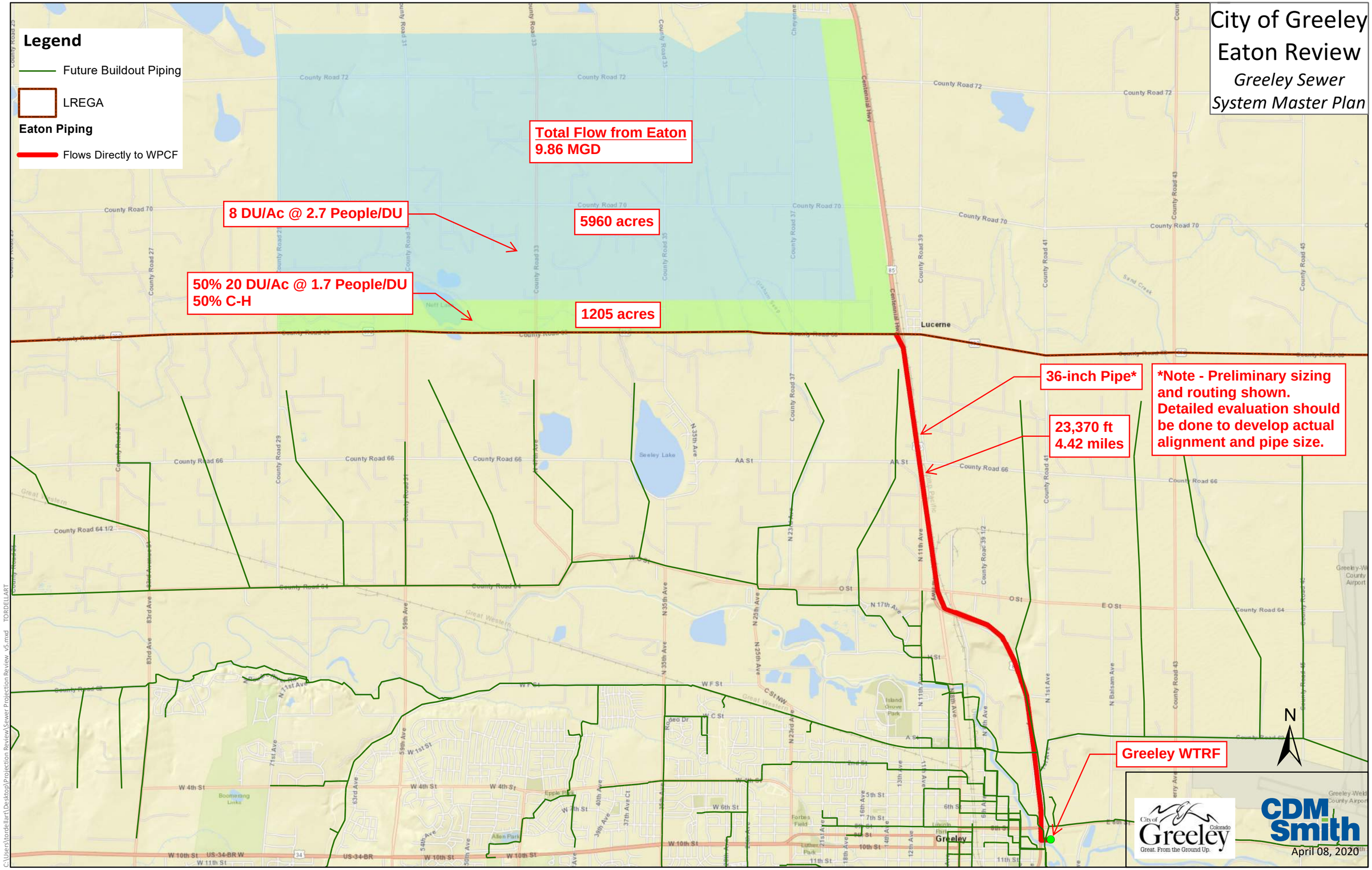

Figure E-3: Eaton Service to Greeley

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E.4.1.7 Johnstown

The City will coordinate with Johnstown separately from this stakeholder process. Johnstown's collection system and wastewater treatment plant are reported as inadequate for their current population growth, resulting in Johnstown planning a $50 million wastewater treatment improvement by 2025.

The City's discussion with Johnstown indicate Johnstown is open to serving areas of overlap depending on how the property was annexed. Johnstown has plans for expanding their Low Point Treatment Plant from 0.5 mgd to 1.5 mgd in 2021 with full build out of 2.5 mgd. The Low Point Plant is indicated to serve the area of overlap per Johnstown's 208 Boundary. There is no sewer infrastructure east of the Low Point Plant. Johnstown also noted that the Central Treatment Plant could serve the area of overlap and there are plans to expand the plant to 2.5 mgd in the 2025 time-frame. In either case it would require significant infrastructure including crossing barriers including the Big Thompson River and railroad crossings.

E.4.2 Regional Opportunities

The following collaboration opportunities were identified during a workshop that focused on identifying regional solutions including service area connections, emergency overflows, and wastewater treatment. The following opportunities for regional collaboration were discussed by the stakeholders.

Residuals disposal and/or land application

Stakeholders are facing additional challenges with management of residuals and final disposal and expressed interest in exploring regional solutions including a consolidated management facility. Stakeholders noted challenges such as the limited ability of some stakeholders to dewater residuals, varying management and class designations of biosolids between the stakeholders and concern over PFAS requirements. The stakeholders also noted potential overall cost savings and opportunities for energy recovery from a larger regional biosolids management approach.

Effluent temperature discharge compliance

Several stakeholders have effluent temperature compliance concerns during shoulder months and noted a regional approach to stream segment improvements may be of interest to the CDPHE. A regional approach would allow stakeholders to develop an overall stream management strategy instead of individualized discharge requirements.

Industrial pretreatment

Several stakeholders are (re)implementing industrial wastewater pre-treatment programs and expressed interest in sharing program requirements and implementation strategies/challenges. Stakeholders have noted the opportunity for shared staff enforcement and sampling of dischargers.

Laboratory analysis and testing resources

The City may consider expanding its testing laboratory to including testing for metals and whole effluent toxicity (WET). Several stakeholders are interested in either using the City's testing laboratory and/or developing joint testing programs with the City.

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Wastewater conveyance and treatment

Stakeholders have interest in regional wastewater treatment to serve as a secondary treatment facility with emphasis on locations north and/or west of the Poudre River. Stakeholders noted the areas south of the Platte River and challenges in providing service, suggesting a regional treatment plant or conveyance solution may be warranted.

Staffing and training

Several stakeholders expressed concerns regarding employment and staffing of their treatment facilities and would like to consider sharing local experienced plant operators and developing a regional plan to train or attract operators to the region. The City is working to develop a program for operator trainings at Aims Community College including internships and an evaluation intern process that can be used for hiring future plant operators. Red Rocks Community College and local high schools offer potential plant operator recruitment opportunities through potential regional job fairs. Regionally the stakeholders can work to develop higher level operators through training and experience at the treatment plants.

Stakeholders also noted opportunities to share training and expertise for staff through annual meetings, technical and regulations learning, and job specific training.

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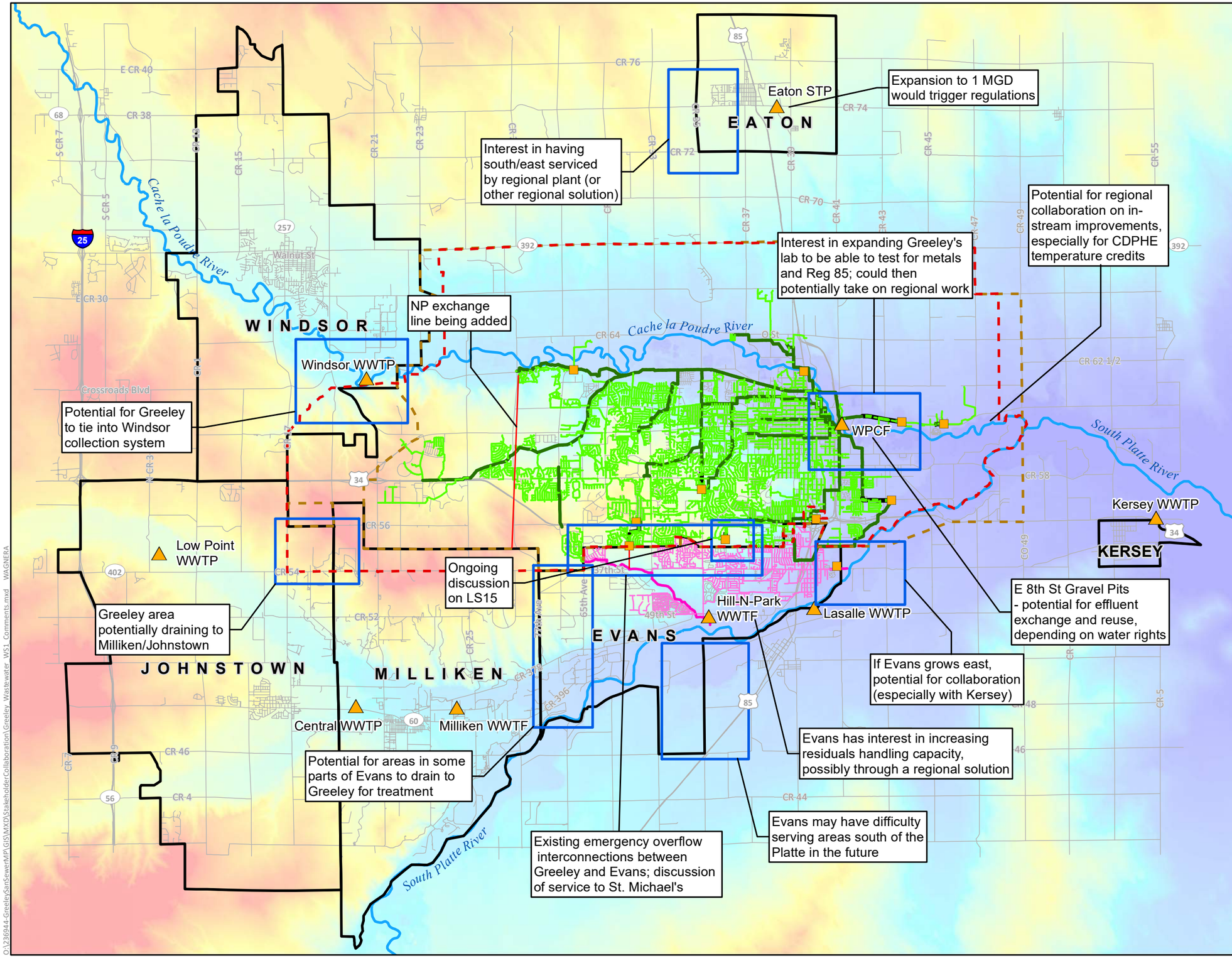
City of Greeley Regional Stakeholders - Wastewater

Greeley Sanitary Sewer System Master Plan



N

0 1 2 3
Miles

Legend

- WWTP
- Lift Station

Sewer Mains

- Collector Line
- Force Main
- Overflow Line
- Trunk Line
- Stakeholder Sewer Mains
- Greeley LREGA
- Greeley 208 Boundary (existing)
- Stakeholders 208 Boundary (existing)
- Notes/Potential Regional Collaboration
- River

Elevation

High : 5172 ft

Low : 4564 ft

City of Greeley Colorado Great. From the Ground Up.

CDM Smith

February 28, 2020

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Appendix F

Comprehensive Plan for Demand Projections

Markup Areas	Area	% of Total Area per Non-Residential Land Use Category				% of Total Area per Residential DU/Acre Category				Projected Population Increase	Projected Residential Flow	Projected Non-Residential Flow
	(acres)	C-L	C-H	I-L	(gpd)	1.0	2.5	4.0	20	(people)[1,2]	(gpd)	(gpd)
83rd Avenue/Highway 34	578		65%						35%	6,878	412,680	563,550
83rd Avenue/10th Street	650		15%					45%	40%	12,467	748,020	146,250
20th Street North	883		25%					50%	25%	12,980	778,800	331,125
Southeast Bluffs	123		15%					45%	40%	2,359	141,540	27,675
North of the River – East 1	1,969		10%		80%	10%				610	36,600	1,082,950
North of the River – East 2	5,708		20%		30%			35%	15%	53,884	3,233,040	2,568,600
North of the River – West 1	4,410		15%		10%	10%		50%	15%	51,200	3,072,000	1,212,750
North of the River – West 2	3,783		10%		20%	30%		30%	10%	30,453	1,827,180	945,750
East Greeley	1,292				30%	40%		30%		6,408	384,480	193,800
Southwest Greeley	2,860						100%			22,165	1,329,900	0
Interchange 34 West	3,719		20%		10%			50%	20%	48,347	2,900,820	1,301,650
									Total	**247,751**	**14,865,060**	**8,374,100**

[1] For 20 DU/acre, 1.7 people per DU was assumed. For 1-4 DU/acre, 3.1 people per DU was assumed.

[2] The estimated population increase of 247,751 people is assumed to occur by "buildout", which is estimated to be in approximately 2116.

Note:

- The following map shows the areas from Table F-1. Each area has been subdivided to vary the density similarly to the original comprehensive plan. The City directed CDM Smith to distribute the residential/nonresidential demand to each of the subdivided areas.
- Each subdivided area is shown in black outline with labels for the resulting projected growth.
- To enable comparison to future development, the resulting people/acre and nonresidential flow/acre has been shown.

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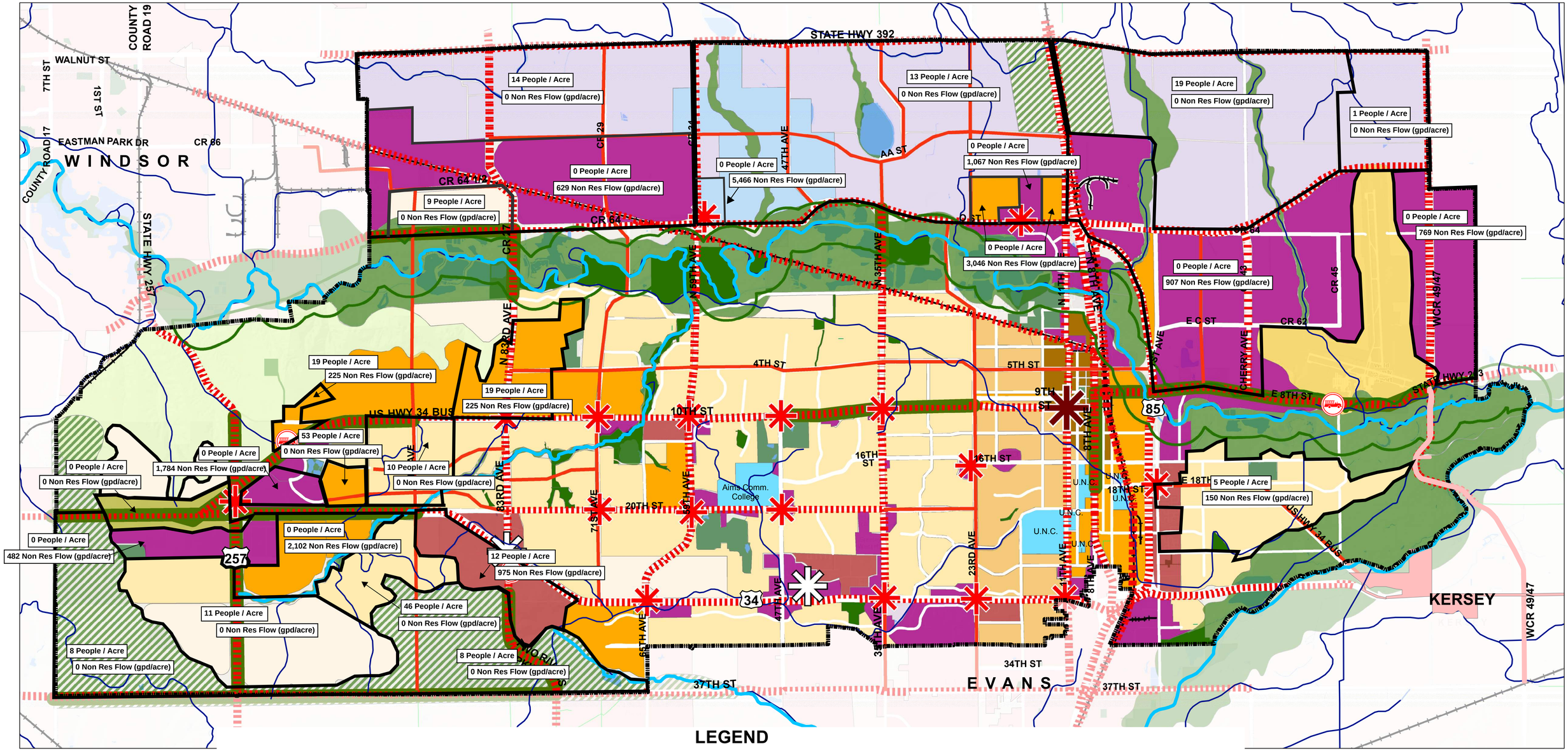
LAND USE GUIDANCE MAP



LEGEND

CENTERS

- Downtown Center
- Regional Center
- Neighborhood Center

CORRIDORS

- Multi-Modal Corridor
- Special Multi-Modal Corridor Landscaping
- Poudre River Greenway

SPECIAL RECOMENDATIONS

- Potential Fire Station Locations

AREAS

- Airport Area
- Higher Education Hubs
- Employment, Industrial, and Commercial Areas
- North Annexation Area
- Mixed Use High Intensity
- Urban Reserve

OPEN LANDS & NATURAL AREAS

- Bluffs
- Community Separator
- Entryway Character Corridor
- Riparian Land
- City Owned Natural Areas

Town of Kersey

- Town of Kersey

NEIGHBORHOODS

- Rural
- Suburban
- Legacy Urban
- Mixed Use
- Downtown

N

0 0.375 0.75 1.5 2.25 3 Miles

Date of Preparation 12/1/17

IMAGINE GREELEY

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Appendix G

Goals from Comprehensive Plan

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ECONOMIC HEALTH & DIVERSIFICATION (ED)

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal ED-1: Promote a healthy, progressive, and competitive local economy.			
IMP ED-1.1 Conduct a market analysis of the Greeley trade area to: – Determine which products and/or services are sought by consumers; – Identify segments of the Greeley market that are experiencing sales tax leakage to other communities; and – Analyze market or other local conditions to identify impediments to the attraction of desired goods and services to the area.	**Lead** Economic Development **Partners** Chamber of Commerce	Policies and Programs	Ongoing
IMP ED-1.2 Conduct "business retention visits" to facilitate communication and resource sharing in support of local business expansion.	**Lead** Economic Development **Partners** Chamber of Commerce SBDC Northern Colorado Economic Alliance Update Colorado Economic Development	Policies and Programs	Ongoing
IMP ED-1.3 Follow-up with new and expanding businesses to offer support and a personal contact for questions in the early stages of business development.	**Lead** Economic Development **Partners** Chamber of Commerce	Policies and Programs	Ongoing
IMP ED-1.4 Evaluate existing codes, ordinances, regulations, taxes and fees, and permit processes to identify opportunities to streamline these processes and reduce costs of doing business in Greeley, balancing these considerations with the City's fiscal needs and the health and welfare of residents.	**Lead** Economic Development **Partners** Community Development Finance	Regulatory Revision	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP ED-1.5 Develop informational guides for businesses and employers describing: – Available local resources; – Relevant municipal codes and regulations; – Incentive programs; – A checklist of things to consider when starting, relocating, and expanding a business in Greeley; and – A "Frequently Asked Question" guide for start-ups, expanding businesses, and businesses looking to relocate to Greeley.	**Lead** Economic Development **Partners** Community Development Communication & Engagement Chamber of Commerce SBDC Northern Colorado Economic Alliance Update Colorado Economic Development	Policies and Programs	Near-Term
IMP ED-1.6 Identify areas where the use of Enterprise Zones, Urban Renewal Areas, and other similar tools to encourage business use and development in established areas. Pursue the use or adoption of these tools as needed.	**Lead** Economic Development **Partners** Community Development Greeley Urban Renewal Authority	Policies and Programs	Near-Term
IMP ED-1.7 Evaluate needs for reinvestment in and improvements to public infrastructure in existing employment areas, commercial centers, and other retail areas and prioritize those which are most necessary for improving the economic vitality of these areas.	**Lead** Public Works **Partners** Economic Development Community Development	Public Investments	Long-Term
IMP ED-1.8 Develop a process and/or platform for making demographic, market, and related City information readily available to those seeking such information for use in the management and growth of their business.	**Lead** Economic Development **Partners** Community Development Information Technology Communication & Engagement	Policies and Programs	Long-Term
Goal ED-2: Promote desired economic sectors.			
IMP ED-2.1 Maintain an inventory of vacant commercial and industrial land within Greeley and its LREGA that is suitable to support development of desired industries.	**Lead** Community Development **Partners** Economic Development	Policies and Programs	Ongoing
IMP ED-2.2 Develop an economic development strategy for the City.	**Lead** Economic Development **Partners** Community Development Finance Public Works Chamber of Commerce Communication & Engagement	Plans	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP ED-2.3 Review, and modify as appropriate, the City's zoning code to ensure that zoning and development regulations applied to employment areas identified on the Land Use Guidance Map support desired uses and industries envisioned in those areas.	**Lead** Community Development **Partners** Planning Commission Economic Development Chamber of Commerce Public Works	Regulatory Revision	Near-Term
IMP ED-2.4 Finalize a scope of work and timeline for developing a coordinated economic development strategy. Once finished, work to develop the strategy. Ensure the strategy includes guidance on those elements identified in Objective EC-2.1.	**Lead** Economic Development **Partners** Finance City Manager's Office Community Development Chamber of Commerce SBDC Northern Colorado Economic Alliance Update Colorado Economic Development	Plans	Near-Term
IMP ED-2.5 Review, and revise as needed, existing economic development incentives and programs to ensure such efforts support and encouraged economic development in desired industries.	**Lead** Economic Development	Regulatory Revisions	Near-Term
IMP ED-2.6 Develop and disseminate marketing materials advertising Greeley's incentive programs, amenities, quality of life, and other aspects of the city/community that will help attract businesses in desired industries to Greeley.	**Lead** Economic Development **Partners** Communication & Engagement	Policies and Programs	Near-Term
IMP ED-2.7 Identify staff and resources needed to support the economic activities and programs identified in this Comprehensive Plan or a more detailed economic development strategy. Allocate resources as possible to address identified needs.	**Lead** Economic Development **Partners** City Manager's Office City Council Finance	Public Investments	Near-Term
Goal ED-3: Attract and maintain an employed, skilled, and adaptable workforce.			
IMP ED-3.1 Regularly review and report the City's performance in its service delivery by meeting with and/or surveying business consumers as to their customer satisfaction level. Use this review to identify areas for improvement.	**Lead** Economic Development **Partners** Finance Communication & Engagement Office	Policies and Programs	Ongoing

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP ED-3.2 Work with the school district, University of Northern Colorado, Aims Community College, and local businesses to identify and promote internship opportunities for students.	**Lead** City Manager's Office **Partners** All City Departments Chamber of Commerce	Policies and Programs	Near-Term
IMP ED-3.3 Develop and maintain an inventory of emerging employment needs and skills necessary to successfully perform such jobs in order to cultivate education and training programs for students and/or workers.	**Lead** Economic Development **Partners** Chamber of Commerce University of Northern Colorado Aims Community College School District	Policies and Programs	Long-Term
IMP ED-3.4 Promote employee association networks that foster interest, growth, and satisfaction related to business activities, such as with the Young Professionals group.	**Lead** Economic Development **Partners** Chamber of Commerce Communication & Engagement	Policies and Programs	Long-Term
IMP ED-3.5 Monitor community-wide employee workplace services and amenities, such as childcare, in order to proactively address gaps in facilities and/or services needed to attract and support a diversified work force.	**Lead** Economic Development	Policies and Programs	Long-Term
IMP ED-3.6 Support and recognize efforts by local business organizations to provide affordable and competitive employee benefit options.	**Lead** Economic Development **Partners** Communication & Engagement Chamber of Commerce	Policies and Programs	Long-Term
IMP ED-3.7 Develop and disseminate marketing materials advertising Greeley, its amenities, quality of life, and advantages compared to other Front Range communities to potential workers/residents.	**Lead** Economic Development **Partners** Communication & Engagement	Programs and Policies	Long-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal ED-4: Facilitate intergovernmental and public/private partnerships which foster successful economic development.			
IMP ED-4.1 Develop programs, informational materials, and other methods to support: – Special financing programs to increase access to capital; – Research and develop referral systems; – Training and support programs; – The availability of suitable business facilities and/or sites; – Development of appropriate initiatives and innovative programs; – Home occupations and/or – Provide business incubation support.	**Lead** Economic Development **Partners** Chamber of Commerce SBDC University of Norther Colorado Aims Community College Northern Colorado Economic Alliance Update Colorado Economic Development	Policies and Programs	Ongoing
IMP ED-4.2 Promote Greeley's quality local convention space to attract events and visitors.	**Lead** Economic Development **Partners** Chamber of Commerce Communication & Engagement University of Northern Colorado Aims Community College	Policies and Programs	Long-Term
IMP ED-4.3 Explore opportunities with local educational institutions to expand their roles in providing research, professional, and technical assistance to industrial and economic development projects, including programs which involve the implementation of technology transfer programs.	**Lead** Economic Development **Partners** Chamber of Commerce University of Northern Colorado Aims Community College	Policies and Programs	Long-Term

EDUCATION, HEALTH, AND HUMAN SERVICES (EH)

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal EH-1: Promote community excellence related to a fully-integrated health care system.			
IMP EH-1.1 Develop programs and promotions which provide basic safety and first-aid training, including CPR, first aid, life guard training and other related programs.	**Lead** Fire Department **Partners** Culture, Parks, and Recreation Police Department Communication & Engagement	Policies and Programs	Ongoing
IMP EH-1.2 Develop and disseminate promotional and marketing materials advertising Greeley's exceptional medical services, such as those provided by North Colorado Medical Center and its affiliated service providers as a method for attracting top health care professionals to Greeley.	**Lead** Communication & Engagement **Partners** Economic Development	Policies and Programs	Long-Term
IMP EH-1.3 Evaluate the City's zoning code and map to identify any barriers to the development of a full continuum of health care services, clinics, and facilities ranging from neighborhood clinics, emergency response and urgent care facilities to fully-equipped and staffed hospital care. Also consider zoning changes to encourage the development of health care service facilities in areas where gaps in the continuum of service exist.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Long-Term
Goal EH-2: Integrate healthy living into community planning and development.			
IMP EH-2.1 Identify and address safety issues within neighborhoods that are perceived by residents as a barrier to active lifestyles, such as sidewalk gaps, busy street intersections, or narrow sidewalks.	**Lead** Neighborhood Resource Office **Partners** Culture, Parks, and Recreation Community Development Public Works Communication & Engagement	Public Investments	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP EH-2.2 Evaluate the feasibility of providing healthy food and drink choices through vendors and vending machines in City facilities.	**Lead** Culture, Parks, and Recreation	Policies and Programs	Near-Term
IMP EH-2.3 Develop a marketing/ informational campaign to encourage greater participation in the City's employee wellness program.	**Lead** Human Resources **Partners** Culture, Parks, and Recreation Communication & Engagement	Policies and Programs	Near-Term
IMP EH-2.4 Encourage development proposals and site plans to include considerations for supporting healthy living and providing access to nearby services, particularly food retailers and health and human service providers, for a range of modes.	**Lead** Community Development **Partners** Planning Commission	Policies and Programs	Near-Term
IMP EH-2.5 Identify and address gaps in transportation systems and services in order to effectively link residents with community recreational facilities and essential health services.	**Lead** Community Development **Partners** Public Works Greeley-Evans Transit	Public Investments	Long-Term
IMP EH-2.6 Explore the feasibility of, and opportunities for integrating community gardens and/or food and nut trees into parks, neighborhoods, or other locations where irrigation can be provided using existing facilities, and formal maintenance agreements can be established, such as with a homeowners association or neighborhood organization.	**Lead** Neighborhood Resources Office **Partners** Public Works Sewer and Water Community Development	Public Investments	Long-Term
Goal EH-3: Ensure that residents are aware of and have access to efficient and effective health and human services.			
IMP EH-3.1 Assess special population and service needs and opportunities to coordinate response through the City's Neighborhood Building Blocks program.	**Lead** Neighborhood Resource Office **Partners** Culture, Parks, and Recreation	Policies and Programs	Ongoing
IMP EH-3.2 Regularly convene meetings of the Urgent Responders Coalition of area emergency, human service and related service providers to share information, service challenges and strategies to optimize service response and encourage self-sufficiency of community members.	**Lead** City Manager's Office **Partners** Neighborhood Resource Office	Policies and Programs	Ongoing

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP EH-3.3 Create a single online platform where residents can easily access information on all of City services and programs.	**Lead** City Manager's Office **Partners** All Departments	Policies and Programs	Near-Term
IMP EH-3.4 Regularly update the City's contact and program information on directory resources, such as the United Way 211 Information and Referral Line, to facilitate the effective referral of service request questions to appropriate City departments. Ensure such information is readily available, particularly on the City's website.	**Lead** Neighborhood Resource Office **Partners** Communication & Engagement Information Technology	Policies and Programs	Near-Term
IMP EH-3.5 Explore the feasibility of establishing a 311 line to provide ready access to residents needing to access government services.	**Lead** City Manager's Office **Partners** Communication & Engagement	Policies and Programs	Near-Term
IMP EH-3.6 Promote resident involvement in the City's "Neighbor Labor" program which works with United Way to match volunteers with special needs residents to address property care issues that may limit quality of life and impact neighborhood well-being.	**Lead** Neighborhood Resource Office **Partners** Communication & Engagement	Policies and Programs	Long-Term
IMP EH-3.7 Develop a survey or other feedback mechanism to allow customers or other participants in health and human service-related programs managed or funded by the City of Greeley to provide input on the service and/or provide recommendations for improvements.	**Lead** Neighborhood Resource Office **Partners** Communication & Engagement	Policies and Programs	Long-Term
IMP EH-3.8 Develop a set of performance measures or metrics that allows the City to gauge the performance and results of health and human service programs managed or funded by the City.	**Lead** Neighborhood Resource Office **Partners** Communication & Engagement	Policies and Programs	Long-Term
Goal EH-4: Support and collaborate with the city's school districts.			
IMP EH-4.1 Review and provide comments on new academic facilities being developed as they relate to site design, architectural elements and related improvements in order to complement neighborhood features.	**Lead** Community Development **Partners** Culture, Parks, and Recreation	Policies and Programs	Ongoing

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP EH-4.2 Assess the feasibility of adopting school site dedication requirements as part of subdivision requests.	**Lead** Community Development **Partners** City Manager's Office Culture, Parks, and Recreatio	Regulatory Revision	Near-Term
IMP EH-4.3 Explore the feasibility of creating a land dedication or 'cash-in-lieu' fee to support land acquisition for school sites commensurate with new residential growth. Such a fee should be universally applied within all school districts serving Greeley residents.	**Lead** Community Development **Partners** City Manager's Office Finance	Policies and Programs	Long-Term
Goal EH-5: Be an education center of excellence.			
IMP EH-5.1 Develop and promote a consolidated list or online calendar of educational programs, classes, and other offerings for persons of all ages and abilities.	**Lead** Culture, Parks, and Recreation **Partners** Communication & Engagement Information Technology	Policies and Programs	Ongoing
IMP EH-5.2 Develop intergovernmental agreements with area educational institutions which define a coordinated approach to such matters as school location and construction, facility maintenance and joint use objectives.	**Lead** City Manager's Office **Partners** Culture, Parks, and Recreation Community Development	Policies and Programs	Near-Term
IMP EH-5.3 Research and promote the expanded use of communication and creative technologies for off-site educational learning and community information access.	**Lead** Information Technology **Partners** Communication & Engagement Culture, Parks, and Recreation	Policies and Programs	Long-Term
IMP EH-5.4 Stimulate opportunities for access to educational resources for all age groups, ranging from early childhood development programs to "Elder-garden" settings.	**Lead** Culture, Parks, and Recreation	Policies and Programs	Long-Term

GROWTH & CITY FORM (GC)

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal GC-1: Manage growth effectively.			
IMP GC-1.1 Update the Community Indicators report at 5-year intervals as a means to monitor trends that have an impact on Greeley's quality of life. Work with community agencies and organizations to formulate a strategic response to correct the conditions leading to the negative trend.	**Lead** Community Development	Policies and Programs	Ongoing
IMP GC-1.2 Consider interim development opportunities within the North Annexation Area in the near-term, provided the uses and development configurations proposed will not preclude the viability of future development and/or transportation networks needed to serve adjacent areas.	**Lead** Community Development **Partners** Planning Commission	Policies and Programs	Ongoing
IMP GC-1.3 Develop land use tools to assist in the preservation of important natural features, farmland, community separators, and open space in targeted areas.	**Lead** Community Development **Partners** Culture, Parks, and Recreation Planning Commission	Policies and Programs	Near-Term
IMP GC-1.4 Amend the Development Code to formalize the method of establishing the APFA by: – Establishing a system that graduates the development fees due by the development, in addition to the infrastructure expansion, proportionate to its distance from the APFA; and – Developing a mechanism for subsequent developers who benefit from the new infrastructure to reimburse a pro-rata share of the cost of the new infrastructure if subsequent development occurs within ten years of its initial installation or expansion.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP GC-1.5 Develop a method the City can use to anticipate, monitor and respond to the cumulative fiscal impacts of new development as build-out occurs.	**Lead** Community Development **Partners** Finance	Policies and Programs	Near-Term
IMP GC-1.6 Conduct a sub-area plan process for urban reserve lands within Greeley's Long Range Expected Growth Area (LREGA), to engage property owners, the community, and other stakeholders in a discussion regarding future land uses and adequate public facilities, for these areas.	**Lead** Community Development **Partners** Planning Commission	Policies and Programs	Near-Term
IMP GC-1.7 Work with Windsor, Severance, Eaton, Kersey, and other regional partners to develop IGAs for urban reserve lands within Greeley's Long Range Expected Growth Area (LREGA), as shown on the Land Use Guidance Map.	**Lead** Community Development **Partners** City Manager's Office City Council Adjacent municipalities	Policies and Programs	Near-Term
IMP GC-1.8 Review and update, as appropriate, Development Code provisions associated with sand and gravel mining to assure that reasonable mitigation and accommodation of potential impacts to adjacent land uses, such as from transportation, environmental quality, and nuisance conditions, are provided.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Long-Term
Goal GC-2: Promote a balanced mix and distribution of land uses.			
IMP GC-2.1 Update the Development Code and/or amend the zoning map so that zoning districts that are consistent with the Land Use Guidance Map.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Near-Term
IMP GC-2.2 Develop and adopt a mixed-use zone--or amend existing zoning districts--to support a greater mix of uses in Greeley. Review Development Code standards to utilize parking standards to promote mixed-use developments with joint use and opportunity for parking space reduction.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Near-Term
Goal GC-3: Ensure new development, infrastructure investments, and public realm improvements enhance the character of the community.			
IMP GC-3.1 Update the City's Development Code to include additional design standards that will encourage more innovative and high-quality design that reflect contemporary, progressive and sustainable building design trends.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP GC-3.2 Update the City's design standards to require new development to offer unique physical elements or improvements that contribute to the area's character and identity including: – Distinct site elements or architecture; – Historic or cultural resources; – Amenities such as views, open space, water courses, varied topography, or connectivity to existing or new trails; or – A central gathering place for residents of the neighborhood or subdivision.	**Lead** Community Development **Partners** Planning Commission Historic Preservation Commission	Regulatory Revisions	Near-Term
IMP GC-3.3 Explore the feasibility of re-establishing the citizen Architectural Review Advisory Committee, which would acts as a technical and community resource to City staff and applicants in evaluating and trouble- shooting specific project design issues, as requested.	**Lead** Community Development **Partners** Planning Commission	Policies and Programs	Near-Term
IMP GC-3.4 Update the City's Sign Code to reflect contemporary design elements and construction options and promote the attractive appearance of commercial corridors through functional and appealing property and business identification that is well- integrated into other site improvements.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Long-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal GC-4: Prioritize infill and redevelopment			
IMP GC-4.1 Assess and amend as needed the Development Code and other City regulations related to infill development and redevelopment to protect the existing neighborhood areas. Regulations (or lack thereof) that address, among other issues: – Site design and building massings and forms that are compatible with or complimentary of the surrounding neighborhood; – Mitigation of any compatibility issues (such as parking, noise, hours of operation) that could arise from non-residential land uses/developments; – Transitions between higher-intensity development and lower-intensity development (particularly single-family neighborhoods); – The development of a diverse range of higher-density housing types, not just multi-family apartment buildings; – The development of accessory dwelling units; and – Protection, preservation, and adaptive re-use of historic buildings or other structures.	**Lead** Community Development **Partners** Planning Commission Historic Preservation Commission Public Works Greeley Urban Renewal Authority	Regulatory Revisions	Near-Term
IMP GC-4.2 Amend municipal, building, and fire codes to eliminate barriers which would prevent, or place unreasonable costs on property-owners looking to rehabilitate and/or re-use older structures.	**Lead** Community Development **Partners** Historic Preservation Commission Fire	Regulatory Revisions	Near-Term
IMP GC-4.3 Where the adoption of regulations are not possible, or not desired by the neighborhood, explore developing non-regulatory design guidelines, or other materials that provide guidance to developers on how their projects can best complement the existing qualities and characteristics of that neighborhood.	**Lead** Community Development **Partners** Planning Commission Historic Preservation Commission	Policies and Programs	Long-Term
IMP GC-4.4 Explore the feasibility of establishing a financial resource whereby existing buildings may be improved to comply with or meet the intent of building and fire code standards through low interest-rate loans or similar incentives.	**Lead** Community Development **Partners** Fire	Policies and Programs	Long-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal GC-5: Facilitate the rebirth of Downtown Greeley as a regional multi-use activity area while preserving and promoting the cultural aspects of the area.			
IMP GC-5.1 Explore expanding existing programs or establishing new programs which encourage the development of attainable housing, particularly "to own" housing, for Downtown workers, such as with the Urban Homesteader program.	**Lead** Neighborhood Resources Office **Partners** Community Development Downtown Development Authority Greeley Urban Renewal Authority	Policies and Programs	Near-Term
IMP GC-5.2 Update the menu of incentives available to Downtown landowners and provide information about such resources in broad formats and in a timely manner.	**Lead** Community Development **Partners** Downtown Development Authority Historic Preservation Commission	Policies and Programs	Long-Term
IMP GC-5.3 Explore regulatory amendments to the Model Traffic Code which would allow for multiple, alternative and special forms of transportation to be allowed in a defined Downtown area, such as Smart cars, horse drawn carriages, trolley, and other similar devices.	**Lead** Public Works **Partners** Community Development Downtown Development Authority	Regulatory Revisions	Long-Term
Goal GC-6: Maintain and enhance the character and inter-connectivity of Greeley's neighborhoods.			
IMP GC-6.1 Continue to work with the University of Northern Colorado and its affiliated off-campus student organizations (such as fraternities/sororities) to educate students on how to be a respectful tenant and maintain "good neighbor conduct" in order to ensure that residences occupied by students are well-maintained and compatible with surrounding properties.	**Lead** Neighborhood Resources Office **Partners** University of Northern Colorado	Policies and Programs	Ongoing

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP GC-6.2 Review, and update as needed, the Subdivision Regulations and Development Code to assure: – Aesthetics are well- integrated in public places, roadways, adjacent uses; – Natural land features or forms are well integrated into the overall design of the subdivision; – Inclusion of a range of housing types is encouraged; – The integration of non-residential uses are encouraged; – New subdivisions provide for a range of transportation options (such as bike and pedestrian pathways) within the development; and – Connections to adjacent neighborhoods and/or non-residential areas (such as neighborhood centers) are provided.	**Lead** Community Development **Partners** Planning Commission Public Works Culture, Parks, and Recreation	Regulatory Revisions	Near-Term
IMP GC-6.3 Work with the community to explore the possibilities of establishing a "character overlay district" to support neighborhood driven covenants or design characteristics to protect the distinctiveness of an area. Also explore the establishment of local historic districts in neighborhoods that contain a preponderance of historic resources and such a designation is supported by property owners.	**Lead** Community Development **Partners** Planning Commission Historic Preservation Commission	Policies and Programs	Near-Term
IMP GC-6.4 Review and update Development Code standards related to the redevelopment of land lease or manufactured home communities to promote homeownership and a stable neighborhood setting.	**Lead** Community Development **Partners** Neighborhood Resources Office	Regulatory Revisions	Long-Term
IMP GC-6.5 Review and update as appropriate the requirement for perimeter landscape treatment plans for new subdivisions in order to better link neighborhood via complimentary perimeter treatment schemes.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Long-Term
IMP GC-6.6 Prohibit the siting of residential uses immediately adjacent to medium- or high-intensity industrial uses and/or zoning districts without a Development Concept Master Plan or a neighborhood area master plan (within the Redevelopment District).	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Ongoing

HISTORIC & CULTURAL RESOURCES (HC)

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal HC-1: Preserve and promote local heritage.			
IMP HC-1.1 Implement, and regularly update, the Greeley Historic Preservation Plan.	**Lead** Historic Preservation Commission **Partners** Community Development	Plans	Ongoing
IMP HC-1.2 Periodically research and publicize other financial sources of support for historic preservation activities, including state, federal and private foundation sources.	**Lead** Community Development **Partners** Historic Preservation Commission Communication & Engagement	Policies and Programs	Ongoing
IMP HC-1.3 Catalogue and promote places in the community which have special significance to the development of the area, such as the Cache la Poudre River, the Union Pacific Railroad, irrigation ditches and improvements, and similar features which provide an important context of community identity. Seek grants and other resources to provide markers, plaques and other identification, as appropriate.	**Lead** Culture, Parks and Recreation **Partners** Historic Preservation Commission Poudre Heritage Alliance Visit Greeley	Policies and Programs	Near-Term
IMP HC-1.4 Identify and prioritize areas of the city that may contain historic resources that have yet to be surveyed. In addition, identify and prioritize areas or neighborhoods that need to be re-surveyed or have completed surveys updated.	**Lead** Community Development **Partners** Historic Preservation Commission	Policies and Programs	Near-Term
IMP HC-1.5 Produce materials which describe and illustrate elements associated with historic structures, architectural styles, the care or maintenance of historic structures, provide interpretive displays and exihibts, and other related topics.	**Lead** Community Development **Partners** Historic Preservation Commission Communication & Engagement Culture, Parks, and Recreation	Policies and Programs	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP HC-1.6 Explore technological opportunities to expose the public to historic preservation programs and resources.	**Lead** Community Development **Partners** Historic Preservation Commission Information Technology	Policies and Programs	Near-Term
IMP HC-1.7 Explore ways in which the City of Greeley can facilitate the availability of private loans at attractive rates and terms through local lenders for landowners seeking financial support in the renovation, rehabilitation, or restoration of an historic structure.	**Lead** Community Development **Partners** Historic Preservation Commission Culture, Parks, and Recreation Finance	Policies and Programs	Long-Term
Goal HC-2: Support and celebrate the rich diversity of human experience within the community.			
IMP HC-2.1 Continue to fund the Greeley Unexpected campaign as a means to promote the city's diversity and unique cultural offerings.	**Lead** City Manager's Office	Policies and Programs	Ongoing
IMP HC-2.2 Solicit citizen participation on City boards and commissions which represents a broad geographic, cultural, gender, age, and ability cross-section of the community.	**Lead** City Clerk's Office **Partners** All Boards and Commissions	Policies and Programs	Ongoing
IMP HC-2.3 Continue efforts to achieve a City workforce which is a reflection of the cultural and demographic population of the community.	**Lead** All City Departments	Policies and Programs	Ongoing
IMP HC-2.4 Continue support for the Community Mediation program and explore new programs, venues, or opportunities to support residents, businesses, and government work through differences and resolve conflicts in an amicable and mutually respectful way. Publicize existing and future programs to build awareness within the community.	**Lead** Neighborhood Resources Office **Partners** Human Relations Commission Communication & Engagement	Policies and Programs	Ongoing
IMP HC-2.5 Develop and expand resources, exhibits, and programs through the city's museums, libraries, and other public venues which educate residents in a thoughtful manner about the diverse cultures within the community.	**Lead** Culture, Parks and Recreation **Partners** High Plains Library District University of Northern Colorado Model Railroad Museum	Policies and Programs	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP HC-2.6 Explore new opportunities to increase the involvement of diverse groups of residents in community issues and City-sponsored events.	**Lead** Communication & Engagement **Partners** All City Departments Human Relations Commission	Policies and Programs	Near-Term
IMP HC-2.7 Explore venues, events, and ongoing programs to expand knowledge, understanding, and appreciation of differences between people in order to diminish stereotypes and reduce intolerance and disparities between various community populations.	**Lead** Culture, Parks and Recreation **Partners** Human Relations Commission Area Non-Profit Organizations Neighborhood Resources Office Communication & Engagement	Policies and Programs	Long-Term
Goal HC-3: Develop and promote art and culture experiences.			
IMP HC-3.1 Promote the City's One Percent for Art Program which incorporates artistic design and art works installation as component of its capital construction projects, thereby enriching the interest, quality and relevance of public improvements and the community areas in which they are located.	**Lead** Culture, Parks and Recreation **Partners** Greeley Art Commission Communication & Engagement	Policies and Programs	Ongoing
IMP HC-3.2 As the city grows, promote and expand local museum facilities and/or programming to provide a context for residents to understand those who preceded them in the development of the community, as well as to provide a mechanism to document key events, people and community features to help bring history alive for area residents and visitors.	**Lead** Culture, Parks and Recreation **Partners** Communication & Engagement	Public Investments	Ongoing
IMP HC-3.3 Retool the City's art program to expand community awareness, experience, and involvement through hands-on demonstrations and outreach by bringing artwork out into various parts of the community through the use of a "mobile gallery."	**Lead** Culture, Parks and Recreation **Partners** Greeley Art Commission Greeley Creative Arts District School Districts Aims Community College	Policies and Programs	Long-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP HC-3.4 Evaluate the City's Development Code to assess whether current regulations limit or create barriers to the creation of arts and culture venues or hosting of arts and culture events. Address any such barriers in order to expand access to arts and culture venues and events throughout the city.	**Lead** Community Development **Partners** Planning Commission Greeley Art Commission Greeley Creative Arts District	Regulatory Revisions	Long-Term
IMP HC-3.5 Explore locations in West Greeley for the establishment o f a commercial regional outdoor amphitheater.	**Lead** Culture, Parks, and Recreation **Partners** Community Development	Policies and Programs	Long-Term
IMP HC-3.6 Continue to promote music-focused events, such as the UNC Jazz Festival, the Blues Jam, and FridayFests	**Lead** Economic Development	Policies and Programs	Ongoing

HOUSING (HO)

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal HO-1: Improve access to housing for all income-levels, ages, and physical abilities.			
IMP HO-1.1 Conduct and maintain an inventory of public, deed-restricted, subsidized, Section 8 or other types of designated affordable housing units in Greeley. Include if the units are rental or ownership units, the size (including number of bedrooms and bathrooms), and the population/income range to which the unit is affordable. Monitor to understand how the supply of affordable housing in the city is changing over time.	**Lead** Greeley Urban Renewal Authority **Partners** Greeley-Weld Housing Authority Community Development	Policies and Programs	Near-Term
IMP HO-1.2 Conduct an inventory of City-owned properties and identify parcels that could be used to support the City's housing goals (e.g., for disposition to an affordable housing developer).	**Lead** Community Development **Partners** City Manager's Office	Policies and Programs	Near-Term
IMP HO-1.3 Following the development of a comprehensive housing strategy (see Objective HO-2.1), assess the need to increase staff capacity and/or resources to implement the strategy's recommended actions. Increase capacity as needed.	**Lead** Community Development **Partners** City Manager's Office	Public Investments	Long-Term
IMP HO-1.4 Explore public/private partnerships to encourage home ownership through services like first-time home buyer's assistance programs, and other home ownership incentive programs.	**Lead** Greeley Urban Renewal Authority **Partners** Neighborhood Resource Office	Policies and Programs	Long-Term
IMP HO-1.5 Provide new and prospective home buyers with information concerning property maintenance, budgeting, community resources and related areas to support a successful transition from renting to ownership.	**Lead** Greeley Urban Renewal Authority **Partners** Neighborhood Resource Office	Policies and Programs	Long-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal HO-2: Encourage a broad diversity of housing options.			
IMP HO-2.1 Monitor the local housing market in order to evaluate trends, identify gaps in types of housing or price-points, adjust housing-related programs and policies, and understand the effectiveness and impact of the City's housing strategy, once determined. Trends to be monitored should include: – The types of housing units built in the city each (including tenure and housing type); – Number of public, subsidized, or deed restricted (for purposes of affordable housing) housing units; – The composition (by tenure and housing type) of the city's housing stock; – The cost of housing, home sales prices and rents; – Vacancy rates; and – Area median income and the housing affordable to varying AMI levels (e.g., 80% AMI, 60% AMI, etc.).	**Lead** Community Development **Partners** Greeley Urban Renewal Area University of Northern Colorado Colorado Housing Division	Policies and Programs	Ongoing
IMP HO-2.2 Review and update, as appropriate, Development Code standards to update zoning districts or adopt new zoning districts that are consistent with the Land Use Guidance Map in order to allow for a greater diversity of housing options.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Near-Term
IMP HO-2.3 Develop and adopt an accessory dwelling unit (ADU) ordinance.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Near-Term
IMP HO-2.4 Explore modifications to existing programs or establishing new programs which provide information and resources to renters and landlords on topics such as maintenance and safety of rental properties, rights and responsibilities of tenants and landlords, evictions, and crime prevention.	**Lead** Neighborhood Resource Office **Partners** Community Development Greeley Urban Renewal Authority Greeley Police Department	Policies and Programs	Long-Term

INFRASTRUCTURE (IN)

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal IN-1: Ensure developed areas in Greeley are served by adequate public facilities and services.			
IMP IN-1.1 Annually review and update the City's Adequate Public Facilities Area (APFA) concurrent with annual growth and development projections to assist in the planning and funding of municipal infrastructure to accommodate growth. Prepare maps depicting the boundaries of existing and budgeted service areas for infrastructure included in the APFA requirements.	**Lead** Community Development **Partners** Planning Commission Public Works Police Fire Water and Sewer Culture, Parks, and Recreation	Policies and Programs	Ongoing
IMP IN-1.2 Continue to support timely and effective development in the Long Range Expected Growth Area as it relates to 208 Wastewater planning and treatment. Where possible and practical, look for opportunities to share and/or coordinate such capital improvements with other jurisdictions to efficiently use public resources.	**Lead** Water and Sewer **Partners** Community Development	Policies and Programs	Ongoing
IMP IN-1.3 Through the annual Population Growth and Projections and Capital Improvements Plan, identify the location for new fire stations, parks and other public facilities commensurate with the City's expected growth.	**Lead** Community Development **Partners** Culture, Parks, and Recreation Police Department Fire Department	Policies and Programs	Ongoing
IMP IN-1.4 Complete and implement a basin-wide study that addresses drainage improvements through larger, shared, facilities which could also achieve an attractive, functional community or regional park use.	**Lead** Public Works **Partners** Culture, Parks, and Recreation	Plans	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP IN-1.5 Evaluate existing capacity within established areas of the city to understand where investments in expanding infrastructure will be needed in order to support the type and/or intensity of development envisioned in the Land Use Guidance Map	**Lead** Water and Sewer **Partners** Public Works Culture, Parks, and Recreation Community Development	Policies and Programs	Near-Term
IMP IN-1.6 Update existing functional master plans for infrastructure and services as needed to account for changes in land uses and intensities that result from the adoption of this Comprehensive Plan and completion of implementation actions.	**Lead** All City Departments	Policies and Programs	Near-Term
IMP IN-1.7 Develop functional master plans detailing the maintenance, operation, and expansion of infrastructure and public facilities where such documents do not currently exist.	**Lead** All City Departments	Plans	Near-Term
IMP IN-1.8 Consider the extension of water lines to serve larger groups of users and along primary roadways to provide non-potable water to landscaped medians and parkways.	**Lead** Water and Sewer **Partners** Culture, Parks, and Recreation Community Development	Public Investments	Long-Term
Goal IN-2: Ensure the design, construction, and appearance of City infrastructure and facilities contributes to the character of the community.			
IMP IN-2.1 Evaluate current best practices in designing, developing, and constructing green infrastructure and incorporate appropriate practices into the City's approach to stormwater management.	**Lead** Public Works **Partners** Culture, Parks, and Recreation Community Development	Policies and Programs	Near-Term
IMP IN-2.2 Evaluate, and update as needed, existing design guidelines for infrastructure and public facilities to ensure aesthetics and considerations for the visual or quality of life impacts on surrounding neighborhoods are considered.	**Lead** Public Works **Partners** Water and Sewer Culture, Parks and Recreation Community Development	Regulatory Revisions	Long-Term

NATURAL RESOURCES & OPEN LANDS (NR)

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal NR-1: Protect, conserve, maintain, and improve the quality and quantity of water available to Greeley.			
IMP NR-1.1 Develop and maintain incentive programs which induce water conservation installations and practices, including irrigation systems.	**Lead** Water and Sewer **Partners** City Manager's Office Finance	Policies and Programs	Ongoing
IMP NR-1.2 Develop and maintain a water rate structure that provides incentives for the efficient use of water and reflects actual costs for service.	**Lead** Water and Sewer **Partners** Finance	Policies and Programs	Ongoing
IMP NR-1.3 Monitor and comment on development proposals, land uses, or other activities within the Cache la Poudre, Big Thompson, or Upper Colorado watersheds which may impact or threaten the quality of water obtained by Greeley from these sources. Include those proposals outside of the City of Greeley.	**Lead** Community Development **Partners** Water and Sewer	Policies and Programs	Ongoing
IMP NR-1.4 Audit water use associated with City facilities and review options to convert to xeric landscape treatments or strategically redesign sites for water conservation.	**Lead** Water and Sewer **Partners** Public Works Culture, Parks and Recreation	Policies and Programs	Near-Term
IMP NR-1.5 Develop incentives to encourage use of non-potable water in landscape irrigation and other appropriate applications.	**Lead** Water and Sewer **Partners** Community Development Finance	Policies and Programs	Near-Term
IMP NR-1.6 Implement and periodically update the City's *Water Master Plan* to ensure that the City's future needs for raw water are estimated and planned for.	**Lead** Water and Sewer	Plans	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP NR-1.7 Review Development Code standards, and updated as needed, to assure regulations encourage the sensitive, effective and desirable incorporation of water and irrigation elements into the design of the site in such a way as to protect water quality, promote conservation and efficiency, and create more natural and appealing development design and function.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Long-Term
Goal NR-2: Manage emissions, effluents, waste, and other sources of pollution that impact our quality of life and natural environment.			
IMP NR-2.1 Identify and employ methods to minimize and mitigate noise impacts generated from existing and planned traffic corridors, transit operations, and other capital improvements.	**Lead** Public Works **Partners** Community Development CDOT North Front Range MPO Weld County	Policies and Programs	Ongoing
IMP NR-2.2 Minimize the exposure to excessive and disturbing noise through the enforcement of daytime and nighttime noise ordinances, as well as through assertive traffic enforcement actions.	**Lead** Community Development **Partners** Police Department	Policies and Programs	Near-Term
IMP NR-2.3 Update, as appropriate, Development Code standards to limit impacts caused by errant light on adjacent properties and rights-of-way (such as requirements for downward directed lighting), and create standard illumination levels for various types of development.	**Lead** Community Development **Partners** Planning Commission Public Works	Regulatory Revisions	Near-Term
IMP NR-2.4 Consider and provide comment on land use applications which may generate ground and surface water pollution from point and non-point sources, such as from industrial or manufacturing uses, practices associated with agriculture, and landscape maintenance and seasonal roadway treatments (e.g., pest control, fertilizers, de-icing applications). Develop appropriate management and mitigation strategies or requirements to address areas of concern.	**Lead** Community Development **Partners** Planning Commission Public Works Culture, Parks and Recreation	Policies and Programs	Near-Term
IMP NR-2.5 Explore the feasibility of adopting local design standards for future construction and major redevelopment projects to reduce impervious surfaces and the heat emitted from the completed development.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP NR-2.6 Evaluate Low-Impact Development techniques and best practices to determine which are most appropriate to Greeley, its climate, and soils. Develop informational materials and guidelines for LID practices and features, and consider incorporating some or all into the Development Code.	**Lead** Community Development **Partners** Public Works Water and Sewer Culture, Parks and Recreation	Policies and Programs	Near-Term
IMP NR-2.7 Work with community partners to assess the effects of household hazards in the form of lead-based paint, radon, asbestos, carbon monoxide, mold, and other potential indoor hazards; and support continued efforts to educate residents on the identification and management of such household hazards.	**Lead** Community Development **Partners** Weld County Department of Public Health and Environment Communication & Engagement	Policies and Programs	Near-Term
IMP NR-2.8 Evaluate and implement best practices for mitigating the impacts of air pollution generated from road sanding and other snow/ice treatments, wood burning fireplaces and stoves, and agricultural and ditch burning practices.	**Lead** Community Development **Partners** Public Works	Policies and Programs	Long-Term
IMP NR-2.9 Identify and encourage crop management practices that limit air quality impacts.	**Lead** Community Development **Partners** Farm Bureau Colorado State University Extension	Policies and Programs	Long-Term
IMP NR-2.10 Monitor traffic-related noise levels throughout the community to establish baseline standards and evaluate noise 'hot spots' to ascertain mitigation or management alternatives to address noise pollution from transportation activity.	**Lead** Public Works **Partners** Community Development Neighborhood Resources Office	Policies and Programs	Long-Term
Goal NR-3: Demonstrate stewardship of the environment.			
IMP NR-3.1 Work with neighborhoods, community facilities, and institutions to define the character of neighborhoods by the types and locations of trees and major vegetation in order to provide guidance and incentives for replacing in-kind when such trees and vegetation must be removed.	**Lead** Community Development **Partners** Culture, Parks and Recreation	Policies and Programs	Long-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP NR-3.2 Develop promotional materials to build awareness of the City's Backyard and Natural Areas Certification Program.	**Lead** Culture, Parks, and Recreation **Partners** Community Development Communication & Engagement	Policies and Programs	Ongoing
IMP NR-3.3 Provide on-going education to the public, area plant nurseries, and landscape businesses about noxious weeds, their threat to local habitats and wildlife, and regulatory provisions and fines related to the presence of such weeds on property.	**Lead** Culture, Parks, and Recreation **Partners** Community Development Communication & Engagement	Policies and Programs	Ongoing
IMP NR-3.4 Periodically review and revise the location and extent of wetland resources to ensure accuracy in the identification and preservation of these natural resources.	**Lead** Culture, Parks and Recreation **Partners** Community Development	Policies and Programs	Ongoing
IMP NR-3.5 Develop intergovernmental agreements or similar arrangements with other jurisdictions and conservation organizations to preserve open space areas, either through acquisition, conservation easements, or other approach.	**Lead** Culture, Parks and Recreation **Partners** Community Development Town of Windsor City of Evans Colorado Division of Parks and Wildlife Colorado Open Lands Trust for Public Lands	Policies and Programs	Near-Term
IMP NR-3.6 Develop minimum standards for acceptance of land for natural areas, public open space, greenways, or parks. Consider a requirement for establishment of native vegetation for such areas.	**Lead** Community Development **Partners** Culture, Parks and Recreation Planning Commission Parks & Recreation Advisory Board	Regulatory Revisions	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP NR-3.7 Establish a multi-departmental Open Space Team, including representation by companion citizen boards and community at large members to provide comprehensive interface and coordinated attention to oversee open space planning and management.	**Lead** Culture, Parks and Recreation **Partners** Community Development Public Works City Manager's Office Parks & Recreation Advisory Board Planning Commission	Policies and Programs	Near-Term
IMP NR-3.8 Identify and secure a range of funding sources and other financial mechanisms that will enable the implementation of the Open Lands and Natural Areas program and community separator concept in a way that balances individual property interests while securing important visual and natural areas for public enjoyment and/or protection of habitat and other environmentally sensitive areas.	**Lead** Culture, Parks and Recreation **Partners** City Manager's Office Finance Community Development	Policies and Programs	Near-Term
IMP NR-3.9 Develop intergovernmental agreements with Weld County to assure that the manner of mineral extraction and reclamation is consistent with City standards within its Long Range Expected Growth Area. Such an agreement should address the provision of buffer areas from existing development and sensitive natural areas.	**Lead** Community Development **Partners** Weld County	Policies and Programs	Near-Term
IMP NR-3.10 Develop and implement management plans for all open lands or natural areas in the city. Management plans should focus primarily on sustaining and enhancing the natural and ecological functions of the area, but should seek opportunities to promote and support low-impact recreation opportunities when possible.	**Lead** Culture, Parks and Recreation **Partners** Community Development	Plans	Near-Term
IMP NR-3.11 Work with the property owner early in the aggregate mining land use permitting process to establish expectations for reclamation of the site upon completion. Incorporate these standards into the initial land use permitting process.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Long-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP NR-3.12 Review and revise as appropriate, local regulations related to the extraction of subsurface aggregate material to create mitigation requirements to protect the natural environment, surrounding neighborhoods and properties, and provide for the review of reclamation plans.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Long-Term
IMP NR-3.13 Undertake a study of the Poudre River sand and gravel mining corridor to establish a comprehensive design scheme for this important reclaimed mining area and identify means by which to ensure its accomplishment.	**Lead** Culture, Parks and Recreation **Partners** Community Development Water and Sewer	Plans	Long-Term
IMP NR-3.14 Review various community master plans including the *Parks, Trails, and Open Lands Master Plan, Poudre River Trail Master Plan*, and the *Comprehensive Drainage Master Plan* to ascertain areas to develop a prioritized list of parcels that could be protected as open lands. Higher priority should be given to parcels or areas that help implement or advance the greatest number of plans.	**Lead** Community Development **Partners** Culture, Parks and Recreation Water and Sewer Planning Commission	Policies and Programs	Long-Term
IMP NR-3.15 Evaluate the feasibility of establishing a program to aid in the protection, enhancement or development of wetland areas in order to restore natural habitats, improve water quality, or provide flood protection. Consider the merits of the development of a "wetlands bank" as part of this evaluation in order to provide additional options for mitigating wetland destruction (when permitted).	**Lead** Culture, Parks and Recreation **Partners** Community Development	Policies and Programs	Long-Term
Goal NR-4: Use resources efficiently and sustainably.			
IMP NR-4.1 Provide the public and the building community with information about the short- and long-term return on investment (monetarily and environmentally) associated with the use of energy-wise products, water-conserving products, and other green building practices.	**Lead** Community Development **Partners** Communication & Engagement	Policies and Programs	Near-Term
IMP NR-4.2 Evaluate the feasibility of standardizing the use of energy-efficient lights, such as LEDs, in City facilities, street and other outdoor lights maintained by the City, and in other municipal applications in new facilities or devices, or through upgrades to existing facilities and devices.	**Lead** Public Works **Partners** Culture, Parks, and Recreation City Manager's Office	Policies and Programs	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP NR-4.3 Periodically review and consider adoption of the most current edition of the International Energy Conservation Code.	**Lead** Community Development **Partners** Public Works Water and Sewer	Regulatory Revisions	Near-Term
IMP NR-4.4 Periodically update the Greeley *Natural Resources and Wildlife Master Plan* to keep it relevant and up-to-date in order to address emerging issues and incorporate best management practices into the Plan.	**Lead** Community Development **Partners** Culture, Parks, and Recreation Colorado Division of Parks and Wildlife	Plans	Near-Term
IMP NR-4.5 Encourage agencies which develop housing for lower income residents to maximize energy efficient installations to help reduce housing costs as it relates to energy consumption.	**Lead** Community Development **Partners** Greeley-Weld Housing Authority	Policies and Programs	Long-Term
IMP NR-4.6 Consider requiring all new or renovated City buildings and facilities to meet green building standards, such as LEED, Energy Star, or the International Green Construction Code. In addition, evaluate and consider adoption of a green building program and/or develop incentives to encourage the incorporation of green building techniques and practices into private development.	**Lead** Public Works **Partners** Community Development	Policies and Programs	Long-Term
Goal NR-5: Engage all members of the community in the process of supporting the stewardship of our natural and built environments.			
IMP NR-5.1 Prepare an annual report to the community that provides an inventory of environmental resources, their use, considerations, and emerging stewardship accomplishments, needs, and opportunities.	**Lead** Community Development **Partners** Culture, Parks and Recreation Communication & Engagement	Policies and Programs	Ongoing
IMP NR-5.2 Catalogue the trees and plantings which carry such significance and share such information with land owners and the public to enhance the protection and appreciation of such natural elements.	**Lead** Culture, Parks and Recreation **Partners** Community Development Historic Preservation Commission	Policies and Programs	Ongoing

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP NR-5.3 Continue tree planting and replacement incentive programs accompanied by educational materials to support a successful establishment of the new installations.	**Lead** Culture, Parks, and Recreation **Partners** Community Development Communication & Engagement	Policies and Programs	Near-Term
IMP NR-5.4 Explore and develop programs which cultivate citizen stewardship and responsibility for the care and protection of special natural areas in the community, such as an Adopt-a-Trail program..	**Lead** Culture, Parks, and Recreation **Partners** Community Development Communication & Engagement	Policies and Programs	Long-Term

PARKS & RECREATION (PR)

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal PR-1: Develop and maintain an inter-connected system of parks, trails, and recreational facilities.			
IMP PR-1.1 Periodically review and update the functional organization structure of the Parks Division set forth in the *PTOL Master Plan*, and validate recommended staffing levels.	**Lead** Culture, Parks and Recreation **Partners** City Manager's Office Finance	Policies and Programs	Ongoing
IMP PR-1.2 Periodically survey the city's residents to gauge whether current park amenities, recreational facilities, and recreation programing meet their needs. Adjust amenities, facilities, and programing as needed to address gaps or shifts in residents' preferences.	**Lead** Culture, Parks and Recreation **Partners** Parks and Recreation Advisory Board Communication & Engagement	Policies and Programs	Ongoing
IMP PR-1.3 Create a Recreation Facility Master Plan to address the opportunities and needs for indoor recreation.	**Lead** Culture, Parks and Recreation **Partners** Parks and Recreation Advisory Board	Plans	Near-Term
IMP PR-1.4 Develop outreach and marketing materials advertising Greeley's parks, trails, recreational facilities, and programs targeted to active seniors, minority populations, and persons with disabilities.	**Lead** Culture, Parks and Recreation **Partners** Parks and Recreation Advisory Board Communication & Engagement	Policies and Programs	Near-Term
IMP PR-1.5 Review City-owned parcels and explore opportunities to use such parcels for public recreation, as appropriate. Parcels considered should include public rights-of-way, streets, utility easements, and stormwater retention sites.	**Lead** Culture, Parks and Recreation **Partners** Community Development Public Works Water and Sewer City Manager's Office	Policies and Programs	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP PR-1.6 Review subdivision requirements and the Development Code to ensure that new development is required to provide quality streetscape improvements and connections to parks and trails.	**Lead** Community Development **Partners** Culture, Parks and Recreation Public Works Planning Commission	Regulatory Revisions	Near-Term
IMP PR-1.7 Identify opportunities to co-locate or develop parks through reviewing development plans of other entities, such as University of Northern Colorado or the school district.	**Lead** Culture, Parks and Recreation **Partners** Community Development University of Northern Colorado Aims Community College School Districts Parks and Recreation Advisory Board	Policies and Programs	Long-Term
IMP PR-1.8 Develop a plan to implement the vision for the Cache la Poudre set forth in the *Comprehensive Cache la Poudre Greenway Guide – Greeley-Windsor Reach*.	**Lead** Culture, Parks and Recreation **Partners** Community Development	Plans	Long-Term
Goal PR-2: Ensure the City's system of parks, trails, and recreational facilities align with and support other community goals.			
IMP PR-2.1 Evaluate the feasibility of providing non-potable water for irrigation of parks.	**Lead** Water and Sewer **Partners** Culture, Parks and Recreation	Policies and Programs	Near-Term
IMP PR-2.2 Assess existing parks, recreation areas, trails, and open lands for opportunities to incorporate interpretive elements which provide educational information on the environment, history, or other notable aspects of the site.	**Lead** Culture, Parks and Recreation **Partners** Parks and Recreation Advisory Board Historic Preservation Commission	Policies and Programs	Long-Term

PUBLIC SAFETY (PS)

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal PS-1: Minimize loss of life and property from hazards			
IMP PS-1.1 Provide regular education and training to citizens and businesses to enable educated lay parties to initiate appropriate emergency and medical response until professional response is on scene.	**Lead** Police Department **Partners** Fire Department Communication & Engagement	Policies and Programs	Ongoing
IMP PS-1.2 Regularly and proactively update floodplain data and, as necessary, modify designated boundaries and classifications to minimize potential for property damage.	**Lead** Community Development	Policies and Programs	Ongoing
IMP PS-1.3 Publish and distribute an annual Emergency Response Community Guide and expand current home and safety guides to educate residents and businesses on the emergency protocol in the event of an area emergency.	**Lead** Police Department **Partners** Fire Department Communication & Engagement	Policies and Programs	Ongoing
IMP PS-1.4 Evaluate the impacts of prohibiting or severely limiting new development in flood hazard areas and consider the possibility of dedicating floodplains as a wetlands "bank" to mitigate loss of wetlands due to development.	**Lead** Community Development **Partners** Public Works Culture, Parks, and Recreation Planning Commission	Regulatory Revisions	Near-Term
IMP PS-1.5 Evaluate the feasibility of participating in the Federal Emergency Management Administration's (FEMA) Community Rating System in order to reduce National Flood Insurance Program premiums.	**Lead** Community Development **Partners** City Manager's Office	Policies and Programs	Near-Term
IMP PS-1.6 Review, and update as needed, existing hazard-related regulations within the Development Code, such as the Hillside Development Standards and the Floodplain Overlay District to ensure these incorporate best practices that are appropriate to Greeley's situation and risk of hazards.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP PS-1.7 Develop a Community Wildfire Protection Plan.	**Lead** Fire Department **Partners** Community Development Culture, Parks, and Recreation Weld County Emergency Services	Plans	Near-Term
Goal PS-2: Maintain high-quality public safety and emergency response services.			
IMP PS-2.1 Train and maintain the City's workforce emergency preparedness level through accepted standards such as the National Incident Management System (NIMS) and practice preparedness on a regular basis to maximize response effectiveness.	**Lead** Fire Department **Partners** Police Department	Policies and Programs	Ongoing
IMP PS-2.2 Regularly evaluate staffing levels within the Greeley Fire Department and Police Department to ensure adequate staff levels needed to ensure public safety, particularly as Greeley's population grows.	**Lead** City Manager's Office **Partners** Police Department Fire Department	Public Investments	Ongoing
IMP PS-2.3 Maintain the level of training and preparedness as recommended by the federal Department of Homeland Security (DHS) to provide community safety at levels deemed to be "best practices" and to qualify the City to access to emergency preparedness and response funding grants and services.	**Lead** Fire Department **Partners** Police Department	Policies and Programs	Ongoing
IMP PS-2.4 Continue to convene informal service provider networks, such as the Urgent Responders Cooperative, to complement coordination of communication related to common community response needs.	**Lead** Fire Department	Policies and Programs	Ongoing
IMP PS-2.5 Develop a continuity of government plan or protocol in order to maintain the basic services required by residents to be available in times of emergency.	**Lead** City Manager's Office **Partners** All City Departments	Plans	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal PS-3: Develop and maintain a safe, aesthetically pleasing, and livable community.			
IMP PS-3.1 Provide active code enforcement to limit the negative impacts to neighborhoods from "broken window" conditions (e.g. weeds, trash, inoperable vehicles, general property neglect) with greater attention and penalties to properties with chronic neglect and code violations.	**Lead** Community Development **Partners** Police Department Culture, Parks, and Recreation	Policies and Programs	Ongoing
IMP PS-3.2 Continue educational and rewards programs that encourage property owners, property managers, and tenants to provide a high level of maintenance and care for their property.	**Lead** Neighborhood Resource Office **Partners** Community Development	Policies and Programs	Long-Term
IMP PS-3.3 Explore the feasibility of adopting minimum standards for the condition of rental housing properties.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Long-Term
IMP PS-3.4 Evaluate the Development Code for opportunities to incorporate design standards or best practices for discouraging or preventing crime or criminal activity, such as CPTED (crime prevention through environmental design).	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Long-Term

TRANSPORTATION & MOBILITY (TM)

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal TM-1: Develop and maintain an integrated, safe, and efficient transportation system			
IMP TM-1.1 Revise, as appropriate, traffic design standards to match actual experience with various land use types.	**Lead** Public Works **Partners** Community Development Citizen Transportation Advisory Board Planning Commission	Regulatory Revisions	Near-Term
IMP TM-1.2 Develop standards which control volume and speed on local streets through pro-active traffic calming strategies.	**Lead** Public Works **Partners** Community Development Citizen Transportation Advisory Board	Regulatory Revisions	Near-Term
IMP TM-1.3 Review Development Code standards to evaluate and update parking requirements for various zoning districts to ensure that excessive parking areas are not created, and attractive parking lot design is required.	**Lead** Community Development **Partners** Planning Commission Public Works Downtown Development Authority	Regulatory Revisions	Near-Term
IMP TM-1.4 Establish minimum short- and long-term off-street parking requirements for new development that incorporate special vehicles and purposes including areas for those with disabilities, car pools, van pools, and bicycles	**Lead** Community Development **Partners** Public Works	Regulatory Revisions	Near-Term
IMP TM-1.5 Develop and enforce an Access Control Plan which supports efficient travel on major roadways through a combination of access management and the number and spacing of driveways and intersections. The Access Control Plan should support the efficient, functional and attractive development of land through compatible design measures.	**Lead** Public Works **Partners** Community Development Citizen Transportation Advisory Board Planning Commission	Plans	Long-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal TM-2: Provide residents with a range of transportation choices and options.			
IMP TM-2.1 Explore design features or incentives to induce greater use of pedestrian or bicycle travel to school.	**Lead** Public Works **Partners** Community Development Culture, Parks and Recreation School Districts	Policies and Programs	Ongoing
IMP TM-2.2 Utilize a wide variety of public service messages such as information concerning Greeley's level of air quality and emissions to encourage the use of transit, carpooling and the other forms of travel as an alternative to single-occupant travel.	**Lead** Community Development **Partners** Greeley-Evans Transit Communication & Engagement	Policies and Programs	Ongoing
IMP TM-2.3 Continue to implement, and updated as needed, the *Greeley Bicycle Master Plan*. Where needed, updated City regulations and design standards to align with the recommendations of that plan.	**Lead** Public Works **Partners** Culture, Parks, and Recreation Community Development Citizen Transportation Advisory Board Planning Commission	Policies and Programs/ Regulatory Revisions	Ongoing
IMP TM-2.4 Continue to implement, and update as needed, the *Greeley Evans Transit Strategic Plan*.	**Lead** Greeley-Evans Transit **Partners** Public Works Citizen Transportation Advisory Board Planning Commission	Policies and Programs	Ongoing
IMP TM-2.5 Develop standards for and implement the recently adopted Complete Streets Policy for new City and developer initiated street projects.	**Lead** Public Works **Partners** Community Development	Policies and Programs	Near-Term
IMP TM-2.6 Evaluate the feasibility of requiring subdivision applications to include, where applicable, a "Safe Routes to School" plan which clearly shows intended pedestrian and bicycle routes to nearby schools.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Near-Term
IMP TM-2.7 Retain rights-of-way to accommodate potential future transportation corridors, such as light rail capacity.	**Lead** Public Works **Partners** Community Development	Policies and Programs	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal TM-3: Ensure that land use and transportation decisions, strategies, and investments are coordinated and complementary.			
IMP TM-3.1 Monitor vehicle trips by land use types on a periodic basis in order to measure the accuracy of transportation demand expectations (e.g. daily and peak hour activity).	**Lead** Public Works **Partners** Greeley-Evans Transit Community Development	Policies and Programs	Ongoing
IMP TM-3.2 Where appropriate, explore development incentives that will encourage and promote adjacent transit networks.	**Lead** Community Development **Partners** Planning Commission	Policies and Programs	Near-Term
IMP TM-3.3 Identify TOD corridors in City maps and through the Development Code to alert developers and landowners to the desired intensity of development in these areas.	**Lead** Community Development **Partners** Public Works	Policies and Programs	Near-Term
IMP TM-3.4 Develop a users' manual of locally-approved practices which guide development in transit- oriented design.	**Lead** Community Development **Partners** Public Works Greeley-Evans Transit Planning Commission	Policies and Programs	Long-Term
Goal TM-4: Promote the orderly movement of goods and services throughout the city and region.			
IMP TM-4.1 Commence negotiations with landowners to reserve adequate rights-of-way to assure that orderly and effective development of the roadways is achieved. Immediate attention needs to be focused on the following roadways: – Two rivers Parkway (83rd Avenue) – North City east/west bypass routes (SH392 and also "O" Street – 4th Street extension from 83rd Avenue to SH 257	**Lead** Community Development **Partners** Public Works	Policies and Programs	Ongoing
IMP TM-4.2 Coordinate with the Airport Authority in the implementation of an Airport Infrastructure Plan to install capital improvements needed to realize the full development of the airport as a regional air transportation facility.	**Lead** Public Works **Partners** Greeley/Weld Airport Authority Community Development	Plans	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP TM-4.3 Amend the City's Development Code to incorporate structure height limitations in restricted Airport Influence Areas as may be necessary.	**Lead** Community Development **Partners** Greeley/Weld Airport Authority	Regulatory Revisions	Near-Term
IMP TM-4.4 Pursue the installation of "Quiet Zones" in sensitive rail corridors where the train whistles are incompatible with and disruptive to adjacent uses.	**Lead** Community Development **Partners** Citizen Transportation Advisory Board Planning Commission	Policies and Programs	Near-Term
IMP TM-4.5 Enhance the main travel corridors used to travel to and from the airport with special attention to way-finding signage, well-defined and complete roadway systems, and attractive landscaping, public art or other distinctive community features. Particular attention should be paid to the improvement, appearance and function of the following road corridors: – State Hwy 263 (E. 8th Street), which should also be considered for expansion to meet the diverse and growing number of industrial users in the area – US Hwy 85 – 8th Street from US Hwy 85 to Downtown – Consider carefully the types of land uses in these corridors and promote those which provide compatible and complementary uses to the airport.	**Lead** Public Works **Partners** Citizen Transportation Advisory Board Community Development Greeley/Weld Airport Authority	Public Investments	Long-Term
IMP TM-4.6 Undertake a study to develop a Rail Master Plan which evaluates the safe, compatible and effective use of rail to, from and through the City.	**Lead** Public Works **Partners** Community Development Citizen Transportation Advisory Board Planning Commission	Plans	Long-Term
IMP TM-4.7 To the degree practical provide a trailhead or loop trail from the Poudre Trail Corridor to the airport.	**Lead** Culture, Parks and Recreation **Partners** Public Works	Public Investments	Long-Term
IMP TM-4.8 Establish minimum design standards for properties adjacent to rail lines to assure compatibility between different uses.	**Lead** Community Development **Partners** Planning Commission	Regulatory Revisions	Long-Term

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GLOSSARY

A

Access Control Plan - a plan that identifies the location and type of access for properties along a state or federal highway.

Action step/strategy - specific activities or strategies intended to accomplish the goals of the Comprehensive Plan.

Adaptive reuse - the development of a new use for an older building or for a building originally designed for a specific or special purpose.

Adequate public facilities - the public facilities and services needed to maintain the adopted level or service standards.

Adequate Public Facilities Area (APFA) - that area within which a full complement of City infrastructure is available to support growth and development. .

Affordable housing - housing costs that do not exceed 30% of a household's income.

Airport Authority - the governing body of the Greeley-Weld County Airport.

Airport Influence Area - the area affected by noise and/or safety considerations, as identified on the airport layout plan drawings as contained in the Greeley/Weld County Airport Master Plan.

Airport Zoning Overlay District - those lands depicted within the airport development area as contained within the Greeley-Weld County Airport Master Plan.

Alternative mode - a different method or type of transportation than is typically used.

Amendment - a change to the adopted Comprehensive Plan, which must be approved by the City Council and be processed in thesame manner as the original adoption of the plan.

Amenity - a natural or built feature that enhances the aesthetic quality, visual appeal, or makes more attractive or satisfying a particular property, place, or area.

Americans with Disabilities Act (ADA) - adopted in 1990, a civil rights law that prohibits discrimination on the basis of disability.

Annexation - the incorporation of land into an existing community with a resulting change in the boundaries of that community.

Annual Growth and Population Projections - projections prepared annually by the Greeley Planning Office to estimate future population growth in Greeley.

Aquifer - a geologic formation that contains a usable supply of water.

Architectural Review Advisory Committee - a citizen design review committee responsible for resolving architecture and design issues on development proposals.

Areas of ecological significance - areas which have significant environmental features and attributes, including critical wildlife habitat and populations, native and unique plant communities and valuable natural features.

Arts & Entertainment District - a district proposed by the Downtown Development Authority's Plan of Development that emphasizes Downtown Greeley as an area for activities and events related to arts and entertainment.

B

Big box - a retail or commercial use or combination of retail or commercial uses in a structure that exceeds forty thousand (40,000) square feet of gross floor area.

Bike lane - an area on a street that is striped and identified as an area for bicyclists, which is generally located between the travel lane and curb.

Bike path - a path for bicyclists that is separated from or located off- street.

Buffer yard - a landscaped area used to physically separate or screen one use or property from another.

Building Code - One of several building codes adopted by the City of Greeley, and administered through its Building Inspection Division, which allows the alteration of an existing building to consider and follow the code standards in place when the building was constructed under certain conditions.

C

Capital Improvements Plan (CIP) - a plan for future capital improvements to be carried out during a specific time period and prioritized, along with cost estimates and the anticipated means and sources of financing each project. Improvements include acquisition of property major construction projects or acquisition of equipment expected to have a long life.

Cash-in-lieu - money collected instead of providing a land dedication for purposes such as for schools, or parks.

Central Business District - the centrally—located business area within a community which is often referred to as the "downtown".

Character Overlay District - an overlay district established for the purpose of maintaining and preserving the attributes which make up the character of a particular and definable area within the city.

City Council - the City Council of the City of Greeley, Colorado.

Citizen Transportation Advisory Board (CTAB) - an appointed board of citizens that provides advice to the Greeley Public Works Department on transportation-related matters.

Cluster development - a design technique that concentrates buildings on a portion of the site while allowing the remaining area to be used for common open space, recreation, and/or protection of environmentally sensitive areas.

Colorado Primary Drinking Water Standards - those standards used for treating drinking water in Colorado.

Community Policing - a policing strategy and philosophy based on the concept that community interaction and support can help control crime.

Community park - a park intended to serve the entire community, ranging in size from 34 to 100 acres.

Community separator - an area that serves as a physical and/or visual separation between communities.

Compatibility - having harmony in design, appearance, use and/ or function of the characteristics of a building or structure, a neighborhood, or an area.

Complete neighborhoods - neighborhoods designed to provide a full-range of services and products, such as education, shopping, employment, and recreation opportunities, for residents of the neighborhood.

Complete streets - roadways designed and operated to enable safe, comfortable, and attractive access and travel for all users.

Comprehensive Plan - a long-range plan intended to guide the growth and development of a community or region.

Comprehensive Drainage Master Plan - the storm drainage plan for the City of Greeley, adopted in 1998, revised in 1999.

Comprehensive Transportation Plan - a long-range transportation plan for the City of Greeley to the year 2015, adopted in 1996.

Concurrency - the requirement for the provision of adequate public facilities and/or services at the time the demand for those facilities or services is created.

Connectivity or interconnectivity - the ability to be linked, such as through transportation systems, between areas.

Conservation - management of a natural resource to prevent exploitation or destruction.

Cooperative Planning Area (CPA) - areas of mutual development interest between Greeley and its adjacent communities for which it has formal agreements.

Covenants - a set of restrictions and conditions that are intended to maintain neighborhood or character and prevent improper use of land and which are administered by a homeowners' or property owners' association.

Coving - subdivision design characterized by non-uniform lot shapes and home placement, and when combined with winding roads, results in increased lot area, fewer intersections, and decreased road area.

Creative class - individuals who work as lawyers, physicians, architects, educators, researchers and scientists, artists, designers, and in technology-related fields who tend to be problem-solvers, with a high level of formal education.

Culture - elements relating to customary beliefs, social forms, physical structures and related traits of racial, religious or social groups, and, aspects of intellectual or artistic taste.

D

Density - the number of dwelling units per acre of land area.

Design review - a process for reviewing development proposals within a Neighborhood Development District.

Development Code - the City of Greeley's Zoning and Subdivision regulations, adopted in 1998 and amended in 1999.

Development rights - the right to develop property.

Downtown Development Authority (DDA) - The organization responsible for maintaining and improving the economical viability of a 55-block area around downtown Greeley.

Downtown Development District - the boundaries of the Downtown Development Authority, within which a range of land uses and special districts exist to support the vitality and preservation of Downtown.

Downtown Greeley Historic District - locally designated historic district located between 7th – 10th Streets, between 8th and 9th Avenues, which is the area around which Greeley developed.

Dwelling unit - one (1) room, or rooms connected together, constituting a separate, independent housekeeping establishment for owner occupancy, or rental or lease as a single unit, on a monthly basis or longer, physically separated from any other room or

dwelling unit which may be in the same structure and served by no more than one (1) gas meter and one (1) electric meter.

E

Employment corridors - a land use corridor typically located along a major community arterial/entryway which is primarily intended for employment and major employers.

Employment sector - one of the major groupings of jobs by nature of work, including agriculture/fisheries/forestry; professional/scientific/ technical/business services; natural resources/mining/construction; leisure; transportation/utilities; manufacturing; and information.

Enterprise Zone - areas where development and reinvestment is encouraged through the use of state tax credits and related support for starting or expanding businesses within the zone.

F

Federal Emergency Management Administration (FEMA) - the federal agency responsible for the management of natural disasters.

Flood plain - an area which is adjacent to a stream or watercourse and which is subject to flooding as a result of the occurrence of an intermediate regional flood and which is so adverse to past, current or foreseeable construction or land use as to constitute a significant hazard to public health and safety or to property. This term includes but is not limited to, mainstream flood plains, debris fan flood plains and dry wash channels and flood plains.

Floodway - the channel of a river or other watercourse and the adjacent land areas that shall be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one (1) foot.

Food shed - the system that describes the flow of food used to feed a particular area, starting with the origins of the food, its destination, and transportation to the destination.

Foreclosure - the process where a mortgagee or lien holder obtains a court order to terminate the mortgagor or homeowner's interest in the property.

Form-based zoning - an approach to regulating development to achieve a specific urban form, by creating a predictable public realm through controlling physical form, with less emphasis on land use.

G

Greeley-Evans Transit (GET).

Goal - a broad statement of the community's desired future.

Greeley National Register - the City of Greeley's listing of locally designated historic landmarks, as designated by the Historic Preservation Commission and City Council.

Greeley Urban Renewal Authority (GURA) - a political subdivision of the state, formed by and with members appointed by local government to carry out a variety of urban renewal activities on behalf of the City and in accordance with state and often federal grant requirements.

Greeley-Weld County Airport Master Plan - a plan for future development of the Greeley Weld County Airport, adopted in 1978 with subsequent amendments in 1984 and 1993, and 2004.

Greenways - a linear open space or natural area or corridor typically used by pedestrians and bicyclists.

Greenfield development - development on property that has not been previously developed.

Groundwater - the supply of freshwater under the surface in an aquifer or geological formation that forms the natural reservoir for potable water.

H

Hazardous materials/waste - shall mean any substance or materials that by reason of their toxic, caustic, corrosive, abrasive, or otherwise injurious properties may be detrimental or deleterious to the health of any person handling or otherwise coming into contact with such material or substance, or which may be detrimental to the natural environment and/or wildlife inhabiting the natural environment.

Historic - the public and private resources in the City, including buildings, homes, replicas, structures, objects, properties, parks and sites that have importance in the history, architecture, archeology or culture of the City, State or Nation, as determined by the Historic Preservation Commission.

Historic preservation - the protection, rehabilitation, and restoration of districts, sites, buildings, structures, objects, and artifacts that are significant in history, architecture, archaeology, or culture.

Human Relations Commission - an 11-member Council-appointed citizen commission responsible for fostering mutual respect and understanding among all members of the community.

I

Implementation - carrying out or fulfilling plans and proposals.

Incentive - a way to encourage a particular action that is considered desirable or beneficial.

Infill - a lot or grouping of lots or tracts of land with the majority of their perimeter boundary adjacent to existing development.

Infrastructure - facilities and services needed to sustain residential, commercial, industrial and all other land use activities including utility lines, streets and roadways, communication systems and public facilities such as fire stations, parks, schools and police stations.

Interconnectivity or connectivity - the ability to be linked, such as through transportation systems, between areas.

L

Land lease community - a housing development where homeowners lease the land under their homes from a landowner who typically provides community infrastructure and amenities and which is most commonly found in mobile home parks.

Land use Guidance Map - a map used to guide future land use planning decisions in Greeley, and including such things as employment and industrial uses; parklands and open space; commercial nodes; special uses; and multi-modal corridors.

Level of Service (LOS) - an indicator of the extent or degree of service provided by, or proposed to be provided by a facility based on and related to the operational characteristics of the facility.

Living history - an activity that incorporates historical tools, activities and dress into an interactive presentation that gives observers and participants a sense of stepping back in time.

Long-Range Expected Growth Area (LREGA) - the area within which community growth is expected for the next 20 plus years and which encompasses all other growth and service area boundaries for the City.

Low-income - income levels at 0 – 50.0% of area median income.

M

Median - the central area between travel lanes of streets and highways, which may be covered with landscape materials, hard- surfaced, or a combination of materials.

Mediation - a form of dispute resolution intended to assist two or more parties to reach agreement.

Metropolitan Planning Organization (MPO) - a regional transportation planning group consisting of the municipal areas within Larimer and Weld counties.

Mini-park - a park that range in size from 0.5 – 5.0 acres in size, intended to serve the immediate residential or commercial area.

Mitigate - mechanism for addressing undesirable impacts on the natural environment, alleviating or lessening the impact of development.

Mixed-use - a building or structure that contains two (2) or more different uses.

Mobile source emissions - air quality emissions that come from mobile or moving sources, such as automobiles.

Moderate-income - incomes at 50.0 – 80.0% of area median income.

Multi-modal - offering a number of different types or modes of transportation.

Multi-modal corridor - a transportation corridor that offers different types or modes of transportation.

Municipal Code - the adopted code of the City of Greeley.

Municipal Services Suitability Area (MSSA) - full range of municipal services is currently available in this area.

N

National Incident Management System (NIMS) - a system used in the United States, through its Homeland Security Department, to coordinate emergency preparedness and incident management among various federal, state, and local agencies.

National Register of Historic Places - the US government's official list of districts, sites, buildings, structures, and objects deemed worthy of preservation.

Native species - plants or animals that are naturally found within an area.

Natural resources - natural elements relating to land, water, air, plant and animal life of an area or community and the interrelationship of these elements.

Neighborhood center - a grocery-based commercial area of 5-20 acres in size, located at the intersection of arterial/arterial roads or major collector/arterial roads and which has a typical trade area of 1.5-3 miles.

Neighborhood park - a park intended to serve a smaller portion of the community, or a neighborhood, ranging in size from 1 to 34 acres.

Neighborhood plan - a plan for the future development or redevelopment of a land area which includes lots or areas which are adjacent to one another and have a community of shared interest.

Neighborhood Watch - a voluntary program where neighbors work together with City representatives to address crime, property maintenance, traffic and noise issues in their neighborhood.

New urbanism/neo-traditional development - a form of development which is characterized by the integration of housing, shops, work places, parks and civic facilities into communities that are walkable, served by transit and area designed around a central public place such as a school, park, church, meeting hall or other civic use.

Non-native vegetation - vegetation that is not naturally found within an area.

Non-point source pollution - air pollution from a non-definable source.

Non-potable water - water that is not suitable for drinking or cooking purposes.

O

Open space - any parcel of land or water which is essentially unimproved and which may include crop land, areas of ecological significance or other natural features.

P

Planning Commission - the Planning Commission of the City of Greeley.

Policy - a statement of intent against which individual actions and decisions are evaluated.

Potable water - water that is suitable for drinking and cooking purposes.

Primary employment - business that is usually industrial in nature, which generates revenue from outside the community and does not include support or service type businesses.

Public nuisance - a nuisance that unreasonably interferes with a right that is common to the general public.

Q

Quality of life - is the degree of well-being felt by an individual or group of people, consisting of physical and psychological.

Quiet zones - areas established under federal rules where the use of railroad locomotive horns at crossings will be discontinued or minimized to reduce noise levels.

R

Raw water - the water rights a developer must dedicate to the City of Greeley in return for water service.

Recycling/pre-cycling - the process by which waste products are collected, separated, stored and reduced to raw materials and transformed into new and often different products.

Redevelopment - development activities intended to enhance the existing social, economic, physical and environmental nature of a community and which may include restoration or re-use of existing buildings and structures, as well as construction of new buildings and structures in developed areas.

Regional Activity Center - a commercial area intended to serve a population of 50,000 – 75,000 and which is located on major arterial roads. Regional activity centers are found in Downtown, Greeley Mall/ Gallery Green/Elk Lakes PUD/Gateway PUD area and the Promontory PUD area.

Regional park - a park in excess of 100 acres, intended to serve the community, as well as areas beyond.

Rehabilitate - the upgrading of an area which is in a dilapidated or substandard condition for human habitation or use.

Renovate - to restore a building, structure, or object to a previous or better condition.

Resource management - the management of natural resources so that such resources are protected and enhanced.

Riparian - an area where the presence of surface and/or high subsurface water levels permits the existence of increased vegetative diversity and abundance as contrasted to surrounding areas.

Rural - a sparsely populated area, where the land is primarily used for agricultural purposes.

S

School Resource Officer - a law enforcement officer stationed at a high school and occasionally middle school during the school year to provide education and enforcement strategies for students.

Scrape-off - the removal of all structures, buildings, and objects from a site.

Single occupant vehicle (SOV) - a motor vehicle occupied by only one (1) person.

Smart growth - an urban planning and transportation approach that concentrates growth in the center of a city to reduce urban sprawl and advocates compact development that is transit-oriented, walkable, and bicycle-friendly with a mix of land uses and a wide range of housing choices.

Sprawl - development that is usually low-density in nature and located in areas that were previously rural and typically some distance from existing development and infrastructure.

Strategic plan - a plan that lets an organization know where they are currently and where they want to be some time in the future, as well as the actions needed to get there.

Streetscape - the overall character and appearance of a street that is formed by elements and features that frame the street, such as building façades, street trees and plants, lighting, furniture, or paving.

Sustainable - meeting the needs of the present without sacrificing the ability for future generations to meet their own needs.

Sustainable design - the art of designing and producing places, products, and services in a way that reduces the use of non-renewable resources, also known as "green design", "eco-design" or "design for the environment".

T

Tax increment district - a state-defined special district for redevelopment and community improvement projects which are financed through the growth of tax revenue resulting from the redevelopment of a distressed area.

Traffic calming - methods and techniques used to slow or "calm" traffic on streets and roadways.

Transit-Oriented Design - design intended to encourage and facilitate the use of public transit and which may include a mix of land uses, as well as such things as the spacing of collector streets, location and nature of sidewalks and pedestrian paths, and transit stop location and design.

Transportation Demand Management (TDM) - strategies aimed at reducing the number of vehicular trips, shortening trip lengths and changing the timing trips from peak hours.

U

Urban - a highly developed area that includes a central city or place and contains a variety of residential, commercial, industrial, recreational and cultural uses.

Urban forest - the trees growing within an urbanized community.

Urban heat island - a dome or bubble of increased air temperature that forms over a city or community that results in increased day and night temperatures; impacts and enhances the production of harmful ground level ozone layers (smog); causes greater stress on humans and machinery; increases financial expenses; creates a community's own weather system. Urban heat islands are created when vegetation is removed and replaced by large areas of dark material, usually asphalt on roads, parking lots, and roofs.

Urban renewal - the clearing, rebuilding and/or redevelopment of declining urban areas.

Urgent Responders Cooperative - an informal consortium of urgent responder professionals, such as enforcement, emergency response, and health and human services,

from a range of public agencies that meet monthly to coordinate their service delivery to the community.

V

Vehicle miles traveled (VMT) - the total distance traveled by all motor vehicles.

View shed - the surface areas from which a viewpoint is seen.

W

Walkable - the ability of a community to be accessible by walking, often measured by such things as land use mix, street connectivity, residential density, and orientation and proximity of homes and buildings to "watch over" the street.

Waste energy - new energy that is captured as a by-product from the decomposition or new generation of waste products.

Water rights - a decreed right to use, in accordance with its priority, a portion of the waters of the state by reason of the appropriation and use of the water.

Way-finding - the way in which people orient themselves in physical space and navigate from place to place, including signage.

Wetlands mitigation - compensation for wetlands that are lost or impacted by restoring, enhancing, or creating new wetlands.

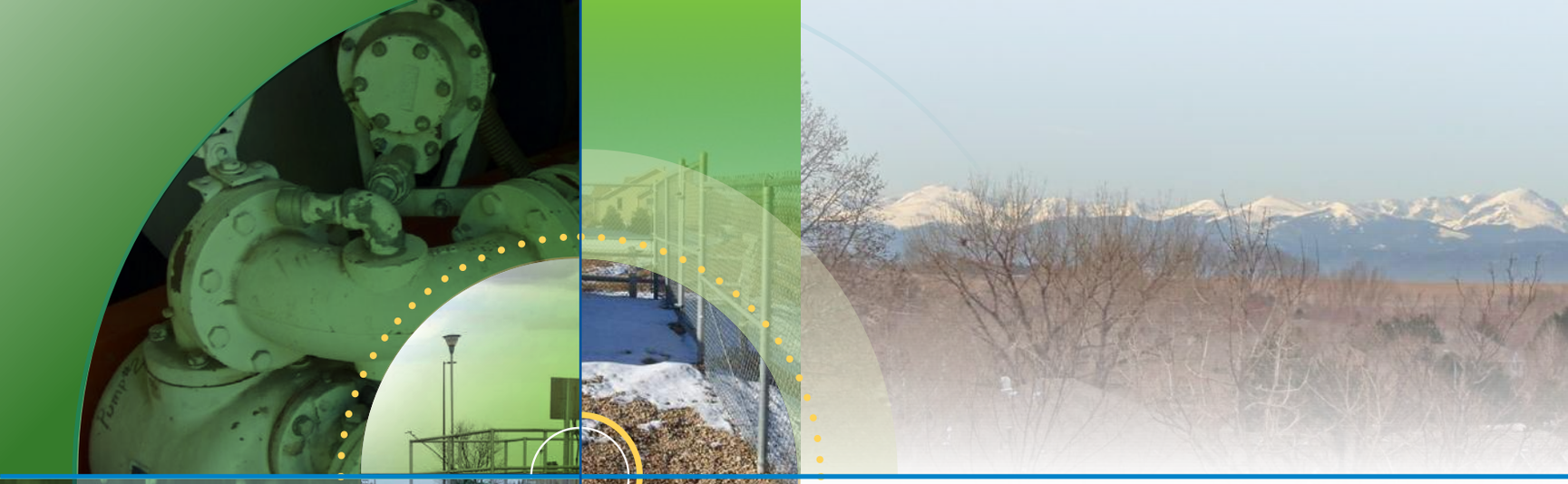
X

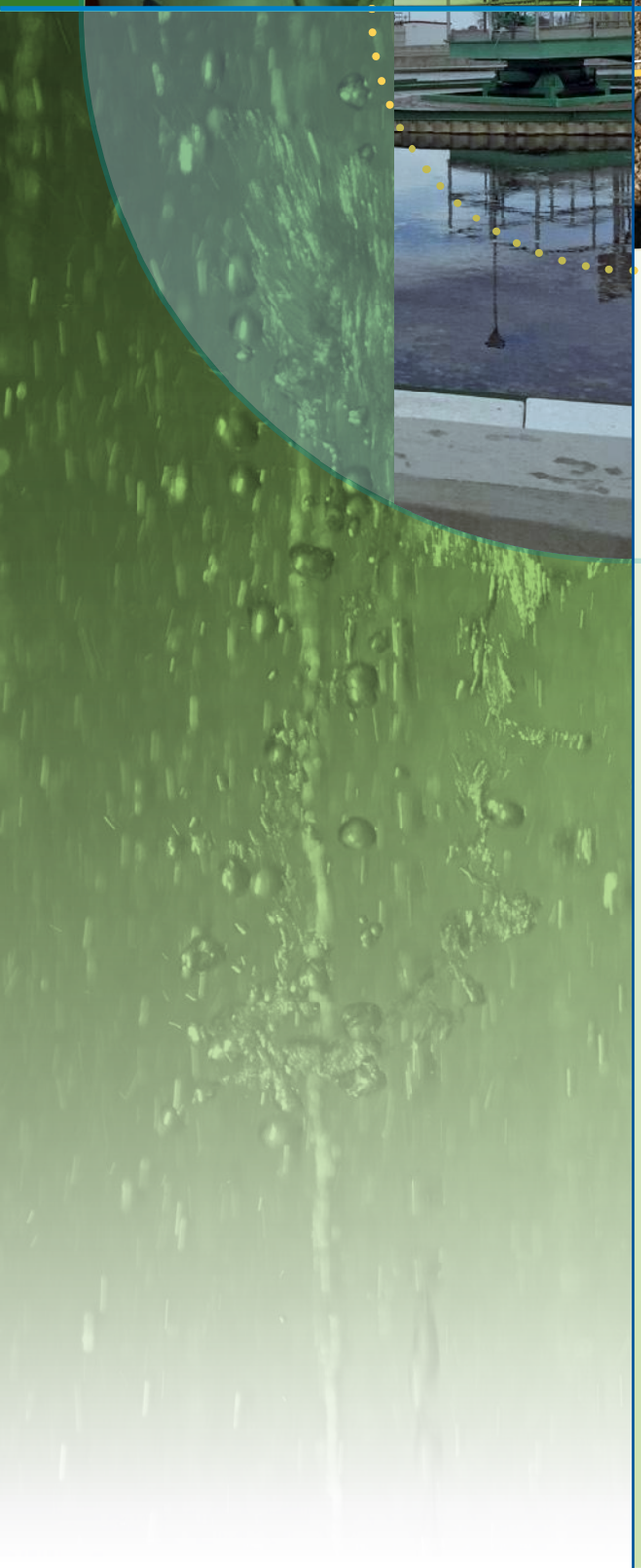
Xeric - a form of landscaping intended to conserve water.

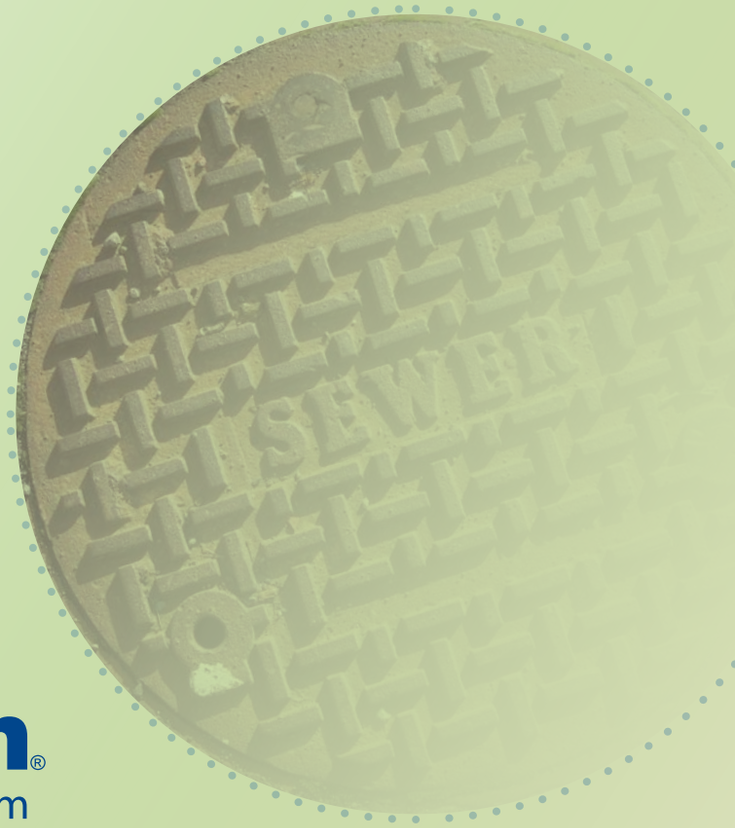
Y

Youth Commission - a 14-member Council-appointed commission of youth, ages 11-18, responsible for promoting understanding of youth concerns and contributions and encouraging youth participating in the community.

City of Greeley Colorado







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City of Greeley Colorado

FINAL

Water Transmission and Distribution Master Plan

June 2021

CDM Smith

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Abbreviations and Acronyms

$/LF	dollars per linear foot
2003 MP	2003 Water Master Plan
AFY	acre-feet per year
AWWA	American Water Works Association
BBC report	City of Greeley Population and Water Demand Projections
CDPHE	Colorado Department of Public Health & Environment
C-H	commercial high intensity
CIP	capital improvement plan or program
City's Specifications	City of Greeley Design Criteria and Construction Specifications
C-L	commercial low intensity
DBP	disinfection byproduct
DU/acre	dwelling units per acre
DU	dwelling unit
EDR	engineering development review
ENR-CCI	Engineering News Record Cost Construction Index
EPA	U.S. Environmental Protection Agency
EPS	extended period simulation
fps	feet per second
GIS	geographic information system
gpd	gallons per day
gpd/acre	gallons per day per acre
gpm	gallons per minute
HDD	horizontal direct drilling
HGL	hydraulic grade line
I-H	industrial high intensity
I-L	industrial low intensity
I-M	industrial medium intensity
J&B	jack and bore
LRAA	locational running annual average
LREGA	long-range expected growth area
MCL	maximum contaminant levels
MG	million gallons
mg/L	milligrams per liter
MGD	Million gallons per day
NPDWR	National Primary Drinking Water Regulations
NPMP	Non-Potable Water System Master Plan
OPCC	opinion of probable construction cost
ppb	parts per billion
PRV	pressure reducing valve
psi	pounds per square inch
PUD	Planned Unit Development
R-E	residential estate
R-H	residential high density

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R-L	residential low density
R-M	residential medium density
R-MH	residential mobile home
SCADA	supervisory control and data acquisition
SSMP	Sanitary Sewer Master Plan
TOC	total organic carbon
UNC	University of Northern Colorado
WTDMP	Water Transmission and Distribution Master Plan
WTP	water treatment plant

Definitions

Buildout - the theoretical point in time where the City has experienced complete development within the LREGA, expected to be sometime after year 2090.

Capital improvement - a recommended City construction project to improve or expand the system, summarized in the capital improvement plan.

Extended period simulation - a hydraulic modeling methodology that shows how the system performs over a set timescale, during which demands and operating conditions can vary.

Fire flow - the theoretical water demand that would be used to put out a fire; this value is added to other demands and is used for pipe and storage sizing.

Flow factor - value used to estimate the water demand that a given amount of land will produce once its developed, depending on its land use.

Long range expected growth area - the limits of the City's expected growth and where it plans to provide water and wastewater services.

Minimum month demand - the average demand anticipated during a minimum one-month period for a typical year, typically experienced during the winter.

Non-potable water - raw (untreated) water from agricultural ditches used to irrigate certain areas within the City.

North of the River - the geographic area north of the Poudre River and within the City's LREGA.

Opinion of probable construction cost - the costs borne by the contractor to construct a capital project.

Peak day demand - the maximum demand anticipated to occur during a one-day period expressed as the daily average.

Peak hour demand - the average demand anticipated during a maximum one-hour period for a typical year; this is considered to be a conservative value for infrastructure sizing.

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Peak month demand - the average demand anticipated during a maximum one-month period for a typical year, typically experienced during July.

Planning horizon - a timeframe used to estimate expected demands and infrastructure needs; for this master plan, the three planning horizons are 5-year (2025), 20-year (2040) and buildout.

Pressure zone - geographic areas (labeled 1, 2, 3, and 4) within the City that are at similar elevations and operate at the same HGL, as regulated by storage tanks, PRVs, and closed valves.

Summer water use - the amount of water used in summer months, defined as July and August.

Tier 1, 2 or 3 - tier of information used to distribute future flow parameters to currently undeveloped areas or areas of redevelopment.

Water age - a measurement of how long a given volume of water has been in the piped water transmission and distribution system; this value is typically used as a stand-in for water quality, as disinfection byproducts degenerate the more aged water is.

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Executive Summary

The City of Greeley, Colorado (the City) is in Weld County approximately 60 miles northeast of Denver, east of Fort Collins and Loveland. Greeley is the twelfth largest city in Colorado and has developed into a cultural and academic hub, hosting educational institutions such as the University of Northern Colorado (UNC) and Aims Community College. The City offers an affordable cost of living with many options for housing and economic growth. The City's population grew from 20,354 in 1950 to an estimated 108,175 in 2019. The City continues to experience strong population growth through both infill and expansion of residential, industrial, and commercial development within the City's defined service area.

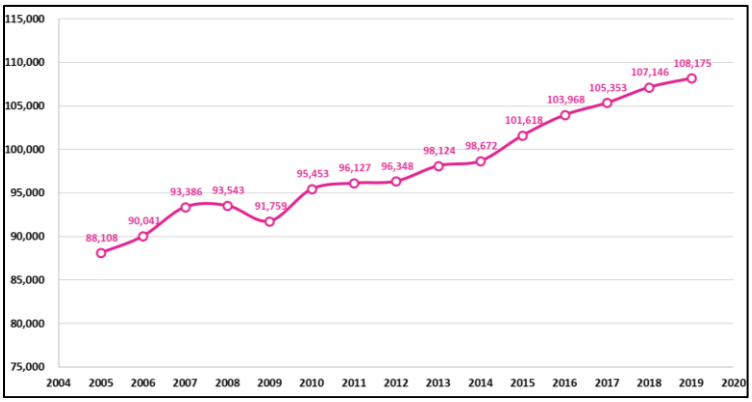

Figure ES-1. Historical Population for the City of Greeley

ES.1 Greeley Master Plan Integration

To address existing and future system needs, the City developed their 2003 Water Master Plan (2003 MP) and model to reflect changes in the system and forecast needs for water supply, transmission, distribution, treatment, and storage. The 2021 Water Transmission and Distribution Master Plan (WTDMP) update occurred concurrently with updates to the City's Sanitary Sewer Master Plan (SSMP) and Non-Potable Water Master Plan (NPMP) providing consistent data for population and growth; common planning horizons of 5-year, 20-year, and buildout; and an integrated planning approach to capital improvement plan (CIP) development. This approach to integrated master planning provides the City with a defensible and coordinated CIP and allows for scheduling of CIP projects to minimize impacts to citizens. **Figure ES-2** illustrates the critical points of coordination between the three master plans.

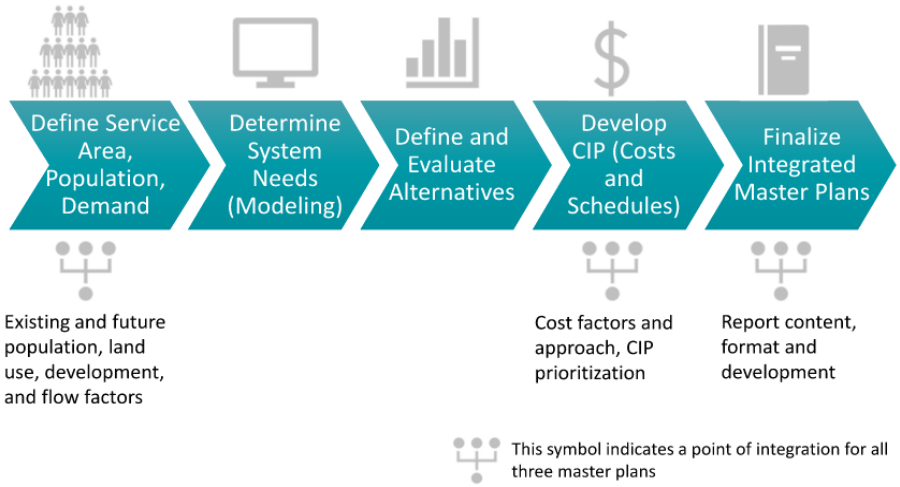

Figure ES-2. Master Plan Approach and Integration with Other Master Plans

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ES.2 Conservatism and Uncertainty in Planning

During master plan development, assumptions were made for existing and future conditions. These included population distribution and flow factors to develop water demand projections for growth and development under future conditions with considerations for extreme seasonal conditions that would emphasize higher demands while also considering future water conservation planning to help reduce these impacts. The master planning assumptions trended toward conservative values, which may result in the predicted demands being higher than actual. Care is taken to consider the modeling results and needs for capital improvements or timing of improvements. This WTDMP analyzes the existing system and defines future needs, which should be validated by the City as new data becomes available.

The water system model, in conjunction with its non-potable companion model, is a tool for analyzing the existing system and defining future capacity needs, but this tool has limitations. Knowing the limitations is important in making decisions regarding improvement projects. Actual planning and timing of development will inevitably vary from the best planning projections, resulting in the need to review areas where the model indicates system deficiencies.

Additional uncertainty occurs during the development of the CIP. Planning-level cost development considers major categories of capital projects and does not include the finite detail available during the preliminary and final design stages of projects. The CIP was developed based on anticipated growth, modeling results, and planning information. The CIP is subject to change if the planning information and forecasts differ from those used to develop the CIP. Prior to COVID-19, a global pandemic, cost inflation tools provided high confidence for predicting unit prices within a given year. However, during and after COVID-19, these cost inflation tools may not be as accurate.

ES.3 Existing System Information and Model Development

City-provided information was used to inform the development of the master plan update. This included mapping, asset information, planning data, development plans, and physical data like reservoir and water treatment plant (WTP) flow records and summer water billing data. The basis for the water transmission and distribution model used in this master plan was a calibrated existing system model developed by others from which future planning and development extensions and upgrades could be constructed and evaluated. Although this existing model included hard calibration synced up with supervisory control and data acquisition (SCADA) records, multi-year water storage and treatment plant production records were used to develop system-wide diurnal demand patterns for peak, average, and minimum demand conditions hourly. Future developments that would be considered largely residential in nature, with less emphasis on industrial and commercial development associated with the existing system, were simulated using a more aggressive residential peaking pattern with expected higher demands during summer irrigation seasons, resulting in more conservative stressing of the transmission and distribution system with the goal to avoid undersizing future water mains and appurtenances. All future planning was based on time-based milestones established as 5-year (2025), 20-year (2040), and buildout within the long-range expected growth area (LREGA), as shown in **Figure ES-3.**

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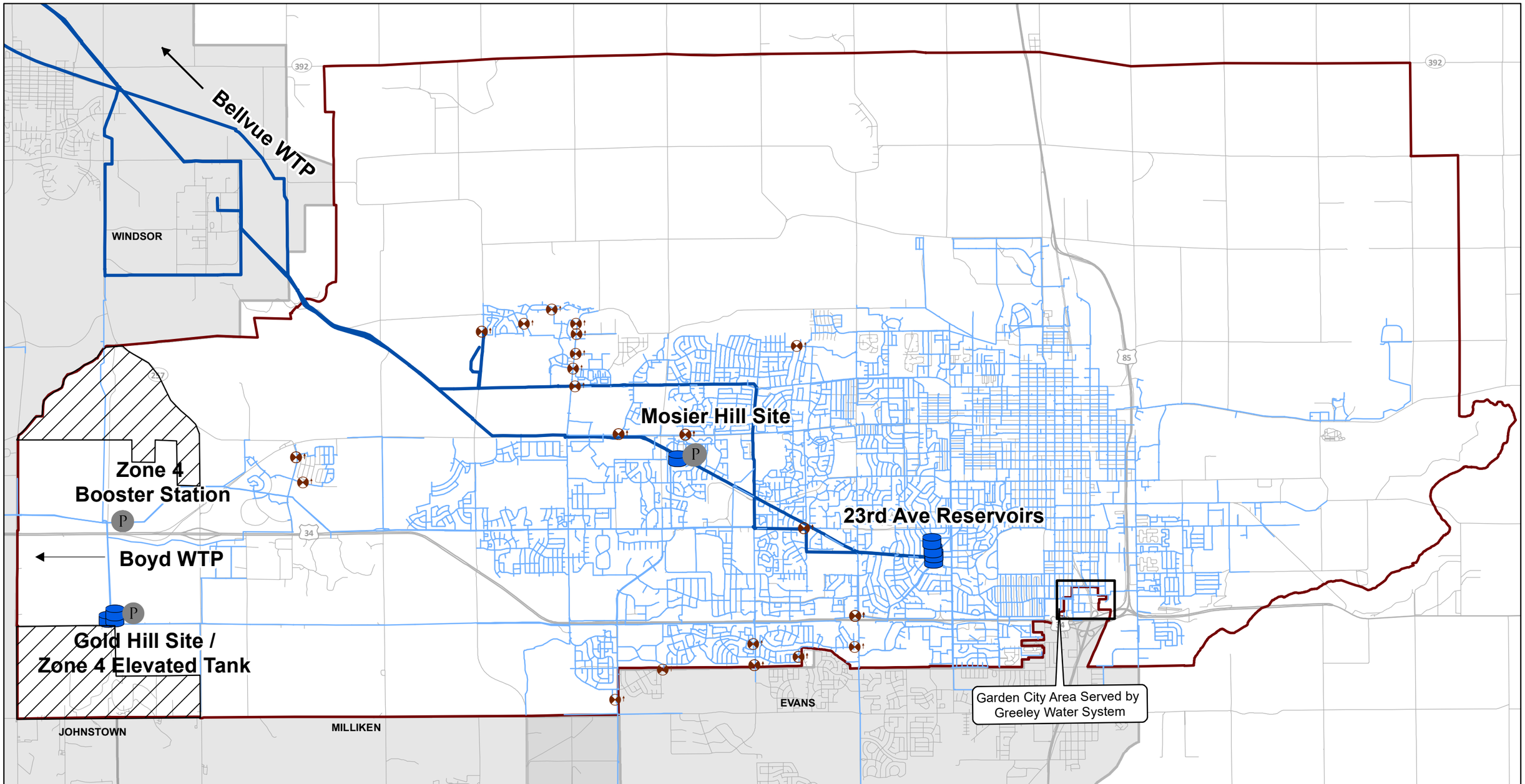

Legend

- Existing Pump Stations
- Existing Storage
- PRV
- LREGA
- Distribution Mains
- Transmission Mains
- Overlapping Growth Area (to be negotiated in future IGAs)
- Neighboring Towns

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Water Master Plan Area

Figure ES-3

Greeley Water System Master Plan

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ES.4 Service Area, Population, and Demand Projections

The City's LREGA is the area where it plans to provide water and sewer services. The future population (and resulting demands) that were distributed over the LREGA for each planning horizon was the "middle" projection from the *City of Greeley Population and Water Demand Projections* (BBC Research & Consulting 2018), referred to as the BBC report, as shown in **Figure ES-4**. Because the 2075 projection does not represent the buildout year for the City within the LREGA boundary, a buildout population was extrapolated using planning data and factors.

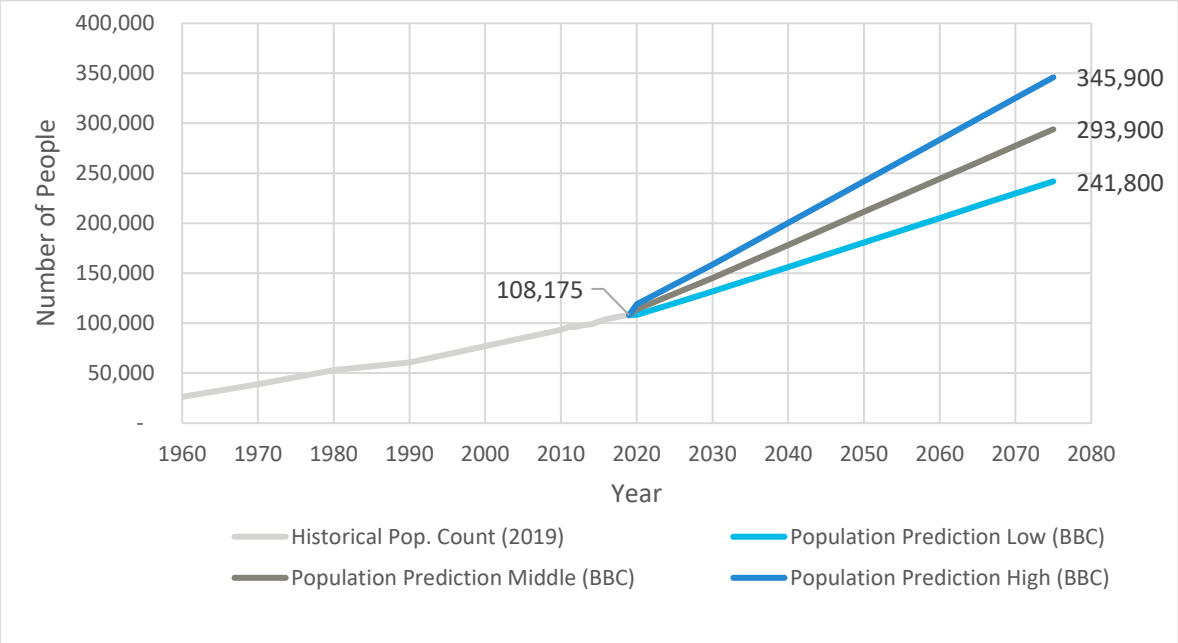

Figure ES-4. Historical and Projected Population

Future demand parameters were distributed to currently undeveloped areas or areas of redevelopment using a three-tiered approach. **Figure ES-5** shows the distribution of growth areas and tier designations throughout the LREGA planning area.

It is assumed that the Tier 1 projects will be completed first. For this reason, most of the Tier 1 projects are assumed to be 100 percent (%) complete at the 2025 planning horizon and all of them complete at the 2040 planning horizon.

Because of the large areas within the Tier 2 projections category, the Tier 2 percent complete values for the 2025 and 2040 planning horizons have been developed through close discussion with the City. The Tier 2 areas that the City and CDM Smith have identified for growth at the 2025 and 2040 planning horizons are the areas that the City's planning department identified as the most likely growth areas.

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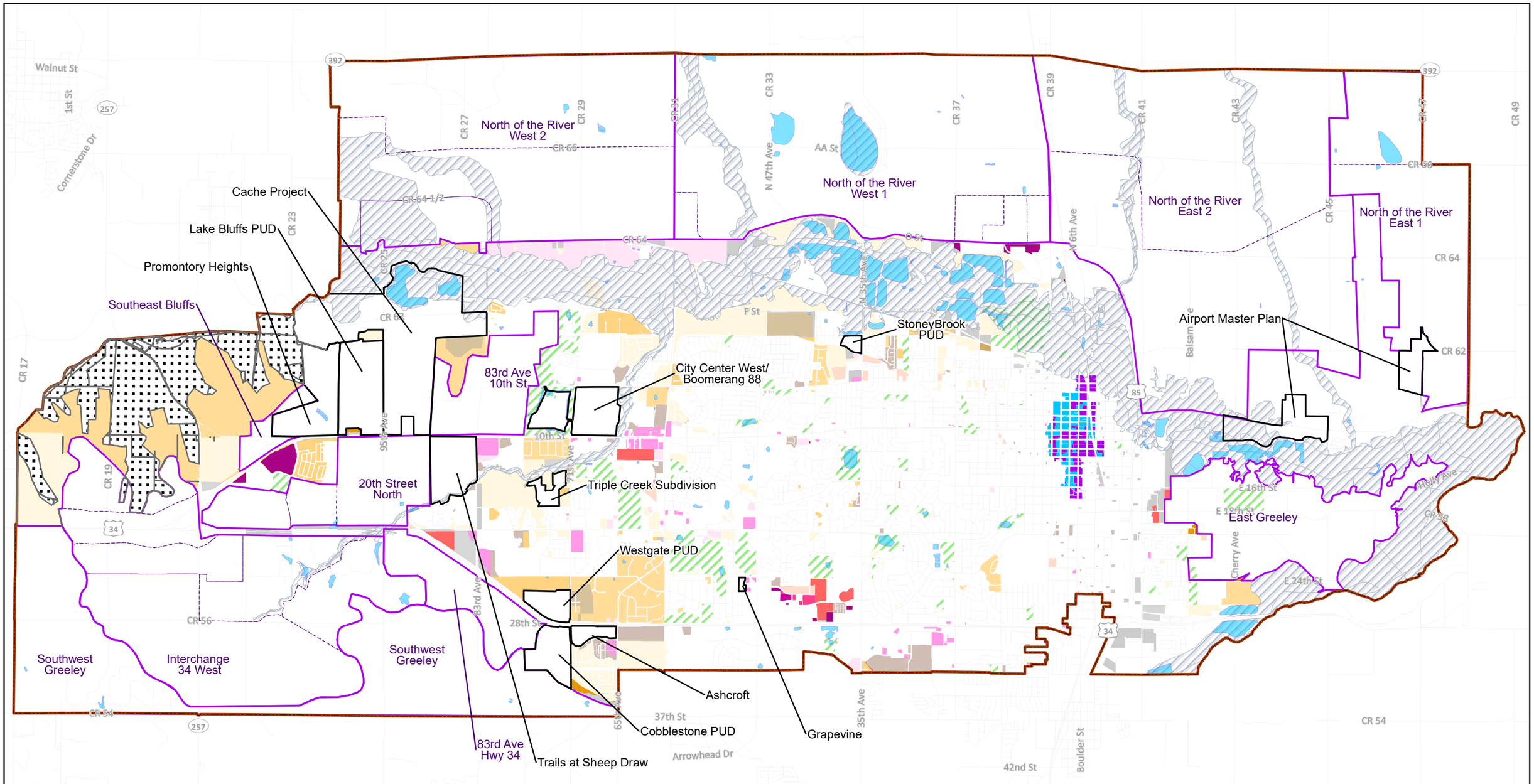

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Legend

- LREGA
- Tier 1 (Planned Developments)
- Tier 2 (Greeley Markup)
- Tier 2 (Sub-Areas)

Tier 3

- C-H
- C-L
- I-L
- I-M
- R-E
- R-H
- R-L
- R-M
- R-MH
- Downtown Development Authority (Existing Flow)
- Downtown Development Authority (Redevelopment)
- Employment, Industrial, and Commercial
- Mixed Use
- Mixed Use High Intensity
- Residential
- Rural
- Bluffs - No Developement
- 100-yr Floodplain
- Lakes and Ponds
- Parks

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Future Projection Areas by Growth Type

Figure ES-5

Greeley Water System Master Plan

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The Tier 3 growth identified for the 2025 planning horizon was chosen through discussions with the City. Tier 3 growth included at the 2040 planning horizon is assumed to include all the infill around the Tier 1 and Tier 2 projected growth areas. The percent complete values for each tier were chosen through discussions with the City. **Figure ES-6, Figure ES-7,** and **Figure ES-8** show a visual representation of the assumed growth areas for each planning horizon.

It is likely that the water demands will be decreased in the future if some of the irrigation demands can be met with non-potable water. In particular, larger irrigated areas such as parks, schools, commercial and industrial areas, and large residential developments may be eligible for non-potable irrigation, although potential non-potable customers should be evaluated on a case-by-case basis for feasibility. The projected water demands could be offset by non-potable water by either servicing future developments with non-potable water or by converting existing areas from potable to non-potable service. Because non-potable service would only decrease the water demands, the analysis conducted for this WTDMP represents a conservative "worst case" scenario, where potable water is used to meet all water demands. For more information on non-potable demand projections, please refer to the NPMP.

Ultimately, two demand scenarios were modeled: the system if all water demands are met by water (all potable demands scenario), and the system if some water demands are offset by non-potable water (non-potable offsets demand scenario). Considering both scenarios will help the City avoid under-sizing either system (potable or non-potable).

Demand projects under all future scenarios are included in **Table ES-1**, but do not include non-potable offsets, which are further clarified later in the WTDMP.

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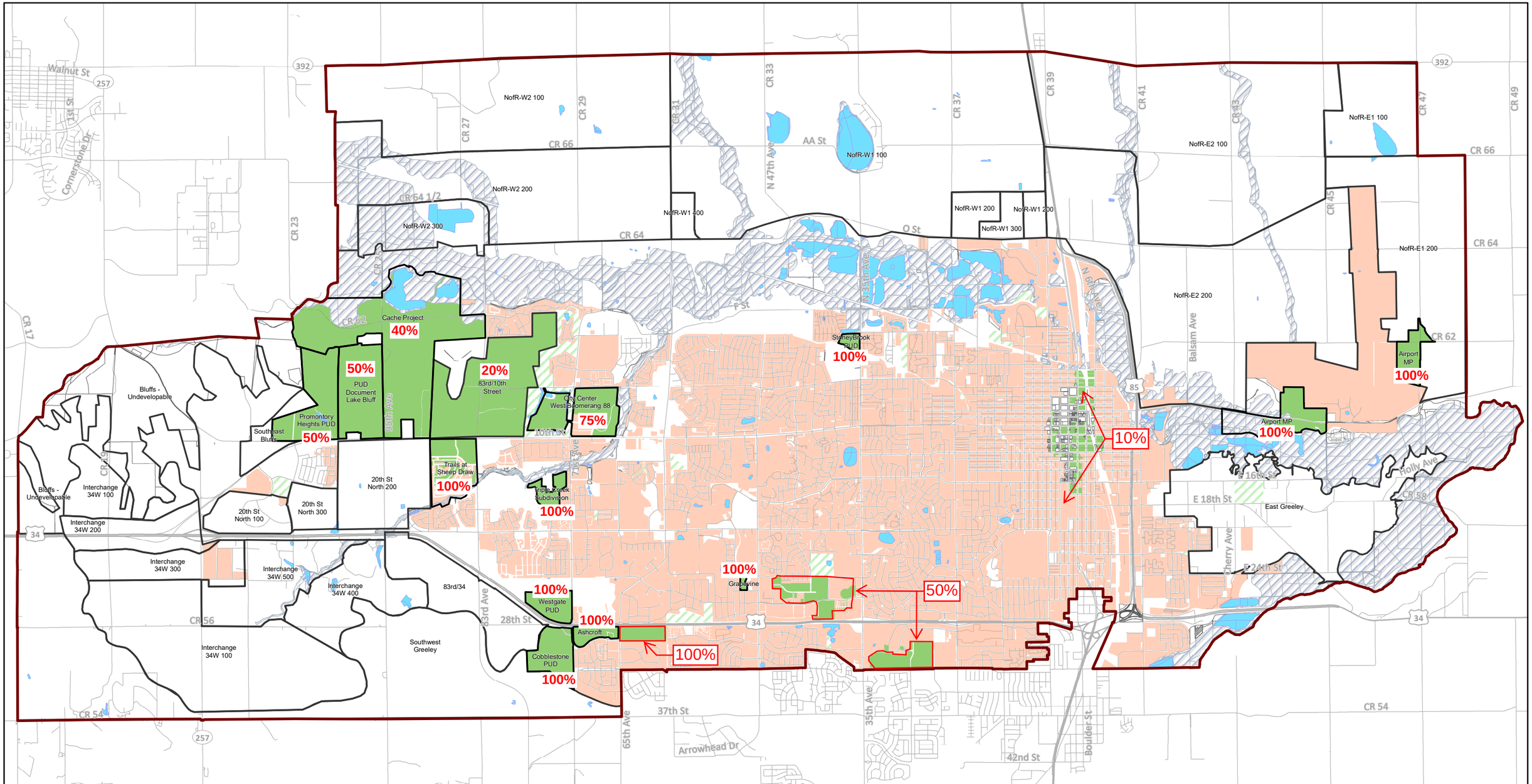

Legend

- LREGA
- Demand Projection Area
- 100-yr Floodplain
- Lakes and Ponds

% = Percent Developed

- Future Development
- Existing Service Area
- No Development
- Park

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Developed Area Projections: 2025

Figure ES-6

Greeley Water System Master Plan

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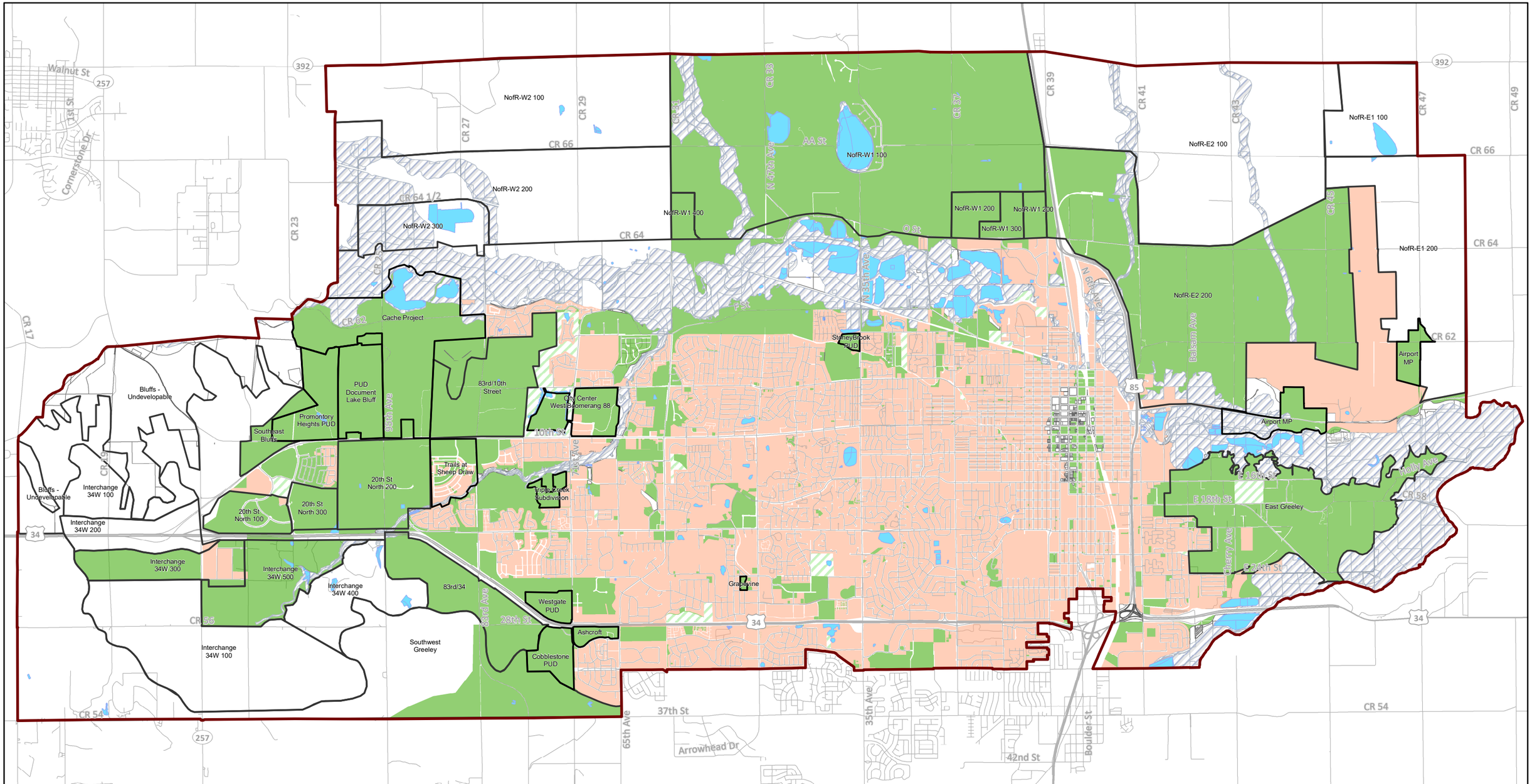

Legend

- LREGA
- Demand Projection Area
- 100-yr Floodplain
- Lakes and Ponds
- Future Development
- Existing Service Area
- No Development
- Park

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Developed Area Projections: 2040

Figure ES-7

Greeley Water System Master Plan

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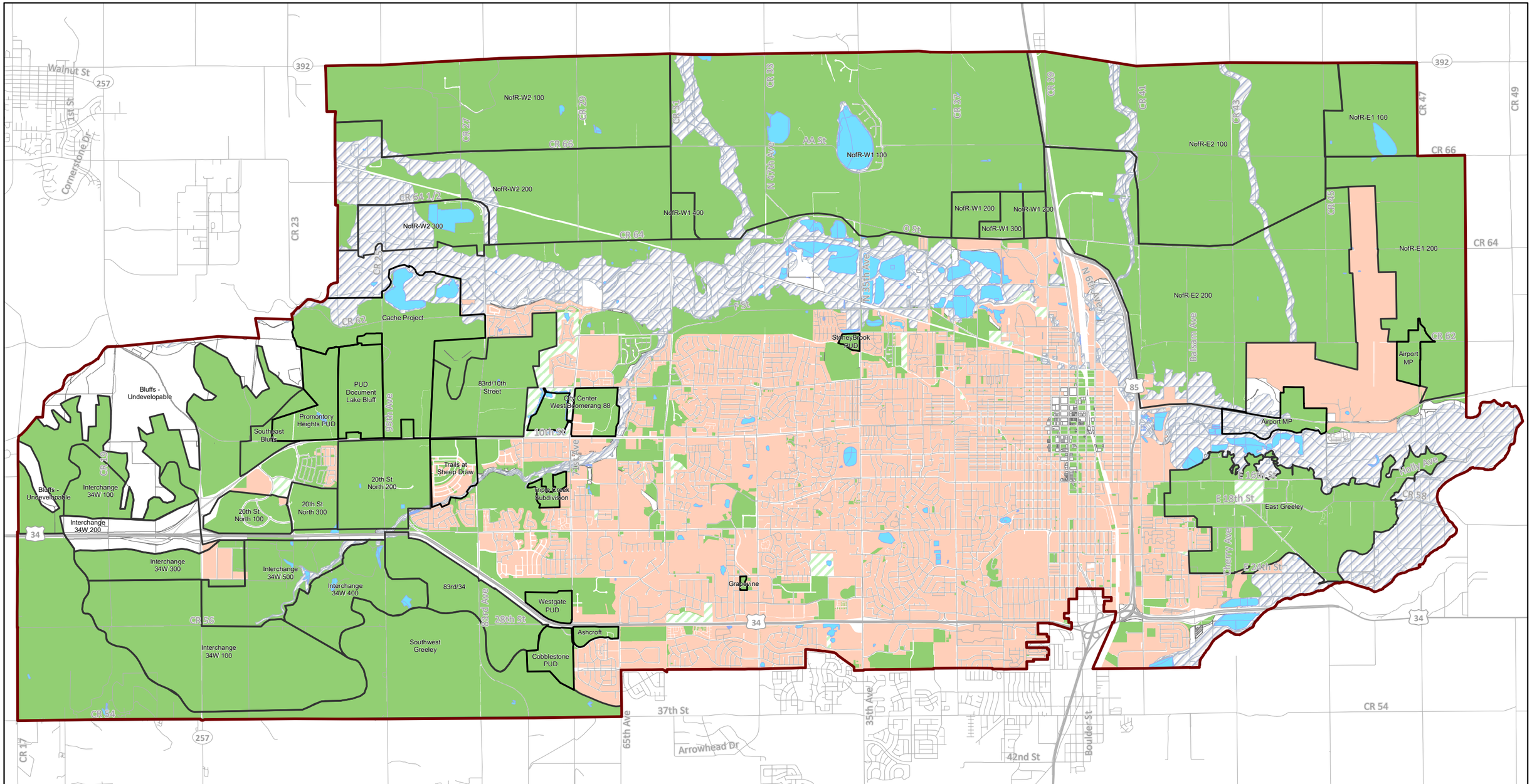

Legend

- LREGA
- Demand Projection Area
- 100-yr Floodplain
- Lakes and Ponds
- Future Development
- Existing Service Area
- No Development
- Park

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Buildout Developed Area

Figure ES-8

Greeley Water System Master Plan

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Table ES-1. Future Peak Month Demand Projections

Projection Tier	Acres	Population	Residential Demand	Nonresidential Demand	Total Demand
			(MGD)	(MGD)	(Million gallons per day [MGD])
Existing	11,883	107,146	N/A	N/A	46.0
2025	15,116	128,458	2.4	2.1	50.5
2040	29,467	179,430	8.2	5.5	59.7
Buildout	44,914	425,271	35.9	20.4	102.4

While the WTDMP is primarily focused on planning for infrastructure needs based on peak summer demands, it is also important for the City to plan for the total annual water demands through buildout. Water conservation methods, such as improved landscaping practices and the encouragement and adoption of NP water for irrigation, may help reduce the City's annual potable water demands. The City previously conducted a water resources planning study (BBC report), which focused on developing three alternative scenarios for annual water demands. The total annual demands developed for the WTDMP under the NP offsets demand scenario at buildout are captured in **Table ES-2**. This demand scenario was modeled for certain demand scenarios, as discussed in **Section 4.2.4**.

Table ES-2. NPMP Annual Demand Projections at Buildout

Demand	Total Water Demand (AFY)	Potable Water Demand (AFY)	NP Water Demand (AFY)
Existing	30,500	28,600	1,900
Future Demands	33,500	28,300	5,200
New I-H Users (6)	10,300	10,300	0
Total	74,300	67,200	7,100

[1] Potable demand shown in this table is for NP offset scenario

ES.5 Model Evaluation and Infrastructure Planning

The future modeling effort was an extension of the existing system model as previously discussed and represents anticipated development through buildout within the LREGA. To fully evaluate the system, it was necessary to analyze various demand conditions that would stress the transmission and distribution system under each timing milestone. These scenarios include the following:

- Peak demands – Equivalent to peak hour during the high demand (summer) season
- Peak demands with fire flow – Utilizing the peak day with fire flow conditions applied
- Water quality – A function of water age evaluated under minimum month conditions

To best accomplish these evaluations, the model was populated with diurnal patterns applied to demands within an extended period simulation (EPS). Peak hour and day analysis was conducted on 48-hour diurnal EPS while water age analysis was conducted for a 24-day continuous simulation (576 hours) to ensure stability in water age.

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ES.5.1 Water Quality Evaluation

Water quality concerns are defined as insufficient disinfection residual for purposes within the WTDMP. Based on historical conditions under which comprehensive disinfection sampling was conducted and for which historical water age modeling had been completed (by others), a comparison was made to determine if a correlation could be found for residual concentration vs. water age. A general trend was established that shows a decay condition over time with a residual level of about 0.2 milligrams per liter (mg/L) corresponding to approximately 190 hours of water age. As a result, predictions of water age above 190 hours were considered a flag for concern that may justify further system investigations.

Recent changes to tank operations at Gold Hill, a storage facility with two reservoirs, have improved turnover in the tanks and reduced water age throughout the system. The new 60-inch Bellvue transmission line will also enable water to be delivered to the west side of the City directly from Bellvue WTP with reduced water age. Additionally, the increased demands shown with each planning horizon can improve turnover in the tanks, improving initial water age over time. A clear conclusion is that water age and disinfection residual will improve with future growth and development; therefore, present conditions represent a general worse case. **Figure ES-9** depicts predicted water age across the system under these existing conditions.

The 2025 and 2040 evaluations showed similar water age trends to the existing system. In general, water ages from west to east, as distance from the Bellvue WTP supply source increases. The exception to this is where water is delivered directly to Mosier Hill from Bellvue WTP and distributed to the central portions of Zones 2 and 3. This results in fresher water and reduced water age in the eastern portions of Zones 2 and 3. Although some areas may appear to have older water than other areas, ongoing sampling throughout the year has confirmed that the City is in compliance with chlorine residuals standards and all other water quality standards required by the Colorado Department of Public Health & Environment (CDPHE), meaning that the older areas are providing safe drinking water for all customers.

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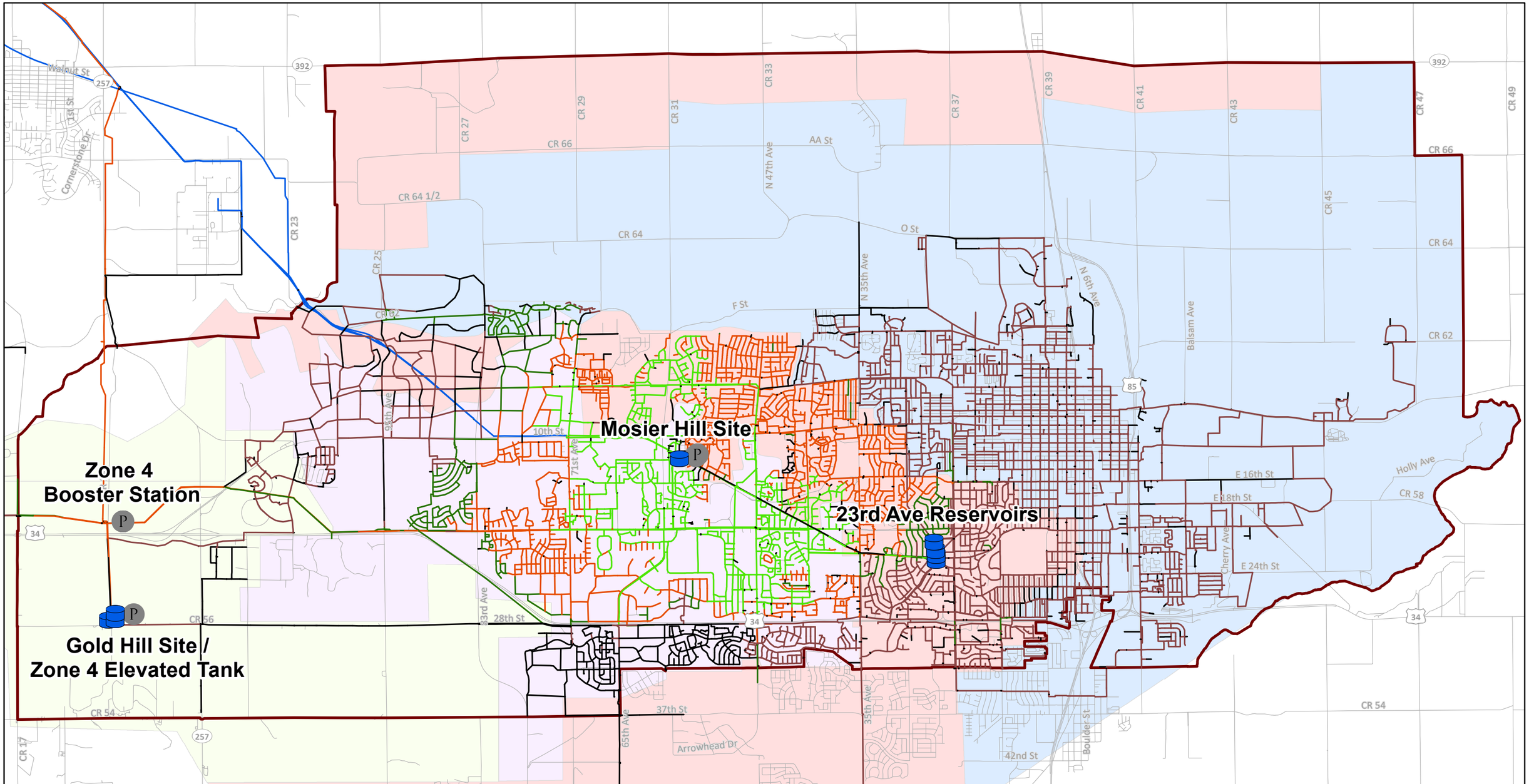

Legend

- LREGA
- Existing Storage
- Existing Pump Stations

Pipes - Average Water Age (hr)

- Less than 24
- 24 - 72
- 72 - 120
- 120 - 168
- 168 - 240
- Greater than 240

Future Pressure Zone

- Zone 1
- Zone 2
- Zone 3
- Zone 4

N

0 0.5 1 2
Miles

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2025 Water Age (Min. Month)

Figure ES-9

Greeley Water System Master Plan

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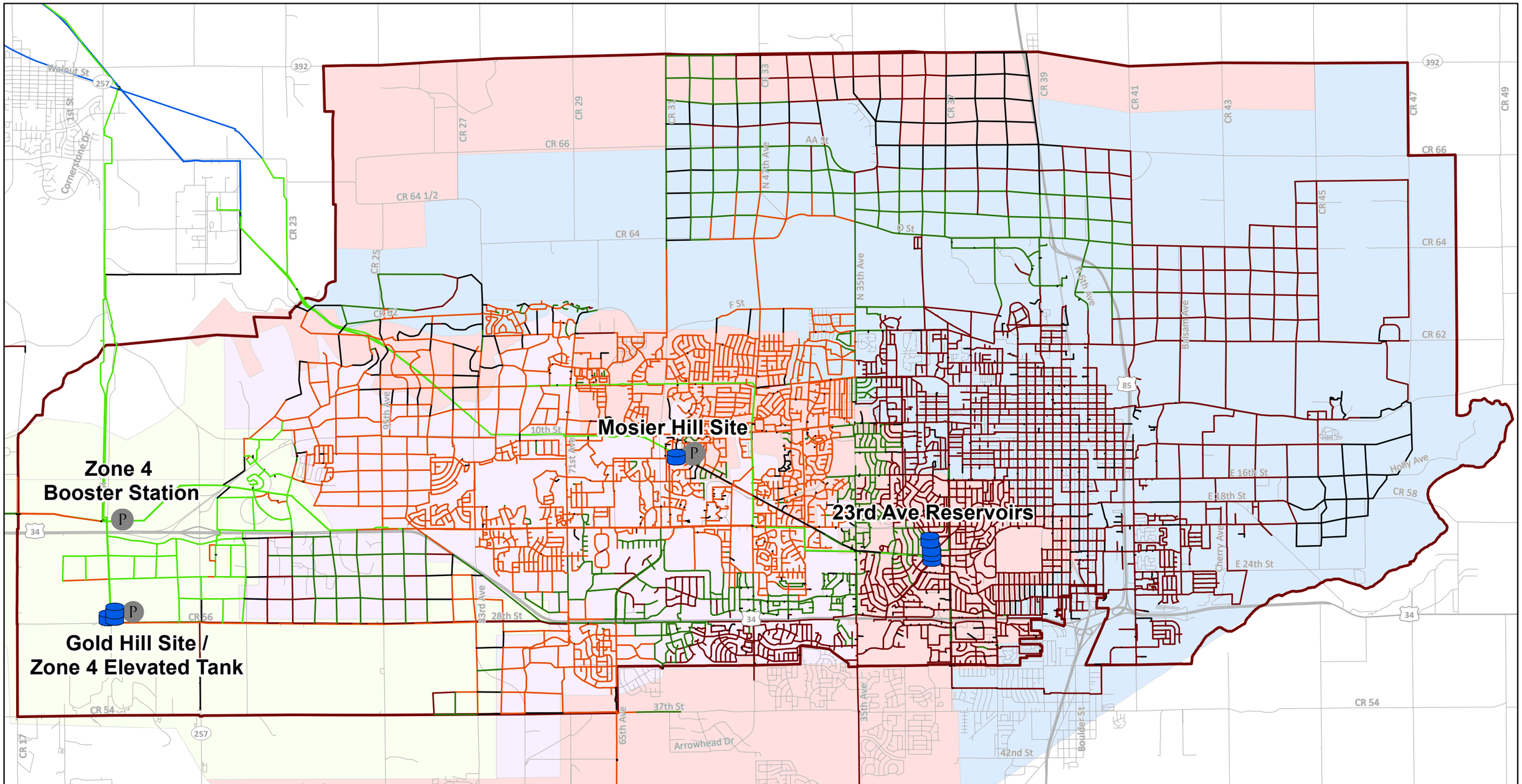

Legend

- LREGA
- Existing Storage
- Existing Pump Stations

Pipes - Average Water Age (hr)

- Less than 24
- 24 - 72
- 72 - 120
- 120 - 168
- 168 - 240
- Greater than 240

Future Pressure Zone

- Zone 1
- Zone 2
- Zone 3
- Zone 4

N

0 0.5 1 2
Miles

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2040 Water Age (Min. Month)

Figure ES-10

Greeley Water System Master Plan

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ES.5.2 Fire Flow Analysis

Fire flow criteria established for the WTDMP were defined as sufficient if a flow under peak day conditions could be maintained at 1,500 gallons per minute (gpm) at existing hydrant locations or established nodes in the future system. Deficient nodes may occur at dead-ends undersized lines or locations with insufficient operating pressure. Some areas such as Spanish Colony and the Evans/Milliken service area are served by alternate fire departments and were not addressed as part of this WTDMP effort. Deficient nodes are summarized in **Table ES-3** to be addressed under the 2025 planning horizon. These values were found to generally correlate with field results provided by the City's fire department. In total, 11,285 feet of existing pipe are recommended to be upsized to meet fire flow, as shown in **Figure ES-11**.

The future system model did not reveal any new deficiencies under either demand scenario for all planning horizons. However, developers should ensure that their designs allow for appropriate fire flow capacity, especially in areas where a full distribution grid may not be fully built yet.

Table ES-3. Fire Flow Improvements (2025)

Deficient Node	Preliminary Available Fire Flow (gpm)	Description of Upgrades Needed to Improve Fire Flow	Final Available Fire Flow (gpm)
CR01373023	640	Upsize lines along 9th Street (from 21st Avenue to 19th Ave) from 4 to 8 inches	2,020
PC01480006	470	Upsize lines along 5th Avenue (from 21st Street to 20th St) from 4 to 8 inches	2,190
RD01304037	320	Upsize some lines along 9th Avenue and 2nd Street from 4 to 8 inches and some from 8 to 12 inches	1,570
TEE01268014	630	Upsize lines along Vern Schaffer Blvd from 4 to 8 inches	2,190
TEE01373033	480	Upsize lines along 21st Avenue (from 11th Street to 10th St) and 10th Street (from 21st Avenue to 20th Avenue) from 4 to 8 inches	1,700
TEE01411006	390	Upsize lines along 1st Avenue and 12th Street from 4 and 6 inches to 8 inches	1,570
TEE01619002	440	Upsize lines from 17th Avenue along 30th Street Rd from 4 and 6 inches to 8 inches	2,210
PC03508001	670	Upsize lines along 22nd Street from 4 to 8 inches	2,980
RD02371020	740	Upsize lines along 31st Avenue from 4 to 8 inches	2,100
RD02371021	470	Upsize line between 32nd Avenue and 31st Avenue from 4 to 8 inches	920 [1]
TEE03475001	750	Upsize lines along W Wagon Trail Road and Homestead Road from 6 to 8 inches	1,550

[1]Adjacent nodes are above 1,500 gpm due to piping upsizing.

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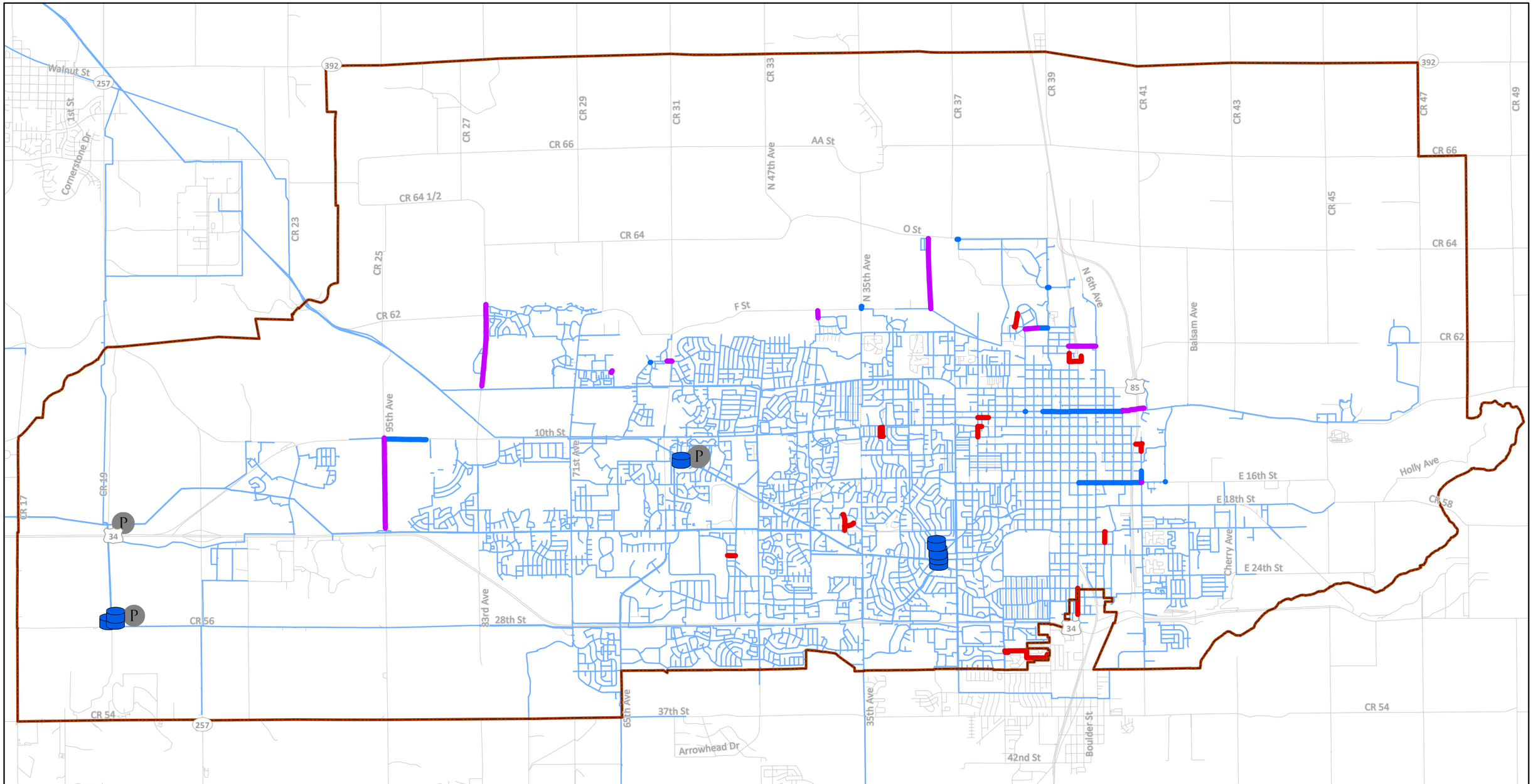

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Legend

- LREGA
- Existing Storage
- Existing Pump Stations
- Existing Pipes

Existing System Improvements

- 2025 Pipe Improvements (Fire Flow)
- 2025 Pipe Improvements
- 2040 Pipe Improvements

N

0 0.5 1 2
Miles

Existing System Improvements
Figure ES-11
Greeley Water System
Master Plan

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ES 5.3 Buildout Configuration

At buildout, many areas are expected to fully develop that are farther out from the City's existing infrastructure. In particular, the North of the River area is expected to see some areas with large pressure swings or consistently low pressures without additional infrastructure. Alternatives were considered for serving this area, as shown in **Figure ES-12**. Because the buildout scenario is so far in the future, additional study will be needed as more information becomes available regarding growth patterns and density.

It was determined that the North Weld option would be considered for additional analysis and system optimization, as the existing intergovernmental agreement would make this a feasible and preferred option to enhance service to the North of River area although additional planning and coordination would be required.

Under all scenarios, it is anticipated that a new reservoir would be needed in Zone 2 North to provide pressure stability in this area as well as emergency short term supply. The location shown in **Figure ES-12** was placed in the model at a point with highest elevation. More detailed studies should be conducted to identify an ideal location, size, and design for this reservoir. The City may also consider coordinating with other regional stakeholders for a potential shared storage to serve this area. At current projections, this new reservoir is not expected for at least 20 years.

It is anticipated that additional pumping capacity would be needed at the Zone 4 pump station by buildout. This pump station was designed with this expansion in mind, and already has empty pump slots that would be filled to meet buildout growth and demands.

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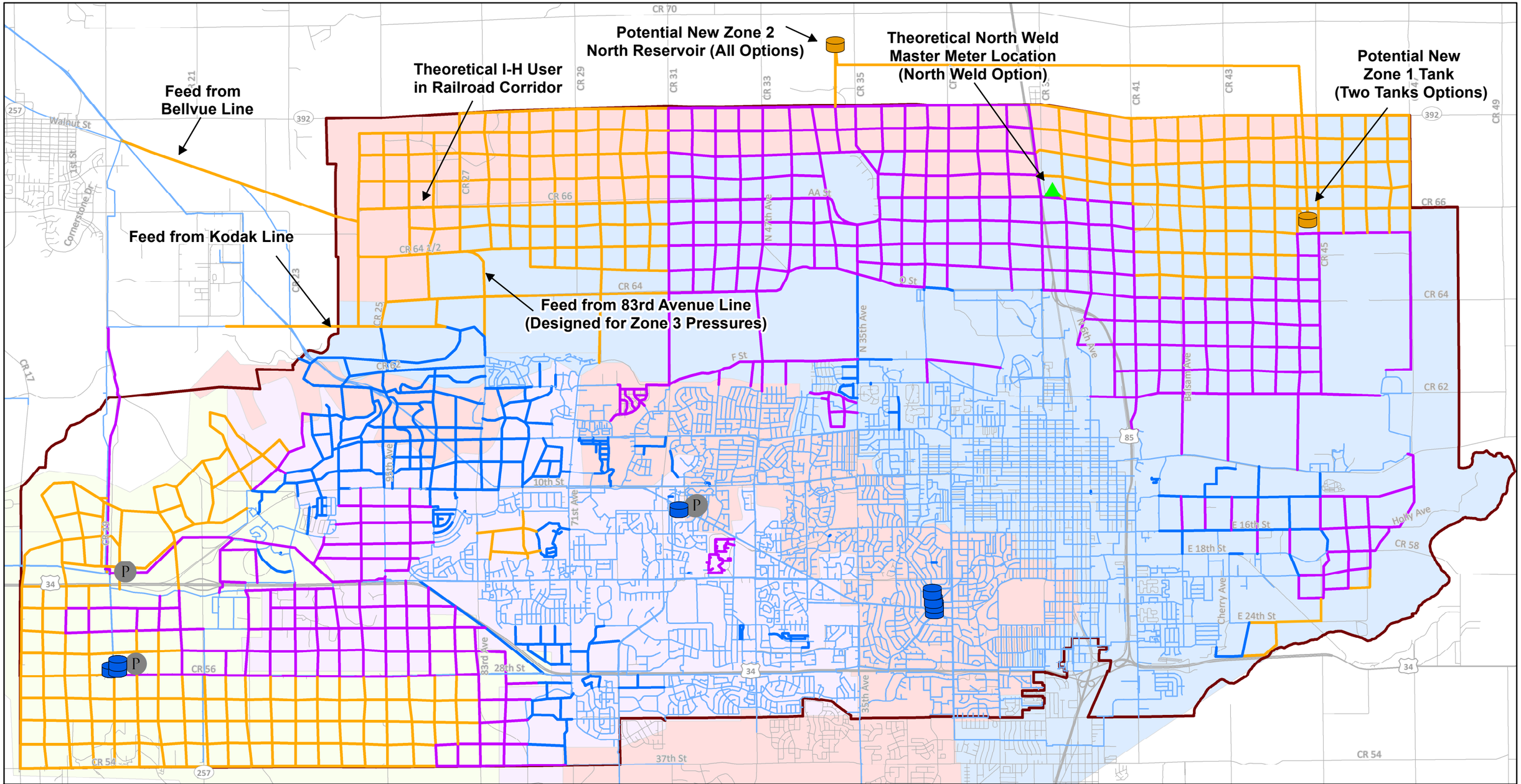

Legend

- LREGA
- Existing Storage
- Existing Pump Stations
- Master Meter
- Future Storage (Buildout)
- Existing Pipes
- 2025 Pipes
- 2040 Pipes
- Buildout Pipes

Future Pressure Zones

- Zone 1
- Zone 2
- Zone 3
- Zone 4

N

0 0.5 1 2
Miles

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Buildout Options Evaluation

Figure ES-12

Greeley Water System Master Plan

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ES 5.4 Summary of Recommended Water System Infrastructure

The total population for the City is projected to increase from about 107,000 to 428,000 between the existing and buildout planning horizons. To accommodate the increase in projected population and resulting demands, future system evaluations indicate a need for a new reservoir in Zone 2 North and additional pumping capacity at the Zone 4 pump station by the buildout planning horizon. The City's water system would need about 400 miles of additional pipe to serve buildout demands, as shown in **Table ES-4**. A good portion of the new pipes are development-driven and therefore will be the responsibility of the developer rather than the City.

Table ES-4. Length of New Pipe by Diameter and Planning Horizon

	Length of Pipe by Diameter (Miles)								
Planning Horizon	**8-inch**	**12-inch**	**16-inch**	**20-inch**	**24-inch**	**27-inch**	**36-inch**	**60-inch**	**Total**
2025	26.7	24.3	8.1	1.7	-	-	-	0.8	61.6
2040	99.3	41.5	18.9	2.1	7.1	-	3.3	1.9	174.1
Buildout	88.9	32.6	31.2	2.8	11.8	2.8	-	-	170.2
Total	214.9	98.4	58.2	6.7	19.0	2.8	3.3	2.7	405.9

[1]Table does not include existing pipes that would need to be upsized in the future.

[2]Table includes both City and development-driven projects. Projects will be broken out by responsible party in CIP.

ES.6 Capital Improvement Plan Projects and Schedule

The opinion of probable construction cost (OPCC) is considered the costs borne by the contractor to construct a capital project. The project CIP costs include the OPCC and project implementation costs, such as planning and design, administration, and construction management. Assumptions made during CIP development can add to the variability of final bid project costs when compared to the planning level costs. The assumptions are necessary to capture costs for project elements that cannot be defined at a planning level. Project CIPs were developed using modeled pipeline quantity estimates and data multiplied by unit cost estimates. During design development, the more specific data will be used to inform the design and resulting project cost estimate. **Table ES-5** provides a breakdown of the different costing factor assumptions used for project implementation and contingency.

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Table ES-5. Costing Factors for Construction Bid and Total CIP Project Costs

Category	Item	Costing Factor
Construction Bid Cost (includes infrastructure and contractor overhead, profit, bonds, and insurance)	Erosion Control/Stormwater Pollution Prevention[1]	2%
	Mobilization and Demobilization[1]	5%
	Contingency[2]	35%
Project Implementation[3]	Feasibility and Site Studies	9% for OPCC ≤ $1 million 6% for OPCC of $1 million to $10 million 5% for OPCC > $10 million
	Preliminary and Final Design	9% for OPCC ≤ $1 million6% for OPCC of $1M to $10 million5% for OPCC > $10 million
	Engineering Services During Construction	5%
Additional Project-Related Costs[3]	Outside Construction Management - not used if OPCC is < $1M	5%
	Outside Project Management - not used if OPCC value is < $1M	3%

[1] Construction costing factors for erosion control/stormwater pollution prevention, mobilization, and demobilization are added to the subtotal of unit cost items.

[2] Contingency is 35% of the subtotal of the unit cost items and contractor born costs determined by costing factors.

[3] Project implementation and additional project-related cost categories are determined as a percentage of the construction cost and part of the total CIP project costs.

ES.6.1 Identified CIP Projects

Figures ES-13 and **ES-14** show locations of 5-year and 20-year recommended capital improvements based on the hydraulic analysis associated with the WTDMP. Identified projects were categorized into two groups—City and development projects for the 2025 (projects for 2020 through 2025) and 2040 (projects for 2026 through 2040) time frames. Unique project tag identifiers were assigned for each project based on directional grids system across the LREGA. Detailed cost estimates (breakdowns of OPCC and/or total CIP costs) per project can be found in **Appendix B**.

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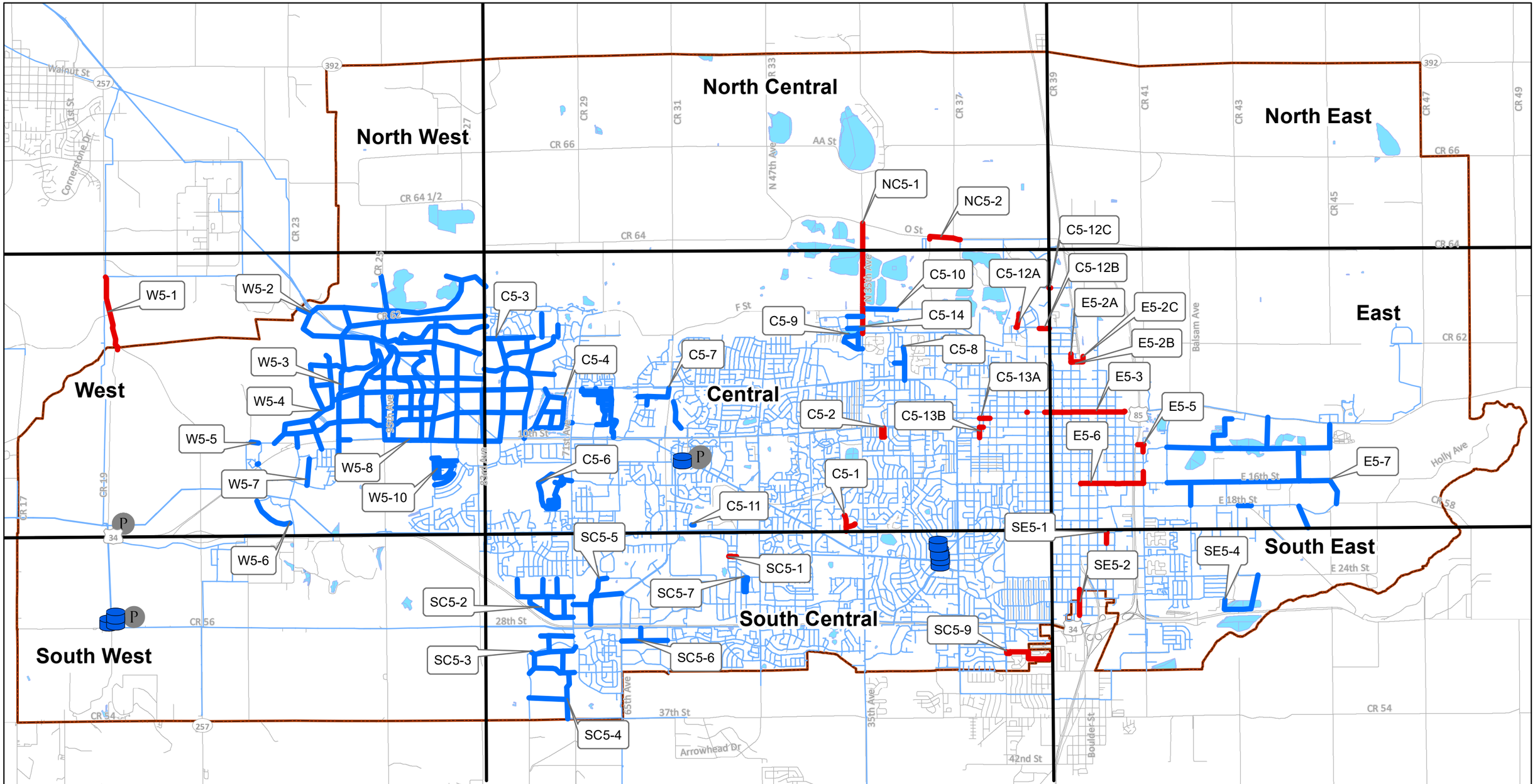

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Legend

- LREGA
- Tanks
- Pump Station
- Lakes and Ponds
- Existing Pipes
- 2025 City CIP Projects
- 2025 Development Projects
- CIP Grids

N

0 0.5 1 2
Miles

Recommended 5-Year Improvements

Figure ES-13

Greeley Water System Master Plan

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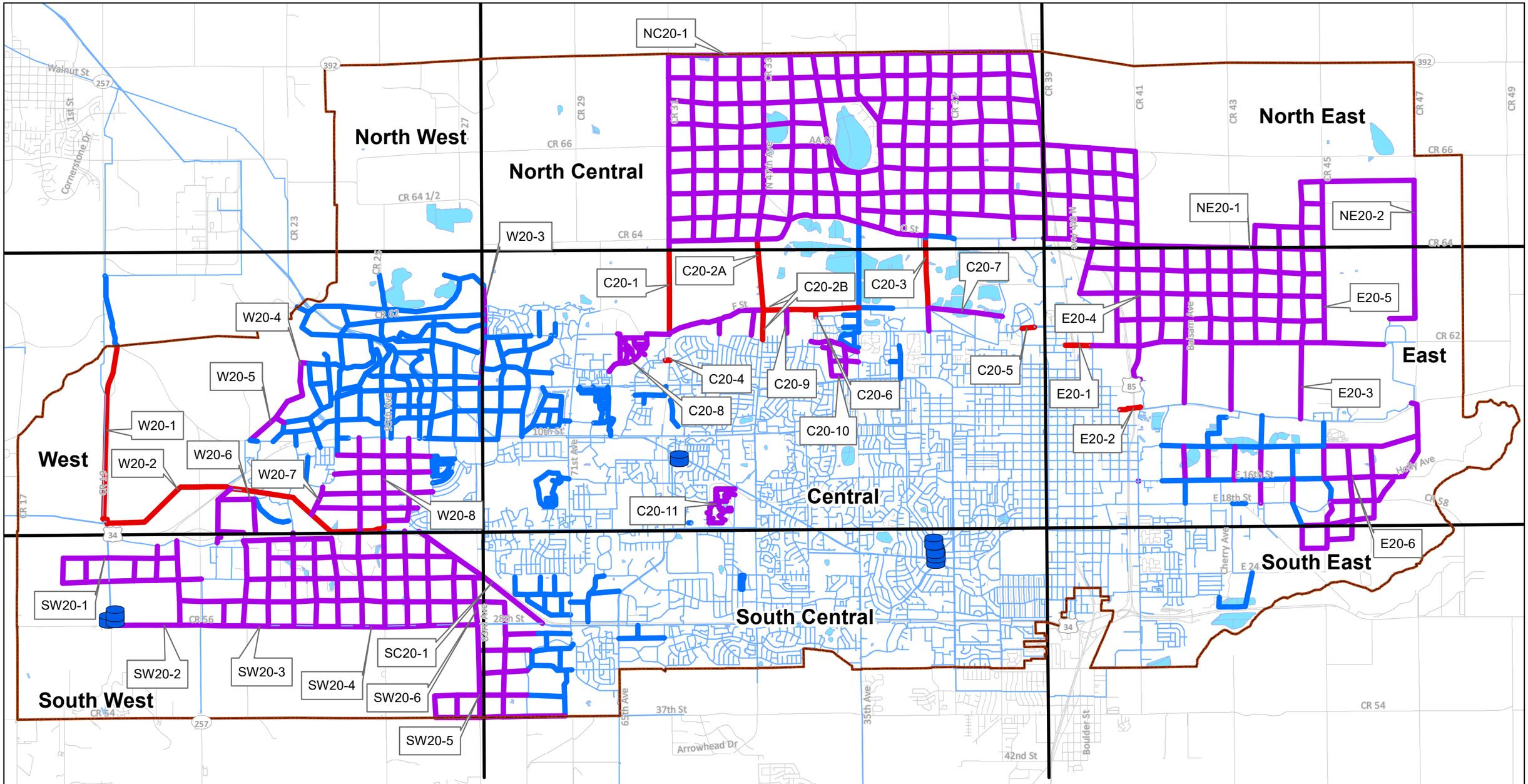

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Legend

- LREGA
- Tanks
- Pump Station
- Lakes and Ponds
- Existing Lines
- 2025 City CIP and Development Projects
- 2040 Development Projects
- 2040 City CIP Projects
- CIP Grids

N

0 0.5 1 2
Miles

Recommended 20-Year Improvements

Figure ES-14

Greeley Water System Master Plan

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ES.6.2 CIP Implementation Schedule

The CIP schedule implementation process considered several other factors that influence a project schedule in addition to the hydraulic evaluation. The City provided Water and Sewer 10-year CIP, public works CIP, and parks CIP to integrate with projects identified in the WTDMP for developing CIP implementation schedules.

Table ES-6 provides cost information for the 5-year and 20-year CIP projects with anticipated planning, design, and construction start dates. **Table ES-7** presents City rehabilitation projects with anticipated construction start dates and projected total costs. The growth-driven projects will be funded by either the City or developer (or combination), depending on the project driver.

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Table ES-6. 5- and 20-Year City CIP Summary

Projects	Project Type	Project Driver	Project Location	Planning Start Year	Design Start Year	Construction Start Year	OPCC (Millions)	CIP Total Cost (Millions)
5-Year Planning Horizon								
C5-12C	Pipe Replacement	Capacity Improvement	H St. & 11th Ave.	2021	2022	2023	$0.1	$0.1
C5-14	New Pipe	Projected Development	35th Ave. (F St. to C St.)	2021	2022	2022	$0.7	$0.9
C20-2B	New Pipe	F St. Water & Wastewater Operations Facility	F St. (47th Ave. to 35th Ave.) & 47th Ave. (F St. to B St.)	2021	2022	2023	$3.1	$4.0
W5-1	New Pipe	Projected Development	Gold Hill: Windsor Phase (Hwy 257)	2022	2023	2024	$6.2	$8.0
C5-12B	Pipe Replacement	Capacity Improvement	Island Grove Park (D St.)	2022	2023	2024	$0.3	$0.4
NC5-2	New Pipe	Projected Development	O St. (23rd Ave. to 25th Ave.)	2022	2023	2024	$0.3	$0.4
NC5-1	New Pipe	Projected Development	35th Ave. (O St. to F St.)	2024	2025	2026	$3.3	$4.1
C5-1	Pipe Replacement	Fire Flow Improvement	Homestead Rd. & W Wagon Trail Rd.	2025	2026	2027	$0.4	$0.5
C5-2	Pipe Replacement	Fire Flow Improvement	11th St. (32nd Ave. to 31st Ave.)	2025	2026	2027	$0.4	$0.5
C5-12A	Pipe Replacement	Fire Flow Improvement	Island Grove Park (Vern Schaffer Blvd.)	2025	2026	2027	$0.2	$0.3
C5-13A	Pipe Replacement	Fire Flow Improvement	9th St. (19th Ave. to 21st Ave.)	2025	2026	2027	$0.2	$0.3
C5-13B	Pipe Replacement	Fire Flow Improvement	10th St. (20th Ave. to 21st Ave.) & 21st Ave. (10th St. to 11th St.)	2025	2026	2027	$0.3	$0.4
E5-2A	Pipe Replacement	Fire Flow Improvement	9th Ave. (1st St. to 2nd St.)	2026	2027	2028	$0.2	$0.3
E5-2B	Pipe Replacement	Fire Flow Improvement	2nd St. (West of 8th Ave. to 9th Ave.)	2026	2027	2028	$0.4	$0.5
E5-2C	Pipe Replacement	Fire Flow Improvement	West of 8th Ave. (1st St to 2nd St.)	2026	2027	2028	$0.1	$0.2
E5-5	Pipe Replacement	Fire Flow Improvement	12th St. & 1st Ave.	2026	2027	2028	$0.3	$0.4
SC5-1	Pipe Replacement	Fire Flow Improvement	22nd St. (50th Ave. to 51st Ave.)	2026	2027	2028	$0.1	$0.2
5-Year Subtotal							**$16.6**	**$21.2**

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Projects	Project Type	Project Driver	Project Location	Planning Start Year	Design Start Year	Construction Start Year	OPCC (Millions)	CIP Total Cost (Millions)
20-Year Planning Horizon								
E5-6	Pipe Replacement	Capacity Improvement	1st Ave., 16th St., & 18th St. (1st Ave. to 7th Ave.)	2027	2028	2029	$2.5	$3.2
W20-1	New Pipe	Projected Development	Gold Hill Segment Phase 2 (Bellvue Line)	2027	2028	2029	$10.8	$13.9
C20-1	New Pipe	Projected Development	59th Ave. (O St. to F St.)	2027	2028	2029	$3.9	$4.8
C20-3	Pipe Replacement & New Pipe	Projected Development and Capacity Improvement	25th Ave. (O St. to F St.)	2027	2028	2029	$2.2	$2.8
SE5-1	Pipe Replacement	Fire Flow Improvement	5th Ave. (20th St. to 21st Ave.)	2028	2029	2030	$0.2	$0.3
C20-4	Pipe Replacement	Capacity Improvement	1st St. (56th Ave. to 59th Ave. Ct.)	2028	2029	2030	$0.4	$0.4
E5-3	Pipe Replacement	Capacity Improvement	8th St. (3rd Ave. to 12th Ave.)	2029	2030	2031	$2.4	$3.0
SC5-9	Pipe Replacement	Fire Flow Improvement	30th St. Rd. (11th Ave. to 17th Ave.)	2029	2030	2031	$1.2	$1.5
E20-1	Pipe Replacement	Capacity Improvement	A St. (6th Ave. to 9th Ave.)	2030	2031	2032	$1.1	$1.4
E20-2	Pipe Replacement	Capacity Improvement	9th St. (1st Ave. to 3rd Ave)	2032	2033	2034	$1.1	$1.4
C20-5	Pipe Replacement	Capacity Improvement	Island Grove Park	2034	2035	2036	$0.3	$0.4
W20-2	New Pipe	Projected Development	Boyd WTP Transmission Line (North of US 34 from 95th Ave. to CR 17)	2036	2037	2038	$12.3	$15.8
C20-2A	New Pipe	Projected Development	47th Ave. (O St. to F St.)	2037	2038	2039	$3.5	$4.6
SE5-2	Pipe Replacement	Fire Flow Improvement	8th Ave. (25th St. to 27th St. Rd.)	2038	2039	2040	$0.5	$0.6
C20-6	Pipe Replacement	Capacity Improvement	St. U (F St. to St. W)	2039	2040	2041	$0.2	$0.2
20-Year Subtotal							**$42.4**	**$54.1**
						Total	**$59.0**	**$75.3**

Note: CIP schedule was adjusted based on other master plans and public works CIP projects.

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Table ES-7. 5-Year City Rehab Summary

Projects	Construction Start Year	Total Cost (Millions)
19th Avenue - 6th Street Road to 7th Street and 6th Street Road – 18th Avenue to 19th Ave	2022	$0.1
1800 block of 28th Avenue CDS	2022	$0.02
400 and 500 block of E 20th Street	2022	$0.1
500 block N 9th Avenue	2022	$0.1
5500 27th Street	2022	$0.1
200 23rd Avenue	2022	$0.1
1st Street - 23rd Avenue to mobile home park master meter	2022	$1.0
2100 30th Street Apartment Complex	2023	$0.3
6500 and 6400 28th Street	2023	$0.2
11th Avenue and Highway 34 bypass	2025	$0.4
30th Street - 17th Avenue to 23rd Avenue	2026	$0.5
49th Street between 65th Avenue and 47th Avenue	TBD	—
49th Street - 83rd Avenue to 95th Avenue Grid Line	TBD	$1.1
5th Avenue – 14th Street to 15th Street	TBD	—
Tie-in 13th Street 2900 Block/Scott School Lane, new fire hydrant and major valve work	TBD	$0.01
83rd Avenue and 49th St	TBD	$0.1
Kodak Water Line Replacement	2021	$3.0
24018 West County Road 15 (Line 1)	2022	$0.2
Lemay (Line 3)	2022	$0.2
Forest Hills (Line 1)	2022	$0.2
20th/95th Avenue	2023	$0.7
Highway 257	2024	$1.6

Based on the 5- and 20-year CIP schedule, annual funding requirements for City water projects from 2021 through 2040 are shown in **Figure ES-15**.

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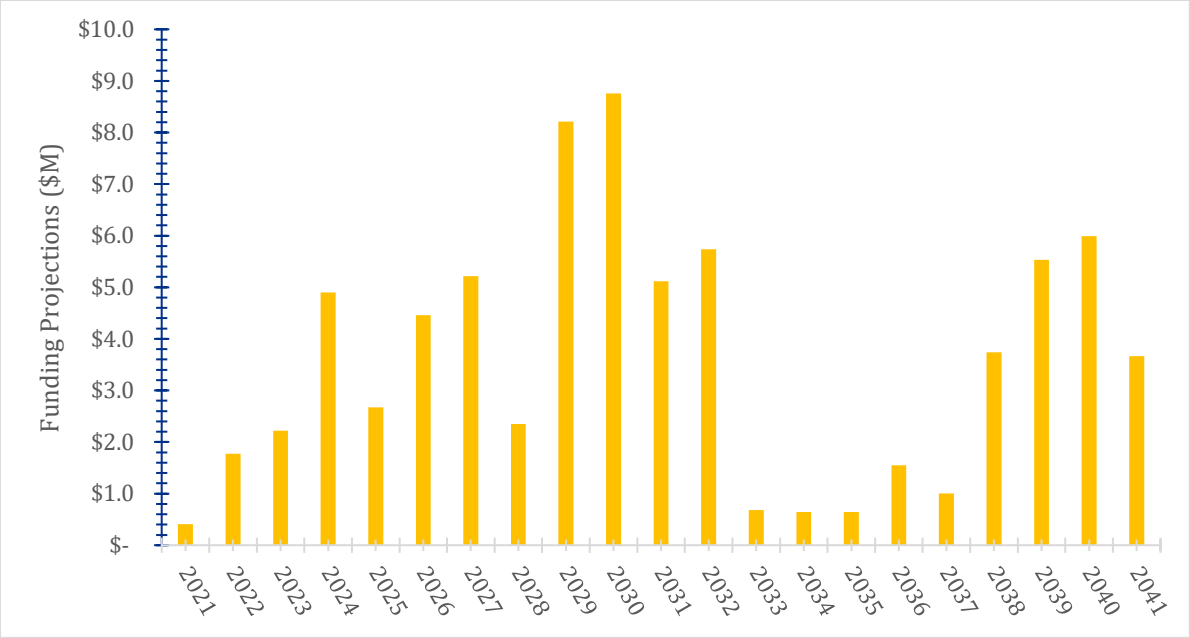

Figure ES-15. Annual Water Funding Projections for City CIP Projects

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Section 1

Background and Project Purpose

The City continues to experience strong growth in population through both infill and expansion of residential, industrial, and commercial development within the City's defined service area. To address existing and future system needs with consideration of growth, existing system performance, and improvements required to meet their committed level of service to the new growth areas, the City has developed a new WTDMP (2021). This master plan documents the approach and assumptions used to evaluate the system and define the capital improvements needed for the long-range CIP for the water transmission and distribution system through the year 2040.

1.1 Master Planning Process and Organization

The WTDMP was developed in conjunction with the City's SSMP and NPMP. The City integrated the three master created a consistent approach to determining existing and future population and water demands and to define capital projects and costs. A schematic of the City's integrated water system for water, wastewater, and non-potable water is shown in **Figure 1-1**.

Figure 1-1. Greeley's Integrated Water System

The future population projections and associated water demand, planning horizons, and approach to capital and project cost development are consistent between the three master plans, as shown in **Figure 1-2**. This figure also shows the critical points of coordination between the three master plans.

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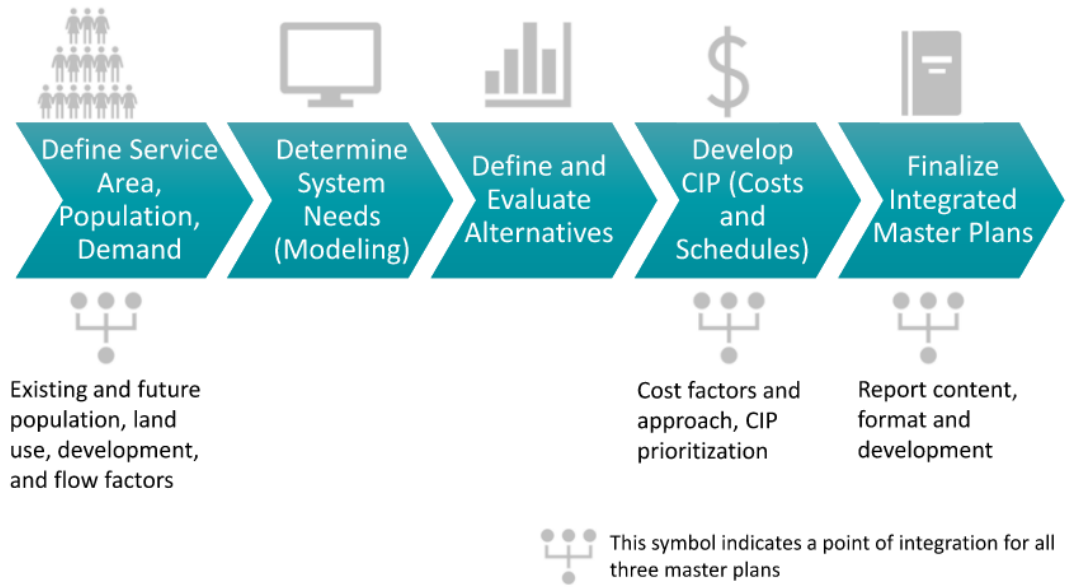

Figure 1-2. Master Plan Approach and Integration with other Master Plans

1.1.1 Report Organization

The WTDMP is organized into the following sections:

- Section 1 – Background and Project Purpose
- Section 2 – Future Population and Water Demand Projections
- Section 3 – Future System Model Development
- Section 4 – Future System Model Evaluation
- Section 5 – Capital Improvements Plan
- Section 6 – Findings and Recommendations

1.2 Existing System Overview

The City's existing water distribution system is described in this section. In general, the system has two components: transmission and distribution. The transmission system brings water from two WTPs into four storage facilities, which helps balance out fluctuating demands and provides emergency storage. From there, the distribution system piping conveys water to customers in four pressure zones. Three pump stations support this system. The system also uses pressure reducing valves (PRVs) to supply water across certain pressure zone boundaries. **Figure 1-3** illustrates the highlights of the City's existing water system.

1.2.1 Treatment

Water is supplied to the distribution system from the Bellvue WTP and Boyd Lake WTP. The Bellvue WTP supplies water from a clearwell through 30 miles of various transmission pipelines to all storage facilities. The Boyd Lake WTP supplies water from a clearwell by pumping directly

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into the Zone 3 distribution system, which fills the Gold Hill reservoirs. The Boyd Lake WTP only operates during peak months and is considered to be a peaking plant to help the primary Bellvue WTP, which operates year-round. Bellvue WTP has a capacity of 35 MGD and Boyd Lake WTP has a capacity of 38 MGD.

1.2.2 Pressure Zones

The City's water system operates under four pressure zones to provide adequate service at acceptable pressures as shown in **Figure 1-3**. Four pressure zones are served by a combination of flows and sources.

- Zone 1 is served entirely by gravity flow from the Bellvue WTP. This Zone starts at 4,740 feet and extends to the far east.
- Zone 2 is served by PRVs from Zone 3. This Zone extends from 4,840 feet to 4,740 feet.
- Zone 3 is served directly from the Boyd Lake WTP lines and from the Gold Hill reservoirs (which receive water from both Bellvue WTP and the Boyd Lake WTP). This Zone extends from 4,940 feet to 4,840 feet.
- Zone 4 currently has the least development. It is served from the Zone 4 elevated tank, which is filled from Bellvue WTP and Boyd Lake WTP via the Zone 4 pump station. This Zone extends from 5,100 feet to 4,940 feet.

1.2.3 Storage Facilities

The distribution system includes four treated water storage facilities (eight total tanks) with a total storage capacity of 74.5 million gallons (MG). The tank type, names, location, and capacity per tank are summarized in **Table 1-1.** The 23rd Avenue reservoirs facility consists of four storage tanks connected to each other, which float on the hydraulic grade line (HGL) in the zone. The Gold Hill facility consists of two reservoirs (15 MG and 5 MG) on the same HGL. In total, the system has 74.5 MG of storage, including the additional storage at 23rd Avenue Reservoir #4.

Table 1-1. Storage Facilities

Storage Tank	Type	Overflow Elevation (feet)	Pressure Zone Served	Capacity (MG)
23rd Avenue Reservoirs	3 underground; 1 aboveground	4841	1	30[1]
Mosier Hill Tank	underground	4868	2/3	15
Gold Hill Reservoirs	2 underground	5073	3	20
Zone 4 Elevated Tank	elevated	5225	4	2

[1] Reservoir #4 can also provide an additional 7.5 MG of emergency storage via pumping into the other reservoirs, bringing the total potential storage at 23rd Avenue Reservoirs to 37.5 MG.

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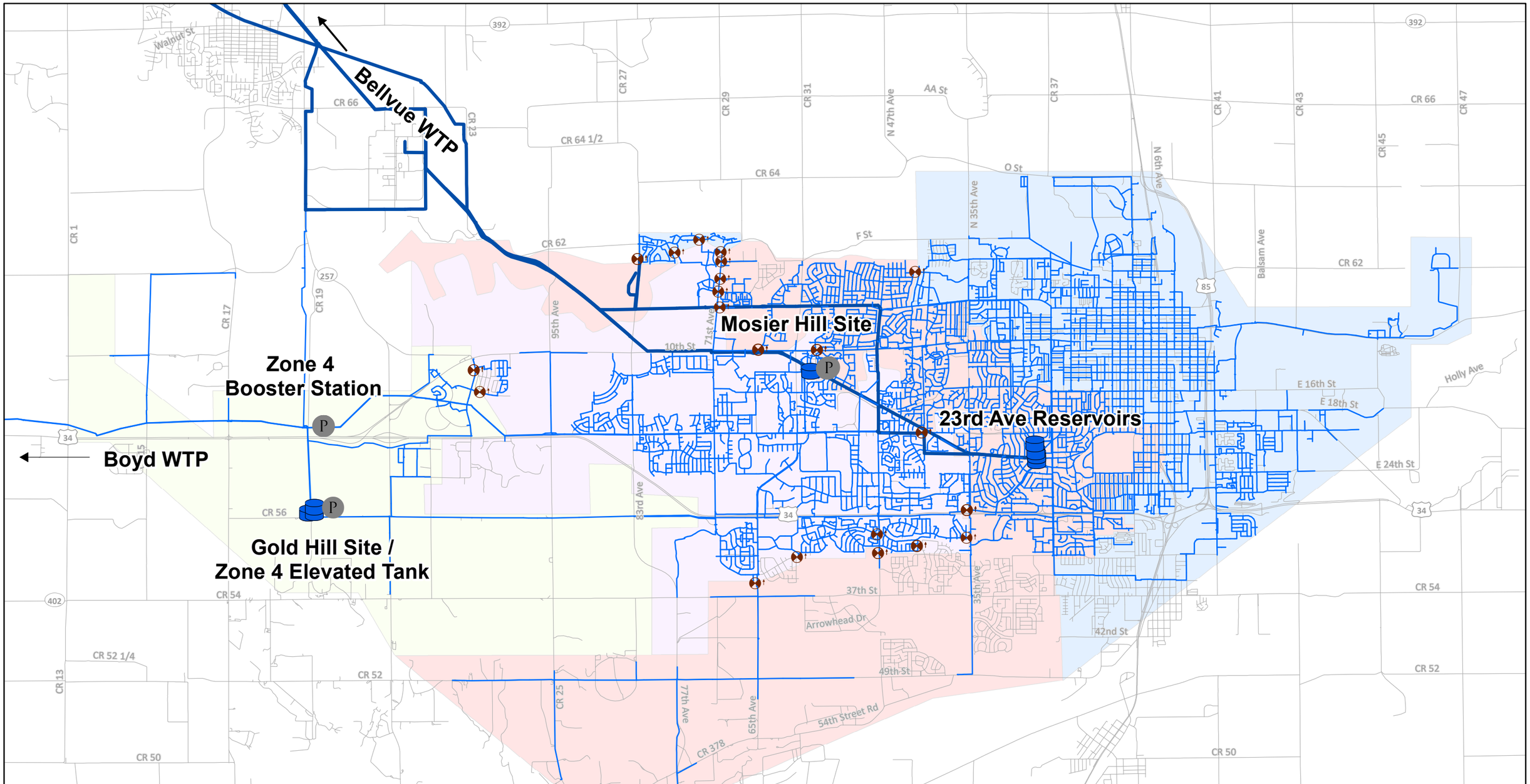

Legend

- Existing Pump Stations
- Existing Storage
- PRV
- Distribution Mains
- Transmission Mains

Existing Pressure Zones

- Zone 1
- Zone 2
- Zone 3
- Zone 4

N

0 0.5 1 2

Miles

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May 06, 2021

Existing Water System

Figure 1-3

Greeley Water System Master Plan

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1.2.4 Pump Stations

The City's water system includes four pump stations. One of these is used to pump treated water from Boyd Lake WTP to Zones 3 and 4. The remaining three are part of the distribution system. The Zone 4 jockey pump acts as a booster pump, taking suction directly from Zone 3 to supply the Zone 4 elevated tank and serve the higher-pressure Zone 4. This pump is not used regularly. During higher Zone 4 demands, flow to the elevated tank is supplemented by a higher-capacity Zone 4 pump station, which takes suction directly from the Bellvue WTP and Boyd Lake WTP transmission lines. Water from the Mosier Hill storage tank is pumped to Zone 3 through Mosier Hill North and South pump stations. **Table 1-2** summarizes rated capacities of all the pump stations.

Table 1-2. Pump Stations Summary

Pump Station	Pump Number	Pressure Zone Served	Rated Capacity (gpm)	Rated Head (feet)
Boyd Lake WTP North[1]	6	3	7,000	312
	7		7,000	312
	8		7,000	312
	9		7,000	312
	10		7,000	312
Zone 4 Pump Station	1	4	200	250
	2		500	250
	3		750	250
	4		2,500	300
	5		2,500	300
Mosier Hill North	1	3	1,500	262
	5		2,800	190
	6		2,800	210
	7		2,800	210
Mosier Hill South	2	3	2,100	190
	3		1,000	198
	4		1,000	198
	T1		100	20
	T2		100	20
Zone 4 Jockey Pump	1	4	230	164

[1]Boyd Lake WTP South was recently put out of service.

1.2.5 Pipelines

The water distribution and transmission system consist of about 641 miles of piping, ranging in size from 1- to 60-inches in diameter. There are three major transmission lines from Bellvue WTP and two major transmission lines from Boyd Lake WTP with sizes ranging from 20-inch to 60-inch. Pipe materials include cast iron, concrete, ductile iron, steel , and PVC. Pipe lengths for various pipe sizes are tabulated in **Table 1-3**. The 12-inch and smaller diameter pipes account for 67% of total pipe length and 16-inch and larger pipes account for 33% of total pipe length.

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Table 1-3. Pipes Summary

Pipe Diameter (inches)	Pipe Length (miles)
< 8	133
8	231
10	9
12	52
16	34
20	46
24	19
27	52
30	16
34	8
36	6
38	2
48	3
54	6
60	25
Total Miles of Pipe	***641***

1.2.6 Valves

The City's water distribution system includes several PRVs that regulate downstream pressure when there is substantial drop in topographical elevations and thereby control delivery of excessive pressures to customers. These PRVs are generally located along the boundary between Zones 4 and 3 and the boundary between Zones 3 and 2. There are also three main control valves on the transmission system that regulate flow to the 23rd Avenue reservoirs. Zone valves or isolation valves which are normally closed separate the pressure zones across boundaries, especially along the boundary between Zones 2 and 1.

1.3 Summary of Previous Water Master Plan

This master plan builds on information and analysis completed in the 2003 MP, which is summarized below. Refer to **Section 4.5** for more information on how the conclusions and modeling results of this WTDMP correlate with the 2003 MP.

The 2003 MP focused on evaluating projects necessary for the 2020 planning horizon, along with longer-term plans for 2050. It focused on meeting demands through the urban growth boundary, instead of the LREGA. A 2.5% population growth was assumed through 2020, and a 2.0% population was assumed from 2020 to 2050.

While the scope of the 2003 MP and this WTDMP overlap, the WTDMP focuses more on distribution, and the 2003 MP focused more on supply. The 2003 MP looked at 57 potential new raw water supply sources, five treatment plant alternatives, and associated transmission options. It emphasized the need for water conservation, including maximizing non-potable water usage, which is still a key goal for the City. Financial recommendations, such as the establishment of a

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future water account, were discussed in greater detail in the 2003 MP than in the WTDMP. Ultimately, the 2003 MP provided a CIP through 2012.

1.4 Summary of Available Data

The City-provided information used to inform the development of the master plan update is described in the following sections. This information includes mapping, asset information, planning data, and historical data like SCADA and sampling records.

1.4.1 Water System Hydraulic Model

The City provided a hydraulic model of their existing water system, developed in InfoWater under a separate contract by others. The existing system model was built on 2018 SCADA and geographic information system (GIS) data. The existing system model was calibrated to September 2018 SCADA data (using time-based controls for the 24-day run), and included scenarios for average month, minimum month, and peak month demands. The existing model was also evaluated for power costs, water age, source tracing, and fire flow analyses. This calibrated existing system model was used to build and evaluate future water systems as part of the WTDMP.

The existing model was accompanied by a report, *2018 Water Distribution System Model* (2019), which summarized key components of the existing system and described the model development, validation, calibration, and various analyses conducted.

1.4.2 GIS Data

The City provided their current GIS files (November 2019) including planning, land use, population, water system, and drainage information. Although comprehensive GIS data on the existing system was provided, this data was primarily supplemental to the existing water system model, which was the primary source of the existing system network.

1.4.3 Historical Data Collection Records

The City provided historical reservoir, WTP, and water quality sampling data, as summarized in **Table 1-4**.

Table 1-4. Historic Data Records

Data Provided	Description
Reservoir Flow	Spreadsheet of hourly influent and effluent flow data for the 23rd Avenue reservoirs, Mosier Hill, and Gold Hill from 7/18/16 through 7/24/16
Plant Production	Spreadsheet of daily flow data for Bellvue WTP and Boyd Lake WTP from 1/1/10 through 1/1/20
Plant Peak Week Production	Spreadsheet of hourly flow data for Bellvue WTP and Boyd Lake WTP from 7/18/16 through 7/24/16
Sampling Data	PDF records of monthly water quality sampling and a pdf of sampling locations

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1.4.4 Planning Information

Tables 1-5 and **1-6** review the previous studies, reports, planning information, and intergovernmental agreements provided by the City. The City of Greeley adopted the I*magine Greeley Comprehensive Plan* in 2018, which is a policy guide that provides framework for public and private growth and development decisions made by the City of Greeley over the next ten to twenty years. As a part of the Comprehensive Plan, a list of recommended actions was identified in Chapter 5 to assist in implementation of this plan. A summary of action items addressed with the development of this WTDMP to ensure implementation of the Comprehensive Plan can be found in **Appendix G**. In addition to this data, the City provided the City of Greeley Design Criteria and Construction Specifications (City's Specifications) and monthly water billing data (2014–2019).

Table 1-5. Previous Studies and Reports

Report	Year
2018 Water Distribution System Model	2019
Aims and University of Northern Colorado (UNC) Reports	2020
Airport Master Plan	2016
Annual Growth and Development Projections Report	2019
Boomerang 88 Subdivision Sewer System Analysis	2007
Cache Project Planned Unit Development (PUD)	2020
City Center West Hydraulics Report	2019
City of Greeley Population and Water Demand Projections	2018
City of Greeley Strategic Housing Plan	2018
Cobblestone PUD	2019
Downtown Redevelopment Plan	2020
Final Hydraulic Report – The Trails at Sheep Draw	2018
Gold Hill Overview	2019
Grapevine PUD	2019
Imagine Greeley Comprehensive Plan	2018
Imagine Greeley Comprehensive Plan Appendices	2018
Imagine Greeley Comprehensive Plan Economic Analysis	2017
Initial Distribution System Evaluation Report	2009
Lake Bluffs PUD 2019	2019
Lake Bluffs PUD 2020	2020
Lakes Bluffs East Area	2013
North of the River Study	2010
Promontory Heights PUD	2019
Stoneybrook PUD	2019
Triple Creek Subdivision PUD	2019
Water Facilities Master Plan	1977
Water Master Plan	2003
Westgate PUD	2019

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Table 1-6. Intergovernmental Agreements

Name	Type	Year
Garden City	Water and sewer service	2018
Milliken	Water service	2017
Windsor	Water service	2017
North Weld Water Service	Water service	2013
Windsor Greeley Intergovernmental Agreement Cooperative Land Use Agreement	Development and utility service	2008
Town of Windsor	Development and utility service	2004
Evans	Water service	1998

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Section 2

Future Water Demand Projections

To plan for the water needs of the City, current and future demands on the system were analyzed to help determine what steps the City should take to ensure that sufficient supply is available. This section presents the methodology for projecting and distributing future water demands for the water transmission and distribution system hydraulic model (water model). This methodology was coordinated with the SSMP flow projections. It was also extended to project and distribute non-potable water demands the methods should overlap, thereby creating consistency between the SSMP, NPMP, and WTDMP, as illustrated in **Figure 2-1**.

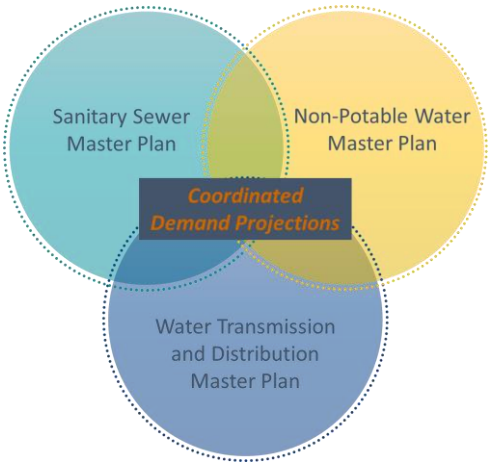

Figure 2-1. Coordinated Demand Projections

The goal of the process described herein is to develop the values and parameters related to modeling water demands for each of the planning horizons, which are defined as existing, 2025, 2040, and buildout. An overview of the methodology is outlined below:

- For existing conditions, demands were previously calibrated by Bohannan Huston, Inc. during the creation of the water system model. These demands were left unchanged for modeling the future system.
- The next step was to define the buildout scenario. All areas not currently developed or planned for redevelopment within the service area boundary were assigned demands based on planned development, zoning, and future land use information provided by the City. Density factors recommended for each land use type to describe residential or nonresidential demands per acre were applied to the additional acreage to be developed, including new development, redevelopment, and infill.
- The final step was to define and spatially distribute the demands for the 2025 and 2040 planning horizons. Planned development progress information from the City was used for this step.

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This section presents the parameters derived from the information available and the necessary calculations and assumptions needed to distribute that information spatially for each planning horizon. The parameters are presented in terms of how they are used for the WTDMP. The SSMP and NPMP use similar parameters as appropriate for determining wastewater flows and non-potable water demands.

2.1 Existing Demands

The demands for the existing system were previously developed by others and were allocated in the existing water model. These demands were determined based on existing billing and metering data from June 2017 to June 2018. Certain billed customers were not allocated within the existing model, such as those who use well water or those from neighboring water districts that are tracked for sewer billing purposes. In addition to monthly billing data, hourly automatic meter reading data was collected from the largest 316 water users, known as profilers. This data was used to better understand usage patterns and locational effects, instead of just total consumption.

Ultimately, these demand sources were used to create various demand datasets, including average month, minimum month, peak month, a calibration month, and September 2018. The demands were allocated into the water model using InfoWater's "Demand Allocation Manager" tool, with the "closest junction" method.

Calibration of the existing system, including the existing demands, was completed by others as part of the existing water system model development. These existing demands were left unchanged for future modeling scenarios and will be the same for every planning horizon.

2.2 Service Area and Population Projections

The planning information used to calculate demands was spatially distributed through the LREGA boundary, as shown in **Figure 2-2**. This represents the limits of the City's expected growth and where they plan to provide water and wastewater services in the future.

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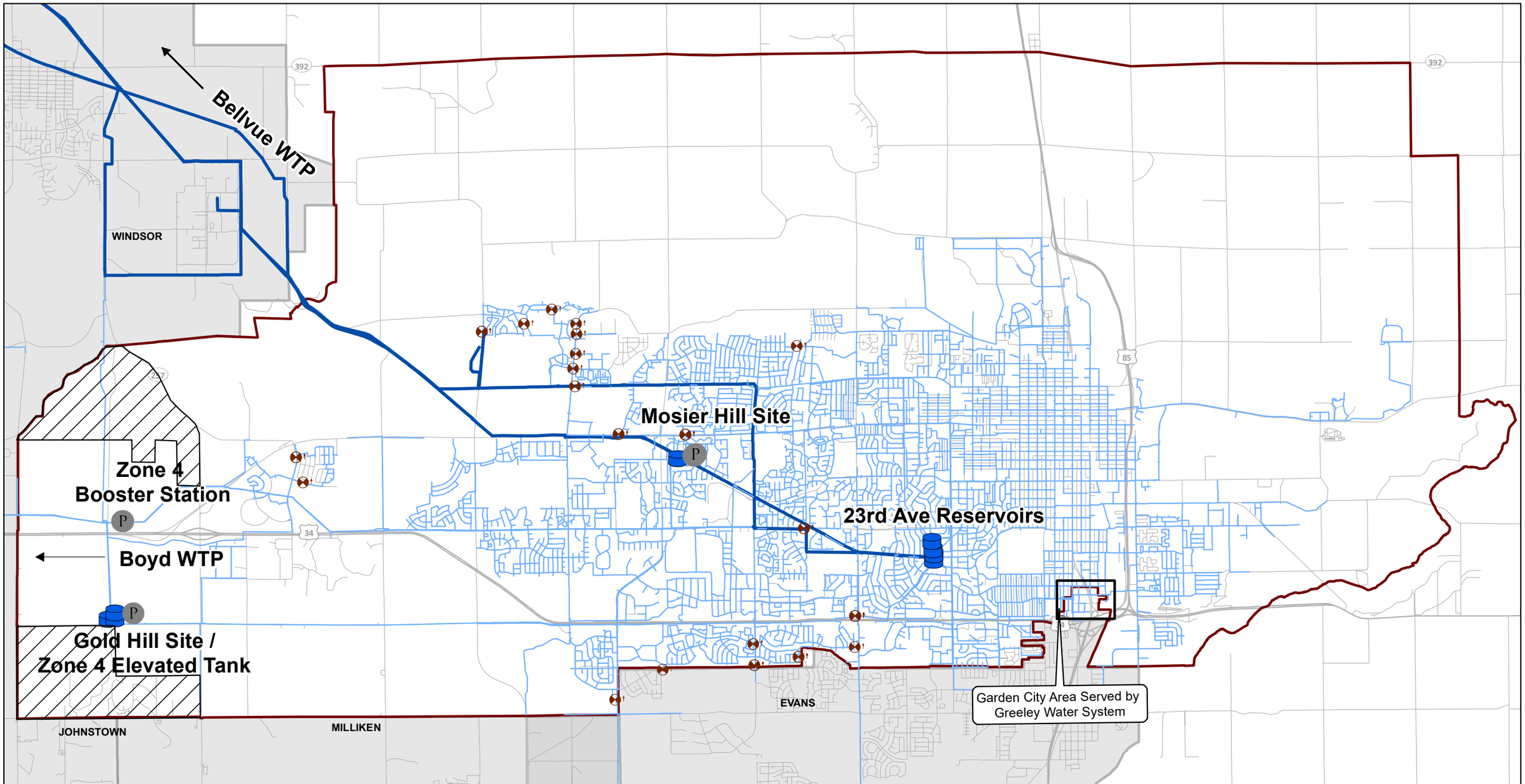

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July 01, 2021

Legend

- Existing Pump Stations
- Existing Storage
- PRV
- LREGA
- Distribution Mains
- Transmission Mains
- Overlapping Growth Area (to be negotiated in future IGAs)
- Neighboring Towns

N

0 0.5 1 2

Miles

Water Master Plan Area

Figure 2-2

Greeley Water System Master Plan

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Population projections represent the timing of population growth to be distributed throughout the LREGA. Various sources of population projections were reviewed and discussed with the City. The most relevant projections come from the *City of Greeley Population and Water Demand Projections* (BBC Research & Consulting 2018), referred to as the BBC report. Historical, low, middle, and high population projections are shown in **Figure 2-3**. The three population projections result in a linear annual growth rate of 2.2% for the low scenario, 3.1% for the middle scenario, and 4.0% for the high scenario. The current population and projected 2075 populations for each growth rate is noted. Based on discussions with the City and their knowledge from other studies, it is assumed that 2075 does not represent the buildout year for the City within the LREGA boundary. The BBC report notes that the buildout scenario is likely even later than 2090.

The City estimates that the population currently served by the water system is approximately 107,146. To project future water demand, the proposed population increases from the BBC report are used to spatially distribute demands for each planning horizon. Following agreement with the City, the "middle" projection has been selected for wastewater and water system analysis and is the basis of population projections. A buildout population is extrapolated beyond 2075 based on the planning data and factors as described in the following sections.

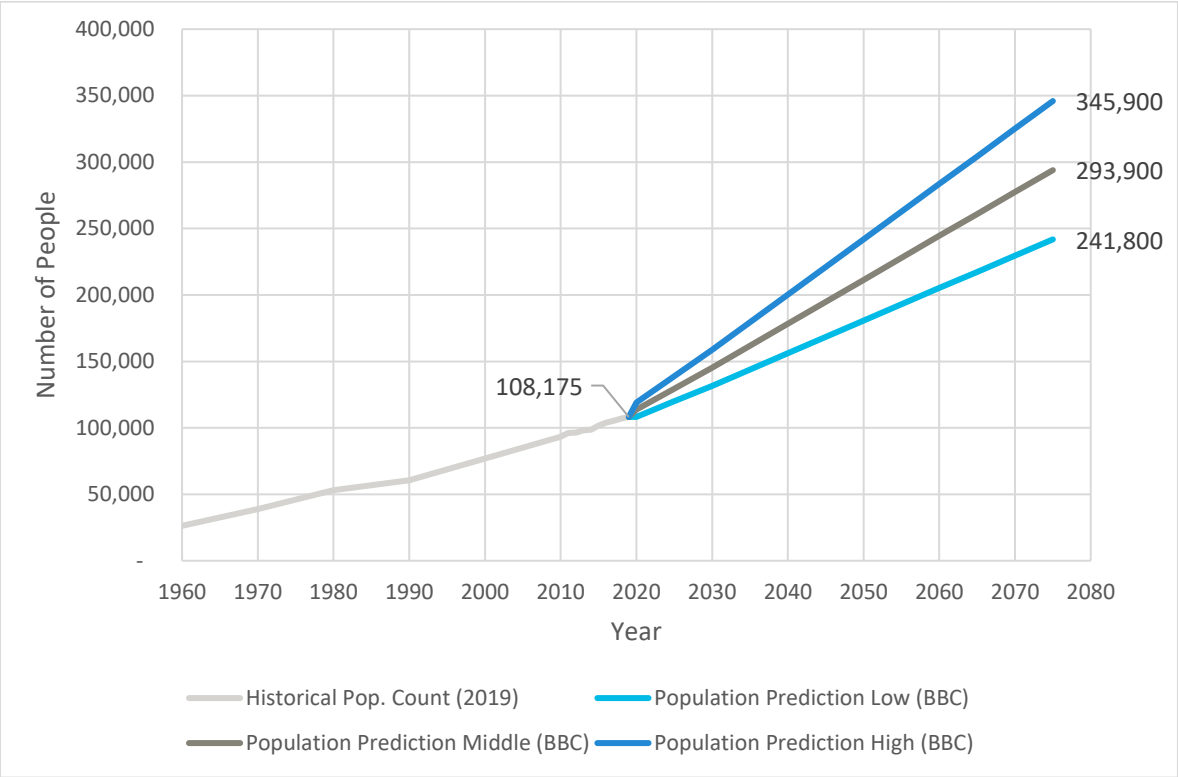

Figure 2-3. Historical and Projected Population (BBC Report 2019)

To project future water demand, the proposed population increases from the BBC report are used to spatially distribute flows for each planning horizon. (i.e., the spatially distributed additional population plus the existing population at each planning horizon is set to match the "middle" population projection). The "middle" projection was selected for system analysis and as the basis of the projections methodology. A buildout population is extrapolated beyond 2075 based on the

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planning data and factors described in the following sections. **Table 2-1** lists the population for each decade and planning horizon year out to the BBC report 2075 population. Residential demand is calculated by multiplying the population by gallons per day per person (gpd/person). This is not the same as gallons per capita per day because residential demand does not include nonresidential demand contributions.

Table 2-1. Middle Population Projection (BBC Report 2019)

Year	Middle Population Projection
2018	107,146
2020	113,700
5-year, 2025	129,450
2030	145,200
20-year, 2040	178,300
2050	211,400
2060	244,400
2065	260,900
2070	277,400
2075	293,900
Buildout	428,148

2.3 Water Billing Data

The existing water demand was largely established through analysis of monthly water billing data, provided by the City from 2014 through 2019. Summer (July/August) water billing data from 2018 and 2019 was used to initially develop the demands. To determine the distribution of the future population, the total of dwelling units (DUs) were multiplied by the appropriate factors from the City's Specifications:

- Low-density residential (R-L): 3.1 people per unit.
- Medium-density residential (R-M): 2.7 people per unit.
- High-density residential (R-H): 1.7 people per unit.

The nonresidential billing data from the same period was joined with zoning data and converted to gallons per day per acre (gpd/acre) to compare summer water use among various nonresidential zoning categories. Based on conversations with the City, it was decided that irrigation meters should be removed from the billing data to more accurately reflect true commercial and industrial flow factors. Irrigation meters were identified by assuming that irrigation meters meet the following criteria: were in the list of water customers but not wastewater customers; had demand in August but not January; and were billed to commercial, school districts/UNC, or the City. This information was used to project water demands in future development areas where only zoning information is available. While there are no industrial high (I-H) areas identified for future development in the WTDMP, it is expected that the City could see

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up to six future I-H users. The zoning categories for nonresidential water use include the following:

- C-H: commercial high intensity
- C-L: commercial low intensity
- I-L: industrial low intensity
- I-M: industrial medium intensity

A box and whisker plot of gpd/acre for the 2018–19 nonresidential summer water use by zoning category is shown in **Figure 2-4.** This plot includes the following statistics:

- The bottom and top of the vertical lines represent the minimum to maximum values excluding outliers. Outliers are defined as any point that lies 1.5 times the interquartile range or the length of the "box" in the plots shown.
- The bottom and top of the box are the 25th and 75th percentiles, respectively.
- The line inside the box is the median.
- The "x" is the average.

The recommended values are rounded from the 75th percentile of all data within each category based on discussions with the City.

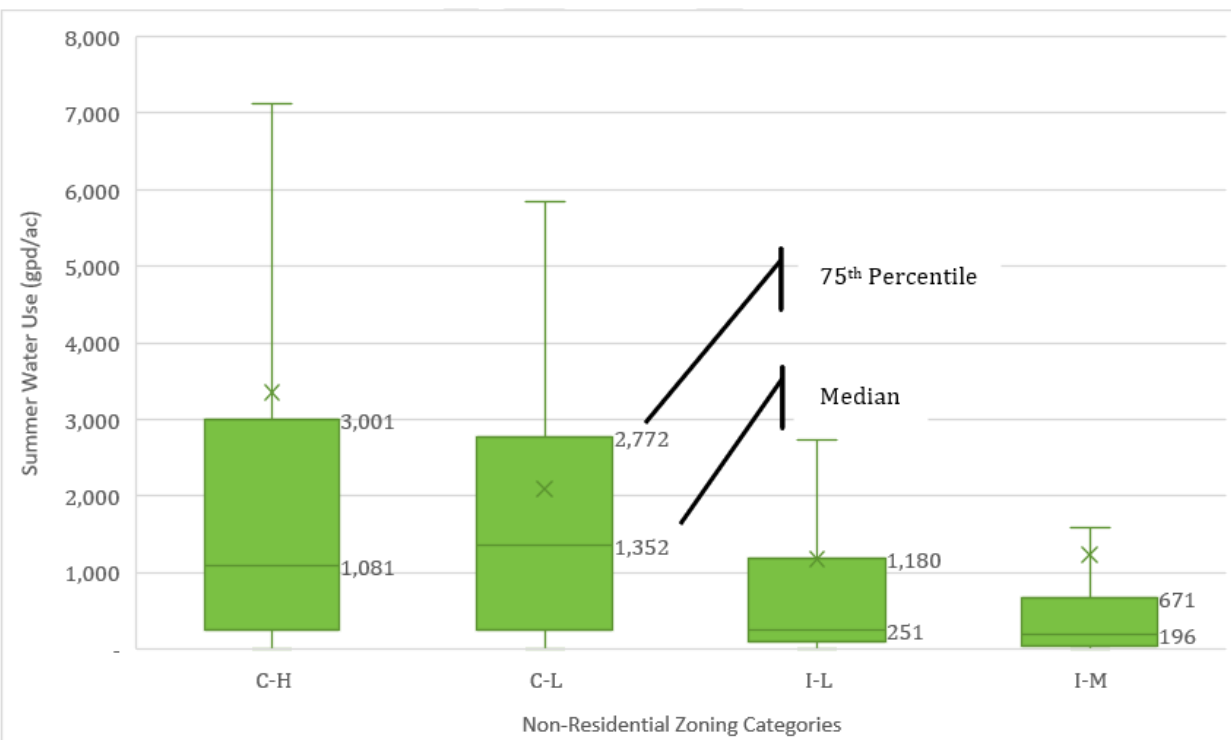

Figure 2-4. Box and Whisker Plot: 2019 Nonresidential Summer Water Use by Commercial Class

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Table 2-2 summarizes the median and 75th percentile values for the zoning categories, with the recommended values rounded up from the 75th percentile. This information was used as part of projecting future water demands.

Table 2-2. Nonresidential Summer Water Billing Data Summary

Nonresidential Zoning Categories	Median (gpd/acre)	75th Percentile (gpd/acre)	Recommended Value for Future Demand Projections (gpd/acre)
Commercial Low Intensity, C-L	1,352	2,772	2,800
Commercial High Intensity, C-H	1,081	3,001	3,000
Industrial Low Intensity, I-L	251	1,180	1,500
Industrial Medium Intensity, I-M	196	671	750

[1] I-L and I-M flow factor values were established based on historic billed water use. The C-L, C-H, I-L, and I-M categories are for zoning purposes only, and do not necessarily represent low and medium water demand.

2.4 Demand Projection Methodology

Many areas in the City are already fully developed. These areas do not represent a future demand and were left out of the demand projection calculations. Existing demands from these areas were previously calibrated within the InfoWater model, and were used for the hydraulic model of the future system.

Future demand parameters are distributed to currently undeveloped areas or areas of redevelopment based on the best available information for each area. Three tiers of information are described below:

1. Tier 1: Planned Developments.
2. Tier 2: City of Greeley Land Use (Sub-Areas) and Zoning Markup Map (Greeley Markup).
3. Tier 3: Zoning and Comprehensive Plan Information.
    a. Zoning from the *Annual Growth & Development Projections Report* (City of Greeley 2019).
    b. Land use guidance from the *Imagine Greeley Comprehensive Plan* (City of Greeley Community Development Department 2018).

Refer to **Figure 2-5** below for a map showing the future projection areas by tier and growth type.

The City of Greeley adopted the *Imagine Greeley Comprehensive Plan* in 2018, which is a policy guide that provides framework for public and private growth and development decisions made by the City of Greeley over the next ten to twenty years. As a part of the Comprehensive Plan, a list of recommended actions was identified in Chapter 5 to assist in implementation of this plan. A summary of action items addressed with the development of this WTDMP to ensure implementation of the Comprehensive Plan can be found in **Appendix G**.

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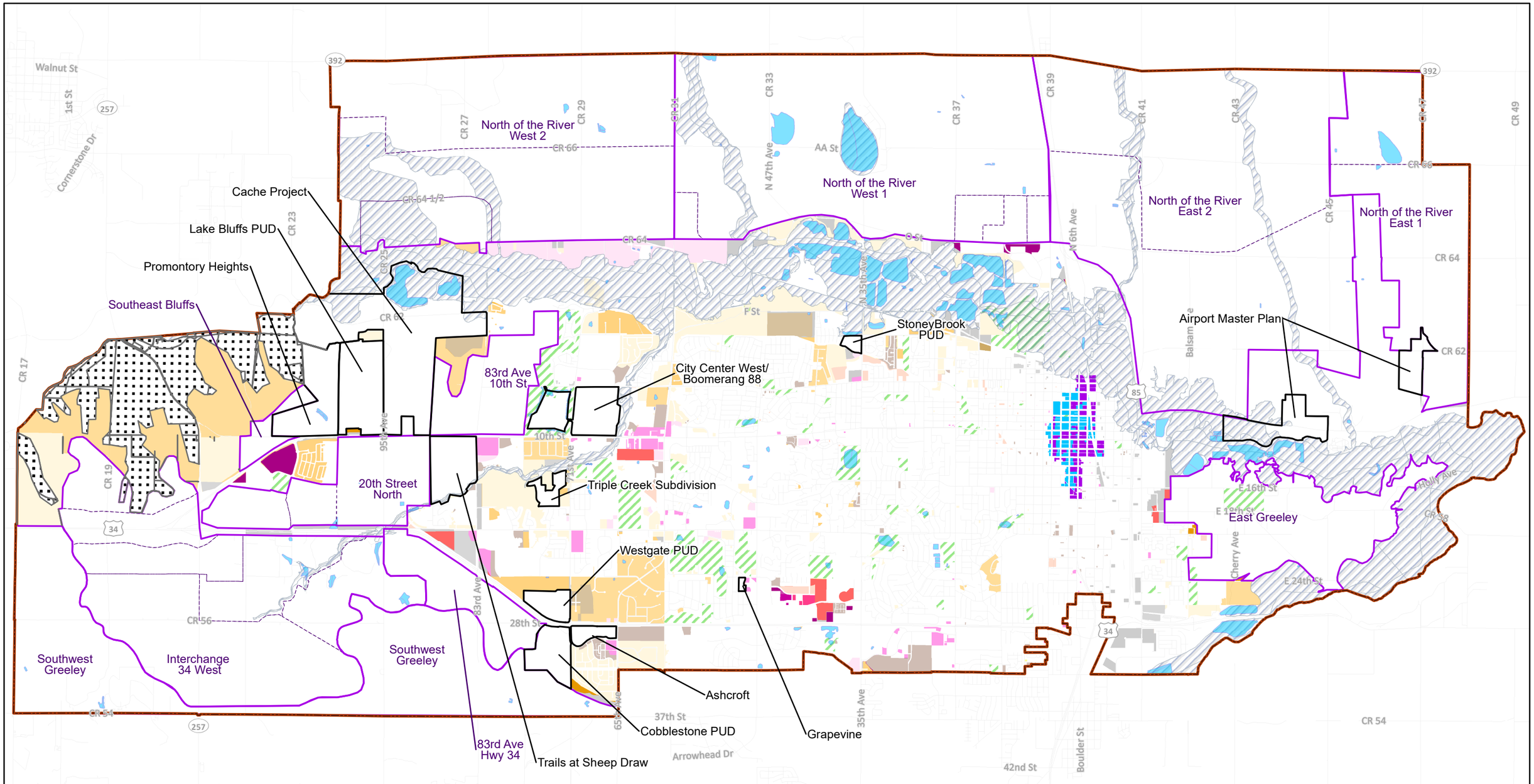

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February 25, 2021

Legend

- LREGA
- Tier 1 (Planned Developments)
- Tier 2 (Greeley Markup)
- Tier 2 (Sub-Areas)

Tier 3

- C-H
- C-L
- I-L
- I-M
- R-E
- R-H
- R-L
- R-M
- R-MH
- Downtown Development Authority (Existing Flow)
- Downtown Development Authority (Redevelopment)
- Employment, Industrial, and Commercial
- Mixed Use
- Mixed Use High Intensity
- Residential
- Rural
- Bluffs - No Developement
- 100-yr Floodplain
- Lakes and Ponds
- Parks

N

0 0.5 1 2
Miles

Future Projection Areas by Growth Type

Figure 2-5

Greeley Water System Master Plan

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2.4.1 Tier 1: Planned Developments

Several development plans have been submitted to the City for areas within the LREGA. This information was used to delineate areas and distribute future populations for modeling future demands. The various planned developments are described in **Table 2-3** and shown in **Figure 2-5**.

Table 2-3. Planned Development Information (Tier 1)

Planned Development	Area	Projected Population	Projected Residential Demand	Projected Nonresidential Demand
	(acres)	(people)	(gpd)	(gpd)
Airport Master Plan	196	0	0	749,122
Cache Project	800	8,444	954,172	74,685
City Center West/Boomerang 88	214	3,001	339,113	0
Cobblestone PUD	145	3,049	344,537	76,031
Grapevine	6	119	13,447	0
Lake Bluffs PUD	305	2,308	260,804	601,920
Promontory Heights	276	2,936	331,768	148,452
StoneyBrook PUD	20	350	39,550	0
Trails at Sheep Draw	93	2,304	260,352	417,816
Triple Creek Subdivision	51	282	31,866	0
UCHealth – Ashcroft	45	0	0	141,120
Westgate PUD	85	1,012	114,356	47,717
Total	2,237	23,805	2,689,965	2,256,862

2.4.2 Tier 2: City of Greeley Land Use and Zoning Markup Map

Outside of the planned development areas described in **Table 2-3**, available information for the remaining areas was the 2019 Zoning Map and the 2018 *Imagine Greeley Comprehensive Plan*. The City reviewed the data sets and marked up 11 areas to which a specific growth distribution was applied. The City's planning department assigned percentages of land use type to each growth area. **Table 2-4** describes the distribution of land use projections for each growth area. For example, for the area within the 83rd Avenue/Highway 34 boundary, 65% of the total acreage is assumed to be C-H, while 35% of the total acreage is assumed to be R-H at 20 dwelling units per acre (DU/acre).

The population for each area was calculated by multiplying the DU/acre (as determined by the City's planning department) by the percentage of the total area marked for residential and then applying the appropriate population factors (people/DU) described above. The nonresidential demand was calculated by multiplying the total area by the percentage of nonresidential use and then applying the appropriate density factor (gpd/acre) developed in **Table 2-2**.

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Table 2-4. City of Greeley Markup Map Summary (Tier 2)

Markup Areas	Area	Percent of Total Area per Nonresidential Land Use Category				Percent of Total Area per Residential DU/Acre Category				Projected Population Increase	Projected Residential Demand	Projected Nonresidential Demand
	(acres)	C-L	C-H	I-L	I-M	1.0	2.5	4.0	20	(people)[1]	(gpd)	(gpd)
83rd Avenue/Highway 34	589		65%						35%	7,003	791,339	1,147,601
83rd Avenue/10th Street	649		15%					45%	40%	12,456	1,407,528	292,247
20th Street North	895		25%					50%	25%	13,162	1,487,306	671,516
Southeast Bluffs	130		15%					45%	40%	2,499	282,387	58,626
North of the River – East 1	2,006		10%		80%	10%				622	70,286	1,805,587
North of the River – East 2	5,734		20%		30%			35%	15%	54,128	6,116,464	4,730,450
North of the River – West 1	4,417		15%		10%	10%		50%	15%	51,285	5,795,205	2,319,069
North of the River – West 2	3,793		10%		20%	30%		30%	10%	30,531	3,450,003	1,706,727
East Greeley	1,358				30%	40%		30%		6,736	761,168	305,549
Southwest Greeley	2,906						100%			22,520	2,544,760	0
Interchange 34 West	3,676		20%		10%			50%	20%	47,786	5,399,818	2,481,177
									Total	**248,728**	**28,106,264**	**15,518,549**

[1] For 20 DU/acre, 1.7 people per DU was assumed. For 1-4 DU/acre, 3.1 people per DU was assumed.

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To spatially distribute the calculated demands within each Tier 2 growth area, the total demand is split into sub-areas within each Tier 2 growth area based on direction from the City. The distribution of demand to each sub-area intended to follow the density distribution of the original *Imagine Greeley Comprehensive Plan* and was reviewed and verified with the City.

2.4.3 Tier 3: Zoning and Land Use Guidance (Infill)

For the remaining area within the LREGA, zoning and land use information was used to distribute future populations and water demand parameters. The 2019 Zoning Map was used except in areas defined as Planned Unit Development or Holding Agriculture (H-A). In these zones and areas outside the 2019 Zoning Map, the *Imagine Greeley Comprehensive Plan* land use guidance was used to define future population and water demand parameters.

The City's Specifications provide a typical range of density (population per acre) within each zoning type. To project future demands, a typical density was chosen for each zoning type. The recommended densities were based on discussions with the City and a review of the following sources:

- Existing summer water billing data for nonresidential areas (in gpd/acre by category).
- *Imagine Greeley Comprehensive Plan* (City of Greeley Community Development Department 2018).
- The City of Greeley's "Design Criteria and Construction Specifications," which includes zoning district development standards.
- Similar future projection studies.

Table 2-5 summarizes the recommended densities by zoning and land use guidance category used for the projection methodology. Values recommended for nonresidential water demands are based on the values previously presented in **Table 2-2**. **Table 2-6** shows the resulting population and nonresidential demand projection from the Tier 3 areas.

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Table 2-5. Recommended Zoning and Land Use Guidance Densities (Tier 3)

Zoning or Land Use Guidance Category	Design Criteria Residential Density[1] (DU/acre)	Recommended Residential Density for Planning (DU/acre)	People Per Unit[2]	Recommended Nonresidential Water Demand Density (gpd/acre)[3]
Residential Estate (R-E)		1	3.1	
Residential Low Density (R-L)	3 to 5	4	3.1	
Residential Medium Density (R-M)	6 to 10	6	2.7	
Residential High Density (R-H)	11 to 20	20	1.7	
Residential Mobile Home (R-MH)		6	2.7	
Commercial Low Intensity (C-L)[5]				2,800
Commercial High Intensity (C-H)[5]				3,000
Industrial Low Intensity (I-L)[5]				1,500
Industrial Medium Intensity (I-M)[5]				750
For areas zoned as – Planned Unit Development (PUD) or Holding Agriculture (H-A) The projection categories from the 2018 *Imagine Greeley Comprehensive Plan* are used. See below:				
Employment, Industrial, and Commercial				3,000
Mixed Use High Intensity (assume 50% R-H, 50% C-L)	4 to 20	15	1.7	1,400
Mixed Use (assume 50% R-M, 50% C-L)	4 to 20	10	2.7	1,400
Suburban	2 to 10	10	2.7	
Residential	3 to 5	4	3.1	
Legacy Urban	4 to 20	10	2.7	
Downtown Development Authority (Redevelopment)	N/A	45	1.7	
Rural	0 to 2	2	3.1	

[1]The City's Specifications provided as reference values for the recommended residential zoning densities. Reference values from the *Imagine Greeley Comprehensive Plan* provided for the Mixed Use, Suburban, Legacy Urban Residential, and Rural areas.

[2]People per unit are based on the City's Specifications, described above.

[3]Recommended nonresidential water demand densities per **Table 2-2**.

[4]Recommended density of 45 units/acre within the Downtown Development Authority area is per discussions with the City.

[5] Commercial and industrial land use categories and their associated intensity designations (C-L, C-M, C-H, I-L, I-M, and I-H) are for zoning purposes only and do not indicate volume of water use.

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Table 2-6. Zoning and Comprehensive Plan Projections (Tier 3)

Zone	Acres	Projected Population	Projected Residential Demand	Projected Nonresidential Demand
		(people)	(gpd)	(gpd)
Commercial High Intensity (C-H)	167	0	-	501,060
Commercial Low Intensity (C-L)	460	0	-	1,286,964
Industrial High Intensity (I-H)[1]	0	0	-	0
Industrial Low Intensity (I-L)	91	0	-	136,800
Industrial Medium Intensity (I-M)	200	0	-	150,240
Residential Estate (R-E)	934	2,894	327,022	0
Residential High Density (R-H)	194	6,597	745,461	0
Residential Low Density (R-L)	1,629	20,196	2,282,148	0
Residential Medium Density (R-M)	143	2,317	261,821	0
Residential Mobile Home (R-MH)	2	34	3,842	0
Comprehensive Plan Area Category	**Acres**	**Projected Population**	**Projected Residential Demand**	**Projected Nonresidential Demand**
		(people)	(gpd)	(gpd)
Downtown Development Area	91	6,966	787,158	0
Employment, Industrial, and Commercial	131	0	-	391,860
Legacy Urban	0	0	-	0
Mixed Use	25	199	22,487	34,468
Mixed Use High Intensity	122	2,076	234,588	170,982
Residential	250	3,102	350,526	0
Rural	196	1,213	137,069	0
Total	**4,635**	**45,594**	**5,152,122**	**2,672,387**

[1] An I-H user with demands of 1 MGD was used for one model sensitivity test. See **Sections 4.2.5** and **4.3.5** for additional information.

2.5 Growth Estimates by Planning Horizon

To distribute the future demand parameters in the model at each planning horizon, the percent to which each future development tier is built out at the end of each planning horizon was estimated as shown in **Table 2-7** and **Table 2-8**, based on the BBC report. At the 2025 and 2040 planning horizons, the calculated population was matched to the BBC report. The overall buildout population was assumed to exceed the 2075 BBC projected population. The total buildout population is projected to be 425,271.

The percent complete values listed in **Table 2-7** and **Table 2-8** and development areas included for each tier were chosen through discussions with the City. **Figure 2-6**, **Figure 2-7**, and **Figure 2-8** are visual representations of the information within **Table 2-7** and **Table 2-8** as well as depictions of the assumed growth areas for each planning horizon.

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It is assumed that the Tier 1 projects will be completed first. For this reason, most of the Tier 1 projects are assumed to be complete at the 2025 planning horizon, and all of them complete at the 2040 planning horizon.

Because of the large areas within the Tier 2 projections category, the Tier 2 percent complete values for the 2025 and 2040 planning horizons have been developed through close discussion with the City. The Tier 2 areas identified for growth at the 2025 and 2040 planning horizons are the areas that the City's planning department identified as the most likely growth areas.

The Tier 3 growth identified below for the 2025 planning horizon was chosen through discussions with the City. Tier 3 growth included at the 2040 planning horizon was assumed to include all the infill around the Tier 1 and Tier 2 projected growth areas.

Table 2-7. Planned Development/Markup Area Information (Tier 1)

Planned Development – Tier 1	2025 (Percentage Complete)	2040 (Percentage Complete)	Buildout (Percentage Complete)
Airport Master Plan	100%	100%	100%
Cache Project	40%	100%	100%
City Center West/Boomerang 88	75%	100%	100%
Cobblestone PUD	100%	100%	100%
Grapevine	100%	100%	100%
Lake Bluffs PUD	50%	100%	100%
Promontory Heights	40%	100%	100%
StoneyBrook PUD	100%	100%	100%
Trails at Sheep Draw	100%	100%	100%
Triple Creek Subdivision	100%	100%	100%
UCHealth – Ashcroft	100%	100%	100%
Westgate PUD	100%	100%	100%
Total Population Increase – Tier 1	15,072	23,804	23,804

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Table 2-8. Planned Development/Markup Area Information (Tiers 2 and 3)

Markup Areas – Tier 2	2025 (Percentage Complete)	2040 (Percentage Complete)	Buildout (Percentage Complete)
83rd Avenue/Highway 34	0%	10%	100%
83rd Avenue/10th Street	20%	25%	100%
20th Street North (100)	0%	10%	100%
20th Street North (200)	0%	15%	100%
20th Street North (300)	0%	10%	100%
Southeast Bluffs	0%	75%	100%
North of the River – East 1 (100)	0%	0%	100%
North of the River – East 1 (200)	0%	0%	100%
North of the River – East 2 (100)	0%	0%	100%
North of the River – East 2 (200)	0%	5%	100%
North of the River – West 1 (100)	0%	5%	100%
North of the River – West 1 (200)	0%	25%	100%
North of the River – West 1 (300)	0%	25%	100%
North of the River – West 1 (400)	0%	5%	100%
North of the River – West 2 (100)	0%	0%	100%
North of the River – West 2 (200)	0%	0%	100%
North of the River – West 2 (300)	0%	0%	100%
East Greeley	5%	10%	100%
Southwest Greeley	0%	10%	100%
Interchange 34 West (100)	0%	0%	100%
Interchange 34 West (200)	0%	0%	100%
Interchange 34 West (300)	0%	50%	100%
Interchange 34 West (400)	0%	0%	100%
Interchange 34 West (500)	0%	5%	100%
Total Population Increase – Tier 2	2,828	10,520	244,212
Zoning and Land Use Guidance – Tier 3	**5-Year**	**20-Year**	**Buildout**
Tier 3 Areas	7% (1)	76% (1)	100%
Total Population Increase – Tier 3	3,501	37,960	50,110
Summary	**5-Year**	**20-Year**	**Buildout**
Projected Population Increase – Tier 1–3 Total	21,402	72,284	318,125
BBC report – Population Increase	21,275	70,125	N/A

[1]Percentage increases for the Tier 3 area are relative to total Tier 3 population increase. This increase will occur in specific areas per discussions with the City.

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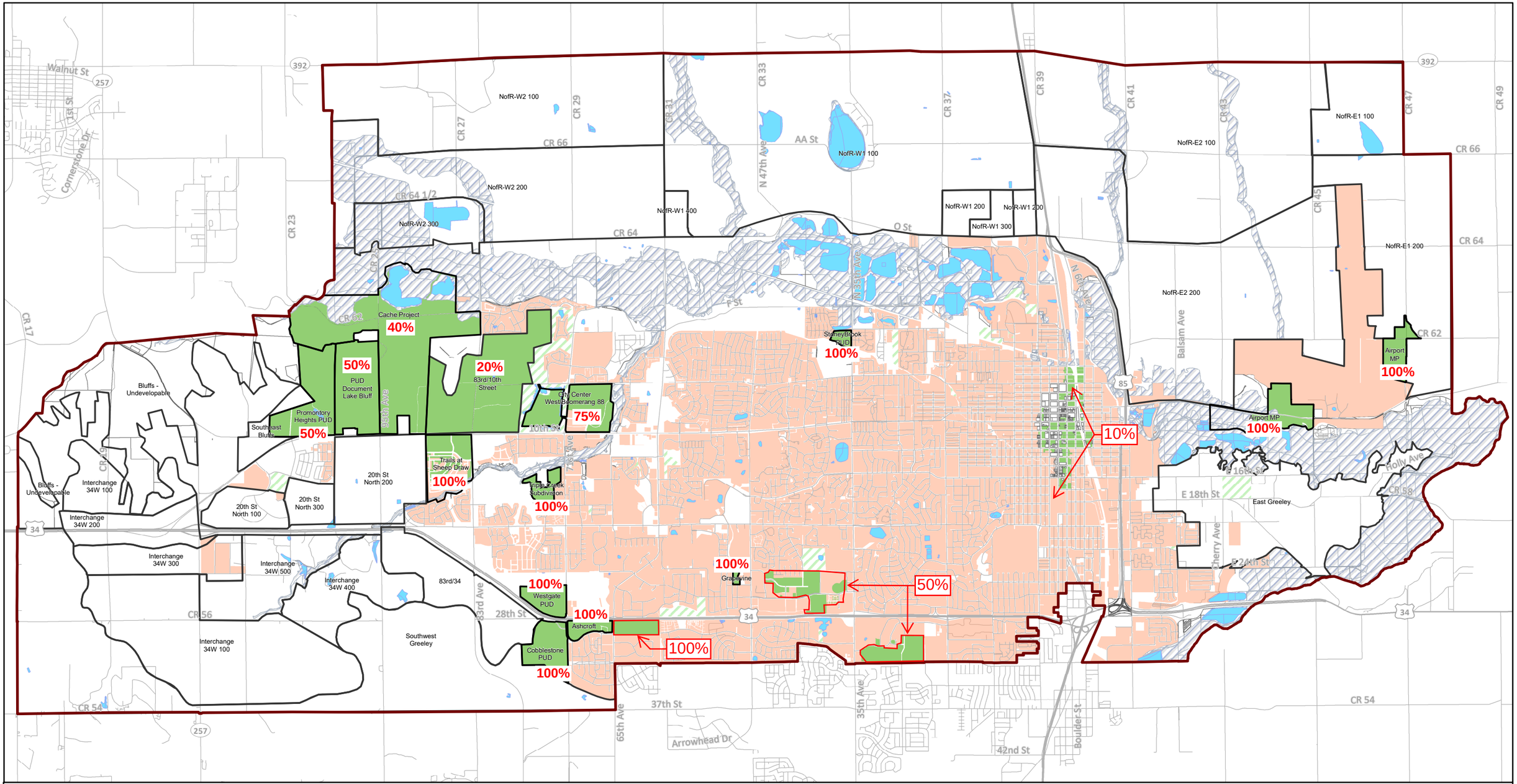

Legend

- LREGA
- Demand Projection Area
- 100-yr Floodplain
- Lakes and Ponds

% = Percent Developed

- Future Development
- Existing Service Area
- No Development
- Park

N

0 0.5 1 2

Miles

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Developed Area Projections: 2025

Figure 2-6

Greeley Water System Master Plan

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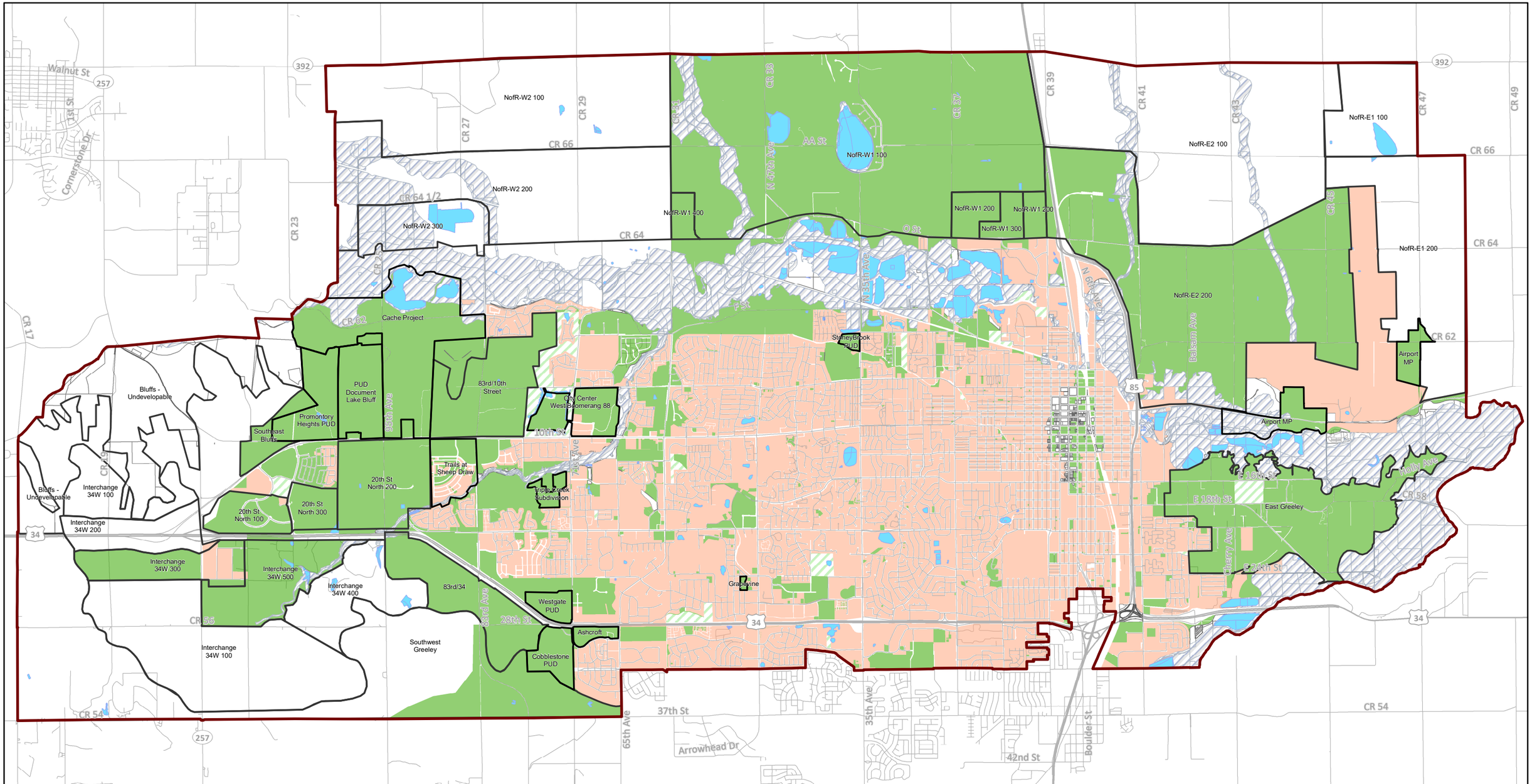

Legend

- LREGA
- Demand Projection Area
- 100-yr Floodplain
- Lakes and Ponds
- Future Development
- Existing Service Area
- No Development
- Park

N

0 0.5 1 2

Miles

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Developed Area Projections: 2040

Figure 2-7

Greeley Water System Master Plan

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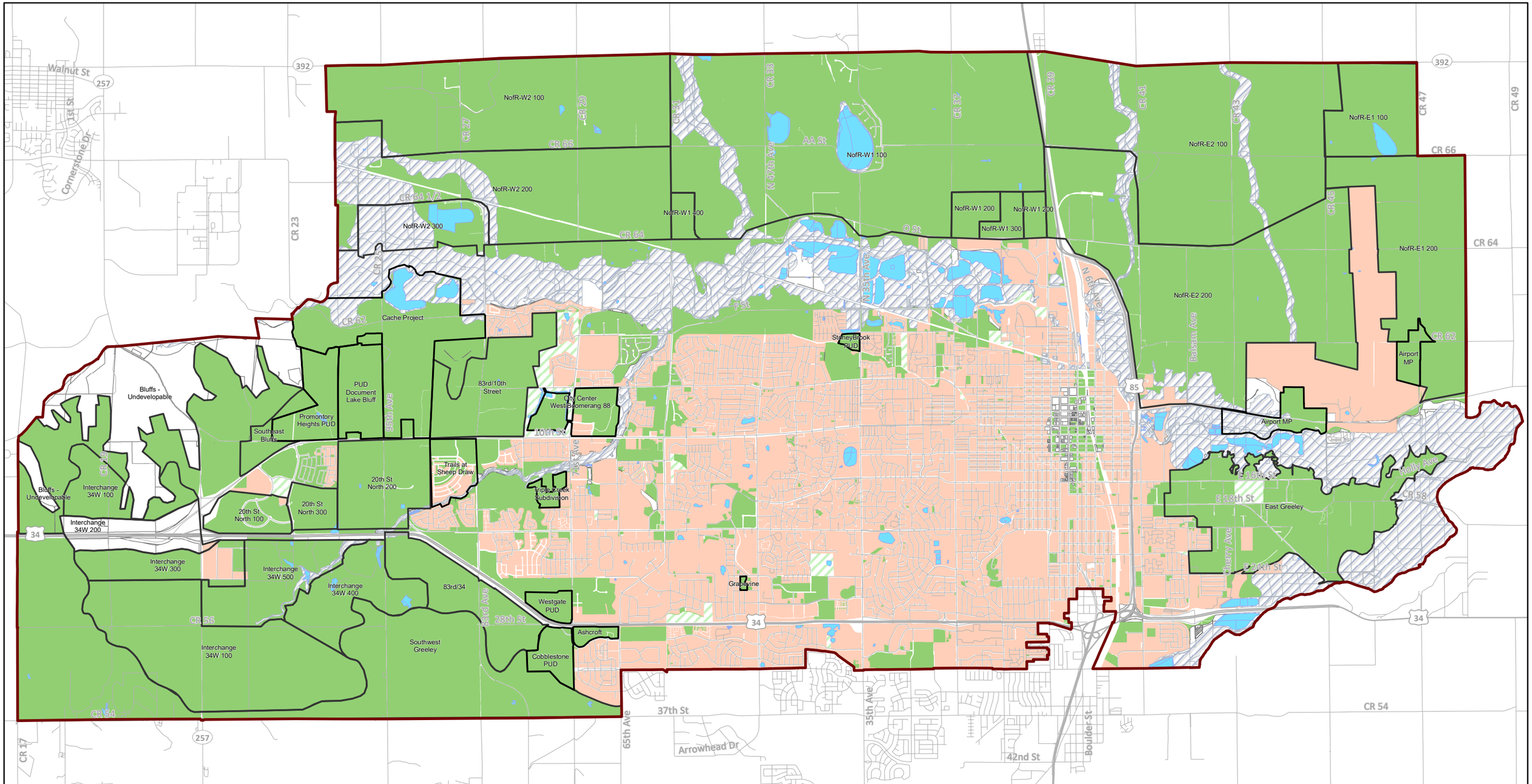

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Legend

- LREGA
- Demand Projection Area
- 100-yr Floodplain
- Lakes and Ponds
- Future Development
- Existing Service Area
- No Development
- Park

N

0 0.5 1 2
Miles

Buildout Developed Area

Figure 2-8

Greeley Water System Master Plan

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2.6 Non-Potable Demands

The demand projections conducted in this section represent a total summer water demand, with irrigation demands accounted for within the demand factors. It is likely that the water demands will be decreased in the future if some of the irrigation demands can be met with non-potable water. In particular, larger irrigated areas such as parks, schools, and large residential developments or commercial/industrial areas may be required to use non-potable irrigation. The projected water demands could be offset by non-potable water by either servicing future developments with non-potable water or by converting existing areas from potable to non-potable service. Because non-potable service would only decrease the water demands, the analysis done throughout **Section 2** represents a conservative "worst case" scenario, where potable water is used to meet all water demands.

The projections for non-potable demands are discussed in greater detail in the NPMP, which projects demands throughout the LREGA and within the current City limits. Per discussion with the City, the non-potable demands created by conversion areas will not be removed from the existing water demands for projection purposes. For more information on the development of the non-potable demands, see **Appendix D**.

Ultimately, two demand scenarios were modeled: the system if all water demands are met by water (all potable demands scenario), and the system if some water demands are offset by non-water (non-potable offsets demand scenario). Considering both scenarios will help the City to avoid undersizing either system (potable or non-potable). The demands for the non-potable offsets demand scenario are included in **Table 2-9**. The total future water demand for the non-potable offsets demand scenario (59.0 MGD) is slightly different from the all potable total future water demand (56.4 MGD) to reconcile the fact that conversion areas were not removed from the water demands under the all potable scenario. Additional discussion of modeling of the non-potable offsets demand scenario is included in **Section 4.2.4** and **Section 4.4**.

Table 2-9. Peak Month Non-Potable Offsets Demand Scenario by Planning Horizon

Planning Horizon	Total Future (additional) Water Demand (MGD)	Future Potable Water Demand (MGD)	Future Non-Potable Water Demand (MGD)
Existing	47.3	46.0	1.3
2025	51.8	49.4	2.4
2040	61.0	56.9	4.1
Buildout	106.3	93.5	12.8

2.7 Water Resources Correlation

It is important for the City to plan for the total annual water demands through buildout. Water conservation methods, such as improved landscaping practices and encouragement and adoption of non-potable water for irrigation, may help reduce the City's annual water demands. The City previously conducted a water resources planning study (BBC report), which focused on developing three alternative scenarios for annual water demands. The WTDMP primarily focused on planning for future infrastructure needs based on peak summer and fire flow demands. **Table 2-10** provides a comparison summary between the BBC report and the WTDMP.

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Table 2-10. WTDMP and BBC report Comparison

WTDMP Approach	BBC Approach
Focused on infrastructure sizing, particularly during peak month demands	Focused on supply-side annual demands for water resources planning
Used a peak month: average month ratio of 1.8 for potable demands and 2.5 for non-potable demands to estimate annual demands from the calculated peak month demands	Only calculated annual demands and did not calculate demands for peak seasons
Separated residential and nonresidential demands to account for different customer diurnal curves and peak hours	Established a universal gallons per capita per day value that included commercial, industrial, and residential demands
Correlated population projections to the BBC report and other City planning department data	Developed three population projections (low, medium, high)
Geolocated demands based on land use to incorporate demand density for infrastructure planning	Used bulk demands for water resources planning, and did not spatially locate demands within the City
Conducted sensitivity analyses for how a large industrial user would impact the buildout water distribution system (see Section 4.2.5)	Estimated that the City will take on six large industrial users by buildout
Estimated a single most-likely demand scenario for 2025, 2040, and buildout based on historic data and planning data	Provided detailed water resources planning for three scenarios every 5 years through 2075 and a less detailed buildout scenario

The total annual demands developed for the WTDMP under the non-potable offsets demand scenario at buildout are captured in **Table 2-11**. These demands are within the range established by the BBC report of 62,000 to 84,000 acre-feet per year (AFY) for total water demands at buildout. Although the six I-H users are included in these totals, these users were not used for modeling purposes, as their location is unknown and could lead to oversizing the system. Each large user's location will require specific evaluation of how each additional user could have adverse impacts on the supplies or infrastructure of the system. The City may consider using the water distribution system InfoWater model to examine the impacts of a large industrial user when more definitive information becomes available. A sensitivity analysis for a single I-H user was conducted in the water model, as discussed in **Section 4.2.5** and **Section 4.3.5**.

Table 2-11. WTDMP Annual Demand Projections at Buildout (Non-Potable Offsets Demand Scenario)

Demand	Total Water Demand (AFY)	Potable Water Demand (AFY)	Non-Potable Water Demand (AFY)
Existing	30,500	28,600	1,900
Future Demands	33,500	28,300	5,200
New I-H Users (6)	10,300	10,300	0
Total	74,300	67,200	7,100

It is recommended that the City rely on the BBC report for supply-side planning, and the WTDMP for infrastructure and distribution system planning.

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2.8 Demand Projections Summary

In summary, the total residential and nonresidential water demands are spatially projected throughout the LREGA. To calculate the final projected water demands, population must be converted into gallons per day (gpd). To do this, a summer water demand of 113 gpd/person is used. This value was provided by the City's water conservation department, which conducts many studies of water use for both single family and multifamily customers.

Table 2-12 below summarizes the total demands calculated for each tier, using the factors from **Table 2-2** and **Table 2-5**. Notably, 67.2% of the total Tier 3 area (9,743 acres) is designated as having no future water demand. This designation is due to flood zone designations and the Bluffs Region. **Table 2-13** summarizes the demands by planning horizon.

Table 2-12. Peak Month Buildout Demand Projections by Tier

Projection Tier	Acres	Population	Residential Demand	Nonresidential Demand	Total Demand
			(gpd)	(gpd)	(MGD)
Tier 1	2,237	23,805	2,689,965	2,256,862	4.95
Tier 2	26,153	248,728	28,106,264	15,518,549	43.62
Tier 3	14,106	45,594	5,152,122	2,672,387	7.82
Total	42,496	318,125	35,948,125	20,447,797	56.40[1]

[1] All population and demands shown in Table 2-12 are additional future demands. Buildout total demand is 46 MGD (existing) + 56.4 MGD (future) = 102.4 MGD

Table 2-13. Peak Month Demand Projections by Planning Horizon

Projection Tier	Acres	Population	Residential Demand	Nonresidential Demand	Total Demand
			(MGD)	(MGD)	(MGD)
Existing	11,883	107,146	N/A	N/A	46.0
2025	15,116	128,458	2.4	2.1	50.5
2040	29,467	179,430	8.2	5.5	59.7
Buildout	44,914	425,271	35.9	20.4	102.4

[1] In **Table 2-9**, the total demand for both potable and NP water is 106.0 MGD. The 106.0 MGD includes both the existing NP demand of 1.3 MGD (not accounted for in the all potable demands scenario calculations shown in **Table 2-13**), and the conversion area demand of 2.3 MGD (which was added to the NP demand but not removed from the potable demand for projection purposes, as discussed in **Section 2.6**).

[2] The future potable water infrastructure should be designed for a buildout demand of 102.4 MGD. This could be decreased to 93.2 MGD or lower depending on future NP policy, as discussed in **Section 2.6** and the NPMP.

Demand scenarios with all water and with non-potable irrigation will both be incorporated into the future model to plan for sufficient system capacity at all planning horizons. The projected demands are future peak month (summer) water demands that come directly from water use and follow a diurnal pattern with a peaking factor. These demands are divided into residential and nonresidential demand components in the model. Other demand scenarios, such as minimum month and fire flow, will be based on the peak month demands set for future analyses.

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Section 3

Future System Model Development

This section presents the future system hydraulic model set up, underlying assumptions, inputs, and methodology used to complete static modeling runs as well as results from preliminary modeling runs of the City's water model through all planning horizons. A pipe network was developed to meet demands throughout the LREGA.

A pipe network was developed for the 2025, 2040, and ultimate buildout scenario, building on the existing system model. Updates to the model included incorporating additional pipes to areas already within the City's current service area (infill) and expanding/adding the pipe network necessary to serve demands throughout the LREGA (new development). Pipe network, pressure zones, preliminary pipe sizing, and other model setup requirements were incorporated into the peak month static model. Modeling scenarios such as fire flows, minimum month, and other scenarios captured by EPS runs were used to refine the model, as described in **Section 4**.

3.1 Review of the Existing System Model

To facilitate development of the future model, the existing system model and accompanying report was provided, which was developed under a separate contract and was not part of the WTDMP scope. The existing system model became the backbone of the future model. Although it was assumed that the existing model is an accurate representation of the City's water system and no further calibration was needed, cursory checks of the model were completed to ensure usability and validate that it was a sound baseline for future model development. The existing system model was built on 2018 SCADA and GIS data. Ultimately, the existing system model was calibrated to September 2018 SCADA data (using time-based controls for the 24-day run), and included scenarios for average month, minimum month, and peak month demands. The existing model was also set up for power costs, water age, source tracing, and fire flow analyses. In this model, the WTPs were modeled as infinite reservoirs, meaning they were modeled as being able to provide an unlimited supply of water. Other controls, such as valves, limit the amount of water coming from the plants.

In addition to the existing system model and report, the City provided background information on the existing model. This included a geodatabase of the City's existing pipes and information on the exiting pressure zones. After review of the provided background information, CDM Smith made the following observations and changes:

- Limited documentation was available for the existing model's diurnal curves. Creation of new diurnal curves is discussed in the peaking factors technical memorandum, included in **Appendix A**.
- The City's most recent GIS data was compared with the existing model to reconcile any differences.
- Certain orphan nodes in the existing model were found to be duplicates and were removed.

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- Limited documentation was available on the derivation of the existing model's water quality calculations, which correlate water age and free chlorine. Discussion in the existing system model report that correlates water age to chlorine residual for a limited subset of comparisons indicates that there is some correlation of residual decline to water age, which is likely heavily impacted by initial water age established in the storage reservoirs. Seasonal and operational factors can also impact water quality in the system. Please see **Section 4.2.2** for additional information on water age to chlorine residual correlation.

- The Bellvue transmission lines were over pressurized in the existing model. This was remedied by changing the settings on Reichert's valve, which had been incorrectly set as closed, creating a backfeed from the distribution system.

- Certain areas in the existing model were exhibiting negative pressures. These areas were examined and resolved or explained. In most of these cases, it was decided that it was due to minor elevation datum differences that were not ultimately affecting the operation of the model and specific changes were avoided to minimize possible impacts on the previous Bohannan Huston, Inc.-prepared calibration analysis.

- The existing model had selection sets of "demand nodes" and "non-demand nodes," but the non-demand nodes set had existing demands allocated to many of them. It was decided to not change the existing demand allocations, and to only allocate future demands to the demand nodes.

- Some valves were incorrectly set as open or closed, based on the description. These changes were corrected and documented.

3.2 Future Model Setup, Inputs, and Assumptions

As discussed above, the preliminary future model was first set up for the buildout scenario, which involves setting up a grid throughout the LREGA to account for a 129% increase in demands from existing (2018) demands. The current City limit is 31,346 acres, while the LREGA is 58,306 acres, representing an 86% increase in land area by buildout. This includes some areas that are currently served by North Weld but are expected to be taken over by the City by 2040 and onward. While it is impossible to completely predict future development needs, this model should provide a roadmap for pressure zone boundaries, the size of main pipes, and potential interconnections between key areas. Developers should work with the City's engineering development review (EDR) and water and sewer departments to discuss how new developments fit into the City's overall plan to provide water service at acceptable pressures in both new and existing areas.

3.2.1 Future Pipe Network

To establish a proposed grid through the LREGA, pipes were added in from the following sources:

- **Greeley Geodatabase**. Pipes included in the City's pipe geodatabase that were not included in the existing model were assumed to have been built after the creation of the existing model. These pipes have known diameter, connectivity, etc., and were added into the master plan model as future pipes.

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- **Planned Development Reports.** Some PUDs in later stages of planning have design reports and/or hydraulic modeling reports that include proposed pipe layouts. These pipes were translated into GIS and added into the future model. Although many of these development reports do not represent final construction, they are assumed to be sufficient to capture the overall pipe network in these areas. These reports are not limited to the areas defined as PUDs for demand projection purposes. For many of these areas, pipe diameters were provided.

- **Other Areas**. All other areas were modeled based on the City's Specifications and typical methodology. Generally, 16-inch pipes were placed every mile, 12-inch pipes every half section, and 8-inch pipes every quarter section, although piping was refined in later modeling stages (see **Section 4.4**) to meet hydraulic criteria required per the City's Specifications (see **Section 3.4.3**). Where possible, pipelines were set up to follow roads but minimize railroad and river crossings. Dead ends were minimized to protect water quality, although not all dead ends in the existing system were addressed in this study. The City also provided input on specific areas or projects that were not yet captured in formal design reports.

The elevation of future nodes was based on ground surface elevation. Future pipes were modeled with a roughness ("C") of 130. The overall future pipe network for the buildout scenario is shown in **Figure 3-1.** This figure highlights key areas of interest, such as the North of the River area, the Bluffs Region, all PUDs, and the existing pump stations and reservoirs.

It was assumed that all parcels with a water demand will require some amount of water (i.e., no parcel will have demand fully met by non-potable water). Additionally, it was assumed that future piping will only serve areas within the LREGA. Some additional demands are expected from external stakeholders at existing master meters, but no additional piping was constructed to these stakeholders.

3.2.2 Pressure Zone Development

Most areas throughout the LREGA were already within the City's established pressure zones, with the exception of the North of the River area. In this area, a new boundary between Zone 1 and Zone 2 North was established in the model. This boundary was primarily based on existing elevations and contours, using the existing pressure zone elevation criteria and boundaries, as shown in **Figure 3-2.**

The overall pressure zone boundary for the North of the River area is shown in **Figure 3-2.** To separate the two zones, closed PRVs were set every mile (reducing from Zone 2 pressures into Zone 1), with normally closed valves on all other intersections along the boundary. The pipeline that runs along the boundary was sized as 24-inch to provide a "backbone" to the entire area, providing sufficient volume to meet demands while staying within the hydraulic design criteria in the City's Specifications (see **Section 3.4.3**). Specific pipe sizes should be refined during design stages. Zone 2 North includes inputs from the 60-inch Bellvue line, the Kodak line, and the 83rd Avenue line (which is designed for Zone 3 pressures). Zone 1 includes inputs from various lines crossing from the south of the Poudre River, and the various PRVs from the North of the River Zone 2. PRV settings were based on their elevation and the required head for the pressure zone;

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valve settings may change during the model analysis phase. Some hydraulic challenges with the North of the River area (pressure swings in Zone 2 and low pressures in Zone 1) will require unique solutions outside of a simple grid of pipes. These solutions are discussed in greater detail in **Section 4.3.4**.

3.2.3 Models by Planning Horizon

Based on the buildout model, modeling scenarios were created for the peak month for the 5-year (2025) and 20-year (2040) planning horizons, as depicted in **Figure 3-1**. These models were driven by the location of demands at each planning horizon. Pipes were maintained from the buildout model in areas where future demand was anticipated. Please see **Section 2.5** for more information on demands by planning horizon. Some pipes will need to be upsized at different planning horizons.

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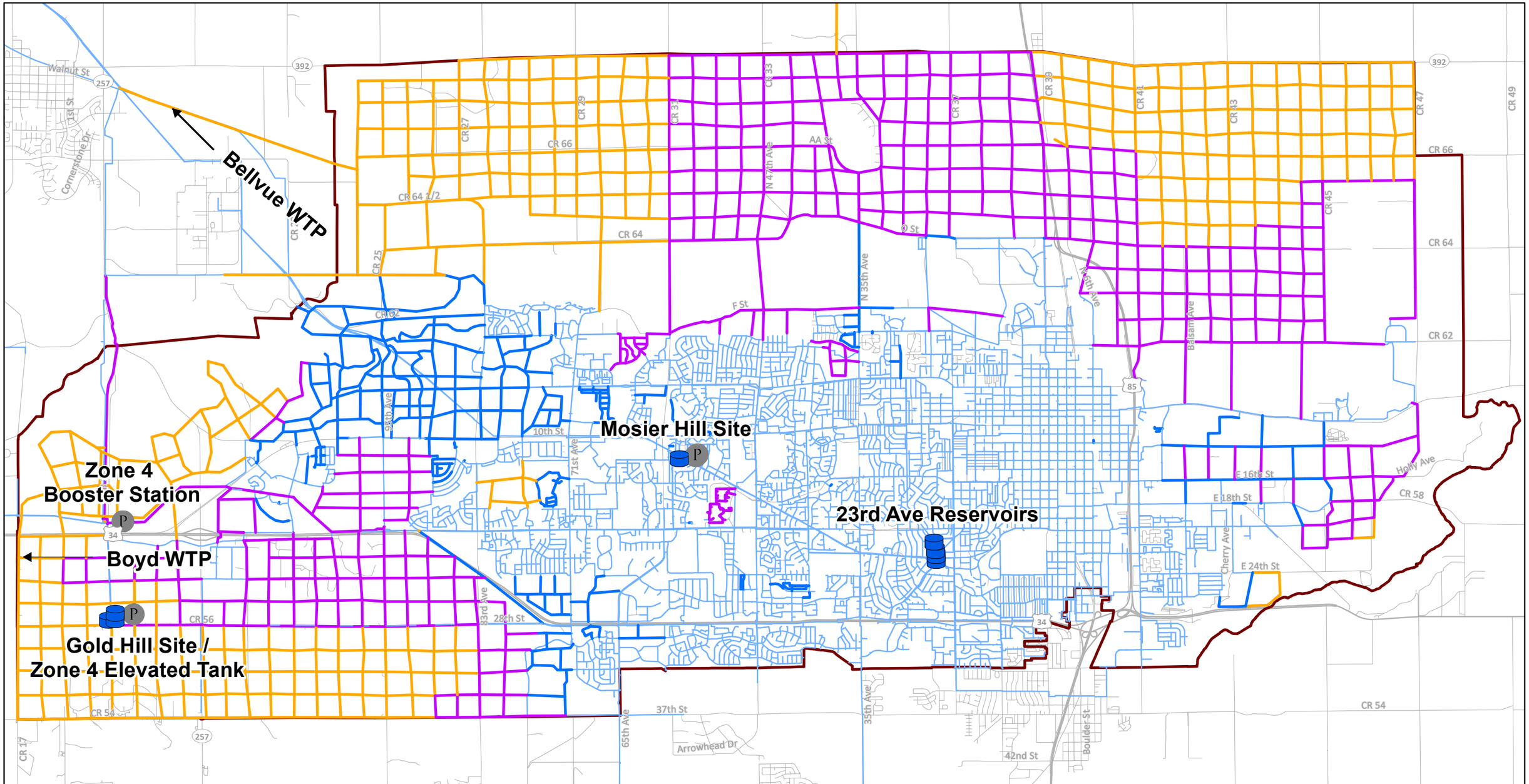

Legend

- LREGA
- Existing Storage
- Existing Pump Stations

Pipes (Planning Horizon)

- Existing
- 2025
- 2040
- Buildout

N

0 0.5 1 2
Miles

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Future Water System Network

Figure 3-1

Greeley Water System Master Plan

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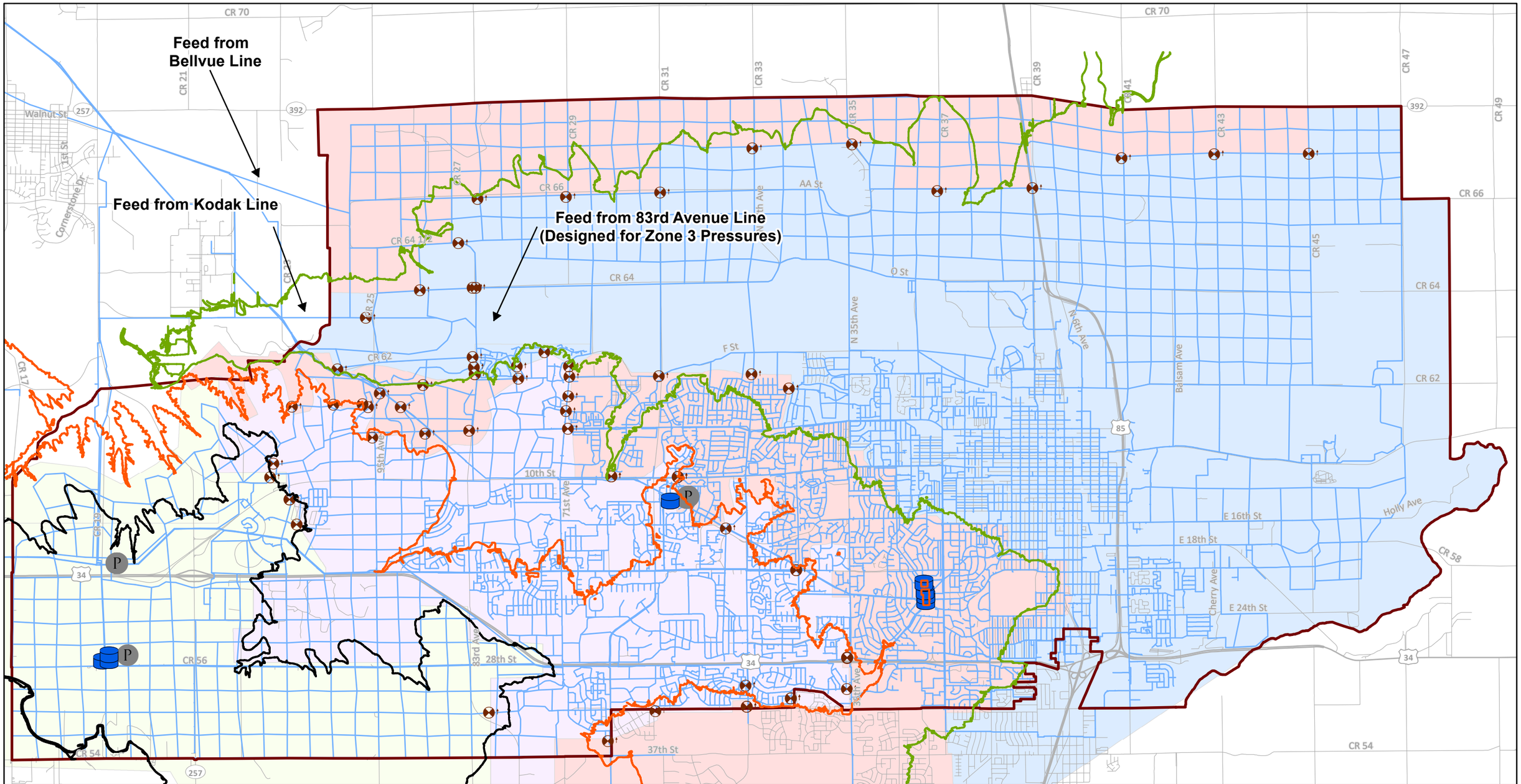

Legend

- LREGA
- Existing Storage
- Exisitng Pump Stations
- PRV
- Pipe

Contour (Ft)

- 4740
- 4840
- 4940

Future Pressure Zones

- Zone 1 HGL - 4740
- Zone 2 HGL - 4840
- Zone 3 HGL - 4940
- Zone 4 HGL - 5100

N

0 0.5 1 2

Miles

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Pressure Zones

Figure 3- 2

Greeley Water System Master Plan

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3.3 Future Demand Allocation

After the piped network was established, the future demands were allocated throughout the system. Details on demand projections at the 2025, 2040, and buildout planning horizons can be found in **Section 2.5**.

Existing system model demands were previously allocated to existing system nodes based on metered data. The existing model included multiple demand sets such as the average month, minimum month, peak month, a calibration month, and September 2018. The model consisted of a set of "non-demand nodes," which included "facilities such as PRV vaults, pump stations and tanks, and pipelines running through a pressure zone with service provided by another zone (*City of Greeley 2018 Water Distribution System Model,* 2019)."

A future demands data set was created for each planning horizon that used the existing peak month demand set for existing water users along with future peak month demands developed for new and infill areas. Future residential and nonresidential demands were set as separate demands within the InfoWater demands database. A new selection set of junctions with demands was created, which excluded "non-demand nodes," nodes outside of the LREGA, and other facilities such as nodes near pump stations and on certain transmission lines. All future residential and nonresidential demands were distributed to the nearest demand nodes.

3.4 Extended Period Simulation Setup

After establishment of the buildout network and incorporation of demands, the model was transitioned to EPS to evaluate how the peak month model would respond to diurnal variation. The 2025 and 2040 models were run in EPS after the buildout model was used for general setup.

3.4.1 Run Setup

A 48-hour runtime was used for the peak month model, as the existing system model was calibrated to this runtime. For water quality runs during model analysis, a 576-hour (7-day) runtime was used to simulate longer-term impacts.

Two diurnal curves were incorporated into the model to represent peaks in residential and nonresidential demands. The curve for residential demands was based on typical usage patterns for single family residential homes with irrigation, and the nonresidential demands were based on historical SCADA data for the outflow from the City's existing reservoirs. For further information on the development of these diurnal curves, please see the peaking factors technical memorandum in **Appendix A**. The existing demands continue to use the summer diurnal curve developed as part of the existing system model, as these demands are not separated by residential and nonresidential demands.

3.4.2 Pump Controls

Many of the pump controls for the existing system model were hardwired based on timesteps, or had pumps permanently set to open or closed. To design for the buildout scenario, level-based controls were used for pump stations for added flexibility, as described in **Table 3-1**. The new controls will allow more pumps to run to meet the increased demands. The pump controls are the same for all planning horizons, although additional pumping will likely be necessary at the Zone 4

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pump station after 2040. This table is only intended to capture modeling methodology; for additional information on general operational recommendations, please see **Section 4.7** and **Section 6.2**.

Table 3-1. Pump Station Controls for Modeling

Pump Station	Controls Description and Changes
Zone 4 Pump Station	Controlled based on the level of the Zone 4 water tower. Additional pumping capacity will be necessary by buildout. Flow control valves were added to ensure pumping within range.
Boyd Lake Pump Station	The southern pump station is no longer in use. The northern pump station is controlled based on the level of the Gold Hill 15-MG reservoir.
Mosier Hill	Controlled based on the level of the Gold Hill 20-MG tanks.

3.4.3 Design Criteria

The primary goal of the water model is to ensure that all demands are met through buildout, while maintaining pressures, velocities, and water age within the City's acceptable range. Pressure should be 40 to 125 pounds per square inch (psi), velocity should be less than 10 feet per second (fps) at fire flow, and typically less than 5 fps under all other conditions. The sizing of pipes and other infrastructure will primarily be based on a balance of creating sufficient capacity to meet fire flow demands, without creating water quality issues because of low velocities during other demand scenarios (especially minimum month).

The model was also set up to maintain steady water supply from the WTPs, and instead allow tank levels to fluctuate with demands. Although the WTPs are modeled as having an infinite supply, valve controls were used to control flow from the WTPs. This WTDMP is primarily focused on the transmission and distribution system; water supply should be coordinated with the City's treatment and supply master plan.

3.5 Review of Preliminary EPS Results

The future system steady state model development achieved the following modeling goals:

- Establish a piped network that can serve all areas through the LREGA
- Allocate projected demands throughout the system
- Check overall system connectivity
- Establish future pressure zones throughout the LREGA
- Maintain pressures within the City's acceptable range of 40 to 125 psi for all conditions except fire flow (discussed in **Section 4.2.3**)

Other modeling goals such as maintaining acceptable water age, refining pipe sizing, and checking system resiliency under fire flow are discussed in **Section 4**. Preliminary static model runs were performed to check for adequate pressures and velocities throughout the LREGA before transitioning to EPS. The average pressures under peak month demand scenario for each planning horizon are shown in **Figure 3-3, Figure 3-4,** and **Figure 3-5**. Maximum and minimum pressures were found to be acceptable during these analyses, except for some buildout pressures (as evaluated in **Section 4.3.4**).

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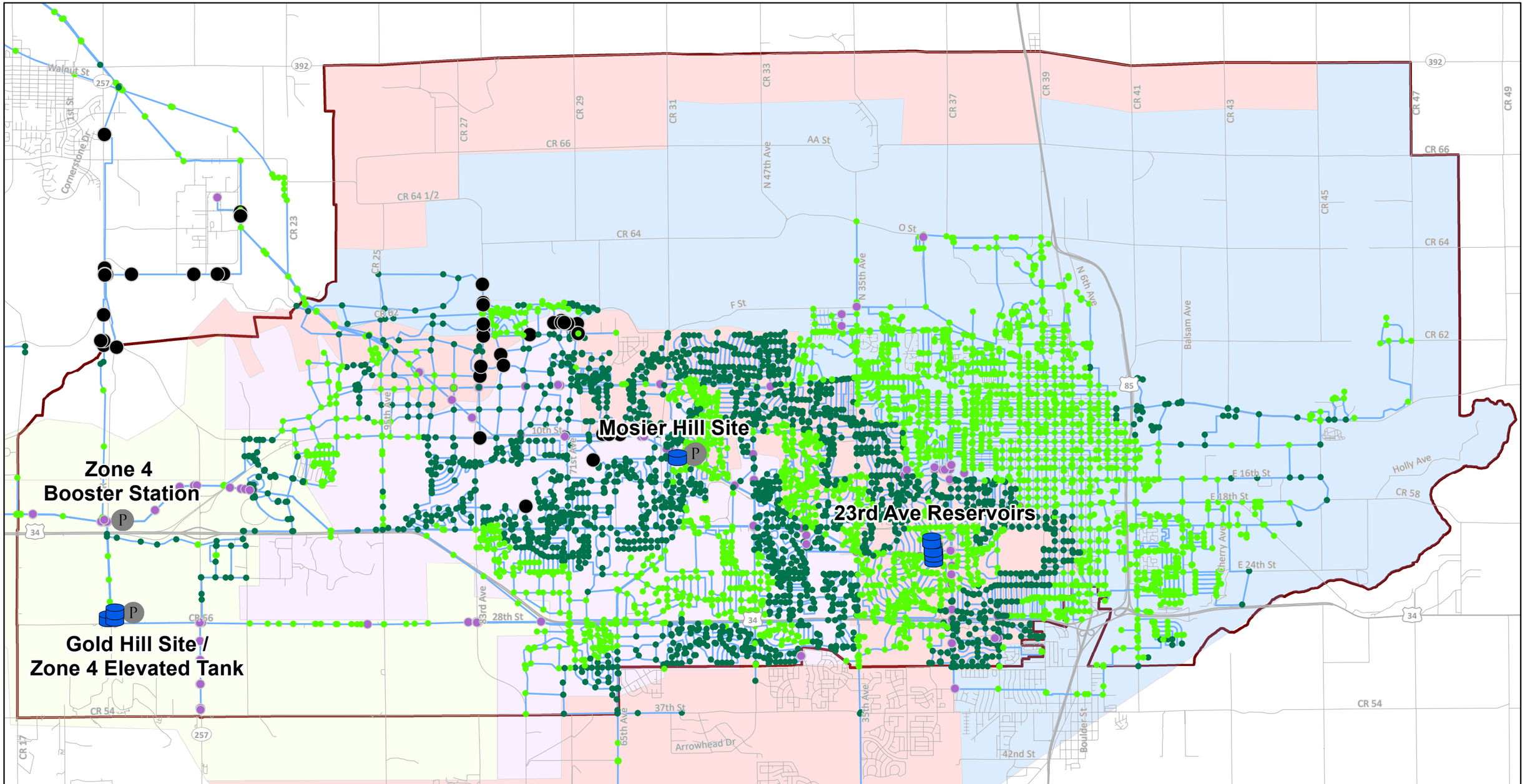

Legend

- LREGA
- Existing Storage
- Existing Pump Stations
- Pipes

Junctions (Avg. Pressure)

- < 40 psi
- 40 - 80 psi
- 80 - 125 psi
- > 125 psi

Future Pressure Zone

- Zone 1
- Zone 2
- Zone 3
- Zone 4

N

0 0.5 1 2
Miles

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2025 Average System Pressures

Figure 3-3

Greeley Water System Master Plan

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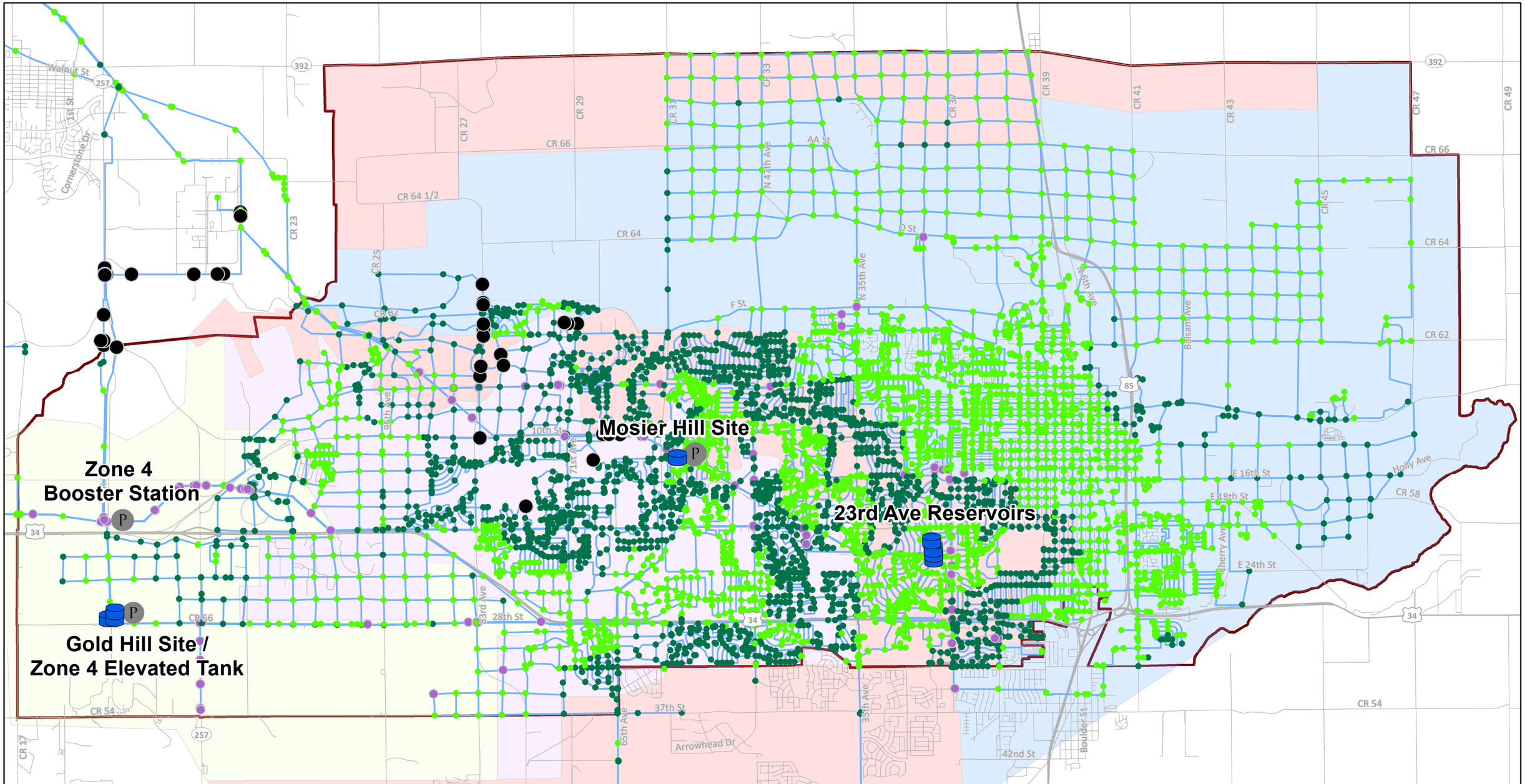

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Legend

- LREGA
- Existing Storage
- Existing Pump Stations
- Pipes

Junctions (Avg. Pressure)

- < 40 psi
- 40 - 80 psi
- 80 - 125 psi
- > 125 psi

Future Pressure Zone

- Zone 1
- Zone 2
- Zone 3
- Zone 4

N

0 0.5 1 2
Miles

2040 Average System Pressures

Figure 3-4

Greeley Water System Master Plan

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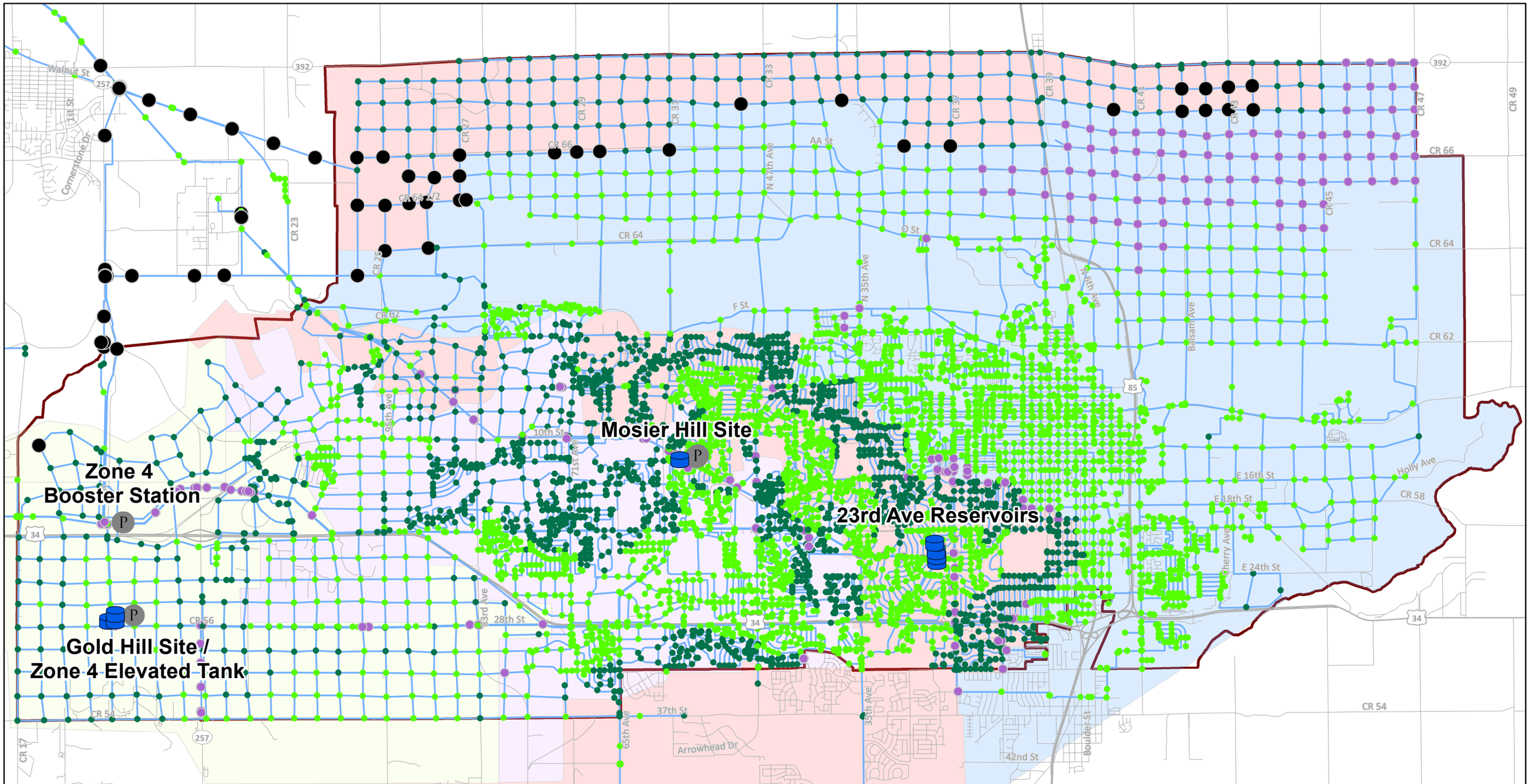

Legend

- LREGA
- Existing Storage
- Existing Pump Stations
- Pipes

Junctions (Avg. Pressure)

- < 40 psi
- 40 - 80 psi
- 80 - 125 psi
- > 125 psi

Future Pressure Zone

- Zone 1
- Zone 2
- Zone 3
- Zone 4

N

0 0.5 1 2
Miles

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Buildout Average System Pressures

Figure 3-5

Greeley Water System Master Plan

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Two areas required careful consideration because of their unique geographic features and elevation shifts: the Cache Project Area and the Bluffs Region. The Cache Project Area is expected to begin development by 2025 and finish construction by 2040. By working with the City's staff, pressure zones were established in these areas to meet the City's pressure requirements during static runs. It is expected that valve settings and pipe sizes will need to be adjusted in these complex areas during design to ensure they are within the City's Specifications. Maps of these two regions can be found in **Figure 3-6**.

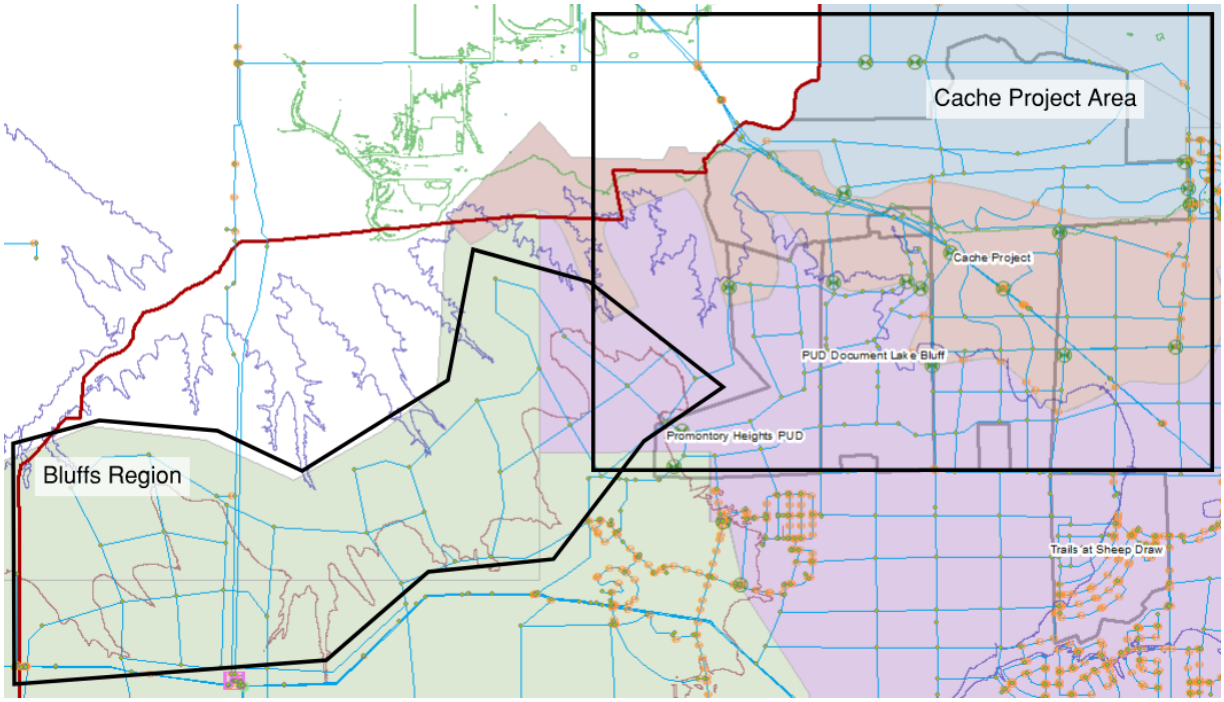

Figure 3-6. Bluffs Region and Cache Project Area (Buildout)

The North of the River also requires unique engineering approaches to appropriately serve it because of its distance from existing infrastructure. At buildout, there is expected to be additional transmission and storage required to serve this area, as discussed in **Section 4.3.4**. However, in 2040, there is only limited development, meaning that very low demands are expected. To avoid constructing large transmission pipes and storage tanks decades before they would be fully used (and to avoid the water quality concerns this would raise), an interim solution was created for the 2040 model. At this planning horizon, the 47th Avenue line would be used as an isolated Zone 2 line, instead of using a PRV to change it to Zone 1 pressures (as is planned at buildout). Additionally, some of the pipelines in North of the River may be put in at a smaller diameter by 2040, then upsized by buildout to avoid water quality concerns. This area is shown in **Figure 3-7**.

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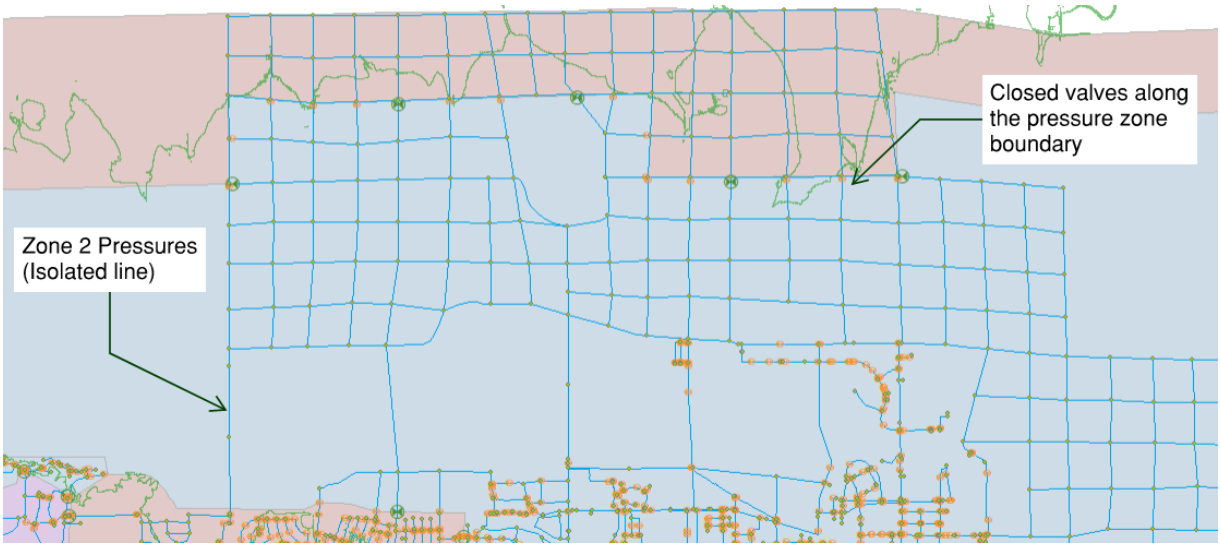

Figure 3-7. North of the River (2040)

Preliminary EPS results revealed that two areas will need additional infrastructure by buildout to meet these criteria: Zone 4 and the North of the River area, which includes some areas currently served by North Weld that are expected to be taken over by the City starting in 2040. Zone 4 currently has very little development, and additional pumping will be needed at the Zone 4 pump station to meet future demands. The Zone 4 pump station was designed with pump cans for three additional 7,500-gpm pumps. The North of the River area experienced large swings in pressure, and constant low pressures in the northeast corner of the LREGA. Storage will likely be required to regulate pressure swings. Additional information on the North of the River area at buildout is discussed in **Section 4.3.4**.

As Zone 1 develops, certain operational changes may also help maintain the supply to the east. In particular, the system has two valves that help control the amount of water going to Zone 1: the 47th Avenue ball valve and the bypass valve near Mosier Hill. Because less growth is expected in Zones 2 and 3 than in Zone 1, it is recommended to divert water into Zone 1 through these as development occurs. Regular maintenance and assessment should be completed to ensure that these valves can support increased flow.

Using these models, it was possible to examine how plant production and tank levels vary by planning horizon. Based on this preliminary analysis, Bellvue WTP will reach capacity around 2040; therefore, expansion is not expected to be necessary until after this planning horizon. Boyd Lake WTP will likely not need expansion, even through buildout. The City generally intends to use Bellvue WTP as the primary supply and Boyd Lake WTP as the secondary supply to supplement peak demands. An operational goal for storage tanks is to absorb demand fluctuations so that the treatment plants can operate steadily. Any future plant upgrades or expansions should be coordinated with the City's future supply and treatment master plan.

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Section 4

Future System Model Evaluation

This section presents the future system hydraulic analysis to confirm the feasibility of proposed solutions and identify any hydraulic deficiencies in the existing or proposed system at all planning horizons. Analyses include water quality evaluations, fire flow evaluations, sensitivity analysis for non-potable offsets, and resiliency to handle a large industrial development in addition to base demands. Ultimately, infrastructure is sized based on a balance of water age concerns and fire flow concerns, to maintain a robust and resilient water distribution system.

4.1 Model Limitations

The existing system model developed under a separate contract in 2018 has been updated and calibrated to support master planning efforts using best available data; however, there are limitations, as in any model. Knowing those limitations is important in making decisions regarding capital improvement projects. The limitations and how they will be addressed are outlined below:

- Many areas of the model are based on preliminary development and PUD reports provided by developers. The pipe layouts were based on either the developers' planned layouts, or on the preliminary street layouts. As these development areas are finalized, their piping may be revised to produce more appropriate system-wide modeling.

- The current system is generally operated based on operator discretion instead of programmed rules for pumps and tanks. As a result, these model results represent typical or expected scenarios for various conditions, but operators should continue to follow established best practices to address daily changes in demand and balance multiple inputs. The City may also consider increased automation, the development of a system-wide standard operation procedure, and/or a detailed operations study to further evaluate current operations, as described in **Section 4.7**.

- Water resources planning outside of this master plan (BBC report) has indicated the possibility for six large industrial users to be constructed in the City by buildout, which could pose a significant stress to the water system and lead to local piping being undersized. Although some preliminary sensitivity tests were run to stress the system with such large user demand, it is impossible to predict the exact location and demands for all potential industrial customers. Continuing to construct larger lines as a backbone to the system in developing areas may help prepare the system to handle an unexpected large user. The water model developed to inform the WTDMP could serve as a valuable tool to evaluate feasibility of adding additional customers as more information becomes available in future years.

- The modeling methods used here represent a flowrate for a specific time frame (i.e., peak month or minimum month based on gpm or MGD) to aid in infrastructure sizing and should

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not be used to calculate total annual water demands in AFY under water resource planning horizons.

- This model is primarily focused on the transmission and distribution pipe network and does not address treatment or supply. The WTDMP should be coordinated with the City's treatment and supply master plan to address any concerns with the plants.

4.2 Evaluation Criteria and Methodology

This section discusses the criteria used to analyze the water system model. **Table 4-1** summarizes analyses conducted at different planning horizons under two demand scenarios. The "all potable demands scenario" refers to the scenario where all future demands are met by potable water, and the "non-potable offsets demand scenario" refers to the scenario where some of the water demands are offset by non-potable irrigation. For more information on demand scenarios, see **Section 2**.

Table 4-1. Analyses by Planning Horizon

		All Potable Demands Scenario				Non-Potable Offsets Demand Scenario	
Planning Horizon		Peak Month	Peak Month + Fire Flow	Minimum Month Water Age	I-H User	Peak Month	Peak Month + Fire Flow
2025		X	X	X	-	X	X
2040		X	X	X	-	X	X
Buildout[1]	North Weld[2]	X	X	-	X	X	-
	Two Tanks	X	-	-	-	-	-
	PRVs	X	-	-	-	-	-
	Shifted Pressure Zone Boundary	X	-	-	-	-	-

[1] Four different options were considered for serving the buildout scenario through North of the River, as described in **Section 4.3.4**.

[2] The North Weld option was selected for additional modeling based on feasibility and the existing intergovernmental agreement criteria. This does not guarantee that this is a final design or the final selected option. Additional coordination will be needed between Greeley and North Weld as this area develops.

This section discusses the evaluation criteria used for each analysis and describes the methodology and setup for each analysis. **Section 4.3** includes key results and findings from each analysis.

4.2.1 Water Quality Evaluation (Minimum Month)

Treated water produced at the Bellvue and Boyd Lake WTPs is disinfected with chlorine to provide a residual disinfectant to protect water quality in the pipelines before it reaches the City's customers. When the treated water remains in the pipeline for an extended period (which can occur because of low flows), the residual chlorine dissipates over time, creating increased vulnerability to contamination. To evaluate the potential for this issue to occur, water age analyses were conducted at the 2025 and 2040 planning horizons. These analyses were run during the minimum month (December), which represents the lowest demands and therefore the highest average water age annually to be conservative. Water age analyses can help identify

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oversized pipe, possible connection or looping improvements, or the need for additional chlorine injection stations with the goal to shorten water age and thereby improve disinfection protection within the distribution system.

Recent changes to tank operations at Gold Hill have improved turnover in the tanks and reduced water age throughout the system. The new Gold Hill transmission lines enable water to be delivered to the west side of town directly from Bellvue WTP with reduced water age. Additionally, the increased demands shown with each planning horizon can improve turnover in the tanks, improving initial water age over time.

Based on historical water demands (July and December 2016), the peak month to minimum month demands ratio is 3.1. This factor was applied globally to the peak month demands to calculate the minimum months' demands. A daily hour to hour diurnal curve based on existing winter demand patterns was applied to all demands, as shown in **Figure 4-1**.

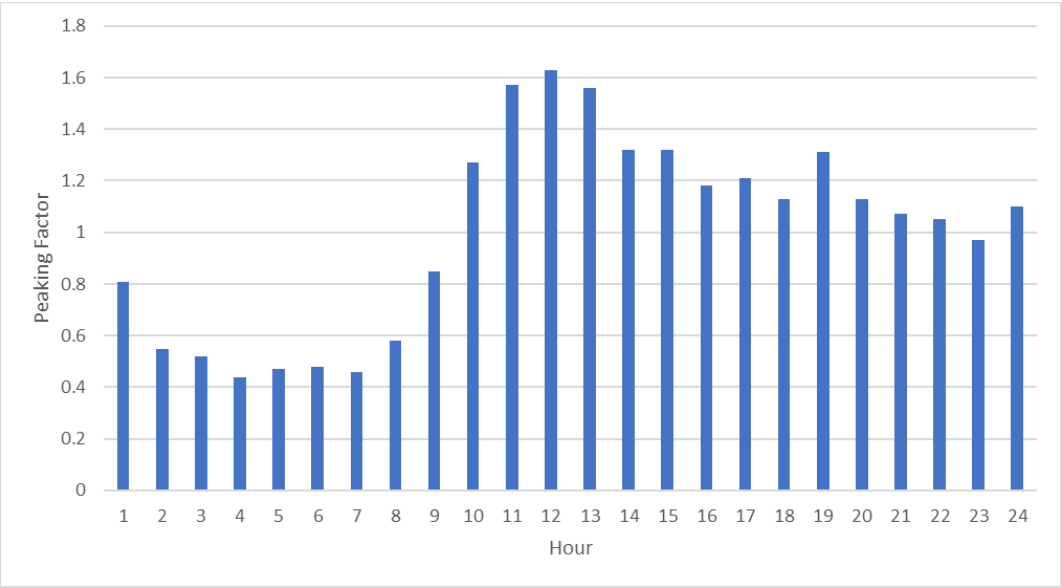

Figure 4-1. Winter Diurnal Curve

4.2.2 Correlation of Water Age to Chlorine Residual

It is typical that disinfection residual will decay with time, but the rate of decay can be highly variable depending on the water characteristics, distribution piping, seasonal temperatures, and numerous other factors. The City tracks chlorine residual and other constituent parameters within the distribution system monthly for reporting and regulatory compliance purposes. As part of the WTDMP, an effort was made to correlate chlorine residual to water age. Because hydraulic modeling can easily track water age within the distribution network, a reliable trend would help to determine an age threshold at which residual decay would be of concern.

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Records were obtained for the month of November 2018 for residual testing conducted across the City network and compared with water age predicted by the existing hydraulic model for the same time period. An advantage of the lower demand months analyses is that all water supply traveling within the network comes from the Bellvue WTP and represents a single supply source with consistent water treatment without mixing supplies between the Bellvue and Boyd treatment sources (which could further complicate a residual to water age comparison exercise). The model analyzed a continuous operating period of 24 days to predict stabilized average water age within the network and potable storage facilities.

Although there is reasonable confidence in the water age analysis prediction, there are uncertainties that could impact water age prediction at specific locations across the network. Similarly, the testing results can be subject to sampling and testing errors that can impact the reliability of comparison results. Both testing and water age prediction indicated that water age and residual decay is highest along pressure zone boundaries in areas where water moves more slowly and could become old. This is because water flows to lower zones through PRVs that occur only at specific points and operate less frequently during lower demand periods, when there is lower local demand to freshen the water in these locations. If continued sampling were to identify a problem with water age, additional connections between zones and case-by-case piping improvements to promote circulation around dead end locations could be evaluated as potential solutions. Additionally, further investigation of chlorine residual and water age may be required in the future if additional storage is constructed in the North of the River, as discussed in **Section 4.5**.

A correlation trend was developed for water age vs. chlorine residual using approximately 35 measurement points spread across pressure zones throughout the existing distribution network. These points were considered reliable measurements, but a few of these were discarded as anomalies when trying to establish a trend line. Although there is still a wide scattering of residual levels vs. water age, an averaging trend clearly shows a decay condition over time with a residual level of about 0.2 mg/l corresponding to approximately 190 hours of water age. As a result, predictions of water age above 190 hours were considered a benchmark that may justify further field testing to evaluate if water age predictions truly represent insufficient disinfection residual. Reports to date indicate that disinfection within the network is not a major concern for any particular month but might be worth further investigation during the lowest demand periods of the year. The results of the correlation trend are shown in **Figure 4-2**.

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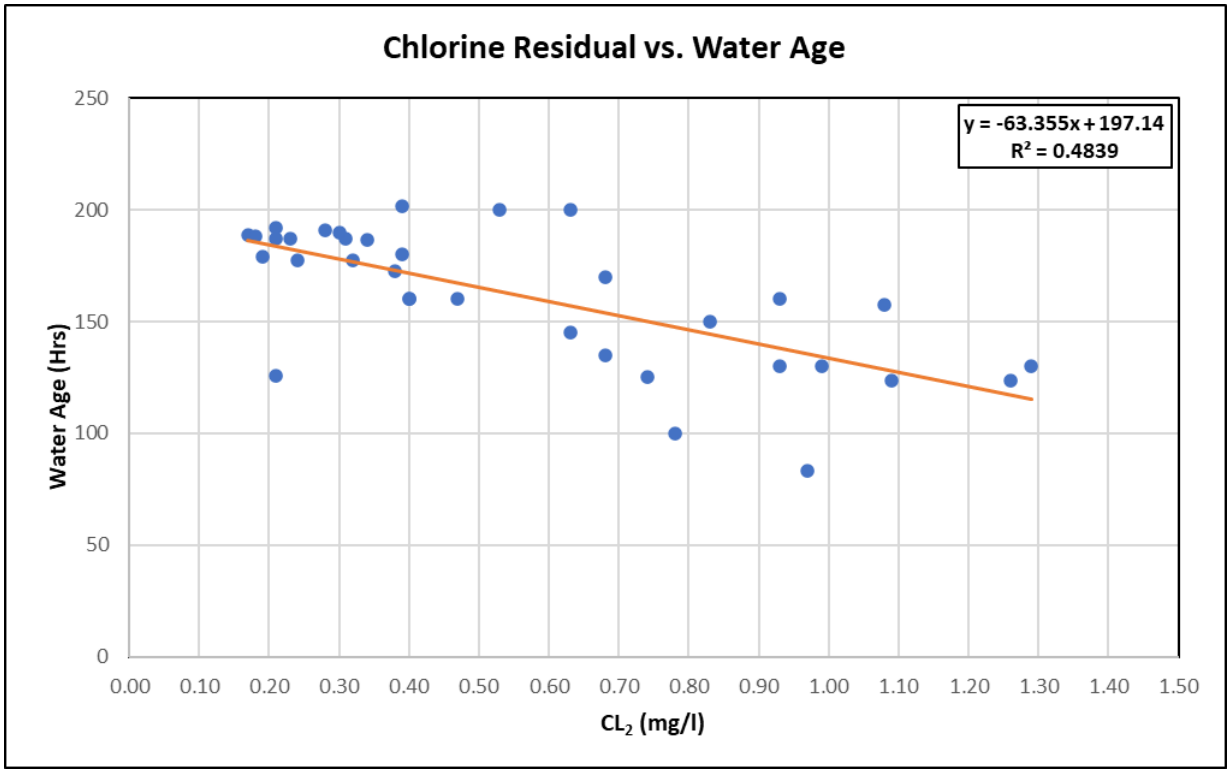

Figure 4-2. Correlation of Chlorine Residual and Water Age

Information from the water model related to chlorine residual and disinfection byproducts (DBP) indicates there are areas in the distribution system where water age can approach 8 days (190 hours) during low demand periods, which results in the free chlorine residual approaching the minimum CDPHE required residual of 0.2 mg/L. These are also areas where disinfection byproducts, THMs and HAAs are expected to reach the highest levels. The high quality of the City's raw water supply typically results in treated water total organic carbon (TOC) less than 2.0 mg/L from the Bellevue WTP and 3.0 mg/L from the Boyd WTP, which results in locational running annual average (LRAA) THMs and HAAs that are approximately 40-50% below the maximum contaminant levels (MCLs) of 80 parts per billion (ppb) and 60 ppb respectively. The low concentration of THMs and HAAs normally provides the City with the flexibility to increase the free chlorine residual leaving the WTP to maintain the minimum 0.2 mg/L residual in the distribution system during low demand periods without exceeding the THM and HAA MCLs.

Future trends that could impact compliance with DBP regulations are poorer treated water quality due to changes in the raw water supply that increase treated water TOC and chlorine demand and the increases in chlorine residual leaving the WTPs to maintain the minimum residual in the distribution system. The THM and HAA data provided in the 2009 Initial Distribution System Evaluation Report for DBP sampling locations indicates that DBPs typically spike in July and August. This can result in the LRAA DBPs approaching the MCLs when treating raw water with high TOCs, as occurred in 2003, when it was a unusually wet spring and high run-off. The TOC in the treated water from Bellevue WTP was 3.9 mg/L and the TOC from the Boyd WTP was 4.1 mg/L. Changes in raw water quality could also result from droughts and wildfires that will increase the raw water TOC or chlorine demand.

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The U.S. Environmental Protection Agency (EPA) is also considering potential revisions to the microbial and DBP rules as a result of the mandated six-year review of the National Primary Drinking Water Regulations (NPDWR). This review considered new information related to public health risks, treatment technologies and system operations to identify NPDWRs for potential updates or revisions. Data identified an increased risk of microbial contamination associated with opportunistic organisms such as *Legionella*, nontuberculosis mycobacteria (NTM) and *Pseudomonas aeruginosa*. These can be associated with increases in heterotrophic bacteria and biofilms in the distribution system downstream of final disinfection. As a result, the EPA may consider increasing the minimum disinfection residual concentrations in the distribution system. Increasing the disinfection residual to reduce the microbial risk could impact DBPs, so the surface water treatment rule and Long Term Enhanced Surface Water Treatment Rule could also be updated or revised. EPA identified the following eight NPDWR as potential candidates for revision: Chlorite, Cryptosporidium, Haloacetic acids, heterotrophic bacteria, Giardia lamblia, Total Trihalomethanes, and viruses. There is also the potential that two currently unregulated DBPs, chlorate and nitrosamines, would be added to the list of NPDWRs.

The potential change in the regulations is uncertain, and adoption of any changes is not expected for several years. This would allow time for the City to evaluate and implement potential changes in water treatment processes and disinfection practices to comply with the revised regulations such as pre-treatment with chlorine dioxide, enhanced coagulation, pH adjustment or conversion to chloramines for the distribution system residual.

4.2.3 Fire Flow Evaluation

Fire flow evaluations test if the distribution system can provide sufficient flow and pressure to meet the high demands required to put out a fire. To determine that the City's water system can meet fire code, fire flow analyses were conducted at the 2025 and 2040 planning horizons (under both demand scenarios), and for one potential buildout scenario (North Weld option) under the all potable demands scenario. Typically, fire flow represents the highest demand on a system. Fire flow analyses can help identify undersized pipes or storage deficiencies.

Fire flow requirements vary based on building size, construction, occupancy, and exposure, and typically range from 500 to 12,000 gpm over a specified duration (typically 2 hours). Individual developers should check the fire flow requirements for their land use and unique property during construction. Additionally, the City criteria requires maintenance of a residual pressure of 20 psi and a maximum velocity of 10 fps.

For master planning purposes, a target fire flow of 1,500 gpm was selected, which is a typical value for design of a single hydrant with a 4-inch outlet nozzle (per American Water Works Association [AWWA] C-502). It is considered acceptable if two adjacent nodes combined can provide 1,500 gpm of fire flow. Initial tank levels set to half full with no pumps running represented the most conservative demand scenario to test fire flows. The maximum velocity was set to 10 fps, to align with the City's Specifications. Steady-state simulation was used (with time step at 15:00), where the diurnal curve corresponds closest to 1.0 (meaning peak day instead of peak hour conditions, which is a typical approach because fire flow on top of peak hour demands is usually considered too extreme of a criterion). The fire flow analysis was conducted for all

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demand nodes within the existing and future system. These junctions do not necessarily correspond to physical hydrant locations.

4.2.4 Non-Potable Offset Demands Scenario – Peak Month and Fire Flow

The City has historically used non-potable irrigation to offset potable demands as part of ongoing conservation efforts. If non-potable irrigation offers significant offsets, it may be possible to downsize some future pipes because of decreased potable demand. Because the use of non-potable irrigation is often driven by policy and economic feasibility decisions, it is important to find a balance between taking advantage of the cost savings of downsizing pipes, while mitigating the risk of undersizing pipes in the main gridline by relying on non-potable irrigation. For more information on non-potable irrigation demands by planning horizon, please see **Appendix D**.

The non-potable offsets peak month demands were run for all three planning horizons to optimize the size of pipes in the main grid system. Additionally, fire flow analyses were conducted for the non-potable offsets demand scenario in 2025 and 2040 to determine whether downsizing lines would risk the system's ability to meet fire demand. The non-potable offsets demand scenario may also be used to inform certain CIP projects.

4.2.5 Large Industrial User

Although the City's zoning does not currently have any areas zoned as I-H[1], it is possible that large industrial users with high water demands will develop in the City. A hypothetical industrial user was added into the system to test system performance under peak month buildout scenario (North Weld option).

Based on City knowledge of potential customers, it was decided to conduct a sensitivity analysis for a hypothetical I-H user in the northwest railroad industrial corridor with a 1 MGD base demand, with additional demand during the peak hour (up to 1.9 MGD). This location is identified in **Figure 4-3** and is in Zone 2 North. Because this user already represents a conservative sensitivity analysis, fire flow analysis was not conducted for this location.

4.3 Future Water System Evaluation

This section describes the analyses conducted at the 2025, 2040, and buildout planning horizons to ensure that the future system is resilient and meets City standards. These analyses were used to finalize the future system models. All analyses described in this section were conducted under the all potable demands scenario.

4.3.1 Peak Month Evaluation

As described in **Section 3**, the peak month model primarily served to check if the system was within the acceptable pressure and velocity ranges defined in the City's Specifications. Model results indicated most of the system was within acceptable ranges. Some areas have existing high or low pressures, especially along the pressure zone boundaries, meaning their average pressure was higher than 125 psi or lower than 40 psi—these were considered acceptable because the water system has already been built for these pressures or they were within the margin of error.

[1] As discussed in previous sections, land use designations employed by planning (I-L, I-M, and I-H) do not necessarily refer to the amount of water the user consumes. For this analysis, it was assumed that the theoretical I-H user requires high demands.

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The City may consider doing field tests in areas with high pressures to confirm the actual pressures in these areas and decide whether pipe improvements are necessary. Peak month results for all planning horizons can be found in **Section 3.5**.

Certain existing lines are recommended to be upsized by 2025 or 2040 to support phased growth and to strengthen the distribution system's backbone. These lines are shown in **Figure 4-5** (see **Section 4.3.3**).

4.3.2 Water Quality Evaluation

Water age analyses were conducted under the all potable demands scenario to evaluate water quality under low demand conditions. The resulting average age during the minimum month is shown in **Figure 4-3** for 2025 and **Figure 4-4** for 2040.

The 2025 and 2040 evaluations showed similar water age trends to the existing system. In general, water ages from west to east, as distance from the Bellvue WTP supply source increases. As a result, there is lower water age near zone boundaries. Boyd Lake WTP is not expected to operate during minimum months through 2040, which can contribute to higher water age in the west (especially Zone 4). This may be improved in the future by additional development and the completion of the 60-inch Gold Hill line, which will bring water directly from Bellvue WTP at a higher flowrate, shortening the time the water is spent in the transmission and distribution system. Although some areas receive water with a higher water age than other areas, ongoing sampling throughout the year has confirmed that the City is in compliance with chlorine residuals standards and all other water quality standards required by CDPHE, meaning that the City is providing safe drinking water for all customers.

Large storage volumes may be contributing to higher water age during the minimum month, especially in areas where the tanks are not fed directly from Bellvue WTP, such as at Gold Hill. Monitoring the tanks and reservoirs during low demand months may help validate modeling results and determine whether water is staying in storage for longer than a typical industry standard of 30 days. If results of monitoring show that water is staying in storage for longer than a typical industry standard of 30 days, the City may consider improving water age by promoting circulation via additional baffling or changes to the inflow and outflow configuration, or by adding a chlorine booster station at the tank discharge. Detailed hydraulic models of the tanks may help identify preferred solutions or improvements.

As the City develops in phases, some areas may experience higher water age as the pipes will be sized for full development. One example of this is the Cache Project Area. This area shows higher water age in 2025 than it does in 2040 because the full demand is not expected to be met until after 2025, resulting in low flows until then. Developers should work with the City to ensure that water quality standards are met throughout the interim growth phases.

The North of the River area is expected to develop intermittently, starting after 2025, and not fully developed until buildout. During this time, developers should work with the City to ensure that lines are designed for future demands, without leading to extended water age before then. Additionally, it may be beneficial for the City to establish feeds from North Weld, which may provide fresher water because of the proximity of their existing system to this area.

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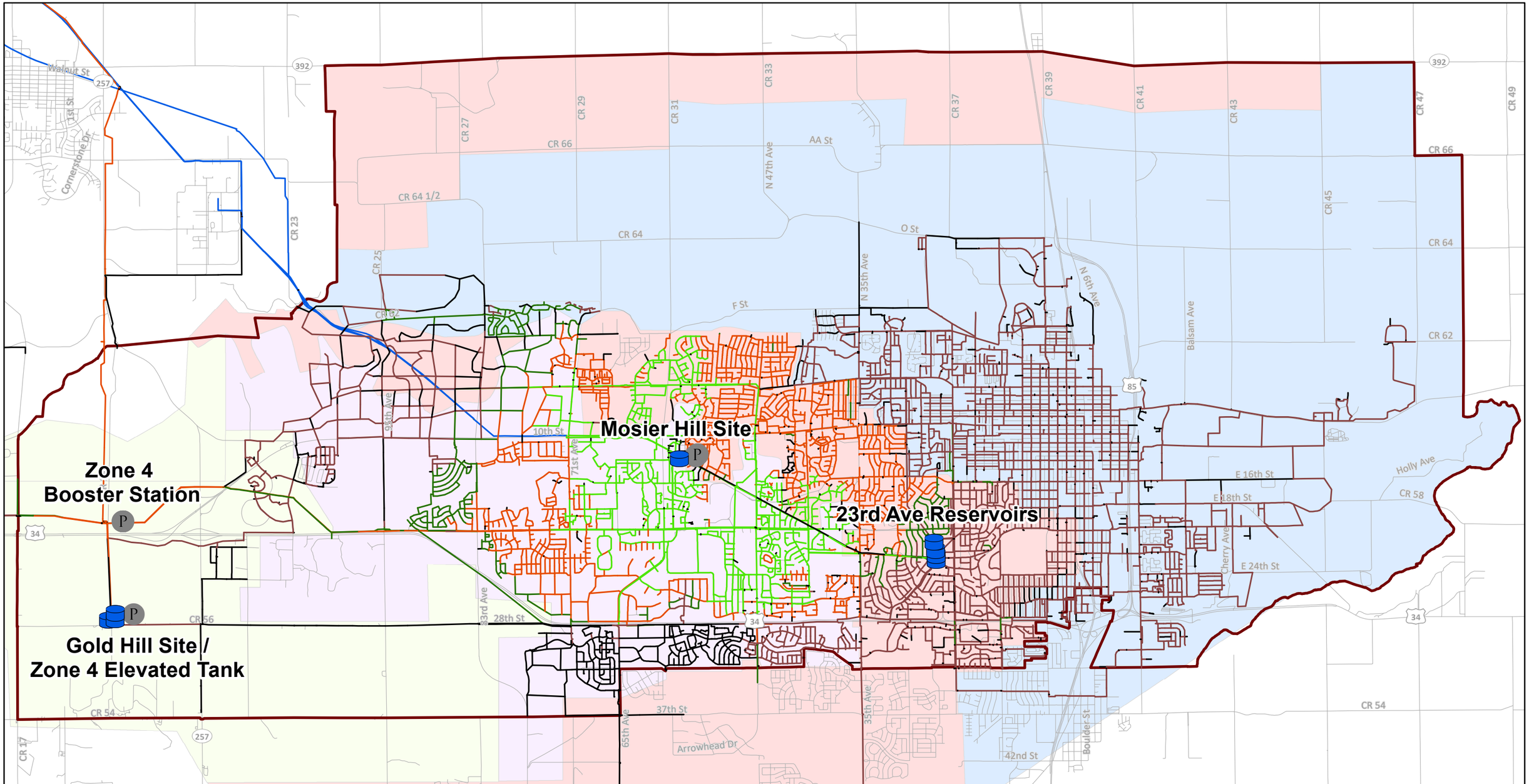

Legend

- LREGA
- Existing Storage
- Existing Pump Stations

Pipes - Average Water Age (hr)

- Less than 24
- 24 - 72
- 72 - 120
- 120 - 168
- 168 - 240
- Greater than 240

Future Pressure Zone

- Zone 1
- Zone 2
- Zone 3
- Zone 4

N

0 0.5 1 2
Miles

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2025 Water Age (Min. Month)

Figure 4-3

Greeley Water System Master Plan

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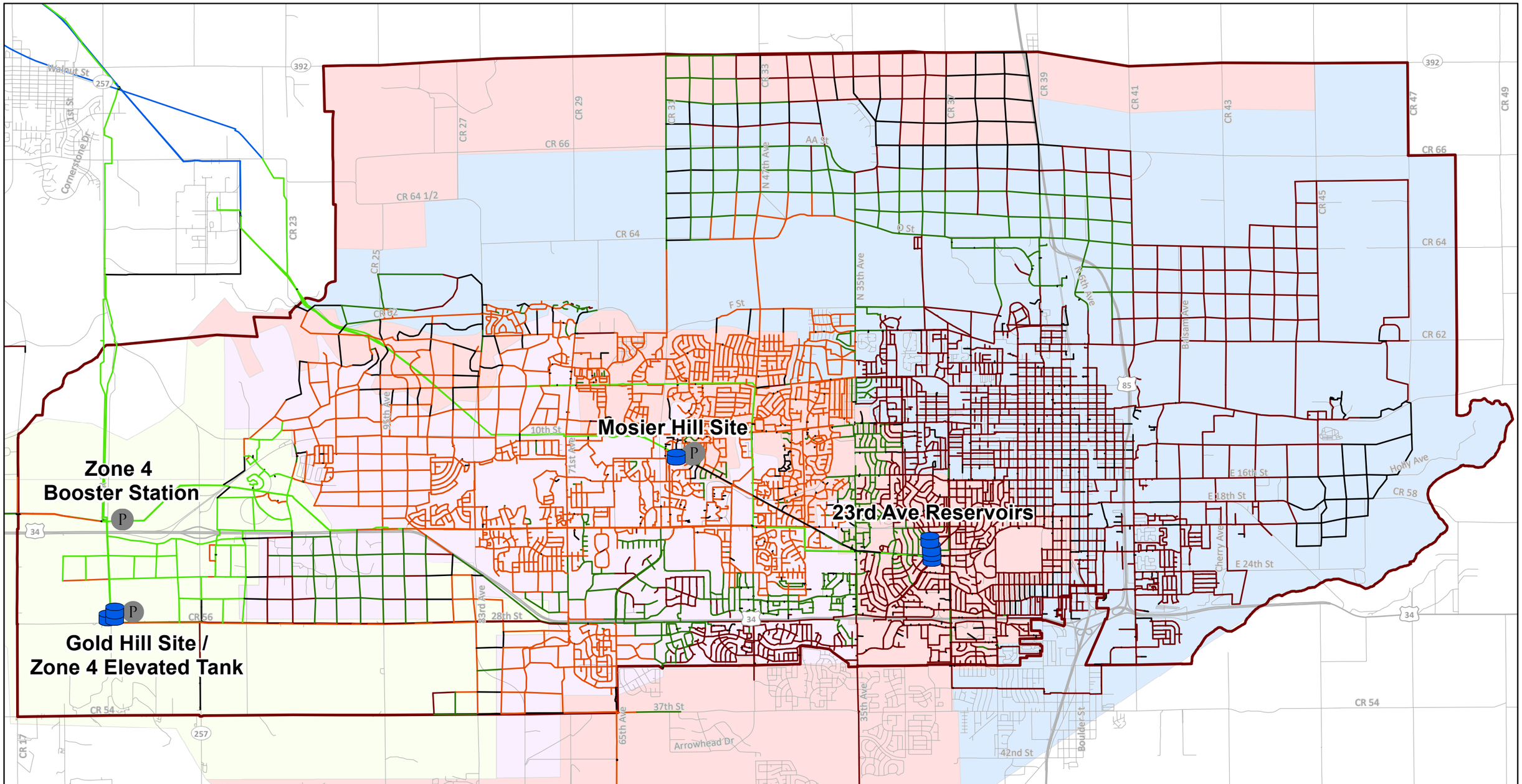

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Legend

- LREGA
- Existing Storage
- Existing Pump Stations

Pipes - Average Water Age (hr)

- Less than 24
- 24 - 72
- 72 - 120
- 120 - 168
- 168 - 240
- Greater than 240

Future Pressure Zone

- Zone 1
- Zone 2
- Zone 3
- Zone 4

N

0 0.5 1 2
Miles

2040 Water Age (Min. Month)

Figure 4-4

Greeley Water System Master Plan

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4.3.3 Fire Flow Evaluation

Modeling efforts predating the WTDMP had previously identified limited potential fire flow improvements in the existing system. Nodes that were at dead ends, on a line running through a different zone, or not near a hydrant were removed from the list of improvements, as these lines are not intended for fire flow. Additionally, some areas such as Spanish Colony and the Evans/Milliken service area are served by alternate fire departments and were not addressed as part of this master planning effort. The remaining nodes, summarized in **Table 4-2**, were addressed under the 2025 planning horizon, where short-term CIP projects will be recommended. These values generally correlated with field results provided by the City's fire department. In total, 11,285 feet of existing pipe are recommended to be upsized to meet fire flow, as shown in **Figure 4-5**; however, these are preliminary planning results, and the system may be improved through other methods (such as adding connections between pipes instead of upsizing an existing pipe). Further design is necessary to finalize and refine these projects. Here, "available fire flow" refers to the amount of water that a specific node can supply without the system dropping below 20 psi or 10 fps.

Table 4-2. Fire Flow Improvements (2025)

Deficient Node	Preliminary Available Fire Flow (gpm)	Description of Upgrades Needed to Improve Fire Flow	Final Available Fire Flow (gpm)
CR01373023	640	Upsize pipelines along 9th Street (from 21st Avenue to 19th Avenue) from 4 to 8 inches	2,020
PC01480006	470	Upsize pipelines along 5th Avenue (from 21st Street to 20th Street) from 4 to 8 inches	2,190
RD01304037	320	Upsize some pipelines along 9th Avenue and 2nd Street from 4 to 8 inches and some from 8 to 12 inches	1,570
TEE01268014	630	Upsize pipelines along Vern Schaffer Boulevard from 4 to 8 inches	2,190
TEE01373033	480	Upsize pipelines along 21st Avenue (from 11th Street to 10th Street) and 10th Street (from 21st Avenue to 20th Ave) from 4 to 8 inches	1,700
TEE01411006	390	Upsize pipelines along 1st Avenue and 12th Street from 4 and 6 inches to 8 inches	1,570
TEE01619002	440	Upsize pipelines from 17th Avenue along 30th Street Road from 4 and 6 inches to 8 inches	2,210
PC03508001	670	Upsize pipelines along 22nd Street from 4 to 8 inches	2,980
RD02371020	740	Upsize pipelines along 31st Avenue from 4 to 8 inches	2,100
RD02371021	470	Upsize pipelines between 32nd Avenue and 31st Avenue from 4 to 8 inches	920 [1]
TEE03475001	750	Upsize pipelines along W Wagon Trail Road and Homestead Road from 6 to 8 inches	1,550

[1] Adjacent nodes are above 1,500 gpm because of piping upsizing.

The future system model did not reveal any new deficiencies under either demand scenario for all planning horizons. However, developers should ensure that their designs allow for appropriate fire flow capacity, especially in areas where a full distribution grid may not be fully built yet.

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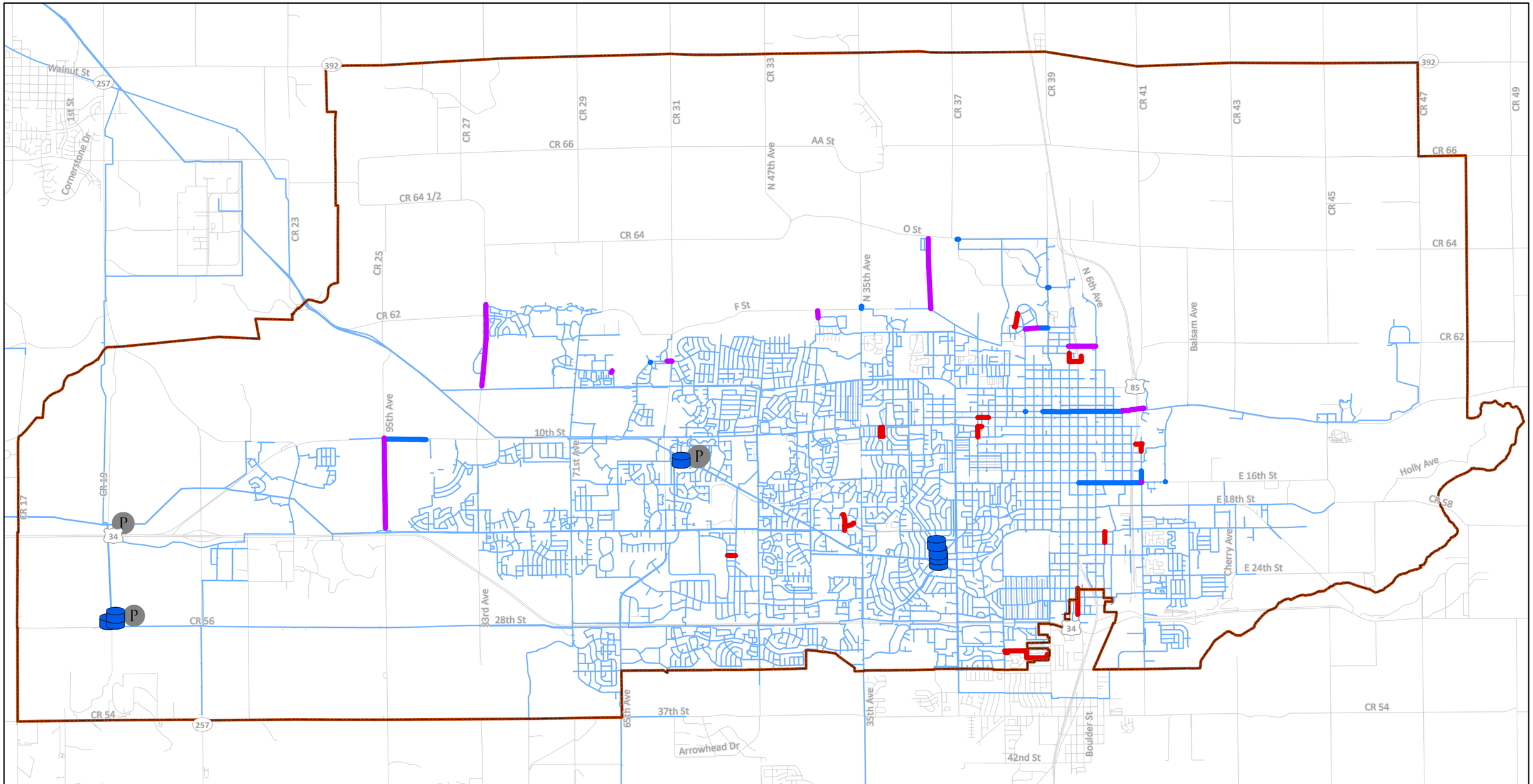

Legend

- LREGA
- Existing Storage
- Existing Pump Stations
- Existing Pipes

Existing System Improvements

- 2025 Pipe Improvements (Fire Flow)
- 2025 Pipe Improvements
- 2040 Pipe Improvements

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0 0.5 1 2
Miles

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Existing System Improvements
Figure 4-5
Greeley Water System
Master Plan

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4.3.4 Buildout Options Evaluation

At the buildout scenario, many areas are expected to fully develop that are farther out from the City's existing infrastructure. In particular, the North of the River area is expected to see some areas with large pressure swings or consistently low pressures without additional infrastructure. Four alternatives were considered to serve this area, as described below and shown in **Figure 4-6**. Because the buildout scenario is so far in the future (expected later than 2090), future study will be needed of this area to reevaluate alternative feasibility to reflect any changes to planned growth.

- **North Weld Option.** Under this option, the City would take water from North Weld through strategically placed master meters, in line with the existing intergovernmental agreement (attached in **Appendix E**). Although a location was selected for preliminary modeling purposes, the City would need additional coordination with North Weld for this option to be feasible. The current location was based on the City's pressure needs (in the City's Zone 1 area) and on North Weld's existing infrastructure (along an existing 16-inch line). The flowrate of 4.9 MGD used for modeling was based on applying a peak month: average month factor to the annual volumes specified in the existing intergovernmental agreement; specific demand would be coordinated with North Weld as this area develops.

- **Two Tanks Option.** This option would add two new reservoirs in the North of the River area—one in each pressure zone (Zone 1 and Zone 2 North). The exact size and location of these tanks would need to be evaluated under a separate dedicated study. For preliminary feasibility modeling efforts, the Zone 1 tank was sized at 5 MG, and the Zone 2 North reservoir was sized at 10 MG. Additional transmission lines would be needed to supply water to these tanks. Although this option is feasible and may create a more robust system for the long term, it does present some water quality concerns due to water age in the tanks and it is the most expensive option.

- **PRVs Option.** Under this option, the City would open some of the PRVs along the Zone 1/Zone 2 North boundary. This option may be the least expensive, as the PRVs would already be constructed, but is less hydraulically efficient than other options. While this option did improve some pressures in Zone 1, it lowered pressures in Zone 2 North, ultimately not improving the overall system. In general, the City would prefer not to rely on PRVs for normal operation.

- **Shifted Pressure Zone Boundary Option.** This option involves adjusting pressure zone boundaries to moving the Zone 1/Zone 2 North boundary further south, serving more of the areas preliminarily identified as Zone 1 with Zone 2 North pressures. While this solution improved pressures in some areas, it also created low pressures in other areas.

After discussions with the City, it was determined that the North Weld option would be considered for additional analysis and system optimization, as the existing intergovernmental agreement would make this a feasible and preferred option. However, this does not represent a final design recommendation, and additional coordination would be needed with North Weld if this plan was followed closer to buildout. A copy of the existing intergovernmental agreement is found in **Appendix E.**

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Under all scenarios, it is anticipated that a new reservoir would be needed in Zone 2 North to balance out pressure swings in this area. The preliminary location, shown in **Figure 4-6**, was placed in the model at a point with highest elevation. More detailed studies should be conducted to identify an optimal location, size, and design for this reservoir. An elevated tank in the City's LREGA could be considered as an alternate, as less piping would be required. The City may also consider coordinating with other regional stakeholders for a potential shared storage to serve this area.

It is anticipated that additional pumping capacity would be needed at the Zone 4 pump station by buildout. This pump station was designed with this expansion in mind, and already has empty pump slots that would be filled to meet buildout growth and demands.

4.3.5 Large Industrial User Evaluation

The addition of a large industrial (I-H) user to the North Weld option model showed that the system can handle the additional demand while still maintaining the City's pressure and velocity standards. While the I-H user was added in Zone 2 North, as shown in **Figure 4-6**, the planned pipe network would also be easy to reconfigure to serve a large user in Zone 1. Further evaluation and modeling analysis would be necessary to check that the system could handle a new user when more information on those users' demands and location becomes available.

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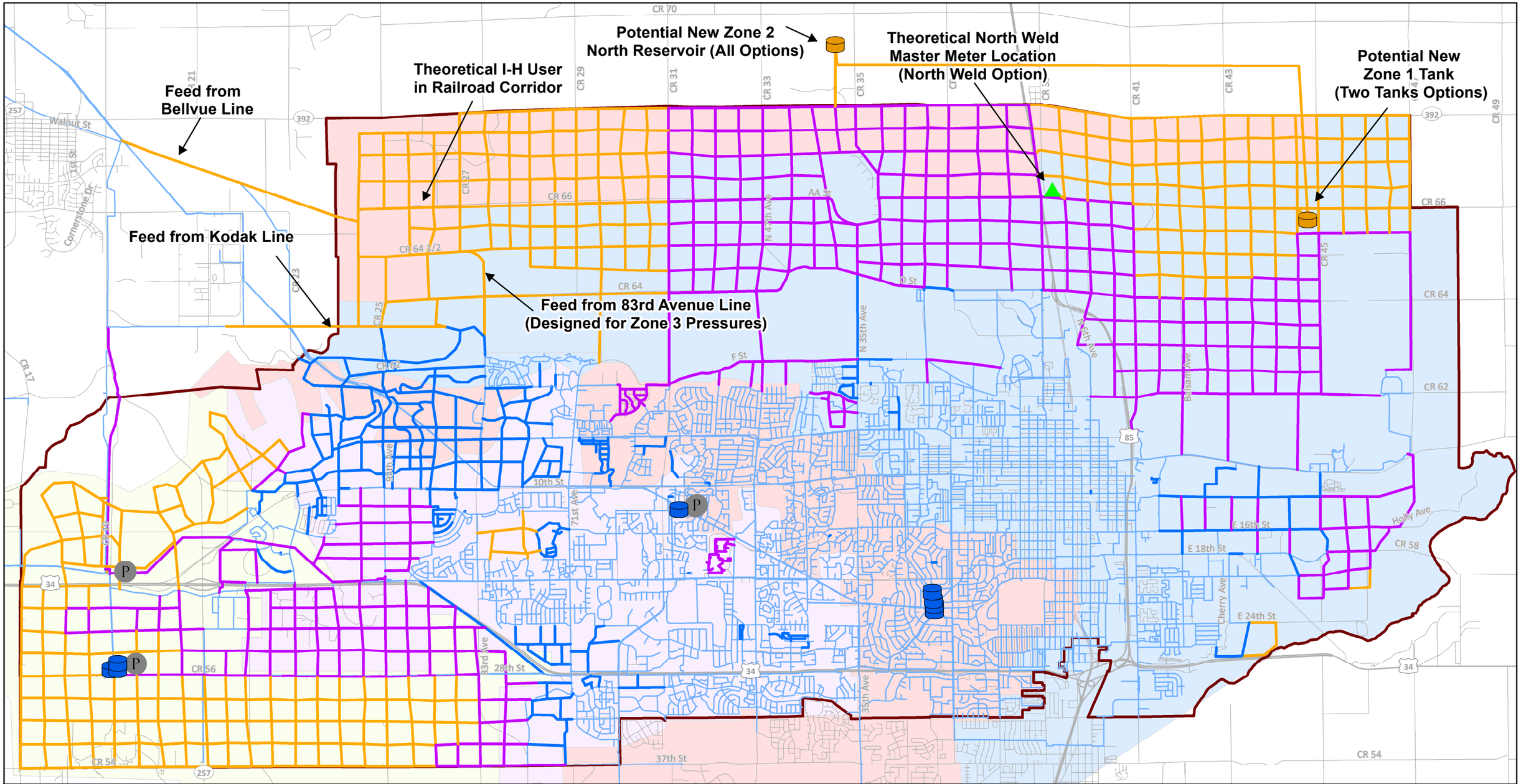

Legend

- LREGA
- Existing Storage
- Existing Pump Stations
- Master Meter
- Future Storage (Buildout)
- Existing Pipes
- 2025 Pipes
- 2040 Pipes
- Buildout Pipes

Future Pressure Zones

- Zone 1
- Zone 2
- Zone 3
- Zone 4

N

0 0.5 1 2
Miles

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Buildout Options Evaluation

Figure 4-6

Greeley Water System Master Plan

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4.4 Pipe Network Optimization

After initial modeling, pipe size optimization was conducted in the model under the all potable demands scenario to identify new lines that could be smaller, or existing lines that did not need to be upsized. This was done by identifying lines that were still showing low velocities, even during the peak month at buildout. The fire flow analyses were used to ensure that downsizing future lines did not put the system at risk of not meeting fire flow demands. Additionally, a grid system was preserved, so that long stretches of pipe retained the pipe size even if some individual segments were showing low velocity with the potential to reduce pipe size.

A similar pipe size optimization approach was then used for the non-potable offset demand scenario, to determine if some pipes could be downsized under a scenario where potable demands were lower because of non-potable irrigation. For example, some lines in the North of the River area and in Zone 3 were able to be downsized from 12 to 8 inches. The lower demands presented in this scenario also somewhat improved pressures in the North of the River area. While water quality analyses were not conducted for the non-potable offsets demand scenario, it is expected that the smaller pipe sizes would also improve water age during minimum months. As expected, there is no difference between the all potable and non-potable offsets demand scenarios during months where there is no irrigation.

The non-potable offset demand scenario optimization helped to establish a rough estimate of cost savings because it used more non-potable offsets. The cost savings in this scenario came from two methods: using smaller diameter pipes for new lines and avoiding upsizing existing lines. A very high-level cost estimate was developed and compared for two pipe sizes with and without non-potable offset demands. This comparison showed potential savings[2] around $441,000 by 2025 and $1,615,000 between 2025 and 2040 by downsizing potable lines and avoiding upsizing existing lines. However, this does not consider the cost of the non-potable infrastructure. Non-potable demands are also hyper-localized to a specific parcel, meaning that there may not actually be non-potable irrigation in the areas planned for downsizing. It is recommended that the City carry a CIP budget for the all potable demands scenario to avoid undersizing key infrastructure, unless specific cases of non-potable irrigation are identified during design.

4.5 Storage Desktop Analysis

In addition to hydraulic modeling efforts described in this section, a separate analysis was conducted to assess additional storage needs in the system through buildout. The CDPHE Design Criteria for Potable Water Systems states that "storage tanks must have sufficient capacity, as determined from engineering studies, to meet domestic demands, and…fire flow demands." The CDPHE requires a minimum storage capacity equal to the "average daily consumption" and notes that "excessive storage capacity should be avoided," but it does not define specific emergency storage or fire flow storage requirements. In general, storage requirements are a sum of operational storage (the amount of water that fluctuates throughout the day to supply water to customers), fire storage (the amount of water required to put out fires), and emergency storage (an operational assessment of storage needs to handle a short- or long-term supply shortage caused by a system disruption). For more information on planning, modeling, and design of water

[2] Based on August 2020 dollars.

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distribution storage, please see AWWA M32: Computer Modeling of Water Distribution Systems, AWWA M42: Steel Water-Storage Tanks, and AWWA M50: Water Resources Planning.

- **Operational storage** is the amount of water that fluctuates throughout the day to supply water to customers. To calculate this, the buildout demands were summarized for average day, peak day, and peak hour for each pressure zone. Operational storage is calculated based on the difference between the peak hour demands and the peak day demands with the understanding that peak day production is met by the WTPs.

- **Fire storage** is the amount of water required to put out fires in the system. Because storage reservoirs are large infrastructure investments and may need to handle simultaneous fire flow events, a more conservative fire flow requirement was estimated than in the node-to-node analysis described in **Section 4.2.3**. Consistent with previous studies and AWWA guidance, it was assumed that each zone should be able to supply 3,500 gpm for a duration of 3 hours. For more information on fire storage requirements, see AWWA M31: Distribution System Requirements for Fire Protection.

- **Emergency storage** is an additional storage volume of water reserved for disruptions to normal operations that prevent the WTPs or in-system conveyance or pumping facilities from refilling the reservoirs in a timely manner. The emergency storage requirement was assumed to be 2 times the operational storage, meaning the reservoirs would be able to supply two extra days of emergency storage. Per conversations with the City, the transmission and distribution system has been reliable with redundancy within the water system. The volume of emergency storage seems reasonable.

The existing storage volume was then compared to the calculated storage requirements by planning horizon, as summarized in **Figure 4-7** and **Table 4-3.** The CDPHE requirement for average day storage was compared to the calculated storage requirements described above, and the larger volume was selected to be more conservative.

Zone 1, served by the 23rd Avenue reservoirs, is expected to have sufficient capacity through buildout. Zones 2 and 3 were combined because these two zones are served by the Gold Hill and Mosier Hill reservoirs. These zones are also expected to have sufficient storage through buildout. Although the analysis initially showed that Zone 4 may need additional storage by buildout, this may not actually be the case. Based on discussions with the City, it is expected that Zone 4 will be served directly from the Zone 4 pump station, bypassing the Zone 4 elevated tank and reducing operational storage requirements. Zone 4 also is projected with very limited development until after 2040. Storage requirements in this area should be monitored based on when a development comes in.

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Table 4-3. Buildout Storage Calculations

Pressure Zone	Average Day Demand (gpm)	Peak Hour Demand (gpm)	Peak Day Demand (gpm)	Operational Storage[1] (MG)	Fire Storage[2] (MG)	Emergency Storage[3] (MG)	Total Storage Required[4] (MG)
Zone 1	14,774	46,435	31,615	5.34	0.63	10.67	**21.27**
Zone 2	9,807	30,675	20,987	3.49	0.63	6.97	**14.12**
Zone 3	10,087	32,685	21,585	4.00	0.63	7.99	**14.52**
Zone 4	3,489	15,958	7,467	3.06	0.63	6.11	**6.11**

[1] Operational storage is based on the difference between peak day and peak hour demand.
[2] Fire storage assumes a demand of 3,500 gpm for three hours.
[3] Emergency storage is twice the operational storage.
[4] Total storage requirement selects the higher of emergency storage or operation + fire storage. It was found that the emergency storage was the maximum required storage.
[5] Some demands not associated with a specific zone, such as those located on the transmission system or related to external stakeholders, are excluded from this analysis.

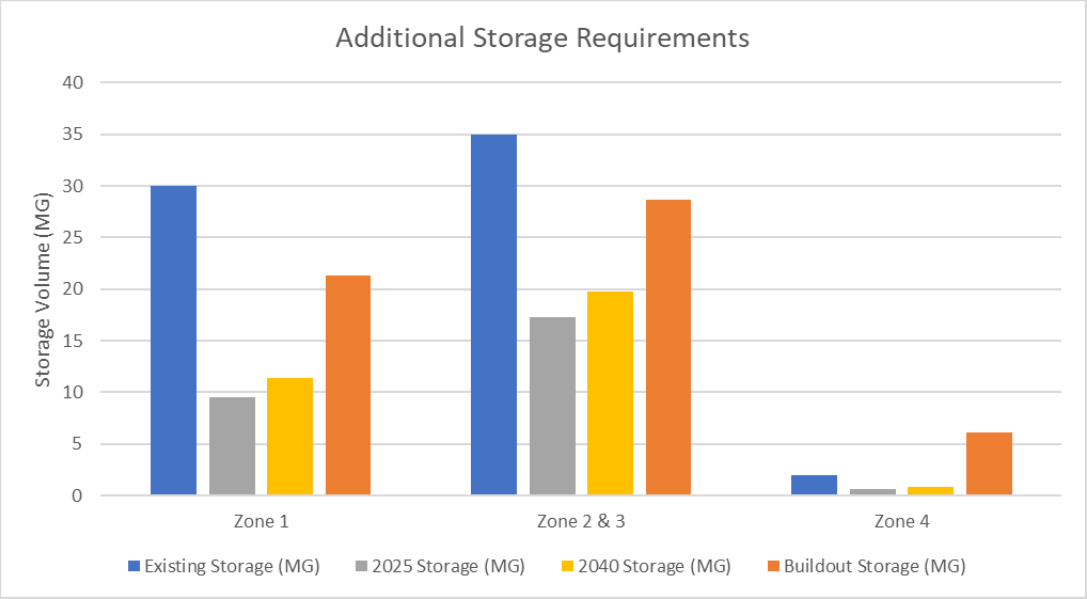

Figure 4-7. Storage Requirements by Pressure Zone and Planning Horizon

This analysis was based on bulk volume and does not consider how reservoirs impact the hydraulics of the system. Hydraulic modeling showed that while the existing reservoirs have sufficient storage, there is likely a need for additional storage to help balance out pressure fluctuations in the North of the River area at buildout because of this area's distance from existing reservoirs. Additional discussion is included in **Section 4.3.4**.

4.6 Coordination with the 2003 Master Plan

The 2003 MP identified various vulnerabilities throughout the water system. Many of these have been addressed by the City since 2003 and are no longer a concern. This section comments on improvements that have been made to the system. In general, this WTDMP focused more on analyzing the distribution system, while the 2003 MP was focused on other items such as

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treatment, water resources, and high mountain reservoirs. Please see **Section 1.2** for more information on the 2003 MP.

- The 2003 MP identified vulnerabilities along the Bellvue lines due to poor condition and undersized pipes. The 60-inch parallel line has been constructed and is in limited service now. The 60-inch Gold Hill segment, when complete, will further address these issues.
- Reconstruction of the Gold Hill 15-MG inlet/outlet and construction of the Gold Hill 5-MG reservoir have improved water quality and reduced reliance on the Gold Hill 15-MG reservoir. This has increased storage for Zone 3.
- The 2003 MP evaluated potential storage needs using very high emergency storage requirements, to be conservative. However, improvements to the piping system, including the new 60-inch transmission pipeline from Bellvue, since the 2003 MP was adopted have led to increased redundancy protection compared to before. The new 60-inch Bellvue line improves reliability of the entire transmission system, as it can still supply large volumes of water to the distribution system if the other transmission lines experience an outage. The updated storage analyses as part of this WTDMP have shown that there is not expected to be a need for additional storage before 2040.

Because this WTDMP is focused on the transmission and distribution systems, it does not address concerns related to water resources planning or treatment. Additional studies are recommended to ensure that vulnerabilities identified in the 2003 MP related to these topics have been addressed, and to identify any new needs or vulnerabilities.

4.7 Summary of Recommended Water System Improvements

The total population for the City is projected to increase from about 107,000 to 428,000 between the existing and buildout planning horizons. To accommodate the increase in projected population and resulting demands, future system evaluations indicate a need for a new reservoir in Zone 2 North and additional pumping capacity at the Zone 4 pump station by the buildout planning horizon. The Zone 4 pump station was originally designed for additional pumps, which should facilitate this growth after 2040. No necessary improvements to storage or pumping were identified before 2040. The City's water system would need 400 miles of additional pipe to serve buildout demands, as shown in **Table 4-4**. Most of the new pipes are development-driven and therefore will be the responsibility of the developer rather than the City. This additional piping includes the 60-inch Gold Hill expansion and the construction of an additional transmission line starting at the Zone 4 pump station in parallel with the existing lines from Boyd Lake WTP.

This recommended expansion of the water system allows the City to plan for future growth and development and to manage, operate, and maintain all parts of the water system while providing highly reliable service to the citizens of Greeley.

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Table 4-4. Length of New Pipe by Diameter and Planning Horizon

	Length of Pipe by Diameter (Miles)								
Planning Horizon	**8-inch**	**12-inch**	**16-inch**	**20-inch**	**24-inch**	**27-inch**	**36-inch**	**60-inch**	**Total**
2025	26.7	24.3	8.1	1.7	-	-	-	0.8	61.6
2040	99.3	41.5	18.9	2.1	7.1	-	3.3	1.9	174.1
Buildout	88.9	32.6	31.2	2.8	11.8	2.8	-	-	170.2
Total	214.9	98.4	58.2	6.7	19.0	2.8	3.3	2.7	405.9

[1] Table does not include existing pipes that would need to be upsized in the future.

[2] Table includes both City and development-driven projects. Projects will be broken out by responsible party in CIP section.

While the WTDMP is primarily focused on projected infrastructure and CIP projects, operational practices were also considered. In general, no significant operational concerns were identified. The following general recommendations may help the City improve operational efficiency:

- Complete a detailed operations study of the system, which could include looking at pumping costs, historic tank and reservoir fluctuations, and staffing needs. This study could help identify recommendations for automated setpoints.
- Work with City operations staff to identify and promote automation of certain systems, such as pump and valve controls. Well-calibrated automation can reduce energy consumption by identifying the most efficient way to operate pumps.
- Develop a system-wide standard operating procedure, to help create a consistent operational plan and train new operations staff.
- Monitor tanks and reservoirs during low demand months to determine whether water is staying in storage for longer than a typical industry standard of 30 days. If results of monitoring show that this is the case, the City may improve water age within storage by adding baffling or changing the inflow and outflow lines to promote circulation. Detailed hydraulic models of the tanks may help identify preferred solutions or improvements.

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Section 5

Capital Improvements Plan

5.1 Approach to Capital Improvement Plan Development

Section 4 modeled water transmission and distribution system improvements to address anticipated renewal and replacement needs and provide system capacity to accommodate growth. This section builds on the CIP projects identified in **Section 4** at the 2025 and 2040 planning horizons and defines the approach for development of the 5-year and 20-year CIPs. The identified CIPs were developed with consideration of the City's current and long-range population and projected flows using City growth projections and planning information, existing CIP projects in the budgeting process, and improvement needs identified using the hydraulic model associated with this WTDMP. Conditions will change with time and uncertainties will impact the accuracy of each plan in later years. As projects approach implementation, it is important that the City reevaluate each CIP to better reflect growth and development.

This section provides planning-level cost estimates for capital improvement project scheduling. Major capital elements are itemized with unit prices. Information from past projects and outside resources, both locally and nationwide, was relied upon to develop unit prices for major capital categories. CIP projects were developed using pipeline quantity estimates and modeling data. GIS mapping was used to identify areas of interest, such as utilities and road crossings. The unit prices were then multiplied by the quantity of each element. Project elements that were difficult to estimate during the planning stage are included in the overall cost as either allowances or as a percentage of the total for the itemized project elements. During design development, more specific data will be available to inform the design and resulting project cost estimate.

5.2 Cost Development

Unit costs were developed to aid in CIP budgeting, as described below. Cost estimating is considered the Association for the Advancement of Cost Engineering Class 5 – Conceptual engineering phase.

5.2.1 Project Implementation and Additional Project-Related Costs

Apart from the unit costs used to build-up project material costs (e.g., pipes, valves, and fire hydrants), several other project elements were added as factors. Construction factors include items such as erosion control/stormwater pollution prevention and contractor mobilization and demobilization. These costs are estimated as a percentage of the construction unit costs. Contingency is applied to the subtotal of these construction cost elements to account for variations in unit prices or quantity estimates. Programmatic elements include engineering, permitting, legal, and administration and are estimated as a percentage of the construction cost. **Table 5-1** provides a breakdown of the different assumptions used for project implementation and contingency.

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Table 5-1. Costing Factors for Construction Bid and Total CIP Project Costs

Category	Item	Costing Factor
Construction Bid Cost (includes infrastructure and contractor overhead, profit, bonds, and insurance)	Erosion Control/Stormwater Pollution Prevention[1]	2%
	Mobilization and Demobilization[1]	5%
	Contingency[2]	35%
Project Implementation[3]	Feasibility and Site Studies	9% for OPCC ≤ $1 million 6% for OPCC of $1 million to $10 million 5% for OPCC > $10 million
	Preliminary and Final Design	9% for OPCC ≤ $1 million 6% for OPCC of $1 million to $10 million 5% for OPCC > $10 million
	Engineering Services During Construction	5%
Additional Project-Related Costs[3]	Outside Construction Management - not used if OPCC value is < $1 million	5%
	Outside Project Management - not used if OPCC value is < $1 million	3%

[1] Construction bid cost costing factors erosion control/stormwater pollution prevention and mobilization and demobilization are added to the subtotal of unit cost items.

[2] Contingency costing factor is 35% of the subtotal of the unit cost items and contractor born costs determined by costing factors.

[3] Project implementation and additional project-related cost categories are determined as a percentage of the construction cost and part of the total CIP project costs.

5.2.1.1 Project Erosion Control/Stormwater Pollution Prevention

Project erosion control and stormwater pollution prevention includes the contractor's cost to manage the stormwater during construction through best management practices such as silt fences, rock socks, vehicle tracking, and silt prevention at storm inlets. This category is assumed as 2% of the OPCC subtotal of the items that have unit costs and is based on estimator's judgement. This costing factor is added to calculate project OPCC totals.

5.2.1.2 Mobilization and Demobilization

Contractor mobilization and demobilization includes the contractor's startup costs (moving equipment and personnel to the project location, obtaining permits and bonds, etc.) and closeout costs (project cleanup, moving equipment and personnel from the project location, etc.). The mobilization and demobilization category is assumed as 5% of the OPCC subtotal of the items that have unit costs and is based on estimator's judgement. This costing factor is added to calculate project OPCC totals.

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5.2.1.3 Contingency

During the planning phase, the field work and design have not been completed for the projects. Therefore, the cost development relies on estimated quantities for each construction element. Project contingency provides for these uncertainties by adding additional costs to the project total. The contingency at the planning level is typically 35% of the OPCC subtotal after erosion control/stormwater pollution prevention and mobilization and demobilization costing factors have been included. Project contingency also provides for cost associated with items that are difficult to itemize at a planning level.

5.2.1.4 Feasibility and Site Studies

This cost element includes the planning and field investigations (geotechnical, survey, ground sampling, subsurface utility engineering (SUE) and locates, etc.) required to implement a project. This are estimated as a percentage of the subtotal of the previous elements. The percentage varies based on the OPCC (plus contingency).

5.2.1.5 Preliminary and Final Design

The preliminary and final design cost element includes the cost for engineering services to develop biddable plans and specifications in accordance with applicable standards. This cost is estimated using a percentage of the OPCC (plus contingency).

5.2.1.6 Engineering Services During Construction

Engineering services during construction include review of contractor submittals, requested changes, and design adjustments that may be required during construction. A flat percentage of the OPCC is used to estimate this cost element.

5.2.1.7 Additional Project-Related Costs

Outside construction and project management costs are estimated for projects that are not directly managed by the City. For purposes of this master plan, only projects in excess of $1 million were assigned these cost elements.

5.3 Identified Capital Improvement Plan Projects

Development of the water system hydraulic model involved incorporating planning data, PUDs, and demand projections to predict where new pipes would need to be constructed to support future development, and where existing pipes would need to be upsized to handle additional demand and increase hydraulic efficiency. See **Figure 5-1** for the proposed water system network through buildout. All pipes were sized for the buildout scenario to avoid future upsizing. In general, pipes were sized to ensure they are big enough for the peak hour or fire flow demands scenario, without creating expensive oversized pipes that negatively impact water age. Pipe size optimization was used to identify the smallest pipe diameter that could be used, to avoid unnecessary construction costs. Specifically, the minimum pipe diameter recommended for the proposed water system network through buildout was 8 inches. From there, projects were

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identified within 2025 and 2040 project improvement time frames based on the following criteria:

- Upsize pipes to accommodate additional capacity needed from population growth and development by planning horizon at the peak hour.
- Address capacity limitations resulting from pipes not being able to supply fire flow demands.
- Construct new transmission or main distribution lines to serve new development.
- Upgrade existing pipelines to convey water to new development areas and/or a PUD.

Identified projects were categorized into two groups—City and development projects for the 2025 (projects for 2020 through 2025) and 2040 (projects for 2026 through 2040) time frames. Unique project tag identifiers were assigned for each project based on directional grids system across the LREGA. The City and development projects were grouped based on the following criteria:

- Pipe Size: When applicable, sections of water distribution and transmission pipeline were grouped based on similar pipe size. For example, a section of pipe with a 60-inch diameter was classified as a separate project than pipe sections of 8- and 12-inch pipe sizes.
- Project Purpose: When applicable, sections of water distribution and transmission pipeline were grouped based on whether such sections were new pipe being installed or pipe being replaced and upsized to accommodate capacity or fire flow improvements.
- Location: When applicable, sections of water distribution and transmission pipeline were grouped based on proximity to each other. For example, several pipeline segments passing through a park were grouped as one project while two parallel pipelines recommended for upsizing to address fire flow improvements were grouped together as another project.

Detailed cost estimates (breakdowns of OPCC and/or total CIP costs) per project can be found in **Appendix B**. The estimations included in **Appendix B** for development projects are to be used as a guide for high-level planning purposes only and are not inclusive of all potential project costs. Given the Development projects are not funded by the City, OPCC estimates for each project only include the unit cost item of pipe lengths based on pipe size. OPCCs do not include additional line item units such as fire hydrants, PRV stations, dewatering, and crossings.

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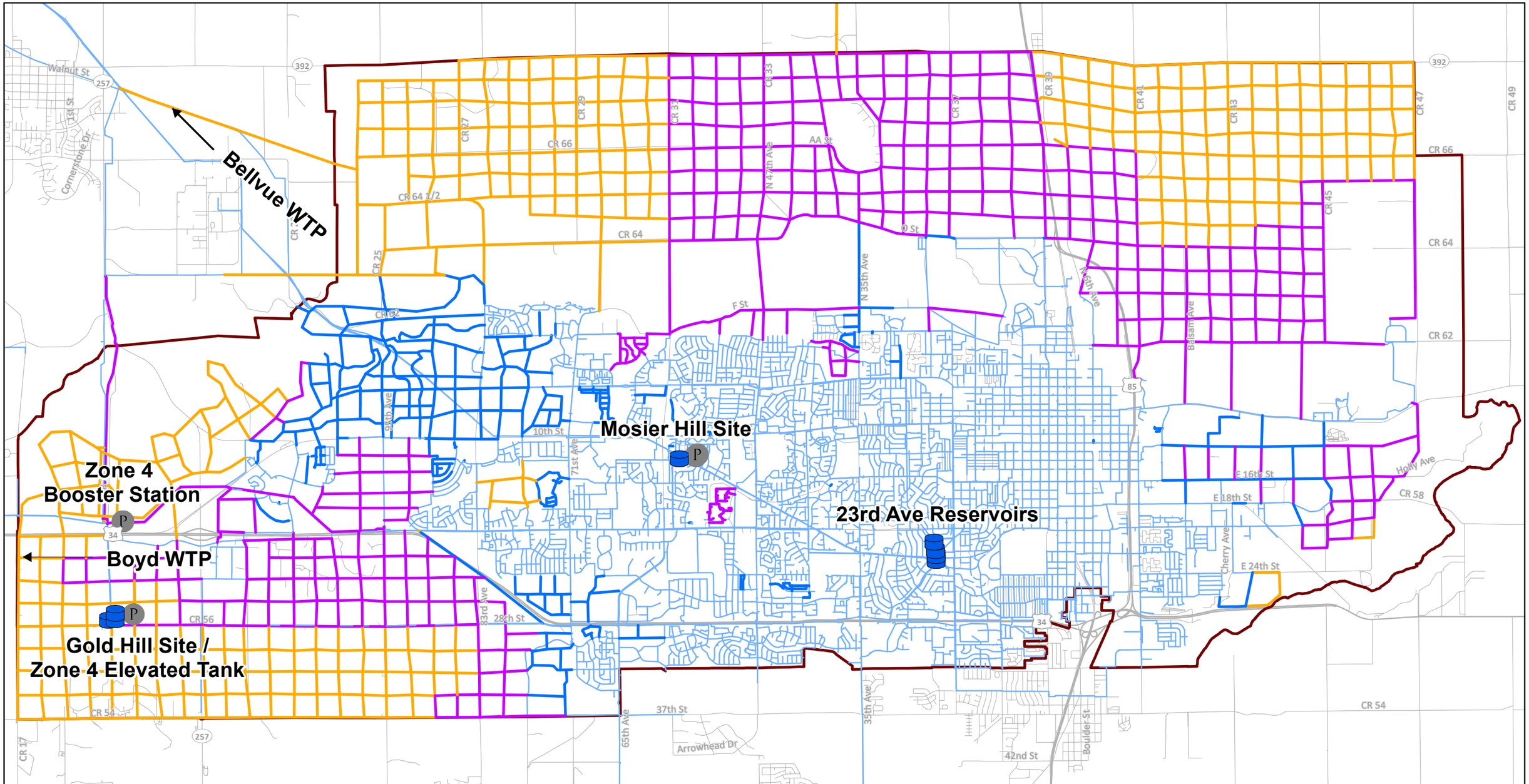

Legend

- LREGA
- Existing Storage
- Existing Pump Stations

Pipes (Planning Horizon)

- Existing
- 2025
- 2040
- Buildout

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Miles

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New Pipes at Buildout

Figure 5-1

Greeley Water System Master Plan

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5.3.1 5-year Project Improvements

City CIP and development projects identified within the 5-year project improvement time frame based on the future modeled system hydraulic requirements are listed in **Tables 5-2** and **5-3**, respectively, along with the respective drivers and whether new pipe is installed or replaced for each. City CIP total cost estimations and development project OPCCs are included as well. Not all potential City projects are included in the CIP estimation. Generally, projects identified from the water transmission and distribution model, as discussed in **Section 4**, were included in CIP cost estimations. The following project was not included in City CIP estimations:

- F Street – West of Stoney Brook PUD: A project was identified by the City west of the Stoney Brook PUD along F Street; however, the project was not included in CIP cost estimations because there was no information provided for the project during future system model development and the project is pending.

Figure 5-2 illustrates the recommended 5-year project improvements with unique project tags. Naming convention of each project tag is by location (e.g., north = N, south = S, east = E, west = W, etc.), CIP year (e.g., 5), and project number (e.g., -1, -2, -3). As an example, W5-1 equates to Project West No. 1 within 5-year project improvements. OPCC and CIP breakdowns for each project are included in **Appendix B1**. For development-driven projects, the City will provide developers with the material cost difference for installation of upsized piping (if required) to accommodate service needs under future projected conditions. High-level OPCC estimations for development projects are included in **Appendix B3**.

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Table 5-2. 5-year City CIP Projects

Project Tag[1,2]	Project Type	Project Driver	Location of Project	CIP Total Cost (Millions)
W5-1	New Pipe	Projected Development	Gold Hill: Windsor Phase (Highway 257)	$8.0
C5-1	Pipe Replacement	Fire Flow Improvement	Homestead Road & W Wagon Trail Road	$0.5
C5-2	Pipe Replacement	Fire Flow Improvement	11th Street (32nd Avenue to 31st Avenue)	$0.5
C5-12A	Pipe Replacement	Fire Flow Improvement	Island Grove Park (Vern Schaffer Boulevard, D Street)	$0.3
C5-12B	Pipe Replacement	Capacity Improvement	Island Grove Park (Vern Schaffer Boulevard)	$0.4
C5-12C	Pipe Replacement	Capacity Improvement	H Street & 11th Avenue	$0.1
C5-13A	Pipe Replacement	Fire Flow Improvement	9th Street (19th Avenue to 21st Avenue)	$0.3
C5-13B	Pipe Replacement	Fire Flow Improvement	10th Street (20th Avenue to 21st Avenue) & 21st Street (10th Street to 11th Street)	$0.4
C5-14	New Pipe	Projected Development	35th Avenue (F Street to C Street)	$0.9
E5-2A	Pipe Replacement	Fire Flow Improvement	9th Avenue (1st Street to 2nd Street)	$0.3
E5-2B	Pipe Replacement	Fire Flow Improvement	2nd Street (West of 8th Avenue to 9th Avenue)	$0.5
E5-2C	Pipe Replacement	Fire Flow Improvement	West of 8th Avenue (1st Street to 2nd Street)	$0.2
E5-3	Pipe Replacement	Capacity Improvement	8th Street (3rd Avenue to 12th Avenue)	$3.0
E5-5	Pipe Replacement	Fire Flow Improvement	12th Street & 1st Avenue	$0.4
E5-6	Pipe Replacement	Capacity Improvement	1st Avenue, 16th Street, & 18th Street (1st Avenue to 7th Avenue)	$3.2
NC5-1	New Pipe	Projected Development	35th Avenue (O Street to F Street)	$4.1
NC5-2	New Pipe	Projected Development	O Street (23rd Avenue to 25th Avenue)	$0.4
SC5-1	Pipe Replacement	Fire Flow Improvement	22nd Street (50th Avenue to 51st Avenue)	$0.2
SC5-9	Pipe Replacement	Fire Flow Improvement	30th Street Road (11th Avenue to 17th Avenue)	$1.5
SE5-1	Pipe Replacement	Fire Flow Improvement	5th Avenue (20th Street to 21st Avenue)	$0.3
SE5-2	Pipe Replacement	Fire Flow Improvement	8th Avenue (25th Street to 27th Street Road)	$0.6

[1] Projects listed do not include development projects.

[2] W = west; C = central; E = east; NC = north central; NE = north east; SC = south central; SE = south east

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Table 5-3. 5-year Development Projects

Project Tag[1,2]	Project Task	Project Driver	Location of Project	OPCC (Millions)
W5-2	New Pipe	PUD	Cache Project	$18.5
W5-3	New Pipe	PUD	PUD Document Lake Bluff	$5.9
W5-4	New Pipe	PUD	Promontory Heights PUD	$5.3
W5-5	New Pipe	Projected Development	Southeast Bluffs	$0.1
W5-6	New Pipe	Projected Development	20th Street North 100	$0.7
W5-7	New Pipe	Projected Development	105th Avenue (12th Street to 16th Street)	$0.4
W5-8	Pipe Replacement & New Pipe	Capacity Improvement & Projected Development	20th Street North 200	$1.3
W5-10	New Pipe	PUD	Trails at Sheep Draw	$2.4
C5-3	New Pipe	Projected Development	83rd/10th Street	$14.1
C5-4	New Pipe	PUD	City Center West/Boomerang 88	$5.6
C5-6	New Pipe	PUD	Triple Creek Subdivision	$2.7
C5-7	New Pipe	Projected Development	West of 59th Ave, South of 4th Street, & East of 63rd Avenue	$1.2
C5-8	New Pipe	Projected Development	East of 30th Avenue, South of C St, & North of 4th Street	$0.6
C5-9	New Pipe	PUD	Stoney Brook PUD	$1.0
C5-10	New Pipe	Growth	35th Avenue (C Street to F Street) - Branches	$0.9
E5-7	New Pipe	Projected Development	East Greeley	$7.9
SC5-2	New Pipe	PUD	Westgate PUD	$3.2
SC5-3	New Pipe	PUD	Cobblestone PUD	$3.1
SC5-4	New Pipe	Projected Development	Southwest Greeley	$1.0
SC5-5	New Pipe	Projected Development	East of 71st Avenue, West of 65th Avenue, South of 24th Street, & North of 28th Street	$2.5
SC5-6	New Pipe	Projected Development	29th Street Multifamily	$0.8
SC5-7	New Pipe	PUD	Grapevine	$0.6
SE5-4	New Pipe	Projected Development	East Greeley	$1.0

[1] City CIP projects are not included in this list.

[2] W= west; C = central; E = east; SC = south central; SE = south east

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City rehabilitation projects were included from the City's current Operation Rehab Project 2021–2025 Excel spreadsheet. Such identified projects, summarized in **Table 5-4**, were not included within the water transmission and distribution system model; however, such projects were included to help identify projects within the 5-year project improvements where pipe segments needed to be updated based on aging condition rather than hydraulic deficiencies. Although these projects are included as a part of 5-year project improvements, the rehabilitation projects will be prioritized after other City CIP projects that needed capacity and/or fire flow improvements. **Table 5-4** summarizes identified project locations, tasks, estimated construction years, and reasons for inclusion as part of the City's rehabilitation projects (City of Greeley 2021).

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Table 5-4. 5-year City Rehabilitation Projects (City of Greeley 2021)

Project Area	Project Type	Project Driver	Construction Start Year	Total Cost (Millions)
19th Avenue - 6th Street Rd to 7th Street and 6th Street Rd - 18th Avenue to 19th Ave	Pipe Replacement	Age	2022	$0.1
1800 block 28th Avenue CDS	Pipe Replacement	—	2022	$0.02
400 and 500 block of E 20th Street	Pipe Replacement	Age	2022	$0.1
500 block of N 9th Avenue	Pipe Replacement	Age	2022	$0.1
5500 27th Street (do soil samples)	Pipe Replacement	Age	2022	$0.1
200 23rd Avenue	Pipe Replacement	Age	2022	$0.1
1st Street - 23rd Avenue to mobile home park master meter	Pipe Replacement	Age	2022	$1.0
2100 30th Street apartment complex	Pipe Replacement	Age	2023	$0.3
6500 and 6400 28th Street	Pipe Replacement	Age	2023	$0.2
11th Avenue and Highway 34 bypass	Pipe Replacement	Age	2025	$0.4
30th Street - 17th Avenue to 23rd Avenue	Pipe Replacement	Age	2026	$0.5
49th Street between 65th Avenue and 47th Ave	Pipe Replacement	Age	TBD	—
49th Street - 83rd Avenue to 95th Avenue Grid Line	Pipe Replacement	Age	TBD	$1.1
5th Avenue – 14th Street to 15th Street	Pipe Looping Project	—	TBD	—
Tie-in 13th Street 2900 Block/Scott School Lane, new fire hydrant and major valve work	Pipe Looping Project	—	TBD	$0.01
83rd Avenue and 49th Street	Pipe Replacement	Age	TBD	$0.1
Kodak Water Line Replacement	Transmission Line Replacement	Age	2021	$3.0
24018 West County Road 15 (Chicken Lady) (Line 1)	Transmission Line Installation	Valve, actuator, pressure and flow meters, vault, SCADA, electrical (automated flow control)	2022	$0.2
Lemay (Line 3)	Transmission Line Installation	Valve, actuator, pressure and flow meters, vault, SCADA, electrical	2022	$0.2
Forest Hills (Line 1)	Transmission Line Installation	Valve, actuator, pressure and flow meters, vault, SCADA, electrical	2022	$0.2
20th/95th Avenue	Transmission Line Replacement	Age	2023	$0.7
Highway 257	Transmission Line Replacement	High pressures	2024	$1.6

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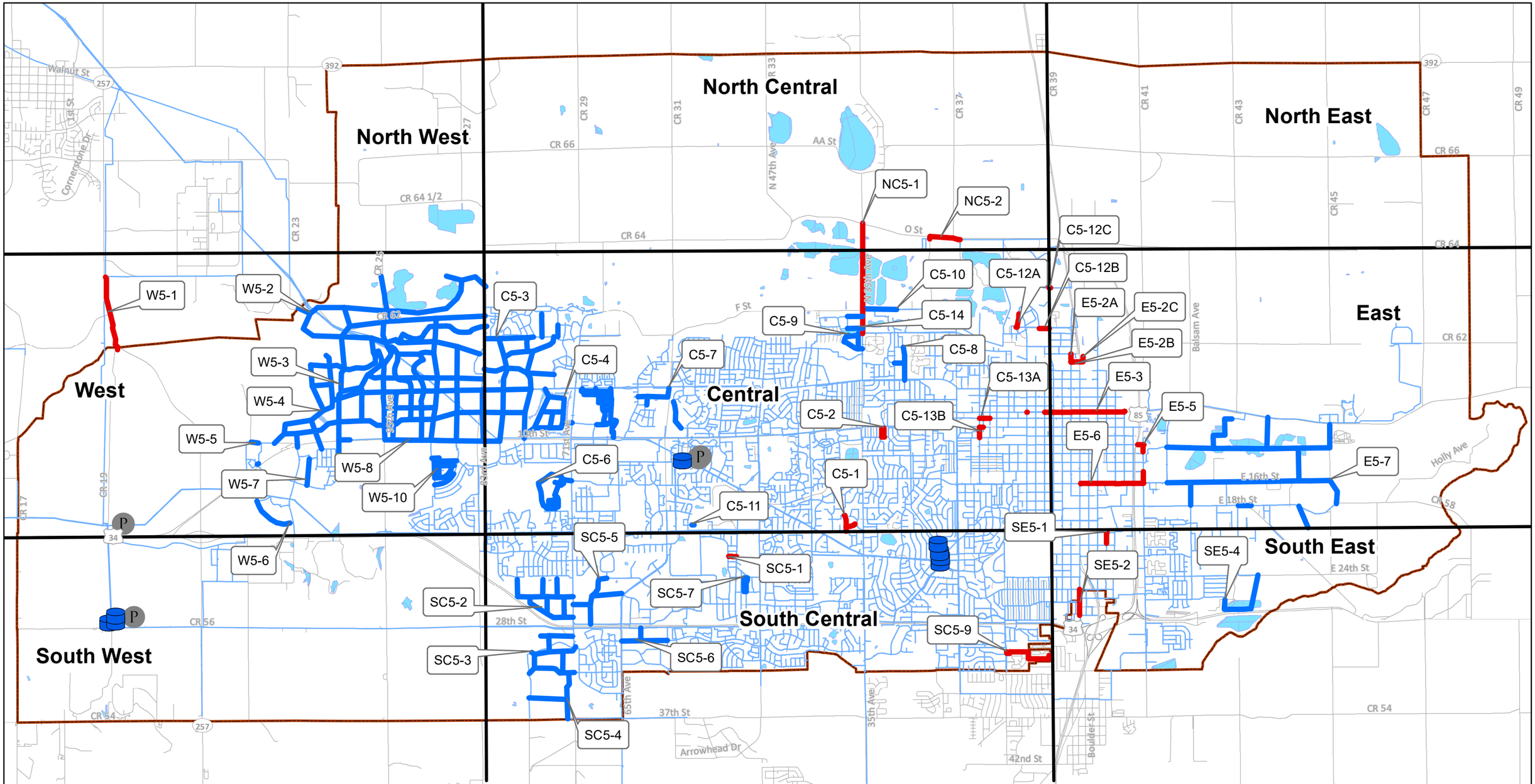

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May 28, 2021

Legend

- LREGA
- Tanks
- Pump Station
- Lakes and Ponds
- Existing Pipes
- 2025 City CIP Projects
- 2025 Development Projects
- CIP Grids

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Recommended 5-Year Improvements

Figure 5-2

Greeley Water System Master Plan

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5.3.2 20-year Project Improvements

City CIP projects identified within the 20-year project improvements are listed in **Table 5-5,** while identified 20-year development projects are summarized in **Table 5-6**. The project location, type, and motivation for including each project are included. City CIP total cost estimations and development project OPCCs are also included. Not all potential City projects are included in the CIP estimation. Generally, projects identified from the water transmission and distribution model, described in **Section 4**, were included in CIP cost estimations. The following project was not included in City CIP estimations:

- Central No. 12 (Amour Hill Drive): A small segment of pipe, less than 6 feet, was recommended for replacement and upsizing to 12-inch diameter pipe based on the hydraulic model. The pipe section was not included in City CIP cost estimations because of the pipe length.

Figure 5-3 illustrates the recommended 20-year City CIP improvements with unique project tags. Naming convention of each project tag is by location (e.g., north = N, south = S, east = E, west = W), and CIP year (e.g., 20), and project number (e.g., -1, -2, -3). As an example, W20-1 equates to Project West No. 1 within 20-year project improvements. OPCC breakdowns for each project are included in **Appendix B2**. For development-driven projects, the City will provide developers with the material cost difference for installation of upsized piping (if required) to accommodate service needs under future projected conditions. High-level OPCC estimations for development projects are included in **Appendix B4**.

Table 5-5. 20-year City CIP Projects

Project Tag[1,2]	Project Type	Project Driver	Location of Project	CIP Total Cost (Millions)
W20-1	New Pipe	Projected Development	Gold Hill Segment Phase 2 (Bellvue Line)	$13.9
W20-2	New Pipe	Projected Development	Boyd WTP Transmission Line (North of US 34 from 95th Avenue to County Road 17)	$15.8
C20-1	New Pipe	Projected Development	59th Avenue (O Street to F Street)	$4.8
C20-2A	New Pipe	Projected Development	47th Avenue (O Street to F Street)	$4.6
C20-2B	New Pipe	F Street Water & Wastewater Operations Facility	F Street (47th Avenue to 35th Avenue) & 47th Avenue (F Street to B Street)	$4.0
C20-3	Pipe Replacement & New Pipe	Projected Development and Capacity Improvement	25th Avenue (O Street to F Street)	$2.8
C20-4	Pipe Replacement	Capacity Improvement	1st Street (56th Avenue to 59th Avenue Court)	$0.4
C20-5	Pipe Replacement	Capacity Improvement	Island Grove Park	$0.4
C20-6	Pipe Replacement	Capacity Improvement	Street U (F Street to Street W)	$0.2
E20-1	Pipe Replacement	Capacity Improvement	A Street (6th Avenue to 9th Avenue)	$1.4
E20-2	Pipe Replacement	Capacity Improvement	9th Street (1st Avenue to 3rd Ave)	$1.4

[1] Projects listed do not include development projects.

[2] W = west; C = central; E = east

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Table 5-6. 20-year Development Projects

Project Tag[1,2]	Project Type	Project Driver	Location of Project	OPCC (Millions)
W20-3	Pipe Replacement & New Pipe	Projected Development and Capacity Improvement	83rd/10th Street	$2.4
W20-4	New Pipe	PUD	Promontory Heights	$0.9
W20-5	New Pipe	PUD	Southeast Bluffs	$0.9
W20-6	New Pipe	Projected Development	20th Street North 100	$2.4
W20-7	New Pipe	Projected Development	20th Street North 300	$0.5
W20-8	New Pipe	Projected Development	20th Street North 200	$10.5
C20-7	New Pipe	Projected Development	East of F Street, West of Island Grove Park, North of C Street, & South of F Street	$1.5
C20-8	New Pipe	Projected Development	East of 66th Avenue, West of 60th Avenue, North of 4th Street, & South of C Street	$3.3
C20-9	New Pipe	Projected Development	F Street (61st Avenue to 47th Avenue) & F Street Branch (44th Avenue)	$2.8
C20-10	New Pipe	Projected Development	East of 40th Avenue, West of 35th Avenue, North of 4th Street, & South of C Street	$2.3
C20-11	Pipe Replacement	Capacity Improvement	Aims Community College	$1.2
E20-3	New Pipe	Projected Development	Greeley-Weld County Airport	$2.0
E20-4	New Pipe	Projected Development	West of Highway 85 (7th Avenue to A Street)	$2.2
E20-5	New Pipe	Projected Development	East of Highway 85, West of Greeley-Weld County Airport, South of O Street, & North of 8th Street	$29.8
E20-6	New Pipe	Projected Development	East of Highway 85, West of Weld County Parkway, South of 8th Street, & North of 24th Street	$12.9
NC20-1	New Pipe	Projected Development	North of the River (North of O Street from 59th Avenue to 11th Avenue)	$95.7
NE20-1	New Pipe	Projected Development	East of Highway 85, West of Greeley-Weld County Airport, South of CR 66, & North of O Street	$22.0
NE20-2	New Pipe	Projected Development	Greeley-Weld County Airport (CR 47)	$3.6
SW20-1	New Pipe	Projected Development	Interchange 34W 300	$5.5
SW20-2	New Pipe	Projected Development	Interchange 34W 100	$3.6
SW20-3	New Pipe	Projected Development	Interchange 34W 500	$12.0
SW20-4	New Pipe	Projected Development	Interchange 34W 400	$12.5
SW20-5	New Pipe	Projected Development	Southwest Greeley	$8.4
SW20-6	New Pipe	Projected Development	83rd/34	$6.4
SC20-1	New Pipe	Projected Development	Highway 34 (20th Street to 28th Street)	$2.9

[1] City CIP projects are not included on this list.

[2] W = west; C = central; E = east, NC = north central; NE = north east; SC = south central; SE = south east; SW = south west

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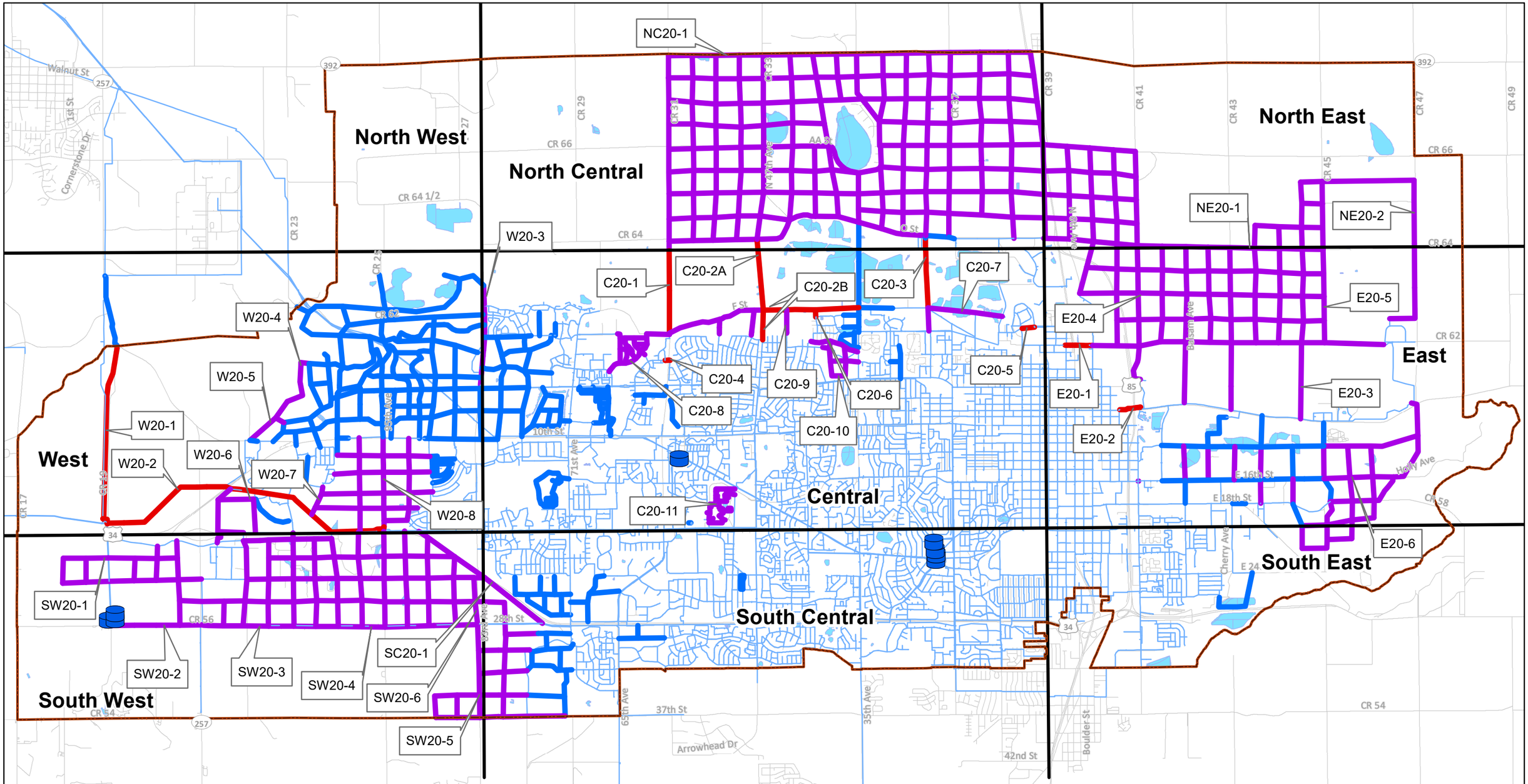

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- Pump Station
- Lakes and Ponds
- Existing Lines
- 2025 City CIP and Development Projects
- 2040 Development Projects
- 2040 City CIP Projects
- CIP Grids

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Recommended 20-Year Improvements

Figure 5-3

Greeley Water System Master Plan

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5.4 CIP Implementation Schedule

CDM Smith developed an Excel-based CIP tool called the "CIP Planning Tool: WTDMP, NPMP, and SSMP City of Greeley Excel Spreadsheet" to integrate capital projects for water, sanitary sewer, and non-potable water systems (CDM Smith, 2021). The City provided the existing 10-year CIP and public works and stormwater CIPs to inform the CIP implementation schedule.

Projects identified within the 5- and 20-year improvements based on hydraulic evaluations were given projected planning, design, and construction start years. It was assumed that each stage (planning, design, and construction) will take at least 1 year with the construction phase spread out over 2, 3, or 4 years if the total CIP cost for a project was greater than $1 million, $5 million, or $10 million, respectively. For scheduling purposes, 5-year improvements were identified from 2022 through 2027 design start year while 20-year improvements were identified from 2028 through 2042 design start year. The recommended improvements were strictly tied to hydraulic evaluation under a planning horizon (2025, 2040, etc.). The CIP schedule implementation process considered several other factors that influence a project schedule in addition to the hydraulic evaluation. Projects will be referred to as 5- and 20-year projects in this section.

CIP schedule implementation included the following sequential steps:

1. Within the WTDMP, identified improvement projects were prioritized based on capacity improvement, new pipeline installation, and fire flow projects. Several fire flow projects identified within 5-year improvements may be shifted to 20-year improvements to accommodate City rehabilitation projects which would typically take a higher priority.

2. The prioritized City CIP water projects were then overlaid in GIS with other master plan CIP projects, the City's current rehabilitation projects, and roadwork and park improvements to identify overlapping projects. Construction start years were adjusted to align multiple infrastructure projects and known initiatives across the City. See adjusted CIP schedules for City projects in **Table 5-7** within the 5- and 20-year water improvements.

3. Projects that exceeded $1 million had project construction costs spread out over the 5-year time frame, across each fiscal year.

4. Above steps were repeated for the 20-year City CIP projects to establish a 20-year CIP schedule.

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Table 5-7. 5- and 20-Year City CIP Summary

Projects	Project Type	Project Driver	Project Location	Planning Start Year	Design Start Year	Construction Start Year	OPCC (Millions)	CIP Total Cost (Millions)
5-Year Planning Horizon								
C5-12C	Pipe Replacement	Capacity Improvement	H St. & 11th Ave.	2021	2022	2023	$0.1	$0.1
C5-14	New Pipe	Projected Development	35th Ave. (F St. to C St.)	2021	2022	2022	$0.7	$0.9
C20-2B	New Pipe	F St. Water & Wastewater Operations Facility	F St. (47th Ave. to 35th Ave.) & 47th Ave. (F St. to B St.)	2021	2022	2023	$3.1	$4.0
W5-1	New Pipe	Projected Development	Gold Hill: Windsor Phase (Hwy 257)	2022	2023	2024	$6.2	$8.0
C5-12B	Pipe Replacement	Capacity Improvement	Island Grove Park (D St.)	2022	2023	2024	$0.3	$0.4
NC5-2	New Pipe	Projected Development	O St. (23rd Ave. to 25th Ave.)	2022	2023	2024	$0.3	$0.4
NC5-1	New Pipe	Projected Development	35th Ave. (O St. to F St.)	2024	2025	2026	$3.3	$4.1
C5-1	Pipe Replacement	Fire Flow Improvement	Homestead Rd. & W Wagon Trail Rd.	2025	2026	2027	$0.4	$0.5
C5-2	Pipe Replacement	Fire Flow Improvement	11th St. (32nd Ave. to 31st Ave.)	2025	2026	2027	$0.4	$0.5
C5-12A	Pipe Replacement	Fire Flow Improvement	Island Grove Park (Vern Schaffer Blvd.)	2025	2026	2027	$0.2	$0.3
C5-13A	Pipe Replacement	Fire Flow Improvement	9th St. (19th Ave. to 21st Ave.)	2025	2026	2027	$0.2	$0.3
C5-13B	Pipe Replacement	Fire Flow Improvement	10th St. (20th Ave. to 21st Ave.) & 21st Ave. (10th St. to 11th St.)	2025	2026	2027	$0.3	$0.4
E5-2A	Pipe Replacement	Fire Flow Improvement	9th Ave. (1st St. to 2nd St.)	2026	2027	2028	$0.2	$0.3
E5-2B	Pipe Replacement	Fire Flow Improvement	2nd St. (West of 8th Ave. to 9th Ave.)	2026	2027	2028	$0.4	$0.5
E5-2C	Pipe Replacement	Fire Flow Improvement	West of 8th Ave. (1st St to 2nd St.)	2026	2027	2028	$0.1	$0.2
E5-5	Pipe Replacement	Fire Flow Improvement	12th St. & 1st Ave.	2026	2027	2028	$0.3	$0.4
SC5-1	Pipe Replacement	Fire Flow Improvement	22nd St. (50th Ave. to 51st Ave.)	2026	2027	2028	$0.1	$0.2
						5-Year Subtotal	**$16.6**	**$21.2**

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Projects	Project Type	Project Driver	Project Location	Planning Start Year	Design Start Year	Construction Start Year	OPCC (Millions)	CIP Total Cost (Millions)
20-Year Planning Horizon								
E5-6	Pipe Replacement	Capacity Improvement	1st Ave., 16th St., & 18th St. (1st Ave. to 7th Ave.)	2027	2028	2029	$2.5	$3.2
W20-1	New Pipe	Projected Development	Gold Hill Segment Phase 2 (Bellvue Line)	2027	2028	2029	$10.8	$13.9
C20-1	New Pipe	Projected Development	59th Ave. (O St. to F St.)	2027	2028	2029	$3.9	$4.8
C20-3	Pipe Replacement & New Pipe	Projected Development and Capacity Improvement	25th Ave. (O St. to F St.)	2027	2028	2029	$2.2	$2.8
SE5-1	Pipe Replacement	Fire Flow Improvement	5th Ave. (20th St. to 21st Ave.)	2028	2029	2030	$0.2	$0.3
C20-4	Pipe Replacement	Capacity Improvement	1st St. (56th Ave. to 59th Ave. Ct.)	2028	2029	2030	$0.4	$0.4
E5-3	Pipe Replacement	Capacity Improvement	8th St. (3rd Ave. to 12th Ave.)	2029	2030	2031	$2.4	$3.0
SC5-9	Pipe Replacement	Fire Flow Improvement	30th St. Rd. (11th Ave. to 17th Ave.)	2029	2030	2031	$1.2	$1.5
E20-1	Pipe Replacement	Capacity Improvement	A St. (6th Ave. to 9th Ave.)	2030	2031	2032	$1.1	$1.4
E20-2	Pipe Replacement	Capacity Improvement	9th St. (1st Ave. to 3rd Ave)	2032	2033	2034	$1.1	$1.4
C20-5	Pipe Replacement	Capacity Improvement	Island Grove Park	2034	2035	2036	$0.3	$0.4
W20-2	New Pipe	Projected Development	Boyd WTP Transmission Line (North of US 34 from 95th Ave. to CR 17)	2036	2037	2038	$12.3	$15.8
C20-2A	New Pipe	Projected Development	47th Ave. (O St. to F St.)	2037	2038	2039	$3.5	$4.6
SE5-2	Pipe Replacement	Fire Flow Improvement	8th Ave. (25th St. to 27th St. Rd.)	2038	2039	2040	$0.5	$0.6
C20-6	Pipe Replacement	Capacity Improvement	St. U (F St. to St. W)	2039	2040	2041	$0.2	$0.2
						20-Year Subtotal	**$42.4**	**$54.1**
						Total	**$59.0**	**$75.3**

Note: CIP schedule was adjusted based on other master plans and parks and public works CIP projects.

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Once the 5- and 20-year CIP schedules were developed, annual funding requirements were established for City water projects from 2021 through 2042, as shown in **Figure 5-4**. **Appendix B5** presents a summary of the annual funding breakdown by project in tabular format. Funding requirements across the three systems—sewer, water, and non-potable systems—are shown in **Figure 5-5**.

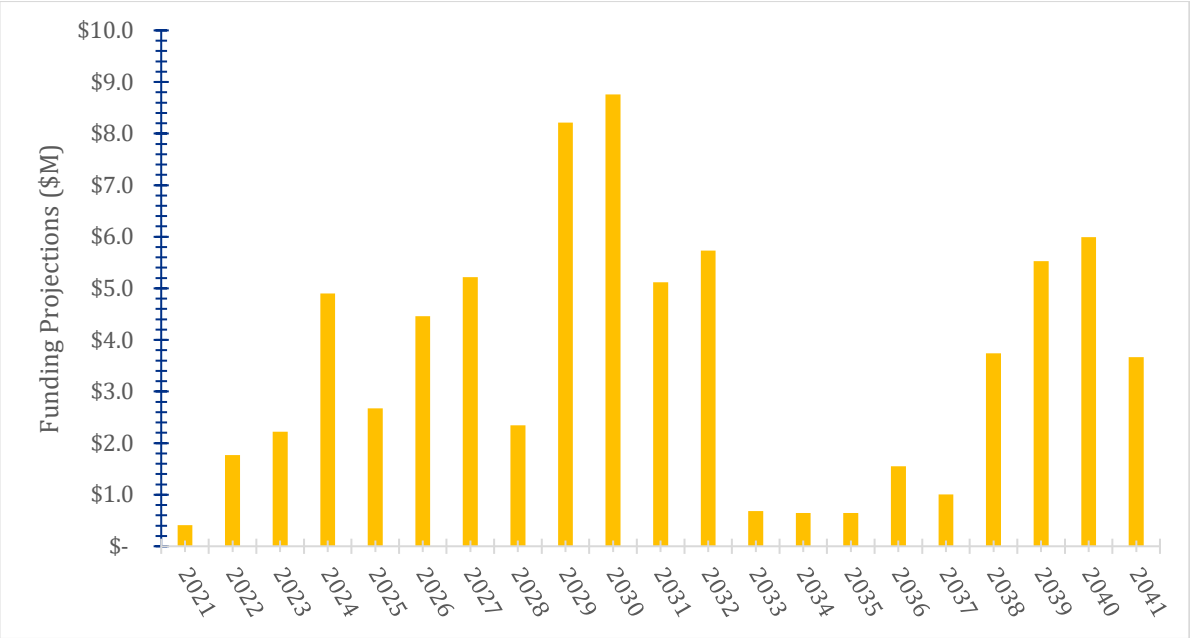

Figure 5-4. Annual Water Funding Projections for City CIP Projects

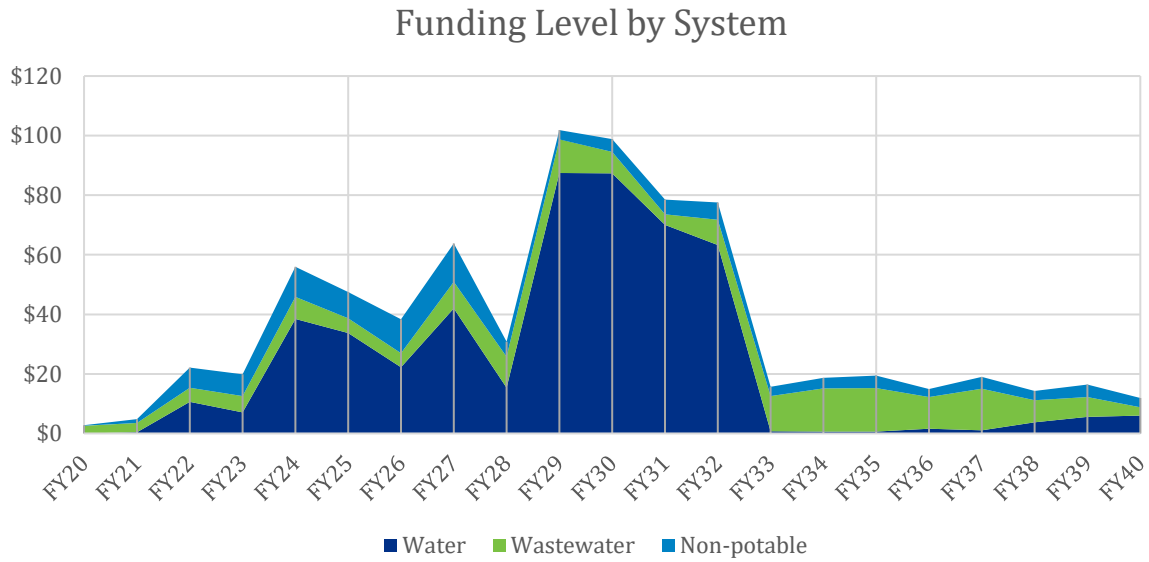

Figure 5-5. Annual Funding by System

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5.4.1 Cost Sharing Evaluation

There is a high level of uncertainty when it comes to development projects; therefore, they were not considered in the schedule implementation process. However, when more information about a development becomes available, the City may consider integrating these into their CIP schedule to plan their cost sharing commitments. The City will provide reimbursement to developers for upsizing pipes to support growth into the future. For budgetary planning purposes, pipe material cost differences were calculated for new development pipes sized greater than 8 inches (i.e., 12- and 16-inch pipe) for buildout demand conditions. **Table 5-8** provides the cumulative lengths of 12- and 16-inch pipe across all development projects within the 5-year planning horizon and the estimated financial reimbursement the City should budget per year in the form of material cost differences. Pipe material cost is typically between one-third to half of the total pipe installed cost. As a conservative planning estimate, the pipe material cost was assumed to be half of the total pipe installed cost.

Table 5-8. Estimated Reimbursement Costs for 5-Year Development Projects

Pipe Size (inches)	Cumulative Length (LF)	Pipe Material Unit Cost ($/LF)	Cumulative Developer Reimbursement (Millions)	Fiscal Year Developer Reimbursement (Millions)
8	—	86	—	—
12	132,403	92	$0.8	$0.2
16	45,225	112	$1.2	$0.2
Total			**$2.0**	**$0.4**

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Section 6

Findings and Recommendations

The findings and recommendations summarized in this section have been drawn from the planning and evaluation sections of this WTDMP. The recommendations identify system needs, actions, and capital improvements through the buildout planning horizon. However, the actual implementation time frame will depend on actual growth rates, the order of development, and the level of available capital funding. Additionally, the actual scope and implementation of these recommendations may vary with detailed planning and design.

6.1 Key Findings

Key findings identified as part of the WTDMP include:

- The City has a comprehensive and well-maintained GIS system for their water utilities. Other key data collection mechanisms include SCADA data and monthly billing data. For more information, see **Section 1**.
- The most likely population projection expects about a 3% growth per year. This growth is primarily expected in the west side of the City for the 2025 planning horizon, as multiple developments are expected to begin construction in the near future. Total peak month demand is expected to double by buildout, which is anticipated to be later than 2090. For more information, see **Section 2.**
- In general, the City's distribution system is robust and the WTDMP did not identify any significant existing system deficiencies. Most drivers for CIP projects and other improvements are to support ongoing development. No additional pumping or storage needs are anticipated until after the 2040 planning horizon. For more information, see **Section 3** and **Section 4**.
- Interim growth in undeveloped areas, such as North of the River, may create temporary water age concerns until the area is more developed. The City should coordinate with developers to plan for both buildout and interim demands. Other areas may also represent hydraulic challenges due to drastic elevation changes (Cache Project Area, Bluffs Region) or distance from existing storage facilities (such as North of the River). For more information, see **Section 4**.
- Water age analysis showed correlation with chlorine residuals during the minimum month. The City's sampling records do not show any water quality concerns, even during periods of low demand. For more information, see **Section 4**.
- Industrial users represent a large uncertainty in demands and may create additional stress on the system in the future. The location and demand of these users is unknown. Preliminary sensitivity analyses demonstrated that the water system is capable of serving a high-demand industrial user. For more information, see **Section 2** and **Section 4**.

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6.2 Recommendations

The recommendations for the WTDMP include:

- Continue maintenance of both the City's water system GIS databases and the InfoWater model. Maintaining the InfoWater model can include adding new pipes, adjusting demands, deleting abandoned pipes, tracking open and closed valves along the pressure zone boundaries, and reflecting operational changes as the system continues to expand.
- Monitor residential and nonresidential diurnal trends to observe any major shifts in demand usage that would impact peak demands and related system performance.
- Coordinate this WTDMP with other relevant planning documents, including the City's treatment and supply master plan. It is recommended to use this WTDMP as a guide for infrastructure planning and to use the BBC report as a guide for water resources planning.
- Continue investing in conservation and non-potable irrigation to reduce water treatment needs and avoid upsizing. Integrating future water and non-potable projects and developments can help efficient infrastructure planning and water usage.
- Continue water quality sampling practices to maintain compliance with regulations. Conducting focused studies on tank water quality, especially at Gold Hill, may be used to better inform/evaluate water quality in the system. Bringing in additional feeds from Bellvue WTP, such as the planned Gold Hill 60-inch line, is expected to help with system reliability and water quality in the west.
- Increased flow through the control valves—the 47th Avenue Ball valve and Mosier bypass valve—may support further development in Zone 1. Perform routine maintenance to assess valve condition/operation to support additional flow.
- New pipe and tank layouts are purely conceptual in nature and are primarily intended to show hydraulic feasibility for master planning purposes. Conduct a detailed evaluation of pipe and tank layout and sizing (for buildout) as projects move into design and implementation stages when there is more certainty of demands and pipe locations. The InfoWater model can be used as a tool to support future planning decisions, if regularly maintained.
- Complete a detailed operations study of the system, which could include looking at pumping costs, historic tank and reservoir fluctuations, and staffing needs. This study could help identify recommendations for automation setpoints.
- Monitor tanks and reservoirs during low demand months to determine whether water is staying in storage for longer than a typical industry standard of 30 days. If results of monitoring show that this is the case, the City may improve water age within storage by adding baffling or changing the inflow and outflow lines to promote circulation. Detailed hydraulic models of the tanks may help identify preferred solutions or improvements.

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- Work with City operations staff to identify and promote automation of certain systems, such as pump and valve controls.
- Develop a system-wide standard operating procedure to help create a consistent operational plan and train new operations staff.
- Complete the capital improvements recommended in **Section 5**, prioritizing the 5-year CIP-recommended projects. Coordinate closely with the City's rehab projects, other utility and City projects, and developers to regularly update the scheduling of these projects. The City should consider using the InfoWater model as a tool to inform developer plans while coordinating with them. Coordination with developers is particularly critical in the Cache Project Area because of the varying elevation in this area.
- Coordinate with the fire department to help prioritize fire flow improvements.
- Update the WTDMP every 5 years, including reevaluating demand and population projections every 5 to 10 years. Planning assumptions made for the water system in the next 20 years and beyond is based is subject to change with time.
- Collaborating with other regional stakeholders can help identify regional solutions and meet multiple parties' needs. Consider holding at least annual regional workshops to revisit potential regional solutions needed to meet growing demands. Coordinate potential takeover of the North Weld service area in the North of the River area and discuss potential master meters or shared storage in this area, per the existing intergovernmental agreement.
- No changes to existing policies are recommended.

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Section 7

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Appendix A

Peaking Factors Analysis

The following technical memorandum explains the methodology used to produce peaking factors used for the hydraulic model, as discussed in **Section 3**.

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Memorandum

To: *Dan Moore, City of Greeley*

From: *Tom Charles P.E., Shilpa Shivakumar P.E.*

Date: *August 25, 2020*

Subject: Peaking Factors Selection - DRAFT

Peaking Analysis

Approach

To fully determine future infrastructure sizing, it is necessary to simulate performance under a variety of conditions such as fire events, maximum normal demands, and minimum demand conditions. While transmission and larger distribution mains are sized to minimize high velocities and excessive head loss under high demand conditions, it is also necessary to evaluate storage and circulation patterns within the distribution system under a variety of demand conditions to minimize the negative effects of water quality degradation due to excessively aged water.

Recent modeling performed for the City of Greeley (COG) by another consultant team in 2018 was based on establishing system accuracy utilizing system response based on real historical conditions derived using SCADA records showing demand history for major user accounts and fluctuations in storage tanks and metering at pressure reducing valves (PRVs). This resulted in a hardwiring approach to the existing distribution system that does not lend itself well to extending peaking assumptions into the future system, particularly if land use patterns and future effects of conservation programs, etc. emphasize changes not reflective of the existing distribution areas and zone performance patterns.

In conjunction with COG staff, it was determined that CDM Smith would use a hybrid approach to establish appropriate peaking assumptions for the future system modeling. These steps included the following:

1. Evaluate system wide maximum, seasonal, and average day conditions based on water treatment plant production records for recent periods (last 5 years if available).
2. Utilize storage performance records (hourly) to establish peak hour conditions based on recent available records during high demand conditions (July). Evaluate this by zone where possible and on a combined basis.

3. Establish an acceptable peaking factor to capture peak hour and integrate this into a diurnal curve suitable for extended period simulation in the hydraulic model.

4. Compare the peaking factors identified for COG existing conditions to other front range communities for reasonableness.

Maximum Day

Most communities summarize peaking factors for their systems in terms of maximum to average day and peak hour to average day. Therefore, the goal of the analysis was to determine these factors based on historical conditions for direct comparison to both COG design criteria and other similar communities to COG. COG staff were able to provide daily water treatment plant production rates for the years 2015 through 2019 for evaluation (for both the Bellvue and Boyd water treatment plants). Using this data, it was feasible to develop values for average day, maximum day and peak month productions and compare them across the 5 year record.

Table 1 shows the various production conditions and associated daily peaking factors for each year of the record for comparison.

Table 1 – Daily Production Summary and peaking factors for Bellvue and Boyd Water Treatment Plants

	Production (mgd)			Peaking Factor (PF)		
Year	Average Day	Peak Month (Average Day July)	Max Day	Peak Month/ Average Day	Max Day/ Average Day	Max Day/ Peak Month
2015	21.75	38.28	44.00	1.76	2.02	1.15
2016	23.32	42.49	49.90	1.82	2.14	1.17
2017	23.19	40.86	46.12	1.76	1.99	1.13
2018	19.81	32.31	41.58	1.63	2.10	1.29
2019	18.52	29.93	38.49	1.62	2.08	1.29

All production values are in million gallon per day (mgd) units and peaking factors are ratios of these values. 2016 was the year of highest average and maximum day productions and includes the highest peak month production during the 5 year period of record. However, peaking factors are relatively consistent across the 5 year period of record.

A consistent peaking factor for Maximum to Average day is 2.0 to 2.1. Likewise, the Maximum Day to Peak Month factor is fairly consistent at about 1.15 to 1.30. There do not appear to be any trends that would show a downward movement in these factors across the 5 year period of record based on conservation measures or other demand control strategies and policies. These effects may exist, but the variability of weather and summer extremes would seem to be a bigger controlling factor on both production maximums as well as peaking factors.

Peak Hour Analysis

COG staff provided storage reservoir data (inflow and outflow) for 23rd Avenue, Gold Hill, and Mosier reservoirs. These hourly fluctuations during peak periods were plotted to determine hourly changes in peaking across an 8-day continuous period during July of 2016.

Additional data was provided for some hourly peaking at the Water Treatment Plants during this same period, but this shows a maximum shift in production of about 15 percent, timed to coincide with a period when production is ramped up to help refill storage. Given the travel time within the system to reach the tanks and some offset in demands within the system, this production increase was deemed to have little influence on the hourly fluctuations in storage and, therefore, should not be directly factored into an overall peak hour calculation for the COG distribution system.

Figures 1 through **4** show the hourly fluctuation patterns for each of the storage reservoirs referenced above along with the pattern for all three storage reservoirs combined.

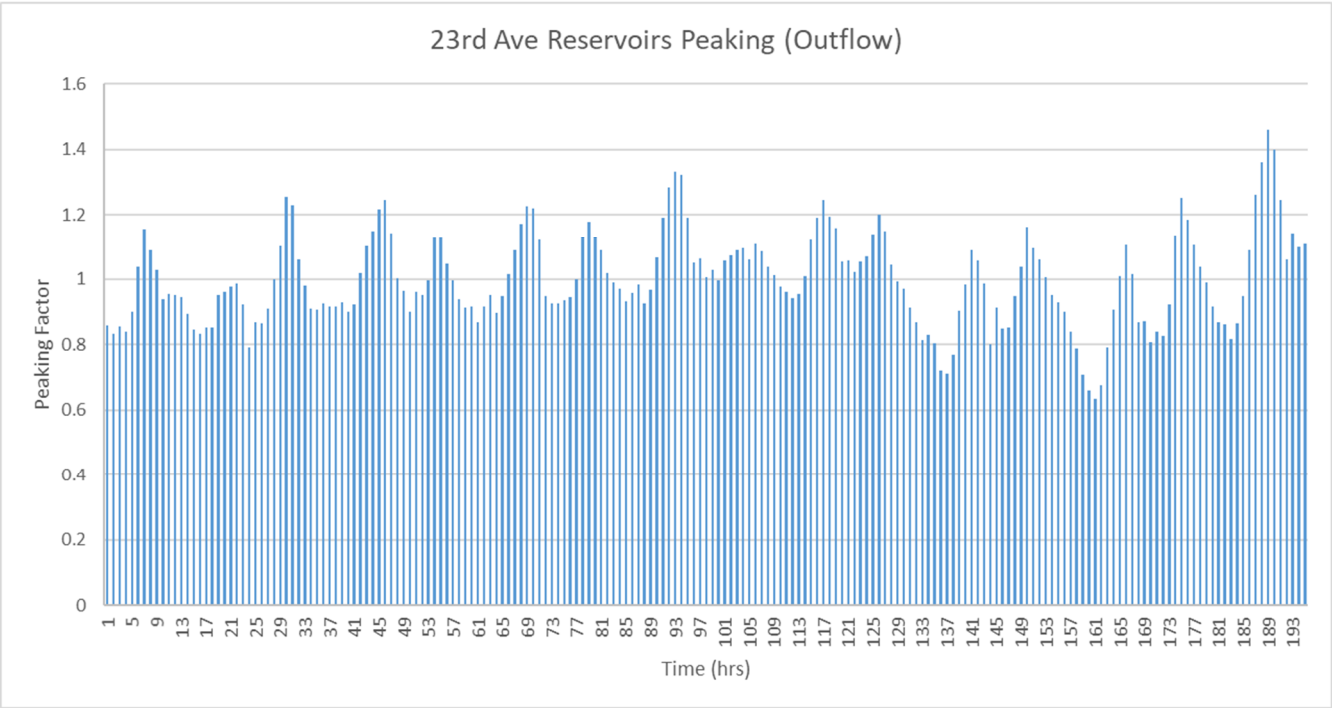

Figure 1 – 2016 Peak Period Outflow Pattern for 23rd Avenue Reservoirs

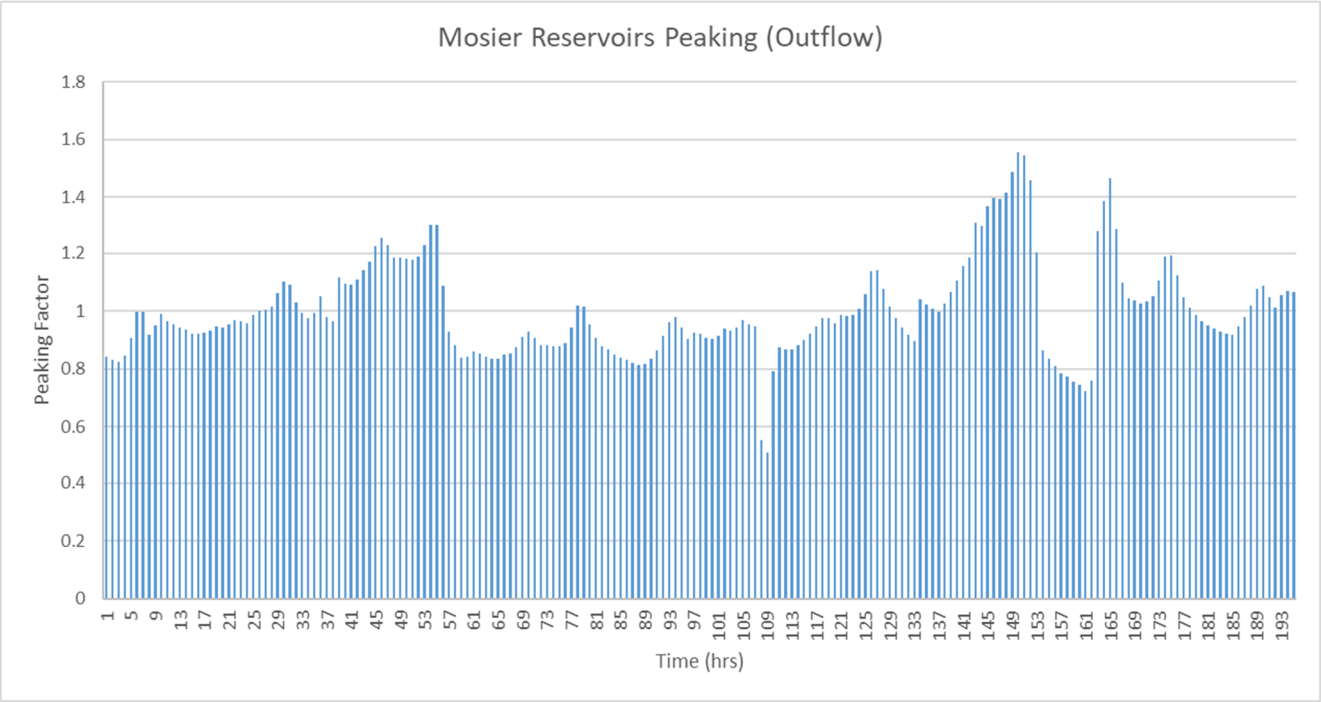

Figure 2 – 2016 Peak Period Outflow Pattern for Mosier Reservoirs

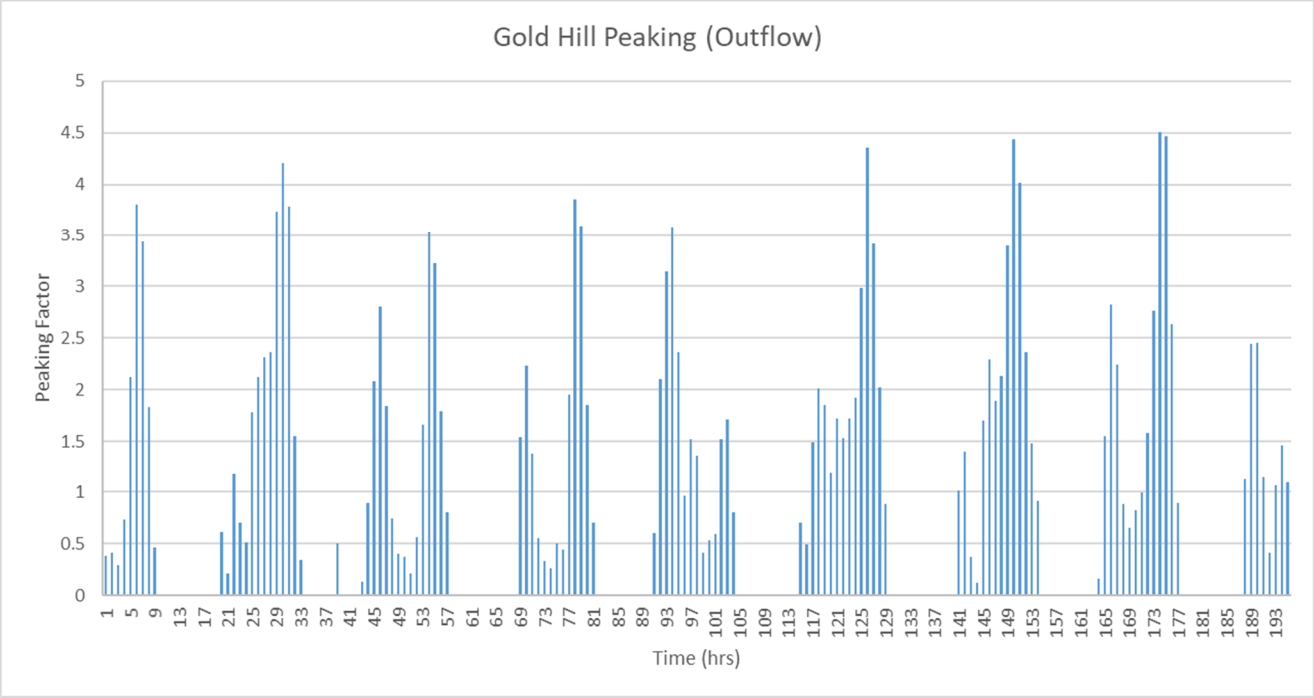

Figure 3 – 2016 Peak Period Outflow Pattern for Gold Hill Reservoirs

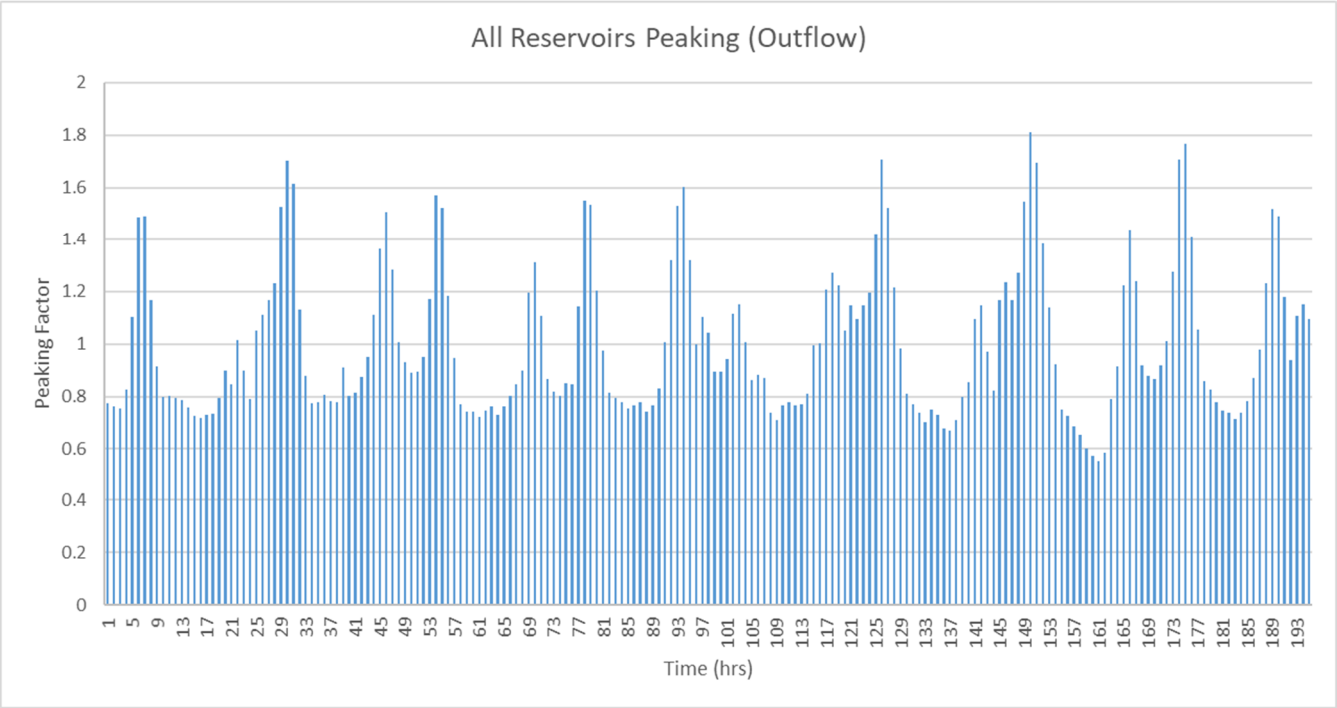

Figure 4 – 2016 Peak Period Outflow Combined Pattern for All Reservoirs

Under combined reservoir conditions, the maximum hourly peaking factor under the maximum day condition for July of 2016 is 1.8 (July 24, 2016 – 6:00 am).

Combining the Maximum to Average Day and Peak Hour to Maximum Day factors for the year 2016 results in a COG system wide condition of:

- Maximum Day/Average Day: 2.14
- Peak Hour/Average Day: 3.85

Comparison with Greeley and Front Range Community Factors

Comparison of peaking factors with front range communities researched by CDM Smith is included in **Table 2**. It shows a range of Maximum to Average Day peaking of 2.5 to 2.8. This compares with COG values based on the most recent 5 years of 2 to 2.15. Peak hour to average day ranges from 4.0 to 6.0 for these same communities, as compared with a 2016 calculated value for COG of about 3.85. The lower factors for COG may be reflective of Greeley community factors and strong conservation measures, but it is also important to recognize that most of these published values for the other communities represent standards and guidelines as opposed to measured actual historic data. While there are expected differences between design peaking factors and historic peaking factors, this research shows that Greeley is reasonably close to what other communities have published. It

should be noted that the researched communities only used one peaking factor for the whole system, and did not break out peaking factors by land use (or residential vs. non-residential peaking).

Table 2 – Front Range Communities Peaking Criteria

Community	Max Day[1]	Peak Hour[2]	Source
Loveland	2.5	6.0	Loveland Design Standards
Castle Rock	2.5	5.5	Castle Rock Water Criteria Manual
Westminster	2.5	4.0	Westminster Design Manual
Aurora	2.8	4.5	Aurora 2020 Water Specs
Average	**2.6**	**5.0**	

[1]Maximum Day = (Peaking factor) * (Average Day)
[2]Peak Hour = (Peaking Factor) * (Average Day)

Comparison with COG design standards shows that it is not easy to compare actual data across the distribution network with the land use-specific published criteria as shown in **Table 3**. Peak hour design criteria for residential land uses appear to be quite conservative when compared with system wide actual conditions, but it is unknown what base demand condition is being peaked and, therefore, challenging to compare it with one of the standard Front Range patterns or COG record data. Using the provided summer average residential demands (113 gpcd) results in very conservative peaking. However, established criteria for commercial applications appear to be much closer to the system wide actual conditions. Again, a direct apples-to-apples comparison is not applicable based on combined uses vs. land use specific criteria and actual data vs. published design standards.

Table 3 – Greeley Water Demand Design Criteria for New Development

Residential ADD (SUMMER) = 113 gpcd (provided by COG as part of WTDMP)

Use	Occupancy (ppl/DU)	PHD (gpm/unit)	PHD (gpcd)[1]	Peaking Factor
R-L	3.1	1.9	883	7.8
R-M	2.7	1.7	907	8.0
R-H	1.7	1.1	932	8.2
				8.0 = average residential peaking factor

[1] PHD (gpcd) = PHD (gpm/unit) / Occupancy (ppl/unit) * 1440 min/day

Commercial:

Use	ADD (gpm)	PHD (gpm)	Peaking Factor
Office Building	0.14	0.6	4.3
Restaurant	0.35	1.5	4.3
Small Business	0.14	0.6	4.3
Supermarket	0.14	0.6	4.3
Big Box/Dept. Store	0.14	0.6	4.3
Laundry, Dry Cleaning	0.7	2.9	4.1
Service Station	0.02	0.08	4.0
Car Wash	1.32	5.5	4.2
Hotel/Motel	0.24	1	4.2
Warehouse	0.07	0.3	4.3
			4.2 = average commercial peaking factor

GENERAL NOTE: Greeley does not provide peak day

Diurnal Curve Development

For extended period simulation in the hydraulic model, it is desirable to simulate real life (COG-specific) demand conditions on an hourly basis to reflect the most accurate anticipated system response. In addition, the peak hour condition should be captured within the diurnal curve simulation to ensure the most stressful condition on the system is simulated.

As mentioned above, the hour-by-hour extended period model simulation is the condition under which evaluations will be conducted for modeling and inclusion in the analysis for infrastructure sizing impacts on distribution and transmission mains, storage, and other distribution items (PRVs, etc.). Development of a realistic 24-hour diurnal curve pattern that incorporates the peak hour condition is critical to model simulations under these conditions.

The existing water model provided by COG for CDM Smith use in developing the future model has a diurnal pattern for summer peaks within it. The intent is to use the peak month model for the basis for these stress inducing conditions. A comparison of the values in the provided model of the existing system (created by the other consultant team) compared with the pattern associated with the 2016 maximum day (hour by hour) is shown in **Figure 6**.

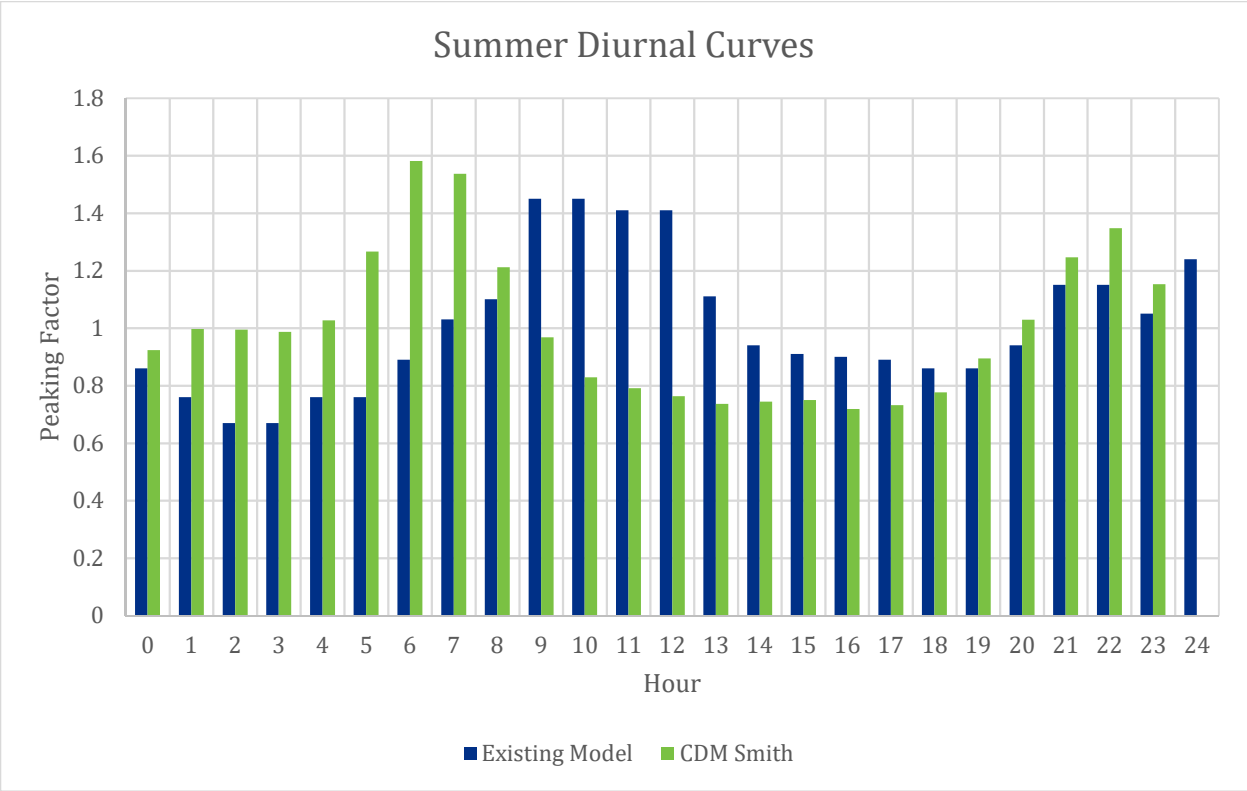

Figure 6 – Summer Diurnal Pattern Comparison – COG provide model vs. 2016 All Reservoirs

The source of information for the pattern provided in the previous water model is unknown. Discussions with COG staff indicate that the morning and evening hourly peaks included in the 2016 data are consistent with expectations.

Since the selected diurnal pattern is to be applied to the peak month model, an adjustment is needed to go from peak month to maximum day. For 2016, this value is 1.17 and when applied to the 2016 pattern, results in a peaking factor pattern shown in **Figure 7**. It is recommended to use the pattern shown in **Figure 7** (reflective of maximum day and peak hour for July of 2016) for general peaking analysis in the extended period model for future conditions.

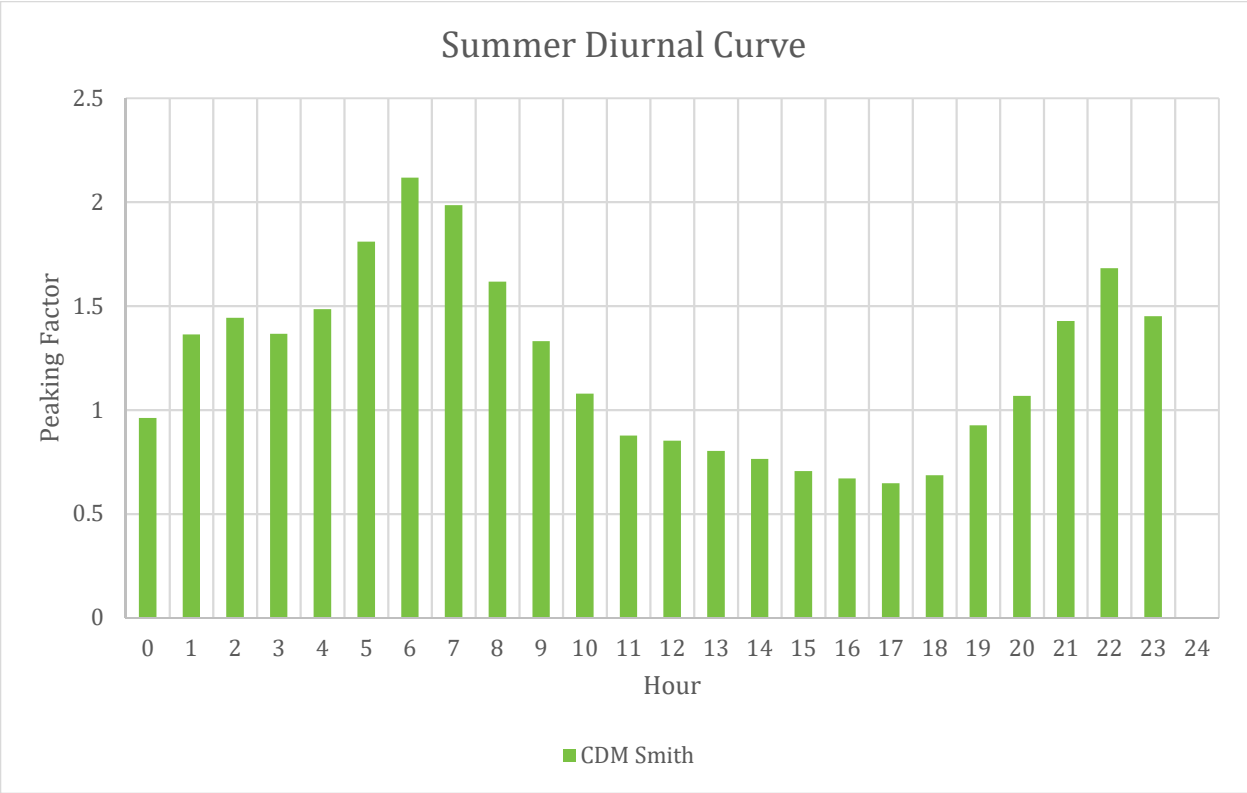

Figure 7 – Recommended Summer Composite Diurnal Pattern

Residential Diurnal Peaking

Further discussion with COG indicates that a single diurnal pattern, while representative of current overall City conditions, will likely not be entirely appropriate for future and infill development that will be largely residential in nature. Although there are metering records available for large COG user customers, there are no readily available metering records for large blocks of residential-only customers that can be used to establish a peak summer, hour-by-hour diurnal pattern. As a result, CDM Smith was requested to review other communities' previous master planning efforts that would produce a reasonable residential peaking pattern appropriate for use with this COG Water master planning effort.

CDM Smith conducts distribution system modeling and master planning in many areas across the United States with experience in many geographical regions as well as both larger and smaller urban communities. A common set of diurnal patterns has been used in recent years. This set of patterns is considered generally representative for patterns to be adopted by communities that lack actual customer use patterns based on metering records. These general patterns are being used by CDM Smith most recently for small and medium size communities in Texas, considered representative of drier arid regions.

Representative patterns include the following land use and seasonal demand categories:

- Single Family Residential (SFR)
- Single Family Residential with Irrigation (SFR-Irrigator)
- Multi-Family Residential
- Office
- Retail
- School

All patterns are based on a heavy demand period typical of summer use conditions. Weekly (7 day) patterns were examined and the peak weekday 24-hour pattern was selected in each case for further evaluation. **Figure 8** represents the SFR – Irrigator 24-hour pattern, which has the highest single hourly demand factor of any of these patterns.

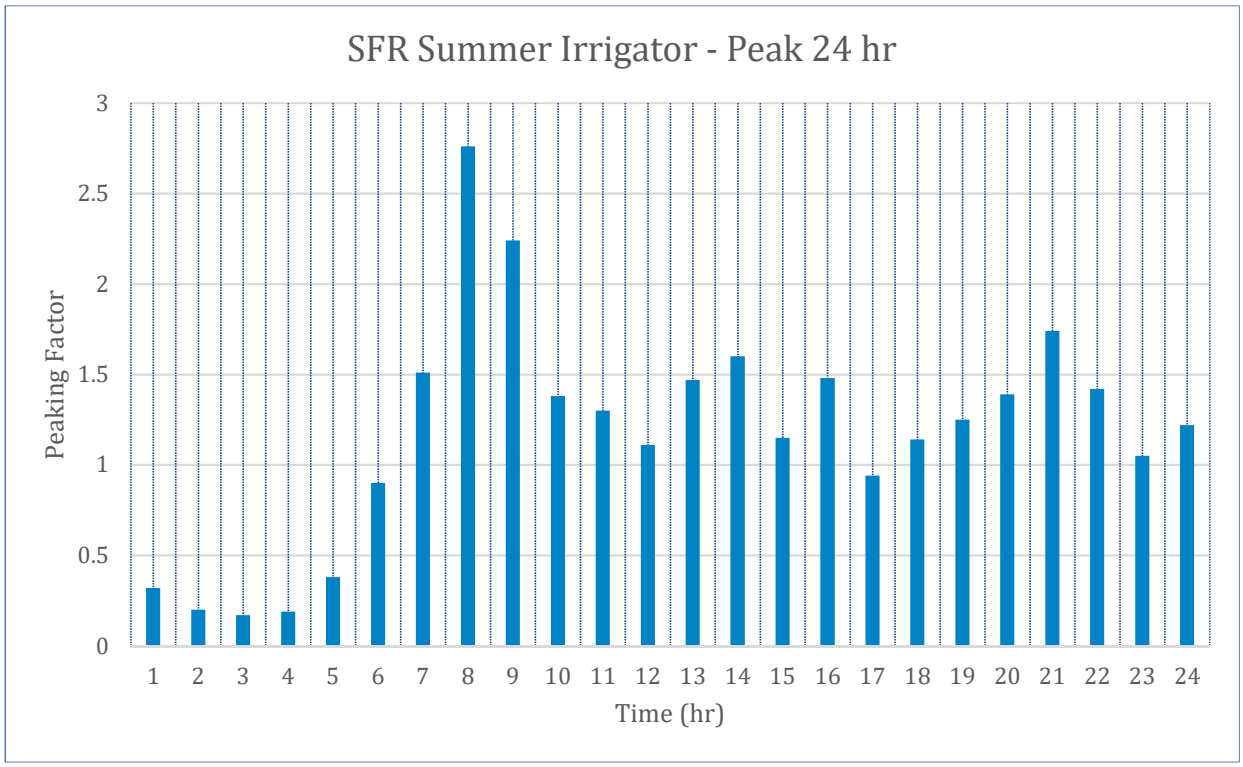

Figure 8 – Representative Single Family Residential Irrigator Diurnal Pattern

Comparison with the overall COG pattern in **Figure 7** shows a peak hour condition in the morning (about 8 am) consistent with the COG-specific pattern which shows a morning peak a couple of hours earlier. It is notable that the SFR-Irrigator peak hour factor is higher (approximately 2.75) than the peak hour for the COG-specific pattern (approximately 2.1), which would be expected. However, the early morning hours show much lower demands than in the COG specific pattern with a very rapid morning buildup and moderating pattern in the afternoon and evening hours. Rigid adherence with afternoon watering restrictions would likely show lower demands in this afternoon period, but there may not be universal adherence to such restrictions and, thus, the SFR – Irrigator pattern would tend to stress system needs harder in daytime hours than a more restrictive pattern indicative of a more conservative approach for single family users.

Although a direct comparison of this SFR-Irrigator pattern with COG overall peaking factors is not possible, using the overall 2016 maximum day to average day peaking factor of 2.14 multiplied against the SFR-Irrigator peak hour factor results in an overall peak hour/average day factor of 5.9 (applicable to single family residential only). This compares favorably with information presented in **Tables 2** and **3** above for regional peaking factors and COG design criteria for residential use. Likewise, using the COG overall diurnal pattern peak hour factor in conjunction with the maximum day factor results in a peak hour/average day factor of 4.5 (3.85 before the pattern is adjusted for model use from peak month to maximum day). Again, these overall peaking factors compare well with the regional conditions summarized in **Table 2**.

It is recommended that the SFR-Irrigator diurnal pattern (**Figure 8**) be used for future single and multi-family residential users in the master plan simulation model associated with peak demand conditions. Specific recommendations for application of the SFR-Irrigator pattern are as follows;

- Tier 1 – all residential demand is single family, apply the SFR-Irrigator pattern
- Tier 2 – apply the SFR-Irrigator pattern to all residential generally (difficult to differentiate between single and multi-family in this Tier group, but application of the revised pattern is a conservative approach)
- Tier 3 – apply the SFR-Irrigator pattern to R-L, R-M, RMH (mobile home), R-E (residential estate) and multi-family areas (similar to Tier 2 as a conservative approach).

This pattern should also apply for infill users in the same single and multi-family land use categories. The general COG diurnal pattern (**Figure 7**) is recommended for all other land use categories under future condition simulations.

cc: Adam Prior, Erin Walsh

Appendix B

Construction Cost and Capital Improvement Plan Tables

The cost development methodology (Appendix B1) for recommended 5- and 20-year City CIP improvements is discussed in this appendix along with detailed cost breakdowns of each recommended City CIP and development projects (Appendices B2 through B5). Annual funding requirements for recommended 5- and 20-year City CIP improvements follow (Appendix B6).

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B1 – Cost Development

B1.1 – Variability in Data

Data was obtained from past contractor bidding information provided by the City, other Front Range communities, and national sources, which included unit costs for potential capital expenditures within wastewater, water, and non-potable projects. The data varied in level of detail and definition of each cost element. For example, pipeline costs may or may not include dewatering, restoration, or paving project sites. Pipe cost data from the different sources also varied by construction depth, ground conditions, and method of installation for pipeline. For example, one data source may have identified unit price for a given pipe size at a given depth while another data source provided unit costs for given pipe sizes of various depths within developed or undeveloped land areas. Both data sources provide information regarding pipe installation costs but need to be considered based on the level of detail that is desired for project CIP development.

B1.2 – Unknown Elements and Assumptions

Assumptions made during CIP development can add to the variability of final bid project costs when compared to the planning-level costs. The assumptions are necessary to capture costs for project elements that cannot be defined at a planning level. Examples of undefinable costs include dewatering areas, utility pipeline crossings, permitting for project implementation, final contractor bid quantities, seasonal soil and ground conditions, and stormwater management of project sites. Assumptions are also made for pipe installation method, project timings, and construction materials. During design development, additional field information, including survey, geotechnical data, groundwater levels, traffic control requirements, and final pipe alignment of project areas will be available to help refine the project elements and construction methods.

Trendlines and linear interpolation are used to develop costs for project elements for which data was incomplete. For example, cost data was obtained for the trenchless installation of water distribution and transmission lines for 4- through 60-inch diameter pipe; however, there was limited cost information for 36-inch pipe. Trend line equations for linear, polynomial, and logarithmic and their respective coefficient of determination (R^2) values were compared to identify the most probable estimation equation. The coefficient of determination is used to statistically assess the correlation between two independent variables—in this case, data points and trendline equations used to predict additional data points. When a trendline has an R^2 value close to one, there is a high correlation between the trendline and the data set it predicts. A trendline with an R^2 value closest to 1 was selected as the most probable estimation equation. Because the trendline with the most pertinent R^2 value may not reflect the true data trend, CDM Smith recommends the City readjust cost data throughout the planning horizon, which is the length of time into the future for which projects are planned.

An example of comparing different trend line equations and their respective R^2 values for approximating missing data for the jack and bore (J&B) trenchless installation of water distribution and transmission pipeline items is shown in **Figure B1-1**. In this example, the second order polynomial trend line (shown by the purple dotted line below) has the closest R2 value to 1 compared to the exponential and logarithmic trend lines (shown by the blue and green dotted

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lines below, respectively) based on available data. As a result, without additional industry knowledge and experience, the linear trend line would be assumed to best approximate unit costs for J&B trenchless pipe installation for pipe sizes not available from the given data set. This assumption may conflict with actual J&B trenchless pipe installation data trends known in industry, which may better be approximated by exponential or logarithmic trend lines—especially when predicting trenchless pipe installation for large pipe sizes (i.e., greater than 24 inches) where predictions of data points of the trend lines begin to greatly diverge. At a planning level, this limitation is acceptable given a cushion of construction cost contingency (i.e., 35%) is added to help absorb this unit cost uncertainty. However, at an engineering design level where construction cost contingency is lowered and/or removed, the chosen trend line that best reflects industry data trends should be used to model trenchless pipe installation (and for all unit cost items where trendlines are used), regardless of if the chosen trend line has an R2 value closest to 1 to avoid unnecessary error.

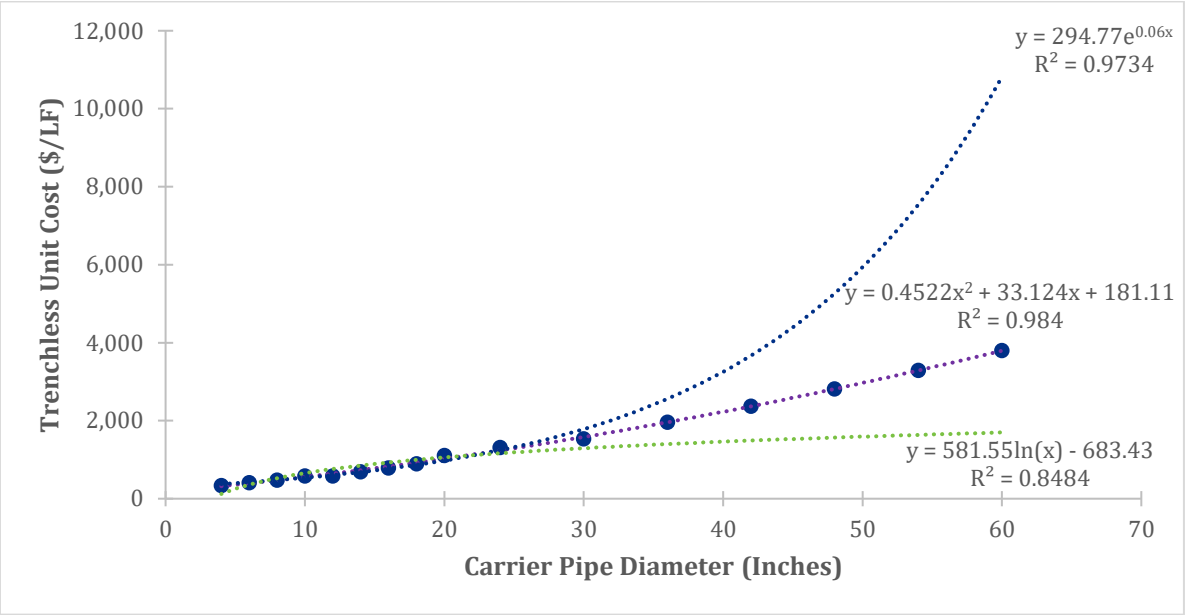

Figure B1-1 – Example of Different Trendlines for Finding Missing Data of a Line Item

B1.3 – Unpredictability

There is unpredictability to consider during CIP development, which is captured in the cost range provided for the overall CIP. Examples of unpredictability include future economic trends and inflation rates of CIPs. Prior to COVID-19, a global pandemic, cost inflation tools provided high confidence for predicting unit prices within a given year. However, after COVID-19, these previous assumptions for economic inflation may not be as accurate.

B1.4 – Data Sources

Major sources of cost factors included City bid tabs and databases, CDM Smith past project and contractor construction bid tabs, CDM Smith estimator group probable costs, and vendor quotes for project components. A list of external sources that CDM Smith used to develop unit costs and/or

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to plan the scheduling for the City's CIP water transmission and distribution cost estimates included:

- City of Greeley Project Initiation Form (City of Greeley 2021)
- Operation Rehab Project 2021–2025 Spreadsheet (City of Greeley 2021)
- Water and Sewer Department 10-Year CIP 2021–2030 Spreadsheet (City of Greeley 2021)
- Collection, Distributions, Transmission Projects Phase I – (Construction Management at Risk) (City of Greeley 2019)
- City of Greeley Pipe Rehabilitation Cost Estimating Template (City of Greeley 2019)
- Keep Greeley Moving Phase 2 by Neighborhood 2023–2029 (City of Greeley 2021)

The data for cost estimates was compiled in a single file with line item data reflected as unit costs (e.g., dollars per linear foot of pipe installed [$/LF], dollars per each PRV, etc.). When needed, unit costs for specific line items were calculated using trend line equations. Line items that were not specific and/or harder to estimate using specific unit cost quantities were reflected as a percentage addition to project costs (e.g., mobilization and demobilization, erosion control/stormwater pollution prevention).

The costs estimated in the project CIPs are in August 2020 dollars. Historical data was adjusted to the equivalent August 2020 data by using Engineering News Record's 20-City Construction Cost Index (ENR-CCI). ENR estimates a project each month in 20 different cities around the U.S. and calculates the composite index. Costs are adjusted by multiplying a cost element with the ratio of the current day 20-City ENR-CCI and date of data.

$$\textbf{Construction Unit Cost } (\mathbf{T2}) = \textbf{Construction Cost } (\mathbf{T1}) \times \frac{\mathbf{CCI}(\mathbf{T2})}{\mathbf{CCI}(\mathbf{T1})}$$

T2 and T1 reflect the desired projected year and month desired and the original year and month of unit costs, respectively.

B1.5 – Major Cost Elements

Water transmission and distribution system CIP costs were developed using five general cost element categories, as shown in **Figure B1-2** and described below.

Figure B1-2 – CIP Cost Elements

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- Pipeline and Valves: Quantities are derived from model results. Costs are developed by multiplying the estimated quantity by a unit price for that quantity.
- Fire Hydrants: Quantities are determined per unit length of newly installed, fire flow, and/or upsize of pipeline.
- Crossings and Land Considerations: Quantities for each category are determined from GIS mapping. Unit costs are more subjective than with pipe and valves. Land considerations provide for permanent easements acquired outside of City right-of-way. Permanent easements ensure that there will be reserved land space for future project pipelines that do not follow City roadways. The easement acquisition was estimated as a costing factor multiplier of the total OPCC for each project. OPCCs provide cost estimates of some specific project material and labor costs, including water distribution and transmission pipeline, reservoirs, and tank installations; removal of water from soils, major road, railway, and irrigation ditch crossings; erosion control; project implementation and cleanup; and project contingency, but not generic project administration and engineering costs.
- Dewatering: Dewatering, removal of water from soil by pumping where pipeline will be placed/replaced, relies on estimated quantities based on project location and depth and assumed cost applied on a linear foot basis using GIS mapping. The estimated cost for dewatering is subject to considerable variance.
- Construction Bid Cost: This cost element includes the previous cost elements with the addition of percentage additions. The percentage additions are taken from the subtotal of the first two cost elements. The total of the first two cost elements with the percentage additions create the construction bid cost element.
- Project Implementation: This cost element is most subjective of the five primary categories and are based on percentage additions of the subtotal of the construction bid cost element.
- Additional Project-Related Costs: This cost element is similar to the project implementation cost element and is based on percentage additions of the of the construction bid cost and project implementation cost elements.

Each of these cost elements is discussed in more detail in the following subsections. Unit priced line items, mobilization and demobilization, and stormwater pollution prevention/erosion control were reflected to the nearest whole dollar. Project contingency was rounded to the nearest $10 and added to the OPCC subtotals to determine the OPCC project totals, which were rounded to the nearest $10,000. Subsequent costing factors were added to the OPCC project totals to determine CIP estimations used in high-level planning of water transmission and distribution, sewer, and non-potable master plans.

B1.6 – Pipeline, Valves, and Fire Hydrants

B1.6.1 – Installation of Pipe

Water distribution and transmission lines were generally assumed to be installed using open cut construction, where contractors remove surface soils to insert pipe, except for arterial roadway and highway, railroad, irrigation ditch, river, and lake crossings. In such instances, trenchless pipe

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installation was conservatively assumed, which inserts pipe through tunneling and boring—J&B or horizontal directional drilling (HDD) methods. Although during project construction, not all crossings described may require trenchless installation, trenchless installation was assumed for all cases where pipe intersected described crossings as a conservative approach. Open cut and trenchless pipeline installation unit costs (in $/LF) include the pipe and bedding, excavation, installation including traffic control, tie-ins for service laterals, backfill, restoration, removal of old pipe, and flow and control valves. Water distribution pipelines were classified with pipe diameters up to 20 inches while water transmission lines were classified with pipe diameters 24 inches and above.

The open cut installation was divided into developed and undeveloped categories. The developed category includes pipe installed in developed areas such as in neighborhoods, along major City streets, across two-lane roads, through developed commercial property and designated agricultural land, and around City boundaries. The undeveloped category was assigned to pipe installed in permanent open space designated as city parks and open space such as agricultural land. It was assumed that all water distribution and transmission lines were installed at less than 10-foot depth unless using trenchless installation for crossings.

Trenchless installation costs (in $/LF) include the casing and carrier pipe, supports and contact grouting of the interstitial space, launching and receiving pits, and ground monitoring using J&B drilling or HDD. Unit prices were developed using bid tabs and CDM Smith's construction cost database.

Table B1-1 gives the unit cost breakdown for installation and replacement of water distribution and transmission lines.

Table B1-1 – Unit Costs for Water Distribution and Transmission Lines Installation and Replacement

Pipe Diameter (inches)	Unit Cost ($/LF of Pipe)			
	Undeveloped Land Designation	Developed Land Designation	Trenchless J&B (Crossings)	Trenchless HDD (River Crossings)
8	119	172	478	585
12	131	184	584	803
16	158	224	791	944
18	171	256	897	1,023
20	184	289	1,105	1,107
24	211	315	1,314	1,272
30	237	368	1,531	1,530
36	264	421	1,960	1,796
42	302	486	2,370	2,054
48	355	566	2,813	2,312
54	395	657	3,288	2,570
60	460	763	3,796	2,827

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B1.6.2 – Valves

New PRVs, which included valves and vaults, accompanied some water distribution and transmission lines, where required. The unit cost for each new PRV installed was based on the upstream and downstream water distribution or transmission line pipe size and included PRV and bedding, excavation, installation including traffic control, tie-ins for connection to water distribution or transmission lines, backfill, and restoration. **Table B1-2** lists the unit costs used for installing new PRVs.

Table B1-2 – Unit Costs of PRVs and Vaults

PRV Station Connection Pipe Size (inches)	Unit Cost ($/Each PRV)
8	20,000
12	30,000
16	40,000
20	50,000

B1.6.3 – Fire Hydrants

The unit cost per fire hydrant was estimated assuming installation of new fire hydrants across the entire pipe length of a given project at $5,646 per fire hydrant. This conservative estimate accounts for removal and replacement of existing fire hydrants that are at the end of their service lifetime or would need to be upsized given their connection to pipe of increased diameter size. Fire hydrant spacing was estimated at 400-foot spacing and quantity estimates factored into costing were only considered for water distribution pipe diameters up to 20 inches (distribution pipe typically within subdivision). The following equation was used to estimate the number of fire hydrants required as a function of total water distribution and transmission pipe length. One additional fire hydrant was added per project for a conservative estimate:

$$\textbf{Total Fire Hydrant No.} = \frac{\textbf{Total Project Pipe Length}}{\textbf{400}} + \textbf{1}$$

B1.7 – Crossings, Land Considerations, and Dewatering

B1.7.1 – Irrigation Ditch, River Crossings, and Lake Crossings

ArcMap GIS was used to identify irrigation ditch, river, and lake crossing locations. Irrigation ditch, river, and lake crossings were assumed as 100 feet in length, 250 feet in length, and estimated crossing length, respectively. Unit costs for irrigation ditch, river, and lake crossings were approximated by trenchless pipe installation regardless of pipe depth using J&B for ditch crossings and HDD drilling for river and lake crossings.

B1.7.2 – Utility, Roadway, and Railway Crossings

ArcMap GIS was used to identify road, utility, and railroad crossings. Unit prices were developed assuming installation by J&B, where applicable, using the following assumptions:

- Roads were separated into typical (two- to three-lane roads located on side streets and in neighborhoods), arterial (major roadways of four lanes or more assumed at 200 feet wide), and highways (major roadways with Colorado Department of Transportation right-of-way requirements at 250 feet wide). Widths were based on the U.S. Department of

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Transportation Federal Highway Administration guidelines (USDOT 2014). Typical road crossings were included as part of overall open cut installation, while arterial road and highway crossings were accounted as a part of trenchless pipe installation costs.

- Railway crossings were estimated as 150 feet in length and included in trenchless installation costs.
- Other City and non-City utilities were not included in unit cost estimates but assumed to be covered under project contingency.

B1.7.3 – Easements

Easement acquisition was assumed to be required for all new pipeline not in City right-of-way or on City-owned property. Easement acquisition was assumed as a costing factor multiplier of the total OPCC at 5%.

B1.7.4 – Dewatering

A three-tiered approach was used to determine projected dewatering requirements for 2025 and 2040 City CIP project improvements. The three tiers used for unit cost estimations were developed considering land elevations in and around the City (between approximately 4,600 to 5,060 feet), 100-year floodplain maps, and proximity to irrigation ditches and water bodies. Tier 1 includes water distribution and transmission line construction within the 100-year floodplain and/or within 50 feet of an irrigation ditch, pond, or lake. Tier 2 includes pipe that is not in Tier 1, is below the median elevation of the City (4,828 feet), and is assumed to require 50% of the dewatering needed for Tier 1. Tier 3 includes pipe in areas above the median elevation and assumes no dewatering is required.

Figure B1-3 illustrates the three-tiered dewatering profile for the 2025 and 2040 project improvements. **Table B1-3** lists the unit costs developed for the three-tiered dewatering categories in $/LF of water pipe.

Table B1-3 – Dewatering Unit Costs

Tier	Unit Cost ($/LF of Pipe)
1	105
2	52.5
3	0

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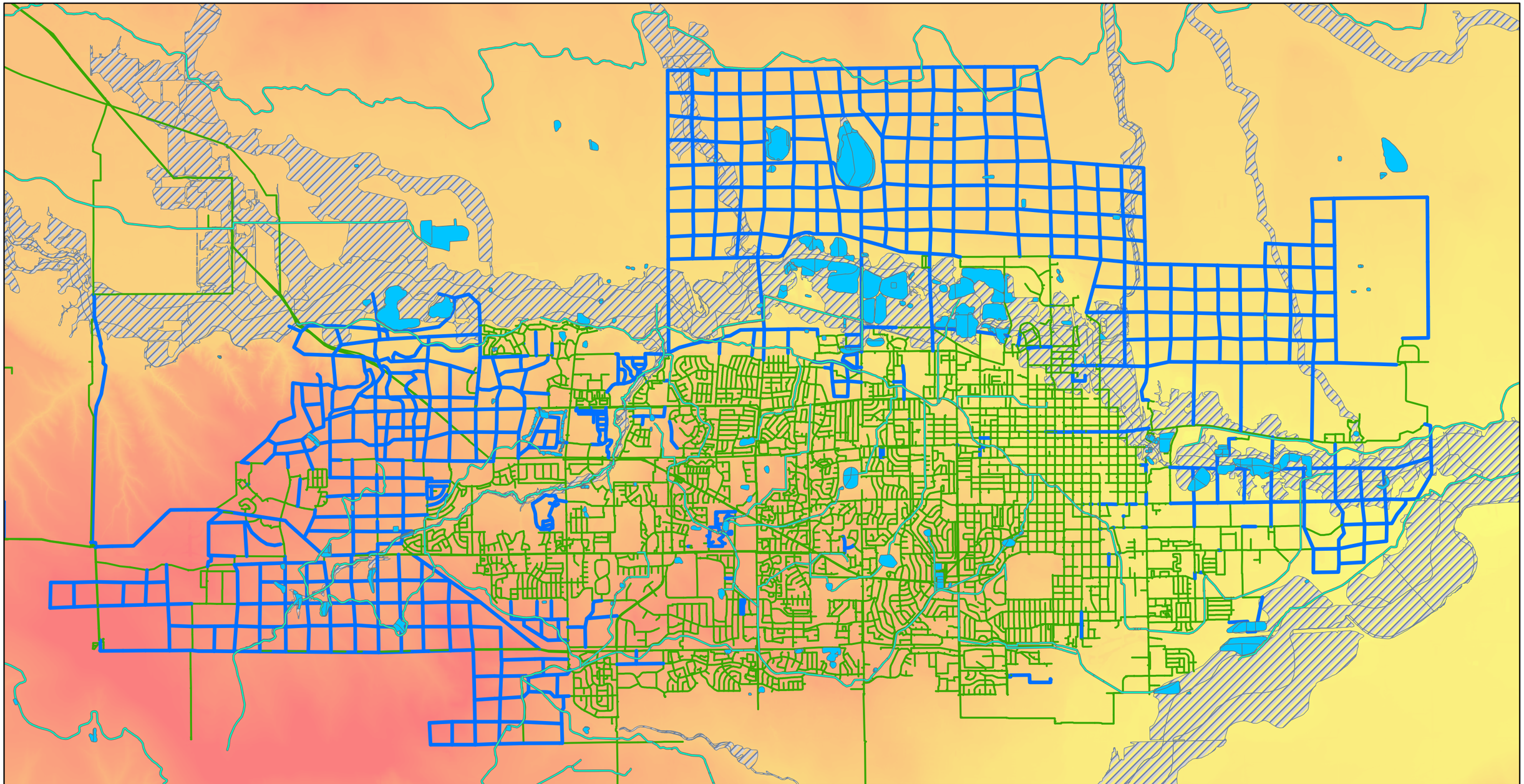

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February 25, 2021

Legend

Tier 1

- 100-yr FloodPlain
- Lakes 50ft Buffer
- Ditch 50ft Buffer

Tier 2

- 4828 ft
- 4596 ft

Tier 3

- 5059 ft
- 4828 ft

- Existing Pipe
- Future Pipe

N

0 0.5 1 2

Miles

Dewatering Profile

FIgure B1-3

Greeley Water System Master Plan

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B1.8 – Project Implementation and Additional Project-Related Costs

Project elements considered part of project implementation and additional project related costs are difficult to quantify at the planning level. Construction elements include items such as erosion control/stormwater pollution prevention and contractor mobilization and demobilization. These costs are estimated as a percentage of the subtotal pipe, fire hydrants, and equipment. Contingency is applied to the subtotal of these construction cost elements to account for variations in unit prices or quantity estimates. Programmatic elements include engineering, permitting, legal, and administration and are estimated as a percentage of the construction cost. **Table B1-4** provides a breakdown of the different assumptions used for project implementation and contingency.

Table B1-4 – Costing Factors for Construction Bid and Total CIP Project Costs

Category	Item	Costing Factor
Construction Bid Cost (includes infrastructure and contractor overhead, profit, bonds, and insurance)	Erosion Control/Stormwater Pollution Prevention[1]	2%
	Mobilization and Demobilization[1]	5%
	Contingency[2]	35%
Project Implementation[3]	Feasibility and Site Studies	9% for OPCC ≤ $1 million 6% for OPCC of $1 million to $10 million 5% for OPCC > $10 million
	Preliminary and Final Design	9% for OPCC ≤ $1 million 6% for OPCC of $1 million to $10M 5% for OPCC > $10 million
	Engineering Services During Construction	5%
Additional Project-Related Costs[3]	Outside Construction Management - not used if OPCC value is < $1 million	5%
	Outside Project Management - not used if OPCC value is < $1 million	3%

[1] Construction bid cost costing factors erosion control/stormwater pollution prevention and mobilization and demobilization are added to the subtotal of unit cost items.

[2] Contingency costing factor is 35% of the subtotal of the unit cost items and contractor born costs determined by costing factors.

[3] Project implementation and additional project-related cost categories are determined as a percentage of the construction cost and part of the total CIP project costs.

B1.8.1 – Project Erosion Control/Stormwater Pollution Prevention

Project erosion control and stormwater pollution prevention includes the contractor's cost to manage the stormwater during construction through best management practices such as silt fences, rock socks, vehicle tracking, and silt prevention at storm inlets. This category is assumed as 2% of the OPCC subtotal of the items that have unit costs and is based on estimator's judgement and prior reports. This costing factor is added to calculate project OPCC totals.

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Mobilization and Demobilization

Contractor mobilization and demobilization includes the contractor's startup costs (moving equipment and personnel to the project location, obtaining permits and bonds, etc.) and closeout costs (project cleanup, moving equipment and personnel from the project location, etc.). The mobilization and demobilization category is assumed as 5% of the OPCC subtotal of the items that have unit costs and is based on estimator's judgement and prior reports. This costing factor is added to calculate project OPCC totals.

B1.8.2 – Contingency

During the planning phase, the field work and design have not been completed for the CIPs and therefore the cost development relies on estimated quantities for each construction element. Project contingency provides for these uncertainties by adding additional costs to the project total. The contingency at the planning level is typically 35% of the OPCC subtotal after erosion control/stormwater pollution prevention and mobilization and demobilization costing factors have been included. Project contingency also provides for cost associated with items that are difficult to itemize at a planning level.

B1.8.3 – Feasibility and Site Studies

This cost element includes the planning and field investigations (geotechnical, survey, ground sampling, utility locates, etc.) required to implement a project and is estimated as a percentage of the subtotal of the previous elements. The percentage varies based on the OPCC (plus contingency).

B1.8.4 – Preliminary and Final Design

The preliminary and final design cost element includes the cost for engineering services to develop biddable plans and specifications in accordance with applicable standards. This cost is estimated using a percentage of the OPCC (plus contingency).

B1.8.5 – Engineering Services During Construction

Engineering services during construction include review of contractor submittals, requested changes, and design adjustments that may be required during construction. A flat percentage of the OPCC is used to estimate this cost element.

B1.8.6 – Additional Project-Related Costs

Outside construction and project management costs are estimated for projects that are not directly managed by the City. For purposes of this master plan, only projects in excess of $1 million were assigned these cost elements.

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B2 – Opinion of Probable Construction and Capital Improvement Plan Costs: 5-Year City Projects

OPCCs and CIP total estimates for 5-Year City CIP Projects are presented in order of priority in on pages B1-1 through B1-9. The estimated cost for each line item, also known as the extended cost, within a project is determined by multiplying the line item quantity times the unit cost. Each line item extended cost is added to the project total cost column to determine OPCC estimates. August 2020 dollars from ENR-CCI was used for project OPCCs and CIPs.

C5-12C OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 12"	97	$184/LF	$17,865	$17,865
Fire Hydrants	2	$5,646/EA	$11,292	$11,292
Tier 2 Dewatering	97	$52.50/LF	$5,093	$5,093
Unit Cost Subtotal				$34,250
Erosion Control/Stormwater Pollution Prevention		2%		$685
Mobilization & Demobilization		5%		$1,713
Subtotal				$36,648
Contingency		35%		$12,830
Opinion of Probable Construction Cost (rounded)				**$50,000**
Feasibility and Site Studies		9% of OPCC		$5,000
Preliminary and Final Design		9% of OPCC		$5,000
Engineering Services During Construction		5% of OPCC		$3,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$0
Capital Improvement Plan Total				**$70,000**

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C5-14 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 16"	968	224/LF	$216,740	$216,740
Water Distribution 20"	421	289/LF	$121,631	$121,631
Fire Hydrants	5	5,646/EA	$28,231	$28,231
Tier 1 Dewatering	1,304	105/LF	$136,920	$136,920
Tier 2 Dewatering	85	52.50/LF	$4,463	$4,463
Unit Cost Subtotal				$507,984
Erosion Control/Stormwater Pollution Prevention		2%		$10,160
Mobilization & Demobilization		5%		$25,399
Subtotal				$543,543
Contingency		35%		$190,250
Opinion of Probable Construction Cost (rounded)				**$740,000**
Feasibility and Site Studies		9% of OPCC		$67,000
Preliminary and Final Design		9% of OPCC		$67,000
Engineering Services During Construction		5% of OPCC		$37,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$0
Capital Improvement Plan Total				**$920,000**

C20-2B OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 12"	5,444	184/LF	$1,002,675	$1,002,675
Water Distribution 16"	449	224/LF	$100,533	$100,533
Water Distribution 20"	1,153	289/LF	$333,113	$333,113
Water Distribution 20" (Trenchless J&B)	100	1,105/LF	$110,546	$110,546
PRV Station 20"	1	50,000/EA	$50,000	$50,000
Fire Hydrants	19	5,646/EA	$107,278	$107,278
Tier 1 Dewatering	946	105/LF	$99,330	$99,330
Tier 2 Dewatering	6200	52.50/LF	$325,500	$325,500
Unit Cost Subtotal				$2,128,974
Erosion Control/Stormwater Pollution Prevention		2%		$42,579
Mobilization & Demobilization		5%		$106,449
Subtotal				$2,278,002
Contingency		35%		$797,310
Opinion of Probable Construction Cost (rounded)				**$3,080,000**
Easement		5% of OPCC		$154,000
Feasibility and Site Studies		6% of OPCC		$185,000
Preliminary and Final Design		6% of OPCC		$185,000
Engineering Services During Construction		5% of OPCC		$154,000
Outside Construction Management - not used if OPCC value is < $1M		5% of OPCC		$154,000
Outside Project Management - not used if OPCC value is < $1M		3% of OPCC		$93,000
Capital Improvement Plan Total				**$4,010,000**

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W5-1 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Transmission 60"	4,023	$763/LF	$3,070,364	$3,070,364
Water Transmission 60" (Trenchless J&B)	250	$3,796/LF	$949,118	$949,118
Tier 1 Dewatering	2,339	$105/LF	$245,595	$245,595
Unit Cost Subtotal				$4,265,076
Erosion Control/Stormwater Pollution Prevention		2%		$85,302
Mobilization & Demobilization		5%		$213,254
Subtotal				$4,563,631
Contingency		35%		$1,597,280
Opinion of Probable Construction Cost (rounded)				**$6,170,000**
Easement		5% of OPCC		$309,000
Feasibility and Site Studies		6% of OPCC		$371,000
Preliminary and Final Design		6% of OPCC		$371,000
Engineering Services During Construction		5% of OPCC		$309,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$309,000
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$186,000
Capital Improvement Plan Total				**$8,030,000**

C5-12B OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 16"	301	$224/LF	$67,395	$67,395
Water Distribution 16" (Undeveloped)	280	$158/LF	$44,155	$44,155
Fire Hydrants	3	$5,646/EA	$16,939	$16,939
Tier 1 Dewatering	581	$105/LF	$61,005	$61,005
Unit Cost Subtotal				$189,494
Erosion Control/Stormwater Pollution Prevention		2%		$3,790
Mobilization & Demobilization		5%		$9,475
Subtotal				$202,759
Contingency		35%		$70,970
Opinion of Probable Construction Cost (rounded)				**$280,000**
Feasibility and Site Studies		9% of OPCC		$26,000
Preliminary and Final Design		9% of OPCC		$26,000
Engineering Services During Construction		5% of OPCC		$14,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$0
Capital Improvement Plan Total				**$350,000**

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NC5-2 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 16"	451	224/LF	$100,981	$100,981
Water Distribution 16" (Trenchless J&B)	100	791/LF	$79,107	$79,107
Fire Hydrants	3	5,646/EA	$16,939	$16,939
Tier 2 Dewatering	551	52.50/LF	$28,928	$28,928
Unit Cost Subtotal				$225,955
Erosion Control/Stormwater Pollution Prevention		2%		$4,519
Mobilization & Demobilization		5%		$11,298
Subtotal				$241,771
Contingency		35%		$84,630
Opinion of Probable Construction Cost				**$330,000**
Feasibility and Site Studies		9% of OPCC		$30,000
Preliminary and Final Design		9% of OPCC		$30,000
Engineering Services During Construction		5% of OPCC		$17,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$0
Capital Improvement Plan Total				**$410,000**

NC5-1 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 20"	4,468	289/LF	$1,290,847	$1,290,847
Water Distribution 20" (Trenchless J&B)	150	1,105/LF	$165,818	$165,818
Water Distribution 20" (Trenchless HDD)	250	1,107/LF	$276,862	$276,862
Fire Hydrants	14	5,646/EA	$79,047	$79,047
Tier 1 Dewatering	3,460	105/LF	$363,300	$363,300
Tier 2 Dewatering	1,408	52.50/LF	$73,920	$73,920
Unit Cost Subtotal				$2,249,795
Erosion Control/Stormwater Pollution Prevention		2%		$44,996
Mobilization & Demobilization		5%		$112,490
Subtotal				$2,407,281
Contingency		35%		$842,550
Opinion of Probable Construction Cost (rounded)				**$3,250,000**
Feasibility and Site Studies		6% of OPCC		$195,000
Preliminary and Final Design		6% of OPCC		$195,000
Engineering Services During Construction		5% of OPCC		$163,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$163,000
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$98,000
Capital Improvement Plan Total				**$4,070,000**

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C5-1 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	1,415	$172/LF	$243,581	$243,581
Fire Hydrants	2	$5,646/EA	$11,292	$11,292
Unit Cost Subtotal				$254,873
Erosion Control/Stormwater Pollution Prevention		2%		$5,097
Mobilization & Demobilization		5%		$12,744
Subtotal				$272,714
Contingency		35%		$95,460
Opinion of Probable Construction Cost (rounded)				**$370,000**
Feasibility and Site Studies		9% of OPCC		$34,000
Preliminary and Final Design		9% of OPCC		$34,000
Engineering Services During Construction		5% of OPCC		$19,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$0
Capital Improvement Plan Total				**$460,000**

C5-2 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	1,008	$172/LF	$173,519	$173,519
Fire Hydrants	4	$5,646/EA	$22,585	$22,585
Tier 2 Dewatering	1,008	$52.50/LF	$52,920	$52,920
Unit Cost Subtotal				$249,024
Erosion Control/Stormwater Pollution Prevention		2%		$4,980
Mobilization & Demobilization		5%		$12,451
Subtotal				$266,456
Contingency		35%		$93,260
Opinion of Probable Construction Cost (rounded)				**$360,000**
Easement		5% of OPCC		$18,000
Feasibility and Site Studies		9% of OPCC		$33,000
Preliminary and Final Design		9% of OPCC		$33,000
Engineering Services During Construction		5% of OPCC		$18,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$0
Capital Improvement Plan Total				**$470,000**

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C5-12A OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8" (Undeveloped)	657	$119/LF	$78,298	$78,298
Fire Hydrants	3	$5,646/EA	$16,939	$16,939
Tier 1 Dewatering	657	$105/LF	$68,985	$68,985
Unit Cost Subtotal				$164,222
Erosion Control/Stormwater Pollution Prevention		2%		$3,284
Mobilization & Demobilization		5%		$8,211
Subtotal				$175,717
Contingency		35%		$61,510
Opinion of Probable Construction Cost (rounded)				**$240,000**
Feasibility and Site Studies		9% of OPCC		$22,000
Preliminary and Final Design		9% of OPCC		$22,000
Engineering Services During Construction		5% of OPCC		$12,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$0
Capital Improvement Plan Total				**$300,000**

C5-13A OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	602	$172/LF	$103,629	$103,629
Fire Hydrants	3	$5,646/EA	$16,939	$16,939
Tier 2 Dewatering	602	$52.50/LF	$31,605	$31,605
Unit Cost Subtotal				$152,173
Erosion Control/Stormwater Pollution Prevention		2%		$3,043
Mobilization & Demobilization		5%		$7,609
Subtotal				$162,825
Contingency		35%		$56,990
Opinion of Probable Construction Cost (rounded)				**$220,000**
Feasibility and Site Studies		9% of OPCC		$20,000
Preliminary and Final Design		9% of OPCC		$20,000
Engineering Services During Construction		5% of OPCC		$11,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$0
Capital Improvement Plan Total				**$280,000**

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C5-13B OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	820	$172/LF	$141,156	$141,156
Fire Hydrants	4	$5,646/EA	$22,585	$22,585
Tier 2 Dewatering	820	$52.50/LF	$43,050	$43,050
Unit Cost Subtotal				$206,791
Erosion Control/Stormwater Pollution Prevention		2%		$4,136
Mobilization & Demobilization		5%		$10,340
Subtotal				$221,267
Contingency		35%		$77,450
Opinion of Probable Construction Cost (rounded)				**$300,000**
Feasibility and Site Studies		9% of OPCC		$27,000
Preliminary and Final Design		9% of OPCC		$27,000
Engineering Services During Construction		5% of OPCC		$15,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$0
Capital Improvement Plan Total				**$370,000**

E5-2A OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 12"	460	$184/LF	$84,723	$84,723
Fire Hydrants	3	$5,646/EA	$16,939	$16,939
Tier 1 Dewatering	460	$105/LF	$48,300	$48,300
Unit Cost Subtotal				$149,961
Erosion Control/Stormwater Pollution Prevention		2%		$2,999
Mobilization & Demobilization		5%		$7,498
Subtotal				$160,459
Contingency		35%		$56,170
Opinion of Probable Construction Cost (rounded)				**$220,000**
Easement		5% of OPCC		$11,000
Feasibility and Site Studies		9% of OPCC		$20,000
Preliminary and Final Design		9% of OPCC		$20,000
Engineering Services During Construction		5% of OPCC		$11,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$0
Capital Improvement Plan Total				**$290,000**

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E5-2B OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	491	$172/LF	$84,522	$84,522
Water Distribution 8" (Trenchless J&B)	200	$478/LF	$95,617	$95,617
Fire Hydrants	3	$5,646/EA	$16,939	$16,939
Tier 1 Dewatering	691	$105/LF	$72,555	$72,555
Unit Cost Subtotal				$269,632
Erosion Control/Stormwater Pollution Prevention		2%		$5,393
Mobilization & Demobilization		5%		$13,482
Subtotal				$288,506
Contingency		35%		$100,980
Opinion of Probable Construction Cost (rounded)				**$390,000**
Easement		5% of OPCC		$20,000
Feasibility and Site Studies		9% of OPCC		$36,000
Preliminary and Final Design		9% of OPCC		$36,000
Engineering Services During Construction		5% of OPCC		$20,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$0
Capital Improvement Plan Total				**$510,000**

E5-2C OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	303	$172/LF	$52,159	$52,159
Fire Hydrants	2	$5,646/EA	$11,292	$11,292
Tier 1 Dewatering	303	$105/LF	$31,815	$31,815
Unit Cost Subtotal				$95,266
Erosion Control/Stormwater Pollution Prevention		2%		$1,905
Mobilization & Demobilization		5%		$4,763
Subtotal				$101,935
Contingency		35%		$35,680
Opinion of Probable Construction Cost (rounded)				**$140,000**
Easement		5% of OPCC		$7,000
Feasibility and Site Studies		9% of OPCC		$13,000
Preliminary and Final Design		9% of OPCC		$13,000
Engineering Services During Construction		5% of OPCC		$7,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$0
Capital Improvement Plan Total				**$180,000**

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E5-5 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	793	172/LF	$136,509	$136,509
Fire Hydrants	3	5,646/EA	$16,939	$16,939
Tier 2 Dewatering	793	52.50/LF	$41,633	$41,633
Unit Cost Subtotal				$195,080
Erosion Control/Stormwater Pollution Prevention		2%		$3,902
Mobilization & Demobilization		5%		$9,754
Subtotal				$208,735
Contingency		35%		$73,060
Opinion of Probable Construction Cost (rounded)				**$290,000**
Easement		5% of OPCC		$15,000
Feasibility and Site Studies		9% of OPCC		$27,000
Preliminary and Final Design		9% of OPCC		$27,000
Engineering Services During Construction		5% of OPCC		$15,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$0
Capital Improvement Plan Total				**$380,000**

SC5-1 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	455	172/LF	$78,325	$78,325
Fire Hydrants	3	5,646/EA	$16,939	$16,939
Unit Cost Subtotal				$95,263
Erosion Control/Stormwater Pollution Prevention		2%		$1,905
Mobilization & Demobilization		5%		$4,763
Subtotal				$101,932
Contingency		35%		$35,680
Opinion of Probable Construction Cost				**$140,000**
Feasibility and Site Studies		9% of OPCC		$13,000
Preliminary and Final Design		9% of OPCC		$13,000
Engineering Services During Construction		5% of OPCC		$7,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$0
Capital Improvement Plan Total				**$180,000**

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B3 – Opinion of Probable Construction and Capital Improvement Plan Costs: 20-Year City CIP Projects

OPCCs and CIP total estimates for 20-Year City CIP Projects are presented in order of priority on pages **B2-1** through **B2-8**. August 2020 dollars from ENR-CCI was used for project OPCCs and CIPs.

E5-6 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	617	172/LF	$106,212	$106,212
Water Distribution 16"	28	224/LF	$6,269	$6,269
Water Transmission 30"	3,182	368/LF	$1,172,120	$1,172,120
Water Transmission 30" (Trenchless J&B)	400	421/LF	$168,531	$168,531
Fire Hydrants	12	5,646/EA	$67,754	$67,754
Tier 2 Dewatering	4,227	52.50/LF	$221,918	$221,918
Unit Cost Subtotal				$1,742,803
Erosion Control/Stormwater Pollution Prevention		2%		$34,856
Mobilization & Demobilization		5%		$87,140
Subtotal				$1,864,800
Contingency		35%		$652,680
Opinion of Probable Construction Cost (rounded)				**$2,520,000**
Feasibility and Site Studies		6% of OPCC		$152,000
Preliminary and Final Design		6% of OPCC		$152,000
Engineering Services During Construction		5% of OPCC		$126,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$126,000
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$76,000
Capital Improvement Plan Total				**$3,160,000**

W20-1 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Transmission 60"	9,813	$763/LF	$7,489,306	$7,489,306
Unit Cost Subtotal				$7,489,306
Erosion Control/Stormwater Pollution Prevention		2%		$149,786
Mobilization & Demobilization		5%		$374,465
Subtotal				$8,013,557
Contingency		35%		$2,804,750
Opinion of Probable Construction Cost (rounded)				**$10,820,000**
Easement		5% of OPCC		$541,000
Feasibility and Site Studies		5% of OPCC		$541,000
Preliminary and Final Design		5% of OPCC		$541,000
Engineering Services During Construction		5% of OPCC		$541,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$541,000
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$324,600
Capital Improvement Plan Total				**$13,850,000**

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C20-1 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 20"	4,709	$289/LF	$1,360,475	$1,360,475
Water Distribution 20" (Trenchless J&B)	350	$1,105/LF	$386,910	$386,910
Water Distribution 20" (Trenchless HDD)	250	$1,107/LF	$276,862	$276,862
PRV Station 20"	1	$50,000/EA	$50,000	$50,000
Fire Hydrants	15	$5,646/EA	$84,693	$84,693
Tier 1 Dewatering	4455	$105/LF	$467,775	$467,775
Tier 2 Dewatering	854	$52.50/LF	$44,835	$44,835
Unit Cost Subtotal				$2,671,550
Erosion Control/Stormwater Pollution Prevention		2%		$53,431
Mobilization & Demobilization		5%		$133,577
Subtotal				$2,858,558
Contingency		35%		$1,000,500
Opinion of Probable Construction Cost (rounded)				**$3,860,000**
Feasibility and Site Studies		6% of OPCC		$232,000
Preliminary and Final Design		6% of OPCC		$232,000
Engineering Services During Construction		5% of OPCC		$193,000
Outside Construction Management - not used if OPCC value is < $1M		5% of OPCC		$193,000
Outside Project Management - not used if OPCC value is < $1M		3% of OPCC		$116,000
Capital Improvement Plan Total				**$4,830,000**

C20-3 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 16"	3,721	$224/LF	$833,150	$833,150
Water Distribution 16" (Trenchless HDD)	250	$944/LF	$235,907	$235,907
Fire Hydrants	11	$5,646/EA	$62,108	$62,108
Tier 1 Dewatering	3086	$105/LF	$324,030	$324,030
Tier 2 Dewatering	885	$52.50/LF	$46,463	$46,463
Unit Cost Subtotal				$1,501,658
Erosion Control/Stormwater Pollution Prevention		2%		$30,033
Mobilization & Demobilization		5%		$75,083
Subtotal				$1,606,774
Contingency		35%		$562,380
Opinion of Probable Construction Cost (rounded)				**$2,170,000**
Easement		5% of OPCC		$109,000
Feasibility and Site Studies		6% of OPCC		$131,000
Preliminary and Final Design		6% of OPCC		$131,000
Engineering Services During Construction		5% of OPCC		$109,000
Outside Construction Management - not used if OPCC value is < $1M		5% of OPCC		$109,000
Outside Project Management - not used if OPCC value is < $1M		3% of OPCC		$66,000
Capital Improvement Plan Total				**$2,830,000**

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SE5-1 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	568	172/LF	$97,777	$97,777
Fire Hydrants	3	5,646/EA	$16,939	$16,939
Tier 2 Dewatering	568	52.50/LF	$29,820	$29,820
Unit Cost Subtotal				$144,535
Erosion Control/Stormwater Pollution Prevention		2%		$2,891
Mobilization & Demobilization		5%		$7,227
Subtotal				$154,653
Contingency		35%		$54,130
Opinion of Probable Construction Cost (rounded)				**$210,000**
Feasibility and Site Studies		9% of OPCC		$19,000
Preliminary and Final Design		9% of OPCC		$19,000
Engineering Services During Construction		5% of OPCC		$11,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$0
Capital Improvement Plan Total				**$260,000**

C20-4 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 16" (Trenchless J&B)	288	$791/LF	$227,829	$227,829
Fire Hydrants	2	$5,646/EA	$11,292	$11,292
Unit Cost Subtotal				$239,122
Erosion Control/Stormwater Pollution Prevention		2%		$4,782
Mobilization & Demobilization		5%		$11,956
Subtotal				$255,860
Contingency		35%		$89,560
Opinion of Probable Construction Cost (rounded)				**$350,000**
Feasibility and Site Studies		9% of OPCC		$32,000
Preliminary and Final Design		9% of OPCC		$32,000
Engineering Services During Construction		5% of OPCC		$18,000
Outside Construction Management - not used if OPCC value is < $1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is < $1M		3% of OPCC		$0
Capital Improvement Plan Total				**$440,000**

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E5-3 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 16"	3,600	224/LF	$806,057	$806,057
Water Distribution 16" (Undeveloped)	503	158/LF	$79,321	$79,321
Water Distribution 16" (Trenchless J&B)	500	791/LF	$395,537	$395,537
Fire Hydrants	13	5,646/EA	$73,401	$73,401
Tier 1 Dewatering	630	105/LF	$66,150	$66,150
Tier 2 Dewatering	3,973	52.50/LF	$208,583	$208,583
Unit Cost Subtotal				$1,629,049
Erosion Control/Stormwater Pollution Prevention		2%		$32,581
Mobilization & Demobilization		5%		$81,452
Subtotal				$1,743,082
Contingency		35%		$610,080
Opinion of Probable Construction Cost (rounded)				**$2,360,000**
Feasibility and Site Studies		6% of OPCC		$142,000
Preliminary and Final Design		6% of OPCC		$142,000
Engineering Services During Construction		5% of OPCC		$118,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$118,000
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$71,000
Capital Improvement Plan Total				**$2,960,000**

SC5-9 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 12"	4,018	184/LF	$740,034	$740,034
Fire Hydrants	12	5,646/EA	$67,754	$67,754
Unit Cost Subtotal				$807,789
Erosion Control/Stormwater Pollution Prevention		2%		$16,156
Mobilization & Demobilization		5%		$40,389
Subtotal				$864,334
Contingency		35%		$302,520
Opinion of Probable Construction Cost (rounded)				**$1,170,000**
Easement		5% of OPCC		$59,000
Feasibility and Site Studies		6% of OPCC		$71,000
Preliminary and Final Design		6% of OPCC		$71,000
Engineering Services During Construction		5% of OPCC		$59,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$59,000
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$36,000
Capital Improvement Plan Total				**$1,530,000**

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E20-1 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 16"	1,106	$224/LF	$247,639	$247,639
Water Distribution 16" (Trenchless J&B)	400	$791/LF	$316,430	$316,430
Fire Hydrants	5	$5,646/EA	$28,231	$28,231
Tier 1 Dewatering	1506	$105/LF	$158,130	$158,130
Unit Cost Subtotal				$750,429
Erosion Control/Stormwater Pollution Prevention		2%		$15,009
Mobilization & Demobilization		5%		$37,521
Subtotal				$802,960
Contingency		35%		$281,040
Opinion of Probable Construction Cost (rounded)				**$1,090,000**
Feasibility and Site Studies		6% of OPCC		$66,000
Preliminary and Final Design		6% of OPCC		$66,000
Engineering Services During Construction		5% of OPCC		$55,000
Outside Construction Management - not used if OPCC value is < $1M		5% of OPCC		$55,000
Outside Project Management - not used if OPCC value is < $1M		3% of OPCC		$33,000
Capital Improvement Plan Total				**$1,370,000**

E20-2 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 16"	715	$224/LF	$160,092	$160,092
Water Distribution 16" (Trenchless J&B)	250	$791/LF	$197,769	$197,769
Water Distribution 16" (Trenchless HDD)	250	$944/LF	$235,907	$235,907
Fire Hydrants	5	$5,646/EA	$28,231	$28,231
Tier 1 Dewatering	1215	$105/LF	$127,575	$127,575
Unit Cost Subtotal				$749,573
Erosion Control/Stormwater Pollution Prevention		2%		$14,991
Mobilization & Demobilization		5%		$37,479
Subtotal				$802,044
Contingency		35%		$280,720
Opinion of Probable Construction Cost (rounded)				**$1,090,000**
Feasibility and Site Studies		6% of OPCC		$66,000
Preliminary and Final Design		6% of OPCC		$66,000
Engineering Services During Construction		5% of OPCC		$55,000
Outside Construction Management - not used if OPCC value is < $1M		5% of OPCC		$55,000
Outside Project Management - not used if OPCC value is < $1M		3% of OPCC		$33,000
Capital Improvement Plan Total				**$1,370,000**

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C20-5 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 16" (Undeveloped)	705	$158/LF	$111,176	$111,176
Fire Hydrants	3	$5,646/EA	$16,939	$16,939
Tier 1 Dewatering	705	$105/LF	$74,025	$74,025
Unit Cost Subtotal				$202,140
Erosion Control/Stormwater Pollution Prevention		2%		$4,043
Mobilization & Demobilization		5%		$10,107
Subtotal				$216,289
Contingency		35%		$75,710
Opinion of Probable Construction Cost (rounded)				**$300,000**
Feasibility and Site Studies		9% of OPCC		$27,000
Preliminary and Final Design		9% of OPCC		$27,000
Engineering Services During Construction		5% of OPCC		$15,000
Outside Construction Management - not used if OPCC value is < $1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is < $1M		3% of OPCC		$0
Capital Improvement Plan Total				**$370,000**

W20-2 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 16"	70	$224/LF	$15,673	$15,673
Water Transmission 36"	17,039	$421/LF	$7,178,979	$7,178,979
Water Transmission 36" (Trenchless J&B)	500	$1,960/LF	$979,813	$979,813
Water Transmission 48"	439	$566/LF	$248,378	$248,378
Fire Hydrants	2	$5,646/EA	$11,292	$11,292
Tier 1 Dewatering	986	$105/LF	$103,530	$103,530
Unit Cost Subtotal				$8,537,665
Erosion Control/Stormwater Pollution Prevention		2%		$170,753
Mobilization & Demobilization		5%		$426,883
Subtotal				$9,135,301
Contingency		35%		$3,197,360
Opinion of Probable Construction Cost (rounded)				**$12,340,000**
Easement		5% of OPCC		$617,000
Feasibility and Site Studies		5% of OPCC		$617,000
Preliminary and Final Design		5% of OPCC		$617,000
Engineering Services During Construction		5% of OPCC		$617,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$617,000
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$371,000
Capital Improvement Plan Total				**$15,800,000**

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C20-2A OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 20"	4,522	$289/LF	$1,306,449	$1,306,449
Water Distribution 20" (Trenchless J&B)	250	$1,105/LF	$276,364	$276,364
Water Distribution 20" (Trenchless HDD)	250	$1,107/LF	$276,862	$276,862
Fire Hydrants	14	$5,646/EA	$79,047	$79,047
Tier 1 Dewatering	4322	$105/LF	$453,810	$453,810
Tier 2 Dewatering	700	$52.50/LF	$36,750	$36,750
Unit Cost Subtotal				$2,429,282
Erosion Control/Stormwater Pollution Prevention		2%		$48,586
Mobilization & Demobilization		5%		$121,464
Subtotal				$2,599,332
Contingency		35%		$909,770
Opinion of Probable Construction Cost (rounded)				**$3,510,000**
Easement		5% of OPCC		$176,000
Feasibility and Site Studies		6% of OPCC		$211,000
Preliminary and Final Design		6% of OPCC		$211,000
Engineering Services During Construction		5% of OPCC		$176,000
Outside Construction Management - not used if OPCC value is < $1M		5% of OPCC		$176,000
Outside Project Management - not used if OPCC value is < $1M		3% of OPCC		$106,000
Capital Improvement Plan Total				**$4,570,000**

SE5-2 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	1,324	172/LF	$227,916	$227,916
Fire Hydrants	5	5,646/EA	$28,231	$28,231
Tier 2 Dewatering	1,324	52.50/LF	$69,510	$69,510
Unit Cost Subtotal				$325,657
Erosion Control/Stormwater Pollution Prevention		2%		$6,513
Mobilization & Demobilization		5%		$16,283
Subtotal				$348,453
Contingency		35%		$121,960
Opinion of Probable Construction Cost (rounded)				**$480,000**
Feasibility and Site Studies		9% of OPCC		$44,000
Preliminary and Final Design		9% of OPCC		$44,000
Engineering Services During Construction		5% of OPCC		$24,000
Outside Construction Management - not used if OPCC value is <$1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is <$1M		3% of OPCC		$0
Capital Improvement Plan Total				**$600,000**

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C20-6 OPCC and CIP Total

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 12"	405	$184/LF	$74,593	$74,593
Fire Hydrants	3	$5,646/EA	$16,939	$16,939
Tier 2 Dewatering	405	$52.50/LF	$21,263	$21,263
Unit Cost Subtotal				$112,794
Erosion Control/Stormwater Pollution Prevention		2%		$2,256
Mobilization & Demobilization		5%		$5,640
Subtotal				$120,690
Contingency		35%		$42,250
Opinion of Probable Construction Cost (rounded)				**$170,000**
Feasibility and Site Studies		9% of OPCC		$16,000
Preliminary and Final Design		9% of OPCC		$16,000
Engineering Services During Construction		5% of OPCC		$9,000
Outside Construction Management - not used if OPCC value is < $1M		5% of OPCC		$0
Outside Project Management - not used if OPCC value is < $1M		3% of OPCC		$0
Capital Improvement Plan Total				**$220,000**

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B4 – Opinion of Probable Construction Costs: 5-Year Development Projects

OPCCs for 5-Year Development projects are presented (generally going from west to east and from north to south) in pages **B3-1** through **B3-7**. Given the Development projects are not funded by the City, OPCC estimates for each project only include the unit cost item of pipe lengths based on pipe size. OPCCs do not include additional line item units such as fire hydrants, PRV stations, dewatering, and crossings. August 2020 dollars from ENR-CCI was used for project OPCCs.

W5-2 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	49,105	$172/LF	$8,453,027	$8,453,027
Water Distribution 12"	23,608	$184/LF	$4,348,116	$4,348,116
Unit Cost Subtotal				$12,801,144
Erosion Control/Stormwater Pollution Prevention		2%		$256,023
Mobilization & Demobilization		5%		$640,057
Subtotal				$13,697,224
Contingency		35%		$4,794,030
Opinion of Probable Construction Cost (rounded)				**$18,500,000**
Easement		5% of OPCC		$925,000

W5-3 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	4,303	$172/LF	$740,727	$740,727
Water Distribution 12"	12,256	$184/LF	$2,257,307	$2,257,307
Water Distribution 16"	4,777	$224/LF	$1,069,593	$1,069,593
Unit Cost Subtotal				$4,067,627
Erosion Control/Stormwater Pollution Prevention		2%		$81,353
Mobilization & Demobilization		5%		$203,381
Subtotal				$4,352,361
Contingency		35%		$1,523,330
Opinion of Probable Construction Cost (rounded)				**$5,880,000**
Easement		5% of OPCC		$294,000

W5-4 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	2,858	$172/LF	$491,982	$491,982
Water Distribution 12"	12,280	$184/LF	$2,261,728	$2,261,728
Water Distribution 16"	3,988	$224/LF	$892,932	$892,932
Unit Cost Subtotal				$3,646,642
Erosion Control/Stormwater Pollution Prevention		2%		$72,933
Mobilization & Demobilization		5%		$182,332
Subtotal				$3,901,907
Contingency		35%		$1,365,670
Opinion of Probable Construction Cost (rounded)				**$5,270,000**
Easement		5% of OPCC		$264,000

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W5-5 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	403	$172/LF	$69,373	$69,373
Water Distribution 16"	86	$224/LF	$19,256	$19,256
Unit Cost Subtotal				$88,629
Erosion Control/Stormwater Pollution Prevention		2%		$1,773
Mobilization & Demobilization		5%		$4,431
Subtotal				$94,833
Contingency		35%		$33,200
Opinion of Probable Construction Cost (rounded)				**$130,000**
Easement		5% of OPCC		$7,000

W5-6 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 12"	2,478	$184/LF	$456,397	$456,397
Unit Cost Subtotal				$456,397
Erosion Control/Stormwater Pollution Prevention		2%		$9,128
Mobilization & Demobilization		5%		$22,820
Subtotal				$488,345
Contingency		35%		$170,930
Opinion of Probable Construction Cost (rounded)				**$660,000**
Easement		5% of OPCC		$33,000

W5-7 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	1,521	$172/LF	$261,828	$261,828
Unit Cost Subtotal				$261,828
Erosion Control/Stormwater Pollution Prevention		2%		$5,237
Mobilization & Demobilization		5%		$13,091
Subtotal				$280,156
Contingency		35%		$98,060
Opinion of Probable Construction Cost (rounded)				**$380,000**
Easement		5% of OPCC		$19,000

W5-8 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 16"	3,982	$224/LF	$891,589	$891,589
Unit Cost Subtotal				$891,589
Erosion Control/Stormwater Pollution Prevention		2%		$17,832
Mobilization & Demobilization		5%		$44,579
Subtotal				$954,000
Contingency		35%		$333,910
Opinion of Probable Construction Cost (rounded)				**$1,290,000**
Easement		5% of OPCC		$65,000

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W5-10 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 16"	7,248	$224/LF	$1,622,862	$1,622,862
Unit Cost Subtotal				$1,622,862
Erosion Control/Stormwater Pollution Prevention		2%		$32,457
Mobilization & Demobilization		5%		$81,143
Subtotal				$1,736,463
Contingency		35%		$607,770
Opinion of Probable Construction Cost (rounded)				**$2,350,000**

C5-3 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	6,954	$172/LF	$1,197,075	$1,197,075
Water Distribution 12"	36,091	$184/LF	$6,647,232	$6,647,232
Water Distribution 16"	8,677	$224/LF	$1,942,822	$1,942,822
Unit Cost Subtotal				$9,787,129
Erosion Control/Stormwater Pollution Prevention		2%		$195,743
Mobilization & Demobilization		5%		$489,356
Subtotal				$10,472,228
Contingency		35%		$3,665,280
Opinion of Probable Construction Cost (rounded)				**$14,140,000**
Easement		5% of OPCC		$707,000

C5-4 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	11,380	$172/LF	$1,958,975	$1,958,975
Water Distribution 12"	10,330	$184/LF	$1,902,577	$1,902,577
Unit Cost Subtotal				$3,861,552
Erosion Control/Stormwater Pollution Prevention		2%		$77,231
Mobilization & Demobilization		5%		$193,078
Subtotal				$4,131,860
Contingency		35%		$1,446,160
Opinion of Probable Construction Cost (rounded)				**$5,580,000**
Easement		5% of OPCC		$279,000

C5-6 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 16"	8,331	$224/LF	$1,865,351	$1,865,351
Unit Cost Subtotal				$1,865,351
Erosion Control/Stormwater Pollution Prevention		2%		$37,307
Mobilization & Demobilization		5%		$93,268
Subtotal				$1,995,926
Contingency		35%		$698,580
Opinion of Probable Construction Cost (rounded)				**$2,700,000**
Easement		5% of OPCC		$135,000

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C5-7 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 12"	4,302	$184/LF	$792,341	$792,341
Unit Cost Subtotal				$792,341
Erosion Control/Stormwater Pollution Prevention		2%		$15,847
Mobilization & Demobilization		5%		$39,617
Subtotal				$847,805
Contingency		35%		$296,740
Opinion of Probable Construction Cost (rounded)				**$1,150,000**
Easement		5% of OPCC		$58,000

C5-8 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	2,485	$172/LF	$427,773	$427,773
Unit Cost Subtotal				$427,773
Erosion Control/Stormwater Pollution Prevention		2%		$8,555
Mobilization & Demobilization		5%		$21,389
Subtotal				$457,717
Contingency		35%		$160,210
Opinion of Probable Construction Cost (rounded)				**$620,000**
Easement		5% of OPCC		$31,000

C5-9 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 16"	3,099	$224/LF	$693,881	$693,881
Unit Cost Subtotal				$693,881
Erosion Control/Stormwater Pollution Prevention		2%		$13,878
Mobilization & Demobilization		5%		$34,694
Subtotal				$742,453
Contingency		35%		$259,860
Opinion of Probable Construction Cost (rounded)				**$1,010,000**
Easement		5% of OPCC		$51,000

C5-10 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	3,652	$172/LF	$628,662	$628,662
Unit Cost Subtotal				$628,662
Erosion Control/Stormwater Pollution Prevention		2%		$12,573
Mobilization & Demobilization		5%		$31,433
Subtotal				$672,669
Contingency		35%		$235,440
Opinion of Probable Construction Cost (rounded)				**$910,000**
Easement		5% of OPCC		$46,000

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E5-7 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	21,703	$172/LF	$3,735,995	$3,735,995
Water Distribution 12"	9,211	$184/LF	$1,696,480	$1,696,480
Unit Cost Subtotal				$5,432,475
Erosion Control/Stormwater Pollution Prevention		2%		$108,650
Mobilization & Demobilization		5%		$271,624
Subtotal				$5,812,749
Contingency		35%		$2,034,470
Opinion of Probable Construction Cost (rounded)				**$7,850,000**
Easement		5% of OPCC		$393,000

SC5-2 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 12"	8,130	$184/LF	$1,497,382	$1,497,382
Water Distribution 16"	3,145	$224/LF	$704,181	$704,181
Unit Cost Subtotal				$2,201,562
Erosion Control/Stormwater Pollution Prevention		2%		$44,031
Mobilization & Demobilization		5%		$110,078
Subtotal				$2,355,672
Contingency		35%		$824,490
Opinion of Probable Construction Cost (rounded)				**$3,190,000**
Easement		5% of OPCC		$160,000

SC5-3 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	870	$172/LF	$149,763	$149,763
Water Distribution 12"	10,733	$184/LF	$1,976,802	$1,976,802
Unit Cost Subtotal				$2,126,565
Erosion Control/Stormwater Pollution Prevention		2%		$42,531
Mobilization & Demobilization		5%		$106,328
Subtotal				$2,275,425
Contingency		35%		$796,400
Opinion of Probable Construction Cost (rounded)				**$3,080,000**
Easement		5% of OPCC		$154,000

SC5-4 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	3,950	$172/LF	$679,960	$679,960
Unit Cost Subtotal				$679,960
Erosion Control/Stormwater Pollution Prevention		2%		$13,599
Mobilization & Demobilization		5%		$33,998
Subtotal				$727,558
Contingency		35%		$254,650
Opinion of Probable Construction Cost (rounded)				**$990,000**
Easement		5% of OPCC		$50,000

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SC5-5 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	6,755	$172/LF	$1,162,818	$1,162,818
Water Distribution 12"	2,984	$184/LF	$549,592	$549,592
Unit Cost Subtotal				$1,712,411
Erosion Control/Stormwater Pollution Prevention		2%		$34,248
Mobilization & Demobilization		5%		$85,621
Subtotal				$1,832,280
Contingency		35%		$641,300
Opinion of Probable Construction Cost (rounded)				**$2,480,000**
Easement		5% of OPCC		$124,000

SC5-6 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	3,323	$172/LF	$572,027	$572,027
Unit Cost Subtotal				$572,027
Erosion Control/Stormwater Pollution Prevention		2%		$11,441
Mobilization & Demobilization		5%		$28,601
Subtotal				$612,069
Contingency		35%		$214,230
Opinion of Probable Construction Cost (rounded)				**$830,000**
Easement		5% of OPCC		$42,000

SC5-7 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 16"	1,892	$224/LF	$423,628	$423,628
Unit Cost Subtotal				$423,628
Erosion Control/Stormwater Pollution Prevention		2%		$8,473
Mobilization & Demobilization		5%		$21,181
Subtotal				$453,282
Contingency		35%		$158,650
Opinion of Probable Construction Cost (rounded)				**$620,000**
Easement		5% of OPCC		$31,000

SE5-4 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	4,018	$172/LF	$691,666	$691,666
Unit Cost Subtotal				$691,666
Erosion Control/Stormwater Pollution Prevention		2%		$13,833
Mobilization & Demobilization		5%		$34,583
Subtotal				$740,083
Contingency		35%		$259,030
Opinion of Probable Construction Cost (rounded)				**$1,000,000**
Easement		5% of OPCC		$50,000

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B5 – Opinion of Probable Construction Costs: 20-Year Development Projects

OPCCs for 20-Year Development projects are presented (generally going from west to east and from north to south) in pages **B4-1** through **B4-7**. Given the Development projects are not funded by the City, OPCC estimates for each project only include the unit cost item of pipe lengths based on pipe size. OPCCs do not include additional line item units such as fire hydrants, PRV stations, dewatering, and crossings. August 2020 dollars from ENR-CCI was used for project OPCCs.

W20-3 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	11	$172/LF	$1,894	$1,894
Water Distribution 20"	5,665	$289/LF	$1,636,672	$1,636,672
Unit Cost Subtotal				$1,638,566
Erosion Control/Stormwater Pollution Prevention		2%		$32,771
Mobilization & Demobilization		5%		$81,928
Subtotal				$1,753,265
Contingency		35%		$613,650
Opinion of Probable Construction Cost (rounded)				**$2,370,000**

W20-4 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 12"	3,300	$184/LF	$607,793	$607,793
Unit Cost Subtotal				$607,793
Erosion Control/Stormwater Pollution Prevention		2%		$12,156
Mobilization & Demobilization		5%		$30,390
Subtotal				$650,339
Contingency		35%		$227,620
Opinion of Probable Construction Cost (rounded)				**$880,000**
Easement		5% of OPCC		$44,000

W20-5 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	1,937	$172/LF	$333,439	$333,439
Water Distribution 12"	1,671	$184/LF	$307,764	$307,764
Unit Cost Subtotal				$641,203
Erosion Control/Stormwater Pollution Prevention		2%		$12,824
Mobilization & Demobilization		5%		$32,060
Subtotal				$686,087
Contingency		35%		$240,140
Opinion of Probable Construction Cost (rounded)				**$930,000**
Easement		5% of OPCC		$47,000

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W20-6 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	1,908	$172/LF	$328,447	$328,447
Water Distribution 12"	7,060	$184/LF	$1,300,309	$1,300,309
Unit Cost Subtotal				$1,628,756
Erosion Control/Stormwater Pollution Prevention		2%		$32,575
Mobilization & Demobilization		5%		$81,438
Subtotal				$1,742,769
Contingency		35%		$609,970
Opinion of Probable Construction Cost (rounded)				**$2,360,000**
Easement		5% of OPCC		$118,000

W20-7 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 12"	1,702	$184/LF	$313,474	$313,474
Unit Cost Subtotal				$313,474
Erosion Control/Stormwater Pollution Prevention		2%		$6,269
Mobilization & Demobilization		5%		$15,674
Subtotal				$335,417
Contingency		35%		$117,400
Opinion of Probable Construction Cost (rounded)				**$460,000**
Easement		5% of OPCC		$23,000

W20-8 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	21,163	$172/LF	$3,643,039	$3,643,039
Water Distribution 12"	11,652	$184/LF	$2,146,063	$2,146,063
Water Distribution 16"	6,025	$224/LF	$1,349,027	$1,349,027
Water Transmission 24"	360	$315/LF	$113,541	$113,541
Unit Cost Subtotal				$7,251,670
Erosion Control/Stormwater Pollution Prevention		2%		$145,033
Mobilization & Demobilization		5%		$362,583
Subtotal				$7,759,286
Contingency		35%		$2,715,760
Opinion of Probable Construction Cost (rounded)				**$10,480,000**
Easement		5% of OPCC		$524,000

C20-7 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	4,253	$172/LF	$732,119	$732,119
Water Distribution 16"	1,312	$224/LF	$293,763	$293,763
Unit Cost Subtotal				$1,025,883
Erosion Control/Stormwater Pollution Prevention		2%		$20,518
Mobilization & Demobilization		5%		$51,294
Subtotal				$1,097,694
Contingency		35%		$384,200
Opinion of Probable Construction Cost (rounded)				**$1,490,000**
Easement		5% of OPCC		$75,000

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C20-8 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 12"	6,656	$184/LF	$1,225,901	$1,225,901
Water Distribution 16"	4,571	$224/LF	$1,023,469	$1,023,469
Unit Cost Subtotal				$2,249,370
Erosion Control/Stormwater Pollution Prevention		2%		$44,987
Mobilization & Demobilization		5%		$112,468
Subtotal				$2,406,825
Contingency		35%		$842,390
Opinion of Probable Construction Cost (rounded)				**$3,250,000**
Easement		5% of OPCC		$163,000

C20-9 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 12"	10,506	$184/LF	$1,934,993	$1,934,993
Unit Cost Subtotal				$1,934,993
Erosion Control/Stormwater Pollution Prevention		2%		$38,700
Mobilization & Demobilization		5%		$96,750
Subtotal				$2,070,442
Contingency		35%		$724,660
Opinion of Probable Construction Cost (rounded)				**$2,800,000**
Easement		5% of OPCC		$140,000

C20-10 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	9,192	$172/LF	$1,582,328	$1,582,328
Unit Cost Subtotal				$1,582,328
Erosion Control/Stormwater Pollution Prevention		2%		$31,647
Mobilization & Demobilization		5%		$79,116
Subtotal				$1,693,091
Contingency		35%		$592,590
Opinion of Probable Construction Cost (rounded)				**$2,290,000**
Easement		5% of OPCC		$115,000

C20-11 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	4,252	$172/LF	$731,947	$731,947
Water Distribution 16"	264	$224/LF	$59,111	$59,111
Unit Cost Subtotal				$791,058
Erosion Control/Stormwater Pollution Prevention		2%		$15,821
Mobilization & Demobilization		5%		$39,553
Subtotal				$846,432
Contingency		35%		$296,260
Opinion of Probable Construction Cost (rounded)				**$1,150,000**

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E20-3 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	4,338	$172/LF	$746,751	$746,751
Water Distribution 12"	3,365	$184/LF	$619,765	$619,765
Unit Cost Subtotal				$1,366,516
Erosion Control/Stormwater Pollution Prevention		2%		$27,330
Mobilization & Demobilization		5%		$68,326
Subtotal				$1,462,173
Contingency		35%		$511,770
Opinion of Probable Construction Cost (rounded)				**$1,980,000**
Easement		5% of OPCC		$99,000

E20-4 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	3,003	$172/LF	$516,942	$516,942
Water Distribution 12"	3,626	$184/LF	$667,836	$667,836
Water Distribution 16"	1,400	$224/LF	$313,467	$313,467
Unit Cost Subtotal				$1,498,245
Erosion Control/Stormwater Pollution Prevention		2%		$29,965
Mobilization & Demobilization		5%		$74,912
Subtotal				$1,603,122
Contingency		35%		$561,100
Opinion of Probable Construction Cost (rounded)				**$2,170,000**
Easement		5% of OPCC		$109,000

E20-5 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	54,255	$172/LF	$9,339,558	$9,339,558
Water Distribution 12"	33,327	$184/LF	$6,138,160	$6,138,160
Water Distribution 16"	22,867	$224/LF	$5,120,032	$5,120,032
Unit Cost Subtotal				$20,597,749
Erosion Control/Stormwater Pollution Prevention		2%		$411,955
Mobilization & Demobilization		5%		$1,029,887
Subtotal				$22,039,592
Contingency		35%		$7,713,860
Opinion of Probable Construction Cost (rounded)				**$29,760,000**
Easement		5% of OPCC		$1,488,000

E20-6 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	45,734	$172/LF	$7,872,737	$7,872,737
Water Distribution 12"	5,875	$184/LF	$1,082,056	$1,082,056
Unit Cost Subtotal				$8,954,793
Erosion Control/Stormwater Pollution Prevention		2%		$179,096
Mobilization & Demobilization		5%		$447,740
Subtotal				$9,581,629
Contingency		35%		$3,353,580
Opinion of Probable Construction Cost (rounded)				**$12,940,000**
Easement		5% of OPCC		$647,000

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NC20-1 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	124,711	$172/LF	$21,467,987	$21,467,987
Water Distribution 12"	79,826	$184/LF	$14,702,335	$14,702,335
Water Distribution 16"	77,948	$224/LF	$17,452,934	$17,452,934
Water Distribution 20"	4,065	$289/LF	$1,174,417	$1,174,417
Water Transmission 24"	36258	$315/LF	$11,435,513	$11,435,513
Unit Cost Subtotal				$66,233,185
Erosion Control/Stormwater Pollution Prevention		2%		$1,324,664
Mobilization & Demobilization		5%		$3,311,659
Subtotal				$70,869,508
Contingency		35%		$24,804,330
Opinion of Probable Construction Cost (rounded)				**$95,680,000**
Easement		5% of OPCC		$4,784,000

NE20-1 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	27,192	$172/LF	$4,680,882	$4,680,882
Water Distribution 12"	32,981	$184/LF	$6,074,433	$6,074,433
Water Distribution 16"	19,959	$224/LF	$4,468,916	$4,468,916
Unit Cost Subtotal				$15,224,232
Erosion Control/Stormwater Pollution Prevention		2%		$304,485
Mobilization & Demobilization		5%		$761,212
Subtotal				$16,289,928
Contingency		35%		$5,701,480
Opinion of Probable Construction Cost (rounded)				**$22,000,000**
Easement		5% of OPCC		$1,100,000

NE20-2 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	14,515	$172/LF	$2,498,639	$2,498,639
Unit Cost Subtotal				$2,498,639
Erosion Control/Stormwater Pollution Prevention		2%		$49,973
Mobilization & Demobilization		5%		$124,932
Subtotal				$2,673,544
Contingency		35%		$935,750
Opinion of Probable Construction Cost (rounded)				**$3,610,000**
Easement		5% of OPCC		$181,000

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SW20-1 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	11,345	$172/LF	$1,952,950	$1,952,950
Water Distribution 12"	9,920	$184/LF	$1,827,063	$1,827,063
Unit Cost Subtotal				$3,780,013
Erosion Control/Stormwater Pollution Prevention		2%		$75,600
Mobilization & Demobilization		5%		$189,001
Subtotal				$4,044,614
Contingency		35%		$1,415,620
Opinion of Probable Construction Cost (rounded)				**$5,470,000**
Easement		5% of OPCC		$274,000

SW20-2 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	5,306	$172/LF	$913,385	$913,385
Water Distribution 16"	6,348	$224/LF	$1,421,348	$1,421,348
Water Distribution 20"	608	$289/LF	$175,657	$175,657
Unit Cost Subtotal				$2,510,390
Erosion Control/Stormwater Pollution Prevention		2%		$50,208
Mobilization & Demobilization		5%		$125,519
Subtotal				$2,686,117
Contingency		35%		$940,150
Opinion of Probable Construction Cost (rounded)				**$3,630,000**
Easement		5% of OPCC		$182,000

SW20-3 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	29,091	$172/LF	$5,007,780	$5,007,780
Water Distribution 12"	4,887	$184/LF	$900,087	$900,087
Water Distribution 16"	10,549	$224/LF	$2,361,972	$2,361,972
Unit Cost Subtotal				$8,269,838
Erosion Control/Stormwater Pollution Prevention		2%		$165,397
Mobilization & Demobilization		5%		$413,492
Subtotal				$8,848,727
Contingency		35%		$3,097,060
Opinion of Probable Construction Cost (rounded)				**$11,950,000**
Easement		5% of OPCC		$598,000

SW20-4 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	30,440	$172/LF	$5,239,999	$5,239,999
Water Distribution 12"	10,357	$184/LF	$1,907,550	$1,907,550
Water Distribution 16"	6,752	$224/LF	$1,511,805	$1,511,805
Unit Cost Subtotal				$8,659,354
Erosion Control/Stormwater Pollution Prevention		2%		$173,187
Mobilization & Demobilization		5%		$432,968
Subtotal				$9,265,509
Contingency		35%		$3,242,930
Opinion of Probable Construction Cost (rounded)				**$12,510,000**
Easement		5% of OPCC		$626,000

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SW20-5 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	15,353	$172/LF	$2,642,894	$2,642,894
Water Distribution 12"	8,400	$184/LF	$1,547,110	$1,547,110
Water Distribution 16"	7,368	$224/LF	$1,649,731	$1,649,731
Unit Cost Subtotal				$5,839,735
Erosion Control/Stormwater Pollution Prevention		2%		$116,795
Mobilization & Demobilization		5%		$291,987
Subtotal				$6,248,517
Contingency		35%		$2,186,990
Opinion of Probable Construction Cost (rounded)				**$8,440,000**
Easement		5% of OPCC		$422,000

SW20-6 OPCC

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 8"	20,973	$172/LF	$3,610,332	$3,610,332
Water Distribution 12"	1,489	$184/LF	$274,244	$274,244
Water Distribution 16"	2,497	$224/LF	$559,090	$559,090
Unit Cost Subtotal				$4,443,666
Erosion Control/Stormwater Pollution Prevention		2%		$88,873
Mobilization & Demobilization		5%		$222,183
Subtotal				$4,754,722
Contingency		35%		$1,664,160
Opinion of Probable Construction Cost (rounded)				**$6,420,000**
Easement		5% of OPCC		$321,000

SC20-1 OPCC[1]

Item	Quantity	Unit Cost	Extended Cost	Total Cost
Water Distribution 16"	8,786	$224/LF	$1,967,228	$1,967,228
Unit Cost Subtotal				$1,967,228
Erosion Control/Stormwater Pollution Prevention		2%		$39,345
Mobilization & Demobilization		5%		$98,361
Subtotal				$2,104,934
Contingency		35%		$736,730
Opinion of Probable Construction Cost (rounded)				**$2,850,000**
Easement		5% of OPCC		$143,000

[1] Although originally considered as a 5-year development project, it was determined that this project was unlikely to occur in the 5-year planning horizon and consequently shifted to the 20-year planning horizon.

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B6 – Annual Funding Requirements for City Water CIP Projects (2020 – 2042)

Project Names	Planning Start Year	Design Start Year	Construction Start Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041
C5-14	2021	2022	2022	$ -	$ 67,000	$ 844,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
C5-12C	2021	2022	2023	$ -	$ 5,000	$ 5,000	$ 53,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
C20-2B	2021	2022	2023	$ -	$ 339,000	$ 185,000	$ 1,740,500	$ 1,740,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
NC5-2	2022	2023	2024	$ -	$ -	$ 30,000	$ 30,000	$ 347,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
C5-12B	2022	2023	2024	$ -	$ -	$ 26,000	$ 26,000	$ 294,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
W5-1	2022	2023	2024	$ -	$ -	$ 680,000	$ 371,000	$ 2,324,333	$ 2,324,333	$ 2,324,333	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
NC5-1	2024	2025	2026	$ -	$ -	$ -	$ -	$ 195,000	$ 195,000	$ 1,836,500	$ 1,836,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
C5-1	2025	2026	2027	$ -	$ -	$ -	$ -	$ -	$ 34,000	$ 34,000	$ 389,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
C5-2	2025	2026	2027	$ -	$ -	$ -	$ -	$ -	$ 51,000	$ 33,000	$ 378,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
C5-13B	2025	2026	2027	$ -	$ -	$ -	$ -	$ -	$ 27,000	$ 27,000	$ 315,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
C5-13A	2025	2026	2027	$ -	$ -	$ -	$ -	$ -	$ 20,000	$ 20,000	$ 231,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
C5-12A	2025	2026	2027	$ -	$ -	$ -	$ -	$ -	$ 22,000	$ 22,000	$ 252,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
E5-5	2026	2027	2028	$ -	$ -	$ -	$ -	$ -	$ -	$ 42,000	$ 27,000	$ 305,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
E5-2C	2026	2027	2028	$ -	$ -	$ -	$ -	$ -	$ -	$ 20,000	$ 13,000	$ 147,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
E5-2A	2026	2027	2028	$ -	$ -	$ -	$ -	$ -	$ -	$ 31,000	$ 20,000	$ 231,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
E5-2B	2026	2027	2028	$ -	$ -	$ -	$ -	$ -	$ -	$ 56,000	$ 36,000	$ 410,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
SC5-1	2026	2027	2028	$ -	$ -	$ -	$ -	$ -	$ -	$ 13,000	$ 13,000	$ 147,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
C20-3	2027	2028	2029	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 240,000	$ 131,000	$ 1,226,500	$ 1,226,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
W20-1	2027	2028	2029	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,082,000	$ 541,000	$ 3,056,750	$ 3,056,750	$ 3,056,750	$ 3,056,750	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
E5-6	2027	2028	2029	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 152,000	$ 152,000	$ 1,424,000	$ 1,424,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
C20-1	2027	2028	2029	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 232,000	$ 232,000	$ 2,181,000	$ 2,181,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
C20-4	2028	2029	2030	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 32,000	$ 32,000	$ 368,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
SE5-1	2028	2029	2030	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 19,000	$ 19,000	$ 221,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
SC5-9	2029	2030	2031	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 130,000	$ 71,000	$ 661,500	$ 661,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
E5-3	2029	2030	2031	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 142,000	$ 142,000	$ 1,333,500	$ 1,333,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
E20-1	2030	2031	2032	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 66,000	$ 66,000	$ 616,500	$ 616,500	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
E20-2	2032	2033	2034	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 66,000	$ 66,000	$ 616,500	$ 616,500	$ -	$ -	$ -	$ -	$ -	$ -
C20-5	2034	2035	2036	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 27,000	$ 27,000	$ 315,000	$ -	$ -	$ -	$ -	$ -
W20-2	2036	2037	2038	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,234,000	$ 617,000	$ 3,486,250	$ 3,486,250	$ 3,486,250	$ 3,486,250
C20-2A	2037	2038	2039	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 387,000	$ 211,000	$ 1,983,500	$ 1,983,500	$ -
SE5-2	2038	2039	2040	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 44,000	$ 44,000	$ 504,000	$ -
C20-6	2039	2040	2041	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 16,000	$ 16,000	$ 179,000
Grand Total				**$ -**	**$ 411,000**	**$ 1,770,000**	**$ 2,220,500**	**$ 4,900,833**	**$ 2,673,333**	**$ 4,458,833**	**$ 5,216,500**	**$ 2,347,000**	**$ 8,211,250**	**$ 8,756,250**	**$ 5,117,750**	**$ 5,734,250**	**$ 682,500**	**$ 643,500**	**$ 643,500**	**$ 1,549,000**	**$ 1,004,000**	**$ 3,741,250**	**$ 5,529,750**	**$ 5,989,750**	**$ 3,665,250**

[1] Refer to 5- and 20-year recommended improvements map in Section 5 for project locations

[2] Construction span was set based on total CIP cost estimates per project: $10M – 4 years, $5M – 3 years, $1M – 2 years, < $1M – 1 year

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Appendix C

Stakeholder Engagement

The following technical memorandum explains the methodology for stakeholder engagement factored in during the development of the WTDMP.

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Memorandum

To: *Dan Moore, P.E., City of Greeley*

From: *Shilpa Shivakumar, P.E., PMP*
Jacqueline Wesley, P.E.
Ryan Keliher, EIT
Erin Walsh, EIT

Date: *February 19, 2021*

Subject: *City of Greeley Water Transmission and Distribution Master Plan (WTDMP)*
Technical Memorandum: Stakeholder Plan (DRAFT)

The City of Greeley ("the City") has contracted CDM Smith to update their water, sewer, and non-potable water master plans. The Water Transmission and Distribution Master Plan (WTDMP) will help the City provide potable water to all residents of Greeley and support larger development goals within the City. To understand regional trends and develop creative solutions, CDM Smith coordinated stakeholder engagement meetings between the City and regional stakeholders of surrounding municipalities. These meetings discussed population growth projections, future water demands, and water infrastructures needs so that of the City could integrate such information and regional stakeholder needs into the WTDMP.

This technical memorandum (TM) presents key regional stakeholders and their relationship to the City, the methodology for stakeholder engagement, summaries from individual stakeholder meetings and stakeholder RWs, and how such takeaways from the stakeholder engagement process were considered and/or integrated into the City's WTDMP.

The purpose of the stakeholder engagement process was to involve local communities in the City's WTDMP and to collaborate on regional options that benefit the area in planning for future growth. The stakeholder engagement process allowed the City to share information and consider future opportunities in which various stakeholders could support planned growth and development in the region. This stakeholder process was intended to help form a collaborative environment with the identified stakeholders. An overview of key goals is outlined below:

- Learn current estimates of population growth projects for regional stakeholders within 5-year, 20-year, and buildout planning horizons and consider resultant water demands for each planning horizon.
- Discuss regional stakeholder water infrastructure challenges and needs.

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- Provide regional stakeholders with overview of the City's WTDMP to facilitate discussion of identifying regional needs between the City and stakeholders. From discussion, come up with regional solutions to meet future water demand projections.

This TM is divided into the following sections:

- Key Stakeholders
- Level of Stakeholder Engagement
- Approach to Stakeholder Engagement
- Regional Solutions Summary
- Integration of Regional Stakeholder Needs into Master Plan

Key Stakeholders

The key stakeholders were identified based on their current system connections with the City, proximity to City boundaries, and historical interest in opportunities for shared service. For many of the stakeholders, the City has an intergovernmental agreement (IGA) in place. These includes potable water service IGAs with North Weld County Water District (North Weld), Windsor, and Garden City.

Level of Stakeholder Engagement

Stakeholder engagement tends to vary depending upon the interest of the stakeholders, potential impact on their customers and systems, and ability to contribute to the project. **Figure1** illustrates various levels of stakeholder engagement that can be achieved depending upon overall goals and objectives ranging from simply being informed to being fully a part of the decision-making process.

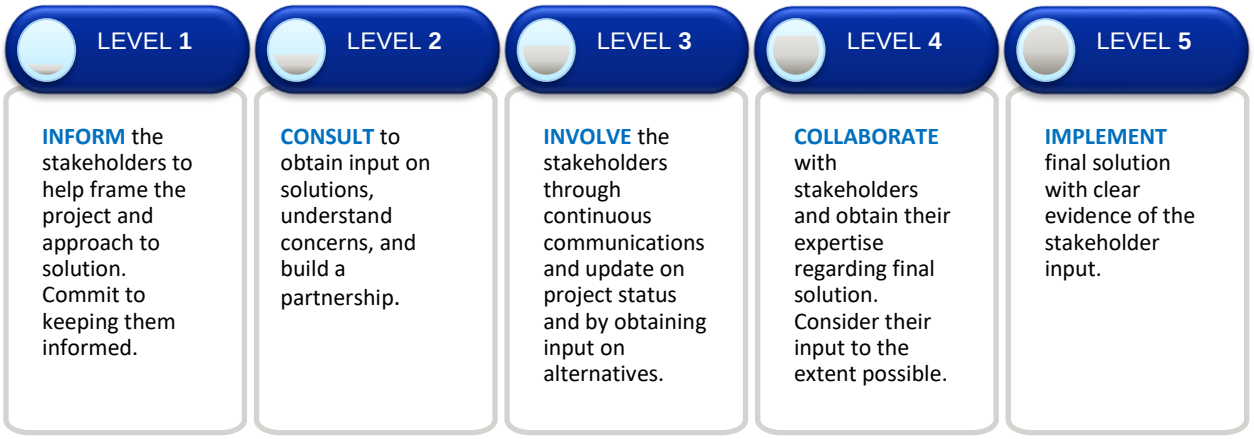

Figure 1. Stakeholder Engagement Levels

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Stakeholder planning defines the existing level of engagement for each stakeholder then develops a plan to reach the desired level of engagement. The existing level of engagement is subjectively determined by considering how active and informed each stakeholder is about the WTDMP and associated infrastructure and how much interest they have historically shown in partnering with the City for services. Stakeholders who have an existing IGA tend to be more informed than those who do not have an existing agreement in place. The perceived existing level of engagement and the City's desired level of engagement for each stakeholder is shown in **Table 1**.

Table 1 - Stakeholder Existing and Desired Level of Engagement

	Level of Engagement	
Stakeholder	Existing	Desired
Evans	1: Inform	5: Implement
Kersey	1: Inform	2: Consult
Johnstown	1: Inform	2: Consult
Windsor	2: Consult	5: Implement
Milliken	1: Inform	2: Consult
Elco	1: Inform	2: Consult
Severance	1: Inform	2: Consult
Eaton	1: Inform	2: Consult
Loveland	1: Inform	2: Consult
North Weld	1: Inform	2: Consult

To keep stakeholders engaged and aligned, it is important to recognize that they each can provide meaningful input in the WTDMP development and ensure that they are provided the opportunity to comment on regionalization and collaboration opportunities.

Approach to Stakeholder Engagement

The stakeholder plan to reach the desired level of engagement has common elements for each stakeholder: communications about ongoing master planning, sharing of information to and from the stakeholders about potential areas of collaboration, and discussion about the path forward to achieve regional or partnering projects. This was accomplished through one-on-one meetings with some stakeholders, workshops with all stakeholders, and individual outreach as required to achieve the engagement goal. CDM Smith did not participate at all the one-on-one stakeholder meetings held in 2019, only the ones shown below.

One-on-One Meetings

Milliken (meeting on June 24th, 2019)

During the one-on-one meeting between the City and Milliken, Milliken's water rates, challenges, and future needs were discussed. Specifically, Milliken shared that it needed to update its rate model and that it may need up to 650 acre-feet per year (AFY) of water from the City and/or Weld

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County in the future, although it is currently connected with Central Weld County. Milliken brought up the following challenges: (1) Although two years ago, Milliken requested an addition connection to the Gold Hill Line which is operated by the City, the pressure of 20 pounds per square inch (psi) is insufficient to include an additional connection. (2) Milliken has rights to treat its water at the City's Boyd Lake water treatment plan (WTP); however, the plant does not operate year-round and Milliken does not currently have access to the plant. As solutions to these issues, it was discussed that the City's 19 & 37 subdivision could serve water to Milliken and that the City could transfer Farmstead to Milliken. In response, the City requested that Milliken determine water demand projections for the town's future needs, maps of probable growth areas, timing of future connections, expectations desired for connections with existing water meters, and Milliken's Comprehensive Plan Map.

Kersey (meeting on July 29th, 2019)

During the one-on-one meeting between the City and Kersey, Kersey's current water demands, future needs, and solutions were discussed. Currently, Kersey has water and sewer service lines up to the Cache de la Poudre River and is growing towards the southeast and east with the area served by United Water. Additionally, Kersey has single source for water from CBT and Windy Gap and is interested in potential back-up water service connections from the City south of US 34 and County Road 49. The following potential solutions were discussed: (1) A back-up connection from North Weld via a 2" agricultural line, although such a connection could not serve as an emergency back-up connection. (2) Connection to the City via a 16" line from Greeley-Weld County Airport, although the City has not established many lines by the airport. (3) Connection to Evans with an emergency service line. (4) North Weld although the town has made changes to their housing rates structure limiting development. Kersey and the City will continue discussing which opportunity seems most feasible as Kersey expands.

Windsor Meeting No. 1 (meeting on July 31st, 2019)

During the one-on-one meeting between Windsor and the City, the two parties discussed water-related topics and action items. Specifically, Windsor is a part of the Northern Integrated Service Plan (NISP) and will receive its water supply from NISP in the future. Additionally, the City and Windsor are negotiating Windsor serving the Oklahoma District (located by Highway 34) as miscellaneous residential connections would transfer to Windsor when the development area is complete. Finally, several private properties were connected to the City's water transmission line (located by Windsor), although private wells providing water to the properties were no longer functioning properly. As a future action item, the City would like Windsor's support as it removes such tie-ins from the main water transmission line passing through the area.

Windsor Meeting No. 2 (meeting on November 11, 2020)

In the follow-up one-on-one meeting between the City and Windsor, the following points were discussed: (1) projected potable requirements for Windsor, (2) water storage, and (3) connecting transmission lines and water treatment between the City and Windsor.

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Specifically, Windsor is expecting its potable demands to increase at a minimum by 8% to 9% per year but projections are estimated to be higher once it completes its water transmission and distribution plan. The City proposed having a storage tank(s) towards the southwest of the Windsor to accommodate shared storage, as this area is expected to experience future population growth with opportunities for transmission line connection as long as water storage does not occur in residential areas. However, Windsor is interested in sharing water storage at Gold Hill. Likewise, Windsor proposed having its own 5,000-gallon storage tanks that it could share with other stakeholders towards the south of Windsor or north such as with Loveland. Regardless, maintaining pressure within the water distribution lines is a priority. For example, having 150 psi in pipes along the river bottom and 35 to 40 psi at the bottom of the storage tanks would suffice. Regarding transmission lines, Windsor is expecting to add 4,200 ft of transmission line by 2023 while adding three miles to connect to Boyd Lake WTP within the next 10 years. Potential transmission connection areas could be at Southgate with Zones 33 or 34 as potential storage and connection points.

Eaton (meeting on July 31st, 2019)

During the one-on-one meeting between Eaton and the City, Eaton discussed how it is looking for an additional emergency water connection that could be supplied from the City; however, no location was identified. Currently, Eaton has only one emergency connection with North Weld. In response, the City suggested that a new transmission line on County Road 33 which feeds the City's west tank could supply Eaton; however, Eaton would need to provide the base demand size for the potential emergency connection in order to make such consideration more feasible.

Evans (meeting on November 11, 2020)

In the one-one-one meeting between the City and Evans, several topics were discussed including Evan's new water transmission and distribution master plan, current construction, projected flows, water storage, collaboration, and water treatment.

Specifically, the City is incorporating changes into its WTDMP such as the updating of its Centennial Park which may affect water distribution to Evans. Consolidating master meters to Evans may help alleviate issues, although the planning horizon projections for the next five to 20 years by Evans is unknown at this time. Additionally, Evans also noted that they are growing to the west which would mean the City should expect increased water demands in that region in the future. Regarding water storage, Evans is considering renting or buying water storage from the City although the City is not planning to increase its water storage until the next 10 years; however, the City is considering resizing its reservoirs at 23rd Avenue and Gold Hill. The City shared that billing rates to Evans would increase for peak use periods although getting storage could negate that charge. Another solution by Evans was creating its own storage tank out west on the hill or west of Twin Rivers, although increased water storage is a goal, not a current need. Evans agreed to share their pressure zone boundaries with the City to make sure that both boundaries align and to help determine pumping needs. The pressure zone boundaries included 35th Avenue at Freedom Park to 77th avenue, 65th to Twin Rivers, and O St. and 54th St. Regarding the Boyd Lake WTP, the City plans on

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wintering it soon and adding a chemical building such as ozone treatment which could help distribute additional water supplies to Evans, although serving Evans from Boyd Lake WTP may be cost-prohibitive.

Regional Workshops

The City conducted a series of regional workshops (RWs) with all stakeholders, to provide a forum for discussion between all stakeholders and allow them to talk about their current water systems, highlight future population growth needs, and collaborate on potential solutions with other stakeholders. The City served as the primary point of contact with stakeholders and CDM Smith functioned in a technical support role by providing meeting materials, presentation, and coordination.

Regional Workshop Number One (RW No. 1) focused on identifying regional solutions to address population growth and resulting increasing water demand which included upgrading existing WTP and water storage capacity, securing service area and emergency connections, expanding non-potable water use, meeting additional water quality regulations, and maintaining qualified WTP operators. During the workshop, participants brainstormed ways to consolidate or provide services with other stakeholders. The follow-up Regional Workshop Number Two (RW No. 2) provided a summary of takeaways brought up during RW No. 1, shared an overview of the City's WTDMP, and discussed in more detail regional service options which needed more input to develop practical solutions.

Regional Workshop No. 1 Current Status

RW No. 1 began with each stakeholder providing an update of their current status, as described in this section.

The City of Greeley

The City hosted RW No. 1 to build interactive cooperation and increase resilience between stakeholders through regional partnerships. The City wanted to discuss the following points: (1) water quality, (2) water staff, and (3) improving future capacity and expansion. The City's population is expected to grow annually by 2.5% to 261,000 by 2065 just in its metropolitan area and planning to expand its drinking water production and service capacity out to its borders is a major concern. Currently, the City's population consumes a base demand of 14 to 15 million gallons per day (MGD) in the winter and 50 MGD in the summer. The City's transmission lines go through other districts. Because there are shared customers between the City and other stakeholders, the City is interested in collaborating with stakeholders to ensure that the relevant entity has the capacity to properly serve these customers. Additionally, the City is looking for opportunities to train new staff to work at its WTPs. The City is developing a program with AIMS Community College to train and recruit WTP operators. The City hopes to use conservation to limit the increase of water demands by using non-potable water for agriculture, city greenery, and private entities. The City's Bellvue WTP has expansion capability to help address growing water demands.

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Windsor

In the RW No. 1, Windsor brought up concerns for its rapid growth towards the north– approximately 9% annually with a future population of 60,000. Windsor is addressing its rapid growth through transfer of water demand to non-potable water demand. It is looking to acquire public non-potable pumping systems and continue using dual use potable and non-potable water systems to help meet its growing water demand. Additionally, Windsor is interested in sharing its potable and non-potable water distribution lines, emergency connections, and storage facilities with other stakeholders and the City. For example, Windsor will soon build a water storage tank that could be shared with other stakeholders for water service distribution needs. Windsor is participating in the NISP. Its base flow (average daily flow) is 1.3 to 1.4 MGD, with winter demands of 1 to 2 MGD and summer (max day) demands of 4 MGD.

Loveland

In the RW No. 1, Loveland discussed needs for addressing population growth. With a current population of approximately 78,000, Loveland is planning for a population of 140,000 with a projected 180,000 population at buildout. Loveland's WTP has a capacity of 38 MGD but can be expanded to 46 MGD. Its current peak day flow is 27 MGD, with interconnections between Fort Collins and Loveland Water Districts. Additionally, Loveland is looking for partnership to help address water demand needs. Loveland is considering forming interconnection ties with the City to get water to its citizens during peak conditions (from the City's Boyd Lake WTP or Little Thompson Water District). However, Loveland's water rights are not fully used, including those from Chimney Hollow Reservoir, and it has 4 to 6 million gallons (MG) of spare storage capacity. Johnstown in particular could potentially be served by Loveland. Loveland does not use non-potable water to help decrease water demand. It is planning to have a water quality lab that can evaluate water samples for secondary standards (odor and taste).

Johnstown

In the RW No. 1, Johnstown addressed its concern for population growth in the north and west and expanded WTP capacity needs. Currently, Johnstown's population is projected to grow at an annual 5% growth rate to between 40,000 and 50,000 by 2050. With an average flow of 2 MGD and a peak flow of 5 MGD, the Johnstown WTP can increase by 15% capacity up to 10 MGD. While increased plant capacity will help address some growing water demand, Johnstown is also looking for alternatives such as gaining emergency supplies from Thornton off the new NISP pipeline, making existing temporary agreements with service from the Boyd Lake WTP, and using more non-potable water to decrease demand. Some demand constraints could be decreased by constructing a regional WTP and having Loveland be serviced by Hillsboro Lake WTP.

Severance

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In the RW No. 1, Severance brought up increasing water demand needs from its projected growing population of 8,000 to 16,000 over the next three to four years, with a goal of serving 25,000 people in the future. The town's average daily flow is 1,000 AFY and its maximum daily flow is 1,000 gallons per minute (gpm). While the town has adequate water supplies for its current population and is participating in the NISP, Severance is concerned with supplying adequate water needs for current development prior to NISP integration and for areas not served by NISP, such as nearby the Soldier Canyon WTP. Additionally, Severance is aiming to draft a drought plan and is discussing how to treat water acquired from the NISP. Severance is interested in a five- to ten-year water lease.

Eaton

In the RW No. 1, Eaton discussed the town's growing population in the south and west, along with staffing issues. Currently Eaton only has one water service connection with North Weld but is looking for an additional emergency connection. Eaton uses non-potable systems and wells to supply some water demands. While Eaton is participating in NISP, all new developments will need to bring in their own water supplies.

Evans

In the RW No. 1, Evans is looking to serve its growing population of 21,000. It has concerns with its raw water supply, which only serves platted lots. Water comes from the City, but Evans is looking to reduce cost rates by increasing storage capacity. Evans is interested in sharing water storage and is looking for a backup and emergency water supply. The NISP will help alleviate water shortages, but Evans is concerned how the raw water will be treated. Evans has an outdated water plan that will need to be updated to address service areas, plan and develop growth, outline collaboration methods with the City, discuss water conservation, and be adequate for future water demands.

North Weld

In the RW No. 1, North Weld discussed its increasing water demand (8,000-acre feet to 16,000-acre feet by 2050) and lack of capacity on its water transmission lines and infrastructure as the town transitions from rural to urban communities. Currently, its WTP treats 40 MGD with expansion capacity to 65 MGD. North Weld has ties with Elco, Fort Collins, and Loveland Water Districts at Soldier Canyon WTP. Currently, it is concerned with drinking water quality pertaining to copper and led contamination. North Weld is interested in learning more about non-potable water as it does not manage any non-potable systems currently.

Regional Workshop No. 1 Discussed Topics

During the RW No. 1, the stakeholders and the City concluded the following based on several categories pertaining to water:

Qualified Technical Staff

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- Hiring qualified technical staff is an important priority as water demand increases across the City and stakeholders. The City is partnering with AIMS community college through internships to grow the local pool of future WTP operators.

Non-Potable Systems

- Many stakeholders, including the City, discussed non-potable water supplies as a viable method for meeting increased water demands. If collective non-potable infrastructure was to be constructed, trading between stakeholders and the City could increase currently treated drinking water capacity.
- Agricultural water from converted land is a main contender for non-potable use.
- Dual use potable and non-potable systems could be used to help meet increasing demand.
- The City will require stricter non-potable usage for future developments and several stakeholders will take over non-potable water management from homeowner associations (HOAs) to address water management needs.
- Stakeholders may be interested in a subcommittee on regional NP usage.

Water Storage

- Several stakeholders, including Evans, need additional water storage, while some stakeholders such as Windsor want to avoid adding additional storage near Gold Hill.
- While there is available water storage regionally, the City and stakeholders are looking to better collaborate on water storage capacity.
- The City could share storage north of the Poudre River.
- Loveland has underused storage tanks north of US 34 and Larimer County 3, which could help stakeholders including Johnstown.

Shared Infrastructure Funding and Grant Opportunities

- There are several opportunities to address aging and undersized infrastructure. For example, the Boyd Lake WTP is undersized. With potential improvements including ozone treatment in 2022 to 2023 and an updated capacity of 38 MGD handling 10 to 20 MGD in summer months, several stakeholders could benefit, including Evans.

Regional Drought, Water Supply, and Water Quality

- Several stakeholders such as Loveland may need another master water meter in the future to cover annual summer peaks.

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- As water quality regulations continue to grow in stringency, upgrades to existing WTPs will be necessary.
- Main concern of water quality regulations focuses on trihalomethanes (THMs) and disinfection byproducts (DBPs). For some stakeholders, including North Weld, lead and copper are a concern.
- There is the opportunity for a regional water quality lab at the City or in Loveland by 2020, especially given that several stakeholders send water quality samples out of the region for testing, which presents problems. Sampling collaboration could be conducted.
- Several stakeholders, including Evans and Johnstown, desire developers to bring in water over cash-in-lieu supply.
- There is opportunity for technical subcommittees to help collaborate on treatment issues, while stakeholders and the City could conduct a regional drought study to understand when the Colorado River curtailment occurs and affects to the region.

Northern Integrated Supply Project

- While several stakeholders are participating in NISP, there is a gap between when the project will be integrated (in 10 to 15 years) and current growing water demand needs. Many short-term solutions are required.

Regional Workshop No. 2 Greeley WTDMP Overview

During RW No. 2, the City shared with other regional stakeholders an overview of its WTDMP five year, 20-year, and buildout planning horizons to provide the foundation for discussion on follow-up steps. Specifically, for its five year MP, the City discussed how its population growth is projected to move west towards Windsor and north of 10th St. while current development areas within the City will be filled in. For its 20-year and buildout planning horizons, the City was more uncertain as to where population growth would occur although the City emphasized that it would continue to expand northward.

RW No. 2 began with recapping highlights from RW No. 1, to build upon former discussions. Specific points brough up included water sharing by different stakeholders provided by the City's Boyd Lake WTP, emergency connections, non-potable water use, water storage sharing, and water meters. From there, the stakeholders had time to discuss their needs and goals, as described below.

Regional Workshop No. 2 Individual Community System Needs and Goals

During RW No. 2, there the City set aside time to bring up individual stakeholder needs and updates, shown in detail in the following sub-sections.

Johnstown

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Johnstown shared that it is expanding its WTP from 5 MGD to 10 MGD and has a 1.5 MG elevated storage tank in the southwest; however, within the next 20 years, it expects its population to double in size and is looking for ways to distribute water to new development towards the north.

Evans

Evans shared that it is projected to increase its water demands to 2.72 MGD and 3.66 MGD in the next five and 20-year planning horizons, respectively. Currently, it receives its main treated water source is from Boyd Lake WTP which can give 2.45 MGD at most while Evans will receive 1.07 MGD of raw water from NISP once completed in the next five years. In the short-term, Evans is looking got increase its raw water portfolio from suppliers and gain additional storage facilities to reduce peak demand charges from supplies. Long term, Evans is looking to ensure transmission lines from NISP and build the necessary piping distribution networks to serve new development growth areas. In response, the City shared that it will follow up with Evans to learn where increased water demands are likely so that the City can accommodate future demands within the next five to 20 years as well as consolidate master meters. Growth is like to occur west of 47th Ave. and beyond Two Rivers Parkway at 37th St.

Kersey

Kersey shared that its population is projected to grow towards the south and west. It has no plans of designing or building new infrastructure soon besides replacing existing service lines; however, finding emergency connection source within the next five to ten years is important. Potential options include Central Weld or building a connection west towards Evans and the City. There are other water sources to the east and a good-sized water storage facility, but Kersey will have a better idea of its future water demand needs once it completes its comprehensive water plan in the near future.

Eaton

Eaton shared that is will have 25% population growth in five years and 100% population growth in the next 20 years. All its new developments will require non-potable water systems for irrigation. Future needs include another emergency connection although Eaton has difficulty finding one as there is not much development around it, future water storage, such as with North Weld, and re-evaluation of its master meter connections (currently one with North Weld). In response, the City shared how there may be the opportunity for potential shared storage towards the north of the City (North of the River area) which could benefit North Weld, Eaton, and the City.

Windsor

Windsor shared that it currently has rapid population growth towards the south and north parts of town, expecting to double in population by the next 10 years. Windsor is looking to increase its water supply acquisitions from Loveland and the City with 25% additional requirements needed

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form Boyd Lake WTP. As a solution there was consideration for connection a master meter by Highway 35.

Regional Solutions

During RW No. 2, the City and stakeholders discussed several regional solutions pertaining to water storage opportunities, emergency connections, and non-potable use. Specifically, the City has 20 MG of water storage at Gold Hill and will increase the water storage within a 10-year planning horizon. The City commented that it could increase Gold Hill's water storage sooner if it had capital investment partners. For example, if Evans or Milliken were interested, each stakeholder could provide capital to help drive capital improvement plan prioritization towards building increased storage capacity for shared partnership. Otherwise, the City could build on its own needs and provide IGAs for later stakeholder collaboration. With regards to Eaton and Johnstown shared that they have one and three emergency connections, respectively. If needed, Johnstown could help provide an interconnection to help offset transmission needs in two to five years. Likewise, the 3 MGD emergency supply connection from Boyd Lake WTP may need to be expanded because of the fires near Loveland, CO. The WTP is working to avoid the need for major changes as it continues winterizing and improving taste and odor control. With regards to non-potable use, the City shared interest in collaboration with non-potable along its southern boundary if Evans saw the arrangement as agreeable and cost effective. Likewise, the City is interested in non-potable water north of the Cache de La Poudre River.

Several stakeholders emphasized their interest in obtaining water from the City's Boyd Lake WTP to help account for water demand growth as their respective populations increased. Additionally, the City shared how it has recently constructed emergency connections of 16 MGD between itself, North Weld, and Elco providing water flow between itself and the two other stakeholders. In response, Kersey brough up how it would like to continue conversations with the City and other stakeholders for potential emergency connections as its only current connection is with Central Weld. Challenges to emergency connections with other stakeholders pertain to the physical barriers of the South Platte and Cache de La Poudre Rivers.

Regarding non-potable water use, Windsor clarified that it is not considering changing its non-potable water systems from private to public but instead keeping them monitored by HOAs and the metro district. Likewise, Evans commented that it will require non-potable irrigation for new residential development managed by both the public and private – two thirds by public management and one third by private management.

After reviewing the regional stakeholder map provided in RW No. 1, several stakeholders brough up discussion regarding transmission lines, master meters, and water storage. Specifically, Evans shared that it has a transmission line connection to the City through Gold Hill and 14 master meter connections total but is looking for water storage. In response, the City shared that it would be evaluating future water demands and locations to help optimize its water allocation with other

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stakeholders. Both Milliken and Windsor shared interest in connecting to Gold Hill. Likewise, Johnstown mentioned that it has a master meter connection off Boyd Line.

Regional Solutions Summary

During the RWs, a map of the region and locations of WTPs, service lines, and water storage developments was provided, shown in **Figure 2**, to help stakeholders and the City to identify and develop potential regional solutions. Potential ideas/solutions pertaining to addressing growing water demands discussed at the RWs (and in summarized in prior sections) are all captured in **Figure 3**.

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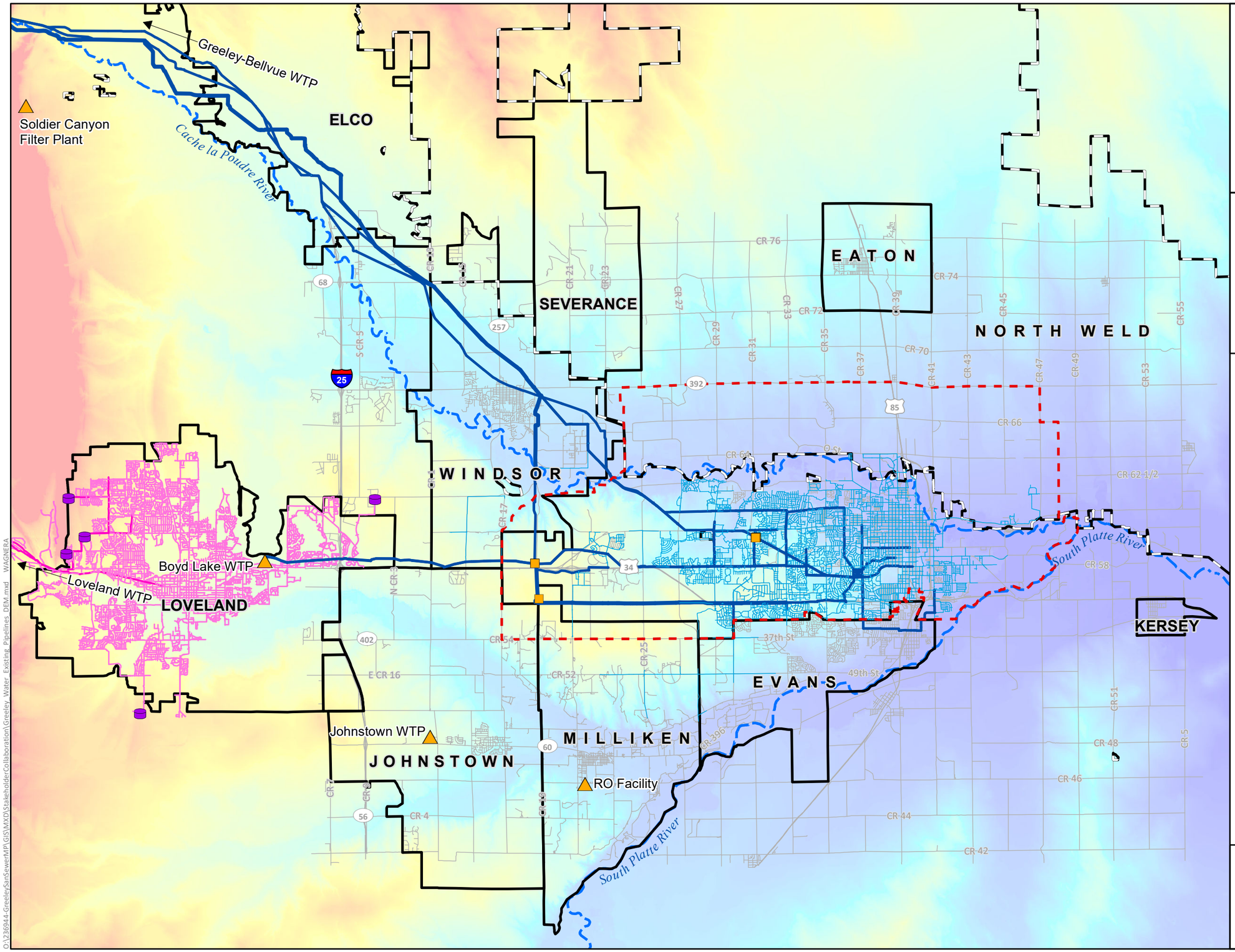
City of Greeley Regional Stakeholders - Water

Greeley Water System Master Plan



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Miles

Legend

- Water Treatment Plant
- Pump Station
- Stakeholder Water Tank

Water Mains

- < 20 in. diameter
- 20 - 40 in. diameter
- > 40 in. diameter
- Stakeholder Water Mains
- Greeley LREGA
- Stakeholders Boundary
- North Weld
- River

Elevation

High : 6100 ft

Low : 4566 ft

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CDM Smith

December 03, 2019

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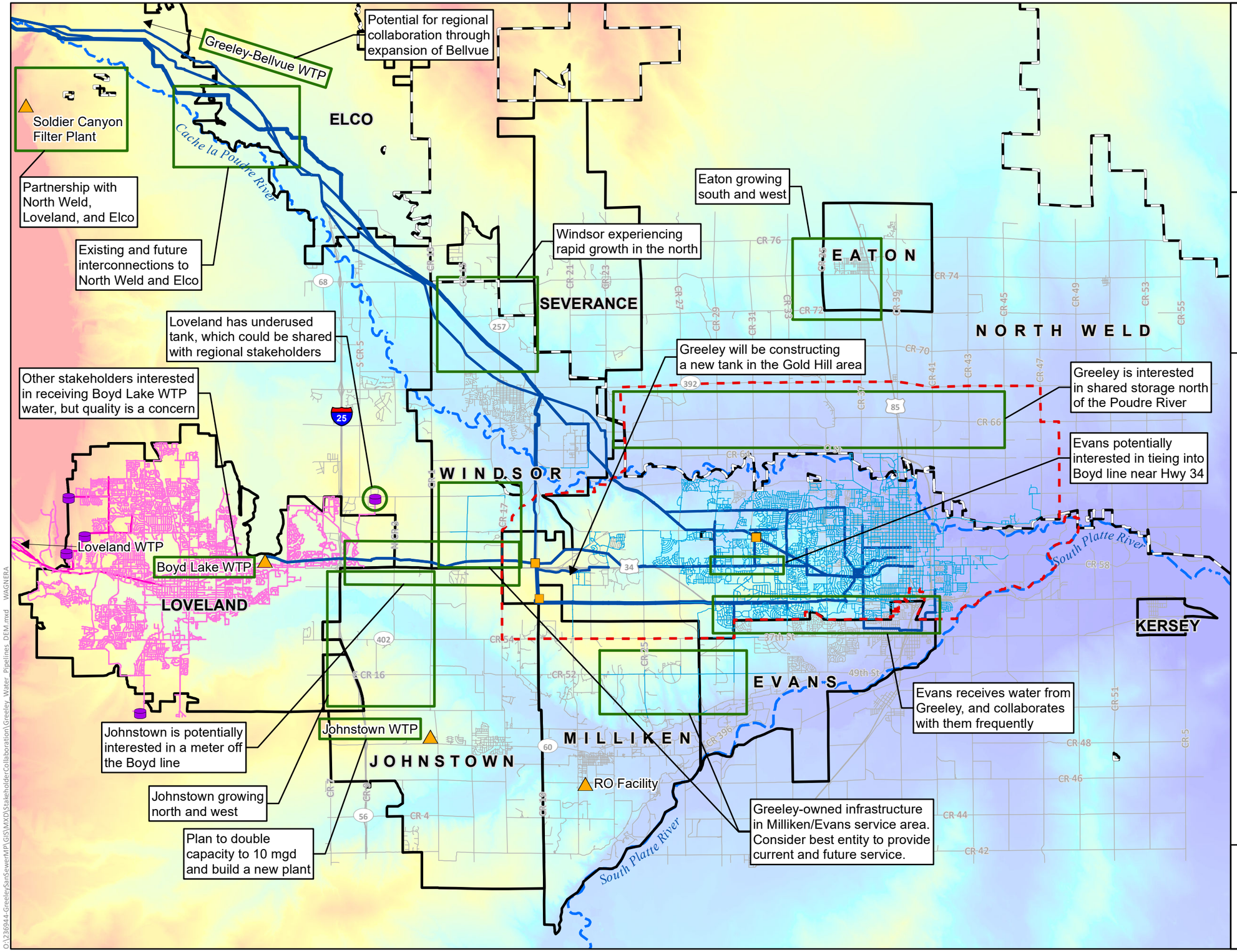
City of Greeley Regional Stakeholders - Water

Greeley Water System Master Plan



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Miles

Legend

- Water Treatment Plant
- Pump Station
- Stakeholder Water Tank

Water Mains

- < 20 in. diameter
- 20 - 40 in. diameter
- > 40 in. diameter
- Stakeholder Water Mains
- Greeley LREGA
- Stakeholders Boundary
- North Weld
- Notes/Potential Regional Collaboration
- River

Elevation

High : 6118 ft

Low : 4566 ft

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January 08, 2020

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Integration of Regional Stakeholder Needs into Master Plan

Stakeholder information was integrated into the WTDMP in two ways: coordination of master meters, and considerations for shared storage in the North of the River area.

Based on conversations with regional stakeholders that already have master meters from the City, it was noted that many of them are experiencing rapid growth (at or above the City's growth rate). Although most of these stakeholders do not have set demand projections through the City's buildout planning horizon, an estimate of expected growth from current demands through the master meters was calculated based on City knowledge of regional growth. **Table 2** summarizes these demands.

Table 2 - Stakeholder Demand Projections

Stakeholder	Existing Demands (gpm)	2025 Demands (gpm)	2040 Demands (gpm)	Buildout Demands (gpm)
Evans	1,700	2,000	2,300	4,600
Milliken	7	8	10	20
Windsor	1,700	2,100	2,500	5,300

Additionally, future collaboration with North Weld was considered for the buildout scenario. The current IGA was reviewed in greater detail to determine the expected peak month flowrate that the City is expected to take from North Weld. Although the exact location, timing, and demand of future master meters requires continued collaboration between the two parties, this appears to be a promising solution that would alleviate low pressures in the North of the River area. On top of master meters, there is a potential to collaborate with North Weld in constructing a new reservoir in the North of the River area (Zone 2 North). Buy-in from regional stakeholders makes this project more feasible.

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Appendix D

Non-Potable System Demands

The following technical memorandum explains the methodology for producing non-potable system demands for the hydraulic model, as discussed in **Section 2**.

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Memorandum

To: *Terry Farrill, P.E., City of Greeley*

From: *Shilpa Shivakumar, P.E.*
Carl Lundin, P.E.
Erin Walsh, EIT

Date: *November 12, 2020*

Subject: *City of Greeley Non-Potable Water Master Plan*
Technical Memorandum 2 – Demands and Economics (DRAFT)

The City of Greeley ("the City") has contracted CDM Smith to update their water, sewer, and non-potable water master plans. The non-potable water master plan (NPWMP) will help the City provide untreated irrigation water to large turf areas, which will preserve potable water for other uses, reduce treatment costs for the Water Department, and lower the irrigation cost for customers. In order to plan for the future non-potable needs of the City, existing and future demands were established, and analysis was completed related to economic feasibility of future expansion. The demands established will be used in the water transmission and distribution master plan (WTDMP) to show how potable water demand can be lowered by meeting demands that do not require potable water quality with non-potable water (e.g., irrigation or construction).

The purpose of Technical Memorandum 2 (TM 2) is to:

- Examine existing non-potable demands to establish patterns of use and sources of variability
- Establish methods for estimating economic feasibility for expansion of the system to assist the City in determining the most effective way to sustainably promote non-potable usage
- Calculate and allocate future demands within the Long Range Expected Growth Area (LREGA) based on expected adoption rates, projected potable water demands, and expected conversion areas

This TM is divided into the following sections:

- Existing System Demands
- Future Usage and Demand Projections
- Demand Estimates by Planning Horizon

- Economic Feasibility for Future Projects

Existing System Demands

The first step in allocating demands in the non-potable water model is to examine how the City currently uses non-potable water. Non-potable water is currently used mostly for irrigation, although it may be possible to expand the system so that it can meet some other demands that do not require potable service, such as construction. Information on non-potable demands was primarily found in the billing data and GIS data, as discussed in TM 1.

Review of Billing Data and GIS Data

In TM 1, existing irrigated areas were examined in GIS and existing billing data was geolocated and categorized by customer type. Through this process, 99.3% of the total non-potable demands from the 2019 billing data were allocated to a geolocated meter. Additionally, the City requested that one "customer" be removed from the total, as it is a shoulder tap that feeds other billed customers. **Table 1** summarizes the billing customers and their associated demands by the category assigned by the City. Categories were subsequently adjusted to match water and sewer customer categories.

Table 1 - Categorized Billing Customers

Customer Category	Number of Customers	Total Annual Consumption[1] (1,000 gal)	Percentage of Total Consumption
Church/Commercial	1	3,578	0.7%
Commercial	37	39,354	7.6%
Golf Course	5	187,859	36.5%
HOA	14	31,292	6.1%
Non-Potable	1	442	0.1%
Parks	20	146,157	28.4%
Residential	3	25,675	5.0%
Residential or HOA	1	841	0.2%
School	13	79,306	15.4%
Total	**96**	**514,503**	

[1] Average of 2018 and 2019 billing data

Pumping data was used to supplement billing data in irrigated areas that did not have an associated meter. **Table 2** contains the pumping data for these areas.

Table 2 - Pumping Data

Pump Name	Pumped Peak Month Demand[1] (1,000 gal)
Greeley West Park	744.6
Cottonwood Park	719.2
Bittersweet Park	4,585.2
Sanborn Park	2,783.0
Josephine Jones Park	1,101.6
Delta Park	712.3
Glenmere Park	1,400.7
Linn Grove	8,327.9
Balsam Sports	2,170.7
Saddle Club	68.8
Island Grove	3,459.2
Island Grove Ball Field	3,300.3

[1] Average of 2018 and 2019 recorded pumping data

Variability in Demand

Non-potable demands are much more irregular than potable water and wastewater demands. In particular, they are largely influenced by seasonal weather patterns, as most non-potable water is used for irrigation. In general, non-potable demand is highest in the summer and lowest in the winter. Both potable and non-potable demands were allocated based on summer usage.

However, these seasonal variations do not account for year-to-year variability. This variability is shown in **Figure 1**, where consumption based on billing data can almost double in certain years.

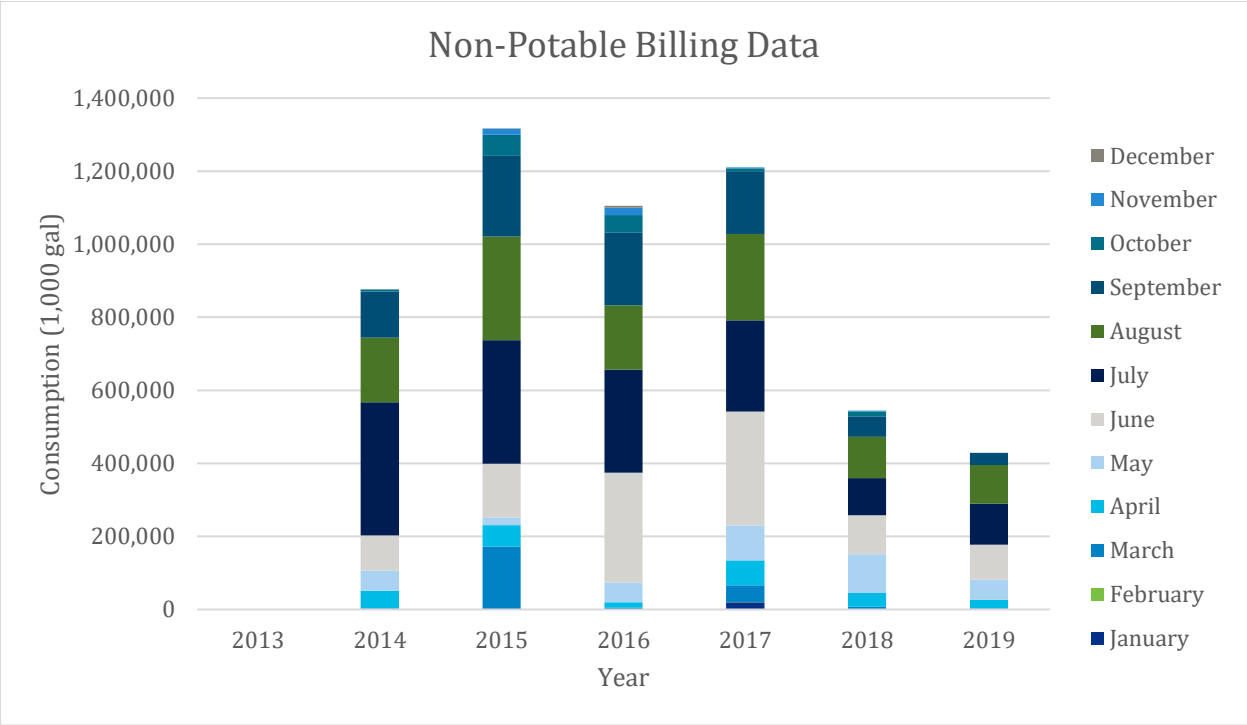

Figure 1 - Variability in Annual Non-Potable Demand

Based on discussions with the City, it was determined that the annual variability was due to increased conservation efforts, especially the installation of water-efficient irrigation systems throughout the parks. To account for these changes, only billing data from 2018 and 2019 will be used in this master plan.

Flow Factor Development

The historic billing data and current non-potable irrigated areas shapefile were coordinated to produce flow factors by customer category. These flow factors can then be used to estimate future non-potable demand scenarios through 2075 based on land use projections established during the WTDMP.

Flow factors were calculated based on conversations with the City's non-potable (NP) operator to examine which areas were irrigated by which meters. The meters (and their associated area) had been previously categorized by the City, which was the basis for the flow factor categories. The total billed consumption by category was divided by the total irrigated acreage by category. This supplied the Irrigated Land peak month flow factor, as shown in **Table 3**. These values represent the amount of consumption for a site where the exact acreage being irrigated is known.

However, in undeveloped areas, the exact irrigated acreage is not known. To account for this, the percent of land that is irrigated out of a total parcel was established by category. The total irrigated

land by category was divided by the total (bulk) parcel by category. These resulted in a Bulk Land peak month flow factor, also shown in **Table 3**. This process is illustrated in **Figure 2**.

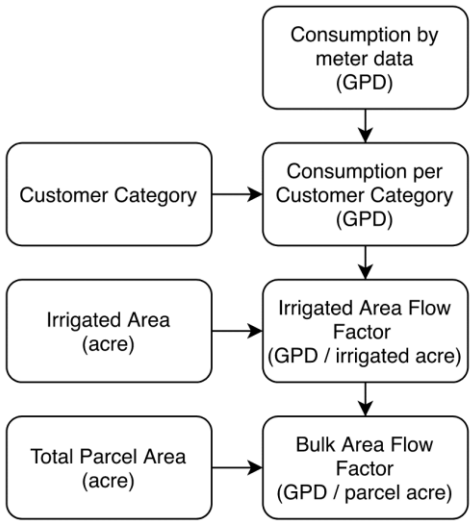

Figure 2 - Flow Factor Calculation

These customer categories were coordinated with the WTDMP land use projections to examine areas throughout the LREGA. Generally, the HOA category was associated with R-H land use category, the Residential customer category was associated with R-M, R-L, and R-E land use categories, and the Commercial customer category was associated with C-H and C-L land use categories. However, because the existing NP system serves a limited number of areas, this process did not fully account for all types of land use within the City. The following changes were included in the final flow factors:

- Some land use types in the City do not currently have any examples of NP irrigation. This includes I-L, I-M, and R-E areas. For these areas, a flow factor was based on the difference between the summer and winter flow factors (developed in the WTDMP and SSMP, respectively).
- Because schools are zoned as R-L, the R-L flow factor was based on a combination of the "Residential" and "School" flow factors.
- Because churches are considered commercial, the "Commercial" flow factor also includes churches. The "Church" category is used for conversion areas only. There are not many churches currently served by NP irrigation, so the "Church" flow factor also looks at existing churches that are only served by potable and compares summer vs. winter demand to determine an estimated flow factor.

Losses due to evaporation/seepage were not included in these calculations, as they primarily occur in the ponds and ditches rather than in the distribution system. These losses are estimated at 30%, based on operator knowledge, and are necessary for determining non-potable supply.

Table 3 - Flow Factors

Category	Description	Peak Month Flow Factor for Irrigated Land (gpd/ac)	Percent Irrigated	Peak Month Flow Factor for Bulk Land (gpd/ac)	Peak Month Flow Factor for Irrigated Land (in/week)	Annual Flow Factor for Irrigated Land (in/yr)	Adoption Rate[2]
Parks	Parks (NP category only)	3,500	47%	1,600	0.9	19.1	90%
Golf Course[1]	Golf course (NP category only)	5,000	87%	4,400	1.3	27.3	N/A
Commercial	C-H and C-L; includes churches	3,200	42%	1,300	0.8	17.5	20%
I-L	Industrial Low; Summer vs. winter flow factor	N/A	N/A	500	N/A	N/A	20%
I-M	Industrial Medium; Summer vs. winter flow factor	N/A	N/A	125	N/A	N/A	20%
Multifamily HOA	R-H	4,400	34%	1,500	1.1	24.0	15%
School	For conversion areas only	4,300	48%	2,100	1.1	23.5	75%
Church	For conversion areas only	2,000	63%	1,300	0.5	10.9	75%
Residential	Single family residential; also used for R-M	5,200	17%	900	1.3	28.4	20%
R-L	Residential Low; Residential and School average flow factor	4,700	26%	1,200	1.2	25.7	20%
R-E	Residential Estate; Summer vs. winter flow factor	N/A	N/A	80	N/A	N/A	15%

[1] No additional golf courses are expected in Greeley through Buildout
[2] Adoption rates based on Milton-Siemen report; see "Adoption Rates" section of this TM

Future Usage and Demand Projections

Using a combination of the City's planning data, land use projections from the WTDMP, and flow factors developed during the existing demands allocations, future non-potable demands through the buildout scenario were projected and allocated. This section captures the assumptions and calculations used to arrive at this value.

Adoption Rates

CDM Smith proposed three different adoption rates (high, medium, and low), as summarized in **Table 4**. The "medium" adoption rate was selected as the most likely scenario and was used when evaluating future development and conversion areas (infill). In all scenarios, it is assumed that all future and existing parks will use NP irrigation by 2075.

Table 4 – General Adoption Rates

Adoption Rate	Infill	New Developments
High	Strong encouragement for conversion; 50% of irrigation converted by 2075	Mandated adoption of NP for all irrigation uses
Medium	**Passive encouragement for conversion; 20% of irrigation converted by 2075**	**Mandated adoption of NP, unless economic infeasibility is proven**
Low	Passive encouragement for conversion where existing lines are located	Allowable; assume 50% of economic feasibility

The BBC-RAS report summary (2019) projects water demands for an assumed buildout year of 2065 under three scenarios: middle, high, and low. It was decided based on conversations with the City that the middle projection represents the most likely demand scenario, as recommended in the report. Notably, the medium scenario for total water consumption produces the highest non-potable consumption. This document included total projected demand at five-year increments and likely adoption rates per customer type, as shown in **Table 3**. These values will be applied to the future demands to get a more realistic picture of how much of the City will use NP irrigation.

Infill and Conversion Areas

As the NP system expands, it may become feasible and beneficial for some areas that are already developed to convert from potable to NP irrigation. These areas, referred to as conversion areas, were identified by the City based on knowledge of the individual customers and their current usage. The City identified over 400 individual areas that could be eligible for NP conversion. These areas were then categorized to identify which flow factors best fit them. The total acreage expected to convert to NP by category is summarized in **Figure 3** and shown in **Figure 4**. Areas that were identified as undeveloped land, roads, or non-irrigated areas were not included in the categorization, as undeveloped land is captured in the demand projections for undeveloped land, and roads (medians) are too small to be accurately categorized.

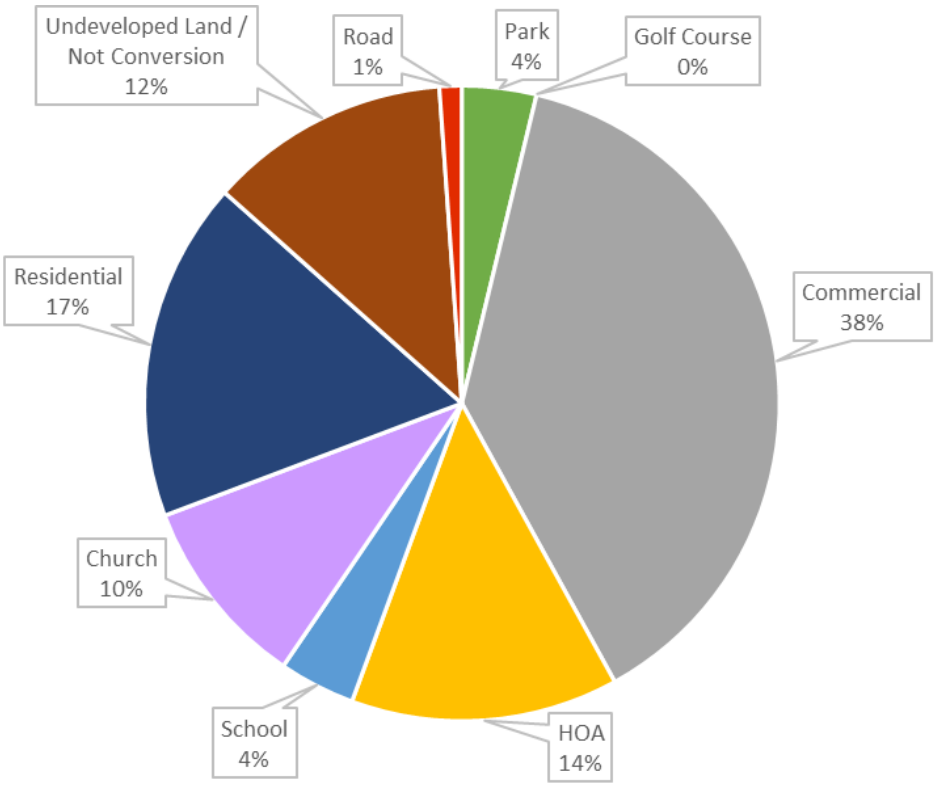

Figure 3 - Conversion Area Categorization by Acreage

The conversion areas represent irrigable land. Therefore, the irrigable land flow factor was applied to each area for its category. Based on conversations with the City, it is not expected that all of these areas will convert to NP. Inclusion on this list means potential conversion, not a requirement. To account for this, the adoption rates were also applied to these areas.

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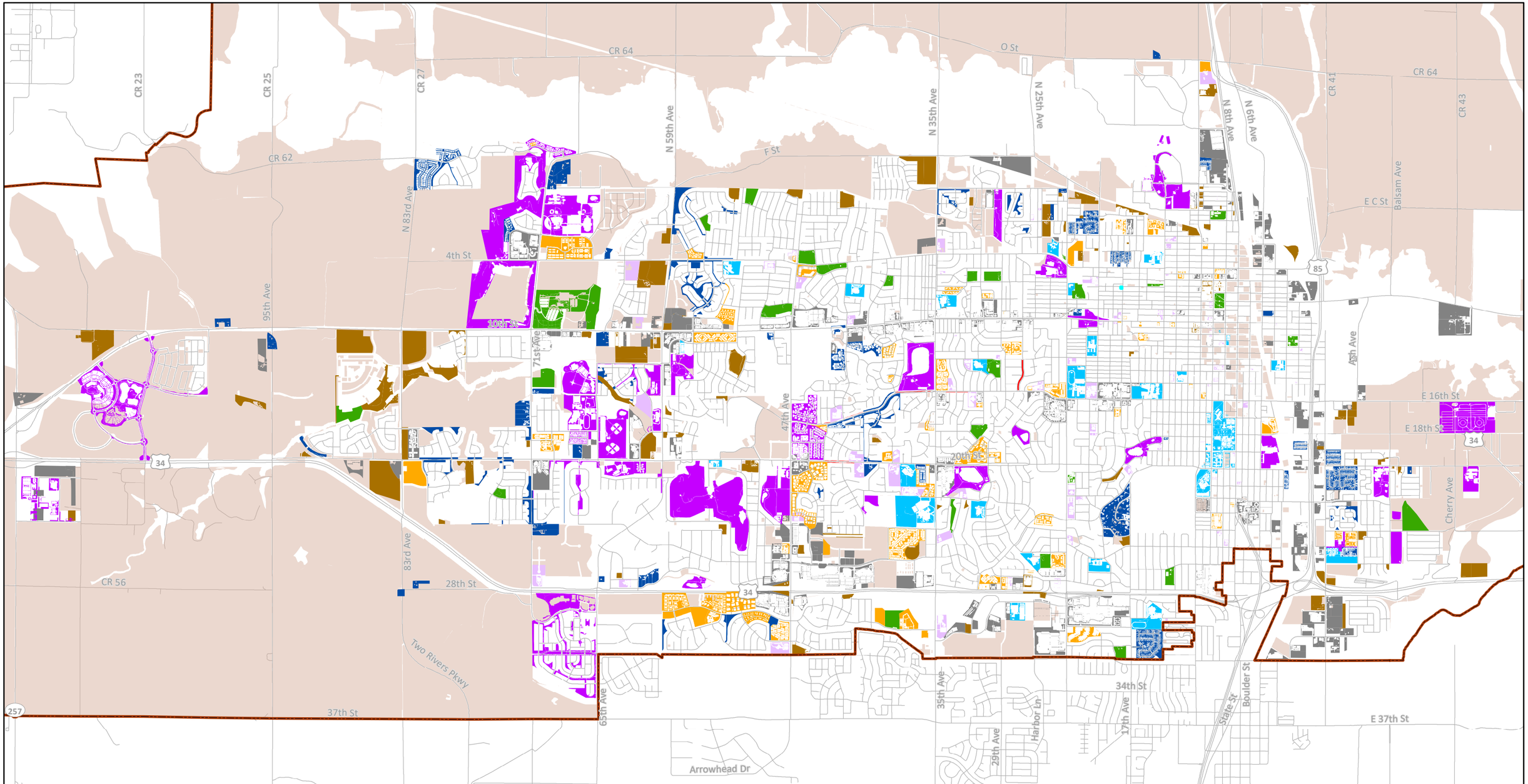

City of Greeley Colorado
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CDM Smith

November 12, 2020

Legend

- LREGA
- Existing NP Areas
- Future Development

Conversion Areas

- Church
- Commercial
- HOA
- Park
- Residential
- Road
- School
- Undeveloped Land

N

0 0.5 1 2

Miles

City of Greeley
Categorized Conversion Areas

Figure 4

Greeley Non-Potable Water System Master Plan

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Parks and Schools

Two land use types required special attention due to their high NP consumption: parks and schools.

Parks locations and sizes were primarily based on the City's Parks, Trails, and Open Lands Master Plan (2016). This document identified potential parks locations for the next 20 years. These locations were supplemented by parks locations identified by CDM Smith and approved by the City to extend parks service through the LREGA (note that the location and size of these parks is subject to change in future parks MPs). The size of the parks was based on population projections from the water and sewer MPs, and the parks service goal of 8.25 acres/1,000 people (total) from the 2016 Parks MP. This methodology was approved by the Parks Department. **Figure 5** shows all future parks locations. Parks will serve as the hubs of the future NP system, as ponds serve both a storage and recreational purpose.

Because schools represent a large irrigable area, the City was interested in incorporating the location of future schools into the future demand projections. However, limited information is available as to the locations, numbers, and size of future schools. Because no locations of the schools are known, it was initially assumed that all schools will be located next to a park (typical for Greeley). To determine the size of schools, CDM Smith reviewed locations in the City where schools are next to parks, and determined that on average, each park is 2.3x the size of the accompanying school. (In general, Planning research showed that schools are typically 15 – 30 acres, which was intended to be used as a check of reasonability.) Using typical school populations provided by the Planning department (after discussion with the school districts), it was determined that there will be somewhere between 97 and 113 future schools. This is not in line with Planning estimates that one of the two school districts will have 4-10 additional schools. Because of this discrepancy, it was considered impossible to select a defensible number, and it was decided to not include schools as a separate source of future demand projections. Instead, school demands are captured in the WTDMP calculations.

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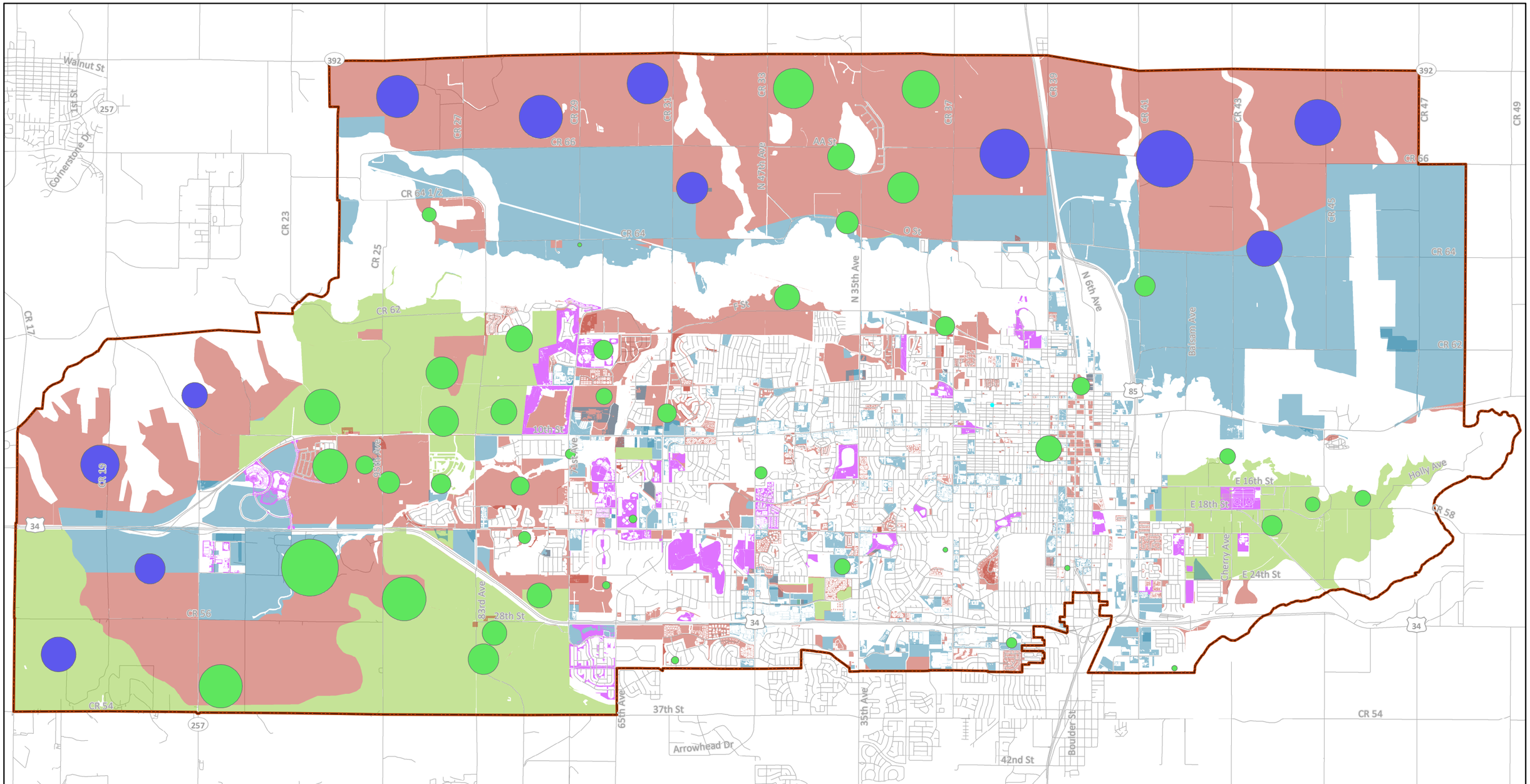

Legend

- LREGA
- Existing NP Irrigated Areas

Future Non-Potable Demand

- Commercial/Industrial
- Residential
- Mixed Use

Park Areas

- Potential Park Location (2016 Parks MP)
- Potential Park Location (Approximate for Planning)

N

0 0.5 1 2
Miles

City of Greeley Future Parks Locations

Figure 5

Greeley Non-Potable Water System Master Plan

City of Greeley Colorado
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CDM Smith

November 12, 2020

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Other Land Uses through the LREGA

Outside of conversion areas and parks, NP demand projections for undeveloped land throughout the LREGA were coordinated with the water demand projections. The water and sewer MPs used a complex land use schema to identify around 60 different land uses within the City, which were used to categorize all currently undeveloped areas or areas of redevelopment. Based on discussions with the City and review of the available information, three tiers of information were used for the potable water demands, as described below:

1. ***Tier 1: Planned developments (PUDs).*** This data was taken from development reports and planning documents for twelve known developments, which are in various stages of design. These areas represent the most detailed planning information available.

2. ***Tier 2: City of Greeley Land Use (Sub-Areas) and Zoning Markup Map (Greeley Markup).*** After review of this data, the City marked up 11 areas of growth to apply a specific growth distribution to each area, based on trends developed after the creation of the document. The City's Planning Department assigned percentages of land use type to each growth area. These areas were then split into sub-areas based on direction from the City to better align with the density distribution of the original *Imagine Greeley Comprehensive Plan*.

3. ***Tier 3: Zoning and Comprehensive Plan Information.*** For all remaining areas, including infill areas, zoning and land use information is used to distribution future populations and water demands. This data was taken from the following sources:

    a. Zoning from the *Annual Growth & Development Projections Report* (City of Greeley, 2019)

    b. Land use guidance from the *Imagine Greeley Comprehensive Plan* (City of Greeley Community Development Department, 2018)

Using this data, each parcel in the City was assigned with a residential and non-residential (commercial/industrial) future water demand based on its land use category. For detailed information on the potable demands calculations, please see WTDMP TM 1.

The water and sewer land use types were then coordinated with the NP flow factor categorizations, discussed previously, to develop separate NP and potable water flow factors for each land use type. These flow factors were applied throughout the LREGA to determine total NP demand.

Buildout Projections Summary

The conversion areas, parks, and undeveloped land was combined to produce a total NP demands set for peak month at buildout. This will be incorporated into the future water model to aid in appropriately sizing infrastructure. The peak month buildout demands projections for potable vs. NP are summarized in , and the NP demand density is shown in **Figure 6**. The NP demands comprise of 20.1% of all future water demands through buildout. NP demands may decrease if planning shows that it is not hydraulically or economically feasible to serve certain areas.

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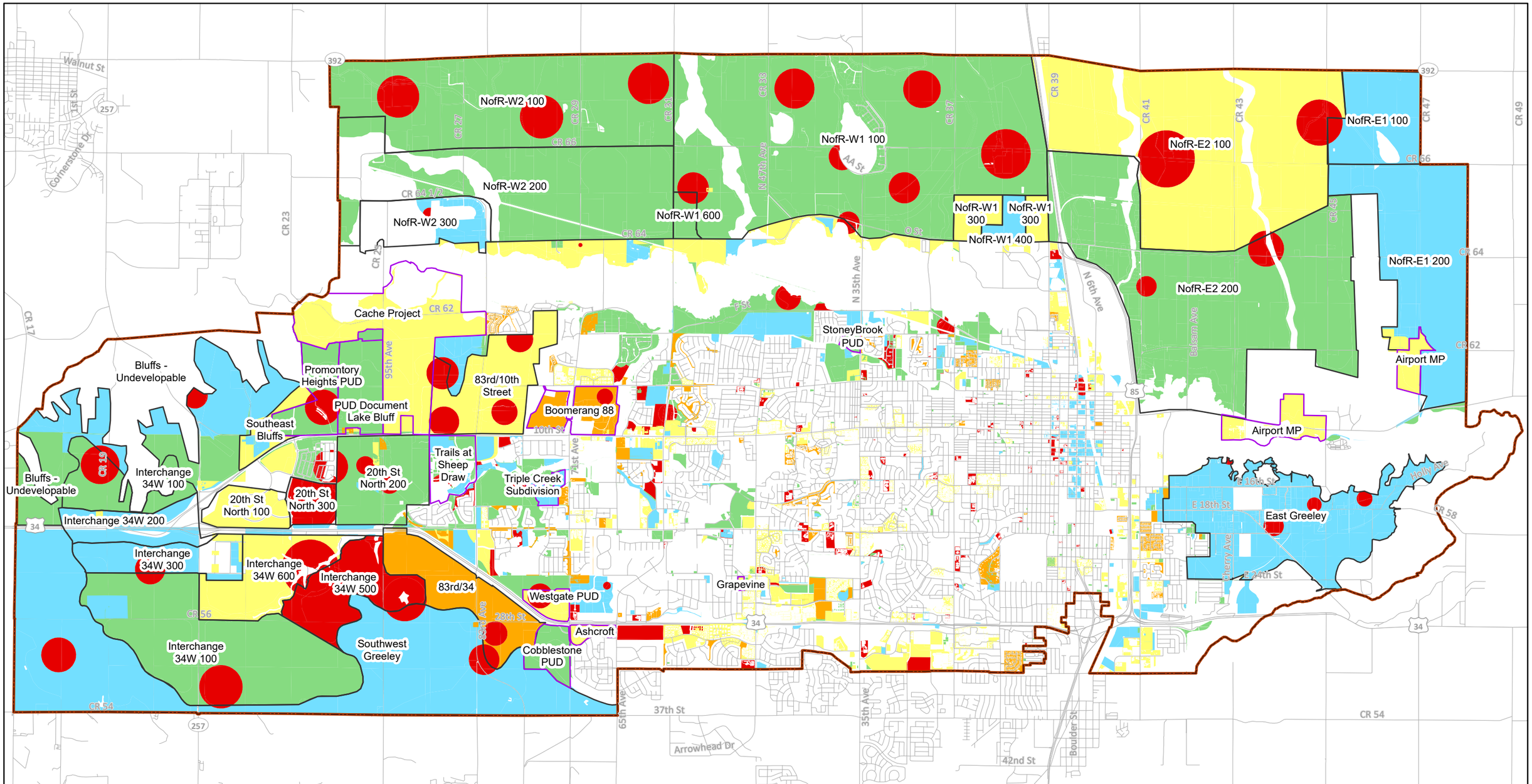

Legend

- LREGA
- Tier 1 (PUDs)
- Tier 2 (Comprehensive Plan)

NP Water Parcels

Density (gpd/ac)

- <250 gpd/ac
- 250 - 500 gpd/ac
- 500 - 750 gpd/ac
- 750 - 1,000 gpd/ac
- >1,000 gpd/ac

N

0 0.5 1 2

Miles

City of Greeley Colorado
Great. From the Ground Up.

CDM Smith

November 12, 2020

City of Greeley
Demand Density (Peak Month, Buildout)

Figure 6

Greeley Non-Potable Water System Master Plan

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Table 5 - Peak Month Buildout Demands Summary

Development Type	Total Future (additional) Water Demand (MGD)	Future Potable Water Demand (MGD)	Future Non-Potable Water Demand (MGD)
Future Development	56.72	47.46	9.26
Conversion Areas	2.29	0	2.29
Total	59.01	47.46	11.55

Demand Estimates by Planning Horizon

To distribute the future demand parameters in the model at each planning horizon, the percent to which each future development tier is built out at the end of each planning horizon was estimated. The basis for these estimates is the *City of Greeley Population and Water Demand Projections* (BBC Research & Consulting, 2018) report, and conversations with the City. At the 2025 and 2040 planning horizons, the calculated population is matched to the BBC Report. The overall buildout population is assumed to exceed the 2075 BBC projected population. The total buildout population is projected to be 425,271. For more information on the percentages used, please see WTDMP TM 1. The total phased potable and NP demands are shown in **Table 6**.

It is assumed that the Tier 1 projects will be completed first. For this reason, the majority of the Tier 1 projects are assumed to be 100% complete at the 5-year planning horizon, and all of them complete at the 20-year planning horizon.

Due to the large areas within the Tier 2 projections category, the Tier 2 percent complete values for the 5-year and 20-year planning horizons have been developed through close discussion with the City. The Tier 2 areas the City and CDM Smith have identified for growth at the 5-year and 20-year planning horizons are the areas which the City of Greeley Planning Department have identified as the most likely growth areas.

The Tier 3 growth identified below for the 5-year planning horizon was chosen through discussions with the City. Tier 3 growth included at the 20-year planning horizon is assumed to include all of the infill around the Tier 1 and Tier 2 projected growth areas.

The rate at which existing developments will convert to NP irrigation will vary location-by-location based on economic feasibility, proximity to NP infrastructure, and willingness of the owner to participate in conservation efforts. In order to estimate the rate of conversion areas, it was assumed that demand from conversion areas will increase at a similar rate to the total additional water projections. The percentage of water demands increase (compared to the buildout projections) at each planning horizon was calculated, and this same percentage was applied uniformly to the conversion areas.

Table 6 - Demands by Planning Horizon

Planning Horizon	Total Future (additional) Water Demand (MGD)	Future Potable Water Demand (MGD)	Future Non-Potable Water Demand (MGD)
2025	4.50	3.37	1.13
2040	13.69	10.87	2.82
Buildout	59.01	47.46	11.54

Economic Feasibility for Future Projects

In most developments, the decision on whether or not to use NP irrigation is based on economic feasibility, meaning whether the cost savings from using NP over potable outweighs the initial cost of infrastructure construction. For master planning purposes, a typical value of savings resulting from switching to NP irrigation was established at approximately $125 per 1,000 gallons of annual demand. This value was based on the differences in water rates and the costs of different water rights, using data from 2019 and 2020. This value was shown to be independent of development size and will be used during the Capital Improvement Plan as a way to examine whether future projects are feasible.

Table 7 – Economic Feasibility

Item	Potable	Non-potable	Units	Notes
Cost of Water and Rights				
Water Rate	$5.02	$3.51	/kgal	
Discount		$1.51	/kgal	
Present Value of Discount		$22.41	/kgal	20yrs @ 3%
Cost of Water Right	$42,857.14	$9,000.00	/ac-ft-yr	Potable based on WSSC, NP based on GIC
	$131.52	$27.62	/kgal-yr	
Water Rights				
Non-potable Fraction	0	0.26		Irrigation fraction of annual demand
Potable Water Right	$131.52	$97.33		Potable demand at water right rate above
NP Water Right		$7.18		NP demand at water right rate above
Total	$131.52	$104.51		
		$103.90	/kgal	Savings per kgal of annual NP demand
Total Feasible Cost of Infrastructure				
Rate Discount		$22.41	/kgal	Savings per kgal of annual NP demand
Water Right Discount		$103.90	/kgal	Savings per kgal of annual NP demand
Feasible Cost of Infrastructure		**$126.31**	**/kgal**	Savings per kgal of annual NP demand

The $125 per 1,000 gallons savings is only intended for use in master planning. Developers must conduct their own cost analyses to determine whether it is economically feasible to include NP irrigation.

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Appendix E

North Weld Intergovernmental Agreement

The following documentation summarizes the intergovernmental agreement between North Weld and the City used for aiding in the development of future water demands by the City.

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WATER SERVICE AGREEMENT

THIS AGREEMENT is made and entered into as of the 5th day of February 2013, by and between the North Weld County Water District, acting by and through the North Weld County Water District Enterprise (hereinafter "District"), and the City of Greeley, a home rule municipality, acting by and through its Water Enterprise (hereinafter "Greeley")(collectively "Parties").

RECITALS

WHEREAS, the District is a statutory special district formed under the laws of the State of Colorado and is a quasi municipal corporation; and,

WHEREAS, Greeley is a home-rule municipal corporation; and,

WHEREAS, the North Weld County Water District Enterprise and the Greeley Water Enterprise are established and administered in compliance with the provisions of Section 20, Article X of the Colorado Constitution and Article 45.1 of Title 37 of the Colorado Revised Statutes, and the Greeley City Charter and Municipal Code, as applicable; and,

WHEREAS, the District (on its own or in cooperation with others) owns, maintains and operates a system for the storage and distribution of potable water within Weld County and Larimer County; and,

WHEREAS, Greeley owns, maintains and operates a separate and independent system for the storage and distribution of potable water to its residents and to other customers in Weld County and Larimer County; and,

WHEREAS, the District, as a non-profit quasi municipal statutory special district, must establish and provide water rates to cover the maintenance and operation, depreciation, replacement, and appropriate funding of capital costs of the District; and,

WHEREAS, Greeley's policy is to provide water service to all Greeley citizens; and,

WHEREAS, the District's policy is to provide water service within the boundaries of the District; and,

WHEREAS, the District has a master plan to serve a portion of its service area, lying north of the Poudre River, at densities between one and two dwelling units per five acres; and,

WHEREAS, portions of the District's service area overlap Greeley's Long-Range Expected Growth Boundary, which is outlined in Greeley's 2060 Comprehensive Plan; and,

WHEREAS, Greeley and the District have determined that it is in the best interest of the residents of Greeley and the District for the Parties to cooperate with each other in providing water services; and,

WHEREAS, by enacting Titles 31 and 32 and specifically § 31-35-402(1)(b) and § 32-1-502(2)(c) of the Colorado Revised Statutes and pursuant to Article XIV, Section 18 of the Colorado Constitution, the Legislature of the State of Colorado has: (a) determined that the State of Colorado has a valid interest in providing water for its citizens; (b) clearly articulated and affirmatively expressed the State of Colorado's policy to allow municipalities and special service districts to provide water by utilizing cooperative agreements and to eliminate competition in areas where each Party is capable of providing service; and (c) developed a structure to actively supervise municipalities and special service districts, if the Parties choose to utilize such agreements; and,

WHEREAS, taking into consideration the foregoing factors and the natural drainage basins and topography that affect the quality and cost of utility service in the overlapping service area, Greeley and the District desire to enter into a long-term contract for the treatment and delivery of potable water, to eliminate overlapping facilities, and to coordinate long-range planning prior to initiating costly capital expansion programs; and,

WHEREAS, Greeley and the District desire to craft this Agreement with the following guiding principles: to keep North Weld financially whole; to allow Greeley to maintain land use control of much denser, urban development in the overlapping service area; and to provide for flexible water sharing between the Parties; and,

WHEREAS, Greeley and the District enter into this Agreement pursuant to the provisions of § 29-1-203, C.R.S; and,

WHEREAS, the District and Greeley shall and will continue to own their own water rights individually and separately, with Greeley relying upon the yield of its own water rights to provide the raw water necessary for treatment proposed under this Agreement; and,

NOW, THEREFORE, in consideration of the premises and the covenants and agreements hereinafter set forth, it is agreed by and between the District and Greeley as follows:

ARTICLE 1
DEFINITIONS

1.1 "Delivery Point(s)" shall mean the point(s) at which the Furnishing Party delivers water to the Receiving Party's water system.

1.2 "Furnish" shall mean to treat, to the standards set forth in Section 3.4, and deliver water, which includes all of the intermediate steps necessary to provide water at the Delivery Point(s).

1.3 "Furnishing Party" shall mean the Party who treats, delivers, and performs all of the intermediate steps necessary to provide water at the Delivery Point(s).

1.4 "Master Meter" shall mean a meter at which the Furnishing Party will furnish water to the Receiving Party to enable the Receiving Party to provide water service to its customers.

1.5 "North Greeley Service Area" shall be that area identified within the Long-Range Expected Growth Boundary outlined in Greeley's 2060 Comprehensive Plan.

1.6 "Notice" shall mean the notice described in Section 10.12

1.7 "Raw Water Requirement" shall mean untreated water in an amount equal to 110% of Greeley's net potable water usage at the Master Meter(s) for the previous year plus any anticipated increases or decreases in net usage.

1.8 "Receiving Party" shall mean the Party who takes delivery of water from the Furnishing Party at a Master Meter.

1.9 "Uncontrollable Forces" shall mean any cause beyond the control of the obligated Party, including, but not limited to, failure of facilities, flood, earthquake, storm, lightning, fire, epidemic, riot, civil disturbance, labor disturbance, sabotage, breach of construction contract by a third party or restraint by court or public authority, which through due diligence and foresight, such Party could not have reasonably been expected to avoid.

1.10 Unless described as "raw water", "water" shall mean water treated to the standards set forth in Section 3.4, and shall have the same meaning as "potable" or "treated" water.

1.11 "Water Service" shall mean providing water directly to individual customers.

1.12 "Water Supply" shall include, but is not limited to, existing water supplies, future water supply projects, and development of existing and after-acquired water rights.

1.13 "Water System" shall mean the distribution system whereby a Party provides water service.

ARTICLE 2
GENERAL PROVISIONS

2.1 This Agreement defines the method by which the Parties shall furnish and provide water service to individual customers located within the North Greeley Service Area. It shall also determine the method of transferring the District's customers to Greeley; the transfer of infrastructure upon the exclusion of territory from the District's service area; the provisions for furnishing water to the Parties' respective water systems; and the method by which this Agreement may be amended to account for future growth, expansion, and development within the North Greeley Service Area.

2.2 To account for the transfer of customers to Greeley within the North Greeley Service Area and to track portions of the District's service area that are excluded there from, this Agreement may be amended, from time to time, through the use of exhibits. The exhibits shall contain the information required by Articles 3, 5, and 8 of this Agreement and shall be identified and generally contain the following:

2.2.1 Exhibit A of this Agreement shall contain the name of each Master Meter and its corresponding location; the annual minimum amount of water that Greeley must purchase through Master Meter(s); and the maximum gallons per minute of water that shall be delivered through a Master Meter based on Plant Investment Fees paid and credited. If any of the foregoing information is inapplicable to a Receiving Party, that portion of Exhibit A shall so reflect.

2.2.2 Exhibit B shall contain a complete list of all customers transferred from the District to Greeley.

2.2.3 Exhibit C shall be a map depicting the North Greeley Service Area and any property excluded from the District's service area.

2.3 The exhibits identified in paragraph 2.2 shall be amended prior to any relocation of a Master Meter, increase in peak demand, transfer of customer, or exclusion of territory from the District's service area. The exhibits shall be redefined as agreed to in writing by the Parties, or their respective designee, and made effective in accordance with the Parties' respective rules and procedures. Each amendment shall fully replace the prior exhibit and shall be effective upon the date specified therein.

2.4 The terms of this Agreement shall only apply to the North Greeley Service Area and shall not be extend to, or binding on, the Parties in any other geographical location.

2.5 This Agreement is not intended to provide for emergency water connections and supplies. If, at any time after the effective date of this Agreement, the Parties determine that an emergency interconnection is needed, then the Parties shall negotiate a separate agreement to determine the locations and facilities that will provide for emergency interconnections and the terms and conditions thereof.

ARTICLE 3
WATER SUPPLY

3.1 The District shall furnish potable water via Master Meter(s) for use in Greeley's water system at the locations and in the maximum and minimum annual amounts, peak demands in gallons per minute, and minimum and maximum pressures that shall be specified in Exhibit A.

3.2 Upon the District's written request, Greeley may furnish potable water via Master Meter(s) for use in the District's water system, subject to the terms of this Agreement, at the location(s) that shall be specified in Exhibit A.

3.3 The minimum and maximum pressures shown in Exhibit A shall be met by the Furnishing Party at the Master Meter(s) only. The Receiving Party is responsible for all pressures within its system following delivery from the Furnishing Party at the Master Meter(s). No promise or guarantee of pressure is made by the Furnishing Party or is to be implied from anything contained herein except as established in Exhibit A.

3.4 The furnished water shall be potable water, the quality of which shall be in accordance with the Federal Safe Drinking Water Act and all other applicable drinking water regulations and potable water law. The Parties shall conduct all testing necessary to assure that the water furnished under this Agreement complies with all Federal and State drinking water standards. The Furnishing Party agrees to provide the Receiving Party with the results of its annual testing, on or before April 1 of each year, as required by Colorado Primary Drinking Water Regulations, 5 CCR 1003.

3.5 Neither Party shall, by reason of this Agreement or by use of any water hereunder, acquire vested or adverse right or future right, in law or equity, in the water rights or water system owned by the other Party.

ARTICLE 4
RAW WATER

4.1 On an annual basis, Greeley shall provide raw water to the District, for treatment and delivery by the District through one or more Master Meters, in the amount of one hundred and ten percent (110%) of Greeley's estimated net demand ("Raw Water Requirement"). The Raw Water Requirement shall be calculated based on Greeley's net potable water usage at the Master Meter(s) for the previous year, plus any anticipated increases or decreases in Greeley's net usage. Not later than September 1 of each year, Greeley will supply the District with estimates of its projected Raw Water Requirement for the following year. The Raw Water Requirement made available to the District shall be provided on an actual gallon basis as measured at the intake station at the Soldier Canyon Filter Plant. The stated "one hundred and ten percent (110%)" shall mean one hundred percent (100%) plus an allowance of ten percent (10%) to cover the estimated shrinkage from the Soldier Canyon Filter Plant to the Master Meter(s).

4.2 Greeley's Raw Water Requirement shall be met from the following sources: Colorado-Big Thompson Project ("CBT"), the Windy Gap Project, the Water Supply and Storage Company, the North Poudre Irrigation Company, or from any other source capable of being delivered to and treated by the District's then existing water treatment system to the standards set forth in Section 3.4, and otherwise usable in the District's water system.

4.3 The District shall not be required to acquire, rent or own any additional raw water necessary to meet the Raw Water Requirement. Greeley is solely liable to make arrangements for the raw water necessary to make available the Raw Water Requirement.

4.4 In the event that Greeley does not make sufficient raw water available to the District, based on Greeley's net usage, the District shall notify Greeley as soon as possible but no later than thirty days prior to the time when such additional raw water will be necessary. If, after such notice, Greeley fails or refuses to provide sufficient raw water, the District may, in its sole and reasonable discretion, provide such raw water, at an additional fee to Greeley ("Water Surcharge"). The Water Surcharge shall be determined solely by the District dependant on the availability of raw water and shall be applied per one thousand gallons of water delivered to Greeley of District supplied raw water. The District shall maintain dominion and control over all raw water provided to Greeley under this Paragraph 4.4, and Greeley releases any right to the return flows that result from such water supplied by District, including any reuse rights associated with such water.

4.5 Greeley shall maintain dominion and control over any and all raw water provided to the District for treatment under this Agreement, and the District releases any right to the return flows that result from such water supplied by Greeley, including any reuse rights associated with such water.

ARTICLE 5
FACILITIES

5.1 The Furnishing Party shall take such actions and make such connections between the Receiving Party's system and the Furnishing Party's system necessary to furnish water to the Receiving Party as required by this Agreement at the Furnishing Party's sole cost.

5.2 The Furnishing Party shall install, replace, relocate, or add any necessary metering equipment and Master Meter vault(s) as required by this Agreement. The Furnishing Party shall design the Master Meter vault(s) and flow control device(s) in accordance with the specification of the Furnishing Party. Design shall consider system growth. The Furnishing Party shall submit all designs to the Receiving Party for review and approval prior to construction or installation. Following the Receiving Party's review and approval of such design plans, the Receiving Party shall reimburse the Furnishing Party for all reasonable and customary costs and expenses including design,

construction and installation of all necessary metering equipment and Master Meter vault(s) replaced, relocated, or added after the date of this Agreement.

5.3 The Furnishing Party shall install, own and operate a flow-restricting device(s) at the Master Meter vault(s). Said device(s) shall be capable of controlling the flow rate, if applicable, to the Receiving Party within the rates set forth in Exhibit A. The Receiving Party shall not be responsible for charges based on deliveries at flow rates greater than the flow rates directed by Receiving Party in writing or as stated in this Agreement.

5.4 The Furnishing Party shall own and maintain the Furnishing Party's water system, including but not limited to any interconnection facilities, water lines, pump station and treatment plant facilities necessary to serve the Receiving Party as required by this Agreement up to the Master Meter(s). The Furnishing Party shall own the Master Meter(s), Master Meter Vault(s), Backflow Prevention Assembly, and flow and pressure control facilities, which shall be managed, administered, operated and maintained exclusively by the Furnishing Party. For the purpose of determining operation and maintenance responsibility, the Furnishing Party shall be responsible up to and including the outlet valve(s) on the Receiving Party's side of the Master Meter(s).

5.5 The Receiving Party shall maintain complete and unilateral control over the Receiving Party's system operations. The Receiving Party agrees that it will, at all times, to the extent practicable in the Receiving Party's reasonable discretion operate its water distribution system on the Receiving Party's side of the Master Meter(s) so as not to unreasonably interfere with service to others dependent upon the Furnishing Party for a supply of water. The Receiving Party agrees that it will, to the extent practicable in the Receiving Party's reasonable discretion, operate its facilities, especially any pumping or storage facilities, in correlation with operation of the Furnishing Party's facilities and will install and use such devices, including telemetry, as are necessary to effectuate correlation; provided, however, that Greeley shall not be obligated to pay for the installation of any physical changes to its water distribution system that will benefit only District customers within the District's service area.

5.6 The Parties agrees to maintain all facilities within their respective water systems in good repair and to make such replacements as may be necessary to keep the facilities in proper operating condition at all times.

5.7 The Parties shall cooperate with each other in acquiring any easements and other permits or approvals necessary to accomplish and place into effect this Agreement and for the construction of any necessary facilities.

5.8 Nothing in this Agreement shall be interpreted as creating an "Integrated System" within the meaning of the Colorado Primary Drinking Water Regulations, 5 CCR 1003. Each Party owns its own water system and each is a separate and independent system from the other.

ARTICLE 6
MASTER METERS

6.1 The Furnishing Party shall read the Master Meter(s) at monthly intervals under its own meter reading schedule. If requested by the Receiving Party, the Furnishing Party shall give the Receiving Party notice of any Master Meter reading and allow a Receiving Party representative to be present and observe. For all Master Meter reads performed by Greeley, as the Furnishing Party, it shall deliver the Master Meter reads to the District, on or before a date mutually agreed to by the Parties, in order for the District to calculate the net monthly flow amount as provided in Section 7.1.

6.2 At least once every five years, the Furnishing Party shall test and calibrate the Master Meter(s) at the Furnishing Party's cost. At anytime, upon the Receiving Party's written request, the Furnishing Party shall make or cause to be made a special meter test at the Receiving Party's cost. The Furnishing Party shall notify the Receiving Party in advance of any Master Meter test and allow a Receiving Party representative to be present and observe.

6.3 The readings of any Master Meter, which has been disclosed by tests conducted pursuant to American Water Works Association standards to be inaccurate, shall be corrected from the beginning of the monthly billing period immediately preceding the billing period during which the tests are made in accordance with the percentage of inaccuracy found by such tests.

6.4 If any Master Meter shall fail to register for any period, the Receiving Party and the Furnishing Party shall agree as to the amount of water furnished during such period and the Furnishing Party shall render a bill therefore. If no agreement can be reached, the billing shall be based upon historical usage data.

6.5 If at any time the Receiving Party desires to change the location of any Master Meter vault(s), the Furnishing Party will attempt to accommodate such request if, in the reasonable opinion of the Furnishing Party, such relocation will not detrimentally affect the Furnishing Party's water system in any manner and only upon the condition that Receiving Party shall be responsible for any and all costs and expenses thereof.

ARTICLE 7
RATES AND CHARGES

7.1 The District shall bill Greeley, in monthly intervals, based on Greeley's net monthly water usage. The net monthly usage shall be determined by the difference between Greeley's total monthly water usage and the District's total monthly water usage. If Greeley's total monthly usage is less then the District's, Greeley shall be given a credit that shall be applied to the next monthly billing cycle. In the event that Greeley has a monthly credit on December 31st of any year this Agreement is in effect,

the same amount shall be paid in full by the District to Greeley by January 31st of the following calendar year.

7.2 The District will adopt water service rates sufficient to totally and fully reimburse the District for all costs of furnishing water under this Agreement. Any portion of the rate that is identified as a recovered return on investment shall be limited to 4.5%. The District may adjust the charges to be made for the use of water hereunder. The rates charged to Greeley shall be directly related and limited to the cost incurred by the District in furnishing water to Greeley as fairly determined by the District. The charges provided for in this paragraph shall remain in effect until the District deems it necessary to raise or lower the charges for the water, in accordance with section 7.3. In addition to any other rate or charge herein provided, Greeley shall pay all applicable fees, and such other rates, tolls, charges or combination thereof as the District may, from time to time, in the exercise of its lawful authority impose consistent with this Article and Article 1, Title 32 of the Colorado Revised Statutes.

7.3 The District will, not less than once, but not more than two times in each calendar year, review the Plant Investment Fee and the rates for potable water furnished hereunder. If necessary and consistent with Sections 7.1 and 7.2 hereof, the District shall adjust such rates based upon actual usage and audit figures to produce sufficient revenues to maintain and operate the system necessary to serve Greeley and to establish and maintain reasonable reserves for operation and maintenance.

7.4 The District shall provide Greeley written notice of any expected rate change or any projected operation, maintenance or capital improvement cost that will affect the rates to be paid by Greeley as follows:

7.4.1 The District shall notify Greeley of a proposal for an increase in the rate charged to Greeley at least thirty days prior to the Board Meeting at which formal action on such proposal is scheduled;

7.4.2 The District shall notify Greeley of any new rate within ten days after the District has adopted it; and

7.4.3 The new rate to be charged to Greeley shall not become effective sooner than thirty days after it has been adopted and shall not apply to water delivered by the District on or before the effective date.

7.5 Billing for each month shall be made on or about the last day of the month and payment is due on the tenth day of the following month. Any bill not paid within sixty days of the payment due date shall be delinquent, and Greeley shall pay an additional delinquent fee of one and one-half percent of the unpaid monthly billing per month. If Greeley refuses or fails to pay any bill within sixty days of the payment due date, the District may discontinue delivery of potable water hereunder upon ninety days written notice to Greeley.

7.6 If Greeley's annual water usage does not equal or exceed the total minimum annual amount of water, as stated in Exhibit A, for all Master Meters furnishing water to Greeley, the District shall bill Greeley for the balance due in January of the following year.

7.7 For water service customers within the North Greeley Service Area, Greeley and the District shall establish their own separate rates, fees, and raw water requirements in accordance with the legal procedures and policies applicable to each entity.

ARTICLE 8
INCREASES IN PEAK DEMAND; TRANSFER OF CUSTOMERS; AND EXCLUSION OF TERRITORY FROM THE DISTRICT'S SERVICE AREA

8.1 The Parties have consulted with each other concerning the North Greeley Service Area using the following criteria: natural drainage patterns, topography, existing installations of capital facilities, the probable future needs of customers, the most cost-efficient means for delivering water service, and considerations which reduce the cost of service or result in higher quality of service to the customer. Based on the foregoing, the Parties agree that Greeley shall be responsible for providing water service to new customers within the North Greeley Service Area and, except as provided in this Agreement, the District shall not provide water service to new customers in the North Greeley Service Area.

8.2 The District presently provides water service to a number of customers within the North Greeley Service Area. Existing customers will continue to be served by the Party presently providing water service, except as provided for herein or as otherwise mutually agreed upon in writing by the Parties.

8.3 The District shall refer to Greeley any request it receives for water service within the North Greeley Service Area. Upon receipt of the referral, Greeley will determine whether it intends, or has the infrastructure in place, to provide water service to the applicant. Greeley shall provide written notice of its determination to the applicant and to the District as soon as possible but no later than ninety days after receipt of the application. If Greeley declines to provide water service to the applicant, then the District may provide water service.

8.4 As Greeley extends water service to new development, but prior to annexation by Greeley, Greeley and District may transfer existing District customers to Greeley's water system within the North Greeley Service Area, if Greeley determines that it intends, or shall have infrastructure in place, to provide water service to the existing customer.

8.5 When existing District customers are transferred to Greeley, the District shall permanently transfer to Greeley one unit of CBT per equivalent three-quarter inch tap transferred. In addition, the District shall credit Greeley with one gallon per minute

Plant Investment Fee per equivalent three-quarter inch tap transferred. Greeley shall, in turn, purchase from the District the annual usage of that tap at a Master Meter. The annual usage shall be set at 120,000 gallons per equivalent three-quarter inch tap. Both the annual use and the Plant Investment Fee credit shall be reflected in Exhibit A.

8.6 If Greeley expects additional demand above the peak demand of the transferred customer(s) as established in section 8.5, Greeley shall make written request to the District for the furnishing of additional water to meet such additional expected demand. Upon receipt of such written request, the District shall have thirty days to notify Greeley in writing of its decision and terms to supply such additional water. If the District decides to furnish such additional water, Greeley shall provide the Raw Water Requirements and pay the then existing Plant Investment Fee adopted by the District for each additional one gallon per minute beyond the peak demand amount specified in Exhibit A.

8.7 If the District expects additional master meters, water usage, or demand above the peak demand identified in Exhibit A upon the effective date of this Agreement, the District shall make written request to Greeley for the furnishing of additional water to meet such additional demand. Upon receipt of such written request, Greeley shall have thirty days to notify the District in writing of its decision and terms to supply such additional water. If Greeley decides to furnish such additional water, the District shall provide Greeley a Plant Investment Fee credit for each additional one gallon per minute peak demand requested by the District. Greeley may, in turn, assign or apply such credit at any Master Meter, identified in Exhibit A, that is furnishing water to Greeley as Receiving Party.

8.8 Following annexation of property located within the North Greeley Service Area and upon receipt of notice of intent to exclude territory, the District shall transfer to Greeley, within one year from the date of notice, all of the District's customers and infrastructure within the annexed area. Such transfer shall include all facilities, which are owned or maintained by the District, necessary to provide such service from the Master Meter(s) to the point of connection at the customer's facilities, including but not limited to mains, local distribution lines, meters, meter pits, booster pumps, easements, permits, or rights of way and valves. Such transfer shall not include any transmission lines or associated facilities, distribution lines or associated facilities, easements, permits, or rights of way the District determines are necessary to serve other existing or potential customers of the District. As consideration for such transfer, the following provisions shall apply:

8.8.1 In accordance with the District's Master Plan, the District anticipates serving an average of two three-quarter inch equivalent taps per every five acres of its service area that is located within the North Greeley Service Area. The Parties agree that the District's anticipated annual usage shall equal an annual use of 240,000 gallons of water per five acres. Therefore, as Greeley excludes portions of the District's territory from the North Weld Service Area, Greeley shall compensate the District by purchasing a minimum annual amount of water from

the District at Master Meters. The minimum annual amount of water shall be calculated based on the greater of either (1) the product of 240,000 gallons of water per five acres of all territory excluded in accordance with this section 8.8 or (2) the total annual usage of each equivalent three-quarter inch tap transferred to Greeley in accordance with section 8.5. The minimum annual amount shall be reflected in Exhibit A.

8.8.2 Greeley shall provide the District fair compensation for all facilities transferred from the District to Greeley, taking into account depreciation. The value determination provisions set forth in C.R.S. § 32-1-502, as the same may be amended from time to time, shall govern such compensation.

8.8.3 Greeley shall be responsible for all reasonable costs, excluding attorney fees, associated with the transfer of customers from the District to Greeley within the North Greeley Service Area. However, in the event litigation is pursued against Greeley and/or the District by a transferred customer, the parties shall be responsible for their own costs, expenses, attorney fees and awards, if any.

8.8.4 Exclusion of land from North Weld's territory shall occur before any further subdivision of the property.

8.9. At the time of transfer of customers and facilities to Greeley, North Weld shall provide the best available and known information regarding locations of water lines, meters, appurtenances, and other associated facilities to the best knowledge of the District. Greeley and the District agree to cooperate in preparation and transfer of such information as the Parties deem necessary. North Weld maintains responsibility for locating any of their active or abandoned lines including all asbestos-cement pipe. Any North Weld line transferred to Greeley becomes Greeley's responsibility for One-Call locating. North Weld will for two years assist Greeley in location of any transferred lines, including potholing and establishing position with GPS.

ARTICLE 9
TAXES AND EXCLUSION

9.1 Portions of the North Greeley Service Area are within the District's service area. Pursuant to Colorado Law, the District has authority to assess property taxes by imposition of a mill levy upon property within the District; however, at the time of this Agreement, no such assessment or levy is in place.

9.2 The District agrees that there shall be no property tax assessment or mill levy on any properties within the boundaries of the District that may be located in the North Greeley Service Area and annexed by Greeley. If it is determined to be necessary and/or required by law, the District agrees to exclude from its service area all such property located in the North Greeley Service Area and annexed by Greeley.

ARTICLE 10
GENERAL TERMS AND REMEDIES

10.1 This Agreement shall be effective on the date first above written and remain in effect on a perpetual basis unless terminated as provided in this Article.

10.2 The Parties agree to act in good faith and to the best of their ability in taking all steps necessary to fully implement the terms and conditions of this Agreement, including the execution and delivery of such other documents, certificates, agreements and other writings and the taking of such other actions as may be necessary or desirable to consummate or implement this Agreement. The Parties agree that this Agreement shall be construed and enforced as the fully integrated expression of their contract with respect to the matters addressed herein. No express or implied covenants not specifically set forth shall be deemed to be a part of this Agreement. The Parties expressly aver that no representations other than those specifically set forth in this Agreement have been relied upon by either Party to induce it to enter into this Agreement.

10.3 The Parties shall use reasonable diligence to provide a constant and uninterrupted supply of water, except for interruption or reductions due to: (1) Uncontrollable Forces; (2) operations or devices installed for water system protection; and (3) maintenance, repair, replacement, installation of equipment, or investigation and inspection of the water system, which interruption or reductions are temporary, and in the opinion of the Furnishing Party, necessary. Excepting cases of emergency, the Receiving Party will be given reasonable advance notice of such interruptions. Neither Party shall be considered in default under this Agreement if prevented from fulfilling any obligations by reason of Uncontrollable Forces. A Party rendered unable to fulfill its obligation by reason of Uncontrollable Forces shall exercise due diligence to remove such inability with all reasonable dispatch.

10.4 The Parties have implemented their own respective water conservation plans and shall not be required to adopt the other Party's conservation plan in whole or in part.

10.5 The invalidity or un-enforceability of any provision of this Agreement shall not affect or impair any other provision unless material to the performance of either Party.

10.6 Neither Party may assign or transfer all or any part of this Agreement without the prior written consent of the non-assigning Party which consent will not be unreasonably withheld.

10.7 In the event of a material breach of any provision of this Agreement by any Party, which is not corrected within one year from the date of notice of the breach, the non-defaulting party may either terminate or pursue litigation for specific performance of this Agreement. However, if this Agreement is terminated by the District due to an uncorrected material breach of any provision of this Agreement by Greeley, the District

will not cease water service to Greeley until after two years from the written date of notice of the breach. In the event of an uncorrected material breach of any provision of this agreement by the District, Greeley may terminate this Agreement due to said material breach in which case termination shall be effective two years from the written date of the notice of the breach.

10.8 The Parties agree that, in addition to any other remedies allowed by law consistent with this Agreement, the provisions of this Agreement may be specifically enforced in a Court of competent jurisdiction and, in any judicial action, the unsuccessful party agrees to pay all reasonable costs of such action as actually incurred by the successful party, including attorney fees. Venue for any action shall be the District Court in and for Weld County, Colorado.

10.9 None of the remedies provided for under this Agreement need to be exhausted or exercised as a prerequisite to either party's pursuit of further relief to which it may be entitled. No Party shall waive its rights hereunder by failing to exercise its rights; any such failure shall not affect the right of such Party to exercise at some future time the rights not previously exercised.

10.10 In the event Greeley desires to terminate this Agreement, Greeley shall give written notice to the District of such intent in accordance with the notice provisions of this Agreement. Twenty years after the giving of such notice, District shall no longer furnish water to the North Greeley Service Area through the Master Meters. However, during this twenty year period Greeley shall be obligated to take and pay for, or in the alternative pay for, the minimum annual volume of water defined by Exhibit A. All other provisions and terms of this Agreement, including but not limited to the establishment and descriptions of the North Greeley Service Area, shall remain in effect.

10.11 It is expressly understood and agreed that the terms and the enforcement of the terms and conditions of this Agreement, and all rights of action relating to such enforcement, are strictly reserved to the undersigned Parties and nothing in this Agreement shall give or allow any claim or right or cause of action whatsoever by any other person not included in this Agreement. It is the express intention of the undersigned Parties that no person and/or entity, other than the undersigned Parties, receiving services or benefits under this Agreement shall be deemed any more than an incidental beneficiary only.

10.12 Any notice, demand or request delivered by mail, in accordance with this Agreement shall be deemed given seventy-two hours after the same is deposited certified mail, in any post office or postal box regularly maintained by the United States Postal Service addressed to the District at P.O. Box 56, Lucerne, CO, 80646 and to Greeley, attention to the Director of the Water and Sewer Department, at 1100 10th Street, 3rd Floor, Greeley, CO, 80631. The addresses may be changed at any time by similar notice.

10.13 Nothing herein shall constitute a multiple fiscal year obligation pursuant to

Colorado Constitution Article X, Section 20. Notwithstanding any other provision of this Agreement, Greeley's obligations under this Agreement are subject to annual appropriation by the City Council of the City of Greeley. Any failure by the Greeley City Council to annually appropriate adequate monies to finance Greeley's obligations under this Agreement shall terminate this Agreement in accordance with paragraph 10.10 at such time as such then-existing appropriations are to be depleted. Notice shall be given promptly to the District of any failure to appropriate such adequate monies.

10.14 To the extent legally possible, each Party shall indemnify and hold the other Party harmless from and against any and all liability, loss, damages, costs and expenses, including reasonable attorney fees, arising from the identifying Party's negligence, including but not limited to, negligent delivery of water at rates or pressures which exceed the maximum pressure or do not meet the minimum pressure established on Exhibit A. By such agreement to indemnify and hold each other harmless, neither Party waives any defenses and immunities to third Parties, which it would otherwise be entitled under the Colorado Governmental Immunity Act.

10.15 This Agreement, along with all exhibits and addendums and amendments hereto, encompasses the entire agreement of the parties, and supersedes all previous understandings and agreements between the parties, whether oral or written. The terms of the Water Supply Agreement dated August 26th, 2011 ("August 26th, 2011, Agreement"), shall remain in effect, except that all exhibits attached to the August 26th, 2011, Agreement shall be incorporated and reflected in the corresponding exhibit that are attached hereto and thus superseded hereby. The parties hereby acknowledge and represent, by affixing their hands and seals hereto, that said parties have not relied on any representation, assertion, guarantee, warranty, collateral contract or other assurance, except those set out in this Agreement, made by or on behalf of any other party or any other person or entity whatsoever, prior to the execution of this Agreement. The parties hereby waive all rights and remedies, at law or in equity, arising or which may arise as the result of a party's reliance on such representation, assertion, guarantee, warranty, collateral contract or other assurance, provided that nothing herein contained shall be construed as a restriction or limitation of said party's right to remedies associated with the gross negligence, willful misconduct or fraud of any person or party taking place prior to, or contemporaneously with, the execution of this Agreement.

IN WITNESS WHEREOF, the Parties have executed this Agreement the day and year first above written.

ATTEST:

By: Robert Ambrecht
Secretary

NORTH WELD COUNTY WATER DISTRICT

By: Charles Ackiger
President

APPROVED AS TO LEGAL FORM:
Lind & Ottenhoff LLP

By: _____
Kenneth F. Lind

CITY OF GREELEY, COLORADO

By: _____
Mayor

By: _____
City Clerk

APPROVED AS
TO SUBSTANCE:

By: _____
City Manager

APPROVED:
Greeley Water & Sewer Board

By: _____
Chairperson

APPROVED AS TO LEGAL FORM:

By: _____
City Attorney

APPROVED AS TO AVAILABILITY OF FUNDS:

By: _____
Director of Finance

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Appendix F

Comprehensive Plan for Demand Projections

The following table and figures provides residential and nonresidential projected water demands used as an aid for the development of future water demands.

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Appendix F - Comprehensive Plan for Demand Projections

Table F-1 - City of Greeley Markup Map Summary (Tier 2)

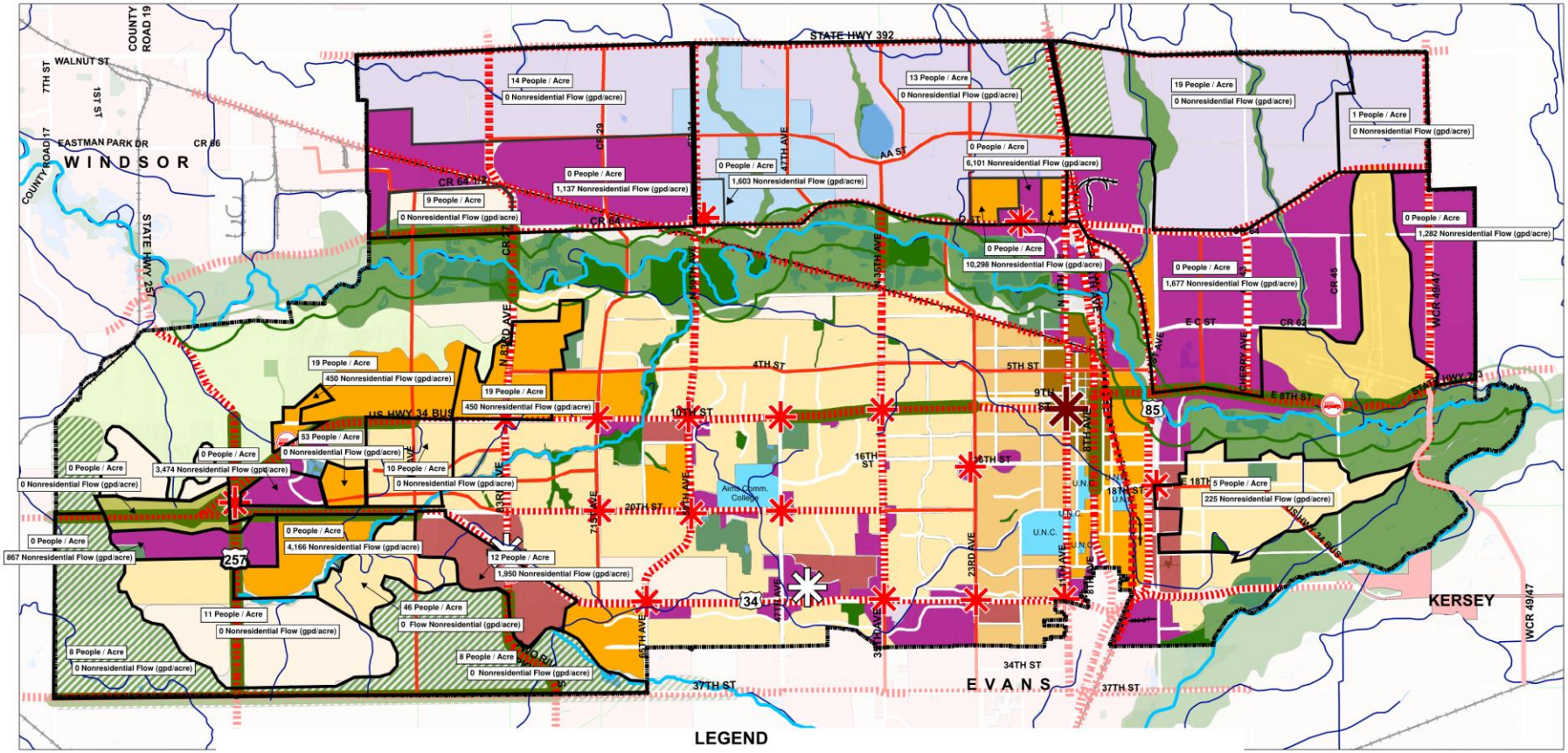
Markup Areas	Area	Percent of Total Area per Nonresidential Land Use Category				Percent of Total Area per Residential DU/Acre Category				Projected Population	Projected Residential Demand	Projected Nonresidential Demand
	(acres)	C-L	C-H	I-L	I-M	1.0	2.5	4.0	20	(people)[1]	(gpd)	(gpd)
83rd Avenue/Highway 34	589		65%						35%	7,003	791,339	1,147,601
83rd Avenue/10th Street	649		15%					45%	40%	12,456	1,407,528	292,247
20th Street North	895		25%					50%	25%	13,162	1,487,306	671,516
Southeast Bluffs	130		15%					45%	40%	2,499	282,387	58,626
North of the River – East 1	2,006		10%		80%	10%				622	70,286	1,805,587
North of the River – East 2	5,734		20%		30%			35%	15%	54,128	6,116,464	4,730,450
North of the River – West 1	4,417		15%		10%	10%		50%	15%	51,285	5,795,205	2,319,069
North of the River – West 2	3,793		10%		20%	30%		30%	10%	30,531	3,450,003	1,706,727
East Greeley	1,358				30%	40%		30%		6,736	761,168	305,549
Southwest Greeley	2,906						100%			22,520	2,544,760	0
Interchange 34 West	3,676		20%		10%			50%	20%	47,786	5,399,818	2,481,177
									Total	**248,728**	**28,106,264**	**15,518,549**

[1] For 20 DU/acre, 1.7 people per DU was assumed. For 1-4 DU/acre, 3.1 people per DU was assumed.

Note:

- The following map shows the areas from Table F-1. Each area has been subdivided to vary the density similarly to the original comprehensive plan. The City directed CDM Smith to distribute the residential/non-residential demand to each of the sub-divided areas.
- Each subdivided area is shown in black outline with labels for the resulting projected growth.
- To enable comparison to future development, the resulting people/acre and non-residential flow/acre has been shown.

LAND USE GUIDANCE MAP



LEGEND

CENTERS
- Downtown Center
- Regional Center
- Neighborhood Center

CORRIDORS
- Multi-Modal Corridor
- Special Multi-Modal Corridor Landscaping
- Poudre River Greenway

SPECIAL RECOMENDATIONS
- Potential Fire Station Locations

AREAS
- Airport Area
- Higher Education Hubs
- Employment, Industrial, and Commercial Areas
- North Annexation Area
- Mixed Use High Intensity
- Urban Reserve

OPEN LANDS & NATURAL AREAS
- Bluffs
- Community Separator
- Entryway Character Corridor
- Riparian Land
- City Owned Natural Areas

Town of Kersey
- Town of Kersey

NEIGHBORHOODS
- Rural
- Suburban
- Legacy Urban
- Mixed Use
- Downtown

N

0 0.375 0.75 1.5 2.25 3 Miles

Date of Preparation 12/1/17

IMAGINE GREELEY

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Appendix G

Comprehensive Plan Action Item List

The City adopted the *Imagine Greeley Comprehensive Plan* in 2018, which is a policy guide that provides framework for public and private growth and development decisions made by the City over the next ten to twenty years. As a part of the Comprehensive Plan, a list of recommended actions was identified in Section 5 to assist in implementation of this plan. A summary of action items addressed with the development of this WTDMP to ensure implementation of the Comprehensive Plan is summarized in the following table.

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INFRASTRUCTURE (IN)

IMPLEMENTATION ACTION	WATER MASTER PLAN ACTION ITEM RESPONSE
Goal IN-1: Ensure developed areas in Greeley are served by adequate public facilities and services.	
IMP IN-1.1 Annually review and update the City's Adequate Public Facilities Area (APFA) concurrent with annual growth and development projections to assist in the planning and funding of municipal infrastructure to accommodate growth. Prepare maps depicting the boundaries of existing and budgeted service areas for infrastructure included in the APFA requirements.	**While the WTDMP does not review or update the APFA, this master plan identifies the critical infrastructure needed to serve all major developable areas within the LREGA (Section 4) and the anticipated CIP cost (Section 5). This master plan will assist in planning and funding of municipal infrastructure and determine the anticipated infrastructure to meet the APFA requirements.**
IMP IN-1.2 Continue to support timely and effective development in the Long Range Expected Growth Area as it relates to 208 Wastewater planning and treatment. Where possible and practical, look for opportunities to share and/or coordinate such capital improvements with other jurisdictions to efficiently use public resources.	**This master plan identified infrastructure upgrades and future infrastructure needs to serve the Greeley up to the LREGA. The City held regional stakeholder meetings with adjacent municipalities to evaluate opportunities to coordinate and plan for future growth. A summary can be found in Appendix C. The major highlights of the stakeholder meetings;** • **Evaluate ways to increase service to the existing municipal customers including Windsor, Milliken, and Evans as their demands increase in the future.** • **Coordinate activities under the existing intergovernmental agreement with North Weld Water District to serve areas north of the Poudre River as Greeley's growth boundaries extend into North Weld's existing service area** • **Consider adding emergency connections to other municipalities to improve reliability.** • **Review opportunities to share major capital projects that may benefit the future needs for infrastructure improvements of neighboring water purveyors.**
IMP IN-1.3 Through the annual Population Growth and Projections and Capital Improvements Plan, identify the location for new fire stations, parks and other public facilities commensurate with the City's expected growth.	**Not Applicable**

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IMPLEMENTATION ACTION	WATER MASTER PLAN ACTION ITEM RESPONSE
IMP IN-1.4 Complete and implement a basin-wide study that addresses drainage improvements through larger, shared, facilities which could also achieve an attractive, functional community or regional park use.	**Not Applicable**
IMP IN-1.5 Evaluate existing capacity within established areas of the city to understand where investments in expanding infrastructure will be needed in order to support the type and/or intensity of development envisioned in the Land Use Guidance Map	**This master plan has evaluated existing infrastructure to confirm sufficient capacity with the existing conditions, with future development of infill and densification of parcels, and full buildout as envisioned by the Land Use Guidance Map.**
IMP IN-1.6 Update existing functional master plans for infrastructure and services as needed to account for changes in land uses and intensities that result from the adoption of this Comprehensive Plan and completion of implementation actions.	**This masterplan incorporates improvements made to the water distribution system from the most recent water masterplan completed in 2003 and the most recent updates to the hydraulic model completed in 2018. This masterplan has incorporated recent land use applications, utilized the Comprehensive Plan to update land uses and anticipated densities, and addressed areas outside of the 20-year plan through guidance and coordination with the planning department.**
IMP IN-1.7 Develop functional master plans detailing the maintenance, operation, and expansion of infrastructure and public facilities where such documents do not currently exist.	**Not Applicable**
IMP IN-1.8 Consider the extension of water lines to serve larger groups of users and along primary roadways to provide non-potable water to landscaped medians and parkways.	**Not Applicable**

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INFRASTRUCTURE (IN)

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
Goal IN-1: Ensure developed areas in Greeley are served by adequate public facilities and services.			
IMP IN-1.1 Annually review and update the City's Adequate Public Facilities Area (APFA) concurrent with annual growth and development projections to assist in the planning and funding of municipal infrastructure to accommodate growth. Prepare maps depicting the boundaries of existing and budgeted service areas for infrastructure included in the APFA requirements.	**Lead** Community Development **Partners** Planning Commission Public Works Police Fire Water and Sewer Culture, Parks, and Recreation	Policies and Programs	Ongoing
IMP IN-1.2 Continue to support timely and effective development in the Long Range Expected Growth Area as it relates to 208 Wastewater planning and treatment. Where possible and practical, look for opportunities to share and/or coordinate such capital improvements with other jurisdictions to efficiently use public resources.	**Lead** Water and Sewer **Partners** Community Development	Policies and Programs	Ongoing
IMP IN-1.3 Through the annual Population Growth and Projections and Capital Improvements Plan, identify the location for new fire stations, parks and other public facilities commensurate with the City's expected growth.	**Lead** Community Development **Partners** Culture, Parks, and Recreation Police Department Fire Department	Policies and Programs	Ongoing
IMP IN-1.4 Complete and implement a basin-wide study that addresses drainage improvements through larger, shared, facilities which could also achieve an attractive, functional community or regional park use.	**Lead** Public Works **Partners** Culture, Parks, and Recreation	Plans	Near-Term

IMPLEMENTATION ACTION	RESPONSIBILITY	TYPE	TIMEFRAME
IMP IN-1.5 Evaluate existing capacity within established areas of the city to understand where investments in expanding infrastructure will be needed in order to support the type and/or intensity of development envisioned in the Land Use Guidance Map	**Lead** Water and Sewer **Partners** Public Works Culture, Parks, and Recreation Community Development	Policies and Programs	Near-Term
IMP IN-1.6 Update existing functional master plans for infrastructure and services as needed to account for changes in land uses and intensities that result from the adoption of this Comprehensive Plan and completion of implementation actions.	**Lead** All City Departments	Policies and Programs	Near-Term
IMP IN-1.7 Develop functional master plans detailing the maintenance, operation, and expansion of infrastructure and public facilities where such documents do not currently exist.	**Lead** All City Departments	Plans	Near-Term
IMP IN-1.8 Consider the extension of water lines to serve larger groups of users and along primary roadways to provide non-potable water to landscaped medians and parkways.	**Lead** Water and Sewer **Partners** Culture, Parks, and Recreation Community Development	Public Investments	Long-Term
Goal IN-2: Ensure the design, construction, and appearance of City infrastructure and facilities contributes to the character of the community.			
IMP IN-2.1 Evaluate current best practices in designing, developing, and constructing green infrastructure and incorporate appropriate practices into the City's approach to stormwater management.	**Lead** Public Works **Partners** Culture, Parks, and Recreation Community Development	Policies and Programs	Near-Term
IMP IN-2.2 Evaluate, and update as needed, existing design guidelines for infrastructure and public facilities to ensure aesthetics and considerations for the visual or quality of life impacts on surrounding neighborhoods are considered.	**Lead** Public Works **Partners** Water and Sewer Culture, Parks and Recreation Community Development	Regulatory Revisions	Long-Term

PLANNING COMMISSION SUMMARY

ITEM: Amending Title 24 of the 2021 Greeley Municipal Code to Recommend Approval of Chapter 3 – Subdivision Standards, Chapter 4 – Zoning Districts and Uses, Chapter 5 – Residential Development Standards, Chapter 6 – Nonresidential Development Standards, and Chapter 13 – Definitions and Terms to be Adopted by Ordinance

PROJECT: Title 24 – Chapter 3 – Subdivision Standards
Title 24 – Chapter 4 – Zoning Districts & Uses
Title 24 – Chapter 5 – Residential Development Standards
Title 24 – Chapter 6 – Nonresidential Development Standards
Title 24 – Chapter 13 – Definitions & Terms

FILE NO: Title 24 – Chapters 3-6 & 13 – CU2021-0005

LOCATION: (City-wide)

APPLICANT: City of Greeley, Community Development Department

CASE PLANNER: Carol Kuhn, AICP, Chief Planner

PLANNING COMMISSION HEARING DATE: July 27, 2021

PLANNING COMMISSION FUNCTION:
The Planning Commission shall consider the staff report, along with testimony and comments made by the staff and the public, and shall then make recommendations to the City Council regarding the proposed amendment to the Development Code.

PROJECT OVERVIEW AND BACKGROUND:
The Community Development Department is undertaking a multi-year project to update the Development Code, with an anticipated final adoption in September of 2021. The last major update to the Development Code was in 1998. A Plan Conformance Report was prepared and used as a guide to determine areas where the code could be improved to conform to the Comprehensive Plan and other policy documents; staff reviewed this report with the citizen Advisory Committee, Planning Commission, and City Council.

The Development Code, Title 18 of the City's Municipal Code, was recently recodified into Title 24 as part of a citywide initiative.

On June 22, 2021 and July 20, 2021, Staff conducted a worksession with the Planning Commission regarding the proposed revisions for Chapters 3-6 and presented Planning Commission with draft code language for Chapters 3-6 during the July worksession.

The proposed schedule for the adoption of the Development Code is as follows:

Track	**Chapter(s)**	**PC Worksession**	**PC Hearing**	**CC Public Hearings**
Track I - Non-substantive changes for organization and improved usability.	Ch 1 – General Provisions	March 23, 2021	April 13, 2021	June 1, 2021 (First Reading) June 15, 2021 (Public Hearing) September 21, 2021 (Final Adoption)
	Ch 2 - Procedures	April 27, 2021	May 18, 2021	
Track II - Non-policy technical changes and coordination with other City policies and documents.	Ch 7 – Access & Parking Ch 8 – Landscape & Site Design Standards Ch 9 – Signs Ch 10 – Special Purpose Districts & Areas Ch 11 – Supplemental Standards Ch 12 - Reserved	May 25, 2021	June 8, 2021	July 6, 2021 (First Reading) July 20, 2021 (Public Hearing) September 21, 2021 (Final Adoption)
Track III - Substantive changes called for in the Comprehensive Plan, Strategic Housing Plan, and Council's 3-Year Priorities that need broader input and direction from the Advisory Committee, Planning Commission, and City Council.	Ch 3 – Subdivision Standards Ch 4 – Zoning Districts & Uses Ch 5 – Residential Development Standards Ch 6 – Non-residential Development Standards Ch 13 – Definitions	June 22, 2021 -and- July 20, 2021	July 27, 2021	August 17, 2021 (First Reading) September 7, 2021 (Public Hearing) September 21, 2021 (Final Adoption)

KEY ISSUES / STAFF ANALYSIS:
The attached drafts of Chapters 3-6 and 13 include updates related to subdivision standards, zoning districts, uses, residential development and design standards, nonresidential development and design standards, and definitions and terms:

Chapter 3. Subdivision Standards

24-301	Streets
24-302	Parks & Trails
24-303	Blocks & Lots
24-304	Required Improvements
24-305	Adequate Public Facilities

This chapter provides planning, engineering, and urban design standards for subdivisions. It establishes development patterns and infrastructure requirements as land is divided and ownership fractures. The changes in this code integrate more "urban design" elements into the planning and development process at this key preliminary stage of development.
Specific provisions would include:
Reorganization of all of the subdivision standards into five key components of large-scale development patterns – Streets, Parks & Trails, Blocks & Lots, Required Improvements, and Adequate Public Facilities (infrastructure).

- *Streets.* Consolidate current street standards from various documents (current Development Code, Public Works Specifications, and Transportation Plan) and include the following additions:
  - Refine the standards related to street connectivity to distinguish different contexts in the plan – primarily distinguishing walkable areas and car-oriented areas.
  - Make the narrow neighborhood street, allowed only as a "performance option" in the current code, applicable for all neighborhoods, provided sufficient connectivity and appropriate neighborhood design features to complement this street type are included.
  - Add walkable mixed-use / commercial streets for application in the "centers" and mixed-use areas identified in Imagine Greeley Comprehensive Plan.

Chapter 4. Zoning Districts & Uses

24-401	District Intent & Applicability
24-402	Allowed Uses
24-403	Accessory Uses
24-404	Specific Use Standards
24-405	District Performance Standards

This chapter establishes the zoning districts; uses are either allowed "by right," subject to the applicable district development and design standards, or are permitted through a Use by Special Review application process, with specific standards unique to that use. This chapter would include few revisions, but would modify the existing standards by:

- Focusing purely on land use, with the zoning district development standards moved to either Chapter 5 (residential) or Chapter 6 (Nonresidential).
- Adding two new Mixed-Use (MU-) districts – MU-L (Low Intensity) and MU-H (High Intensity), which would be proposed as counterparts to the existing commercial (C) districts. These proposed additions are based on the Placemaking discussions with the Advisory Committee, Planning Commission, and City Council. These new districts could be used for new development projects; no existing zoning would be changed through the code update – any applications to rezone to MU-L or MU-H would be applicant-initiated.

Chapter 5. Residential Development Standards

24-501	Intent & Applicability
24-502	Residential Development Standards
24-503	Residential Design Standards
24-504	Neighborhood Features & Common Areas
24-505	Courtyard Pattern
24-506	Residential Micro-Housing District

This chapter includes all of the development and design standards for residential neighborhoods. It consolidates the various residential lot, setback, and height standards, and it incorporates community and building/lot design standards from the current code. All of the topics in this section are currently regulated. These proposed modifications aim to: (1) simplify current standards into objective, measureable standards; (2) focus or emphasize a key component of the current design standards; and (3) create more nuance and distinctions for standards based on the context of a particular neighborhood. Specific revisions to note are:

- *Residential Building Types*. The current standards are a mix of district and building type standards; the proposed revisions shift to a "building type" approach, and place a greater emphasis on "missing middle" housing – higher-density, smaller-scale, multi-unit projects. Changes impacting the existing residential districts are:
  - R-E. No change
  - R-L. Allowing a minimum lot size of 4,500 s.f. lot by right, which is currently allowed through the cluster option.
  - R-M. Increasing the range of building types allowed - specifically the lower end of the "missing middle" types (smaller lot detached houses and small-scale multi-unit buildings, and accessory dwelling units (ADUs))
  - R-H – No significant change, but added specific language regarding standards that may apply to the missing middle building types and promoting these more as strategies for infill.
- *Residential Design Standards.* In the current code, the residential standards are scattered throughout the code. Similar sections repeat throughout the code, but may be phrased differently and reference similar areas of residential design, sometimes causing conflicts and interpretation issues. This section reorganizes the standards to focus on three key components – frontage design, building design, and block and lot design. Over the last few months, staff worked with a homebuilders focus group to refine the existing standards and fine-tune the draft regulations.

- *Neighborhood Features & Common Areas*. This section would establish design standards for neighborhoods and ensure connectivity for open spaces, trails, and parks.
- *Courtyard Pattern.* This pattern is related to a specific infill strategy, but it could also be used in new developments. For this housing type, an exception would be made to allow lots to not front a street and to allow for a minor lot size reduction. This pattern would combine the "missing middle" housing options and the smaller formal open space options into a particular type of residential development that can increase housing options while supplying a higher level of neighborhood design.
- *Residential Micro-Housing District*. These changes would reflect the standards for the existing R-MH district but would also include the following changes:
  - Improve the neighborhood / community design of these projects based on the same principles applied to all neighborhoods – emphasizing the streets and open spaces and improving the relation of housing sites and buildings to those spaces;
  - Reduce the overall project size to allow projects to fit into more areas;
  - Align the density and lot sizes with comparable typical manufactured housing sites;
  - Broaden the applicability of this district to more types of small format housing that would meet the same scale, pattern, design, and intensity standards.

Chapter 6 Nonresidential Development Standards

24-601	Intent & Applicability
24-602	Nonresidential Development Standards
24-603	Nonresidential Design Standards

This chapter includes all of the development and design standards for nonresidential development. Similar to Chapter 5, it consolidates the various commercial and industrial zoning districts found throughout the current code. The topics of the design standards are all addressed in the current code, but are not well-coordinated and are difficult to follow. Many are addressed in alternatives or performance options, but do not have clear criteria as to when and where they should apply. Proposed changes to this section include (1) adding more specific criteria for the circumstances where alternatives and options should apply, (2) emphasizing the primary goal of the design standards (to create better relationships to the public spaces and strengthen the character of an area), and (3) mitigating impacts on surrounding property.
Specific sections to note include:

- *Nonresidential Development Standards.* This section would capture the existing district standards, but add limits on the scale of lots for the new mixed-use districts to promote compact, walkable patterns (maximum sizes, rather than minimum).
- *Nonresidential Design Standards*. An outcome of the placemaking facilitated discussions was to "bundle" most of the building and design standards into packages that escalate as the building moves closer to the street. Key aspects of this strategy include:
  - Build on topics already regulated in the current code by simplifying them into building placement and orientation, transparency, and facade design.
  - Provide options for street-front buildings as well as allow for the existing commercial districts to maintain the default to more car-oriented patterns (C-L and C-H) with a

minimum of a 25' setback, with basic building design standards to reflect existing standards.

- Provide an option for two new mixed use districts (MU-L and MU-H, unmapped) to allow for more options outside of a Planned Unit Development process. These new zone districts would have default standards oriented toward more pedestrian-oriented patterns (0' – 10' setback, with enhanced human scale design), but would allow options for more relaxed standards in specific cases.
- Create a simplified approach using building form and design standards for specific areas, based on a block-by-block urban design pattern.

Chapter 13. Definitions & Terms

24-1301 Definitions
24-1302 Architecture & Design Terms

This chapter includes most of the definitions currently spread throughout various sections of the code. Where multiple definitions were referenced in the existing Title 24, the terms and definitions have been consolidated into one chapter. However, in certain chapters, terms and definitions have a particular meaning and these terms remain in their associated chapters for interpretation of that chapter. A glossary of architecture and design terms to explain concepts, strategies, and techniques that are used to affect building and site design has also been included in Chapter 13.

NOTICE AND COMMENTS:
Notice has been published in the Greeley Tribune on July 21, 2021, pursuant to the City's notification requirements for revisions to the Development Code.

The drafts of Chapters 3-6 and 13 were posted on the City's website and referrals were sent to neighboring jurisdictions. No comments were received.

PLANNING STAFF RECOMMENDATION: Approval

PLANNING COMMISSION RECOMMENDED MOTION:
Based on the project summary and attached drafts of Chapters 3-6 and 13, the Planning Commission finds that the proposed revisions to Chapters 3-6 and 13 are consistent with the City's Comprehensive Plan and are necessary and appropriate in meeting the intent of the Comprehensive Plan and to clarify administration of the Development Code. Planning Commission recommends that the City Council adopt Chapters 3-6 and 13 of Title 24 as shown in Attachments A, C, E, G, and I.

ATTACHMENTS:
Attachment A – DRAFT – Chapter 3
Attachment B – Section Map – Chapter 3
Attachment C – DRAFT – Chapter 4
Attachment D – Section Map – Chapter 4
Attachment E – DRAFT – Chapter 5
Attachment F – Section Map – Chapter 5
Attachment G – DRAFT – Chapter 6
Attachment H – Section Map – Chapter 6
Attachment I – DRAFT – Chapter 13

Chapter 3. Subdivision Standards

24-301 Streets
24-302 Parks & Trails
24-303 Blocks & Lots
24-304 Required Improvements
24-305 Adequate Public Facilities

24-301 Streets

a. **Intent.** The intent of the street design standards is to:

1. Plan street networks to connect to adjacent projects, correspond with the topography, and to ensure the proper arrangement of blocks and lots for coordinated long-range growth and development.
2. Emphasize street design as a key determinant of Greeley's community image and unique identity.
3. Integrate street networks and street designs with open spaces to establish a valuable public realm.
4. Build complete and multi-modal networks of well-connected streets, trails, and paths to improve the access, capacity, safety, and efficiency of transportation systems.
5. Plan frequent collector or neighborhood connector streets to link multiple projects or neighborhoods together, and avoid major streets becoming barriers.
6. Use street design to call attention to differing contexts within the City, and to better support development patterns and uses abutting the streets.
7. Design streets to account for all potential users of the streets, including pedestrians, bicycles, automobiles, trucks, and transit.
8. Implement the Greeley Comprehensive Plan and Transportation Master Plan as development occurs, and in particular, the complete street policies and the connectivity policies of those plans.

b. **Street Network.** Arterial, collector, neighborhood connector, and local streets shall generally be laid out according to the policies of the Comprehensive Plan, Transportation Master Plan, and other major street, parks, trail and open space plans. In the absence of more specific guidance in these plans, the following standards shall apply to street networks:

1. *Blocks and Connectivity.* Streets shall be laid out to provide a network of streets and blocks based on the planning context and development pattern as identified in Table 24-3-1:

Table 24-3-1: Block Sizes & Connectivity

Planning Context *Comprehensive Plan Development Framework Categories*	**Block Size**	**Cul-de-sac Limits**
Walkable Commercial & Neighborhoods *Downtown; Downtown, Legacy Urban, and Mixed Use Neighborhoods; Mixed Use Areas and Centers; and any other commercial areas or neighborhoods where walkable patterns are planned.*	200' min. 500' max. 5.5 ac. max.	Prohibited
Suburban Neighborhoods & General Non-residential	260' min. 1,000' max.	500' max.

Table 24-3-1: Block Sizes & Connectivity		
Planning Context *Comprehensive Plan Development Framework Categories*	**Block Size**	**Cul-de-sac Limits**
Suburban Neighborhoods; Employment, Industrial and Commercial Areas; and other areas supporting commercial corridors or employment areas outside walkable centers.	8 ac. max.	

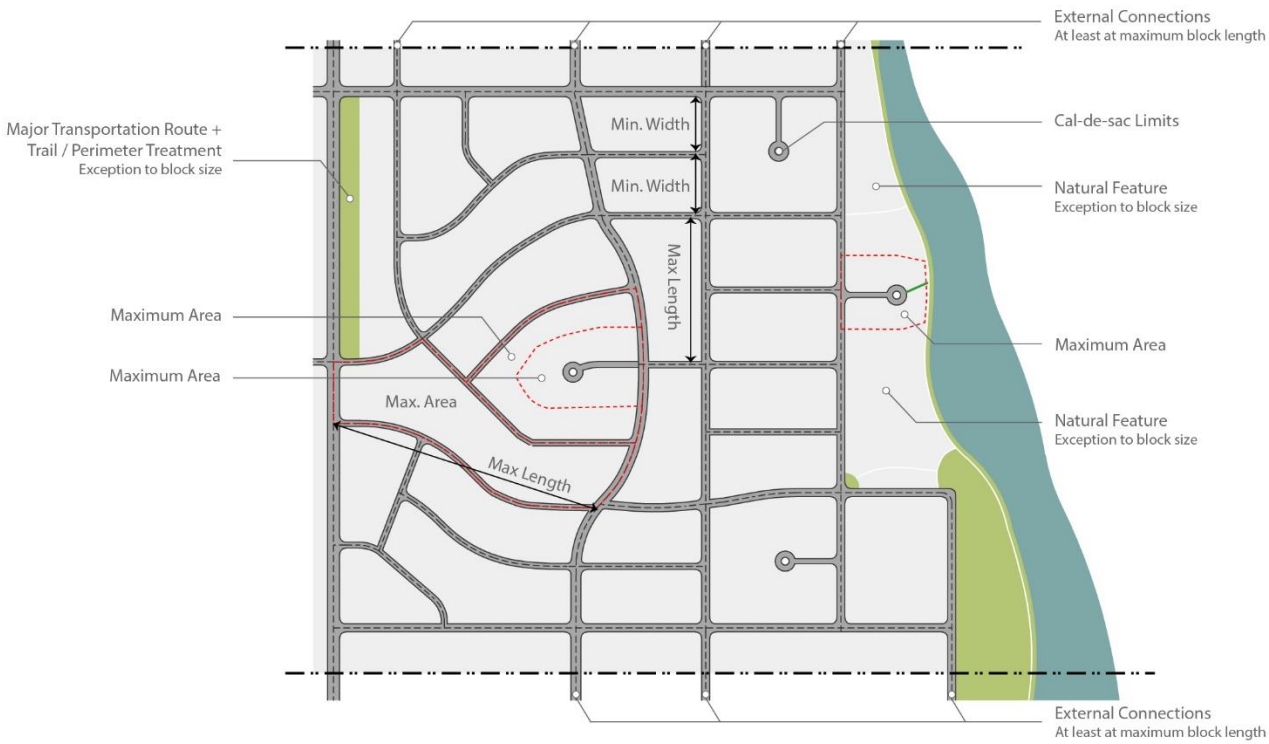


Figure 24-3-1 Connectivity & Block Sizes. Street networks shall be based on maximum block sizes (length between centerlines of perimeter streets and area) and stub to adjacent property at a frequency sufficient to create connected networks, unless exceptions justify not connecting.

2. *Exceptions.* The following are exceptions to the block and connectivity standards in Table 24-3-1:
   (a) *Natural Features, Parks, Trails or Other Civic Spaces.* Blocks or parcels abutting or containing important natural features, topographical constraints or otherwise creating parts of the public parks or common space system, may be larger provided the proposed street layout preserves these features and integrates them into public realm design for the area.
   (b) *Regional Transportation Routes.* Blocks or parcels abutting significant regional transportation routes that impede local network connectivity, such as highways or rail rights-of-way, may be larger provided the street networks and development patterns achieve local connectivity in all other ways possible.
   (c) *Rural Lots or Future Development Tracts.* Property divided into lots of at least five acres for rural or very low-intensity development, or tracts reserved for future development, may exceed block limits provided development is arranged to allow future streets in compliance with these regulations and a logical pattern of re-

subdivision can occur with minimal disruption of buildings, utilities, and other structures.

(d) *Oversized Parcels.* Where oversized parcels are platted for special land uses or projects that involve large-scale buildings and development patterns, such as campuses, large-scale employment complexes, or regional commercial areas, blocks may be larger than specified in Table 24-3-1. Internal access streets shall mimic the block structure in Table 24-3-1, include the urban design amenity of streets in Table 24-3-2, and create logical extensions and connectivity to the public streetscape beyond the project.

(e) In any case where streets are not required to connect by Table 24-3-1 through exceptions to this Section, alternative designs such as loops, eyebrows, closes, or courtyard layouts are preferred over dead ends and cul-de-sacs.

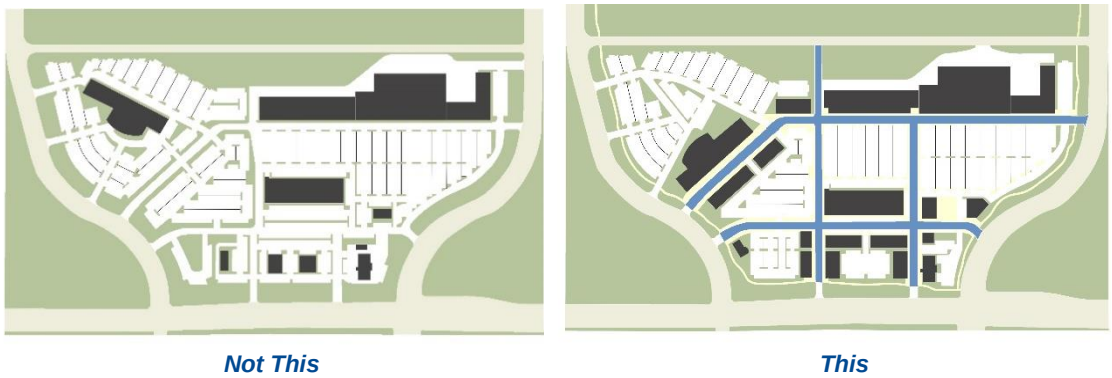


Figure 24-3-2 Internal Access Streets. Internal access streets used to mimic public street networks and streetscapes for over-sized parcels and large scape development (24-301.b.2.(d)).

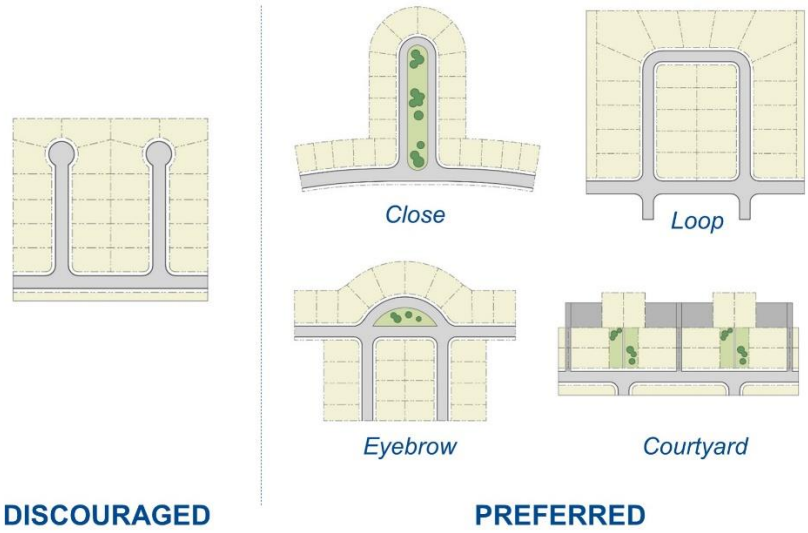


Figure 24-3-3 Disconnected Street Options. Where streets will not connect, blocks and lots should be laid out to limit the need for cul-de-sacs and maximize other options such as loops, closes, eyebrows and courtyard patterns. (24-301.b.2.(e)).

3. *Walkways and Bicycle Routes.* In any case where exceptions for larger blocks apply, or any other area where pedestrian and bicycle connections are important, such as adjacent to schools, parks, trail systems or community centers, the City may require pedestrian walkways or bicycle routes through blocks or at the end of any cul-de-sac. Connections shall be dedicated to the City and meet the City's trail standards or be common areas and meet the Trail or Pedestrian Passage design standards in Section 24-504.

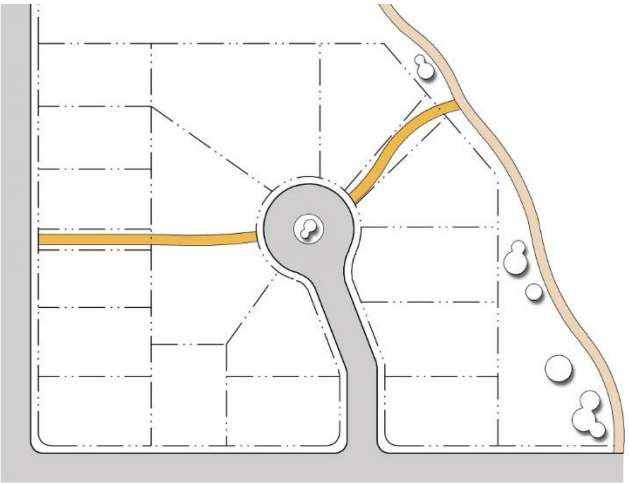


Figure 24-3-4 Walkways and Bicycle Routes. Where streets will not connect or where larger blocks are platted, connections for pedestrians or bikes may be required through blocks or at the ends of disconnected streets. (24-301.b.3).

4. *External Connections.* Streets shall be planned to provide continuation to adjacent undeveloped and future growth areas at intervals of at least the maximum block length in Table 24-3-1, unless justified by an exception in 24-301.b.2. The City may require dedication of right-of-way and construction of streets extended to the boundary line of the property to be subdivided, or approve alternative arrangements for location and timing of construction that equally or better coordinate with anticipated future development of adjacent areas.

5. *Half Streets.* Street systems shall be laid out to eliminate or avoid new perimeter half streets between adjacent property owners. The full right-of-way width of streets shall be dedicated and half-streets shall only be accepted by the City when it conforms to the Transportation Master Plan.

6. *Intersections and Offsets.* Streets shall be laid out to intersect subject to the following:
   (a) Intersection angles should be as near as possible to right angles, and intersections less than 75 degrees are generally not acceptable.
   (b) Oblique streets should be curved approaching an intersection and should be approximately at right angles for at least 100 feet prior to the intersection.
   (c) Intersections should be generally aligned with existing intersections on the opposite side of the street, and offsets of the centerlines between 25 feet and 125 feet are generally not acceptable.
   (d) Intersections of more than two streets at one point are generally not acceptable.

7. *Alternative Compliance*. Alternative compliance to the street network standards established in this Section may be authorized according to the process and criteria in Section 24-208, Alternative Compliance, and where the proposed network meets any of the following additional applicable criteria:
   (a) Better coordinate streets and trail connections with adjacent development, and particularly considering a greater frequency of bicycle and pedestrian connections.
   (b) Implement any officially approved transportation plan for a specific area.

(c) Emphasize unique natural features or better correspond to topography,
(d) Implement traffic calming in a manner that improves pedestrian and bicycle connections.
(e) Create gateways and focal points within the street network by unique arrangements of streets and blocks.
(f) Average block sizes for the project as a whole implement a comparable or greater degree of connectivity, particularly considering the frequency of collector and neighborhood connector streets that can extend beyond the project.

c. **Street Types & Design.** The street types in this section provide typical cross sections to implement context-based street design, design "complete" streets, and result in multi-modal networks for the various contexts in Greeley, based on the policies of the Comprehensive Plan and Transportation Master Plan.

1. *Context & Type.* The street designs are grouped with the following design types for application to specific contexts:
   (a) *Neighborhood Streets.* A neighborhood-oriented residential street type, appropriate where a higher level of neighborhood design amenity and neighborhood walkability is desired. It is characterized by large street trees, wide sidewalks, slow speeds, and occasional on-street parking. Neighborhood streets require a well-connected network to disperse traffic and slow speeds, so that no single street is burdened with high volumes and speeds.
   (b) *Pedestrian Streets.* A pedestrian-oriented commercial or mixed-use street type, appropriate for all areas where walkability is a goal. It is characterized by narrow lanes, slow speeds, on-street parking, wide sidewalks, and large, well-designed pedestrian amenity zones that support social and economic activity along these streets. Pedestrian streets require a highly-connected network so that a variety of street design types can better support abutting uses and urban design characteristics, and ensure that vehicles and pedestrians have multiple alternative and direct routes to destinations.
   (c) *Standard Streets.* A basic street type, appropriate generally where no particular development characteristics or urban design context warrant application of other street types. These streets accommodate peak anticipated vehicle traffic, but seek to balance and integrate other modes of transportation.

2. *Alternative Compliance*. The design standards shown for each street type in Table 24-3-2: Street Types and Cross Sections, are typical. They may be modified based on context and according to the process and criteria in Section 24-208, Alternative Compliance, and any of the following additional applicable criteria:
   (a) The Director shall consult with the Public Works Director to reconcile any planning, urban design, traffic, and engineering issues.
   (b) In contexts where there is constrained rights-of-way, unusual topographic conditions, or unanticipated development pattern and traffic issues, specific elements of the cross section may be modified to best reflect the priorities for the street type expressed in sub-section c.1.
   (c) Any official plan approved by the Planning Commission for streets, or applying specific street types or street sections to a particular area, shall be used by the Director and Public Works Director.
   (d) The Director and Public Works Director may consult the guidance provided by the Transportation Master Plan, or any other street specification and design guides officially authorized by the City that meet the intent of this section.

Table 24-3-2: Street Types & Cross Sections

Street Type	ROW Width	Street Width [1]	Travel Lanes	Edge Condition [2]	Landscape Amenity	Sidewalk	Bicycle Facility [2]	Applicability / Functional Class
Neighborhoods								
Neighborhood Street	54'	30'	16' – 18' yield flow	7' parking both sides	7'+ parkway	5'	N/A slow street / low volume	• Local – Low Volume • Local Residential • 25' – 1-side parking; 20' – no parking
Neighborhood Connector	60'	32' - 34'	2 @ 9'-10	7' parking both sides	8'+ parkway	6' - 8'	6' bike lane (optional)	• Local - Residential • Minor Collector - Residential
Neighborhood Parkway [3]	90'	34' (+ 12' - 20' center median)	2 @ 10'	bike lane	10'+ parkway 12' -20' median (optional)	8' -10'	6' - 7' bike lane	• Minor Collector – Residential • Major Collector – Residential • Minor Arterial - Residential
***Access Alley* [4]**	20'	14'-16' (< 40 units) 16'-18' (41+ units)	n/a	shoulder	n/a	n/a	n/a	• n/a – internal to block
Pedestrian (Walkable centers / Mixed Use areas)								
Pedestrian Street	60' – 80'	36'	2 @ 10'	8' parallel parking both sides (angled optional)	4' – 8' amenity zone	8' -12'	N/A slow street / low volume;	• Local • Minor Collector
Avenue	90' - 100'	56'	4 @ 10'	8' parallel parking both sides (angled optional)	4' – 8' amenity zone	12' – 16'	6' bike lane (optional)	• Minor Collector • Major Collector • Minor Arterial
Access Alley [4]	20'	18' – 20'	n/a	shoulder	n/a	n/a	n/a	• n/a – internal to block
Standard (Commercial / Industrial)								
Standard Local	60'	36'	2 @ 11'	parking and/or bike lanes	7'+ parkway	5' – 8'	6' bike lane (optional)	• Local
Standard Collector	70'	36'	2 @ 11'	parking and/or bike lanes	8'+ parkway	6' -10'	6' bike lane (optional)	• Minor Collector
Standard Collector	90' – 100'	58'	4 @ 11'	bike lane	8'+ parkway	8' -12'	6' – 7' bike lane	• Major Collector
Standard Arterial	120+	72' (w/ 16' center median)	4 @ 11'	bike lanes	12'+ parkway	8' - 12'	6' - 7' bike lane OR 12' multi-use trail (off-street)	• Minor Arterial
Standard Arterial	130+	82' (w/ 16' center median)	6 @ 11	curb & gutter	12'+ parkway & 16' center median	12'+ multi-use trail	12' multi-use trail (off-street)	• Major Arterial

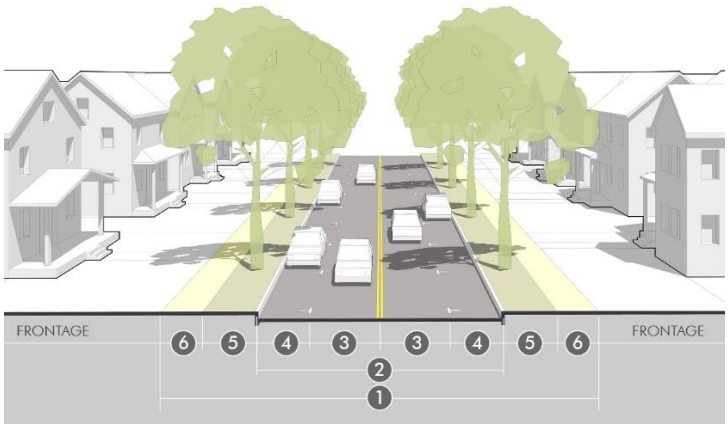
[1] Street width is back-of-curb measurement, with curb and gutter included street width where it is on-street parking or a travel lane. Where bike lanes are on the edge, the curb and gutter may need to be added to the width to provide a clear surface for bicycles.
[2] Configurations reflect typical cross sections; where bicycle lanes or angled parking is optional, or where both are provided, greater street and ROW widths may be necessary for proper configuration.
[3] On a Neighborhood Parkway, a center median is optional, but if not provided space shall be allocated to a wider parkway with additional trees.
[4] Access alleys may be located in an easement at the City's discretion and provided a property owner's association or other entity with financial and administrative capacity for maintenance is established.

Neighborhood Street

①	ROW width	54’
②	Street Width	30 ’*
③	Travel Lanes	16’ – 18’ yield flow
④	Edge Condition	7’ parking both sides
⑤	Landscape Amenity	7’+ parkway
⑥	Sidewalk	5’
⑦	Bicycles	N/A
	Applicability	• Local – Low Volume • Local Residential

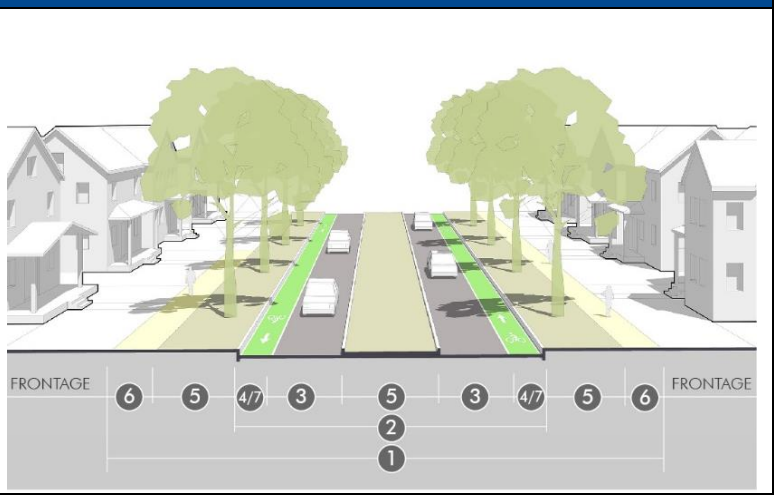
Neighborhood Connector

①	ROW width	60’
②	Street Width	32’ – 34’
③	Travel Lanes	2 @ 9’ – 10’
④	Edge Condition	7’ parking both sides
⑤	Landscape Amenity	8’+ parkway
⑥	Sidewalk	6’ – 8’
⑦	Bicycles	6’ bike lane (optional)
	Applicability	• Local • Minor Collector



Neighborhood Parkway

①	ROW width	90’
②	Street Width (curb-to-curb)	34’ (+median width)
③	Travel Lanes	2 @ 10’
④	Edge Condition	bike lane
⑤	Landscape Amenity	10’+ parkway 12’ – 20’ median (optional)
⑥	Sidewalk	8’ – 10’
⑦	Bicycles	6’ – 7’ bike lane
	Applicability	• Minor Collector • Major Collector • Minor Arterial



Access Alley (Residential)

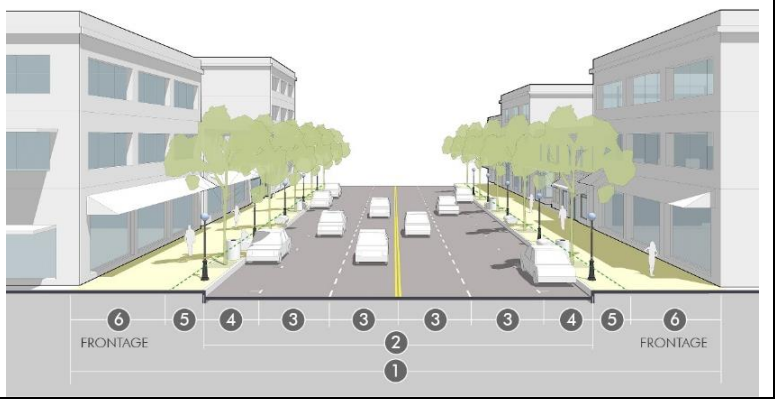
①	ROW / Easement width	20’
②	Street Width	14 – 16’’ (< 40 units) 16’ – 18’ (41+ units)
③	Travel Lanes	N/A
④	Edge Condition	shoulder
⑤	Landscape Amenity	N/A
⑥	Sidewalk	N/A
⑦	Bicycles	N/A
	Applicability	N/A – internal to block

Pedestrian Street

①	ROW width	60’’ – 80’
②	Street Width	36’
③	Travel Lanes	2 @ 10’
④	Edge Condition	8’ parallel parking (angled optional)
⑤	Landscape Amenity	4’ – 8’ amenity zone
⑥	Sidewalk	8’ – 12’ min.
⑦	Bicycles	N/A
	Applicability	• Local • Minor Collector

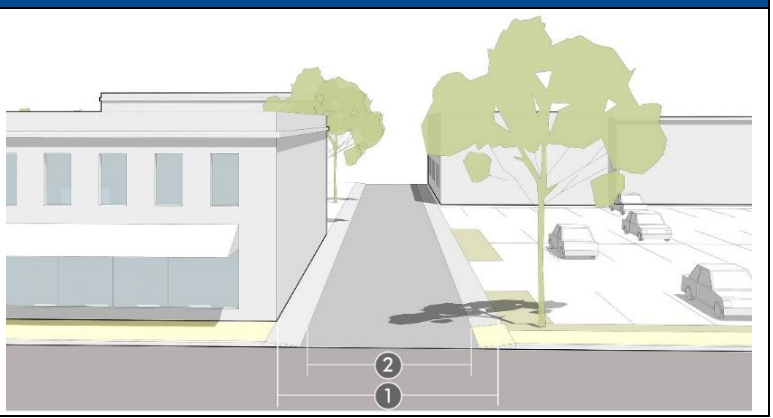
Avenue

①	ROW width	90’ – 100’
②	Street Width	58’
③	Travel Lanes	4 @ 10’
④	Edge Condition	8’ parallel parking both sides (angled optional)
⑤	Landscape Amenity	4’ – 8’ amenity zone 12’ -20’ median (optional)
⑥	Sidewalk	12’ – 16’ min.
⑦	Bicycles	6’ bike lane (optional)
	Applicability	• Minor Collector • Major Collector • Minor Arterial



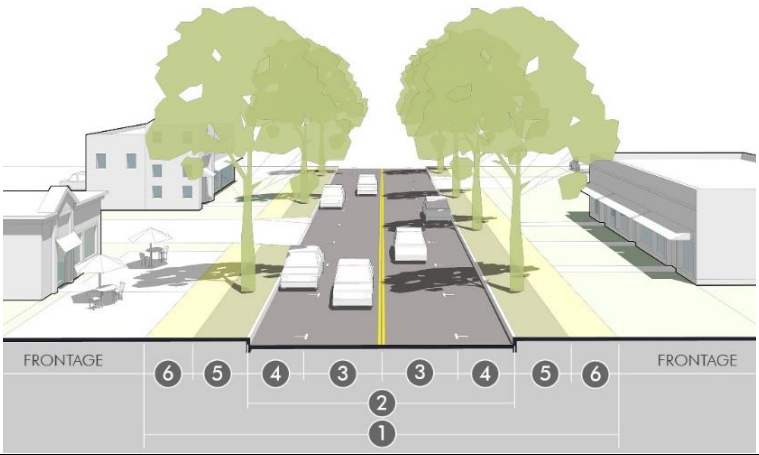
Access Alley (Commercial / Industrial)

①	ROW /Easement width	20’
②	Street Width	18’ – 20’
③	Travel Lanes	N/A
④	Edge Condition	shoulder
⑤	Landscape Amenity	N/A
⑥	Sidewalk	N/A
⑦	Bicycles	N/A
	Applicability	N/A – internal to block



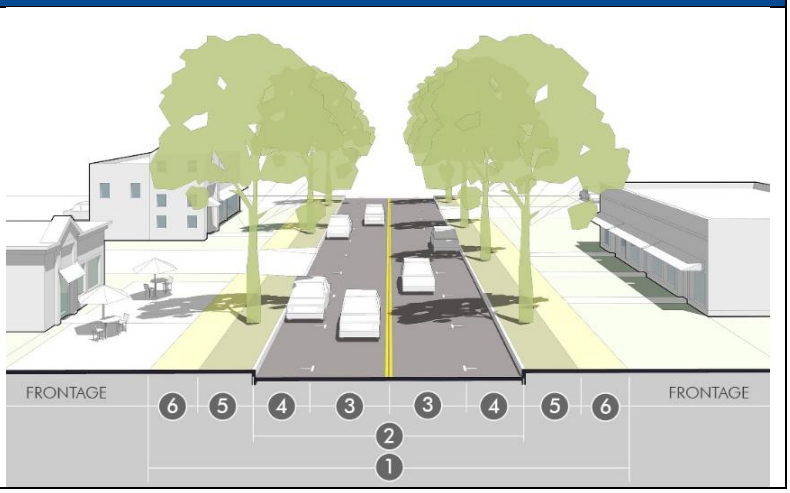
Standard Local

①	ROW width	60’
②	Street Width	36’
③	Travel Lanes	2 @ 11’
④	Edge Condition	Parking and/or bike lanes
⑤	Landscape Amenity	7’+ parkway
⑥	Sidewalk	5’ – 8’
⑦	Bicycles	6’ bike lane (optional)
	Applicability	• Local



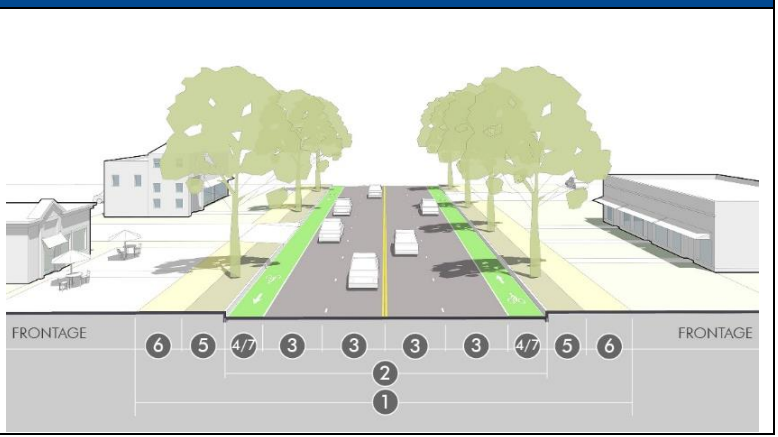
Standard Collector (Minor)

①	ROW width	70’
②	Street Width	36’
③	Travel Lanes	2 @ 11’
④	Edge Condition	Parking and/or bike lanes
⑤	Landscape Amenity	8’+ parkway
⑥	Sidewalk	6’ – 10’
⑦	Bicycles	6’ bike lane (optional)
	Applicability	• Minor Collector



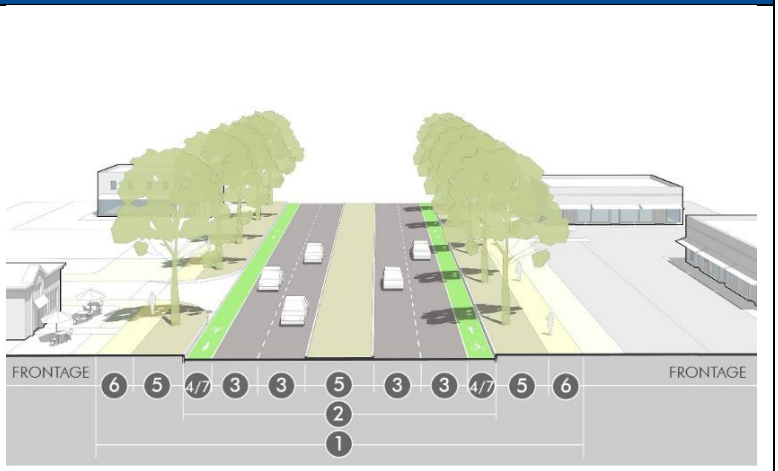
Standard Collector (Major)

①	ROW width	90' – 100'
②	Street Width	58'
③	Travel Lanes	4 @ 11'
④	Edge Condition	bike lane
⑤	Landscape Amenity	8'+ parkway
⑥	Sidewalk	8' – 12'
⑦	Bicycles	6' – 7' bike lane
	Applicability	• Major Collector



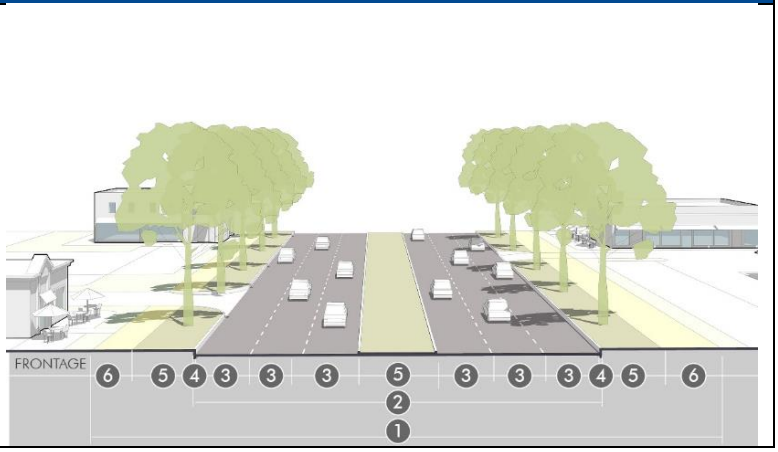
Standard Arterial (Minor)

①	ROW width	120'+
②	Street Width	72' (w/ median)
③	Travel Lanes	4 @ 11'
④	Edge Condition	bike lanes
⑤	Landscape Amenity	12'+ parkway 16' center median
⑥	Sidewalk	8' – 12'
⑦	Bicycles	6' – 7' bike lane OR 12' multi-use trail (off-street)
	Applicability	• Minor Arterial



Standard Arterial (Major)

①	ROW width	130'+
②	Street Width	82' (w/ median)
③	Travel Lanes	6 @ 11'
④	Edge Condition	Curb & gutter
⑤	Landscape Amenity	12'+ parkway 16' center median
⑥	Sidewalk	12' multi-use trail
⑦	Bicycles	12' multi-use trail (off-street)
	Applicability	• Major Arterial



d. **Intersection Design.** Intersections shall generally be designed according to the Greeley Design Criteria and Construction Specifications for streets. The subsections below provide specific and additional considerations to align intersection design with the development patterns and public realm design of a particular area.

1. *Corner Radii.* In order to balance the competing interest of vehicle turning movements and the safety and distance of pedestrians crossing the street, the Director and Public Works Director may approve decreases from the corner radii specified in the Design Criteria and Construction Specifications based on the following considerations:
   (a) The context of a particular development, and in particular, whether walkable development patterns are a priority.
   (b) The impact that the specified radii has on increasing the distance that pedestrians must cross.
   (c) The desired speeds of vehicles in the roadway and the desired speeds and volume of turning vehicles.
   (d) The connectivity of the street network and whether vehicles have multiple alternative routes that minimize frequent turning movements at one particular location.
   (e) The effective turning radius of vehicles considering other features of the specific cross section, including bicycle lanes, on-street parking or other configurations that impact the actual path of turning movements.
   (f) The likelihood that large vehicles will make frequent turning movements at a particular location, compared with the ability of over-sized vehicles or unusual turning movements to safely encroach into other areas of the street.
   (g) Other design guides or industry manuals officially authorized by the City that meet the intent of this section.

2. *Sight Distance.* Proper lines of sight shall be maintained at all intersections and all vehicle connections to the street. The proper line of sight shall be an unobstructed view from the stopping point on the approaching street, or 15 feet back from the flow line where no specific point is evident, to all points 2.5 feet above the roadway along the centerline of the intersecting street. The distance of the unobstructed view shall be based upon the design speed of the intersecting street specified in Table 24-3-4, Clear Sight Distance.

Table 24-3-4: Clear Sight Distance

Class & Speed of Intersecting Street	Left Y Distance	Right Y Distance
Arterial 30 – 50+ MPH	150’	75’
Collector 30-35 MPH	120’	75’
Local 25 – 30MPH	60’	60’

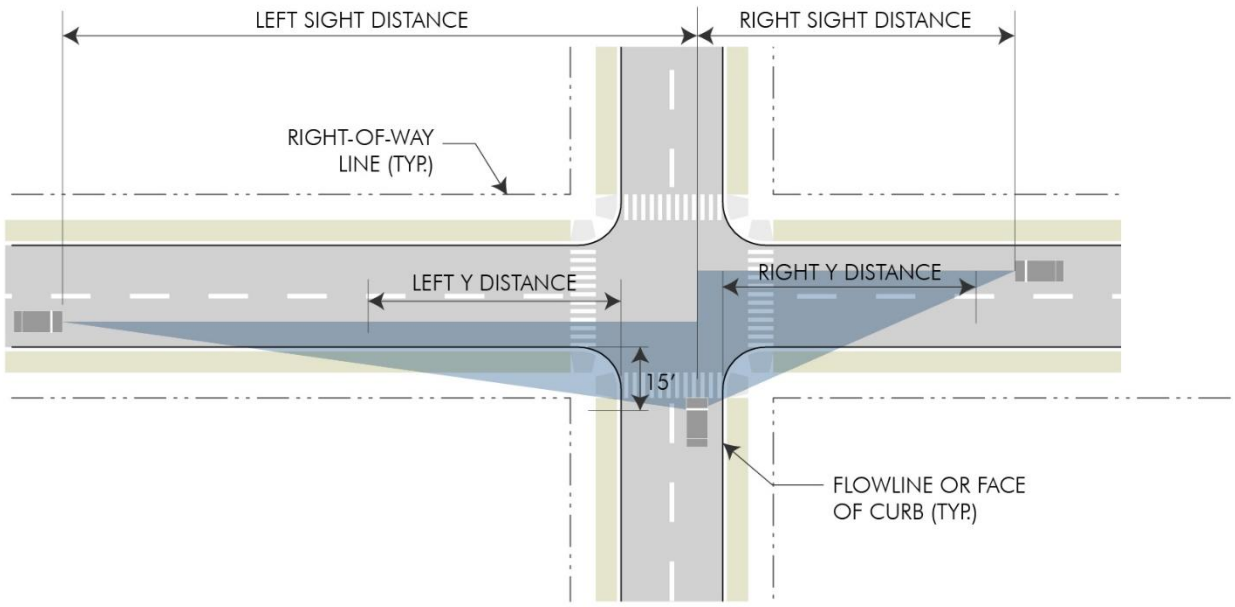


Figure 24-3-5 Clear Sight Distance

(a) Theses distances are typical to be used under normal conditions and may be modified by the Traffic Engineer to protect the public safety and welfare under exceptional conditions.

(b) No building, structure, vegetation or other type of visual obstruction shall be placed or maintained within the triangle created by the centerline of the street intersection, the stopping point on the approaching street, and the sight distance specified in Table 24-3-6 to the centerline of the intersecting street.

(c) Street trees, light poles or other limited narrow obstructions are allowed within the sight triangle provided they do not have any foliage, limbs, or other broad obstructions between 2.5 and 8 feet and are no closer than 20 feet to the intersecting right-of-way line.

(d) Fully controlled intersections where signalization establishes and prioritizes safe turning movements may deviate from the above sight triangle standards if site conditions warrant and based upon a recommendation of the Director and Public Works Director.

3. *Crosswalks.* All intersections and crosswalks shall be designed to address conditions at each specific location, based on the guidance in the Transportation Master Plan and applicable standards in the Design Criteria and Construction Specifications. In general or where this guidance does not provide more specificity, sidewalks or trails intersecting with public streets or other vehicle access shall have crossings meeting the following standards:

(a) Curb ramps meeting Americans with Disability Act (ADA) accessibility standards and guidelines shall provide a direct, non-diverted approach from the sidewalk along the block into the designated or protected crossing area.

(b) Crossings on collector streets or higher classification shall be considered for enhanced crosswalks including pavement markings, bulb outs, signalization, refuge islands or other traffic-calming measures that are appropriate to the context of the intersection.

(c) Where blocks exceed more than 700 feet between intersections or at other locations of high pedestrian activity, mid-block crossings shall be considered. Mid-block crossing designs and locations are subject to a specific recommendation and approval of the Director and Public Works Director.

(d) Any crosswalk over 80 feet, or any other significant pedestrian crossing, may require a pedestrian refuge in the median at the discretion of the Director and Public Works Director.

4. *Turn Lanes*. Turn lanes for left or right turn movements may be required for specific intersections, based on an approved traffic study and with consideration by Director and Public Works Director. Requirements for turn lanes should be based on careful consideration of the context balancing the impact of crossing distances for pedestrians, vehicle turning speeds, and prioritization of other planning, urban design, and traffic engineering issues. In general, this space should come from reconfiguration of the space within the roadway width near the intersection (i.e. within median space, narrowing lanes, or limiting on-street parking) rather than claiming space from the pedestrian area or streetscape, or rather than widening the road and right-of-way.

e. **Traffic Calming.** In order to meet the desired speeds throughout the street network, to manage volumes in association with the street network, and to meet the City's Complete Streets policies and intent of this section, traffic-calming strategies may be required in street plans. Traffic calming may include bulb outs and curb extensions, medians and islands, neck downs, vertical diverters, enhanced or raised crossings, and other speed management techniques approved by the Director and Public Works Director. [*See National Association of City Transportation Officials Guidelines*.]

f. **Engineering and Construction Specifications.** All other engineering specifications, horizontal and vertical alignment, design details, and technical or construction specifications for constructing streets shall be covered by the City of Greeley's Design Criteria and Construction Specifications for streets, and administered by the Public Works Director.

24-302 Parks & Trails

a. **Intent.** The intent of this section is to:

1. Emphasize open and civic space design as a key determinant of Greeley's community image and unique identity.
2. Integrate parks and trail systems, and other common areas into the patterns of streets and blocks to create a coordinated public realm.
3. Value the design, function and appropriate location of different types of open space, rather than solely the quantity of space.
4. Consider the context and multiple functions that open spaces can serve to support development including ecological, recreation, aesthetic and urban design functions.
5. Promote good civic design and create focal points for the community, district, neighborhood or development site.
6. Integrate natural systems into the design of public or common open spaces to improve stormwater management, protect water resources, preserve ecosystems, and improve sustainability efforts.
7. Implement Greeley's Parks, Trails, and Open Lands Master Plan, other plans for natural areas and trails, and coordinate the design and location of other open and civic spaces with these plans.

b. **Required Park Dedication.** All residential subdivision applications shall dedicate land suitable for the development of parks according to the formula in Table 24-3-5: Park Land Dedication. Where no suitable land is available in the proposed development, the City may accept the cash-in-lieu equivalent of the land value. This requirement shall also apply to any rezoning or use by special review for residential uses that is not associated with a plat application, and where a previous plat application was not required to dedicate land or pay a cash-in-lieu equivalent.

Table 24-3-5: Park Land Dedication

	Dedication Requirement	Formula
Total Acre Requirement	9.75 acres / 1,000 people	Units x 2.7 people / unit x 0.00975 acres / person
Neighborhood Park	3.25 acres / 1,000 people	Units x 2.7 people / unit x 0.00325 acres / person
Community Park	3.5 acres / 1,000 people	Units x 2.7 people / unit x 0.0035 acres / person
Sports Complex	1.5 acres / 1,000 people	Units x 2.7 people / unit x. 0.0015 acres / person
Regional Park	1.5 acres / 1,000 people	Units x 2.7 people / unit x 0.0015 acres / person

1. The city reserves the right to adjust the acreage requirement between the four park categories as deemed necessary to meet specific needs and to determine the amount of developed park acreage required based upon recommendations by the Cultural, Parks and Recreation Department.
2. Existing dwelling units within a subdivision shall be excluded from the calculation of the park dedication requirement.
3. Where a final unit count cannot be determined until subsequent stages of a project, land dedication shall be based on an assumed average density. Multifamily density shall be assumed at 20 dwelling units per acre but may be adjusted by the City where more specific information on the site, developable area or anticipated building types exist.
4. Land proposed for park dedication shall be clearly identified on any submitted plat including the number of acres for each site and the total acreage proposed for city park dedication within the project.
5. The dedication shall be by warranty deed, and the title shall be free and clear of all liens and encumbrances, including real property taxes prorated to the time of dedication. The applicant shall provide the City with a title insurance policy in the City's name and a certified survey at the time of conveyance.
6. Land dedicated for parks shall include adequate site access, installation of curb, sidewalks, and storm drainage systems, and the necessary water rights or other available water service to provide for irrigation and drinking water.
7. Community park and/or sports complex park land shall be dedicated to the City prior to recordation of the first final plat for the subdivision as defined by the preliminary plat. Neighborhood park land shall be dedicated at the time of the final plat for the area to be served by the neighborhood park.

c. **Cash-in-lieu of Dedication.** Cash-in-lieu of land dedication may be used when the City determines the cash value of land to be more appropriate in satisfying the needs of the proposed subdivision than land within the proposed subdivision. Typical cases include small developments, locations with disadvantageous topography or access, or developments that already have adjacent facilities that could be expanded to satisfy the need created by the proposed development.

1. The City will adopt a pre-determined per acre cash-in-lieu of land for parks amount, that may be administratively adjusted periodically and will be available on file with the Community Development Department. The pre-determined amount will be based on a mass appraisal performed by an independent qualified appraiser using generally accepted appraisal practices. As an alternative to the City's predetermined cash-in-lieu amount, the applicant may submit a proposal for determination of the cash-in-lieu

amount. The proposal shall supply supporting information, including at least one report by an independent, qualified appraiser using generally accepted appraisal practices. The supporting information supplied must be adequate to allow the City to evaluate the proposed amount. If the City determines that the alternate proposal is not adequately supported, the City's predetermined cash-in-lieu amount will be applied.

2. The cash-in-lieu amount will be paid at the time the plat is recorded, unless otherwise determined by the City and agreed to in a subdivision improvement agreement.
3. The City may adjust the cash-in-lieu requirement between the types of open and civic space in this code, or based on any policies of the Parks, Trails, and Open Lands Master Plan.
4. The City may accept combinations of cash and dedication where only a portion of the required dedication can be met by acceptable park sites within the project. The required cash value shall be pro-rated to the amount of required land not dedicated and accepted.

d. **Trails & Natural Areas.** The City may require or the applicant may offer trails and natural areas for public dedication in addition to the land for parks and rights-of-way. Based on the recommendations of the Parks, Trails, and Open Lands Master Plan, and other plans of the Culture, Recreation and Parks Department, the City may accept the dedication, and may credit this dedication to the parks requirement where it equally or better meets the intent of this section.

e. **Neighborhood Features & Common Area Systems.** Land dedication, or cash-in-lieu of dedication parks is not intended to replace, discourage, or prohibit the creation of pocket parks, civic spaces, or other open lands features operated and owned by a homeowners' association or other governing entities for any other public, common, or private purpose. Section 24-504 includes requirements for Neighborhood Features and Common Areas. These areas shall be coordinated with the design and location of street networks, parks and trails to better leverage a system of parks, trails, open lands, and civic spaces throughout the area.

24-303 Blocks & Lots

a. **Intent.** The intent of the blocks and lots standards is to:

1. Ensure the proper arrangement of blocks and lots to complement the street network, parks and trail system, and neighborhood features and common areas.
2. Arrange blocks, lots and development in a manner that is least disruptive to existing topography and capitalizes on inherent natural characteristics of the land as defining features.
3. Coordinate access and utilities for each lot in association with larger systems of streets and infrastructure.
4. Promote appropriate site, building and frontage designs in relation to streetscapes and open spaces.
5. Ensure that all lots are buildable according to this code, that all sensitive, hazardous or other non-buildable areas are preserved from development, and that all non-developed out lots or other parcels serve an urban design or planning function in relation to the overall development pattern.

b. **Block & Lot Arrangement**

1. *General Layout.* All blocks shall be laid out to have two tiers of lots unless dictated by existing development patterns outside of the control of the project or by access management on major arterial streets or railroad rights-of-way. In these cases, streetscape standards, trails, or common areas should be used to create buffers and transitions where the rear of lots would abut these areas.

2. *Hazards and Unbuildable Areas*. Blocks and lots shall be arranged to avoid hazards and unbuildable areas including steep grades, unstable or expansive soils, lands with inadequate drainage or subject to flooding, and natural drainage areas. These areas shall be incorporated into open and civic space systems, restricted tracts or out lots, or otherwise mitigated to eliminate hazards.

3. *Block Size & Patterns.* The maximum block length and size shall be based on the street connectivity standards in Section 24-301.b.

4. *Lot Patterns.* All lots shall front on a public street, or on an internal access street or common area open space where specifically allowed by these regulations. Lots shall meet the standards for the zoning district, or where applicable for the specific permitted building types. All side lot lines shall generally be perpendicular to front lot lines, or radial to any curves along the front lot lines. Other irregular lot patterns shall only be permitted where they are used to integrate patterns of buildable lots into the overall block structure and to provide consistent relationships of buildings and lots to the streetscape.

5. *Addressing.* All lots and other parcels shall require an address following City address policies and guidelines, including streets and street names.

6. *Easements.* All blocks shall include easements for all utilities, required improvements, and access necessary to serve each lot.
   (a) Easements shall be granted by the owner to the appropriate entity, according to the needs and specifications of that entity.
   (b) Easements shall be coordinated with each entity early in the platting process to ensure proper arrangement of blocks, lots and building sites.
   (c) In general, easements and any associated structures or facilities shall be located on the most remote and least visible portions of sites. Where available, alleys shall be used for easements and services. Otherwise, easements and associated facilities shall be located along rear lot lines, remote corners, and other low-visibility joint lot lines.
   (d) In cases where block, lot and building patterns necessitate easements and facilities along the side or front lot lines, additional design and screening may be required to ensure appropriate relationships to frontages and streetscapes.

7. *Drainage.* Where a subdivision is traversed by a watercourse, drainage way or stream, blocks shall be laid out in coordination with these features.
   (a) A pedestrian or bikeway easement may be required where drainage areas interrupt he block structure more than permitted in Section 24-301.b, or where the City determines the area is appropriate for active recreation or transportation uses.
   (b) All necessary rights-of-way and easements shall be dedicated to the City or other public entity to preserve the hydrologic, environmental, or stormwater function of the watercourse, drainage way or stream.
   (c) Access for service vehicles shall be incorporated into the design of any drainage areas or easements internal to the block structure or common areas.

24-304 Required Improvements

a. **Intent.** The intent of this section is to:

1. Ensure that all improvements necessary to serve lots within a subdivision are constructed, inspected or otherwise assured of completion prior to the issuance of permits and final approvals.
2. Prevent the location or design of a subdivision from placing an undue burden on public utility systems and community facilities serving other areas.
3. Provide appropriate apportionment of costs, and offset higher net costs or premature costs to the public resulting from subdivisions.
4. Protect against subdivisions where soil, subsoil or flooding conditions would create potential dangers to public health or safety.
5. Coordinate subdivisions and construction of required improvements with other anticipated improvements or with future growth.

b. **Timing of Improvements.** All required improvements shall be provided in one of the following ways:

1. *Construction Prior to Building Permit.* Improvements may be constructed and certified record drawings of as-built shall be submitted to the City and certified that it was built as shown and to city specifications by:
   (a) the contractor;
   (b) the project surveyor; and
   (c) the project engineer

2. *Financial Guarantee.* The applicant may defer any improvements by submitting a financial guarantee for 125% of the total cost of improvements based on approved design or construction plans.
   (a) The guarantee shall be in a form and for an amount acceptable by the City.
   (b) Any deferral of streets shall require all weather surfaces of concrete, asphalt or road base placed on the lip of the curb and gutter for interim access of construction and emergency vehicles.
   (c) All improvements for the particular phase of the plat shall be installed prior to a certificate of occupancy for any part of the phase.
   (d) Upon submittal and acceptance of as-built drawings for the improvements, the City may release the financial guarantee, but retain 20% for the 2-year warranty period.

3. *Subdivision Improvement Agreement*. The City and the applicant may enter into a subdivision improvement agreement recorded in association with an approved plan that more specifically defines the type, timing, and guarantees for required improvements.

c. **Required Improvements.** The following improvements and plans are required for all subdivisions. All improvements are subject to the City or other responsible entities' standards, plans, and specifications for improvements.
1. Survey monuments;
2. Sanitary sewer main lines and service lines to each lot;
3. Water main lines and service lines to each lot;
4. All non-potable mains and services to required lots'
5. Fire Hydrants
6. Storm sewers, culverts, detention facilities, bridges and any other approved storm drainage components, or elements required by a Stormwater Management Plan.
7. Dust Abatement and Erosion Control Plan; and
8. Perimeter Treatment Landscape Plan.
9. Utilities (telephone, electrical service, gas lines and cable television). All utilities shall be installed underground and be in place prior to any postponed street or alley surfacing. Above-ground facilities necessarily appurtenant to underground facilities or other installation of peripheral overhead electrical transmission and distribution feeder lines or

other installation of either temporary or peripheral overhead communications, distance, trunk or feeder lines may be above ground. No curb, gutter or sidewalk shall be installed until all utilities are provided.

10. Streets, Alleys and Sidewalks. All streets shall be paved and all other improvements such as sidewalk, bike paths, curb and gutter shall be installed as required. In cases where an existing street has not been brought up to City specifications the street shall be paved and all other improvements such as sidewalk, bike paths, curb and gutter shall be installed in order to meet City specifications. If any subdivision is located adjacent to any existing street right-of-way, the applicant shall improve at least the adjacent half of the street according to City specification.
11. Street signs (on residential projects only);
12. Street Lights
13. All other improvements required as a condition of approval of the plat or contained within the subdivision improvement agreement shall be completed.

d. **Procedures for Improvements**. To ensure that all required improvements are built according to City specifications, the construction process shall generally take the following steps:

Table 24-3-9: Procedures for Improvements

Step 1: *Construction permit application*	• Plans and specifications, submitted by the applicant. • Warranty for improvements submitted per Section 24-304.e.. • Staff review and scheduling of pre-construction coordination meeting.
Step 2: *Construction permit issued*	• Release of grading permits • Release of ROW permits
Step 3: *Initial Inspection*	• Permittee notifies the City of completion of construction as permitted. • As-built drawings submitted by the permittee, certified by the contractor, surveyor and project engineer. Any major changes to the as-built drawings shall be reflected and recertified prior to Final Acceptance. • City inspects and issues a punch list for any necessary deficiencies or maintenance. • If no punch list items, or after punch list completed, Preliminary Acceptance by the City and Certificate of Substantial Completion issued. • City maintenance begins, but permittee financial responsibility for defects, maintenance and repairs continues. • Two year warranty period begins
Step 4: *Intermediate Inspection*	• Option of the City. • Any point at least 120 days prior the expiration of warranty period.
Step 5: *Final Inspection* (30 – 60 days prior to expiration of warranty period)	• Permittee submits request for Final Acceptance Certificate • Punch list issued for any outstanding items to be completed before end of the 2-year warranty. • If no deficiencies identified, Final Acceptance Certificate issued • Release of warranty authorized (unless cash deposit option used, which is non-refundable)

e. **Warranty.** All public improvement infrastructure, perimeter landscaping treatment improvements and common area improvements shall provide a two-year warranty period covering design and construction defects.

1. Warranty shall be one of the following, at the option of the permittee and subject to approval of the form by the City:
   (a) Warranty Bond for 20% of total construction cost of required improvements
   (b). Letter of Credit for 20% of total construction cost of required improvements
   (c) Cash deposit for 1% of total construction cost of required improvements that is non-refundable. A cash deposit is an administration fee and shall not be construed as creating any type of insurer/insured relationship or subject the City to the provisions of Title 10, C.R.S.

2. The warranty amount shall be based on an estimate provided by the applicant, or the Director may determine an alternate amount based on relevant similar projects and comparable improvements.
3. The City may approve the construction permit in clearly defined, logical phases of construction, and may accept the apportioned warranty prior to the beginning of each phase.
4. The use of the warranty shall be restricted for the repair, replacement, completion and maintenance of all improvements subject to the construction permit, including detention facilities, perimeter landscaping and open space.
5. If the City uses any of the warranty, the permittee shall replace that amount used prior to being issued any new construction permits, either for the affected specific project or any other projects in which the permittee has an interest.
6. The City may extend the two-year warranty for all or a portion of the amount if major items have not been repaired/replaced to the City's satisfaction.
7. At least once each year, the City Engineer shall review the use of all cash payment funds received by the City pursuant to this Section. After review, the City Engineer shall report to the City Manager and City Council, and make recommendations regarding the cash payment fund including transfers of fund balances to the General Fund.
8. After final inspection and final acceptance, and at the end of the 2-year warranty period, the City shall release the permittee from any Warranty Bond or Letter of Credit. If the warranty is by cash deposit, this amount is not refundable.

24-305 Adequate Public Facilities

a. **Intent.** The intent of the adequate public facilities standards is to:
1. Anticipate and evaluate the incremental and long-term impact of development on broader public and community facility needs.
2. Identify opportunities to integrate plans for public and community facilities into the planning and design of proposed land divisions.
3. Consider the location of public and community facilities in coordination with the initial planning considerations for streets, open spaces, blocks, and lots, so that needed facilities are appropriately located prior to the premature commitment of these areas to conflicting development patterns.
4. Ensure that public facilities needed to serve new development are available concurrent with development, and maintain service levels in existing areas as new development occurs.
5. Apportion appropriate costs for the impact of new development on existing and planned public facilities.
6. Provide the opportunity to negotiate implementation of public or community facilities beyond the impact of the particular project, where the lack of facilities may otherwise constrain potential future development.
7. Promote fiscal responsibility for all public entities by coordinating the planning, design and financing of public facilities with the impact generated from proposed development.

b. **General Requirements.**

1. *Public Facility Plans.* Public facilities shall be provided consistent with the following adopted City documents:
   (a) Comprehensive Plan;
   (b) Water, Sewer, and Non-potable Water Master Plans;
   (c) Comprehensive Storm Water Master Plans;
   (d) Transportation Master Plan;
   (e) Development Fee Study;

(f) Parks, Trails, and Open Space Master Plan; and
(g) Other adopted documents related to City capital improvements.

2. *Service Area Map.* Available services shall generally mean it is existing, or funds are allocated to construct or service implementation of the facility in the current 2-year city budget cycle. The City shall update the existing and budgeted service area map at least once each year. [include appropriate cross reference to map].

3. *Project Impacts.* Individual projects will be evaluated for adequacy based on specific studies provided by the applicant and accepted by the City that demonstrate:
   (a) The location of the proposed development relative to existing facilities and service;
   (b) The ability of the project to access those facilities and services; and
   (c) The capacity of existing facilities and services to serve the new project while maintaining acceptable levels of service for existing development.

4. *Other Provisions.*
   (a) Finding of adequate facilities does not exempt the applicant from paying impact fees provided in Section 24-305.d.
   (b) Nothing in this Section shall limit the City from denying an application where it otherwise determines that adequate public facilities will not be in place concurrent with the application, despite the effect of any of the requirements or options provided in this Section.
   (c) Nothing in this Section shall prohibit any other public entity from establishing fees that apportion the appropriate contribution for the impacts on planning, design and land acquisition for facilities needed due to the development.

c. **Specific Adequacy Standards.** In addition to being consistent with the public facility plans in Section 24-305.b.1, adequacy of specific public facilities shall be evaluated as follows. City analysis and project-specific studies of the impact, demand and capacity of existing facilities will be required to make a final adequacy determination.

1. *Fire.* Fire service is considered adequate if the proposed development is located within a 1.38 mile radius of an existing, operational fire station. This requirement is based on the analysis that one fire station is needed for every 30,000 people generally living in a six-square-mile area, as applied in the Comprehensive Plan. Proposed developments including land uses that pose a high risk of fire may be subject to more stringent requirements.

2. *Parks.* Park facilities are considered adequate if the proposed development is located within a half-mile radius of a neighborhood park and within a one-mile radius of a community park, where the park is not separated from the proposed development by an expressway, facility or natural feature. Regional parks, trails, natural areas, or sports facilities are not included in the analysis unless they contain facilities equivalent to those available in neighborhood parks.

3. *Police.* Police service extends to the City limits and adequacy shall be determined according to call response times relevant to the proposed development location.

4. *Sanitary Sewer.* Sewer facilities are considered adequate if the proposed development is connected to a sewer line that is eight inches or larger in diameter with sufficient system capacity as defined by the City.

5. *Water.* Water facilities are considered adequate if the proposed development has sufficient connection to existing water lines that are eight inches or larger in diameter with sufficient system capacity.

6. *Storm water*. Storm water facilities are generally considered adequate if the site can safely convey storm water runoff to a regional storm water detention facility with sufficient capacity as defined by the City. If the City determines that the proposed development cannot safely convey runoff to an adequate storm water system, adequacy requirements shall be met with detention facilities constructed on site.

7. *Transportation.* Transportation facilities to support new development are generally considered adequate if the proposed development is connected to a collector or arterial road or expressway (or will be connected at the time the improved arterial or collector is constructed within the two-year budget cycle) constructed to an acceptable cross-section with sufficient capacity to serve the development as defined by the City.

d. **Impact Fees.** To mitigate project impacts on City service systems beyond the improvements required in Section 3.04 Required Improvements, developers shall pay standard impact fees established by Title 6, Chapter 15 of the Greeley Municipal Code
   1. If the facility is currently inadequate, sub-standard, or not existing, the impact fee shall be paid at the time of final plat. For purposes of economic development, the City may defer the impact fees for commercial and industrial development until the time of a building permit.
   2. Impact fees where adequate facilities are existing shall be paid at the time of building permit.
   3. As an alternative to the fee, the City may accept the applicant constructing or upgrading of any facility to the standards of this Section.
   4. *Exceptions.* The City Council may waive requirements that the developer absorb the development costs identified through the adequacy analyses outlined above, and obligate the City to pay said costs only if all of the following conditions are true:
      a. The project meets City economic development goals as defined in Chapter 4.52 of the municipal code;
      b. The cost benefit analysis has been prepared by the applicant and accepted by the City; and
      c. The City Council has identified an adequate mechanism for funding mitigation of impacts at the time of development.

e. **Reimbursement Agreements.** Applicants constructing required improvements for their property, or other adequate public facilities to serve their project, may be required to oversize the facilities to serve areas larger than their project based on planned future facility for the City. The City may require the applicant to enter into reimbursement agreements established elsewhere in the municipal code and according to the policies and procedures of the department responsible for the facility.

f. **Dedication of Land.** The City may require the dedication of land to the City or other government entity with jurisdiction over public and community facilities, for parks, open space, public safety facilities, or other public or community facilities.
   1. The requirement shall be based on an official master plan of the entity having jurisdiction over the facility identifying the general location and extent of the facility, or some other documented need for the facility that is available for public review.
   2. The dedication must be included on the preliminary plat or a condition of approval of the preliminary plat.

3. Acceptance of the dedication shall be agreed to in writing by the entity having jurisdiction over the site or facility prior to approval of the final plat or through approval of the final plat if dedication is to the City.
4. Dedication of land for community facilities beyond the impact of the application may be credited to the required impact fees based on a detailed analysis and documentation showing costs of land.

Reserved Sections 24-306through 24-400

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Chapter 12 Metropolitan Districts

Chapter 13 Definitions & Terms

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24-1302 Glossary of Architecture & Design Terms
24-1303 Definitions

Note: The current subdivision standards in Chapter 04 are written as a "stand alone" code, so many of the sections are repetitive of things that are included in Chapter 1 and Chapter 2 of the updated development code. This section Map tracks all of current Chapter 04 to provide a complete tracking, even though they are not included in Chapter 3 of the updated code.

CHAPTER 3 SUBDIVISION STANDARDS: SECTION MAP		
Current Standards	***Reorganized***	***Comment***
The initial sections track the "Current Standards" column and the "Reorganized" column mostly refers to things that are not included in Chapter 3 of the updated development code		
18.04.100 Purpose	24-301,a Streets, Intent; 24-302 Open & Civic Spaces, Intent; 24-303, Blocks & Lots, Intent; 24-304.a Required Improvements, Intent; 24-305.a. Adequate Public Facilities, Intent	Expanded to be more specific and coordinate with comp plan goals and "purposes" (in 24-101.d; broad and general) and "design objectives (various sub-sections; detailed and outcome oriented or performance based). This aids flexibility and interpretation of the code. (Also replaces 18.04.300 – 1200 – all the #00 numbers which are "Purpose" sections but merely restate the title of the section with no aid to interpreting the section.
18.04.110 Definitions	Chapter 13 Definitions	All definitions will be moved to one location to avoid problems of repeating definitions in multiple sections.
18.04.120 Application and Jurisdiction of Regulations	24-101.c. Jurisdiction	One section for entire code; some detailed provisions broken out into specific "applicability" sub-sections throughout code.
18.04.130 Variances	24-209 Variances	Note: "variances" are a zoning term by statute; flexibility in subdivision regulations should be via exceptions or waivers based on different criteria. Ability for flexibility in subdivisions is reflected in discretion and exceptions in standards, and in the platting process
18.04.200 Pre-application Conference, Process	24-201.c General – All Applications, Pre-application Meeting	Consolidated procedures in one chapter and included all common procedures in one section to avoid repetition.
18.04.300 – 310 Development Concept Master Plan	24-202 Minor Subdivisions; 24-203; Major subdivisions; 24-204.c.5. Rezoning, Criteria	Removed this as a specific application type and process; Emphasis shifted to information to support zoning and plat approvals; Under new procedures and based on the structure of substantive standards, more specific plans can bridge between the comp plan, area plans and the standards; the ability to condition zoning and plats on these types of plans is strengthened in this code as opposed to conditioning approvals on specific projects.
18.04.400 – 440 Preliminary Plat procedures	24-203.b Major Subdivisions; Preliminary Plat	Consolidated procedures in one chapter and included all common procedures in one section to avoid repetition; added public hearing requirement at Planning Commission for preliminary plat (note: in PUDs it may be separated from the plan and zoning decisions and likely a subsequent, and more detailed step.)
18.04.450 Combined Preliminary and Final Plat submittal	24.201.b. General – All Applications, Concurrent Applications	Consolidated procedures in one chapter and included all common procedures in one section to avoid repetition. Generalized combined process to other application types beyond combined preliminary and final plat process.
18.04.500 – 550 Final Plat procedures	24-203,c Major Subdivisions, Final Plat	Consolidated procedures in one chapter and included all common procedures in one section to avoid repetition; clarified steps for administrative approval(staff review and decisions) vs. city council acceptance of public dedications (consent agenda)
18.04.600 – 650 Minor Plat		Consolidated procedures in one chapter and included all common procedures in one section to avoid repetition; Clarified "administrative plat" types and criteria in minor subdivisions, and added condominium plat.
18.04.700 – 710 Easement Dedication, Vacation and Recordation	24-212 Vacation and Dedication of Easements	consolidated procedures in one chapter and included all common procedures in one section to avoid repetition; coordinated better with platting process
18.04.800-810 Right-of-way, Dedication and Vacation	24-213 Vacation and Dedication of Right-of-way	Consolidated procedures in one chapter and included all common procedures in one section to avoid repetition; coordinated better with platting process.

Chapter 3 Subdivision Standards: Section Map		
Current Standards	***Reorganized***	***Comment***
18.04.900 - 910 Filing Plat	24-202.a Minor Subdivisions, Applicability	Simplified as a type of administrative approval as minor subdivisions; see also 24-203 Major Subdivisions and 24-205 PUDs where platting process for PUDs (where "filing plats" were assumed to be most used)
18.04.1000 – 1100 Correction Plat	24-202.a Minor Subdivisions, Applicability	Simplified as a type of administrative approval as minor subdivision
18.04.1100 – 1197 Design & Performance Standards	24-301, 24-302, 24-303, 24-304, and 24-305	See reorganized structure and comments below.
18.04.1200 – 1220, Appeals	24-210, Appeals of Administrative Decisions	Consolidated procedures in one chapter and included all common procedures in one section to avoid repetition; coordinated better with platting process. (Note: plats have automatic appeals built in in Table 24-2-1 and 24-202 and 24-203.
18.04.1300 0 1310 Fees, Violations and Penalties	24-201.a General – All Applications, Applications & Fees; 24-104, Enforcement	Consolidated general provisions and procedures in one chapter and included all common procedures in one section to avoid repetition
18.04.1400 Severability	24-101.e Severability	Consolidated general provisions in one chapter to avoid repetition.
Below this point is organized on the revised structure of the subdivision standards emphasizing distinct design elements – it is based on the "Reorganized" column, rather than the current standards.		
18.04.100 Purposes	24-301.a Streets, Intent	Expanded to be more specific and coordinate with "purposes" (in 24-101.d; broad and general) and "design objectives (various sub-sections; detailed and outcome oriented or performance based). This aids flexibility and interpretation of the code
various sections – (18.04.1120 Site Considerations; 18.04.050 Vehicle Access and Circulation; 18.04.060)	24-301.b. Streets, Street Network	Updated to emphasize large-scale planning and development patterns and distinguish different contexts noted in the comprehensive plan. The street network and connectivity is the first and leading determinant of the structure and character of these different places and the current standards only have a single connectivity standard based on intersection spacing of the functional classes (a traffic focus, rather than a development pattern focus); also emphasized large scale access and connections vs. site- or project-scale access and connections.
18.04.1130 Streets, alleys and easements; 18.38.100 Zoning district development standards, Performance options	24-301.c. Streets, Street types	Updated for urban design elements and "complete streets policies"; and better coordinated with the Transportation Plan and the Street Specifications; Neighborhood streets are modified from the current performance option for narrower streets and the walkable mixed-use / commercial streets are new based on the centers concept in the plan and the "placemaking" discussions in the code update process.
new	24-301.d Intersection design	New, added to emphasize some of the pedestrian and bicycle principles in the comp plan.
new	24-301.e	New, added to support some of the pedestrian and bicycle principles in the comp plan and allow slower traffic where warranted
new	24-301.f. Streets, Engineering and Construction Specifications	New, making a clear distinction in streets between planning and urban design standards (subdivision standards of the development code) and engineering and construction standards (specifications).
18.04.100 Purpose	24-302.a Parks & Trails, Intent	Expanded to be more specific and coordinate with "purposes" (in 24-101.d; broad and general) and "design objectives (various sub-sections; detailed and outcome oriented or performance based). This aids flexibility and interpretation of the code.
18.04.1160 Dedications for public sites; 18.04.1165 Required Improvements for Parks; 18.38.020.I (common open space types	24-302.b-d.. Parks & Trails, Required Park Dedication, Cash-in-liu, Trails & Natural Ares, Required Open Space	Incorporated current public dedication sites with no substantive changes, but some clarification on potential acceptance of Trails or Natural Areas in addition to or as part of parks dedication.
18.04.1165(p) Dedication of parks reference to other common areas	24.302.e. Parks & Trails, Neighborhood Features & Common Areas	Revised and enhanced current statement to "not discourage" other open spaces to a more pro-active planning role for linking and integrating private or common open spaces (Required by Chapter 5, Neighborhood Development Standards) into a system
18.04.1140 Blocks 18.04.1150 Lots and Building Envelopes	24-303 Blocks and Lots	Coordination with larger-scale development pattern issues - street networks and utilities); (Note: overall coordination with better network connectivity; see 24-301.b above

Chapter 3 Subdivision Standards: Section Map		
Current Standards	***Reorganized***	***Comment***
18.04.1170 – 1197 Required Improvements	24-304 Required Improvements	Existing sections reorganized and simplified, with no substantive changes; note potential ability to not do development agreement on every project (obligation to do what the code requires) and/or coordination with subdivision improvement agreements in 24.202 Minor Subdivisions, and 24-203 Major Subdivisions
18.04.1165 Dedication of land for the development of parks; 18.40.040 Adequate Public Facilities and Services	24-305 Adequate Public Facilities	Existing sections reorganized and simplified with no substantive changes, and some coordination with the process for parks dedications (see 24-302.b.).

Chapter 4. Zoning Districts & Uses

24-401 District Intent & Applicability
24-402 Allowed Uses
24-403 Accessory Uses
24-404 Specific Use Standards
24-405 District Performance Standards

24-401 District Intent & Applicability

a. **Intent.** To carry out the purposes of this code, the following districts are established, with the intent given for the context and character of specific areas, the development patterns, and the types or intensity of uses and buildings. The relationship to the Comprehensive Plan is listed to guide the applicability of all zoning districts, but is not determinative in any case without considering the rezoning criterial in Section 24-204.

Table 24-4-1: Zoning Districts & Intent

District & Intent	*Relationship to Comprehensive Plan*
H-A – Holding-Agriculture. The H-A district is intended for properties which have been annexed to the City and are either being used for agricultural purposes or have little or no immediate. Due to the development patterns and inefficiency of providing city services, this area receives only limited infrastructure investment and is therefore used as a "pre-development" district to either preserve open and rural lands and agriculture uses, or hold areas until more coordinated planning for infrastructure, land uses, and design can occur.	Limited application as a pre-development area or for agriculture uses in Rural Neighborhoods
R-E - Residential Estate. The R-E district is intended for very low density residential living with detached houses on larger lots or in rural patterns. The district permits limited institutional uses and less intense rural uses that are compatible with low density living. Due to the dispersed development intensity, this area receives lower levels of infrastructure and public service, and should have limited application unless mixed with an overall pattern of housing options.	General application in Suburban Neighborhoods. Limited application in other Neighborhoods for large lot options on the edges of walkable patterns; or in Rural Neighborhoods as part of conservation and open space patterns.
R-L- Residential Low Density. The R-L district provides residential living (detached houses) in lower-density suburban neighborhood settings with access to supporting uses such as schools, churches, parks and other public facilities. Alternatively, it may be used for single-family areas integrated into walkable or urban neighborhood patterns.	General application Suburban Neighborhoods Limited applicability in Mixed-use, Legacy Urban, and Downtown Neighborhoods if integrated into walkable patterns.
R-M – Residential Medium Density. The R-M district provides residential living (wide range of small-scale residential building types) in a compact, walkable neighborhood settings allowing a mix of housing options at strategic locations which transition to complimentary and supporting non-residential uses. A well-designed public realm provides the focal point to integrate a variety of building types with a consistent neighborhood character.	General application the Mixed-use, Legacy Urban, and Downtown Neighborhoods. Limited Application in Suburban and Rural Neighborhoods, as part of housing mix or creating walkable neighborhoods.
R-H – Residential High Density. The R-H district provides multi-family residential living in a moderate-density pattern in suburban neighborhoods or higher-density, and larger-scale projects in strategic locations for walkable and urban neighborhoods. It is located in areas that have transitions between lower-density neighborhoods or more intense	General application the Mixed-use, Legacy Urban, and Downtown Neighborhoods; Multi-modal Corridors; and Mixed-use High-intensity Areas.

Table 24-4-1: Zoning Districts & Intent

District & Intent	*Relationship to Comprehensive Plan*
non-residential uses and where a high level of accessibility, public amenity and support services are immediately available.	Limited Application in Suburban Neighborhoods, as part of housing mix or creating walkable neighborhoods.
R-MH – Residential Micro-Housing District. The R- MH district provides residential living for smaller format manufactured, mobile, or other small-format residences in a planned community that shares common amenities located in areas that have transitions between lower-density neighborhoods or more intense, non-residential uses and where a high level of accessibility, public amenity and support services are immediately available.	Limited application on a project specific basis, considering context and design. (See Section 24-505 for specific applicability).
C-L - Commercial Low Intensity. The C-L district provides small-scale retail, service, civic and employment uses to support suburban or walkable neighborhoods. Uses are compatible with residential living in terms of scale, operation, intensity, and format. This district is generally located near and well-integrated with residential neighborhoods an along minor arterial streets, or is located as a transition between more intense commercial areas and neighborhoods..	General application in Employment, Industrial, and Commercial Areas Limited Application in Mixed-use Areas, Multi-modal Corridors, of Centers if integrated into walkable patterns
C-H - Commercial High Intensity. The C-H district provides wide range retail, service and employment uses at a scale, intensity or in a format that requires a high level of vehicle accessibility and visibility, typically along corridors or major intersections, and is not easily integrated with other land uses or development patterns. Planned versions of this district can yield campus or mixed-use district patterns that are oriented to internal open space systems or other focal points of development.	General application in Employment, Industrial, and Commercial Areas Limited Application in Mixed-use Areas, Multi-modal Corridors, of Centers if integrated into walkable patterns
MU-L - Mixed Use Low Intensity. The MU-L district provides a mix of retail, service, employment, entertainment and civic uses in a walkable setting, intended for small-scale, neighborhood serving activity centers tightly integrated with and serving the daily needs of adjacent neighborhoods (typically under 15 acres before transitioning to other supporting and compatible uses and districts)	General Application in Neighborhood Centers; Downtown Center; Mixed-use Areas; and Employment, Industrial, and Commercial Areas Limited Application in Mixed-Use High Intensity Areas; Regional Centers, and Multi-modal Corridors
MU-H - Mixed Use High Intensity, The MU-H district provides a mix of retail, service, employment, entertainment and civic uses in a walkable setting that complements higher-density neighborhoods or serves as the center of a more intense, multi-modal community or regional destination. (Typically between 15 and 40 acres before transitioning to other supporting and compatible uses and districts.)	General Applicability in Mixed-Use High Intensity Areas; Regional Centers; and Multi-modal Corridors Limited applicability in Downtown Center; and Employment, Industrial, and Commercial Areas.
I-L –Industrial Low Intensity. The I-L district provides primarily service, employment, manufacturing and distribution uses at a scale, intensity and format that won't have significant impact on adjacent uses, and which can mix with supporting and compatible service and retail uses.	General application in Employment, Industrial, and Commercial Areas; and Airport Areas. Limited application in Centers; Mixed-use Areas; and Multi-modal Corridors.
I-M - Industrial Medium Intensity. The I-M district provides employment, manufacturing and distribution uses and a moderate scale, intensity and format, that is more compatible with high-intensity commercial uses that require a moderate degree of vehicle and freight access from arterial streets, highways or rail corridors.	General application in Employment, Industrial, and Commercial Areas; and Airport Areas. Limited application in Multi-modal Corridors
I-H – Industrial High Intensity. The I-H district provides for the broadest scope of manufacturing and distribution uses that are not compatible with residential or commercial activity due to the scale, operation, intensity or impacts of activities, or due to the high level of transportation access and support infrastructure required of the business.	Limited application Employment, Industrial and Commercial Areas, and Airport Areas

Table 24-4-1: Zoning Districts & Intent	
District & Intent	***Relationship to Comprehensive Plan***
C-D Conservation District. The C-D district intended to provide a zoning classification for commercial mineral deposits, the floodway, farming, parks and permanent open space. It is a non-development district that can provide productive uses without significant building and infrastructure investment, or generates value to surrounding development through ecological, recreation, or aesthetic services on the land.	General application in Open Lands and Natural Areas, or any other natural area warranting conservation and integration into development patterns.
See Chapter 10 for Special Area and Overlay Districts and Chapter 11 for Supplemental Standards in all districts.	

b. **Official Zoning Map.** The boundaries of the districts are shown on the official Zoning Districts Map on file with the Community Development Department. Electronic copies and files of this map shall reference the "Official Copy" on file with the Community Development Department, but any copy should be verified with the Department before materially relying on any electronic or other representative copy of the map.

24-402 Allowed Uses

a. **Use Table.** Table 24-4-2 establishes permitted uses for each zoning districts. These uses and development standards are established to implement the intent of these district, permit a compatible rage of uses within each district, and facilitate complimentary transitions between districts.

1. The table identifies uses as;
   - (a) Permitted uses (P) subject to staff review and/or site plan approval to confirm compliance with general district and building standards applicable throughout this code.
   - (b) Use by special review (S) subject to the review process and criteria in Section 24-206.
   - (c) Uses not permitted in the district (blank).
   - (d) Uses not specifically listed in the Table shall be presumed to be prohibited, except if the Director determines that a use is similar to and has similar impacts as a use listed in the Table, then the Director may make a written determination as to the category and review required for the use.
2. Other accessory or temporary uses may be permitted according to the standards of Section 24-403, Accessory Uses.
3. Uses listed in the table, or more specific types of uses generally enabled in the table, may be subject to specific standards or limits in Section 24-404, Use-specific Standards.
4. Uses in the table are more specifically described in Section 24—402.b., Description of Uses.
5. Uses distinguished by scale are based on gross leasable area (GLA) of the uses space within buildings, size of the lot (acre), or other specified building or site features.

Table 24-4-2: Zoning Districts & Uses

P = Permitted Use S= Use by special review blank = prohibited ***Use***	***Districts***	***R-E***	***R-L***	***R-M***	***R-H***	***R-MH***	***C-L***	***C-H***	***MU-L***	***MU-H***	***I-L***	***I-M***	***I-H***	***H-A***	***C-D***
Residential Uses															

Table 24-4-2: Zoning Districts & Uses

P = Permitted Use S= Use by special review blank = prohibited ***Use***	***Districts***													
	R-E	***R-L***	***R-M***	***R-H***	***R-MH***	***C-L***	***C-H***	***MU-L***	***MU-H***	***I-L***	***I-M***	***I-H***	***H-A***	***C-D***
Single-family Dwelling	P	P	P	P		S	S	P	P				P	
Two-family dwellings			P	P		S	S	P	P					
Row House dwellings			P	P		S	S	P	P					
Multi-family Dwellings			P	P		S	S	P	P					
Mixed-use dwelling				S		P	P	P	P					
Established Residential (all types)						P	P			P	P	P	P	
Accessory Dwelling Unit			P	P		P	P	P	P					
Mobile / Manufactured Home & Parks					P									
Boarding House & Single Room Occupancies				P		S	S	S	S					
Farming	P	P	P	P		P	P			P	P	P	P	P
Residential Care – Group Home	P	P	P	P		P	P	P	P					
Residential Care – Assisted Living			S	S		P	P	P	P	P				
Residential Care - General				S		S	P	S	P	P				
Residential Care - Institutional				S		S	P	S	P	P				
Public & Civic Uses														
Assembly – Limited (up to 499 occupancy)	P	P	P	P	P	P	P	P	P	P	P	P		
Assembly - General (500 – 1,500 occupancy)		S	S	S	S	S	P	S	P	P	P	P		
Assembly – Large (1,501+ occupancy; or outside)							P		P	P	P			
Cemeteries, Columbarium							P	P	P	P	P	P		
Golf Course & Country Clubs (no lights)	P	P	P	P	P	P	P	P	P	P				
Libraries, Museums, Public or Quasi-public	S	S	S	S		P	P	P	P	P	P			
Police, Fire Stations, Ambulance Dispatch & Storage	S	S	S	S		P	P	P	P	P	P			
Parks, Open Spaces & Common Areas	See Section 24-302 and 24-504 for standards applicable to all districts.													
Schools	P	P	P	P	P	P	P	P	P	P				
Schools - Adult (Business, Trade)						S	P	S	P	P	P	P		
Schools - Universities / Colleges	P	P	P	P	P	P	P	P	P	P				
Transportation – Bus, Taxi, or Transit Station							S		S	P	P	P		
Transportation – Freight & Maintenance Yard											P	P		
Transportation – Airport, Heliport / Helipad											S	S		
Transportation – Public Parking	S	S	S	S	S	S	P	S	S	P	P	P		
Transportation – Towing Services							S			P	P	P		
Utilities – Limited (towers under heights permitted by zoned and accessory structures and cabinets)	P	P	P	P	P	P	P	P	P	P	P	P		

Table 24-4-2: Zoning Districts & Uses

P = Permitted Use S= Use by special review blank = prohibited **Use** / **Districts**	R-E	R-L	R-M	R-H	R-MH	C-L	C-H	MU-L	MU-H	I-L	I-M	I-H	H-A	C-D
Utilities – General (towers over heights permitted by zone or large structures and cabinets)	S	S	S	S	S	S	S	S	S	S	S	S		
Utilities - Lines over 33 KVA, overhead	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Utilities – Co-generation or Power Plants											P	P		
Commercial Uses														
Adult Businesses *(See also Section 24-1103)*										P	P	P		
Animal Care – Limited (indoor, < 5K GLA, no boarding)						P	P	P	P	P	P			
Animal Care – General (indoor, 5K-20K GLA or boarding)						S	P	S	P	P	P			
Animal Care – Large (outdoor or > 20K GLA)										P	P			
Animal Care – Stables (> 5 boarded animals)										S	S		S	
Auction Houses (excludes livestock)										P	P	P		
Automobile - Gas Station Limited (up to 8 pumps)						S	P	S	P	P	P	P		
Automobile - - Gas Station General (9 – 20 pumps)							P		S	P	P	P		
Automobile Gas Station Large (21+ pumps)							S			P	P	P		
Automobile - Repair/Service Limited (up to 3 service bays; < 0.5 acre)						S	P	S	P	P	P			
Automobile - Repair/Service General (4-6 service bays; 0.5 – 1.0 acre)							P		P	P	P			
Automobile - Repair / Service Large (7+ service bays; > 1 acre)							S			P	P			
Automobile - Repair / Service for Heavy vehicle and Equipment											P	P		
Automobile - Sales / Rental Limited (< 0.5 acre)						S	P			P	P			
Automobile - Sales / Rental General (0.5 – 1.0 acre)							P			P	P			
Automobile - Sales / Rental Large (> 1.0 acre)							S			P	P	P		
Child Care Home (accessory / home occupation)	P	P	P	P	P	P	P	P	P	P	P	P		
Child Care Center / Pre-School						P	P	P	P	S	S	S		
Drive-through services - Accessory						See Section 24-403.e.								
Entertainment / Even Establishments							P		P	P	P			
Food & Beverage – Bar Limited (< 3K GLA; < 100 seats)							P	P	P	P	P			
Food & Beverage – Brewery / Winery; Bar General							P		P	P	P			
Food & Beverage – Restaurant Limited (< 5K GLA; < 100 seats)						P	P	P	P	P	P			
Food & Beverage – Restaurant Quick Serve							P	S	S	P	P			
Food & Beverage – Restaurant General (5K+ GLA)							P		P	P	P			
Lodging – Short Term Rental	P	P	P	P	P	P	P	P	P	P			P	
Lodging – Bed & Breakfast (up to 5 rooms)				S		P	P	P	P	P				
Lodging – Inn (6 to 40 rooms)							P	S	P	P				

Table 24-4-2: Zoning Districts & Uses

P = Permitted Use S= Use by special review blank = prohibited **Use** / **Districts**	R-E	R-L	R-M	R-H	R-MH	C-L	C-H	MU-L	MU-H	I-L	I-M	I-H	H-A	C-D
Lodging – Hotel/Motel Small (41+ rooms)							P		S	P				
Medical – Limited (< 5K GLA; no emergency service)						P	P	P	P	P				
Medical – General (5K – 20K GLA; no emergency service)						S	P	S	P	P				
Medical – Large (> 20K GLA; or emergency service)							P		P	~~P~~				
Medical - Hospitals						S	P		P	P				
Mortuaries and Funeral Homes						P	P	P	P	P	P			
Office – General (< 20K GLA)						P	P	P	P	P	P	P		
Office – Large (20K+ GLA)							P	S	P	P	P			
Pawn Shops							P			P	P			
Personal Service – Limited (< 5K GLA, < 1.0 acre)						P	P	P	P	P	P			
Personal Service – General (5K+ GLA; 1.0+ acre)							P		P	P	P			
Recreation – Indoor Limited (< 5K GLA; < 0.5 acre)						P	P	P	P	P	P			
Recreation – Indoor General (5K - 20K GLA; 0.5 – 1.0 acre)							P	S	P	P	P			
Recreation – Indoor Large (> 20K GLA; > 1.0 acre)							P		S	P	P			
Recreation – Outdoor Limited (no lights; < 0.5 acre)						P	P	P	P	P	P			
Recreation – Outdoor General (no lights; 0.5 – 1.0 acre)							P			P	P			
Recreation – Outdoor Large (lights or > 1.0 acre)							S			S	S	S		
Recreation – RV and Travel Trailer Park							S			S	S			
Recreation – Outdoor Racetrack											S	S		
Retail – limited (< 3K GLA)						P	P	P	P	P	P			
Retail – General (3K – 20K GLA)							P	S	P	S	S			
Retail – Large (20K – 100K GLA)							P		S	S	S			
Retail – Warehouse (> 100K GLA)							S		S	S	S			
Retail – Outdoor Limited (> 25%; > 0.5 acre)							P	S	P	P				
Retail – Outdoor General (25% - 50%; 0.5 – 1.0 acre)							P		S	P				
Retail – Outdoor Large (> 50%; > 1.0 acre)							S			P	P			
Retail – Outdoor Nurseries and Greenhouse							P		P	P	P			
Retail – Outdoor Flea Market or Swap Shop											P	P		
Industrial Uses														
Auto Dismantling, Junk & Salvage Yards												S		
Commercial Services – Limited (up to 9 vehicle fleet)							P			P	P	P		
Commercial Services – General (11 – 20 vehicle fleet)							S			P	P	P		
Commercial Services – Large (21+ vehicle fleet)										S	P	P		

Table 24-4-2: Zoning Districts & Uses

P = Permitted Use S= Use by special review blank = prohibited **Use** / **Districts**	R-E	R-L	R-M	R-H	R-MH	C-L	C-H	MU-L	MU-H	I-L	I-M	I-H	H-A	C-D
Concrete and Asphalt Batch Plants											P	P		
Crematoriums										P	P	P		
Foundries												S		
Gravel & Mineral Extraction, Batch Plants														S
Grain & Feed Elevators & Supply												S		
Livestock Auctions												S		
Manufacturing – Limited / Artisan (< 5K GLA)						S	P	P	P	P	P	P		
Manufacturing – General (5K – 100K GLA)										P	P	P		
Manufacturing – Large (> 100K GLA)											P	P		
Manufacturing – Food & Beverage Minor (up to 3 acres)							P		P	P	P	P		
Manufacturing – Food & Beverage Major (3+ acres)											S	S		
Manufacturing – Chemical Plant											S	S		
Manufacturing – Rendering, Slaughter & Packaging												S		
Oil & Gas Operations	See Section 24-1102 for standards and procedures applicable in all districts													
Research & Testing Labs							P		P	P	P	P		
Warehousing / Storage – Indoor Limited (< 50K GLA; < 1.0 acre							P		S	P	P	P		
Warehousing / Storage - Indoor General (50K-200K GLA; 1.0 – 5.0 acre)							P			P	P	P		
Warehousing / Storage – Indoor Large (> 200K GLA; > 5.0 acres)							S			S	P	P		
Warehouse / Storage– Distribution Center										S	P	P		
Warehouse / Storage – Outdoor Limited (< 1.0 acre)							S			S	P	P		
Warehouse / Storage – Outdoor General (1.0 + acre)										S	P	P		
Warehouse / Storage – Bulk Storage of Flammable Liquids and Gases											P	P		
Waste Management – Recycling Collection Small						S	P	S	P	P	P	P		
Waste Management – Recycling Processing & Collection							P			P	P	P		
Waste Management – Refuse & Transfer Station											S	S		
Water & Waste Water Treatment Plants											P	P		
Well Drilling Companies											P	P		
Wireless Communication Facilities	See Section 24-1101 for standards and procedures applicable in all districts													

b. **Description of Uses.** This section provides descriptions of uses of land and buildings associated with Table 24-4-2 Allowed Uses. It is organized by Categories and Types of uses. Where a proposed use is not generally listed or appears to meet the description of more than one

use type, the Director shall make an interpretation on the most equivalent described use considering:

(1) The similarity of the use in terms of scale, impact, and operations to other described uses;
(2) The typical building format and site design associated with the use based on relevant and established examples; and
(3) The compatibility of the use with other allowed uses in the zoning district, and the potential for the use to contribute to the intent of the zoning district.

Any uses that may not be interpreted as equivalent to a use in Table 24-4-2 is not anticipated by these regulations and may only be allowed by a text amendment.

1. *Residential Dwelling.*

The Residential Dwelling category is the principal use of land and buildings for dwelling units. A dwelling unit is one or more connected rooms, constituting a separate, independent housekeeping establishment for owner occupancy, or rental or lease as a single unit on a monthly basis or longer, physically separated from any other room or dwelling units which may be in the same structure and served by no more than one gas meter and one electric meter. The arrangement and extent of dwelling units depends on the zoning district uses and building types:

Dwelling, Single-family. A residential building designed and used as a single detached dwelling unit by one family, other than a mobile home. Typical building types are detached houses, with variants based on lot sizes. The term single-family residence shall include a manufactured home which:

(1) Is partially or entirely manufactured in a factory;
(2) Is installed on an engineered permanent foundation; and
(3) Is certified pursuant to the National Manufactured Housing Construction and Safety Standards Act of 1974, 42 U.S.C. §5401, et seq., as amended, and all regulations enacted pursuant thereto, including any local modifications as are expressly allowed by federal law, or which has been certified by the State of Colorado as being in compliance with the requirements of the Uniform Building code, as adopted by the State of Colorado and as is enforced and administered by the Colorado Division of Housing.

Dwelling, Two-family. Residential building designed to accommodate 2 primary dwelling units in a building designed and scaled to be compatible with detached houses, and which may commonly be referred to as a duplex or multi-unit house (with two units). Two-family buildings that share a single common wall may be on a single lot, or may be platted as separate lots along the common wall line subject to the building code and platting restrictions. All other two-family dwellings shall be on a single lot. Duplex / multi-unit houses shall have a scale, design, orientation, access, and entrance features that maintains the appearance and form similar to a detached house.

Dwelling, Row House. A multi-unit residential building designed for 3 to 8 dwelling units each sharing a common wall with the abutting units. Each unit has its own private entry presenting an outward appearance on the frontage as distinct units in a single building. Units may be on a single lot subject to common ownership restrictions or platted on separate lots along the common wall subject to building code and platting restrictions.

Dwelling, Multi-family. A residential building that contains three or more dwelling units, or group of similar buildings in a complex. Typical building and lot types include multi-unit houses (provided they maintain the scale, design, orientation, access and entrance features similar to a detached house), small apartments, medium apartments, large apartments, apartment complexes, and mixed-use buildings with residential uses.

Dwelling, Mixed-use (apartment over commercial / service). A residential use in a building designed for street level retail, service or employment uses, and where dwelling units are accommodated on upper stories, or otherwise separated from the principal commercial function of the building.

Dwelling, Established Residential (all types). Any residential building and use, legally established at when it originated but where new development of the same use or similar building type is no longer permitted in the zoning district. These uses shall be permitted so that continued use and further investment in the building and use is not discouraged.

Dwelling, Accessory Unit. A dwelling unit that is secondary and accessory to a principal dwelling unit and on the same lot. Accessory dwelling units may be in the same building as the principal dwelling unit (basement or attic apartments) or in a detached accessory structure (garage apartment or "granny flat".)

Mobile / Manufactured Home Park. A parcel of land planned and designed for multiple home sites for the placement of manufactured, mobile or other small homes, and used for the principal dwelling of households for long-term residency. These communities include internal common areas, circulation systems and accessory uses and facilities to support the community. Dwellings may either be located on home sites designated within a larger project or on single lots owned through appropriate condominium procedures or platted under certain conditions.

Boarding House & Single Room Occupancy. A residential building is used to accommodate boarders or roomers as the primary residential dwelling, and whose occupants shall have common access to facilities such as kitchen, bathroom, dining areas, or community areas. Boarding and single-room occupancies houses shall be rented or leased on a monthly basis or longer, and not include hotels, motels and lodges.

Farming. The production of crops such as vegetables, fruit trees or grain; the growing of trees and shrubs for landscape purposes; and the raising of farm animals such as poultry or swine, as limited by the standards for accessory keeping of livestock. Farming shall not include the commercial raising of animals, commercial production of milk, commercial pen feeding (feed lots) or the commercial feeding of garbage or offal to swine or other animals.

Residential Care - Group Home. A residential building operated as a single primary dwelling which provides residency, supervision, and other services for up to 8 persons who are in need of special care due to being developmentally disabled, mentally ill, 60 years of age or older, or due to physical condition, illness, or social or behavioral problems. Group homes require up to 2 residential caregivers, and shall be licensed by, operated by, or owned by a governmental agency or non-profit qualified to provide care and supervision. Group homes shall not include alcoholism or drug treatment centers, work release facilities or other housing facilities serving as an alternative to incarceration and shall not house more than one individual per dwelling who is required to register as a sex offender under the provisions of Section 18-3-412.5, C.R.S

Residential Care – Assisted Living. A residential building or planned community operated as the primary residence for persons who do not have an illness, injury or condition that requires 24-hour care or supervisions, but who need social, physical, and therapeutic and recreation support for daily living. Support services are accessory to the residential use and character of the buildings and area, and do not require 24-hour staffing, other than security. Typical examples include assisted living, group homes larger than 8 individuals, and retirement communities.

Residential Care - General. A residential or institutional building, or group of buildings, designed to provide a primary or interim residence and health care for persons who require care on a fill-time basis. Medical support, rehabilitative services, and counseling is provided by professional, nursing and medical staff on site. Accessory support uses include meals, therapeutic services, transportation and recreation. Typical examples include nursing homes, long-term care facility, continuing care facility, congregate care communities, or hospices.

Residential Care – Institutional. A residential or institutional building operated by a government, non-profit, charitable or religious organization providing temporary housing, food, counseling and other support services to persons at risk, on an interim basis and with transitional, protective, or rehabilitative goals. Security and supervisory services are required on-site. Typical examples include emergency shelters, missions, rehabilitation residence, halfway houses.

2. *Public / Civic*

The Public / Civic use category is the use of land and buildings to serve public or community interest by enhancing the daily cultural, social, or recreation needs for residents and neighborhoods. It can include uses generally available to the public at large, community uses structured by voluntary affiliation, or private uses limited by property ownership or membership. It includes the following types:

Assembly. A civic use designed to serve the community for regular or periodic events, including worship, social, cultural, recreation, and accessory uses associated with organized civic or institutional activities.

> *Assembly – Limited (up to 499 occupancy).* A place of assembly designed and located to serve nearby neighborhoods, typically designed for up to 499 people. Examples include small neighborhood association clubhouse, meeting hall, or small religious facility.
>
> *Assembly – General (500 - 1,500 occupancy)*. A place of assembly designed and located to serve the broad community at large, typically designed for 500 – 1,500 people. Examples include a community/recreation center, small event hall, or large religious facility.
>
> *Assembly – Large (1,501+ occupancy, or outside)*. A place of assembly designed and located to serve as a destination for the city or region, typically designed for more than 1,500 people, or where any facility is designed for outside assembly. Examples include an auditorium, large event hall, major worship hall, convention and conference center, or any assembly use with a small outside amphitheater.

Cemeteries and Columbarium. A public or civic use where land or buildings are used for the burial of the deceased and dedicated for interment purposes, including gravesites or buildings used for the internment of ashes of cremated dead.

Golf Courses & Country Clubs (no lights). A public or civic use and designed and dedicated for playing the game of golf, run by a public agency or a private club operated on a membership basis. This includes accessory facilities and structures related to playing golf, but shall not include any lights, activities, or associated events not compatible with outdoor recreation in a residential setting. (See Recreation – Outdoor for commercial recreation activities).

Libraries, Museums, Public or Quasi-public. A public or civic use which provides resources and exhibits to support education, culture, and information exchange open to the public at large.

Police, Fire Stations, Ambulance Dispatch & Storage. A public use that supports the community at large by through public health and safety, protective or related services. Examples include police and fire stations, dispatch, and related facilities, or similar government and quasi-government buildings and grounds.

Parks, Open Spaces & Common Areas. Any parcel or area of land or water permanently reserved for public and/or private use and enjoyment, which is generally open, undeveloped, and characterized by natural features and landscape enhancements, except for facilities to serve the social, recreational, aesthetic, or environmental function of the space. (See Section 24-302 and 24-504 for standards applicable to all districts.)

School. A public or civic building designed, constructed, or used for education or instruction in any branch of knowledge.

School, adult (business, trade). A public or private school primarily teaching useable skills to adults, including, but not limited to, business, vocational, driving and trade courses.

School, compulsory. A public or private elementary, junior high or high school licensed by the state and which meets state requirements for providing compulsory education.

Schools – University / College. A public or private institution dedicated to post-secondary education.

Transportation – Bus, Taxi, or Transit Station. A public transportation facility designed for the transfer, pick-up and drop-off of passengers traveling by bus, taxi, trolley, or similar low-impact means, including with buildings or associated passenger convenience facilities, distinguished from public stops accommodated in the design of the right-of-way.

Transportation - Freight & Maintenance Yard. An area and/or building where storage, maintenance, or dispatch of vehicles used for public transportation occurs, or any other similar high-intensity activities associated with public transportation.

Transportation – Airport, Heliport, or Helipad. Any area of land or water designed for the landing and take-off of aircraft for business or commercial purposes, including all necessary facilities for passenger and cargo loading, maintenance and fueling facilities and housing of aircraft. This includes any area used by helicopters for landing and take-off, passenger and cargo loading.

Transportation – Public Parking. A parcel of land where the principle use is to park vehicles whether on a fee basis operated by a public or private entity or whether to support an adjacent use or business located on a different lot. Parking may be on a surface lot or in a structure.

Transportation – Towing Service. A parcel of land used for the storage, impoundment, and retrieval of vehicles that have been towed.

Utilities – Limited. Any aboveground structure or facility, excluding buildings, which is owned by a governmental entity or any entity defined as a public utility for any purpose by the state public utilities commission, and used in connection with delivery of utility services to nearby lots and other areas, with maximum heights of towers and accessory structures under those permitted by the zoning district. Examples include accessory utility structures that served customary needs of the uses in the zoning district.

Utilities – General. Any aboveground structure or facility, which is owned by a governmental entity or any entity defined as a public utility for any purpose by the state public utilities commission, and used in connection with delivery of utility services to nearby lots and other areas, with maximum heights of towers and accessory structures above those permitted by the zoning district. Examples include substations or other facilities that support the storage and generation of facilities.

Utilities – Lines over 33KVA, overhead. Any utility that utilizes overhead lines that transmit above 33 kilo volt amperes.

Utilities – Co-generation or Power Plants. A facility which is owned by a governmental entity or any entity defined as a public utility for any purpose by the state public utilities commission, and used for generating of power for distribution to sub-stations or other general accessory distribution facilities.

3. *Commercial.*

The Commercial use category is the use of land and buildings for entities engaged in sale of products or services, the limited production and distribution of products, or other administrative or support services to help businesses. It includes the following types of uses:

Adult business. Any store, establishment, tavern, club or theater having a substantial portion of its stock in trade, books, magazines or other periodicals; video movies, films, slides or photographs; instruments, devices or paraphernalia; or live performances, which are characterized by their emphasis on matters depicting, describing, or related to specified anatomical areas or specified sexual activities. For the purposes of this definition, a business shall not be considered an adult business if it carries less than 20 percent of its stock in adult materials and it prevents the public from viewing or observing merchandise or products that depict specified anatomical areas or specific sexual activities, as may be displayed by the products or on the packaging.

1. *Specified anatomical areas* means:
   - (a) Less than completely and opaquely covered human genitals, pubic region, buttocks and female breast above or below a point which would expose any portion of the areola; and
   - (b) Human male genitals in a discernibly turgid state, even if completely and opaquely covered.
2. *Specified sexual activities* means:
   - (a) The fondling or other erotic touching of human genitals, pubic region, buttocks, anus or female breast;
   - (b) Human genitals in a state of sexual stimulation or arousal;
   - (c) Sex acts, actual or simulated, including intercourse, oral copulation or sodomy;
   - (d) Masturbation, actual or simulated; or
   - (e) Excretory functions as part of or in connection with any of the activities set forth in subsections (2)a through d of this definition.

Animal Care. A commercial use that provides care and medical or non-medical services for domesticated animals, including boarding, training, breeding, showing, treatment, grooming, or sale. Animal care is further refined by the scale and intensity of the operations, as follows (for Non-domesticated animals and livestock, see *Farming, and limits on the accessory keeping of Livestock*):

> *Animal Care - Limited.* A small office or facility providing animal care that involves less than 5,000 square feet of commercial area, all activities occur indoors (except routine daily pet care), and any overnight boarding is limited to that necessary for medical care or observation. Examples include a veterinary office, pet grooming or training, and small animal day cares.
>
> *Animal Care – General.* A moderate sized office or facility providing animal care that is between 5,000 to 20,000 square feet of commercial space, or that involves animal boarding. Examples include a veterinary clinic, animal shelters, and indoor commercial kennels.
>
> *Animal Care – Large.* A large office or facility providing animal care that is more than 20,000 square feet of commercial space, or has significant outdoor activity including boarding kennels or play areas where animals may ordinarily be kept and . Examples include domestic animal hospitals, large facilities for pet daycare, and large commercial/outdoor kennels
>
> *Animal Care – Stable (>5 boarded animals).* A commercial use for the keeping, boarding and/or training of horses, ponies, llamas, mules or other animals which may be used for riding purposes, for compensation and which may include an arena.

Auction House. A business that facilitates the buying and selling of assets, such as works of art, collectibles, household estate items, and other personal property. Auction House excludes selling of livestock.

Automobile – Gas Station. A specific retail use engaged in the sale of fuel to the general public, and may involve limited accessory sales of convenience goods. This use may be combined with accessory vehicle

service and repair uses, subject to the service bay limitations stated below. Vehicle – Gas Station uses are further refined by the scale, format and intensity as follows.

Automobile - Gas Station, Limited (up to 8 pumps). A vehicle gas station limited to no more than 8 fueling stations, no more than 2 service islands, no more than 2 accessory vehicle service bays and no more than 1,500 square feet of accessory retail or service areas. Examples include small, neighborhood service stations.

Automobile - Gas Station, General (9-20 pumps). A vehicle gas station limited to between 9 and 20 fueling stations, no more than 5 service islands, no more than 3 accessory vehicle service bays and no more than 5,000 square feet of accessory retail or service areas. Examples include general stores and gas stations.

Automobile - Gas Station, Large (21+ pumps). A vehicle gas station that contains more than 20 fueling stations, more than 5 islands, and up to 4 accessory vehicle service bays and no more than 5,000 square feet of accessory retail or service areas. Examples include a large convenience center and gas station, or truck stops and travel centers.

Automobile – Repair / Service. A specific service use engaged in motor vehicle and mechanical equipment maintenance and repair services, and accessory retail sale of supplies and accessories. Automobile Repair / Service is further refined by scale, format and intensity as follows:

Automobile – Repair / Service – Limited (up to 3 service pays; 0.5 acre max.). An automobile service and repair use limited to no more than 3 vehicle service bays, all vehicles are under 1.5 tons G.V.W, where all work and storage of equipment and supplies occurs indoors, and where on-site or overnight storage of vehicles is limited and requires no special site accommodations other than ordinary parking areas. Sites are limited to no more than 0.5 acres. Examples include a small machine shop, mechanic, lubricant center, tire store, auto glass installation or audio or alarm installation.

Automobile – Repair / Service – General (4-6 service bays; 1.0 acre max). An automobile service and repair use that involves 4 to 6 service bays, all vehicles are under 1.5 tons G.V.W, where all work and storage of equipment and supplies occurs indoors, but where on-site or overnight storage of vehicles may be stored outdoors on the lot. Sites are limited to no more than 1.0 acre. Examples include large mechanic shop, lubricant center, tire store, non-accessory car wash, or an auto body shop.

Automobile – Repair / Service – Large (7+ service bays; 1.0+ acres). An automobile service and repair use that involves 7 or more service bays, all vehicles are under 1.5 tons G.V.W, where all work and storage may occur outdoors and where on-site or overnight storage of vehicles and outdoor storage is typical. Sites are more than 1.0 acres. Examples include large service center, auto body and frame repair facilities, transmission and engine overhaul yards, or automobile painting facilities.

Automobile – Repair / Service for Heavy Vehicles & Equipment. An automobile service and repair use engaged in the maintenance and repair of motor vehicles, recreational vehicles or boats, commercial vehicles, heavy equipment and other vehicles over 1.5 tons G.V.W., and other similar uses where services typically involve outside storage or work. Examples large vehicle maintenance, large truck or boat wash, and equipment yards.

Automobile – Sales / Rental. A commercial business engaged in the sale, lease, or rental of automobiles. Automobile – Sales / Rental is further refined by scale, format and intensity as follows:

Automobile – Sales / Rental – Limited (< 0.5 acres). An automobile sales / rental facility on less than ½ acre that uses outdoor vehicle storage at a similar scale to a small-site commercial

parking area. Examples include an automobile broker that may have little or only temporary on-site storage, or a small car rental office.

Automobile – Sales / Rental – General (0.5 - 1.0 acres). An automobile sales / rental facility on between ½ and 1.0 acre, where outdoor vehicle storage occupies a large portion of the site. Examples include a small car dealership, or a larger rental car facility.

Automobile – Sales / Retail Large (> 1 acre). An automobile sales / rental facility on more than one acre that includes significant amounts of outdoor vehicle storage. Examples include a large car dealership or car or truck rental facility

Child Care Home. A residential dwelling licensed by the Colorado Department of Human Services to provide child care services as a home occupation and an accessory use to the operator's principal residence. The facility may provide care for up to 12 children, and subject to greater restrictions based on Colorado Department of Human Services licensing rules as an accessory use to the operator's principal residence.

Child Care Center. A commercial use that provides care for children outside of the home, or any care for more than 12 children.

Entertainment / Event Establishment. A commercial use that rents facilities and grounds for special events, concerts, social functions, or other large gatherings. This use does not include any events that are accessory to an otherwise permitted civic, institutional, or commercial use.

Food & Beverage. A specific service and retail use engaged in the business of serving prepared food and/or beverages to the public for immediate consumption. Food and beverage uses are further refined by scale, format and intensity based on the following:

Food & Beverage – Bar Limited (Under 3K; under 100 seats). A food & beverage use where a significant portion of the business, in sales and in hours of operation, involves the sale of alcoholic liquors by the drink for consumption on premises, and food services is secondary or accessory. The limited use requires under 3,000 square feet and under 100 seats to ensure compatibility with other neighborhood-serving or small-scale uses in terms of intensity of activity and hours of operation.

Food & Beverage – Brewery / Winery; Bar General. A food & beverage use where a significant portion of the business, in sales and in hours of operation, involves the sale of alcoholic liquors by the drink for consumption on premises, and may include accessory craft manufacturing of alcoholic beverages. This general use is of a scale and intensity that frequently has accessory live entertainment or events and where the scale and intensity of the use is more compatible with general commercial uses.

Food & Beverage - Restaurant Limited (under 5K; under 100 seats). A small scale restaurant under 5,000 square feet and under 100 seats at full capacity.

Food & Beverage – Restaurant Quick Serve. A food and beverage use where the food is served from a counter ready to eat with no significant table service, and where the customer turnover will be high due to any combination of accessory drive-through services, carry out orders, or quick sit-down services

Food & Beverage - Restaurant General (5K+). A large scale restaurant with over 5,000 square feet of commercial area or over 100 seats.

(for accessory drive-through facilities see Section 24-403.e.)

Lodging. A commercial use providing accommodations for temporary, short-term overnight occupancy on at least a 24-hour basis, and accessory uses associated with typical guest services such as food service, recreation or similar accommodations to support overnight-guests. Lodging is refined to the following scales based on building type, format and intensity of use.

> *Lodging – Short Term Rental*. The rental of a dwelling unit, or portion thereof, for less than one month.
>
> *Lodging – Bed & Breakfast (up to 5 rooms).* A small residential building used for lodging, meals, and shared living space between the primary occupants and patrons and includes at least 2 but no more than 5 rooms.
>
> *Lodging – Hotel / Motel Small (6 to 40 rooms).* A small commercial or large residential building providing lodging and includes at least 6 but no more than 40 rooms.
>
> *Lodging – Hotel / Motel General (40+ Rooms).* A large commercial building providing lodging and includes 41 or more rooms.

Medical Care. A commercial service use providing medical, dental, or physical health or wellness care to the public. This use type is further categorized by the following formats.

> *Medical Care – Limited (Under 5K).* A medical care use offering routine outpatient services, that occupies less than 5,000 square feet of diagnostic or treatment area, includes no surgical or in-patient facilities, and operates in normal business hours. Examples include a small doctor or dentist office, eye-care center, or urgent care center that is accessory to a larger retail or pharmacy use.
>
> *Medical Care – General (5K – 20K).* A medical care use offering routine outpatient services, that occupies between 5,000 and 20,000 square feet for diagnostic or treatment areas, includes no inpatient facilities, and operates in normal business hours. Examples include a larger doctor or dentist group practice, small clinic or analytical lab, or small outpatient urgent care or surgical center.
>
> *Medical Care – Large (>20K).* A medical care use offering a full range of services that occupies over 20,000 square feet for diagnostic or treatment areas, and may include emergency care, surgical services or other inpatient treatment. The use may include accessory retail, food service, pharmacy or wellness/fitness uses. Examples include small hospital, remote surgical centers, or large clinic or analytical labs.
>
> *Medical Care – Hospitals.* A medical care use with a full range of diagnostic, surgical, and emergency services, and occupies a large commercial building or multiple buildings arranged around a campus that serves a greater region. It includes a wide range of accessory office, lab, and retail uses related to patron, patient, and visitor needs. Examples include a large hospital or regional medical center campus.

Mortuaries and Funeral Homes. A building used for human funeral services, which may contain space and facilities for services used in preparation of the dead for burial; the storage of caskets, urns, and other related funeral supplies; and the storage of funeral vehicles. Funeral homes shall not include crematoriums as accessory uses.

Office. A commercial use focused on employment and engaged in the administrative, professional, clerical or management aspect of business or professional services that typically do not have frequent or unscheduled on premise interaction with the public or clients. Office uses are further refined by the scale and format of buildings based on the following:

Office – General (under 20K). An office use in a small commercial building with under 20,000 square feet, typically within one moderate-sized building

Office – Large. (20K+). An office use in a large commercial building or multiple buildings in a complex or campus, with over 20,000 square feet.

Pawn Shops. A commercial use engaged in the loaning of money on the security of property pledged in the keeping of the pawnbroker, and the incidental sale of such property.

Personal Service. A commercial use engaged in the business of providing personal or professional services to the public that may include frequent or unscheduled interaction with clients or customers on-premises. Examples include barbershop or beauty salon, travel agency, small equipment repair, tailor, bank or personal financial services. Service uses are further refined by scale, intensity and format based on the following:

Personal Service – Limited (under 5K; under 1 acre). A service use under 5,000 square feet, typically in line with other small-scale uses in a multi-tenant commercial building or in mixed-use building on a site of less than 1 acre.

Personal Service – General (5K+; 1+ acre). A service use between of 5,000 square feet, in a small freestanding building or part of a large mixed-use building

Recreation. A commercial service use engaged in the business of providing daily or regularly scheduled activities for entertainment, leisure activities, training and instruction, or exercise, offered to the public through individual, membership, or group arrangements. This use type is further refined by the scale, format and intensity as follows:

Recreation – Indoor, Limited (< 5K; < 1.0 acre). An indoor recreation/entertainment use that involves a building less than 10,000 square feet. Examples include a small bowling alley, fitness club, billiard hall, or dance or yoga studio.

Recreation – Indoor, General (5K – 20K; 0.5 – 1.0 acre). An indoor recreation/entertainment use that involves a building between 10,001 square feet and 40,000. Examples include a large bowling alley, a small sports and recreation center, a small theater, large health club or fitness center, or small shooting range.

Recreation– Indoor Large (> 20K; > 1.0 acre). An indoor recreation/entertainment use that involves a building more than 40,000 square feet. Examples include a large sports and recreation center, skating ring, or theater complex.

Recreation– Outdoor, Limited (no lights; < 0.5 acre). An outdoor recreation use that involves less than 2 acres of active outdoor recreation grounds. Examples include a small pickle ball center, batting cages, or small community center.

Recreation/Entertainment – Outdoor, General (no lights; 0.5 – 1.0 acre). An outdoor recreation use that involves less between 2 and 5 acres of active outdoor recreation grounds. Examples include miniature golf, swimming pool, tennis center, small band shell or amphitheater.

Recreation/Entertainment – Outdoor, Large (lights or > 1.0 acre). An outdoor recreation use that involves more than 5 acres of active outdoor recreation grounds. Examples include waterpark, drive-in theater, shooting range, driving range, sports and athletic complex.

Recreation – RV and Travel Trailer Park. An outdoor recreation use providing overnight accommodations within a large open area for recreational purposes and may involve associated

accessory buildings or facilities for parking RVs on a temporary basis for recreation or vacation purposes.

Recreation – Outdoor Racetrack. An outdoor recreation use for racing of any motorized vehicles.

Retail. A commercial use primarily engaged in the sale of products for final use to the general public with frequent interaction of patrons or consumers on premises. Retail uses are further refined by scale, intensity and format based on the following:

Retail – Limited (< 3k). A small-scale retail use contained in a building with under 3,000 square feet of gross leasable area.

Retail – General (3K-20K) A retail use contained in a building with at least 3,000 but less than 20,000 square feet of gross leasable area.

Retail – Large (20K – 100K). A large-scale retail use contained in a building with at least 20,000 but less than 100,000 square feet of gross leasable area.

Retail – Warehouse (100K+). A large-scale retail use contained in a building with at least 100,000 square feet of gross leasable area.

Retail – Outdoor Limited (less than 25%; up to 0.5 acres). A retail use where a small portion of the merchandise is displayed permanently outside, limited to no more than 25% of the merchandise area being outside and limited to sites no more than 0.5 acres. Examples include a garden center, statuary store, or small equipment dealer. This does not include accessory outdoor sales and display areas that may be permitted as an accessory use to an otherwise permitted use or seasonal events that may be permitted through a temporary use permit.

Retail – Outdoor General (less than 50%; up to 1 acre). A retail use where a significant portion of the merchandise is displayed permanently outside, limited to no more than 50% of the merchandise area being outside and limited to sites no more than 1.0 acres. Examples include a lumber yard, large equipment rental or dealer, or small landscape supply store.

Retail – Outdoor Large (over 50% or more than 1 acre). A retail use where a substantial portion of the merchandise is displayed permanently outside, including more than 50% of the merchandise area being outside or sites more than 1.0 acres. Examples include a, equipment sales lot, boat or recreational vehicle sales lot, large machine or farm implement sales yard.

Retail – Outdoor Nurseries and Greenhouses. A retail use engaged in the sale of plants and other living vegetation, and where substantial portions of the merchandise is displayed outside.

Retail – Outdoor Flea Market or Swap Shop. A retail use where a large number of vendors will display merchandise indoors or outdoors on a short term or interim basis.

4. *Industrial.*

The Industrial use category involves the use of land and buildings for businesses engaged in the production, processing, storage or distribution of goods, which may have potential impacts beyond the site due to the types of activities, the physical needs of the site or facility, the types of materials used, or the delivery and access operations. Depending on the scale, intensity, and operations of these uses they may not be compatible with other uses or buildings, and may need special districts, more careful location criteria, and/or increased site design or operational limitations in order to be more generally applicable in the City.

Auto Dismantling, Junk & Salvage Yards. An industrial use for collecting, storing or selling scrap metal or discarded material or for collecting, dismantling, storing, salvaging or demolishing vehicles, machinery or other material and including the sale of such material or parts.

Commercial Services. A business engaged in service to other businesses and industries, or engaged in services to the general public but where industrial uses support the service, or where services dispatched from a central location for storage of vehicles, equipment, or merchandise. Examples include plumbing, exterminators, HVAC repair, janitorial services, commercial laundry services, or other similar uses.

> *Commercial Services – Limited (< 10 vehicle fleet)*. A small-scale commercial service use with limited outdoor storage needs and with a vehicle fleet less than 10 vehicles, where surface parking and vehicle storage needs are similar to other general commercial uses.
>
> *Commercial Services – General (10 – 20 vehicle fleet).* A commercial service use where outdoor storage is necessary or with a vehicle fleet between 10 and 20 vehicles, requiring dedicated areas for storage of vehicles during down times or off hours.
>
> *Commercial Services – Large (21+ vehicle fleet).* A large-scale commercial service use that may have substantial outdoor storage needs or with vehicle fleet is more than 20 vehicles, requiring large areas for storage of vehicles or equipment.

Concrete and Asphalt Batch Plant. A facility or equipment used in mixing the dry warm aggregate, padding and asphalt for homogeneous mixture at the required temperature, typically in association with a street, large parking area or other large-scale construction project, sometimes on a temporary or interim basis.

Crematoriums. A place for the cremation of human or animal remains.

Foundries. An industrial use for producing castings in molten metal.

Gravel & Mineral Extraction, Batch Plant. The process of extracting metallic or nonmetallic mineral deposits from the earth and crushing, separating or otherwise processing the extracted mineral deposits into a useable form.

Grain & Feed Elevators & Supply. An industrial use that stores grain and similar agriculture and feed products in bulk for storage, processing, or distribution to other locations.

Livestock Auction. A business that facilitates the buying and selling of livestock, including showing, housing, and otherwise caring for livestock to facilitate the purchase.

Manufacturing – Limited / Artisan (under 5K). A small-scale manufacturing use converting prepared materials into finished products. The activities produce little or no byproducts such as smoke, odor, dust, or noise discernable from outside of the building where deliveries and distribution are made by general consumer delivery services requiring no special large truck access, and where products are made available to the general public. Uses occupy buildings or spaces under 5,000 square feet of gross leasable area. Examples include artists' studios, small wood or metal shops, craft manufacturing, small bakery, or other similar small-scale assembly of finished products.

Manufacturing – General (5K – 100K). A manufacturing use converting prepared materials into finished products or parts. The activities produce little or no byproducts such as smoke, odor, dust or noise are discernable from outside of the building, and where distribution and delivery needs occur through light to moderate commercial truck access. Examples include small equipment or commodity assembly, production of consumer products, or similar businesses.

Manufacturing – Large (100K+). A large-scale manufacturing use converting raw or previously prepared materials into other materials or finished products. The activities may produce byproducts such as noise, dust, smoke or odor, but are mitigated to limit impacts beyond the property boundary. Outside storage and activities may be necessary, and distribution and delivery needs involve frequent or large truck access. Examples include large-scale manufacturing or fabrication plants, large equipment assembly, metal fabrication plants, chemical laboratories or other similar high-intensity manufacturing or distribution operations.

Manufacturing - Food and Beverage Minor (up to 3 acres). A manufacturing establishment primarily for packaging, producing or processing foods for human consumption that meets the definition of *food and beverage processing (major)* but which also dedicates a portion of the building footprint's square footage (a minimum of ten percent [10%], up to fifty percent [50%]) to sales of food, beverages and/or other retail for on-premises purchase and/or consumption; and which occupies a site of three (3) acres or less; and which cannot generate offensive odors, emissions, traffic or other off-site impacts or shall otherwise be considered a major food processing facility.

Manufacturing - Food and Beverage Major (3+ acres). A manufacturing establishment packaging, producing or processing foods for human consumption and certain related products and includes, but is not limited to the following: (1) bakery products, sugar, and confectionary products (except facilities that produce goods only for on-site sales and not wider distribution); (2) dairy products processing; (3) fats and oil products (not including rendering plants); (4) fruit and vegetable canning, preserving and related processing; (5) grain mill products and by-products; (6) meat, poultry, and fish canning, curing and byproduct processing (not including facilities that also slaughter animals); and (7) miscellaneous food preparation from raw products, including catering services that are independent from food stores or restaurants.

Manufacturing – Chemical Plant. An industrial use primarily engaged in the storage, processing, production, and distribution of chemicals on a large scale, where chemical reactions are used to transform materials for use in other industrial or business applications.

Manufacturing – Rendering, Slaughter & Packaging. An industrial use where waste products and livestock carcasses are converted into industrial fats.

Oil and Gas Operations means exploration for oil and gas, including the conduct of seismic operations and the drilling of test bores; the siting, drilling, deepening, recompletion, reworking or abandonment of an oil and gas well, underground injection well or gas storage well; production operations related to any such well including the installation of flowlines and gathering systems; the generation, transportation, storage, treatment or disposal of exploration and production wastes; and any construction, site preparation or reclamation activities associated with such operations. See Section 24-1102 for specific definitions, standards, and procedures related to oil and gas uses.

Research & Testing Labs. A building or group of buildings in which are located facilities for scientific research, investigation, testing or experimentation, but not facilities for the manufacture or sale of products, except as incidental to the main purpose of the laboratory.

Warehouse / Storage. An industrial use engaged in the business of keeping goods and products for interim or long-term periods for personal or business uses, or for the distribution to other businesses and industries, including any logistic services related to this business such as labeling, bulk packaging, inventory control, or light assembly. Warehouse and storage uses are refined further based on the scale, format and intensity as follows:

> *Warehouse / Storage –Indoor Limited (< 50K; up to 1 acre).* A warehouse / storage use where individuals store personal property in units or space leased or rented on a periodic basis and where all storage are accessed from within the principal building. Examples include small indoor self-storage mini-warehouses, or small commercial warehouse.

Warehouse / Storage – Indoor / General (50K – 200K; 1-5 acres). A warehouse / storage use for businesses or larger personal products where all items are stored indoors. Examples include large indoor self-storage mini-warehouse, large commercial warehouses, and long-term garages.

Warehouse / Storage – Large (200K+; 5+ acres). A large-scale warehouse / storage use for long-term storage of products or supplies, and where access and truck traffic is not frequent.

Warehouse / Storage – Distribution Center. A large-scale facility where goods or products are stored on-site temporarily for the purpose of delivery to a retailer or final destination, and where the nature of the operation has frequent daily truck traffic. Such facilities may include automated systems, office space and a pick and pack area to be used by employees for sorting and packaging goods and products for delivery from available, on-site inventory.

Warehousing / Storage –Outdoor Limited (up to 1 acre). A storage use for the public where individuals store personal property in units leased or rented on a periodic basis and where all storage is inside but individual units may be accessed directly from the outside. Examples include small outdoor self-storage mini warehouses or small equipment storage yard.

Warehouse / Storage – Outdoor General (1+ acre). A storage use for the public or other businesses where large-scale household items or machinery, commercial products, raw materials, or supplies are stored on an outdoor lot. Examples include large outdoor self-storage mini warehouse, boat or RV storage, building supply lots or similar industrial supply storage yards.

Warehouse / Storage – Bulk Storage of Flammable Liquids and Gases. The use of grounds for storing tanks used for gasses or liquefied petroleum, often as a distribution point for further shipment or processing or re-use at other locations.

Waste Management – Recycling Collection Small. A small-scale disposal point for recyclable or reusable materials, where items are dropped in bins that protect them from the elements, eliminate them from view of surrounding areas, and otherwise mitigate any noise or odor. These facilities are solely for temporary drop off and storage, until weekly or daily pick up of the materials, can bring them to a separate location for further procession or disposition.

Waste Management – Recycling Processing & Collection. A large-scale disposal point for recyclable or reusable material, where longer-term storage or processing of materials may occur on site.

Waste Management – Refuse & Transfer Station. A facility for the purposes of separation, aggregation and/or compaction of solid waste prior to delivery to a landfill.

Water & Waste Water Treatment Plant. An industrial use used to treat and process water and wastewater for further distribution or disposal.

Well Drilling Companies. A business that stores, supplies, operates or distributes machinery and equipment used for drilling wells.

Wireless Communication Facilities. A pole, tower, or antenna for the purposes of transmitting and receiving communication signals, other than that accessory to a principal use of the property. Wireless communication facilities include monopoles and towers with attached appurtenances such as microwave dishes and antennae, rooftop, wall- and ground-mounted microwave dishes and antennas. See Section 24-1101 for specific definitions, standards, and procedures applicable in all districts.

24-403 Accessory Uses

In addition to the general use and development standards applicable to all districts, permitted uses may include other accessory uses. This section provides basic performance standards for all accessory uses and some specific standards for particular accessory uses.

a. **Accessory Uses, Generally.** All principal uses shall include accessory uses subject to the following general standards:
   1. The use and any structure is clearly incidental and subordinate to an allowed use and customarily associated with the allowed use.
   2. The use is on the same lot as the principal use or otherwise clearly associated with an active principal use.
   3. The use is compatible with the general character of the area and comparable in scale and intensity to uses of other property in the vicinity.
   4. No use or structure may be constructed, maintained, or conducted in a way that produces noise, vibration, noxious odor or material, any visible light, glare or other visible impacts that are harmful, damaging or disturbing to the adjacent property.
   5. Any structures or site design elements to support the use can be screened or located to minimize impact on adjacent property or are not significantly different from what is typical for other allowed uses in the district.
   6. There are no unusual traffic patterns or increases in operational activity that impact the use and design of streets and public spaces differently that other allowed uses.
   7. All uses and structures are conducted in a way that is consistent with the intent and objectives of all other design and development standards applicable to the property.

b. **Accessory Dwelling.** Accessory dwellings are permitted as an accessory use to a principal dwelling as indicated in Table 24-4-2, and subject to the following additional standards:

   1. One accessory dwelling may be permitted per lot only when associated with a detached house or duplex/multi-unit house.
   2. Accessory dwelling units may be located in a detached accessory building or located within the principal building (such as an attic or basement apartment).
   3. The accessory dwelling shall not exceed 60 percent of the living area of the principal dwelling or 1,200 square feet, whichever is less.
   4. All parking necessary for the use shall meet the neighborhood design standards, and be confined to the garage, driveway or street directly in front of the dwelling.
   5. A detached accessory structure shall meet all development and design standards for the building and lot in Chapter 5, Residential Development Standards.
   6. The accessory dwelling shall be compatible with principal building, and whether within the principal building or in a detached structure, be clearly subordinate to the principal dwelling through the location of parking, access, building entrances and other design features that accommodate the dwelling.

c. **Home Occupation.** Home occupations may be accessory to a primary residential use on the lot and shall meet all of the following standards:

   1. The occupation shall be limited to residents of the dwelling and no other employees may be at the site for the purpose of conducting any part of the business operation. If the resident applicant is not the homeowner, the homeowner shall provide authorization with the permit application.
   2. Areas dedicated to the use and storage for a home occupation shall not exceed more than 20% of the habitable floor area of the dwelling, except as may be required for state-licensed child care home.

3. All activity shall be conducted with an enclosed living area, accessory building, or the garage, except as required for state-licensed in-home family child care.
4. Any materials or equipment used in the home occupation that is not customary to a residential use shall be stored within an enclosed structure.
5. No alteration of the exterior of the principal residential building or site shall be made which changes the residential character of the building or site, including use of colors, materials, construction, lighting or signs.
6. No traffic, services, or deliveries shall be generated by the home occupation that is abnormal to a residential neighborhood. In general, this shall be limited to:
   (a) No more than 1 customer vehicle parked at the property at a time, except for drop off of children for child care or instruction;
   (b) No more than 10 client visits per week, except for drop off of children for child care or instruction.
   (c) Delivery of products or materials is limited to that normally associated with residential purposes.
   (d) All parking necessary for the use shall meet the neighborhood design standards, and be confined to the garage, driveway or street directly in front of the dwelling.
   (e) Only one vehicle, not to exceed one-ton capacity, and one trailer which cannot exceed 15 feet, may be related to and used in conjunction with the home occupation and shall be parked on-site except for customary agricultural vehicles and equipment at rural homes.
7. No equipment, machinery or operation shall be used in such activities that is perceptible off the premises because of noise, smoke, odor, dust, glare, radiation, electrical interference or vibration.
8. There shall be no retail operations that result in regular or intermittent customer visits to the home, except for the sale of agricultural produce at a rural home, where all merchandise was produced on site.
9. The property shall be in compliance with all other building codes and property maintenance standards.
10. Use of utilities shall be limited to that normally associated with residential purposes.
11. All home occupations shall require a permit issued by the Director according to the following:
    (a) An application form and materials shall be submitted to the Community Development Department;
    (b) Notice of a permit application shall be posted and mailed to all abutting or other affected property owners according to Section 24-201.f.
    (c) The applicant shall submit the application concurrently to the Finance Department for approval of a business license.
    (d) A permit may be approved by the Director upon a finding that all criteria are met, and the Director may require any additional conditions of limitations to ensure that the criteria continue to be met;
    (e) A permit shall be valid for three years, but may be renewed for subsequent three-year periods;
    (f) A permit is valid only for the original applicant, and is not transferable to another person or to another location;
    (g) The Director may revoke a permit for non-compliance with these criteria, violation of any conditions of the approval, misinformation or misrepresentation in the application, or a change in the nature or extent of the use, or any other circumstance that violates the public health, safety, and welfare.
12. Any home occupation not meeting these criteria, or otherwise denied a permit by the Director, may only be approved according to Section 24-206, Use By Special Review.

c. **Livestock.** The limitations in Table 24-4-3: Animal Unit Equivalency Chart shall apply to the keeping of livestock as an accessory use to farming, residential uses, or any other use involving livestock. This chart shall not be used in a cumulative fashion. For example, in the H-A Zone,

there is a maximum of 2 animal units permitted per acre. These animal units may be derived from a combination of animals, but in no event shall it exceed the maximum of 2 animal units per acre.

Table 24-4-3: Animal Unit Equivalency Chart

Animal Species	*Max Animals Per Acre (by species)*		*Animal Unit Equivalent*
	H-A zone	*Other zone*	
Slaughter, feed & dairy cattle, bison, elk, llamas, horses, mules, burros, yaks, alpacas	2	1	1.0
Swine, butcher & breeding - over 55 lbs.	4	4	0.5
Sheep, lamb, goats	4	4	0.5
Turkeys	10	5	0.2
Chickens, broiler & layer; rabbits	20	10	0.1
Total Cumulative Animal Units Allowed Per Acre (combined species)		H-A district	2.0
		Other zones	1.0

- Young stock, less than 50% of adult weight, reduces the above equivalency factor by one-half).
- "Per acre" refers to areas specifically devoted for animal use.)

d. **Satellite & Communication Equipment.** The following provisions shall apply to the installation of devices and structures used to transmit and receive radio, television or communication signals, except residential satellite dish installations which are three feet or less in diameter, residential single-pole or tower roof or ground-mounted television, or amateur radio antennas:

1. The placement of all equipment shall conform to all standards of the zoning district and overlay district, and shall not be located in any required setback or on any structure unless architecturally screened.
2. The maximum overall height for a ground-mounted antenna shall be as established for building height in the applicable zoning district. The height of a roof-mounted antenna, combined with the building height, shall not exceed the maximum building height in the applicable zoning district.
3. The operation of the antenna shall not cause interference with any electrical equipment in the surrounding neighborhood, such as television, radio, telephone or computers unless exempted by federal regulation.
4. The antenna shall be a single, non-reflective color.
5. The antenna shall be sited to assure compatibility with surrounding development and not adversely impact the neighborhood, and screened according to Section 24-803.
6. The antenna and equipment shall be accessory to the principal use of the lot or site.

e. **Accessory Drive-Through.** Drive-through or drive-up service accessory to an allowed commercial use is permitted subject to the following standards:

1. This section applies to buildings and sites designed for orders to be taken from a customer in a car, where they wait in a queuing area, and then receive products or services delivered to the car from a service window or station. It does not apply to businesses that provide carry-out or to-go products where there is no specific site design or structural facilities dedicated to vehicle service.
2. Accessory drive-through or drive-up services shall be limited to the following districts:
   (a) Non-food and beverage service – C-L, MU-L, C-H, MU-H, I-L, and I-M
   (b) Food & beverage service – C-H, MU-H, I-L, and I-M
3. The service area shall not substantially expand the traffic or vehicle circulation otherwise necessary for access, parking and circulation to serve the site. In general, the service area shall use the same entrance and exit from the site as the principal use, unless a more remote or discrete service off an alley or secondary street better meets this criteria.

4. Vehicle service facilities shall avoid potential pedestrian/vehicle conflicts on the site and along the streetscape.
   (a) Adequate stacking spaces for automobiles shall be provided on site and outside of setbacks to eliminate any impact on public streets.
   (b) Stacking areas shall generally accommodate at least 5 vehicles, but may be modified for greater or lessor stacking dependent on the use or the context of the site, provided no stacking shall impede vehicle access or circulation on the site or in the right of way.
   (c) Circulation, stacking and other access issues shall be designed in a manner that has the least impact on pedestrians entering the principal building from public streets and from internal streets or parking areas. .
   (b) No access or queuing area shall be provided between the building and the street on any street designed to walkable street standards in Section 24-301 (Pedestrian or Avenue street types), or on "Walkable A" frontage type in Section 24-603. Use of alleys, internal access and the rear of buildings for drive-through services is required to preserve the streetscape design and development patterns of these areas.
5. Service areas and windows shall be located on the most remote wall that is practicable, considering adjacencies to public-streetscapes, residential property, or other sensitive adjacent areas.
   (a) No service area, speaker, ordering station, or pick-up window shall be located within 100 feet of any residentially zoned property, or otherwise be audible from residentially zoned property or the public right-of-way,
   (b) Signs, circulation areas, and lighting elements shall not be create any negative impacts on the public right-of-way or adjacent residential property.
   (c) Additional screening or buffers may be required beyond the standards of Section 24-803 in order to ensure compatibility.
6. The Director may require any other drive-through service area that does not clearly meet these standards and criteria to be reviewed subject to the procedures and criteria for Use by Special Review in Section 24-206.

f. **Craft Manufacturing.** Production, storage, and distribution of products, or other on-site manufacturing, is allowed accessory to an otherwise allowed commercial use, provided:
1. The manufacturing area is no more than 50% of the building area, and any outdoor storage is limited to all applicable site design and screening standards.
2. The entire site is limited to less than 1 acre.
3. That all manufacturing areas, warehousing, shipping and distribution facilities are clearly subordinate to the principle commercial use, and all manufacturing is to support the principal use.
4. No byproducts such as smell, waste, smoke or noise results from the manufacturing that is distinctly different or of greater intensity than the principle use.
5. Traffic, customer, and shipping patterns and activities from the manufacturing use are not distinctly different from the principle commercial use in terms of intensity and hours of activity.
6. Examples include microbrewery, bakery, furniture shop, art studio, or similar retail uses with limited and subordinate on-site manufacturing.

Otherwise such uses are only permitted as a principle manufacturing use.
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g. **Outdoor Storage, Non-residential.** Accessory outdoor storage may be permitted in the non-residential districts subject to the following standards:
1. In the C-L, MU-L, and MU-H districts, the storage area shall be located behind the front building line of the principal building.
2. The storage area shall be fully screened from residential property or public spaces according to the standards and design requirement of Section 24-803 and no materials shall be stacked higher than the screening.

3. The storage area shall be located on the most remote section of the site or building as possible, but no closer than 30 feet to any street or right-of- way and outside of required setbacks in all cases.
4. Outdoor storage areas shall be limited to:
   a. No more than 300 square feet in the C-L district.
   b. No more than 500 square feet in the MU-L or MU-H districts.
   c. No more than 30% of the building footprint in the C-H and I-L districts.
5. The storage area shall be paved per the requirements for parking lots, except a stabilized dust-free surface may be used in the I-M and I-H district.
6. Alternatives to these accessory use limits may only be approved by the Director through site plan review procedures in Section 24-207.

h. **Outdoor Display and Service Areas**. Outdoor display and service areas accessory to an allowed commercial use, such as sidewalk seating and dining or sidewalk sales are allowed subject to the following conditions:
1. Outdoor display and service areas shall be located on the same lot as the principal use or along the street frontage immediately abutting the use in the case of street front buildings.
2. Outdoor display areas shall be limited to no more than 20% of the ground floor area of the principal use, and outdoor service areas shall be limited to no more than 50% of the interior service area.
3. Display and service areas shall not be arranged where they interfere with pedestrian or building access or clear vision areas. When located on public, common or private sidewalks accessing the building, at 5 feet clear or at least 50% of the width any sidewalk, whichever is greater, shall remain clear and unobstructed..
4. The area may be located in parking areas, provided it does not interfere with adequate parking and circulation of the entire site. The permanence of any structures shall be considered in evaluating the impact on adequate parking needs for the site.
5. The area shall be screened from view along any property line abutting a residential use or district according to Section 24-803.
6. A site plan shall be provided for any outside display or service area more than 400 square feet, lasting more than seven consecutive days, or more than four separate occurrences per year. A site plan shall show the location, area, and dimensions of the display area, and specifications for all lighting, fencing, screening or temporary or permanent structures.
7. In reviewing the site plan, conditions or performance standards to mitigate noise, visual or operational impacts may be added by the Director to address specific sites or contexts.

i. **Temporary Construction & Sales Offices.** Temporary construction or sales offices that are accessory to a permitted development project shall provide the following:
1. The lot shall be within or adjacent to the construction site, or located so that access from the site does not impact public streets or surrounding uses. A sales office shall be limited to sales for the subject site.
2. Temporary office structures shall be architecturally compatible with surrounding uses and may be permitted on the site until 75% of the project is built out.
3. All structures and materials shall be removed within one month after occupancy of the project.
4. If the sales office is intended as a model home, it shall be completed to meet all Building and Zoning Code requirements.

j. **Temporary Uses.** Uses that may not otherwise be interpreted as being permitted by Table 24-4-2, or accessory uses in Section 24-403, may be permitted through a Temporary Use Permit, provided they are accessory to a principal use of the site or building. Temporary uses on property without a principal use shall be considered under the change of use provisions as a principal use, and are required to meet all applicable standards of the zoning district.

1. *Permit.* An application for a permit shall be submitted by the owner, or an agent of the owner with written permission from the owner at least 10 days prior to the desired issue date.
   (a) The permit shall have a specified start and end date not more than 90 days per year or be based on a schedule that includes no more than 90 days per year.
   (b) The applicant shall submit a complete description of the event or activity, including anticipated traffic, hours and peak times of operation, access and circulation plans, the ability to accommodate fire and police access, and any need for special protection or other public safety, health and welfare needs.
   (c) The applicant shall submit a plan identifying the extent of the grounds, gathering places and circulation routes, any streets or public spaces to be dedicated to the event, the location of all structures, equipment or other accessory facilities, and any utility needs for these structures, equipment or fixtures.
   (d) The Director may extend the permit one time for up to an additional 30 days. The extension shall only be permitted based on circumstances not foreseeable at the time of the original permit and provided no problems have arisen under the original permit.

2. *Standards.* All activities and any temporary structures shall meet the zoning district setbacks and standards, with the exception of the following:
   (a) Outdoor vendors may operate according outdoor vendor regulations and standards contained in Title 8, Chapter 5 of the City's Code
   (b) Parking requirements shall generally be met for the principal use and the temporary use, except that the Director may account for any existing and underutilized parking, the duration of the event, and any transportation management when considering the permit criteria.
   (c) Garage sales for residential property are not subject to the standards of this section or required to get a permit, provided:
      (1) It is operated by the owner or resident of the property;
      (2) It is for goods not acquired specifically for resale; and
      (3) It is limited to no more than 3 consecutive days, and no more than 2 events per calendar year.

3. *Criteria.* A temporary use permit shall be evaluated based on the following, in addition to all other general procedures and criteria for site plans in Section 24-207:
   (a) The proposed use is of a scale, intensity and format that is ordinarily occurring in the vicinity considering the size, anticipated traffic, hours of operation and duration of the event.
   (b) The anticipated traffic and parking can be handled by the existing street network, site access and lot layout, or the applicant has demonstrated sufficient management strategies and procedures to mitigate any potential negative effects on the area.
   (c) The degree of potential negative impacts on adjacent property, and in particular the likelihood of the event violating the general District Performance Standards in Section 24-405. The applicant may submit mitigation plans for any potential impacts, including limiting hours of operation, buffers and screening, transportation management, or other evidence or plans to accommodate concerns and limit impacts on surrounding property owners or residents.
   (d) The use shall comply with all other applicable codes, licenses, or other public health, safety, and welfare requirements.
   (e) The location subject to the temporary use permit shall be restored to its original condition upon the earlier of the expiration of permit or end of operation, except that permanent improvements made to the location may remain with the property owner's written consent.

(f) The Director may impose any other conditions on a permit necessary to protect the public health, safety, and welfare.

(g) Any temporary use permit that does not meet these criteria may only be approved through the procedures and criteria for a Use by Special Review, in Section 24-206.

24-404 Specific Use Standards

a. **Mixed-use Dwelling.** In districts where mixed-use dwellings are allowed uses, the following standards shall apply to a building or structure with two or more different uses, one of which shall be residential:

1. In the commercial zoning districts, at least 50 percent of the ground floor of a mixed-use building shall be in a nonresidential land use. In the R-H Zoning District, no more than 50 percent of the total gross floor area of a structure containing a mixed-use, including basement area, shall be devoted to nonresidential uses.
2. In the R-H zone, only commercial uses permitted in the C-L district are allowed, and they may be further conditioned, limited or prohibited through the Use by Special Review process in Section 24-206. Mixed-use dwellings in commercial and mixed-use zones may include any commercial use permitted within that zoning district.
3. The design and character of all buildings and sites shall be compatible with the predominant character of the surrounding neighborhood. The operating characteristics of a nonresidential land use in a predominantly residential neighborhood shall be compatible with the residential uses. For the purposes of this section, operating characteristics shall include, but not be limited to, hours of operation, lighting, noise and traffic.

b. **Residential Care.** When residential care is a permitted or use by special review, they shall meet the following conditions to ensure they are integrated into neighborhoods, have a non-institutional nature, and maintain the residential character.

1. *Residential Care – Group Home.*
   (a) Group homes shall meet all of the residential design standards applicable in the particular district, and any alterations to support the group living shall be done in a discrete way in accordance with the design standards.
   (b) In the R-L and R-M districts, no group home shall be located less than 750 from another existing group home.
   (c) Group homes shall be supervised at all times, and may include up to 2 resident care givers.
   (d) Group homes shall be licensed by, operated by, or owned by a governmental agency or non-profit qualified to provide care and supervision.
   (e) Group homes shall not include alcoholism or drug treatment centers, work release facilities or other housing facilities qualifying as residential care – institutional.

2. *Residential Care – Assisted Living, General, and Institutional*:
   (a) The use shall be located on a collector street or higher, or otherwise located as a transition between the neighborhoods and other non-residential or mixed-use areas.
   (b) In residential districts, the building(s) and site shall meet all residential design standards so that the use, building and site is compatible with the neighborhood in terms of scale and intensity of activity.
   (c) Any facilities necessary to serve the residents, guests or support the staff, that are non-residential in nature shall be located on the most discrete portions of the

site and building, and otherwise designed and screened to mitigate impacts on adjacent property according to Section 24-803.

c. **Animal Care.** All animal care facilities shall comply with the following:

1. All animal care businesses shall provide proof of compliance with all standards and licenses required by local or state animal care and control laws.

2. Any facility that provides boarding shall provide the following:
   (a) Adequate shelter from the elements for the animals.
   (b) Adequate facilities for preventing the escape of animals from the premises.
   (c) Adequate facilities for keeping the animal environment clean and free of filth.
   (d) Confinement and treatment of animals shall be in a manner that is humane and appropriate, which enclosures where the animal spends the majority of the day or where there is otherwise not access to an outside animal run, shall meet the requirements of Table 24-4-4: Animal Boarding Standards, which do not include required exercise areas:

Table 24-4-4: Animal Boarding Standards

Animal Size	*Minimum Kennel Area Floor Space**	*Height*
Extra-small dogs up to 10" high	4.5 s.f	▪ Min. 18 inches ▪ At least 1.5 times height of animal at shoulder. ▪ Max. Required: 48 inches
Small dogs up to 16" high	6.0 s.f.	
Medium dogs up to 22" high	9.0 s.f.	
Large dogs up to 26" high	12.0 s.f.	
Extra-large dogs up to 30" high	16.0 s.f.	
Giant breeds over 30" high	18.0 s.f.	

* Calculated as:(length of dog in inches + six) (squared) divided by 144 times two equals required floor space in feet

3. Dog runs and exercise areas shall meet the following minimum space requirements:
   (a) The length of the runs and exercise areas shall be a minimum of three times the length of the dog from the tip of its nose to the base of its tail; the width shall allow the dog to turn around easily; and the height shall be 1½ times the height of the dog at the shoulders, with the maximum height required of 48 inches, the minimum of 18 inches.
   (b) Indoor/outdoor runs that have the primary enclosure and the exercise area in combination shall for measuring purposes be considered an exercise run and shall be measured from the extreme inside to the extreme outside for length determination.
   (c) Outdoor or indoor runs used as a combined primary enclosure and exercise area shall be measured from one extreme end to the other extreme end for length. The same criteria will apply to freestanding runs used for exercise areas only.
   (d) Each dog housed in the specified primary enclosure must be provided the opportunity to exercise for a minimum of 60 minutes over a 24-hour period.

4. Adequate supervision of the animals in the kennel facility must be present to the following standards:

(a) There must be a minimum of one human supervisor (at least 16 years of age), present at all times and able to directly view each enclosure or common area where dogs from different owners are commingled.

(b) If more than 15 dogs are housed in a common area or enclosure, there must be at least one adult supervisor present for each 15 dogs housed within each enclosure or common area, with a maximum of 60 dogs housed in any enclosure or common area at a single time.

(c) Where after-business hours or overnight boarding care is provided, the applicant must provide an animal care and supervision plan if human supervision is not provided during this period. Such plan must address how animal care and emergency needs will be managed in the absence of human supervision.

5. Commercial businesses for which the principal use is either a pet shop or grooming operation, a pet management plan may be submitted in lieu of compliance with the confinement and exercise standards within this section. The plan must demonstrate compliance with local and state animal care and welfare standards, and include a description of the alternate accommodations related to area, location, duration of enclosure periods, and access to food, water and shelter.

d. **Automobile Gas Stations.** All automobile gas station uses shall comply with the following:

1. No more than one access drive shall be permitted for each street frontage.
2. All light sources, including canopy, perimeter and flood lights and lenses, shall be shielded or fully recessed within the roof canopy so that light is contained on-site.
3. If on-site convenience store or other retail or service component is provided, the design, location and operation of these facilities shall be compatible with the design, location and operation of the gas station.
4. The maximum height of a canopy shall be 20 feet for flat roofs and 24 feet for pitched roofs.. Canopies shall be architecturally compatible with the principal building and all other accessory structures on the site with the same or complementary materials, architectural style and colors. The material used on the underside of the canopy shall not be highly reflective. Setbacks for the canopy shall be measured from the outside edge of the canopy.
5. Adequate stacking space shall be provided on-site without using any portion of the adjacent street or alley for stacking. Stacking shall not occur in required setbacks.
6. Dispensing pumps and adjacent parking, fueling or service areas shall not be located within the property setbacks.
7 If the convenience store, gas station or auto repair use is immediately adjacent to residential zoned property or existing residential uses on at least two sides, the hours of operation shall be limited to between 6:00 a.m. and 11:00 p.m. daily.

e. **Automobile Repair / Service.** All automobile repair / service uses shall comply with the following:

1. Areas for overnight vehicular storage shall be enclosed or screened from the view of adjacent properties and the public right-of-way except when located in the Industrial - Medium Intensity (I-M) or Industrial -High Intensity (I-H) zones.
2. Where a automobile repair / service use abuts residential uses or residential zones, a minimum 20-foot side yard setback and a minimum 25-foot rear yard setback shall be provided.
3. No used or discarded automotive parts or equipment, or disabled, junked or wrecked vehicles shall be located outside any structure.
4. Landscaping, screen walls, berms, placement of the use or other site design techniques shall be used to screen cars being serviced or waiting for service and to screen overhead doors from view from the public right-of-way.
5. Auto repair uses within an integrated shopping center shall have an architectural style consistent with the theme established in the center. The architecture of any auto repair

use shall be compatible with surrounding uses in form, materials, color and scale. The location, size and design of the auto repair use shall be compatible with and have minimal adverse impact on the use of surrounding properties. Overhead doors shall be constructed of non-reflective materials.

f. **Automobile Repair / Service** - **Car & Truck Washes**. Uses that include car or truck washes as an accessory or principal use shall comply with the following:

1. Bays shall be located so that they are perpendicular to the public right-of-way or screened from view if on a corner site.
2. No auto repair shall be conducted within a car or truck wash bay.
3. All-over spray shall be contained on-site.
4. Operating characteristics of car and truck washes, such as hours of operation and the use of lighting, shall be conducted in such a manner that is compatible with surrounding land uses.
5. Other applicable requirements for car and truck washes may be found in the city's storm drainage and water department standards and criteria.

g. **Bed & Breakfasts.** All bed and breakfast uses shall comply with the following:

1. Cooking facilities, including stoves, hot plates or microwave ovens, shall not be permitted in guest rooms.
2. Meals or food served in the bed and breakfast shall be prepared in a central kitchen on-site and served solely for bed and breakfast occupants.
3. Individual rooms in a bed and breakfast shall not be rented more than twice during a 24-hour period.

h. **Manufacturing – Food & Beverage Minor.** All minor food and beverage manufacturing uses shall comply with the following:

1. Commercial elements of the use shall be visually and physically accessible to the public realm and designed as the most prominent aspect of the site. Commercial elements include the sale of food, beverages or other retail for on-premises purchase or consumption. The use of architecture, sidewalks, landscaping and parking shall be to define and emphasize these commercial components while de-emphasizing the manufacturing and other aspects of the facility.
2. Loading and storage areas, where otherwise allowed by this Development Code, shall be separated from public entrances and areas associated with the commercial elements of a minor food and beverage processing facility and shall be located at the rear of the facility and screened from rights-of-way and off-site uses, to the extent feasible.
3. Traffic by heavy trucks or rail shall be separated from public entrances and areas to avoid regular conflicts with the public and commercial aspects of the use.
4. Environmental impacts, such as odor, heat, glare, noise, vibration and other such emissions or impacts shall be reasonably contained on-site and not discernable at or beyond the property line. The inability to confine such impacts to the site would qualify this use as a major food processing use.
5. The applicant for a minor food and beverage processing facility shall demonstrate that a portion of the building footprint's square footage, equal to or greater than ten percent and no more than 50 percent, is dedicated to sales of food, beverages or other retail or services for on-premises purchase or consumption.
6. All other applicable site and building design standards applicable in the particular district or location shall be met.

i. **Waste Management – Recycling Collection Small.** All small recycling collection uses shall comply with the following:

1. The facility shall be installed as an accessory use to an existing multifamily development, commercial or industrial land use.

2. Facilities shall not be located within 100 feet (excluding right-of-way) of any residential zoning district.
3. The facility shall be no larger than 300 square feet and occupy no more than five parking spaces, excluding space that will be periodically needed for removal of materials or exchange of containers, and one parking space for an attendant, which shall be located outside setbacks.
4. All permanent or temporary structures shall be set back at least 10 feet from any public right-of-way, shall be located so that pedestrian or vehicular circulation is not obstructed, and otherwise located in a manner to limit adverse impacts on adjacent property and the public streetscape.
5. The facility shall accept only glass, metals, plastic containers, papers and similar items; or may be a collection point for donation of reusable, non-perishable household items such as books or clothing.
6. No power-driven processing equipment shall be used except for reverse vending machines.
7. Containers shall be constructed and maintained with durable waterproof and rustproof material, covered when the site is not attended, and shall be of a capacity sufficient to accommodate materials collected and collection schedule. All material shall be stored in the unit and shall not be left outside of the unit when unattended. The facility shall be placed on asphalt or concrete and shall not impact any landscaping or landscaped areas.
8. The facility shall be maintained in a clean and sanitary manner, free of litter and any other undesirable materials.
9. Containers shall be clearly marked to identify the type of material that may be deposited. The facility shall be clearly marked to identify the name and telephone number of the facility operator and the hours of operation, and display a notice stating that no material shall be left outside the recycling containers.

j. **Waste Management – Recycling Processing & Collection.** Recycling collection facilities that do not meet the small facility limits, or all recycling processing and collection uses shall be limited to industrial districts and comply with the following:
1. The facility shall not be adjacent to a parcel designated or planned for residential use.
2. Structure setbacks shall be those provided for the zoning district in which the facility is located.
3. All exterior storage of material shall be in sturdy containers that are covered, secured and maintained in good condition. Outdoor storage shall be screened by a six-foot solid fence or wall. No storage, excluding truck trailers, shall be visible above the height of the wall or fence. No outdoor storage shall be permitted in zoning districts that do not permit outdoor storage.
4. The site shall be maintained clean, sanitary and free of litter and any other undesirable materials and shall be cleaned regularly of loose debris. Containers shall be clearly marked to identify the type of material that may be deposited, and the facility shall display a notice stating that no material shall be left outside the recycling containers.
5. Space shall be provided on-site for a minimum of five vehicles to circulate and to deposit recyclable materials and for employee and commercial vehicle parking.
6. All containers provided for after-hours donation of recyclable materials shall be at least 100 feet from any residential use or zoning district and constructed of sturdy rustproof construction with sufficient capacity to accommodate materials collected, and shall be secure from unauthorized entry or removal of materials.
7. The facility shall be clearly marked with the name and telephone number of the facility operator and the hours of operation. Identification, informational and directional signs shall meet the sign standards of the zoning district.
8. Power-driven processing shall be permitted, provided all noise level requirements are met. Light processing facilities are limited to baling, briquetting, crushing, compacting, grinding, shredding and sorting of source-separated recyclable materials and repairing of reusable materials.

9. The site shall be secured from unauthorized entry and removal of materials when attendants are not present.
10. Hazardous materials, dead animals or yard waste shall not be considered recyclable material, except as otherwise provided in this Development Code.

24-405 District Performance Standards

All principal and accessory uses in non-residential districts shall be operated in a manner that meets the performance standards in Table 24-4-5, Non-residential District Performance Standards.

Table 24-4-5: Non-residential District Performance Standards

	C-L, MU-L	C-H, MU-H, I-L	I-M	I-H
Limits on hours of operation for businesses	6AM – 10PM	n/a	n/a	n/a
No smoke, radiation, vibration or concussion, heat or glare shall be produced that is perceptible outside a building.	☑	☑		
No smoke or particulate matter shall be produced that is a number I or darker on the Ringelmann chart	☑	☑	☑	
No vibration or concussion which is perceptible without instruments at the property line	☑	☑	☑	
Dust, fly ash, radiation, gases, heat, glare or other effects shall not be produced which are obviously injurious or damaging to humans or property beyond the property line;	☑	☑	☑	☑
Lighting	See Section 24-603.e			

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24-1001 Floodplain Overlay District
24-1002 Airport Overlay District
24-1003 Historic Preservation
24-1004 Conservation District
24-1005 Areas of Ecological Significance
24-1006 Downtown General Improvement District
24-1007 Redevelopment Area
24-1008 Character Overlay Districts
24-1009 Entertainment Districts
24-1010 Hillside Development Standards

Chapter 11.Supplemental Standards

24-1101 Wireless Communication Facilities
24-1102 Oil & Gas
24-1103 Adult Uses
24-1104 Marijuana Uses

Chapter 12 Metropolitan Districts

Chapter 13 Definitions & Terms

24-1301 Description of Uses
24-1302 Glossary of Architecture & Design Terms
24-1303 Definitions

Chapter 4 Zoning Districts & Uses: Section Map		
Current Standards	***Reorganized***	***Comment***
18.30.020 Zoning Districts established (plus general "Purpose" statements at beginning of each district in 18.38.	24-401.a District Intent & Applicability, Intent	No substantive changes, but improved description of districts relative to physical patterns, form and design characteristics of each district to better distinguish. Also added "Relationship to Comprehensive Plan" element to provide more specific link to the plan. This is a non-regulatory provision that can be used as a better guide to applying the districts. (Also intent statements for two new districts added)
18.30.040 Zoning Map Established	24-401.a District Intent & Applicability, Official Zoning Map	Simplified with no substantive change; many items in current section are incorporated into the rules of construction in Chapter 1 or procedures in Chapter 2
18.04.120 Application and Jurisdiction of Regulations	24-402.a. Allowed Uses, Use table	Generalized some uses where there was no distinction between the districts they were enabled in, but distinguished other uses by scale and intensity to better refine allowances for the character of different districts – this could allow for greater restrictions on some uses (at larger scales) but more allowances for other uses (at smaller scales). In general, all of the same or similar uses of the current code should be allowed in all of the districts, but the form / format of some may change. Notable changes include: • Adding two new Mixed-use districts • Adding "established residential" to allow existing and legal non-conforming uses an "allowed use" status in districts where residential is prohibited. This can better allow future investment in established housing (currently being addressed by a cumbersome "one time expansion" provision)
18.52 Accessory Uses & Structures 18.53 Temporary Uses & Structures	24-403 Accessory uses	No substantive changes for the current accessory uses, but emphasized a "general" accessory use allowance for any that are not specifically listed and incorporated current temporary use provisions. Moved accessory structures and fences and walls to Chapter 5 and 6 with other development standards. Notable additions to accessory uses include: • Adding an "accessory dwelling unit" (ADU –was secondary dwelling in current code) to the R-M zoning district • Revising home occupation (specifically child care) for recent bill streamlining administrative review of child care homes • Shifted "drive through" as an accessory site design / use element of otherwise allowed uses rather than an allowed principal use in the use table. The standards limit these by a combination of zoning district, context, and street types (relating to some new standards. • Added "craft manufacturing" as an accessory element of other commercial and retail uses. (could be used for micro-brewery/restaurant, bakery/restaurant, manufacturing / art studio, or similar small-scale combinations
18.46.050 Specific Use design standards; and 1846.060 – 1846-200	24-404 Specific Use standards	No substantive change except: • Some uses moved to different sections (Marijuana Uses and Adult uses in Chapter 11); Outdoor Storage and Drive-thru, Drive-in and drive up uses (24-403 Accessory uses for site design-level standards); Electronic Message Displays (Chapter 9 – Signs); and Mobile home and land .lease communities(24-506 R-MH district) • Some "uses" and standards incorporated into general design / development standards (Large Commercial and Entertainment uses (24-603 – non-residential design
18.40.080	24-405 District performance standards	Converted generic "anti-nuisance" standards called "environmental standards" and generally applicable to all districts equally, to slightly more specific performance and ambient impact standards so they could potentially be refined more by different zoning districts.

Chapter 5. Residential Development Standards

24-501 Intent & Applicability
24-502 Residential Development Standards
24-503 Residential Design Standards
24-504 Neighborhood Features & Common Areas
24-505 Courtyard Pattern
24-506 Residential Micro-Housing District

24-501 Intent & Applicability

a. **Intent**. The Residential Development Standards have the following intent.

1. Improve the appearance and livability of neighborhoods with good civic design, and reinforce the distinct character of different neighborhoods based on their context.
2. Design and locate parks, trails and other open spaces as focal points that shape neighborhood character.
3. Design walkable neighborhood streetscapes, with slow traffic speeds, well-connected sidewalks, and shade and enclosure provided by street trees.
4. Orient all buildings and lots to the public street or to common open spaces that serve as an extension of the streetscape and public realm.
5. Promote human-scale buildings and create active social spaces along the streetscape.
6. Provide housing variety within neighborhoods and among different neighborhoods, and ensure compatible transitions between different building types.
7. Promote lasting and sustained investment in neighborhoods with quality design.

b. **Applicability**. The standards in this Chapter provide lot, building development, and design standards, and generally apply to all residential development except:

1. Where stated, some sections may only apply to specific building types, specific districts or specific scales of projects;
2. The Character Overlay established according to Section 24-1007 may modify standards for a particular area;
3. Residential development may be further impacted by the standards for Areas of Ecological Significance in Section 24-1004 or Hillside Development Standards in Section 24-1009; or
4. Any use-specific standards in Chapter 4 may require a more specific or different standard for a particular use.

24-502 Residential Development Standards

a. **Building Types and Lot Standards**. The development standards for residential districts shall be based on the different building types permitted in each district, as specified in Table 24-5-1, Residential District Building Type & Lot Standards. The design standards in other sections of this article may further specify the design and location of each building type in a specific context.

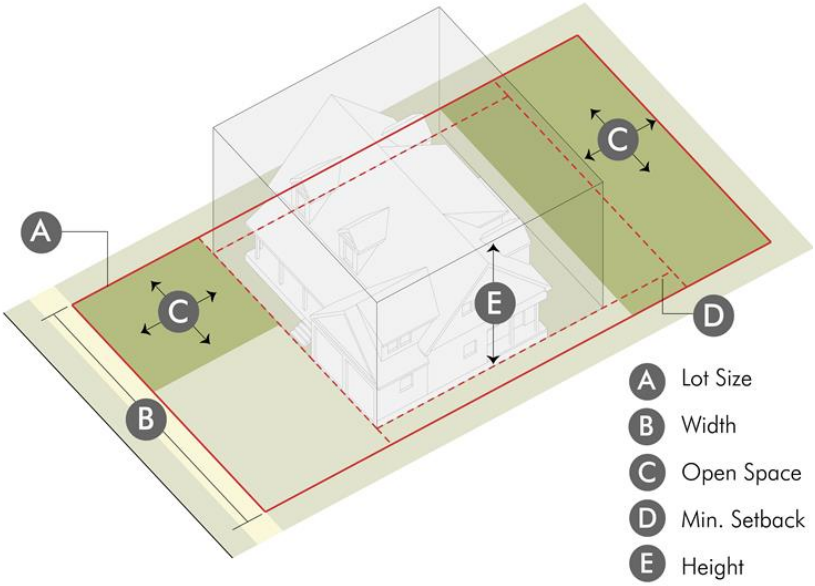

Figure 24-5-1 Building Types

Building types in Table 24-5-1 are distinguished based on lot sizes, unit configuration, building footprints and massing, building placement, and lot open space. This diagram illustrates the key elements standards in Table 24-5-1 applied to a typical lot.

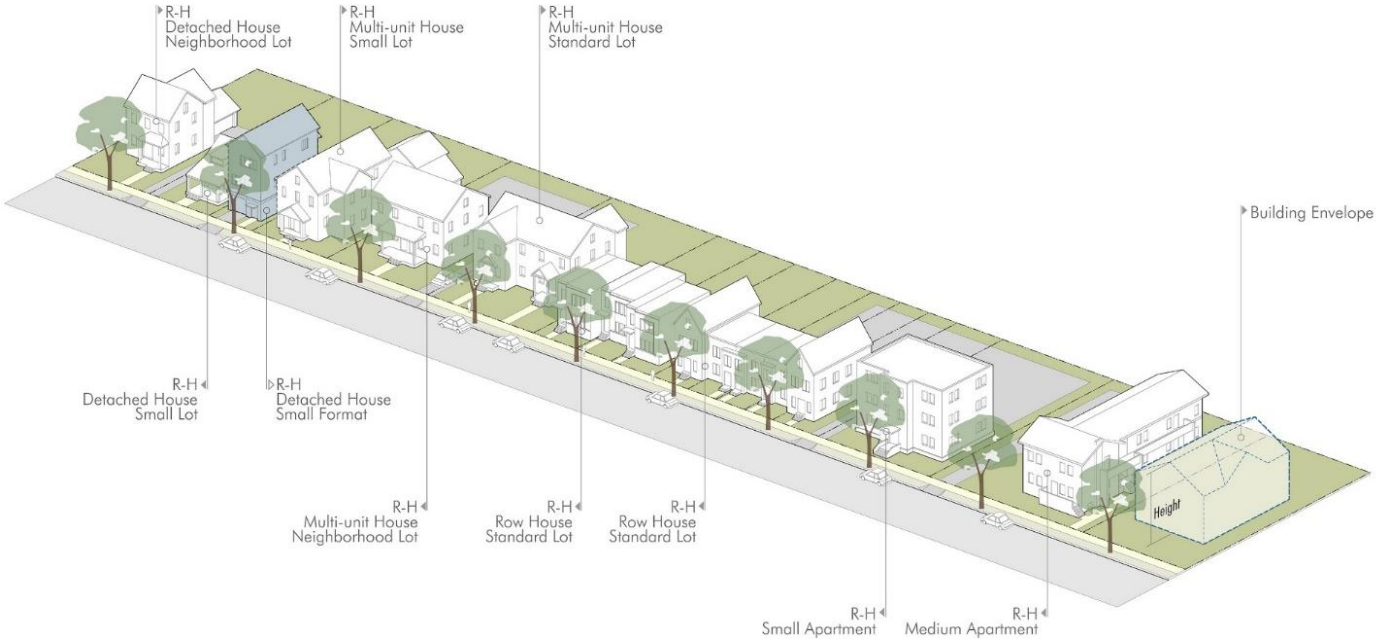

Figure 24-5-2 Range of Building Types

Each zoning district allows a range of building types that are compatible based on the building scale, frontage design, and intent of the specific zoning district. The R-H zoning district allows the greatest range of building types, each specifically defined by the standards of Table 24-5-1: Residential Building Type & Lot Standards.

Table 24-5-1: Residential Building Type & Lot Standards

Zoning Districts						Building / Lot Types	# of Primary Units	Development Standards							
								Lot Standards			Minimum Setbacks [4]				Building Height
H-A	R-E	R-L	R-M	R-H	R-MH			Area	Width [1]	Lot Open Space	Front [2]	Interior Side	Corner Side [1]	Rear	
■						***Agriculture Acreage***	1	40 + ac.	300'+	n/a	35'	25'	25'	50'	30'
	■	■	■	■		***Detached House –*** *Estate Lot*	1	13K + s.f.	100'+	30%	25'	5'	15'	20'	30'
		■	■	■		***Detached House –*** *Standard Lot*	1	6K + s.f.	60' – 99'	30%	25'	5'	15	20'	30'
		■	■	■		***Detached House –*** *Medium Lot*	1	4.5K + s.f.	45' – 59'	25%	25'	5'	10'	20'	30'
			◇	■		***Detached House –*** *Small Lot*	1	3K + s.f.	35' – 44'	20%	10'	5'	10'	20'	30'
			◇	◇	■	***Detached House –*** *Small Format*	1	1.5K + s.f	25' – 34'	15%	10'	3'	8'	10'	40'
			■	■		***Multi-unit House –*** *Standard Lot*	2-4	6.5K + s.f. 2K s.f. per unit	60'= 99'	25%	25'	5'	10'	20'	30'
			■	■		***Multi-unit House –*** *Medium Lot*	2-3	4.5K + s.f. 2K + per unit	45 – 59'	20%	25'	5'	10'	20'	30'
				■		***Multi-Unit House –*** *Small Lot*	2	3K + s.f.	35' – 44'	15%	10'	5'	10'	20'	30'
			■	■		***Row House –*** *Standard Lot*	3-8	1.5K + s.f. per unit	21' – 30' per unit	12%	10'	5' [3]	10'	10'	40'
				■		***Row House –*** *Small Lot*	3-8	1K + sf. per unit	14' – 20' per unit	10%	10'	5' [3]	10'	10'	40'
			◇	■		***Apartment –*** *Small Lot*	3-12	4.5K – 10K s.f.	40' – 79'	200 s.f./unit	10'	5' [3]	10'	10'	40'
				■		***Apartment –*** *Medium Lot*	13-24	10K – 30K s.f.	80' – 150'	150 s.f./unit	10'	5' [3]	5'	10'	50'
				□		***Apartment –*** *Large Lot / Complex*	20+	30K + s.f. 1.5K + s.f. per unit	150'+	300 s.f./unit	25'	10' [3]	15'	10'	70'
□	□	□	□	□	□	***Civic***		30K + s.f.	100' +	40%	25'	5'	20'	20'	40'
■	■	■	■	■	■	***Accessory Buildings***		See Residential Accessory Buildings in Section 24-502.c							
			■	■		***Accessory Buildings***		*See 24-403.b. for ADUs*							

■ Allowed
◇ Limited to projects that meet the housing diversity requirements of Section 24-502.d.
□ Civic buildings and uses, and Apartments – Large Lot or Complexes shall only be located on collector or arterial streets in residential districts.
Zoning Districts: H-A Holding-Agriculture; R-E Residential Estate; R-L Residential Low Density; R-M Residential Medium Density; R-H Residential High Density; R-MH Residential Micro-Housing
[1] Corner lots shall add at least 5' to the required lot width. Otherwise, lot width ranges shall determine the applicable building type standards within a category
[2] Front setbacks shall be modified based on context and the Frontage Design standards in 24-503.b.
[3] Row Houses, Small Apartments, and Medium Apartments shall have a 10' side setback when abutting lots with a detached house; Large Apartments / Apartment Complexes shall have a 20' side setback when abutting lots with a detached house.
[4] Buildings that require a certificate of occupancy shall be setback at least 250' from an oil/gas facility, and 50' from a well that has been plugged and abandoned. Buildings that do not require a certificate of occupancy shall be setback 150' from a tank battery or oil/gas well (unless plugged and abandoned). See Section 24-1102 Oil & Gas.

b. **Dimension Exceptions.** The following are exceptions to setback and building dimensions standards established in Table 24-5-1: Residential Building Type & Development Standards.

1. *Lot and Building Configurations.*
   (a) Row houses and side-by-side duplexes may have individual units platted on separate lots, provided the building meets the standards in Table 24-5-1 and each unit meets any per-unit or proportional standards for each lot. The lots shall be platted with a party wall according to building code standards.
   (b) Side lot easements between abutting lots may be granted in association with a plat to have the effect of "zero lot line" patterns. Easements for exclusive use of the side yard may be granted to the abutting owner to meet the lot open space requirements and design standards in Section 24-503 for the grantee, yet maintain the required setbacks from the platted lot line for each building in Table 24-5-1 for the grantor. Easements shall be private agreements and account for all access and maintenance scenarios for the lots, open space, and buildings.
   (c) The front setbacks for each building may be modified according to the frontage types and Frontage Design Standards in Section 24-503.b.
   (d) Lots may be configured in a Courtyard Pattern as provided in Section 24-505.

Figure 24-5-3 Side Lot Easements

Side lot easements may be used to provide more contiguous areas to meet the lot open space requirements, and have the effect of a zero lot line configuration. (24-502.b.1.(b))

2. *Setback Encroachments.* The following encroachments into the required setback are permitted, except in no case shall this authorize structures that violate the provisions of any easement.
   (a) Primary entrance features may encroach beyond the required front building line, as specified in Section 24-503.b.
   (b) Structural projections such as bay windows, balconies, canopies, chimneys, eaves, cornices, open fire escapes, egress wells, or other non-foundational overhangs or projections may extend up to 4 feet from the foundation and encroach into the setback, but no closer than 3 feet from any lot line. This exception shall be limited to no more than 20% of the total area of a building elevation.
   (c) Unenclosed decks or patios at or below the first floor elevation may extend into the rear or side setback but no closer than 5 feet to any lot line. Where a roof is

provided, it shall only be single story and shall remain unenclosed with at least 65% open and unobstructed on 3 sides.

(d) Ground-mounted mechanical equipment, meters, and utility boxes accessory to the building may be located in the side or rear setback provided that it extends no more than 6 feet from the principal building, no closer than 3 feet to the lot line, and is screened from public right-of-way by structures or landscape. These limitations do not apply to any utility structures otherwise authorized to be located in easements or rights-of-way, subject to the design standards of those specific authorizations.

(e) Any other accessory use or structure within the setback, not specified in Section 24-502.c, shall have a setback of at least 1/3 its height from the property line.

3. *Height Exceptions.* The following are exceptions to the height limits in Table 24-5-1:

(a) Building elements integral to the design and construction of the building, such as parapet walls, false mansards, or other design elements essential to a quality appearance of the building may extend up to 6 feet above the roof deck of a flat roof.

(b) Architectural features such as chimneys, ornamental towers or spires, and similar accessory features that are cumulatively less than 20% of the building footprint may extend up to 50% above the actual building height.

(c) Functional and mechanical equipment such as elevator bulkheads, cooling towers, smoke stacks, roof vents or other equipment may be built up to their necessary height in accordance with building codes, provided they are screened according to the standards of this code.

c. **Accessory Buildings - Residential.** Accessory buildings shall be permitted in association with. and on the same lot as, a principal building or use, subject to the standards in Table 24-5-2, Residential Accessory Structures, and to the following additional limitations.

Table 24-5-2: Residential Accessory Structures

Type	*Quantity*	*Size*	*Height*	*Setbacks*
Minor Structure (small shed, and similar structures)	▪ 1 / lot; ▪ + 1 / each 10k s.f; ▪ Maximum of 3	▪ 120 s.f. max	▪ 12' max	▪ 0' side or rear; ▪ 5' if on a concrete slab or similar foundation; and ▪ Behind the rear building line of the principle structure
Secondary Building (detached accessory building)	▪ 1 / lot ▪ 2 / lot, over 1 ac.; ▪ 1 / principal building (apartments)	▪ 50% of principal building footprint, up to 1,200 s.f. max.	▪ 25' max, but no higher than principal structure.	▪ 5' from side and rear; ▪ 20' from street side; and ▪ At least 12' behind the front building line of the principal structure
	Any building over 12' high or more than 250 square feet shall meet the design standards.in Section 24-502.c.2.			
Out-building (large storage building, barns, etc.)	▪ 1 / lot over 1 ac. ▪ + 1 / each 3 ac. ▪ Maximum of 4	▪ 2,000 s.f. max ▪ 5,000 s.f. max in H-A	▪ 25' max ▪ 60' max in HA	▪ 10' from side and rear; ▪ 30' from any street side; and ▪ Behind the rear building line of the principal structure
	Applies to detached houses and civic / institutional uses only			

1. *Generally.*

(a) All accessory buildings shall be at least 6 feet from the principal building, or other distance specified by applicable building codes based on fire ratings of adjacent walls.

(b) Accessory buildings shall be clearly incidental and subordinate to the principal building or use, in terms of scale, location, and orientation.

(c) Minor accessory structures 120 square feet or less, and not on a foundation or slab do not have a required side or rear setback, but should be movable and are otherwise placed "at risk" by the owner with regard to any easements, fence, or screening requirements.

2. *Secondary Building Standards.* In any residential district, secondary buildings over 250 square feet shall or over 12 feet high shall meet the following massing and design standards to ensure compatibility with the principal structure:

(a) The wall height shall be no more than 9 feet above the finished floor, except that gables, dormers, or other subordinate walls may support a pitched roof.

(b) The roof peak or other top of structure shall not exceed 22 feet above finished floor for pitched roofs with a 6:12 pitch or greater, and no more than 16 feet for shed roofs or pitched roofs below a 6:12 pitch.

(c) The design shall be compatible with the principal building considering materials, architectural details and style, window and door details, and roof forms.

(d) Secondary buildings with vehicle access directly from an alley or shared easement may be built on the lot line at the alley or shared easement.

d. **Housing Diversity.** Individual projects shall meet the following housing diversity guidelines based on the scale and context of the project. Diversity shall be based on the categories and building types indicated in Table 24-5-3, and be applied according to Table 24-5-4. The guidelines shall be met by one or a combination of the following:

1. Use a mix of housing types permitted in the zoning district, or propose more than one zoning districts within the project.
2. The Director may waive this requirement where there is an existing mix of housing within ¼ mile of the project that provides a comparable mix of housing considering the size, price points, and types of housing.
3. The Director may approve alternative compliance if the applicant submits evidence that achieving the mix unreasonable based on industry data and conditions beyond the applicant's marketing information.

Table 24-5-3: Housing Categories & Building Types

Category I: ***Detached Houses***	***Category II:*** ***Missing Middle Housing***	***Category III:*** ***Multi-family and Mixed Use***
▪ Detached House - Estate Lot ▪ Detached House -Standard Lot ▪ Detached House - Medium Lot	▪ Detached House – Small Lot ▪ Detached House – Compact / Small Format ▪ Multi-Unit House – Standards Lot ▪ Multi-unit house – Medium Lot ▪ Row house – Small Lot ▪ Row house – Large Lot ▪ Apartment - Small	▪ Apartment – Medium ▪ Apartment – Large ▪ Apartment – Complex ▪ Apartment – Mixed-use Building

Table 24-5-4: Housing Diversity

	Planning Context *(See Comprehensive Plan Growth Framework, Neighborhood Types)*		
Project Scale	***Rural Neighborhoods / Urban Reserve Area***	***Suburban Neighborhoods***	***Legacy Urban / Downtown Neighborhoods***
< 40 Units	no requirement	no requirement	no requirement

Table 24-5-4: Housing Diversity

Project Scale	Planning Context (See Comprehensive Plan Growth Framework, Neighborhood Types)		
	Rural Neighborhoods / Urban Reserve Area	***Suburban Neighborhoods***	***Legacy Urban / Downtown Neighborhoods***
40-100 Units	no requirement	▪ At least 2 building types ▪ No more than 70% of one type	▪ At least 3 building types ▪ No more than 50% of one type ▪ At least 20% Category II
101-200 units	▪ At least 3 building types ▪ No more than 50% of one type		
201-350 units	▪ At least 3 building types ▪ No more than 70% from Category I	▪ At least 3 building types ▪ No more than 50% of one type ▪ At least 20% Category II	▪ At least 3 building types ▪ No more than 50% of one type ▪ At least 30% form Category II
351+ Units	▪ No more than 50% of a single type among all housing types ▪ At least 30% from Category II		

e. **Fences & Walls.** Fences and walls in residential districts shall be limited to the sizes and locations in Table 24-5-5, Residential Fences & Walls, and the following additional standards.

Table 24-5-5 Residential Fences & Walls

Location	
Front *In the front setback or any location in front of Front Building Line.*	▪ 3.5' high ▪ 3.5' – 6' if it is ornamental design that is at least 75% open (i.e. wrought iron). ▪ Up to 8' for ornamental features at pedestrian entries.
Side and Rear *In the side, street side, or rear yard and behind the Front Building Line.*	▪ 6' high ▪ A fence or wall outside of required setbacks (i.e. in the buildable envelope),and behind front building line can exceed 6', but may be limited by building codes or other general development and design standards.
Perimeter Fences *Any fence within 30' of a Collector or Arterial street right-of-way as part of Perimeter Landscape in Section 24-803.*	Any fence designed as part of a perimeter landscape area along collector or arterial streets, or otherwise located within 30' of a collector or arterial right-of-way and longer than 100', shall meet the following standards: ▪ All fencing shall be softened with landscape materials on the street side of fences meeting the perimeter landscape standards of Section 24-802. ▪ Expanses of over 100' shall be broken up by either: ○ Offsets of +/- 3' on 1/3 of length for every 150' span; or ○ Ornamental designs on at least 50' of every 150' space that is at least 75% open (i.e. wrought iron); or ○ Architectural pillars or posts (i.e. stone, or masonry) at least every 50'. ▪ Alternatives may be approved by the Director in association with the perimeter landscape plans for in Section 24-803, Streetscapes in 24-301, and Neighborhood Features & Common Areas (Trails) in 24-504.
All Locations	All fences or walls along rights-of-way or easements shall be set back at least: ▪ 1' from any ROW or easement that prohibits structures; otherwise fences in easements shall be permitted only subject to specific easement language and limitations. ▪ 2' from any sidewalk. ▪ 3' from the edge of any alley or similar vehicle access surface ▪ Fences or walls may only be located in the right-of-way or public easement by a revocable right-of-way permit from the Public Works Department

1. *General Fence & Wall Design Standards*.

(a) All fences or walls located along common lot lines shall be located so the fence is on the property line, or at least three feet from the property line. Any areas set back three feet or more, which could become enclosed by other similarly located fences, shall provide at least one gate for access and maintenance equipment.
(b) The finished side shall face adjacent property or any public right-of-way, public space, or common areas.
(c) Any fence or wall in the floodplain shall also require a floodplain development permit.
(d) All fence or walls shall be located and designed to comply with sight distance requirements of 24-301.d.2. Any fence or wall that could potentially create a sight obstruction for vehicles crossing pedestrian areas or entering the street may require greater transparency or additional location restrictions to allow for safe sight distances for the vehicle.
(d) Temporary fences for construction may be up to 6 feet tall or as otherwise specified in construction permits
(e) All fences and walls may be subject to additional standards of the building code, approved drainage plans for the lot, or other design and development standards. In particular, the following require a building permit when allowed by this code:
(1) Any fence or wall over 6 feet.
(2) Any retaining walls over 4 feet.
(3) Walls in the setbacks over 6 feet shall only be permitted by alternative compliance in Section 24-208.

2. *Materials.* Fences and walls shall be consistent in character, materials and appearance with the architecture of the principal building(s) on the same lot. Fences and walls shall be constructed out of any of the following materials:
(a) Wood or vinyl simulating wood. Wood shall be either naturally rot resistant (such as cedar), or pressure treated for rot resistance;
(b) Wrought iron or aluminum simulating wrought iron;
(c) Stone, brick, concrete with stone or brick veneer, pre-cast concrete simulated stone or brick, or decorative concrete textured to simulate masonry; or
(d) Chain link or vinyl clad chain link, in the side or rear yard only and limited to 4 feet high, or up to 12 feet for any security fence around sports facilities, courts, pools or similar facilities, provided it is 20 feet from any lot line and provided all portions over 8 feet remain free of opaque screes.

24-503 Residential Design Standards

a. **Applicability.** The Design Standards shall apply to the R-L, R-M, and R-H zoning districts, and to any residential building type permitted in non-residential zoning districts. The standards shall specifically apply to the following circumstances:

Table 24-5-6: Applicability

Activity	*Applicability of Standards*
Site or Landscape work on less than 50% of the lot	Standards only apply to changes associated with the proposed work, and only to the extent that any non-conforming situations for the entire site are brought closer to compliance.
Site or Landscape work on 50% of more of the lot.	All site and landscape for the entire lot shall be brought into compliance with the standards.

Rehabilitation, remodeling or additions to buildings that add more than 200 square feet to the building footprint or mass, but less than 50%.	Standards only apply to changes associated with the propose work, and only to the extent that any non-conforming situations for the entire site are brought closer to compliance. However, staff may require full compliance for the building and lot for any rehabilitation, remodel or addition that is greater than 75% of the assessed value.
New primary structure; or Rehabilitation, remodeling or additions to the building that add more than 50% to the building footprint or mass.	All standards for the entire building and lot shall be met.
Ordinary Maintenance	The standards shall not apply to ordinary maintenance of existing buildings, except that maintenance to any building may not occur in a manner that brings the building or site to a greater degree of non-conformance with these standards.

b. **Frontage Design.** The design of lot frontages establishes the relationship of buildings and lots to the streetscape, including building placement, lot access, garage extent and location, and entry features. Frontage Types designed according to the standards and design objectives of this sub-section may be used to modify the front setback established in Table 24-5-1.

1. *Design Objectives.* Frontage types shall be applied to meet the following design objectives:
   (a) Enhance the image of neighborhoods by coordinating streetscape investment with private lot and building investment.
   (b) Design frontages to the particular context of the neighborhood, block and street.
   (c) Coordinate development across several lots, considering the cumulative impacts on streetscapes from the frontage design of each lot.
   (d) Orient all buildings and lot frontages to the streetscape, while still promoting effective transitions from public spaces to private spaces on the lot.
   (e) Limit the impact on the neighborhood streetscape from frontages designed for car access, particularly on narrower lots or walkable streets and neighborhoods.
   (f) Provide outdoor livable spaces that activate the streetscape.
   (g) Use front entry features to reinforce neighborhood character, promote unique design with subtle variations to building patterns, and create consistent, human-scale connections to the streetscape.

2. *Frontage Design Standards.* Frontage types shall be designed according to the standards in Table 24-5-7, Residential Frontage Types & Design Standards. Sub-sections following the table provide specific design strategies and techniques to be used in meeting these standards and design objectives. Where multiple frontage types are permitted, the frontages should be similar for all lots on the same block face or gradually transition to different building placement and frontage types on adjacent lots. In general, the front building line of adjacent buildings shall not differ by more than 5 feet.

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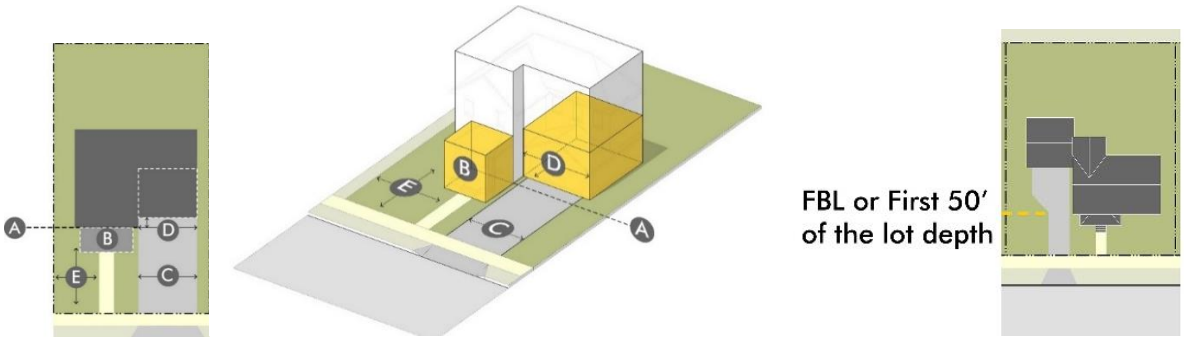
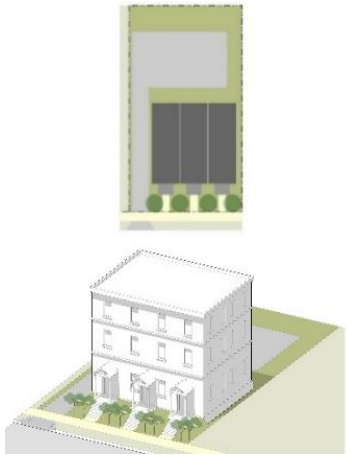
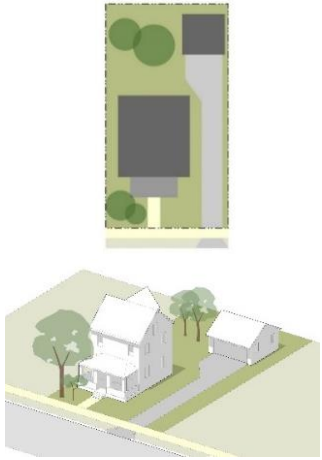
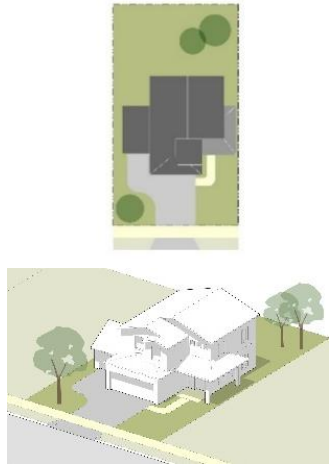


Figure 24-5-4 Frontage Design Standards

This diagram illustrates the key elements of frontage design in table 24-5-7: (A) front building line; (B) front entry features, (C) driveway widths; (D) garage extent and location, and (E) landscape areas. These elements determine the relationship between the building, the lot, and the streetscape, and affect the character of the area when applied across multiple lots on a block.

Table 24-5-7: Residential Frontage Types & Design Standards

Frontage Element		*Terrace Frontage*	*Neighborhood Frontage*	*Suburban Frontage*
				
Application	*R-L*		☐ Required frontage type for R-L in the Legacy Urban & Downtown Neighborhood areas	■
	R-M	☐	■	
	R-H	☐	■	
Front Building Line		10' – 25'	25' – 60'	25' +
Front Entry Feature		Required, See Section 24-503.b.5	Required, See Section 24-503.b.5	Required, See Section 24-503.b.5
Driveway Width		15% of lot width, up to 20' maximum	20% of lot width, up to 20' maximum	50% of lot width, up to 27' maximum
Garage Limitations		▪ 20% of facade – must be at or behind FBL; ▪ Up to 35% if stepped back 12'+ from FBL	▪ 35% of facade – must be at or behind FBL; ▪ Up to 45% if stepped back 12'+ from FBL	▪ 65% of facade –no more than 12' in front of FBL
Landscape [1]		▪ 60% minimum landscape; and ▪ 40% maximum hardscape.	▪ 70% minimum landscape; and ▪ 30% maximum hardscape.	▪ 50% minimum landscape; and ▪ 50% maximum hardscape

■ Required, default standard
☐ Optional, alternative standard to be applied based on context
[1] Landscape refers to allocation of space between front lot line and front building line. See Section 24-802 Landscape Design for planting requirements, standards, and specifications.

3. *Driveway Limits.* Driveway limits maintain active spaces along the frontage, preserve areas of streetscape landscape, and reduce curb cut width protecting sidewalks and curbside parking. The following standards apply to the driveway limits in Table 24-5-7:
   (a) Driveway width limits apply to the first 50' of the lot depth, or up to the Front Building Line, whichever is less.
   (b) Any garage meeting the design standards in this Section may have a driveway expanded to the width of the entry, provided:
      (1) The expansion extends no further than 20' form the garage entry;
      (2) The expansion cannot be closer than 10' to the front property line; and
      (3) The width of the driveway within the right of way and first 10' shall be reduced to no wider than 20' wide.
   (c) In cases where driveway width and garage standards prohibit front-loaded garages and driveways on a particular lot, a range of options with different access patterns and garage locations may be used.
   (d) All parking shall be outside of the frontage area, except detached houses or multi-unit houses may have one of the required parking spaces per unit in the driveway, provided it is at least 7 feet by 18 feet, entirely outside of the right of way, and does not interfere with any pedestrian area.

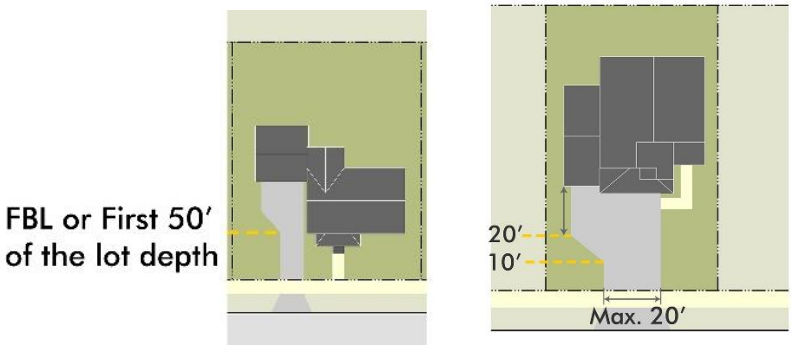


Figure 24-5-5 Application of Driveway Limits

Driveway limits shall apply to the first 50' or up to the Front Building line, whichever is less, except any front-loaded garage meeting these standards may have a driveway expanded to the width of the entry 20 feet in front of the entry. (24-503.b.3.(a) and (b).

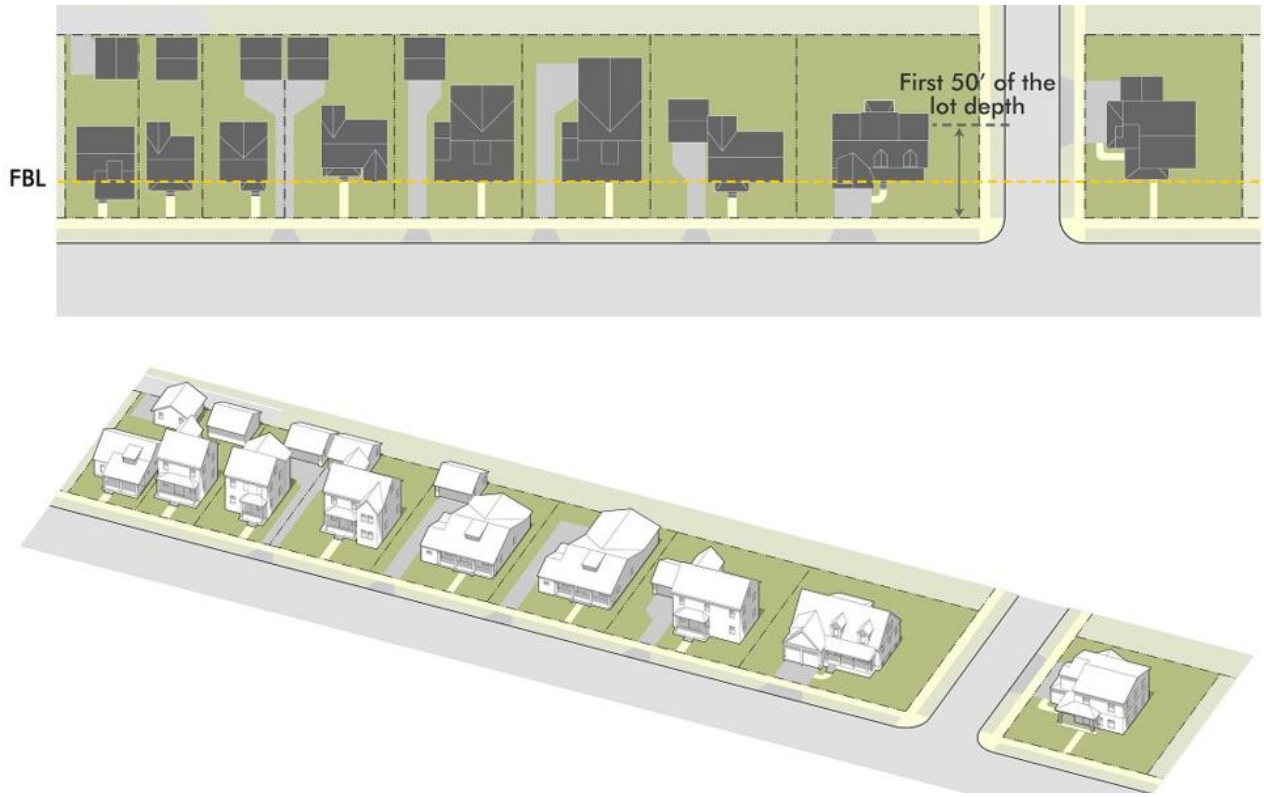


Figure 24-5-6 Driveway & Garage Options

Frontage type standards are based on lot widths to recognize both the proportionate and cumulative effect that frontage design elements have on the streetscape, and narrower or compact lots may be more limited. In these situations, options that reduce the car-orientation yet accommodate the convenience of access of vehicles should be used. Options include narrower entries, side entries, shared drives, common lanes, or internal block alleys. (24-503.b.3.(c).

4. *Garage Design:* Garage design reduces the extent; massing, and proximity and of front-loaded garages relative to the streetscape, and promote more human-scale building elements and active living areas along the frontage. The following standards apply to the garage limits in Table 24-5-7:
   (a) Garage limits apply to front-loaded garages. Alternatives such as detached garages, side or rear-loaded garages, or attached garages that are accessed from the front but located on the rear of buildings are not subject to the limits.
   (b) Garage limits shall be measured by the exterior walls of the floor plan or other clearly distinguished massing element on the front facade;
   (c) Any front-loaded garage that is more than 35% of the elevation or that projects in front of the main mass of the house shall include at least 2 of the following features to reduce the scale and prominence of the garage:
      (1) A front entry feature associated with the non-garage mass of the building that projects in front of or is no more than 4 feet behind the garage entry, and is at least 10 feet wide.
      (2) The wall plane with a garage door is limited to no more than 200 square feet, and distinguished from other wall planes by the following:
         i. At least one bay stepped back at least 2 feet; and/or

ii. Ornamental features such as canopies, eyebrows, or cantilevers distinguish the wall plane of any upper level gables or living space.

(3) Garage doors and any other related wall planes have at least 15% windows, and other ornamental trim or accents are included on the doors and pillars related to the garage entry.

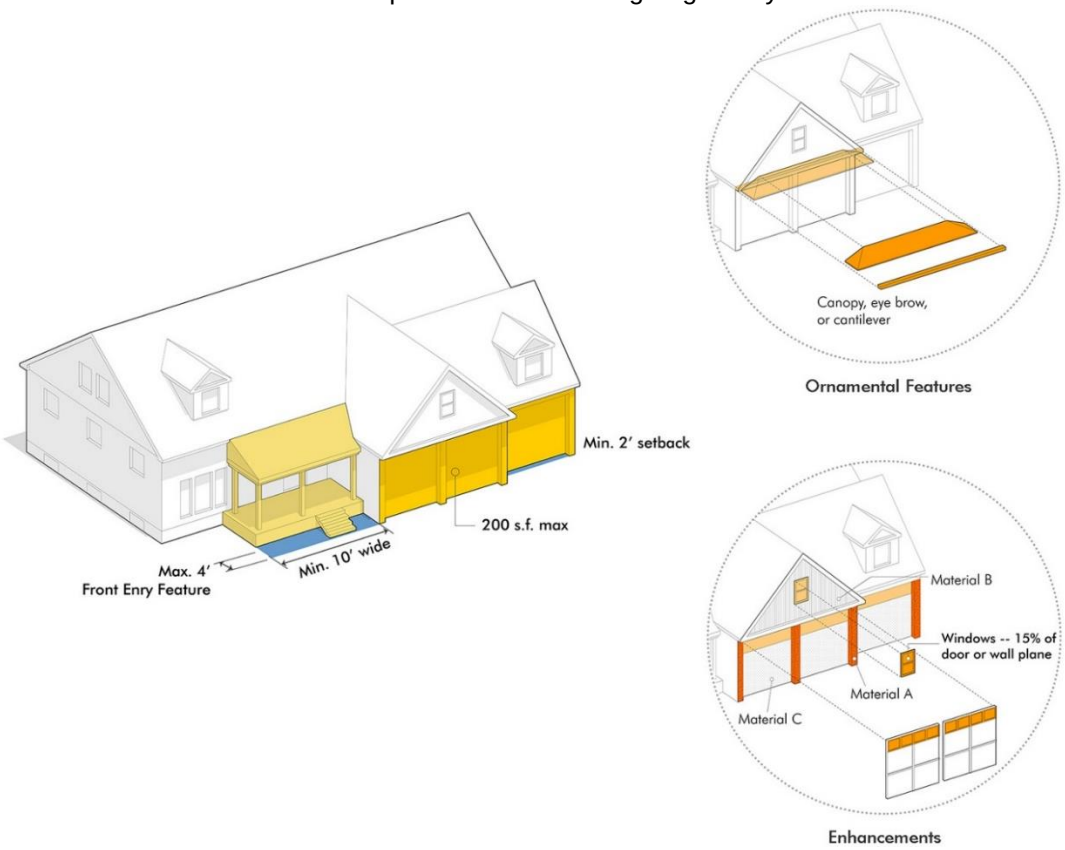


Figure 24-5-7 Front Loaded Garage Design

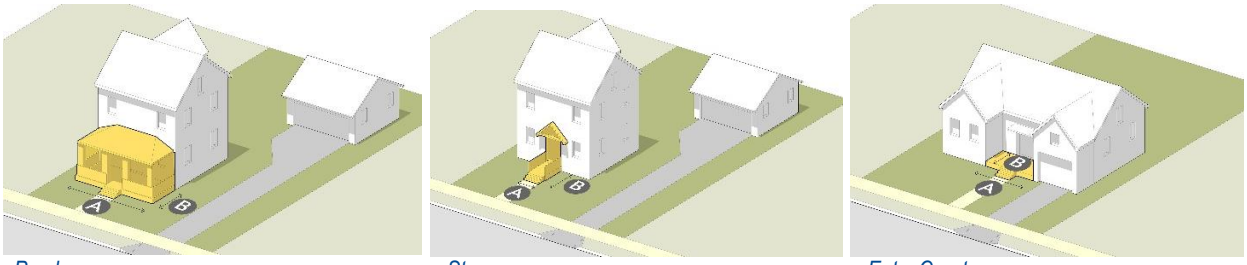
Where front-loaded garages project in front of the main mass or occupy a larger percentage of the elevation, design strategies can be used to reduce the scale and coordinate the garage entries with other livable spaces of the building. (24-503.b.4.)

5. *Front Entry Features.* The entry feature standards and design techniques in Table 24-5-8 shall be used where entry features are required by Frontage Types in Table 24-5-7, and are otherwise recommended to achieve the design objectives of this Section and to meet the standards of Table 24-5-9, Building Design Standards.

Table 24-5-8: Front Entry Features

Design Element	*Width*	*Depth*	*Details & Ornamentation*
Porch	12' minimum	8' - 12'	▪ Decorative railing or wall 2.5' to 4' high along at least 50% of the perimeter. ▪ If not roofed, a canopy, pediment, transom windows, enlarged trim and molding or other similar accents accompany the front entrance.
	Suburban Frontage may reduce porch to 48 s.f.; at least 4' in all directions.		
Stoop	6' – 12'	6' – 8'	▪ Decorative railing or walls along steps and side of stoop.

			▪ Ornamental features accent the front entrance such as canopy, pediment, transom windows, enlarged trim and molding, or other similar accents that emphasize the door over other facade features. ▪ May be associated with a single-story enclosed front entry portico, projecting from the building.
Entry Court	12' +, but never more than 50% of facade	10' – 24'	▪ Recessed entry within the building footprint. ▪ Decorative wall or railing, no higher than between 2.5' and 6' high along at least 50% of the opening. ▪ Ornamental pillars, posts or landscape accent the pedestrian entrance and create a gateway into the entry court.
General Design	▪ All entry features shall have a sidewalk or path at least 4 feet wide directly connecting the entry feature to the public sidewalk or street. For Suburban Frontage, this can connect via the driveway. ▪ All entry features shall be integrated into the overall building design including compatible materials, roof forms, and architectural style and details. ▪ Entry features shall be single-story, so that any roof structure and any ornamentation occur between 8' and 14' above the floor-level of the entry feature. ▪ Entry features meeting these standards may encroach up to 10 feet in front of the front building line, but never closer than 5 feet to a public or common property line, provided they are unenclosed with at least 65% open and unobstructed on all sides that project into the setback. ▪ Any building with more than 150 feet of front facade, or any side greater than 200 feet and permitted within 20 feet of the street, shall have 1 entry feature for every 100 linear feet of building frontage on the street.		



Porch *Stoop* *Entry Court*

Figure 24-5-8 Front Entry Features - Types

The porch, stoop and entry court are three distinct types of entry features that create active, social spaces and human-scale details on the residential frontages. Spaces with a minimum width (A) and depth (B) specified in Table 24-5-8 provide usable social spaces, activate the streetscape and frontage, and contribute to the massing and modulation required by the building design standards.

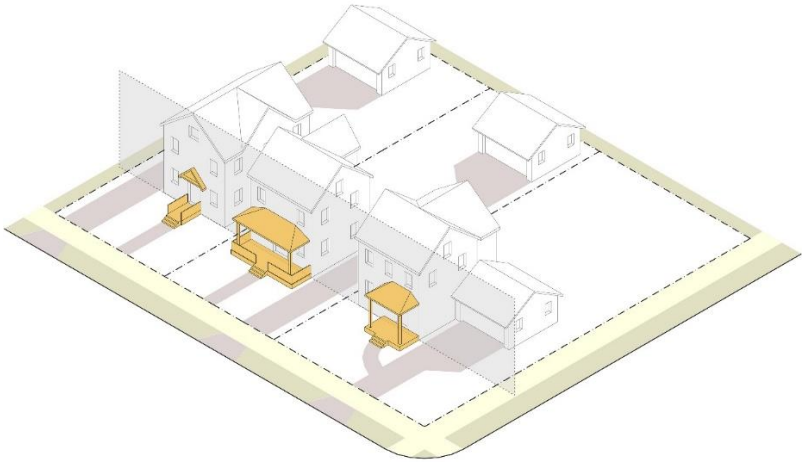


Figure 24-5-9 Primary Entry Feature - Encroachments

Front entry features meeting the standards of this section create social spaces that help activate streetscapes, and create a variety of human-scale details along blocks. These features may encroach into the front setback to improve the frontages along blocks. (24-503.b.5 / Table 24-5-8)

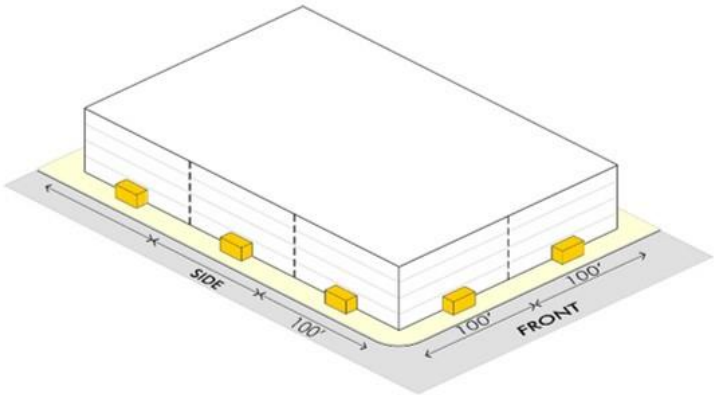


Figure 24-5-10 Primary Entry Feature - Large Buildings

Front entry features should be more frequently located on larger buildings with wall planes in close proximity to the street. This breaks up the building massing and activates the streetscape. (24-503.b.5 / Table 24-5-8)

5. *Alternative Compliance.* Alternative compliance to the frontage design standards established in this Section may be authorized according to the process and criteria in Section 24-208, Alternative Compliance, and any of the following additional applicable criteria:
   (a) The context presents clear pattern of existing buildings and lots on the same block and opposite block face with a different arrangement in terms of the front building line, driveway access patterns, and extent and placement of garages.
   (b) An alternative design allows the building, garage, and access to be sited in a way that preserves topography or other natural features on the site, and does so in a way that equally or better meets the design objectives.
   (c) The alternative preserves the streetscape landscape area and the curb areas available for on-street parking to the greatest extent practical.
   (d) For detached houses or multi-unit houses alternatives to the driveway widths and setbacks may be approved for a required, accessory or guest parking space provided:
      (1) No other reasonable alternative exists;
      (2) It is limited to no more than 140 square feet of additional paved or all whether surfaces;
      (3) The expanded paving is at least 10 feet from the front lot line if 45 degrees to perpendicular to the front, or at least 25 feet if 45 degrees to parallel to the front;

(4) All drainage and potential impacts on adjacent property are addressed; and

(5) The Director may require other design or landscape mitigation to ensure the parking and access is as discrete as possible,

(e) In all cases the deviation is the minimum necessary to address the circumstance and does not negatively impact other design standards applicable to the building or site.

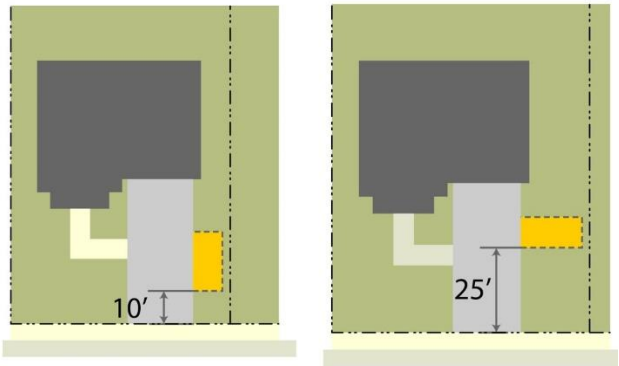


Figure 24-5-11 Accessory Parking Pad

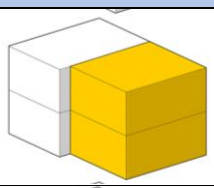
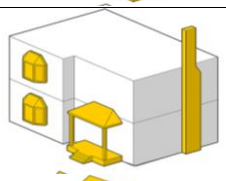
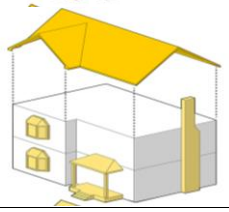
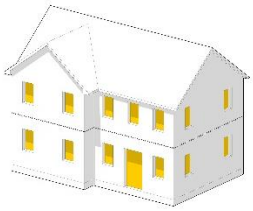
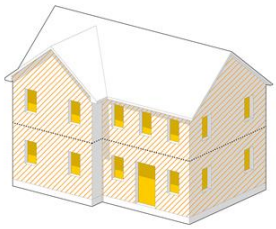
To meet parking requirements, accessory parking pads may be approved by alternative compliance provided they minimize impacts on the streetscape and adjacent property. (24-503.b.5.(c))

c. **Building Design.** Building design refines the scale and form of buildings beyond basic height, setback and lot coverage standards.

1. *Design Objectives***.** The following design objectives shall be used in applying the building design standards in this Section.
   a. Relate buildings to public realm and streetscape in a consistent manner and create a compatible massing along the block.
   b. Arrange buildings in a way that creates meaningful outdoor spaces on the site, with building designs that define and activate these spaces.
   c. Use combinations of height, width, depth, and roof forms break down the building volume into smaller-scale masses
   d. Blend a variety of building sizes and types and create compatible transitions between adjacent buildings of different scale by mimicking similar massing and proportions of adjacent development.
   e. Use materials and human-scale architectural features to create depth, texture, variation and visual interest to walls, particularly on larger facades, along streetscapes, and near active open spaces or adjacent lots.
   f. Encourage unique architectural expression, and promote the use of key details and design characteristics inherent in the chosen style for the building.
   g. Promote enduring investments with the application of durable, quality materials.

2. *Building Design Standards.* Table 24-5-9, Building Design Standards provides standards for massing and facade design. Sub-sections following the table provide specific design strategies and techniques to be used in meeting these standards and design objectives.

Table 24-5-9: Building Design Standards

Design Detail	*Building Type*	*Detached House (all), and Multi-Unit House*	*Row House, Apartment (all)*
Wall Plane Limits. *Maximum wall plane without a massing variation of 4'+ on at least 25% of elevation.*		800 s.f. or 50 linear feet	1,200 s.f. or 70 linear feet
Blank Wall Limits. *Maximum wall plane without modulation on at least 20% of the wall plane.*		500 s.f. or 30 linear feet	800 square feet or 45 linear feet
Roof Pane Limits. *Maximum roof plane without offset of at least2', complex planes, dormers or gables.*		600 s.f. or 50 linear feet	1,000 s.f. or 70 linear feet
		Does not apply to flat roofs, provided there is a parapet, cornice or other defined edge at the roofline	
Transparency. *Minimum window and door openings per elevation (includes decorative trim, molding and casing)*		*Front* – 20%; 15% 1-story *Side* – n/a, except 8% if side yard is > 2x required setback *Street-side* - 10% *Rear* - 8%	*Front* – 20% *Side* – 8% *Street-side* - 10% *Rear* - 8%
		Exterior walls of any allowed garage may be excluded from this requirement, provided other architectural details and materials are used to meet any applicable modulation requirements	
Materials		*Primary Materials* –80% - 90% (limit 2 materials, no more than 80% of any one material) *Secondary / Accent Materials* - 10% - 20% (limit 2 materials)	
		Primary Materials: Lap siding (9" maximum board); vertical siding; alternative exposure pattern siding; brick, stone, stucco, synthetic / veneer brick or stone; and standing seam metal (roofs only) *Secondary / Accent Materials:* All primary materials, plus architectural metals, integrally tinted and textured masonry block; and wood or prefabricated synthetic trim or architectural details.	

3. *Wall Plane Limits.* Massing techniques use changes in the building footprint, height, or significant shifts in wall and roof planes to break down the volume of larger buildings. Wall planes that exceed the wall plane limits in Table 5-5 shall have at least 25% of the elevation differentiated by one or more of the following massing techniques:
   (a) Break the building into distinct masses (primary mass, secondary mass, and wings), where portions of the building are offset from the main mass by at least 8 feet, or are otherwise be noticeably smaller and subordinate to the main mass.
   (b) Step back portions of the building or upper stories by at least 4 feet in association with meaningful outside space, such as a balcony, deck, patio or entry court.
   (c) Use cantilevers of upper stories that provide at least a 2 feet overhang of other portions of the wall plane.
   (d) Provide single-story entry feature that project at least 6 feet from the wall plane.

(e) Articulate rooflines by stepping the roof, using gables and dormers, dropping eaves, and using prominent overhangs to create offsets and projections of at least 2 feet.

(f) Where larger buildings are next to smaller buildings, or are along a block with smaller buildings, step the height of the building or offset secondary masses to create compatible massing with adjacent structures.

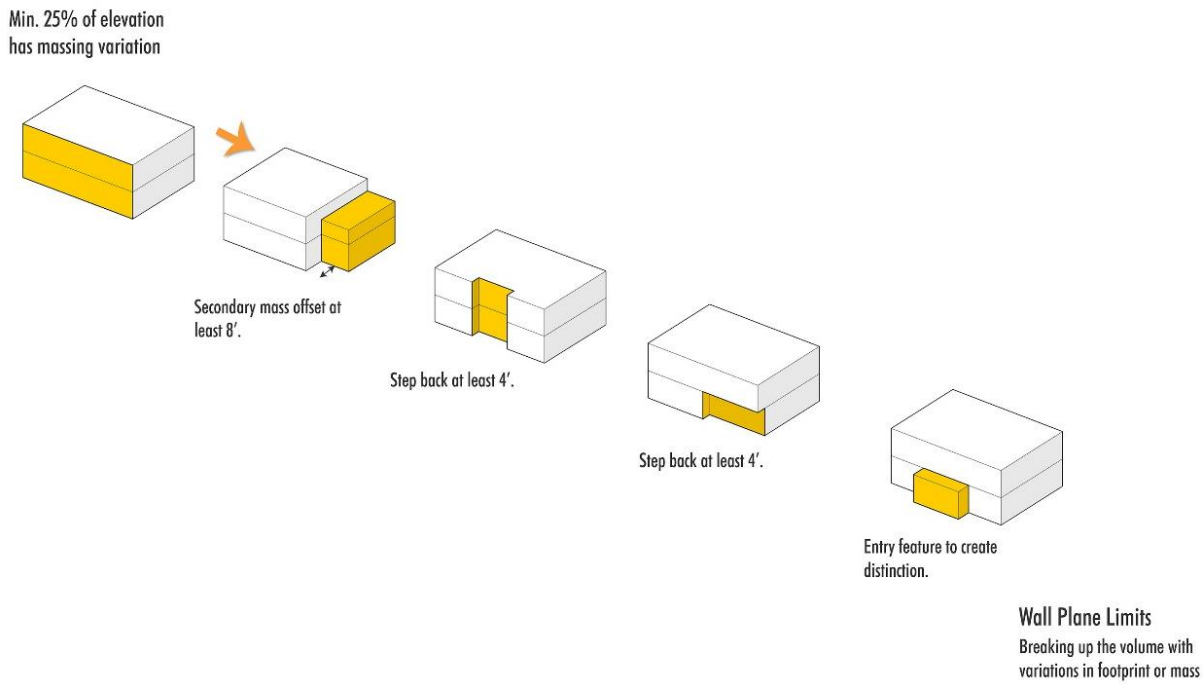


Figure 24-5-12 Wall Plane Limits

Wall planes over the size specified in Table 24-5-9 shall be broken up with a range of techniques so that at least 25% of the elevation is differentiated with distinct wall planes.(24-503.c.3.).

4. *Blank Wall Limits.* Modulation uses materials, ornamental details, and subtle variations in the wall plane to break up blank wall planes. Wall planes that exceed the blank wall limits in Table 24-5-9 shall use one or more of the following techniques so that at least 20% of the facade is distinguished with modulated elements:
   (a) Create projections in the wall planes with bay windows, balconies, awnings, or canopies that project at least 2 feet from the wall plane.
   (b) Create voids in the wall plane with step-backs of upper stories or balconies that recess at least 4 feet beyond the wall plane.
   (c) Differentiate stories, roofs, or other masses with prominent trim materials and/or incorporate material changes on different modules of the building. Significant trim or ornamentation used to break up blank walls or wall planes shall project between 2 inches and 2 feet from the wall and be at least 8 inches wide.
   (d) Use color changes and accent materials to emphasize distinct components of the facade. Material and color changes should wrap corners and occur at the inside corner of a massing element, or occur in association with a significant trim or ornamentation to give a finished and unified appearance to the element.
   (e) Break up remaining large expanses of blank walls with facade composition that considers the location and grouping of windows, doors, or architectural details.

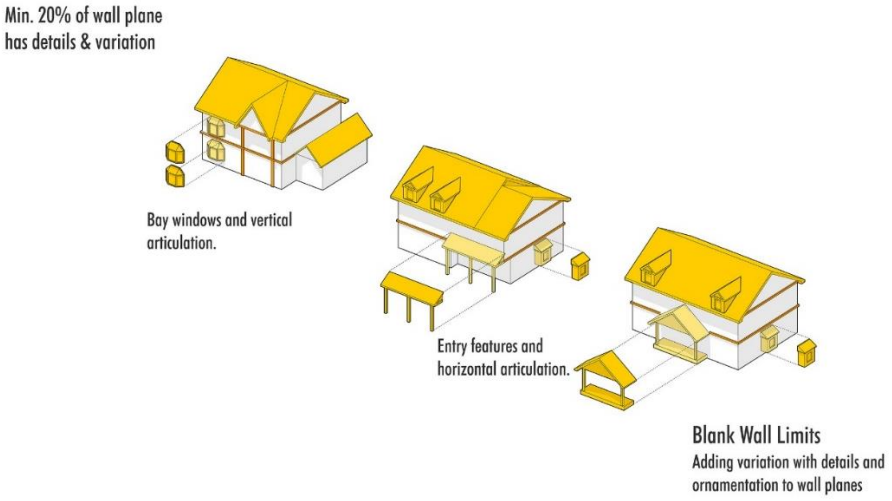


Figure 24-5-13 Blank Wall Limits

Wall planes over the size specified in Table 24-5-9 shall have ornamental details or subtle variations in the wall plane on at least 20% of any wall plane to eliminate large expanses of blank walls. (24-503.c.4).

5. *Transparency.* Windows and doors provide transparency, detail, and visual rhythm on the facade, and they break up blank walls with the location, pattern, and proportions of these openings. The following techniques should be used to achieve the design objectives of this sub-section and to meet the windows and doors requirements of Table 24-5-9, Building Design Standards:
   (a) Provide transparency with the location, pattern, and proportions of windows and doors, and create relationships to surrounding spaces and buildings.
   (b) Incorporate distinct and visually significant windows and doors (size, orientation, and ornamentation) to emphasize key locations on the facade or to relate to important outside open spaces.
   (c) Locate windows doors to create a coordinated facade composition considering the entier facade as a whole, and to break up large expances into different components with the grouping of windows and doors.
   (d) Emphasize a hierarchy of doors with different levels of ornamentation and details, particularly to make multi-unit houses compatible with adjacent detached houses and appear as single houses.
   (e) Locate and design windows strategically in relation to privacy concerns in adjacent spaces and buildings, but maintain consistent exterior patterns; recall that high-bank windows, transom windows, opaque windows, and window treatments that are a adaptable and user-controlled are a better strategy than simply no windows at all.
   (f) Use windows and doors with projecting trim and ornamentation to create depth, texture, and shadows on the facade; to emphasize openings; or to gang groups of openings. Openings that have projecting trim and casements (at least 1 inch off the facade and 4 inches wide); or otherwise group widows with significant details that clearly differentiate these elements from the main facade may count these features for up to 25% of the window and door requirement.

(g) The window requirement may be waived on sides of buildings that are closer than 3 feet to the property line, if necessary to meet applicable building code requirements.

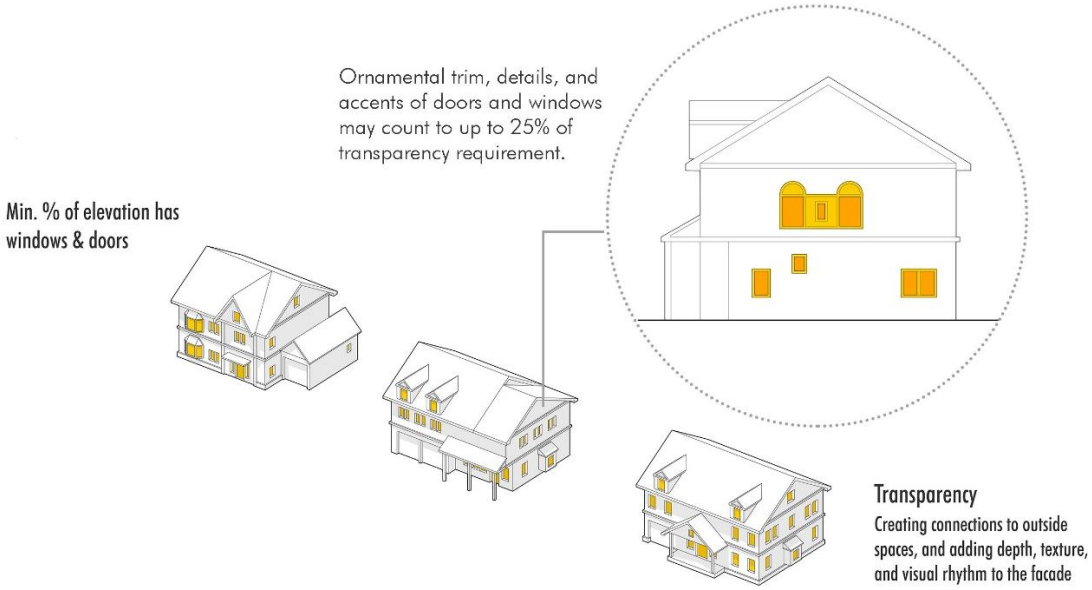


Figure 24-5-14 Transparency

The minimum transparency specified in Table 24-5-9 shall create connections to outside spaces and break up blank walls. Enhancements that emphasize the windows and the location, arrangement, or grouping of windows may count to this requirement. (24-503.c.5).

6. *Materials.* Building materials with texture and patterns create visual interest and signify quality construction and detailing. The following techniques should be used to achieve the design objectives of this section and the materials standards of Table 24-5-9, Building Design Standards:
   (a) Use natural materials such as painted or natural finish wood siding (horizontal lap, tongue-and-groove, board and batten, or vertical), brick, stone, stucco, ceramic, or terra cotta tile. Synthetic alternatives to these natural materials may be used if manufacturer specifications and/or precedents for application demonstrate that it will perform equally or better than the principal materials in terms of maintenance, design, and aesthetic goals.
   (b) Siding shall be continued to within 18 inches of finished grade on any side, unless the foundation is stone, stone veneer, or other ornamental finish is applied.
   (c) Brick, stone, or other ornamental accent materials shall wrap the corner for at least 2 feet on any facade, or otherwise terminate at interior corners to give a finished appearance the architectural element.
   (d) Coordinate changes in color and materials in association other changes in massing and modulation of the building.
   (e) Use changes in color or materials to differentiate the ground floor from upper floors and the main body of the building from the top or roof-structure, particularly on buildings 3 stories or more.
   (e) In multi-building projects, use subtle variations in building materials and colors on different buildings, within a consistent palette of materials and colors.

7. *Variations of Buildings.* All projects involving three or more buildings shall provide variations in the elevation from the two buildings on each adjacent side, and the three nearest buildings on the opposite side of a facing block, with at least two of the following:
   (a) Variations in the front entry features as indicated in 24-503.b.5. Variations should include combinations of at least two of the following changes:
      (1) Different types of entry features: such as, porch, stoop, or entry court;
      (2) Different roof styles associated with the entry feature: such as gable, hip, shed, flat, arched, or no roof;
      (3) Different locations and extent of the entry feature: such as centered, shifted, wrapped; projecting, or embedded; and half or full; and/or
      (4) Different ornamentation or architectural styles that lead to distinct qualities within a similar scale or pattern.
   (b) Variations in the facade composition, including massing, modulation, window types and placement, materials and material changes, and details and ornamentation, to the extent that the buildings have a distinct appearance;
   (c) Variations of the roof forms considering the type of roof, orientation of gables, or use of dormers; or
   (d) Variations of the model or building type with distinctively different floor plans that lead to different massing. Mirror images of the same model and floor plan shall not be used to meet the variation requirement.
   (e) In the case of multi-unit buildings:
      (1) For duplexes / multi-unit houses that are intended to mimic the scale and form of detached houses, a hierarchy of doors and entrances shall be used to create the appearance of a single building, and the variation shall apply between buildings.
      (2) For row houses and similar buildings that are clearly designed for multiple units, subtle variations in the materials and entry features shall apply to emphasize different units, and the variation shall apply between units in the building.

Figure 24-5-15 Front Entry Features - Variety

Using a wide variety of entre feature types, styles and designs is a way to create subtle distinctions between the same or similar building types, and can add common human-scale patterns among different types or scales of buildings. (24-503.b.5 and b.7.)

8. *Alternative Compliance.* Alternative compliance to the building design standards established in this Section may be authorized according to the process and criteria in Section 24-208, Alternative Compliance, and any of the following additional applicable criteria:
   (a) The requirement is not consistent with the particular architectural style selected for the building based on reputable resources documenting the style.
   (b) The requirement would make the building less compatible with designs or characteristics of other buildings or sites adjacent to the project or that are prevalent throughout the area.
   (c) Deviations from material standards and any simulated products demonstrate a proven performance in terms of maintenance and quality appearance.
   (d) In any case, the deviation is the minimum necessary to address the circumstance and does not negatively impact other design standards applicable to the building or site.

d. **Lot Open Space Design.** Lot open space helps scale buildings properly to the lot and block, create transitions from public streetscapes to private lots, and ensure that residents have usable open space and outside social areas. These spaces also complement the neighborhood features, common areas, and public parks throughout the neighborhood. Open space designed according to the standards and design objectives of this sub-section shall be used to meet the lot open space standard established in Table 24-5-1.

1. *Design Objective.* The following design objectives shall be used to apply the lot open space standards in this section.
   (a) Promote the arrangement of neighborhoods, blocks and lots in a way that responds to the existing natural features and ensures access to a variety of open spaces
   (b) Design all unbuilt areas to serve as valuable neighborhood features, considering the aesthetic, ecological, recreation, or community serving potential of these spaces.
   (c) Ensure that all lots and buildings have access and proximity to useable open space, whether public, common or private on-lot spaces.

2. *On-Lot Open Space Design.* On-lot and building open space required for each building type in Table 24-5-1: Residential Building Type & Lot Standards, shall create a common or private amenity for the site and building. Buildings and open spaces on a lot shall be arranged to create usable outdoor spaces that meet one or more of the following types:
   (a) Private frontage areas designed according to Section 24-503-b., excluding any driveways, parking areas or other automobile space;
   (b) A front entry feature designed according to Section 25-503.b.3, provided it is at least 80 square feet, and at least 8 feet in all directions – this space is limited to no more than 25% of the requirement for the lot and building.
   (c) Courtyards, meeting the standards of Section 24-505;
   (d) Rear or side yards provided they are part of an open area at least 300 square feet and at least 15 feet in all directions.
   (e) Uncovered decks or patios, provided they are part of an open area at least 120 square feet and at least 10 feet in all directions – this space is limited to no more than 50% of the requirement for the lot and building;
   (f) For apartment or mixed use buildings:
      (1) Common rooftop decks provided they are at least 200 square feet, and at least 12 feet in all directions – this space is limited to no more than 25% of the requirement for the lot and building; or

(2) Private balconies or patios, provided they are at least 6 feet by 10 feet – this space is limited to no more than 25% of the requirement for the lot and building.

3. *Alternative Compliance*. Alternative compliance to the open space design standards established in this Section may be authorized according to the process and criteria in Section 24-208, Alternative Compliance, and any of the following additional applicable criteria:
   (a) The lot and building has access to at least two different active open space within 1,320 feet, and meeting the design and service area standards Section 24-504, Neighborhood Features and Common Areas.
   (b) All buildings and lots shall include at least 1 of the required lot or open space types.

e. **Exterior Lighting.** All exterior lighting in residential zoning districts shall meet the standards of 24-603.f. Exterior Lighting.

24-504 Neighborhood Features and Common Areas

a. **Design Objectives.** The following design objectives shall be used to design and locate neighborhood features and common space.

1. Arrange neighborhoods, blocks and lots around a connected system of open lands, parks, trails and civic spaces
2. Design and locate unbuilt areas to serve multiple aesthetic, ecological, recreation and social functions
3. Integrate civic spaces and neighborhood features into streetscape designs and create gateways and transitions to unique neighborhoods and districts
4. Design neighborhoods with access to outdoor recreation and opportunities active living.
5. Locate formal civic spaces to serve as gathering places and focal points of compact, walkable neighborhoods
6. Preserve natural features for their aesthetic and ecological value, including groves of trees, prairie, streams, unusual and attractive topography, and similar natural landscape features.
7. Distribute open and civic spaces so that all development has access and proximity to a variety of amenities appropriate to its context.

b. **Required Features & Common Areas**. Neighborhood features and commons areas shall be required for all residential projects based on the number of dwelling units specified in Table 24-5-10. It may include the types of spaces identified in Table 24-5-11 provided they are designed and located according to the criteria in Section 24-504.c.

Table 24-5-10: Required Neighborhood Features

Required Features	*Dwelling Units*
0	<21
1	21-50
2	51 - 100
3	101-200 units
+1	each increment of 100 units

c. **Neighborhood Feature & Common Area Design.** Neighborhood features and common areas may include the types of spaces identified in Table 24-5-11.

Table 24-5-11 Neighborhood Feature & Common Area Types

Type	Size	Service Area	Feature Points
Natural Areas	▪ At least 1 acre, but dependent on ecological value of the space and the ability to other coordinated and undisturbed natural arras (ideally 40 acres or more)	n/a	1 – 3 depending on quality / size
Trail System	▪ 20' min. width landscape corridor; ▪ 8' minimum width paved or crusher fine path; 10' minimum if multi-modal; ▪ At least 1 block length, but sufficient continuity to connect entire project with pedestrian and bicycle systems outside of project.	w/in 1000' of trail, or up to 0.25 mile from trail head.	1
Pocket Park (See 24-302 for larger parks)	▪ 1 – 4 acres ▪ At least 100' wide in all directions ▪ Frontage on at least 1 public street OR connections to street by a trail	w/in 0.25 miles	1
Recreation Center	▪ 10K s.f. – 4 acres ▪ 2K s.f. min. community building and/or ▪ 20' x 40' min. community pool	w/in 0.5 miles	2 for building 2 for pool 3 for both
Square / Green	▪ 5K s.f. – 1 acre ▪ At least 50' wide in all directions ▪ Frontage on at least 2 public streets	w/in 1,000'	1
Plaza / Courtyard / Community Garden	▪ 1K – 5K s.f. ▪ At least 25 wide in all directions ▪ Frontage on at least 1 public street OR connection to street by trail or pedestrian passage	abutting lots or on the same block	1
Enhanced Streetscape	▪ 50% minimum increase above pedestrian / amenity area required by 24-301; OR ▪ Median – 12' minimum on collector; 16' minimum on arterial ▪ At least 1 block length	abutting lots on the same block	0.25
Gateways	▪ 100 – 1K s.f.at all intersections of collector streets or higher classification OR ▪ Smaller but equivalent monumentation and identify features dispersed at all intersections.	abutting lots on the same block	0.25
Pedestrian Passage	▪ 12' – 20' wide corridor ▪ 6' wide minimum paved path ▪ 150' length min, and through the entire block or connecting from street to other civic space.	abutting lots on the same block	0.25

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1. *Design Criteria.* All neighborhood features and common space shall include enhanced landscape design to ensure a distinctive identity and amenity for the neighborhood.
   a. Natural areas (open lands and trails) shall include large areas of vegetation, native or natural landscape, and undisturbed or restored topography and natural features. These areas shall be located to preserve valuable ecological resources such as riparian corridors, plant or animal habitat, or prominent landscape features.
   b. Recreation areas (parks, trails, and recreation centers) shall include playgrounds, sport courts, and larger landscape areas designed for un-programmed outdoor recreation. These areas shall be located at highly-visible, central locations and important intersections of the street networks and/or trial systems.
   c. Formal areas (greens, plazas, squares and courtyards) shall include hardscape, public art, seating areas, ornamental landscape, water features or other

enhancements to serve as focal points and gathering places. These areas shall be located to serve as focal points for compact development patterns or higher density development serving the immediate surrounding area.

2. *Designated Out Lots.* All neighborhood features and common space shall be designated on a plat as out lots under common ownership and reserved for the limited and specified purpose of serving surrounding development with amenities. Except, multi-family projects may include the neighborhood features or common space within the required 30% lot open space in private ownership.

3. *Coordination with Other Public Space.* All neighborhood features and common areas shall be coordinated, to the greatest extent practical, with the larger system of parks and civic spaces required in Section 24-302.

d. **Stormwater Facilities.** Stormwater facilities shall be designed and integrated into the street network or open and civic space system in order to avoid redundant and inefficient facilities on individual lots. Any area used for stormwater may be counted towards the neighborhood feature and common areas provided:

1. It is integrated into the design of the space as aesthetic amenity and is consistent with the design, function, and character of the space.
2. The design does not impact the utility of the space for either purpose (i.e stormwater functions do not compromise the use and value of the space as intended open space, and open space designs do not compromise maintenance and management and performance for stormwater functions according to the design and performance standards of the Design Criteria and Construction Specifications for Stormwater, Volume II).
3. The maintenance and management of the portion of the facility serving stormwater function is clearly identified, whether that is a public dedication or whether it is an obligation of the owner or property owners' association.

e. **Ownership and Management.** Neighborhood features and common areas platted as part of a development shall require specific designation on the final plat as a separate out lot. Options for ownership and management include:

1. Creation of or dedication to a non-profit entity capable of carrying out the ownership and management.
2. Creation of a homeowners', leaseholders' and/or property owners' association that owns the space in common and is capable of carrying out the ownership and management.
3. Dedication to a public entity as part of the rights-or-way, parks or other community facilities element of the plan. The City may accept dedications of land in its sole discretion, provided it meets other open space and conservation goals of the City indicated in the Comprehensive Plan or other official Culture, Parks, and Recreation Department plans.

All neighborhood features and common aras shall require documentation recorded with the final plat that outlines the ongoing maintenance plans, as well as administrative and financial management of the space according to these standards. Documents such as covenants for a homeowners' association, bylaws or charter for a non-profit entity, or similar agreements and guarantees, shall be filed with the clerk and recorders office in association with the plat prior to any building permits.

f. **Alternative Compliance.** Alternative compliance to the neighborhood feature and common areas standards established in this Section may be authorized according to the process and criteria in Section 24-208, Alternative Compliance, and the following additional applicable criteria:

1. The location, accessibility and quality of existing publicly dedicated areas, streetscape, or other public realm elements, particularly as it relates to infill development.
2. The extent of lot open space associated with buildings and the opportunity for it to provide usable open space to residents.
3. Alternatives to the neighborhood amenity and common area types that create a distinct identity or preserve a valuable resources.

24-505 Courtyard Pattern

a. ***Applicability.*** Residential buildings and lots may be designed to front on a courtyard based on the following design standards. The courtyard pattern is appropriate where:
   1. Courtyards are designed as an extension of the public streetscape and open space system for the project, block or neighborhood.
   2. Blocks and surrounding lots are deep, allowing a different configuration of buildable lots; or
   3. Other developed areas where existing lot patterns in the vicinity warrant use of this pattern to facilitate infill development and compatible building types.

b. **Eligible Building Types.** The following building types are eligible for this pattern, subject to the limitations stated:
   1. Small Apartments, up to 5 buildings or 36 units, whichever is less.
   2. Row Houses, up to 4 buildings or 24 units, whichever is less.
   3. Multi-unit House or Detached House, up to 8 buildings.

c. **Design Standards and Exceptions.**
   1. The minimum lot size per building in Table 24-5-1 may be reduced up to 30%, provided the courtyard is owned in common by all lots or otherwise established as a shared-space amenity.
   2. Lots and buildings may front on the courtyard, rather than along a street, provided they otherwise meet the design standards applicable to the front of buildings.
   3. The front setback may be reduced to 5 feet from the courtyard.
   4. Vehicle access and parking for each lot shall be coordinated for all lots and buildings, and designed in a way that minimizes the impact on the public street and the courtyard. Access shall meet all frontage standards applied to the project as a whole.
   5. Any buildings fronting on the street, or the sides of any buildings adjacent to the street shall still meet requirements for public frontages and orientation standards in this section. Corner buildings may need to meet the front building design standards on both the street front and the courtyard.
   6. The courtyard shall meet the following design standards:
      (a) *Size.* 1,000 to 5,000 square feet.
      (b) *Proportions*. The courtyard shall be at least 25 feet in all directions and be no wider than 4:1 (length to width).
      (c) *Frontage & Access*. The courtyard shall be have frontage on a public street, or be visible from and directly connected to the streetscape.
      (d) *Landscape:* At least 25% of the area shall be allocated to planter beds, seasonal plantings, foundation plants or other landscape amenities, and otherwise meet the landscape standards applicable to Terrace frontages.

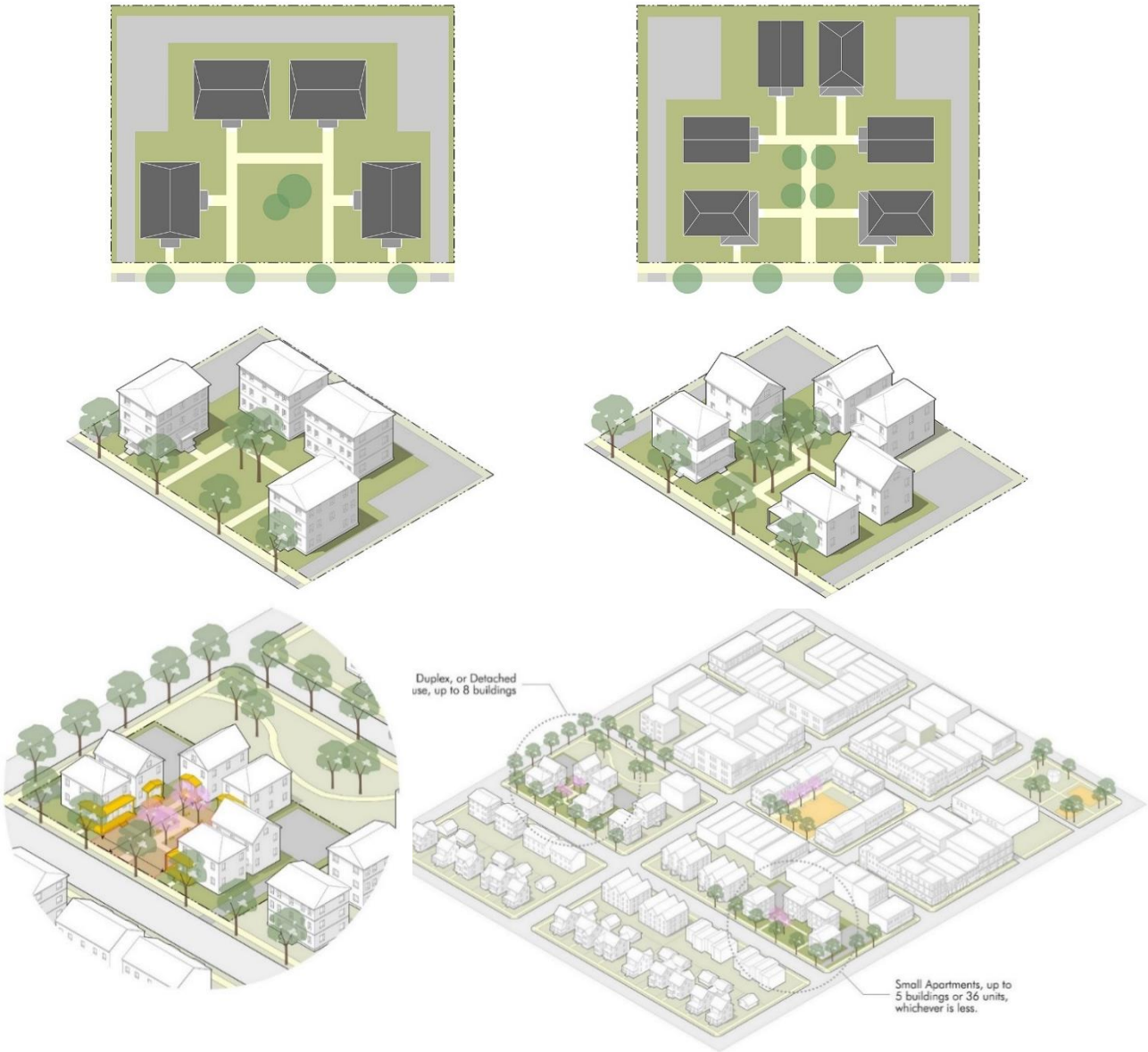

Figure 24-5-16 Courtyard Pattern

Courtyard patterns allow multiple buildings to front on common open spaces with reduced lot sizes and setbacks, provided all open space design standards are met, provided the courtyard and buildings maintain frontage design and streetscape standards on a public street.

24-506 Residential Micro-Housing District

a. **Intent.** The intent of this section is to provide smaller-format manufactured, mobile or other small homes, in a neighborhood or community that includes common neighborhood amenities, and with site designs that limit impacts on adjacent property and promotes development patterns that are compatible with the surrounding areas.

b. **Applicability.** Small format home communities are permitted in the Residential Micro-Housing District (R– MH), and implemented through rezoning conditioned on a specific project plan according to Section 24-204, or as a Planned Unit Development according to Section 24-205. These standards shall not apply to:

1 . Mobile homes, trailers or similar temporary buildings used as an interim structure associated with an ongoing construction project under valid permit;
2. A single mobile or manufactured home used as an accessory structure in the H-A district.
3. Interim or temporary housing strategies to address emergencies; or
4. Detached houses that are assembled off site and "manufactured," provided they meet all other standards of the applicable zoning district.

c. **Development Standards.** Except as otherwise modified through a development plan according to the approval procedures and criteria in Section 24-204, the general development standards for manufactured and other small format home projects are included in Table 24-5-12.

Table 24-5-12: R-MH Development Standards

Project	***Amount of Bonus Units Above Base Density***
Project Size:	5 acre minimum, 150' minimum frontage an arterial or collector 20% open space *Exception:* the Director may recommend a plan for as small as 3 acres and 100 feet of public street frontage if the plan demonstrates exceptional community design and layout for the common areas within the community, a high-quality and well-designed housing concept, and special attention to integrating and relating the project to surrounding areas.
Project Intensity:	10 units per acre, maximum *Exception:* Up to 18 units per acre for any project with more than 30% of the project area designed as useable open space meeting Open & Civic Space standards in Section 24-302.
Perimeter Setbacks	25' minimum from any street boundary; 20' from any property boundary See Section 24-803 for perimeter landscape standards.
Home Sites	
Lot Size	2,500 s.f. minimum, *Exception:* 1,200 s.f. minimum for any project with more than 30% of the project areas designed as useable Open & Civic Spaces meeting the types and standards in Section 24-302
Lot Width	25' minimum, and at least 20' frontage on a public street, common internal street, or common open space with street access at the rear of the site.
Setbacks	Front: 10' minimum, or 18' minimum from internal street edge, whichever is greater Side: 5' minimum, or 3' minimum with 10' between buildings on adjacent lots Rear: 10' minimum All buildings shall meet the project perimeter setback.
Height	30' maximum
Site Design	Each home site shall have a private patio, courtyard or similar outdoor amenity of at least 120 square feet. Any structure associated with this outside amenity may be located within 5 feet of the lot or home site boundary. Each home site may have accessory storage up to 120 square feet, up to 8 feet tall. The accessory storage shall be in an accessory building or in an area screened from the internal streets, common

Table 24-5-12: R-MH Development Standards

	areas or adjacent property. An accessory building shall be set back at least 40 feet from any public or internal street, or behind the dwelling unit. Accessory buildings shall be separated by at least 5 feet from any other structure. Where the project provides a community storage area of comparable size for each unit, storage on the site is not required
Parking	Projects shall meet Chapter 7 for required parking. At least one parking space shall be on the home site. However, and additional space and any required guest parking may be located on the internal street or in a common parking lot within 250' of the home site..

d **Uses.** In addition to any uses enabled for the R-MH district in Table 24-4-2: Zoning Districts and Uses projects may include the following specific uses:

1. Dwelling units consisting of modular homes, mobile homes, or other similar small detached dwellings.
2. Accessory buildings and uses incidental to those listed above and which support the residential community, including offices, recreation buildings, storage areas, maintenance and utility facilities, or other community services.

e. **Common Areas.** All common areas not dedicated as home sites according to the development standards in Section 24-504.c, shall be designed as common spaces according to the development plan. This space shall be allocated to:

1. *Internal Streets*. Internal streets shall laid out to organize the project into blocks and lots so that all home sites and lots are served by streets. Internal streets shall be 20' where no parking is permitted, 24' wide where parking is permitted on one side, and 28' wide where parking is permitted on both sides. Internal streets shall connect to public streets as follows:
   (a) One connection for projects under 25 dwelling units;
   (b) Two connections for projects between 25 and 100 dwelling units.
   (c) One connection per every 50 dwelling units for projects over 100 dwelling units
2. *Neighborhood Features & Common Areas.* Common areas shall meet one of the design types specified in Section 24-504 at a rate specified in Table 24-5-10. All common areas shall be designed and located in a manner that ensures adequate accessibility for all units in the community.
3. At least one of these spaces shall include a community building, which is centrally located, for recreation and meeting functions, laundry facilities, or other common amenities. The community building shall be at least 1,000 square feet, or 15 square feet per dwelling unit, whichever is greater.
4. Other internal circulation or open space such as walkways, landscape perimeters or other site design amenities that improves the quality of the community and its relationship to surrounding areas. Pedestrian connections shall be accounted for on all internal streets or at greater intervals through a trail or path system.
5. A common storage and utility area shall be provided within the plan including at least 100 square feet per unit. This area may be used for storage of large equipment, recreational vehicles, maintenance or other utility functions for the community. This area shall be screened from the project and from surrounding property according to the landscape standards in Article 8.

f. **Building Design.**

1. All dwellings shall have a front entry feature, such as a porch, stoop, or outside patio relating the home site to the lot frontage or other common open space upon which the dwelling is located.
2. Parking spaces on a home site shall be located to the side or rear of the dwelling. Home sites may include a carport, provided it remains open and unenclosed on at least 75% of the perimeter, is no taller than the dwelling unit, is no larger than 400 square feet, but in no case larger than the dwelling unit.
3. Any mobile home or similar non-foundational dwellings shall:
   a. Be secured to the ground by tie downs and ground anchors in accordance with the applicable building code;
   b. Be skirted within 14 days after placement in the community by enclosing the open area under the unit with a material that is compatible with the exterior finish of the dwelling and consistent with the quality of development in the community.
   e. Be located on a hard surface pad with a minimum of 18-inch concrete ribbons or slabs capable of carrying the weight and of sufficient length to support all blocking points, with a proper surface between to control weeds.

g. **Landscape and Parking Design**. The standards of Chapters 7 and 8 are generally applicable to R-MH district development plans, except as modified through a development plan based on the approval procedures and criteria in Section 24-204 or 24-205.

h. **Subdivisions.** Each home site may be individually platted if:
1. All lots shall have public utility access as provided in Chapter 3, including public easements for access to each home site and all other standards and criteria of the subdivision standards are met;
2. All dwellings are on a permanent foundation or affixed to a permanent slab; and
3. There are covenants and restrictions assuring that all provisions of this section and the approved development plan, will be maintained through a management entity or common association.

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Chapter 5 Residential Development Standards: Section Map		
Current Standards	***Reorganized***	***Comment***
n/a	24-501 Intent & Applicability	Compiled from various sections to establish the intent and set up the new approach for all residential development standards
18.38 Zoning District Development Standards 19.38.030-070 for residential districts 18.38.100 Performance Options	24-502.a Residential Development Standards	Converted all of the current residential development standards to a complete range of building types. These roughly parallel current district standards or current building-specific standards where they are included in the current code. Some lot sizes, building heights and lot open space requirements were adjusted to better reflect the specific scale of the projects The most notable changes are: • R-L now includes the cluster option (4,500 s.f. lot) as an allowed type) • R-M includes a much broader range of "missing middle" housing types – specifically multi-unit houses, row houses, and small apartments. • R-H allows the full range of housing types from detached houses to larger apartments (most of these are currently allowed in R-H, but are not clearly called out. • Specific but limited enabling of smaller lot options – Small lot (3K to 4.5K lot) and small format (1.5K t 3K) based on prototypes and precedents studied from other projects.
various sections	24-502.b Dimension exceptions	Incorporation of various exceptions, interpretation rules or additional standards in one section related to the development table. Added an option for a "zero lot line" application through use of easements rather than platted lot lines (b.1.(b)
18.52.030 Accessory Uses & Structures, Accessory Uses & Structures	24-502.c Accessory buildings - residential	Incorporated current standards but refined by type/scale of building and increased some allowances – particularly for larger lot sizes and particularly larger "outbuildings" on larger lot sizes. These are more typical for the types of structures found in these contexts.
New section	24-502.d. Housing diversity	This is a new element. It is added based on 3 considerations in the process: • The advisory committee's discussion of similar provisions in other communities, and the desire to explore the option but be more lenient and reasonable with the ranges and requirements. • The expansion of the range of housing options in the code, and specifically the addition of more small lot and missing middle options. (This tool can ensure that these are integrated into a mix). • The comprehensive plan policies for housing options and diversity. The standards are based on a combination of context (in relation of planning areas), scale (amount of units being proposed) and range of specific categories and types of hosing. The section includes exceptions for alternative compliance and considering projects in their context of established mixes.
18.52.035 Accessory Uses & Structures, Fences and Walls	24-502.e. Fences and walls	Current provisions with no substantive changes
n/a	24-503.a Residential Design Standards, Applicability	Compiled from various sections to establish the intent and set up the new approach for all residential design standards
Various provisions from: • 18.38.100 Performance Options • 18.40.090 Architectural review standards • 18.40.100 Site and building design standards	24-503.b Frontage Design	New approach to a range of standards in current code addressing similar topics. This new approach accomplishes the following: • Allows a more comprehensive approach to the design issues by focusing on the streetscape • Allows adjustments based on context – in this regard, the suburban frontage is relaxed from the current standard and the neighborhood and terrace are increased from the current standard. • Allows more targeted application of "alternative compliance" to allow some flexibility.

Chapter 5 Residential Development Standards: Section Map		
Current Standards	***Reorganized***	***Comment***
• 18.46.040 Infill area design standards		
Same as above	24-503.c Building design	New approach focusing on a few key elements of building design – massing (volume of buildable areas); modulation (composition and breaking up blank walls); transparency (connecting to outside with windows and doors); and materials. Using a similar structure this section sets the intent / design objective; establishes a measureable objective standard; identifies a range of design strategies that may be used to meet that standard; and then allows for alternative compliance when something not listed or something not technically meeting the standard would serve the objective equally or better. This section is derived from the similar range of topics in the current regulations.
Same as above	24.503.d. Lot Open Space Design	Several sections in the current code address the topic of "useable open space" and allow elements at various scales to count towards this. This section refines what can count to this requirement at the lot scale and adds more small and formal options for the smaller lot building types (which have lessor on lot open space requirements). It also establishes connections to the next larger scales – Common areas of the neighborhoods (24-504) and parks and trails at the subdivision scale (24-302)
18.40.110 Lighting Standards	24-503.e Exterior Lighting	This is a cross reference to the existing lighting standards, recently updated by staff.
18.40.100(a)(12) and (b) Neighborhood Identity Features	24-504 Neighborhood Features & Common Areas	This is a reorganization of the current "Neighborhood Identity Features" sections; the goal is the reflect better connections of these spaces as the connection between larger scale open space systems (Parks, Trails and Natural Areas, and the block and lot open spaces of individual building sites. There are only minor adjustments to the current standards in the applicability and types of spaces required.
New section	24-505 Courtyard Pattern	This is a new provision combining two elements from the existing code for a specific pattern option – the building types (and particularly new building types) and arranging them around a specific "neighborhood identity feature" – the courtyard. It can be particularly applicable for infill areas and integrating houses on deeper blocks, but also an added neighborhood design feature in new neighborhoods. It offers a reduction in lots sizes for enhanced courtyard designs – essentially "layering" the front yard / frontages of multiple building in a single space with more design amenities.
18.38.050 R-MH Residential Mobile Home District 18.46.150 Mobile homes and land lease communities	24-506 Residential Micros-housing District (R-MH)	This section is a reorganization of the current manufactured housing district to broaden the application to a wider range of small format housing. The changes are in a few key areas: • Allowing a broader range of small housing options (not just a conventional trailer / manufactured house options) to coordinate with the new Detached House – Small format option in 24-502.a. • Allowing smaller project threshold (5 acres rather than 8) and larger densities (10 unit/acre base instead of 8; and up to 18 units per acre with more open space). These densities are more in range with the typical yield from this smaller home site. • Requiring more specific designs for the common amenity areas (similar to Neighborhood Features & Common Areas in 25-504) and allowing the density to escalate at a particular threshold of this space. These actions align with the Council's strategic housing policy point to explore more manufactured housing opportunities.

Chapter 6 Nonresidential Development Standards

24-601 Intent & Applicability
24-602 Nonresidential Development Standards
24-603 Nonresidential Design Standards

24-601 Intent & Applicability

a. **Intent**. The Nonresidential Development Standards have the following intent.

1. Promote good civic design and improve the appearance and vibrancy of commercial districts, employment centers, civic spaces, and other public places.
2. Design and locate open spaces as an extension of the public realm, and emphasize the different contexts of places throughout the City.
3. Improve the accessibility of centers and districts throughout the City by arranging development within multi-modal networks, and coordinating site access and internal circulation systems with these networks.
4. Use buildings to shape streetscapes and public spaces, and design building facades and lot frontages to relate to these spaces.
5. Refine the design, scale, and details of buildings based on the relationship to the public realm and make distinctions in design based on the context of development.
6. Improve the value of places, strengthen the economic potential of commercial districts and employment centers, and promote lasting and sustained investment in nonresidential development through good design.

b. **Applicability**

1. The standards in this Chapter shall apply to all development in the C-L, C-H, MU-L, MU-H, I-L, I-M, and I-H districts, except where stated that sections only apply to specific districts or specific situations.
2. All new structures shall comply with these standards.
3. Modification or additions to existing structures or sites shall meet these standards to the extent of the modification or addition, except that the Director may waive any design standards applied to modifications or additions that:
   (a) Conflict with the consistent design of an existing building;
   (b) Conflict with the prevailing character on the block or immediate vicinity of the project; or
   (c) To otherwise facilitate infill development or adaptive reuse of an existing building.
4. The standards shall not apply to ordinary maintenance of existing buildings, except that maintenance to any building shall not occur in a manner that brings the building or site to a greater degree of non-conformance with these standards.

24-602 Nonresidential Development Standards

a. **District Lot and Building Standards.** The lot and building standards for nonresidential districts are specified in Table 24-6-1.

Table 24-6-1: Nonresidential District Lot & Building Standards

Zoning District	Lot Standards			Minimum Setbacks				Building Height
	Size	Frontage Width	Open Space	Front [1]	Interior Side [2]	Corner Side [1]	Rear [2]	
C-L *Commercial Low Intensity*	n/a	25'+	20%	25'	0'	25'	0'	40'
C-H *Commercial High Intensity*	n/a	25'+	20%	25'	0'	25'	0'	60'
MU-L *Mixed-use Low Intensity*	20K s.f. max	25' – 100'	15%	0' – 10'	0'	0' – 10'	0'	40'
MU-H *Mixed Use High Intensity*	2 ac. max	25' – 300'	15%	0' – 10'	0'	0' – 10'	0'	60'
I-L *Industrial Low Intensity*	n/a	50' +	10%	25'	0'	25'	0'	40'
I-M *Industrial Medium Intensity*	n/a	100'+	10%	25'	0'	25'	0'	40'
I-H *Industrial High Intensity*	n/a	100'+	10%	25'	0'	25'	0'	60'

[1] Front setbacks may be modified according to the frontage type design standards in 2-603.b.
[2] Non-street setbacks shall be as specified by the building code for each class of building. However, greater setbacks may be necessary to meet the building design standards or landscape standards applicable to a particular use or building.
[3] Any district that permits residential uses may allow residential lots and buildings designed according to the residential building type standards in Chapter 5.

b. **Dimension Exceptions.** The following are exceptions to setback and building dimensions standards established in Table 24-6-1: Nonresidential District Building & Lot Standards.

1. *Setback Encroachments.* The following encroachments into the required setback are permitted, except in no case shall this authorize structures that violate the provisions of any easement.
   (a) Any projections over public rights of way, or any similar area designed for pedestrian circulation, shall be at least 8 feet above the grade, and in no case within 5 feet of any curb for a street, through access drive or other area designed for vehicles.
   (b) Structural projections such as bay windows, balconies, awnings, canopies, chimneys, eaves, cornices, open fire escapes, egress wells, or other non-foundational overhangs or projections may extend up to 4 feet from the foundation and encroach into the setback, but no closer than 3 feet from any side or rear lot line. This exception shall be limited to no more than 20% of a building elevation.
   (c) Ground-mounted mechanical equipment, meters, and utility boxes accessory to the building may be located in the side or rear setback provided that it extends no more than 6 feet from the principal building, no closer than 3 feet to the lot line, and is screened from public right-of-way by structures or landscape. These limitations do not apply to any utility structures otherwise authorized to be located according to easements or in the right-of-way, which shall follow the location and design standards of those specific authorizations.
   (d) A lot may have more than one principal building, provided any accessory, secondary, or principal building shall be located at least 10 feet from any other building on the same or adjacent lots, or be joined by a party wall meeting all aspects of the building code.
   (e) Any other accessory use or structure within the setback, not specified in Section 24-602.c, shall have a setback of at least 1/3 its height from the property line.

2. *Height Exceptions.* The following are exceptions to the height limits in Table 24-6-2:

(a) Building elements integral to the design and construction of the building, such as parapet walls, false mansards, or other design elements essential to a quality appearance of the building may extend up to 6 feet above the roof deck of a flat roof.

(b) Architectural features such as chimneys, ornamental towers or spires, and similar accessory features that are less than 20% of the building footprint may extend up to 15 feet above the maximum building height, but in no case more than 50% above the actual building height.

(c) Functional and mechanical equipment such as elevator bulkheads, cooling towers, smoke stacks, roof vents, or other equipment may be built up to their necessary height in accordance with building codes provided they are screened according to the standards of this code or otherwise incorporated into the architecture of the building.

(d) Accessory site structures such as flag poles, monuments, or water towers, may have a height limit of 50 feet, but shall be setback a distance of at least 1/3 its height from the property line.

(e) 1 foot of additional height may be permitted for each 1 foot in additional setback, up to a maximum of 10 additional feet above the maximum height limit. For any structure using this exception where there is no required setback, and default required setback of 10 feet shall be used for applying this exception. The additional setback area shall be used for landscape areas required by Section 24-803 or open space meeting the standards of Section 24-603.d.

(f) All height exceptions shall be in conformance with air space regulations relative to the Airport Overlay District in Section 24-1002.

c. **Accessory Buildings – Nonresidential.** Accessory buildings shall be permitted in association with and on the same lot as a principal building, subject to the standards in Table 24-6-2, Nonresidential Accessory Structures, and to the following additional limitations.

Table 24-6-2: Nonresidential Accessory Structures

Type	*Quantity*	*Size*	*Height*	*Setbacks*
Minor Structure (small shed, and similar structures)	▪ 1 / lot; ▪ + 1 / each additional 10k s.f; ▪ Maximum of 3	▪ 120 s.f. max.	▪ 12' max.	▪ 0' side or rear; ▪ 5' if on a concrete slab or similar foundation; and ▪ 25' on any street side lot line ▪ Behind the rear building line of the principle structure
Secondary Building (detached accessory building)	▪ 1 / principal building	▪ 25% max. of principal building footprint, up to 1,200 s.f. max.	▪ 25' max., but no higher than principal structure.	▪ 5' from side and rear; ▪ 10' from street side; and ▪ At least 12' behind the front building line of the principal structure
	Any building over 12' high or more than 250 s.f. footprint shall meet the design standards.in Section 24-502.c.2.			

1. *Generally.*

(a) All accessory buildings shall be at least 10 feet from the principal building, or other distance specified by applicable building codes based on fire ratings of adjacent walls.

(b) Accessory buildings shall be clearly incidental and subordinate to the principal building or use, in terms of scale, location, and orientation.

(c) Minor accessory structures of 120 square feet or less, and not on a slab or similar foundation do not have a required interior side or rear setback, but should be movable and are otherwise placed "at risk" by the owner with regard to any easements, fence, or screening requirements.

2. *Secondary Building Standards.* In any nonresidential district, secondary buildings over 250 square feet footprint or 12 feet high shall meet the following massing and design standards to ensure compatibility with the principal structure:
   (a) Any portion of the building or structure potentially visible from the street or other public areas shall use materials, colors, scale and forms (roofs and massing), and architectural details that are compatible with the principal structure, or otherwise be screened according Section 24-803.
   (b) Any building or structure exceeding the limits in Table 24-6-2 shall be treated as a second principal building and meet all lot and building design standards applicable to principal buildings.

d. **Fences & Walls.** Fences and walls in Nonresidential districts shall be limited to the sizes and locations in Table 24-6-3, Nonresidential Fences & Walls.

Table 24-6-3 Nonresidential Fences & Wall

Location	
Front *In the front setback or any location in front of Front Building Line.*	▪ 3.5' high ▪ 3.5' – 6' if it is ornamental design that is at least 75% open (i.e. wrought iron). ▪ Up to 8' for ornamental features at pedestrian entries.
Side and Rear *In the side, street side, or rear yard and behind the Front Building Line.*	▪ 6' high; ▪ 8' in the I-M or I-H district, provided the fence remains open (i.e. wrought iron or chain link) ▪ A fence or wall outside of required setbacks (i.e. in the buildable envelope),and behind front building line can exceed 6', but may be limited by building codes or other general development and design standards.
Perimeter Fences *Any fence within 30' of a Collector or Arterial street right-of-way as part of Perimeter Landscape in Section 24-803.*	Any fence designed as part of a perimeter landscape area along collector or arterial streets, or otherwise located within 30' of a collector or arterial right-of-way and longer than 100', shall meet the following standards: ▪ All fencing shall be softened with landscape materials on the street side of fences meeting the perimeter landscape standards of Section 24-802. ▪ Expanses of over 100' shall be broken up by either: ○ Offsets of +/- 3' on 1/3 of length for every 150' span; or ○ Ornamental designs on at least 50' of every 150' space that is at least 75% open (i.e. wrought iron); or ○ Architectural pillars or posts (i.e. stone, or masonry) at least every 50'. ▪ Alternatives may be approved by the Director in association with the perimeter landscape plans for in Section 24-803, and Streetscapes in 24-301.

1. *General Height & Location Standards*. The following standards are applicable to fences and walls in all locations.
   (a) All fences or walls along rights-of-way or easements shall be located:
      (1) At least 1' from any ROW or easement that prohibits structures; otherwise fences in easements shall be permitted only subject to specific easement language and limitations.
      (2) At least 2' from any sidewalk.
      (3) At least 3' from the edge of any alley or similar vehicle access.
      (4) Fences or walls may only be located in the right-of-way or easement by a revocable right-of-way permit from the Public Works Department.
   (b) All fences or walls located along common lot lines shall be located so:
      (1) The fence is on the property line; or
      (2) The fence is at least three feet from the property line. Any areas set back three feet or more, which could become enclosed by other similarly located fences, shall provide at least one gate for access and maintenance equipment.

(3) The finished side faces adjacent property or any public right-of-way, public space or common areas.

(c) Any fence or wall in the floodplain shall also require a floodplain development permit.

(d) All fence or walls shall be located and designed to comply with sight distance requirements of 24-301.d.2. Any fence or wall that could potentially create a sight obstruction for vehicles crossing pedestrian areas or entering the street may require greater transparency or additional location restrictions to allow for safe sight distances for the vehicle.

(e) Temporary fences for construction may be up to 6 feet or as otherwise specified in construction permits.

(f) All fences and walls may be subject to additional standards of the building code, approved drainage plans for the lot, or other design and development standards. In particular, any of the following allowed by these standards, permitted by alternative compliance, or approved by a variance, requires a building permit:

(1) Any fence or wall over 6 feet high;

(2) Any retaining walls over 4 feet high;

(3) Walls in the setbacks over 6 feet high shall only be permitted by alternative compliance in Section 24-208.

2. *Materials.* Fences and walls shall be consistent in architectural character, materials, and appearance of the principal building(s) on the same lot. Fences shall be constructed out of any of the following materials:

(a) Wood or vinyl simulating wood. Wood shall be either naturally rot resistant (such as cedar), or pressure treated for rot resistance;

(b) Wrought iron or aluminum simulating wrought iron;

(c) Stone, brick, concrete with stone or brick veneer, pre-cast concrete simulated stone or brick, or decorative concrete textured to simulate masonry; or

(d) Chain link or vinyl clad chain link:

(1) Chain link is permitted in the side or rear yard only in the C-L, C-H, MU-L and MU-H districts.

(2) Chain link with slats is only allowed in the I-M and I-H districts, and proved it is not located along a collector or arterial street.

(3) Chain link fences may be up to 12 feet for any security fence around sports facilities, courts, pools or similar facilities, provided it is 20 feet from any lot line and provided all portions over 8' remain free of opaque screes.

(e) Barbed wire may be allowed only in the I-M, I-H, C-D and H-A districts, added to the height of chain link fences and located above 6.5 feet. Barbed wire is limited to no more than three bands. Exterior area security lighting, controlled by an automatic light level switch, is installed and maintained in good operating condition.

Section 24-603 Nonresidential Design Standards

a. **Applicability.** The design standards shall apply to the C-L, C-H, MU-L, MU-H, I-L, I-M, and I-H zoning districts.

1. *General Applicability*. The design standards apply based on the context of a particular project, according to the general applicability provisions in Table 24-6-4.

Table 24-6-4: Applicability of Design Standards

Zoning District	*Applicability*
C-L , C-H, I-L, I-M and I-H	▪ Frontage C standards preferred and generally applicable; ▪ Frontage D standards may apply on large commercial sites (over 2 acres) or industrial buildings; ▪ Frontage A and B standards by alternative compliance.
MU-L	▪ Frontage A standards preferred and on at least 2 blocks or at least 50% of a project; ▪ Frontage B standards generally applicable on the remainder; ▪ Frontage C or D standards by alternative compliance.
MU-H.	▪ Frontage A standards preferred and on at least 4 blocks or at least 50% of a project; ▪ Frontage B standards generally applicable on the remainder; ▪ Frontage C or D standards by alternative compliance.
Residential Development	▪ Where residential building types are permitted in any nonresidential district, they may be developed according to the Residential Development Standards in Chapter 5.

2. *Alternative Compliance.* Alternative compliance to the general applicability of the design standards in Table 24-6-2 may be authorized according to the process and criteria in Section 24-208, Alternative Compliance, and any of the following additional applicable criteria:
   (a) Streets with pedestrian amenities, on-street parking, or designed according to the Pedestrian or Avenue Street type standards in Section 24-301 are generally appropriate for the Frontage A and Frontage B frontage type and design standards.
   (b) Streets with higher traffic speeds or volumes, that lack pedestrian amenities, or that lack on-street parking are generally appropriate for Frontage C and Frontage D frontage type and design standards.
   (c) Where the context of a specific block or site has a prevalence of development that reflects patterns similar to any particular frontage and design type, the prevailing pattern may be implemented.
   (d) A development plan for an area or project may more specifically map street types and frontage types on a block-by-block basis, and any plan officially approved by the Planning Commission or City Council in association with the development may further specify the applicability of the frontage types and design standards for a particular district, area, or project.

b. **Frontage Design.** Frontage design determines the relationship between private development and the public realm, and determines the character of different districts. Building placement, parking and access locations, and landscape and streetscape design encompass the design of the frontage. Frontage types designed according to the standards and design objectives of this sub-section may be used to modify the front setback established in Table 24-6-1, as indicated by the applicability provisions of Section 24-603.a.

1. *Design Objectives.* Frontage types in Table 24-6-5: Nonresidential Frontage Design shall be applied to meet the following design objectives:
   (a) Enhance the image of the City by coordinating streetscape investment with private lot and building investment.
   (b) Orient all buildings and lots to the public street, or to common open spaces that serve as an extension of the streetscape and public realm.
   (c) Design frontages based on the context of the area, block, and street, particularly emphasizing landscape areas to screen and separate sites from higher-volume /

higher speed streets and emphasizing social spaces and human-scale architectural features on streets intended for more compact and walkable development.

(d) Coordinate development across multiple lots along block faces, considering access, parking, landscape, and open space design.

(e) Allow a range of different building types to engage the streetscape in compatible ways along a block through similar frontage designs.

(f) Strengthen the identity and economic value of distinct places by reinforcing consistent patterns of streetscape, frontage design, and building placement and form.

(g) Frontages should be similar for all lots on the same block face or gradually transition to different types in contexts that allow multiple frontage types.

2. *Frontage Design Standards.* Frontage types shall be designed according to the standards in Table 24-6-5: Nonresidential Frontage Design. Sub-sections following the table provide specific design strategies and techniques to be used to meet these standards and the design objectives of this sub-section.

Table 24-6-5: Nonresidential Frontage Design

		Frontage A	*Frontage B*	*Frontage C*	*Frontage D*
Front Building Line (build-to range)		0' – 10'	0' – 25'	25' – 80'	80' +
Required Front Building Line		80%	60%	40%	n/a
Access Width (max.)		20'	24'	32'	40'
Access Spacing (min.)		1 per block	200'	150'	50'
Parking Setback (min.)		Behind rear of building.	Behind front building line	5' – 20' min. See Section 24-704.b. for parking setbacks specific to parking lot size	5' – 20' min.
Extent of Parking Frontage (max.)		0%	30%	n/a	n/a
Landscape		See Sections 24-301 and 24-302		See Section 24-803	
Applicability (See Table 24-6-4)	*MU-L, MU-H*	■	□	◇	◇
	C-L, C-H	◇	◇	■	□
	I-L, I-M, I-H	◇	◇	■	□

■ Preferred
□ Permitted
◇ Limited to Alternative Compliance

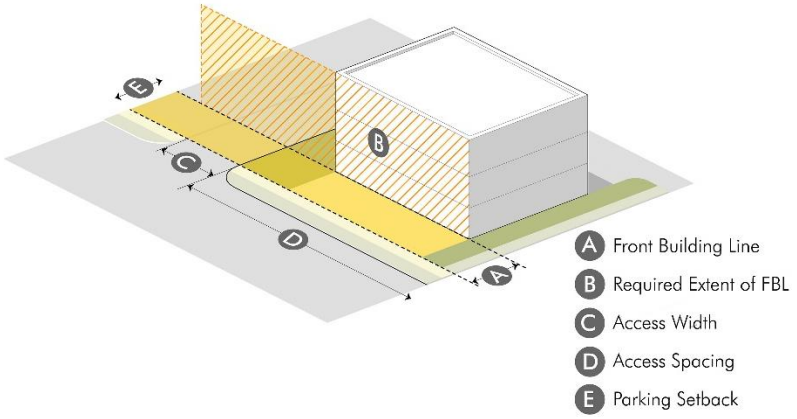

Figure 24-6-1 Frontage Design
Frontage types are differentiated based on the location of the front building line (FBL), the extent of the front building line occupied by the building (Required FBL), access widths, and parking location and extent along frontage. Coordinating frontage design of multiple buildings and sites along a block impacts the character of the streetscape and the block.

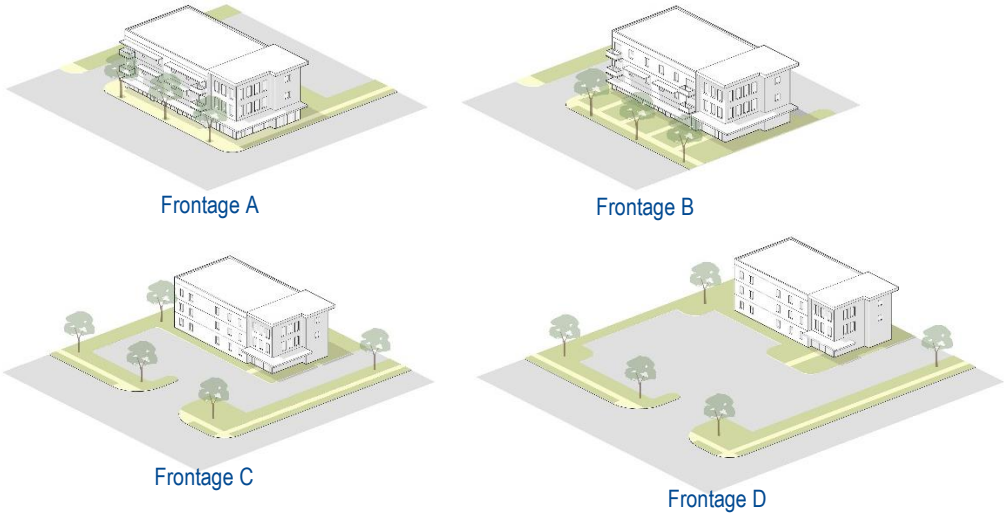

Figure 24-6-2 Frontage Types
The relationship between private development and the public realm determines the character of different districts. Building placement, parking and access locations, and landscape and streetscape design distinguish different frontage type designs. Social spaces and human-scale architectural features are emphasized in more pedestrian-oriented contexts, and landscape screens and setbacks are emphasized in more car-oriented areas.

3. *Building Form and Placement.* All buildings shall establish a front building line within the range specified in Table 24-6-5, Nonresidential Frontage Design. The required front building line shall modify the required front setback in Table 6-2 based on the appropriate frontage for the street and block. All buildings shall occupy the minimum percentage specified for required front building line with either of the following:
   (a) Front building facades meeting the design standards in Table 24-6-6, Nonresidential Building Design; or
   (b) Open spaces meeting the requirements of Section 24-603.d provided:
      (1) It is limited to no more than 50 feet or 50% of the lot frontage, whichever is greater;

(2) There are defining features at the extension of the required front building line, such as decorative walls or fences, landscape features and other human scale details; and

(3) All building facades fronting the open space meet the standards otherwise applicable along the streetscape.

(c) Projects designed around internal access streets according to Section 24-301 may use the internal access streets for the purpose of applying frontage standards.

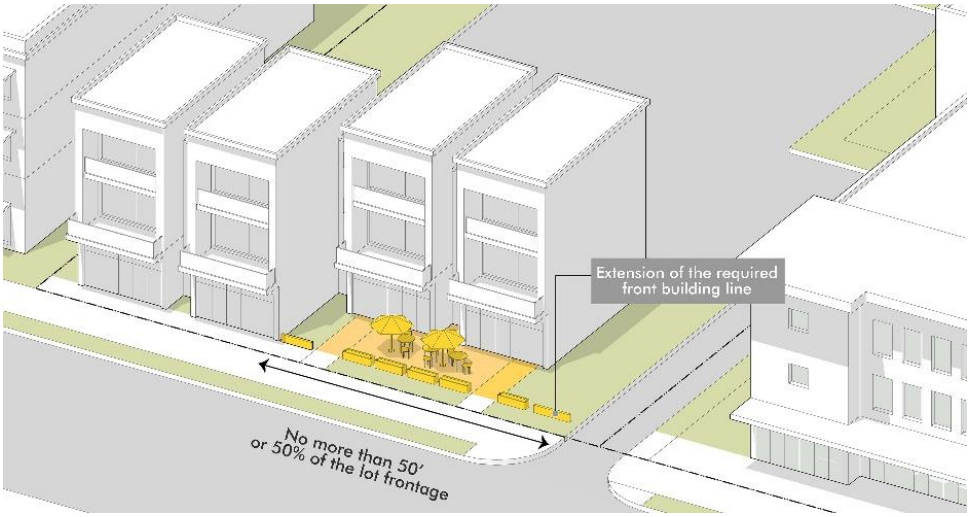

Figure 24-6-3 Required Front Building Line

The required front building line determines the extent of the lot width required to be occupied by building frontage at the front building line. Alternatives spaces that activate the streetscape with active social spaces may serve this function provided they establish similar defining elements of this space along the frontage. 24-603.b.3.(a) and (b).

4. *Access and Parking Limits*. The following standards apply to the driveway and parking limits in Table 24-6-5, Nonresidential Frontage Design:

(a) Access width limits apply to the first 25' of the lot depth, or up to the Front Building Line, whichever is less.

(b) Access spacing specifies the minimum distance between edges of driveways or internal access streets. However, the Greeley Design Criteria and Construction Specifications for Streets may specify different access standards on any particular street or lot.

(c) In cases where these standards limit access to a particular lot, options that coordinate access to lots on the same block shall be used, including mid-block alleys, internal access streets, common access lanes, or shared drives and cross access easements.

(d) All parking shall be setback as specified in Table 24-6-5 and limited only to the extent specified along the frontage, and be screened according to the standards in Chapter 7.

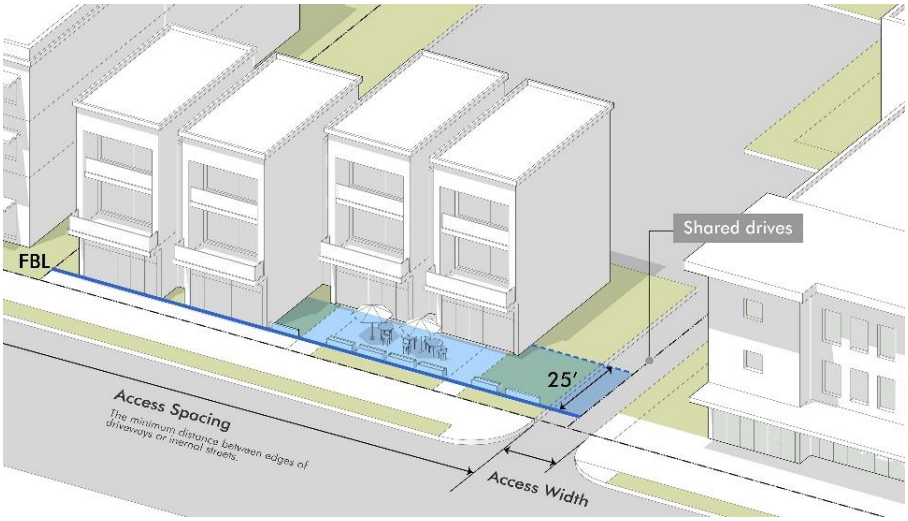

Figure 24-6-4 Access and Parking Limits
Access & parking limits determine the extent of frontages that are designed for cars, including driveways and surface parking. Parking and vehicle access is more limited in the frontage area for pedestrian-oriented contexts, and more permissive in car-oriented areas. 24-603.b.4.(a) and (b).

5. *Landscape.* The remainder of the frontage between the streetscape and front building line shall include landscape and open space designs.
   (a) For Frontages A and B this area shall be designed to coordinate as an extension of the streetscape according to Sections 24-301.
   (b) For Frontages B and C this area shall be designed according to the parking setback and landscape design standards in Chapters 7 and 8.
   (c) On all frontage types, lot open space meeting the standards of Section 24-603.d may be included in this area.

6. *Alternative Compliance.* The appropriate application of frontage types is based upon a combination of the character of the zoning district, the streetscape design on which the development fronts, and the building form and placement on a specific lot. Alternative compliance to the frontage design standards established in this Section may be authorized according to the process and criteria in Section 24-208, Alternative Compliance, and any of the following additional applicable criteria:
   (a) The context presents clear pattern of existing buildings and lots on the same block and opposite block face with a different arrangement in terms of the front building line, driveway access patterns, and extent and placement of parking lots and service areas.
   (b) An alternative design allows the building, access, and parking to be sited in a way that preserves topography or other natural features on the site, and does so in a way that equally or better meets the design objectives.
   (c) Parking and access that serves a greater area beyond the site and block may deviate from these standards, provided the location is consistent with development patterns in the vicinity and it is designed to minimize impacts on streetscapes.
   (d) In all cases the deviation is the minimum necessary to address the circumstance and does not negatively impact other design standards applicable to the building or site.

c. **Building Design.** Building design refines the scale and form of buildings beyond the basic setback, height, and lot coverage standards by breaking down the volume into smaller-scale

masses, and by adding depth, texture, and variation to surfaces to relate to the spaces around the building.

1. *Design Objectives.* Building design standards in Table 24-6-5, Nonresidential Building Design shall be applied to meet the following objectives:
   (a) Reinforce the context, patterns, and design character of the zoning district or a particular area.
   (b) Refine the scale, massing, and details of buildings to a greater degree the closer they are to the public realm and other publicly used spaces.
   (c) Arrange buildings and vary the massing in a way that defines streetscapes, public spaces, and other valuable active and social spaces on the site.
   (d) Locate doors and windows in a way that activates spaces, creates connections to important exterior spaces, and promotes economic activity at the interface of buildings and public spaces.
   (e) Relate buildings to adjacent development by mimicking similar scale, massing and proportions though step-backs and secondary masses that break up larger masses and reduce the volume and perceived size of larger buildings.
   (f) Use materials and human-scale architectural features to create depth, texture, variation, and visual interest to walls, particularly on larger facades, along streetscapes, or near active open spaces or adjacent lots.
   (g) Strengthen the identity and economic value of distinct places by reinforcing any prevailing architectural themes or styles; where no prevailing theme or style exists, encourage unique architectural expression and design characteristics inherent in the chosen architectural style for the building to establish distinctive themes and styles.
   (h) Emphasize the quality and longevity of investments with materials and colors that are attractive, durable, and have low maintenance requirements.

2. *Building Design Standards.* Table 24-6-5, Nonresidential Building Design provides standards for massing and facade design based on the frontage type and the placement of the building. Sub-sections following the table provide specific design strategies and techniques to be used in meeting these standards and the design objectives.

Table 24-6-6: Nonresidential Building Design

	Frontage A	*Frontage B*	*Frontage C*	*Frontage D*
Front Building Line (from Table 24-6-5)	0' – 10'	0' – 25'	25' – 80'	80' +
Wall Plane Limits	50' / 500 s.f	100' / 1,000 s.f.	100' / 1,000 s.f	150' / 2,000 s.f.
Blank Wall Limits	15' / 300 s.f.	30' / 600 s.f	50' / 1,000 s.f.	50' / 1,000 s.f.
Entry Feature Spacing (max)	50'	75'	1 per building	1 per building
First Story Transparency	60% - 90%	40% - 90%	40% - 90% within 50' of entrance	40% - 90% within 25' of entrance
Upper Story Transparency	15% - 40%	15% - 40%	15% - 40%	n/a
Secondary or Side elevations within 20' of ROW	Meet primary frontage design standards for at least 30' or 30% of elevation of building whichever is greater.			
Secondary Side / Rear elevations between 20' and 100' or otherwise directly visible from ROW	Meet standard at 50% of the requirement for primary elevations, except for required entrance ; OR Have a Type III or higher perimeter landscape within 50' of the building per Section 24-803.			

3. *Wall Plane Limits.* Larger building elevations shall be broken into smaller components by one or a combination of the following techniques to meet the wall plane limits in Table 24-6-5, Nonresidential Building Design:
   (a) Emphasize structural bays and vertical breaks in interior components of the building at regular intervals, with visible features such as columns, pillars, or pilasters, or other details and accents that are between 6 and 48 inches wide, project between 4 and 24 inches off the façade. .
   (b) Differentiate massing with projections, balconies, cantilevers or step backs from the main mass associated with entrance features, different stories, or secondary masses of the building. Massing shall create deviations in the wall plane of at least 2 feet if projecting from the façade and at least 4 feet if recessed from the façade, and encompass at least 20% of the entire elevation.
   (c) Horizontal differentiation of a base, body and top of buildings.
      (1) For buildings less than 3 stories, this can be a distinct foundation, a main façade, and an embellished roof structure, such as eaves and fascia for pitched roofs, or cornices and parapets for flat roofs.
      (2) For buildings 3 stories or more, the first floor should be clearly differentiated from upper stories to establish the base and an embellished roof structure.
      (3) Any belt course or trim band establishing the break in base, body and top shall use a material or pattern distinct from the primary material, be 6 to 36 inches wide, and off-set from the wall plane 4 to 24 inches; or be a lessor trim associated with a material change.

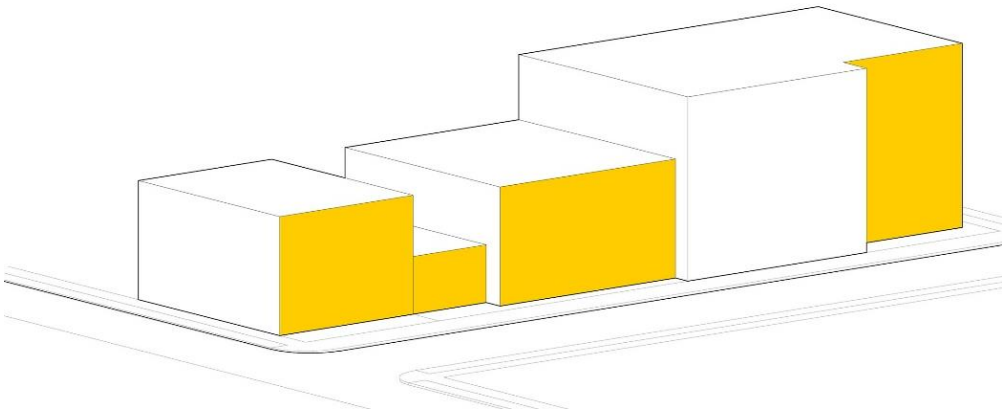

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Figure 24-6-5 Wall Plane Limits
Wall planes that exceed either the linear dimension limits or the square foot limits in Table 24-6-4 wall plane limits shall be broken up by massing elements and/or architectural details. 24-603.c.2. / Table 24-6-6

Figure 24-6-6 Vertical Articulation
Defining buildings with a distinct structural bays creates a finer grain of buildings, both when viewed from a distance and when experiences on the streetscape. This is particularly important for longer expanses of buildings and can help integrate larger buildings and lots within a pattern of smaller buildings and lots. 24-603.c.3.(a)

Figure 24-6-7 Horizontal Articulation
Defining buildings with a distinct base, body and top can help reduce the scale of larger buildings and can create relationships between adjacent buildings with dissimilar scale. 24-603.c.3.(c)

4. *Blank Wall Limits*. Building elevations shall feature interest, variation, depth, and texture by one or a combination of the following techniques to meet the blank wall limits in Table 24-6-5, Nonresidential Building Design:
   (a) Patterns of windows and doors meeting the transparency requirements in Section 24-603.c.5. and 6.
   (b) Massing elements meeting the wall plane limits of Section 24-603.c.3
   (c) Ornamental architectural details complimentary to the materials and architectural style of the building.
   (d) Color and material changes associated with trim or massing elements of the building.

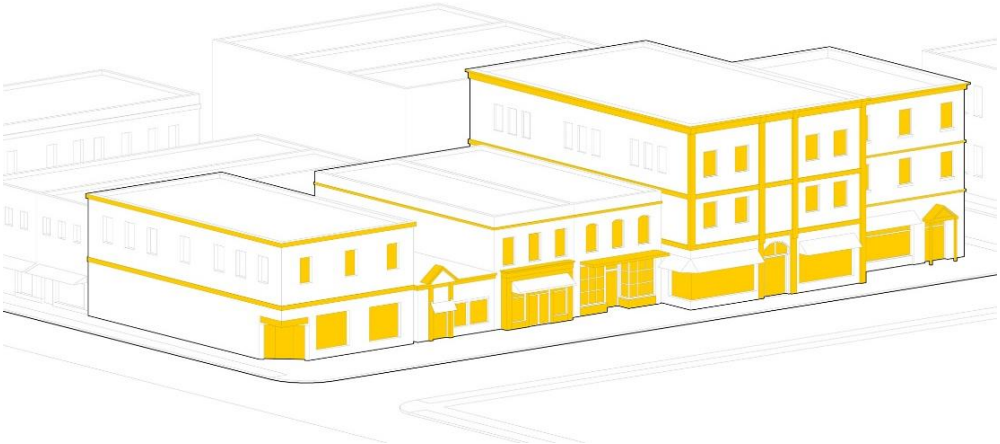

Figure 24-6-8 Blank Wall Limits.
A combination of architectural features, windows and doors breaks up larger expanses of wall plane and allow them to relate better to spaces around the building. More pedestrian-oriented streetscapes or active social spaces limit blank wall areas more strictly than buildings remote from the streetscape or not near active social spaces. 24-603.c.4.

5. *Primary Entrance Features.* Primary public entrances shall be clearly defined on all front facades with at least three of the following elements and be located at intervals specified in Table 24-6-5, Nonresidential Building Design:
   (a). A single-story architectural emphasis such as raised parapets or gables, canopies, porticos, overhangs, pediments, or arches.
   (b) Transom or sidelight windows that frame and emphasize the entry.
   (c) Architectural details such as tile work and moldings, columns, pilasters, or other similar material changes.
   (d) Integral planters or wing walls associated with a recessed or projecting entry court or plaza that integrates landscape and hardscape designs.
   (f) For corner buildings, any entrance feature located on the corner may count to both sides, and may be considered located at 25' from each corner for the purpose of the required Primary Entry Feature intervals.

Figure 24-6-9 Primary Entry Features.
Entrances help activate the streetscape and orient buildings to public spaces. More pedestrian-oriented blocks benefit from the activity created by smaller-scale uses and the rhythm created by more frequent entrances. More car-oriented streets may allow less frequent entrances or alternative orientations of buildings to internal access streets or common spaces. 24-603.c.5.

6. *Transparency.* Buildings shall have the percentage of openings specified in Table 24-6-5, Nonresidential Building Design, based on the following:
   (a) Where expressed as a first story requirement the percentage shall be measured between 2 feet and 8 feet above the sidewalk grade, or within 10 feet above the first floor elevation if the building is set back more than 10 feet from the street.
   (b) Where expressed as an upper story requirement, the percentage shall be measured between the floor level and ceiling of each story.
   (c) All first story windows required shall provide direct views to the building's interior or to a lit display area extending a minimum of 3 feet behind the window.
   (d) For industrial and civic buildings setback more than 25 feet from the street, clerestory windows may meet the first or upper story window requirements.

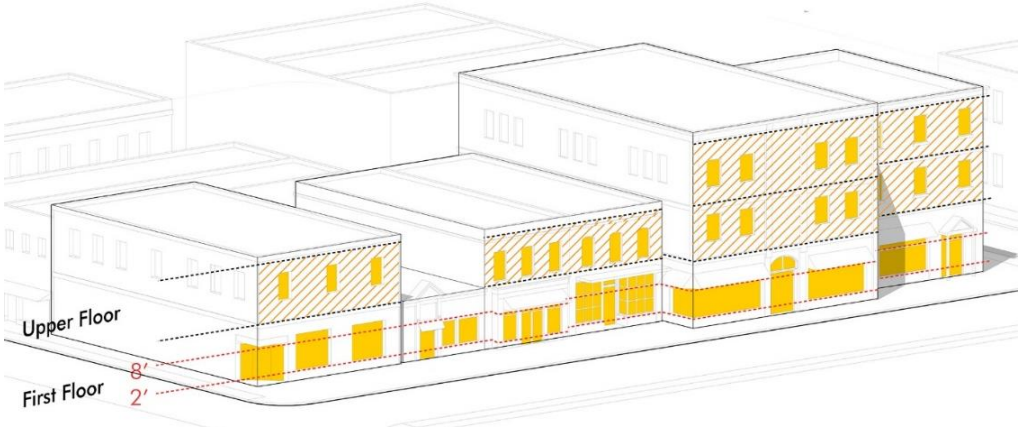

Figure 24-6-10 Transparency.
Transparency requirements eliminate large expanses of blank walls and create physical and perceptual connections to spaces around buildings. Meeting the requirements for each story helps reduce the scale of larger buildings. 24-603.c.6.

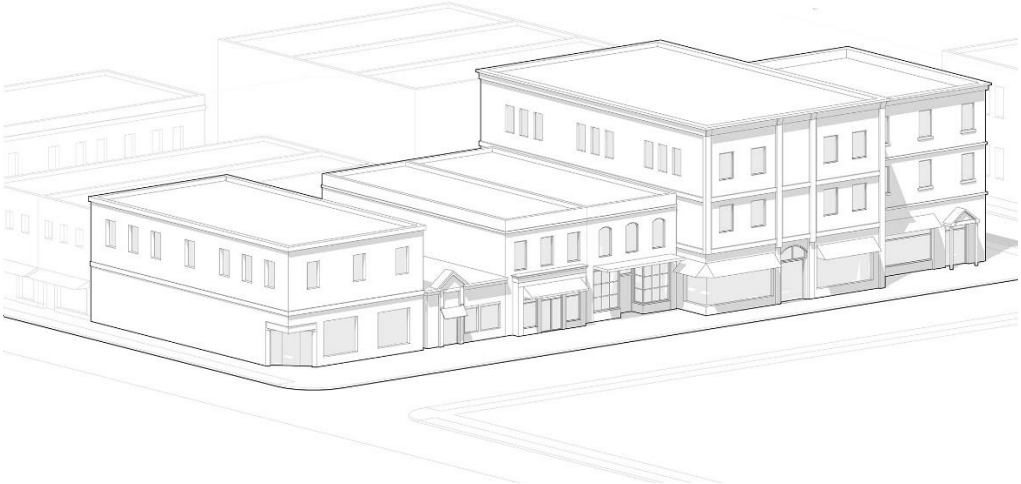

Figure 24-6-11 Facade Composition.
The combination of massing, modulation, entrances, and window transparency determine how a building relates to frontages and adjacent spaces. Building design standards based on the context of the area, type of street, and the position of the building on the block help reinforce the character of distinct districts and places.

7. *Materials.* Use building materials with a texture and pattern that creates visual interest and signifies quality construction and detailing.

(a) The predominant surfaces on building walls shall be one of the primary materials listed in Table 24-6-6, Nonresidential Building Materials.

(b) Synthetic alternatives may be approved by the Director if manufacturer specifications and/or precedents for application demonstrate that it will perform equally or better than the principal materials in terms of maintenance, design and aesthetic goals.

(c) No more than 4 materials should be use, including the use of secondary and accent materials.

(d) Material changes shall emphasize different elements of the building, in association with the massing and modulation standards.

(1) Where material changes are vertical (i.e. different materials stacked one above another), the transition between materials should include a belt course, trim band, sill, cap, frame, roof (if at ceiling height), or similar element to separate the two materials.

(2) Where material changes are horizontal (i.e. different materials side-by-side) the transition between materials should occur at interior corners or at the trim line, architectural column, or pilaster in association with a different structural or massing component of the building.

(e) Material colors shall be used to blend buildings into an area, to coordinate elements of a development, and be drawn from the prevalent color schemes in the surrounding area. Primary material colors should be low-reflectance, subtle, neutral or earth tone colors. Monotonous or monochromatic color palettes are strongly discouraged. The use of high-intensity colors, metallic colors, black or fluorescent colors is limited to accent areas.

Table 24-6-6: Nonresidential Building Materials

Primary Materials (50% to 90%)	***Secondary Materials (20% to 40%)***	***Accent Materials (10% to 30%)***
Brick Stone Stucco Slate Exterior Insulation and Finish System (EIFS) – water managed only Concrete Masonry Units (CMU) - colored and textured only Horizontal wood lap siding (50% limit) Architectural metals (prefinished non-corrugated) (50% limit) Corrugated metals (I-H only) Standing seam metal (roofs only)	Any of the primary materials Architectural tiles Glass Color concrete Precast concrete Corrugated metal (I-L, I-M and I-H only)	Any of the primary or secondary materials Precast stone Wood trim

8. *4-sided Design.* All buildings shall incorporate 4-sided design, so that that no matter what view you have of the building, the design is not interrupted and all parts are perceived as a coordinated part of a unified whole. Specifically:

a. All sides shall exhibit the same quality, continuity, and durability of design including the same primary and secondary materials, although more important sides can reflect priority in the allocation of these materials.

b. All sides that are visible from streets, public spaces or active portions of adjacent sites shall have a similar level trim, accent material, details, and ornamentation, although the extent and details may be different to reflect the greater importance

of certain areas closest to the public realm or with greater visibility, and parts not exposed to the public may be designed for utility.

9. *Alternative Compliance.* Alternative compliance to the building design standards established in this Section may be authorized according to the process and criteria in Section 24-208, Alternative Compliance, and any of the following additional applicable criteria:
   (a) The requirement is not consistent with the particular architectural style selected for the building based on reputable resources documenting the style.
   (b) The requirement would make the building less compatible with designs or characteristics of other buildings or sites adjacent to the project or that are prevalent throughout the area.
   (c) The requirement is inconsistent with the principal function of the building when applied to industrial buildings in the I-M and I-H districts.
   (d) Deviations from material standards and any simulated products demonstrate a proven performance in terms of maintenance and quality appearance.
   (e) In any case, the deviation is the minimum necessary to address the circumstance and does not negatively impact other design standards applicable to the building or site.

d. **Lot Open Space Design.** The design of open space can reinforce the character of unique districts and distinct places. Lot open space coordinates unbuilt areas with the public realm design of commercial, mixed-use, and industrial areas or uses landscape areas to mitigate undesirable impacts..

1. *Design Objective***s.** The required lot open space in Table 24-6-1 shall be designed and located to meet the following design objectives:
   (a) Coordinate site design with the larger open space system and public realm design of the area.
   (b) Use open space as an organizing element for development, creating focal points for buildings or groups of buildings, and creating transitions between distinct building sites or different places.
   (c) Design a hierarchy of gateways, gathering places, parks, landscape perimeters, and natural features, integrated with streets, internal access streets, trails, and pedestrian passages.
   (d) Select open space types based on the context of the areas and natural amenities of the site; in general more compact and formal gathering spaces are most appropriate in walkable commercial and mixed use areas, and more spacious and natural areas are most appropriate in large commercial or industrial areas.
   (e) Use landscape, furnishings, fixtures, art, planters, and other elements of common spaces to complement buildings, coordinate buildings and sites within an area, and distinguish the unique character of different places.
   (f) Preserve natural features and historical drainage patterns that can serve as amenities for development, maintain views to and from important outside spaces, perform ecological functions, or provide important connecting corridors.

2. *Lot Open Space Design.* Lot open space required for each building and lot in Table 24-6-1 shall create a common or private amenity for the site and building. Buildings and open spaces on a lot shall be arranged to create usable outdoor spaces that meet one or more of the following types:
   (a) Private frontage landscape areas designed according to Section 24-603.b., excluding any driveways, parking areas, or other automobile space;

(b) Courtyards, plazas, patios, or similar outdoor seating areas that are either designed as an extension of the public streetscape on the frontage, or at least 500 square feet and 20 feet in all directions if internal to the site;

(c) Common rooftop decks provided they are at least 200 square feet, and at least 12 feet in all directions – this space is limited to no more than 25% of the requirement for the lot and building;

(d) Private balconies or patios, provided they are at least 6 feet by 10 feet – this space is limited to no more than 25% of the requirement for the lot and building; or

(e) Landscape areas and perimeter treatments designed according to the standards of Chapter 8. These areas shall be limited to:

(1) No more than 25% of the requirement for lot open space in mixed-use districts.

(2) No more than 50% of the requirement for lot open space in commercial districts; and

(3) No limit in industrial districts.

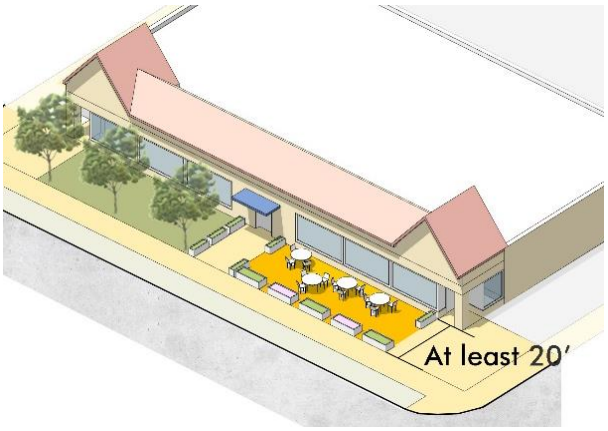

Figure 24-6-12 Courtyards, Patios and Plazas
More compact and walkable places benefit from smaller and more formal social spaces, such as courtyards, patios and plazas. 24-603.d.2.(b).

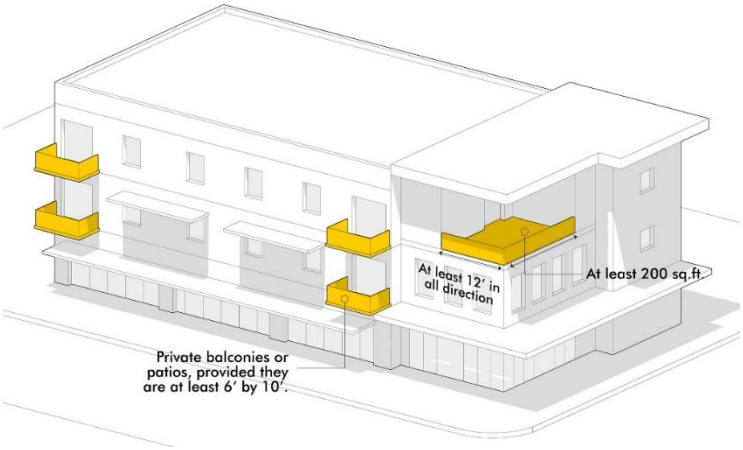

Figure 24-6-13 Private or Common Open Spaces
Private or commons areas incorporated into the building can provide a portion of the useable on-lot open spaces. These elements can also meet design requirements for breaking up the massing or blank wall of buildings24-603.d.2.(c) and (d)

3. *Alternative Compliance*. Alternative compliance to the lot open space design standards established in this Section may be authorized according to the process and criteria in Section 24-208, Alternative Compliance, and any of the following additional applicable criteria:
   (a) The lot and building has access to at least two different active open space on the same block or abutting block, and meeting the design and service area standards Section 24-302 or 24-504.
   (b) Other designs that promote infill development or rehabilitation of existing buildings and sites in a compact, and walkable context.

e. **Exterior Lighting.**

1. *Design Objectives.* The following design objectives shall be used in applying the lighting standards in this Section:
   (a) Provide sufficient illumination for security and safety needs in specific areas
   (b) Ensure lighting does on interfere with the proper and safe function of the rights-of-way, and mitigate any potential negative affects on adjacent property.
   (c) Protect residential property or other low-intensity uses from unnecessary light impacts from adjacent uses.
   (d) Maintain adequate lighting for publicly accessible outdoor areas and social spaces.
   (e) Enable lighting that enhances architectural elements and landscape features, in subtle and attractive ways.

2. *Location & Height*. Exterior lighting shall be located as specified in Table 24-6-7.

Table 24-6-7: Light Location & Height

Location	*Maximum Height*
Within 50' of any Residential Zoning	▪ 20'
All other locations – free-standing	▪ 30', but no taller than the principal building
Building-mounted	▪ 30' or 3' below the eave, parapet or cornice, whichever is less.

3. *Maximum Lighting Levels.* Maximum lighting levels are provided in Table 24-6-8. Lighting levels are average maintained horizontal levels, measured using a calibrated, color and cosine-corrected portable light meter and taken at a level position not more than six inches above the ground which the subject light source is on.

Table 24-6-8: Maximum Lighting Levels*

Area	*Residential Zones*	*Commercial & Industrial Zones*
Building exterior	0.5; (0.0 at property line)	1.0—5.0
Walks, pathways	0.5; (0.0 at property line)	1.0
Parking lots	1.0; (0.0 at property line)	2.0
Street or driveway lighting (internal to site)	0.6; (0.0 at property line)	1.2
Loading docks	N/A	20.0
Auto sales (outdoor display)	N/A	30.0 average, 60.0 spot location

* Information gathered from Illuminating Engineering Society (IES) Lighting Handbook. One footcandle is equal to one lumen uniformly distributed over an area of one square foot.

4. *General Standards.* All lighting shall be the following design and performance standards:
   (a) No lighting shall be used in any way which could interfere with the safe movement of vehicles on public streets, including:
      (1) Any fixed lighting that is not designed for street illumination that produces light which could interfere with the operation of a vehicle;
      (2) Any lighting which could be confused with any type of traffic control device, emergency or warning signals; or
      (3) Any lighting that blinks, flashes, flickers or changes intensity with the exception of temporary holiday displays.
   (b) No light spillage or glare shall be visible at or beyond the property line of the development. Lighting shall be provided at sidewalks or pathways, common areas or facilities, primary building entrances and in parking areas. All outside lighting shall include fixtures with a dimming interface
   (c) Outdoor lighting shall be L.E.D (Light emitting Diode) "Dark Sky" compliant, per the International Dark Sky Association requirements for reducing light pollution and minimizing glare. The use of low pressure sodium light fixtures shall be prohibited in the city.
   (d) The style and materials of light standards and fixtures shall be compatible with the architectural character and materials of buildings on the site, and building mounted lights are encouraged to use ornamental lights rather than wall pack fixtures.
   (e) All lights shall be directed downward and the light source shall be shielded to direct light away from and not visible from any adjacent property.
      (1) An exception for accent and flagpole lighting may be permitted for upward lights as long as the light source is shielded and not visible from any adjacent property.
      (2) Wall lights shall be full cutoff fixtures, with flat lenses, and mounted so the lights are directed downward and the light source shall not go beyond the property line.
      (3) Fixtures installed under canopies, awnings, and overhangs shall be fully recessed.

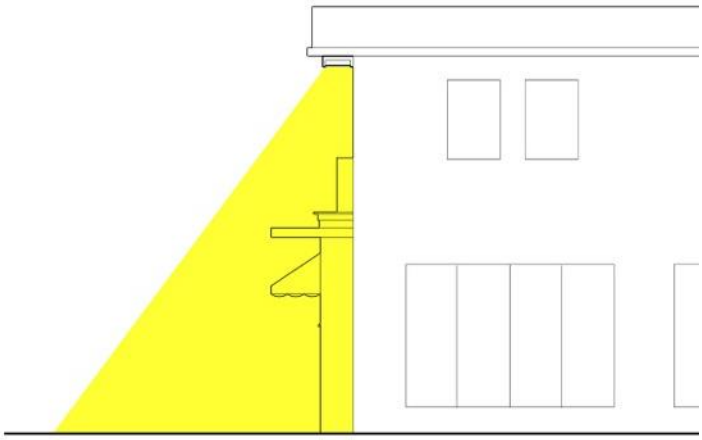

Figure 24-6-14 Lighting Directed Downward onto Site.
.Lighting directed downward eliminates negative impacts of lighting on adjacent property and helps to preserve the night sky views. 24-603.e.4.(e).

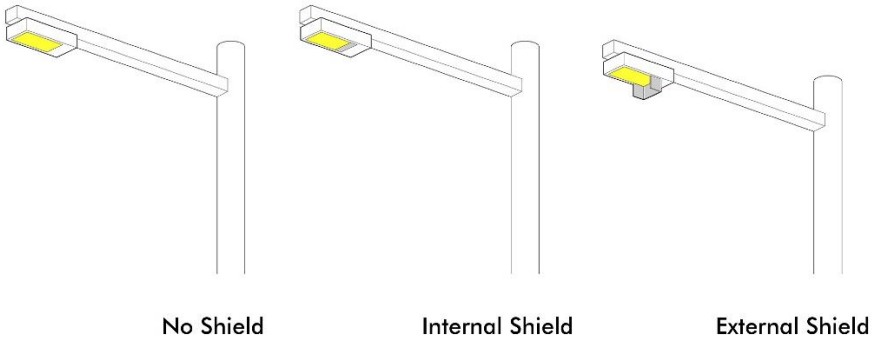

Figure 24-6-15 Light Shielding.
.Light shielding related to the different fixture styles, height, and location helps mitigate the potential negative impacts of specific lights. 24-603.e.4.(e).

(f) No activity shall be conducted within 500 feet of a residential zone which creates glare exceeding 0.0 footcandle at the property line, except for parking lots, neighborhood recreation and service facilities and streets, which may be illuminated at levels up to 1.0 footcandle.

(g) All parking lot lighting fixtures and exterior building floodlights, except those required for security purposes, shall be extinguished within one hour after the end of business hours and remain extinguished until one hour prior to the beginning of business hours. If a portion of a parking lot is offered for use after dark, only that portion shall be lighted.

(h) Lighting within parking structures shall be designed to provide safety and security and be integrated into the architectural character of the structure.

(i) In addition to all other standards lighting of all outdoor recreational facilities except baseball, softball, soccer, volleyball or football fields; driving ranges; outdoor arenas and amphitheaters shall meet the following:
  (1) All lighting or illumination units or sources shall be hooded or shielded and directed downward so that they are not visible from any adjacent lot or property; and
  (2) Lights or illuminating units shall not allow light either directly or through a reflecting device to spill upon any adjacent real property.

(j) In addition to all other standards, baseball, softball, soccer, volleyball or football fields; driving ranges; or other field recreation facilities shall meet the following:
  (1) Light fixture or illumination source shall not exceed 90 feet high.
  (2) Individual lighting of 150 watts or greater shall not be used after 11:00 p.m., or within one hour after the event, whichever is later. Exceptions to this section may be granted by the Director.

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Chapter 13 Definitions & Terms

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Chapter 6 Nonresidential Development Standards: Section Map		
Current Standards	***Reorganized***	***Comment***
n/a	24-601 Intent & Applicability	Compiled from various sections to establish the intent and set up the new approach for all residential development standards
18.38.080 Zoning District Development Standards, Commercial District Standards 18.38.090 Zoning District Development Standards, Industrial District Standards 19.38.100 Zoning District Development Standards, Performance Options	24-602.a Nonresidential Development Standards	Converted all of the current commercial and industrial development standards to single table. These match the current district standards, with the exception of a height increase in C-L (30' to 40' or approx. 3-story building) and C-H (40' to 60' or approach 5-story building). Some of the performance options for building height or building placement are converted into other sections (height exceptions in 24-602.b.2; frontage types in 24-603.b.). This section includes two new Mixed Use districts that feature increased heights, maximum lot sizes, and reduced setbacks to ensure compact, walkable building forms.
various sections, plus 18.38.100 Performance Options	24-602.b Dimension exceptions	Incorporation of various exceptions, interpretation rules or additional standards in one section related to the development standards table.
18.52.030 Accessory Uses & Structures, Accessory Uses & Structures	24-602.c Accessory buildings - residential	Incorporated current standards but distinguished between minor and secondary (by size) for the purposes of setbacks and design standards. Additional buildings beyond these sizes on the same lot would be an additional principal building and need to meet all standards for principal buildings
18.52.035 Accessory Uses & Structures, Fences and Walls	24-602.d. Fences and walls	Current provisions with no substantive changes
n/a	24-603.a Nonresidential Design Standards, Applicability	Compiled from various sections to establish the intent and set up the new approach for all nonresidential design standards. This also introduces the "frontage types" in the applicability table. This is a variation of the current performance options for reduced front setbacks (see 24.503.b.below).
Various provisions from: • 18.38.100 Performance options • 18.40.090 Architectural review standards • 18.40.100 Site and building design standards • 18.46.040 Infill area design standards	24-603.b Frontage Design	The frontage types is a new approach to the current performance option for reduced front setbacks. This approach includes the following additional elements • More variations in range of building placement to account for different contexts • Comprehensive standards for the design of the entire frontage, not just the building placement. • Correspondence with building design standards with the principle that the closer to the street the more human-scale design standards apply • Default standards for particular districts (suburban form for C- and I- districts; walkable form for MU- districts) but with criteria for alternative compliance and applying the different frontage types based on street types (from 24-301).
Same as above	24-603.c Building Design	New approach, derived from a similar range of topics in the current regulations. It focuses the standards on a few key elements of building design – massing (volume of buildable areas); modulation (composition and breaking up blank walls); primary entrance features (more massing and emphasizing connections to streetscape); transparency (connecting to outside with windows and doors); and materials. Variations to the standards are based on building placement and proximity to the street (frontage types). Compared to current standards, the standards are increased for frontage types A & B (buildings between 0' and 25' from thee street); the standards are comparable for frontage type C (buildings between 25' and 80' from the street; and the standards are reduced for frontage type D (buildings 80'+ from the street). This section uses a similar structure as Frontage Design – stating the intent / design objective; establishing a measureable objective standard; identifying a range of design strategies that may be used to meet that standard; and allowing for alternative compliance when something not listed or something not technically meeting the standard would serve the objective equally or better.

Chapter 6 Nonresidential Development Standards: Section Map		
Current Standards	***Reorganized***	***Comment***
Same as above	24.603.d. Lot Open Space Design	This section refines and presents options how to design and use the non-building portions of lots (setbacks and lot open space %) in different context – more landscape, separation and screening in suburban contexts vs. more hardscape and smaller social spaces for mixed-use or walkable). It coordinates with other sections dealing with these topics (24-603.b – frontage design, Chapter 8 – Landscape Design), but in some cases may require additional open space design if these spaces cannot be designed to meet the objectives of the lot open space standards.
18.40.110 Lighting Standards	24-603.e Exterior Lighting	This reflects the existing lighting standards, recently updated by staff.

Chapter 13. Definitions & Terms

24-1301 Definitions
24-1302 Architecture & Design Terms

24-1301 Definitions

All terms used in this code shall have their plain and commonly accepted meaning, based upon the context of their use in the code. The following terms shall have the meaning given below, unless more specifically described, limited or qualified within the standards of this code. Some Chapters have specific definitions where the terms have the given meaning for interpretation of that chapter.

100-year flood. A flood having a recurrence interval that has a one-percent chance of being equaled or exceeded during any given year (one-percent-annual-chance flood). The terms "one-hundred-year flood" and "one-percent-chance flood" are synonymous with the term "100-year flood."

100-year floodplain. The area of land susceptible to being inundated as a result of the occurrence of a 100-year flood.

Abandoned Sign.

(1) A sign or sign structure and components, for which no legal owner can be found; and/or

(2) A sign and structure which are used to identify or advertise a business, tenant, owner, product, service, use, event or activity that has not been located on the premises for a period of 90 consecutive days or longer.

Accessory Building or Structure. A detached building or structure located upon the same lot as the principal building or structure to which it is related, which is incidental to and customarily found in connection with such principal building or structure.

Accessory Use. A use customarily incidental, related and subordinate to the main use of the lot, building or structure which does not alter the principal use.

Adjacent. Close, contiguous, and related to by proximity, sharing a common boundary or otherwise nearby to have a relationship without intervening dissimilar elements. When referring to land, separation caused by a street, alley, sidewalk, railroad right-of-way, utility line, trail, or irrigation ditch, or similarly related land can be considered adjacent.

Abutting. Directly touching elements that share a common edge or boundary.

Alley. A minor way used primarily for vehicular access or service to the back of properties adjacent to a street. An alley shall not be considered a street.

Alteration. Any act or process requiring a building permit, moving permit, demolition permit or sign permit for the reconstruction, moving, improvement or demolition of any designated property or district; or any other action in which a review by either the historic preservation commission or the city's historic preservation specialist is necessary under this article and/or the district designation plan and in accordance with the definitions of major and minor alterations, for the purposes of this article.

American National Standards Institute (ANSI). The standards by said organization that helps development in the use have an equitable and open process that serves industry and the public good, having a consensus in standards development; ANSI's essential requirements.

Animal Unit. A unit of measurement used to determine the animal capacity of a particular site or parcel of land and to establish an equivalency for various species of livestock.

Animated Sign (see *Flashing or animated* or *Imitating sign*).

Antenna. A device used to transmit and/or receive radio, television or any other transmitted signal and which may be rooftop, wall or ground-mounted.

Appeal. A review of a final decision by a higher authority.

Applicant. The owners or lessees of property, their agent, or persons who have contracted to purchase property, or the city or other quasi-governmental entity that is proposing an action requiring review and approval by one or more of the sections in this title. An applicant may subsequently become the developer once approval is granted and, in this case, the terms shall be interchangeable.

Appurtenances. The visible, functional objects accessory to and part of buildings or structures and which may extend above the height of the roof.

Art. All forms of original creations of visual art, including, but not limited to, sculpture; mosaics; painting, whether portable or permanently fixed, as in the case of murals; photographs; crafts made from clay; fiber and textiles; wood; glass; metal; plastics; or any other material or any combination thereof; calligraphy; mixed media composed of any combination of forms or media; unique architectural styling or embellishment, including architectural crafts, environmental landscaping; or restoration or renovation of existing works of art of historical significance. Works of art are not intended to be used for commercial advertising purposes.

Arterial street (see *Street*).

Artificial turf. Any of the various synthetic fibers made to resemble natural grass.

*Awning, Internally Illuminated. A*ny transparent backlit awning or awning lettering which transmits light from within the awning to the outside surface of the awning.

Awning Sign. A sign that is mounted or painted on or attached to an awning.

Backing. The background area of a sign, which differentiates the total sign display from the background against which it is placed.

Basement. Any level of a building where more than one-half of the vertical distance between floor and ceiling is below the grade of the site.

Beacon (see *Searchlight, strobe light or beacon*).

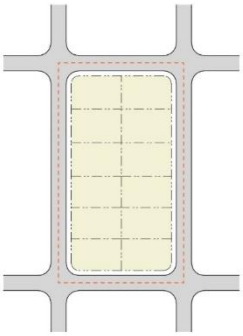
Bedroom. Any room intended and used principally for sleeping purposes.

Berm (see "Earthen berm.")

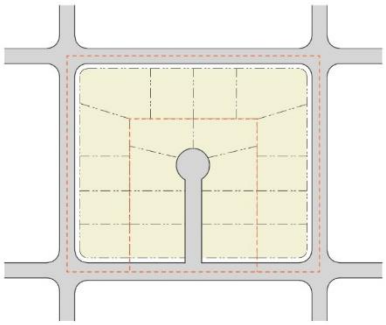
Bioretention Facility. A landscaped stormwater element designed to concentrate or remove debris and pollution from surface water runoff by moving water slowly and horizontally at the surface through vegetation using gently sloped sides that cleanse water from pollutants and soil erosion before it enters the city's stormwater system.

Bioswale. A channeled depression or trench that receives rainwater runoff (as from a parking lot) and has vegetation (such as grasses, flowering herbs, and shrubs) and organic matter (such as mulch) to slow water infiltration and filter out pollutants.

Block. A group of platted lots and outlots surrounded by streets or by other features that interrupt the street network such as parks, railroad rights-of-way, or municipal boundary lines; or the perimeter of all lots fronting on the street in the case of a cul-de-sac.



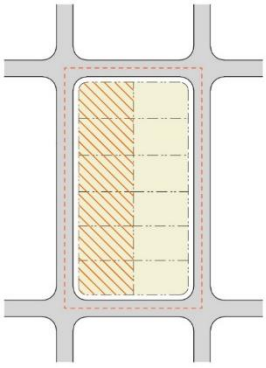
Standard Block



Cul-de-sac Block

Exception

Block face. All lots on one side of a block.



Block Face

Buffer. To promote separation and enhance compatibility between land uses of different intensities.

Building. Any structure built for the shelter or enclosure of persons, animals or property of any kind, excluding fences or walls.

Building Appurtenance. The visible, functional or ornamental object accessory to and part of a building.

Building Code. Any law, ordinance or code which is in force in the city and which pertains to the design and construction of buildings and other structures, or to any components thereof, such as cooling and heating, plumbing, electricity and the like.

Building Envelope. The area in which a building or structure is constructed or placed in a development and in which the land area beyond the envelope is under the single ownership or common ownership of all property owners within the development.

Building Footprint. The outline of the total area which is covered by a building's perimeter at the ground level.

Building Frontage. The area of the lot along the front building line, and when referring to design standards it may include relationship of this area and the primary facade of the building.

Building Frontage, Principal. The horizontal linear dimension which is designated as the primary facade of that portion of a building occupied by a single use or occupancy for the purposes of allocating signs and other design requirements.

Building Frontage, Secondary. That dimension of a building abutting a public right-of-way other than the principal building frontage for the purposes of allocating signs and other design requirements.

Building or Structure Height. The vertical distance from grade at an exterior wall of a building or structure to the highest point of the coping of a flat roof, to the average height of the highest gable of a hipped roof, or a monitor roof, or to the highest point of a curved roof. This measurement shall be exclusive of church spires, cupulas, chimneys, ventilators, pipes, and similar appurtenances. For the purposes of this definition, grade applies as follows:

(1) When there is less than a ten-foot difference between the highest and lowest ground surface within a five-foot horizontal distance from the wall, use the highest elevation.

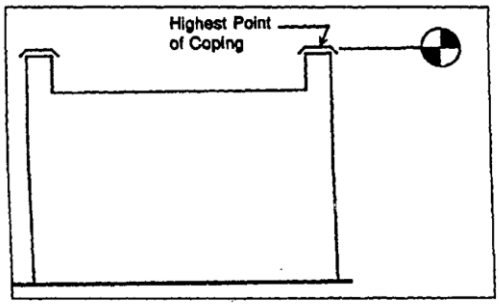
(2) When there is greater than a ten-foot difference between the highest and lowest ground surface within a five-foot horizontal distance from the wall, use ten-feet higher than the lowest elevation in this area.

The height of the building is the vertical distance above a reference datum measured to

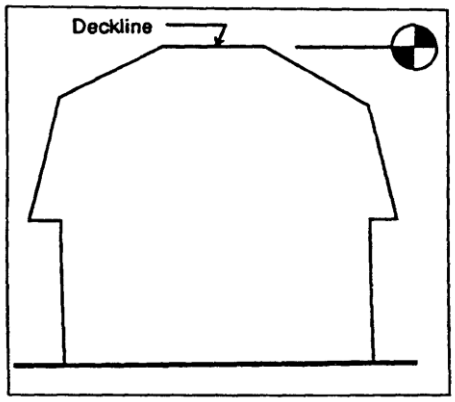
(a) the highest point on a flat roof;

(b) the deck line of a mansard roof;

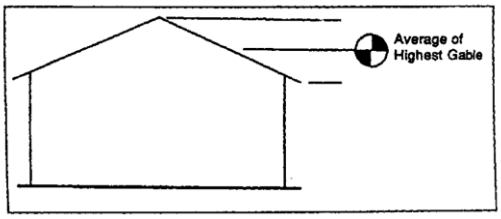
(c) the average of the highest gable on a hip or gabled roof:



Flat Roof (measured to highest point)

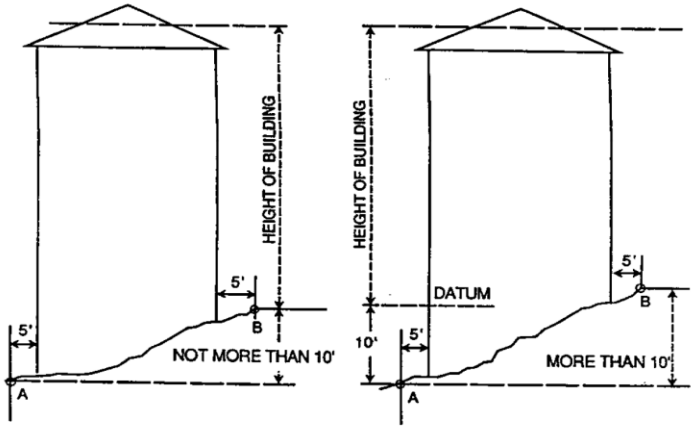


Mansard Roof (measure to deck line)



*Gable roof *(1 gable)*

Gable Roof (2 or more gables)



Building height from ground..

Building, Principal. The primary building on a lot or a building that houses the principal use.

Building Line. The actual line at which a building is constructed, and the location of other elements on the lot or adjacent lots may refer to this line extended outward from the building.

Building Line, Required Front. The portion of the lot frontage required to be occupied by the front facade of a principle structure, or other permitted accessory structures or landscape associated with the frontage design.

Caliper. The diameter or circumference of a tree.

Candela. A unit of luminous intensity, defined as the luminous intensity of a source that emits monochromatic radiation of frequency 540 x 10 12 Hertz and that has a radiant intensity of 1/683watt/steradian and adopted in 1979 as the international standard of luminous intensity.

Centerline (of Public Right-of-Way). A line running midway between the bounding right-of-way lines of a street or alley. For the purposes of calculating signage, the centerline means the apparent centerline of the road determined by finding the point midway between the outer edges of the road surface.

Certificate of Approval. A certificate issued by the city authorizing the construction, alteration or demolition of property and improvements designated under this article.

Certificate of Occupancy (C.O.). A written certificate provided by the city signifying the subject building/structure (property) has complied with city standards allowing for use and occupancy.

Change of Use. A use that substantially differs from the previous use of a building or land and which may affect such things as parking, drainage, circulation, landscaping, building configuration, noise, or lighting. A change of ownership which does not include any of the factors listed above shall not be considered a change of use.

Changeable Copy Sign (also known as a marquee sign). A sign designed to allow the changing of copy as with individual letters through manual means, without altering the sign backing or structure in any such way.

Channel. A natural or artificial watercourse of perceptible extent, with definite bed and banks to confine and conduct continuous or periodic flowing water.

Channel Letters, Individual Letters, Raceway and Channel Sign. Individual letters, flat cutout letters or symbols constructed to be applied singly in the formation of a wall sign or freestanding sign.

Channelization. The artificial creation, enlargement, or realignment of a stream channel.

Circumference. The perimeter measurement of a building or structure, measured as a continuous line.

Clear Vison Zone or Area. That area which the city requires maintenance of in order to preserve the sight distance and safety of motorists, pedestrians, and bicyclists by requiring an unobstructed line of sight necessary for most drivers stopped at an intersection to see an approaching vehicle, pedestrian or bicyclist to avoid a collision.

Collector Street (see *Street*).

Commercial Mineral Deposit. A natural mineral deposit of limestone used for construction purposes, coal, sand, gravel, and quarry aggregate, for which extraction is or will be commercially feasible and regarding which it can be demonstrated by geologic, mineralogic, or other scientific data that such deposit has significant economic or strategic value to the area, state, or nation.

Common Consumption Area. An area designed as a common area located within a designated Entertainment District and approved by the local licensing authority that uses physical barriers to close the areas to motor vehicle traffic and limit pedestrian access.

Comprehensive Plan. The comprehensive plan of the city, as provided for in the city Charter and which provides for the future growth and improvement of the community, for the preservation of historic and natural resources, and for the general location and coordination of streets and highways, recreation areas, public building sites and other physical development. Comprehensive plan may also include any specific plans, polices, or programs adopted under the guidance of that plan for the purposes of interpreting and applying this code.

Condominium. A form of ownership in which the interior floor space of a unit or area is owned individually, and the structure, common areas and facilities are owned by all of the owners on a proportional, undivided basis.

Coverage. Land area which is covered with impervious surfaces, such as buildings, patios, or decks with roofs, carports, swimming pools, tennis courts, or land area covered by any other type of structure, including parking lots.

Cul-de-sac. A local street with one open end and the other end terminating in a vehicular turn around.

Deciduous. A plant with foliage that is shed annually.

Decision Point Distance. Where the clear vision sight distance triangle begins.

Deck. A floored outdoor area, typically elevated above grade and adjoining a residential dwelling.

Dedication. Setting aside property for a specific purpose, including, but not limited to, streets, utilities, parks, and trails.

Demolition. Any act or process which destroys, in part or in whole, any designated property or property located within a designated historic district.

Density. The number of dwelling units per gross acre of land area.

Detention Area. An area which is designed to capture specific quantities of stormwater and to gradually release the same at a sufficiently slow rate to reduce the risk of flooding.

Developer. Any person, partnership, joint venture, association, or corporation or other legal entity who or which shall participate as owner, promoter, designer, builder, or sales agent in the planning, platting, development, promotion, sale, or lease of a subdivision.

Developing. A lot, or grouping of lots or tracts of land, with less than 60 percent of their perimeter boundary adjacent to existing development. For the purposes of this definition, public parks, natural areas and other such areas which are not eligible for further development shall be considered developed. Areas which were originally platted prior to 1978 and which have at least 75 percent of the lots in the development built on within this 20-year period shall also be considered developed. A replat of the original plat shall not affect the commencement of this 20-year period.

Development. Any construction or activity which changes the basic character or use of land on which construction or activity occurs, including, but not limited to, any non-natural change to improved or unimproved real estate, substantial improvements to buildings or other structures, mining, dredging, filling, grading, paving, extraction, or drilling operations.

Development or Subdivision Improvement Agreement. A written instrument for the purposes of specifying all improvements to be constructed by the developer, as well as the timetable for construction of such improvements, any special conditions of construction, and construction cost estimates.

Direct Lighting. Spot or floodlighting used to illuminate a sign surface.

Directional On-Site. Signs that direct the movement or placement of pedestrian or vehicular traffic on a lot without reference to, or inclusion of, the name or logo of a product sold or services performed on the lot or in a building, structure or business enterprise occupying property, such as "welcome," "entrance," "exit," "restrooms," "parking," "loading area," and "drive-thru."

Dissolve. A mode of message transition on an electronic message display accomplished by varying the light intensity or pattern, where the first message gradually appears to dissipate and lose legibility simultaneously with the gradual appearance and legibility of the second message.

District. A portion of the community within which uniform regulations apply.

Downtown Entertainment District. That area contained within the south curb flow line of 7th Street, the west curb flow line of 8th Avenue, the north curb flow line of 10th Street and the east curb flow line of 9th Avenue.

Drive-in or *Drive-through*. Accessory site and building features that encourage or permit customers to order and receive food or beverages while remaining in a motor vehicle for consumption on or off the site and which includes a menu board and audio or video speakers.

Drive-up. Accessory site or building features that encourage or permit customers to receive services or obtain or drop off products while remaining in a motor vehicle and which excludes a menu board and/or audio or video speakers.

Driveway. An improved concrete or asphalt path leading directly to one or more city-approved parking spaces constructed with a concrete, asphalt, or similar all-weather surface.

Dry Wash Channel. Natural passageways or depressions of perceptible extent, containing intermittent or low-base flow.

Dust Abatement Plan. A plan intended and designed to control dust during the construction or development of property.

Dwelling Unit. One room, or connected rooms, constituting a separate, independent housekeeping establishment for owner occupancy, or rental or lease as a single unit, on a monthly basis or longer, physically separated from any other room or dwelling units which may be in the same structure and served by no more than one gas meter and one electric meter.

Earthen Berm. A mound of earth, higher than grade, used for screening or buffering, the definition of space, noise attenuation, and decoration in landscaping.

Easement. A right granted by a property owner permitting a designated part of interest in the owner's property to be used by others for a specific use or purpose.

Ecological Character. The natural features and attributes of an area or landscape that, combined, give the area its character.

Electronic Message Display. A sign capable of displaying words, symbols, figures, or images that can be electronically or mechanically changed by remote or automatic means.

Emergency. An unexpected and sudden event that must be dealt with urgently in order to stabilize or protect a structure.

Entertainment District. An area within the city that is designated as an Entertainment District of a size no more than 100 acres and containing at least 20,000 square feet of premises licensed as a tavern, hotel and restaurant, brew pub, retail gaming tavern, or vintner's restaurant at the time the district is created.

Evergreen. A plant with foliage that persists and remains green year-round.

Existing Development. Any development in the city once all public improvements, including water, sewer, streets, curb, gutter, streetlights, fire hydrants, and storm drainage facilities, are installed and completed.

Exposed Incandescent or *High intensity Discharge Lighting*. Any sign or portion of a sign that utilizes an exposed incandescent or high intensity lamp, with the exception of neon.

Exterior or *Perimeter Wall*. A wall, elements of a wall, parapet wall or any elements or groups of elements which define the exterior boundaries or courts of a building.

Facade. The exterior face of a building.

Fade. A mode of message transition on an electronic message display accomplished by varying the light intensity, where the first message gradually reduces intensity to the point of not being legible and the subsequent message gradually increases intensity to the point of legibility.

Family. An individual living alone, or any number of persons living together as a single household who are interrelated by blood, marriage, adoption or other legal custodial relationship; or not more than two unrelated adults and any number of persons related to those unrelated adults by blood, adoption, guardianship or other legal custodial relationship. In multifamily units, the number of unrelated adults shall be determined based on the provisions of the city's housing code. For the purposes of this definition, a bona fide employee of the family who resides in the dwelling unit and whose live-in status is required by the nature of his employment shall be considered a member of the family.

Federal Register. The official daily publication for rules, proposed rules, and notices of federal agencies and organizations, as well as executive orders and other presidential documents.

Fence. Any artificially constructed barrier of an approved material or combination of materials erected vertically to enclose or screen areas of land.

Figures. An outline, shape or pattern of numbers, letters or abstract images.

Financial Security or Guarantee. A financial obligation, in a form acceptable to the city, which assures completion and payment for all improvements related to development of property.

Flag. Material attached to or designed to be flown from a flagpole or similar device and which may display the name, insignia, emblem or logo of any nation, state, municipality, or commercial or noncommercial organization (see *Pennants*).

Flashing or Animated. Signs or lighting with flashing, blinking, moving or other animation effects or that give the visual impression of such movement by use of lighting, or intermittent exhibits or sequential flashing of natural or appearance of artificial light or colors, including those signs that rotate, revolve, spin, swing, flap, wave, shimmer, or make any other motion, or illusion of motion, or which imitate official governmental protective or warning devices (see *Imitating sign*).

Flood or *Flooding*. A general and temporary condition of partial or complete inundation of normally dry land areas from the unusual and rapid accumulation or runoff of surface waters from any source.

Floodplain. An area which is adjacent to a stream or watercourse and which is subject to flooding as a result of the occurrence of an intermediate regional flood and which is so adverse to past, current or foreseeable construction or land use as to constitute a significant hazard to public health and safety or to property. The term "floodplain" includes, but is not limited to, mainstream floodplains, debris fan floodplains, and dry wash channels and floodplains.

Floor Area, Gross. The total area of a building measured by taking the outside dimensions of the building at each floor level, or from the centerlines of walls separating two buildings and excluding areas used exclusively for the service of the building such as mechanical equipment spaces and shafts, elevators, stairways, escalators, ramps, loading docks, cellars, unenclosed porches, attics not used for human occupancy, any floor space in accessory buildings, or areas within the building which are intended for the parking of motor vehicles.

Flow Line. The low point within a street section wherein water is intended to collect and flow, typically the gutters along each edge of pavement.

Foundation Plantings. Live plantings located immediately around the base of the foundation of a building façade that reflects the formal geometry of the structure.

Frame. A complete, static display screen on an electronic message display.

Frame Effect. A visual effect on an electronic message display applied to a single frame to attract the attention of viewers.

Freestanding Sign. A sign which is not attached to any building. A freestanding sign shall include, but is not limited to, a pole, monument, a canopy, and freestanding wall sign. A sign that extends more than four feet from a wall but is attached and/or is part of a canopy or an awning shall be considered a freestanding sign.

Freestanding Wall or *Fence.* Either a wall that is not attached to a building or a wall attached to a building that projects more than four feet beyond the exterior wall of the habitable portion of the building.

Frontage. The area of a lot between the front building line and the front lot line.

Garage or *Yard Sale*. The occasional sale of new or used goods at a residence, which may be held outside and/or within a garage or accessory building.

Gas. All natural gases and all hydrocarbons not defined as oil.

General Improvement District #1. That 19-block district bounded by 11th Street to the south, 6th Street to the north, 7th Avenue to the east and 11th Avenue to the west, excluding city Block 35.

Geologic Hazard. A geologic condition which is adverse to current or foreseeable future construction or land use associated therewith, constituting a hazard to public health and safety or property, including, but not limited to, landslide, rock fall, subsidence, expansive soils, slope failure, mudflow, or other unstable surface or subsurface conditions.

Ghost Sign. Old hand-painted signage that has been preserved on a building for an extended period of time, whether by actively keeping it or choosing not to destroy it.

Glare. A sensation of brightness within the visual field that causes annoyance, discomfort, or loss in visual performance and visibility.

Grade. The average elevation of the finished surface of the ground, paving, or sidewalk with a radius of five feet from the base of the structure.

Graphics. Drawings, decals, paint, or illustrations.

Gravel. Inert materials such as loose fragments of rock larger than "pea" size and commonly used as parking surface material.

Gross Floor Area (see *Floor area*).

Gross Leasable Area (GLA). The area of a building that can be leased to tenants, including storage areas and common areas apportioned to the number of tenants sharing the area. Gross leasable area shall be measured in the same manner of gross floor area, but is apportioned to specific uses or tenants in the building.

Gross Land Area. The total land area of a site or property, including land to be dedicated for streets and other public purposes.

Ground Cover. Materials that typically do not exceed one foot in height used to provide cover of the soil in landscaped areas, which may include a combination of, but not limited to river rock, cobble, boulders, concrete pavers, grasses, flowers, low-growing shrubs and vines, and those materials derived from once-living things, such as wood mulch. In no event shall weeds be considered ground cover.

Ground Kites. Freestanding frames usually covered with flexible fabric and designed to be animated by the wind to attract attention.

Guest. A person who is visiting at the principal or primary home of another person for up to 30 days, and which home is not the principal or primary home of the guest.

Habitat. Areas that contain adequate food, water and cover to enable one or more species of wildlife to live in or use the area for part of all of the year and which typically consists of natural or planted vegetation, along with one or more sources of water available in the area or adjacent areas.

Hazard. Any structure or use of land which endangers or obstructs the airspace required for aircraft in landing, take-off and maneuvering at the airport.

Hazardous Material. Any substance or materials that, by reason of their toxic, caustic, corrosive, abrasive or otherwise injurious properties, may be detrimental or deleterious to the health of any person handling or otherwise coming into contact with such material or substance, or which may be detrimental to the natural environment and/or wildlife inhabiting the natural environment.

Height (see *Building height*).

Highest Adjacent Grade. The highest natural elevation of the ground surface prior to construction next to the proposed walls of a structure.

Hillside Development. Development in areas which contain existing, natural slopes in excess of 15 percent.

Historic District. A geographically definable area with a concentration of buildings, structures, sites, spaces or objects unified by past events, physical development, design, setting, materials, workmanship, sense of cohesiveness or related historical and aesthetic associations, that is recognized through listing in a local, state or national landmarks register.

Historic Preservation. The protection, rehabilitation and/or restoration of districts, buildings, structures, and artifacts which are considered significant in history, architecture, archaeology, or culture.

Historic Sign. A sign that has been officially designated as an historic landmark.

Historic Structure. Any structure that is:

(1) Listed individually in the National Register of Historic Places (a listing maintained by the Department of the Interior) or preliminarily determined by the Secretary of the Interior as meeting the requirements for individual listing on the National Register;

(2) Certified or preliminarily determined by the Secretary of the Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined by the Secretary to qualify as a registered historic district;

(3) Individually listed on a state inventory of historic places in states with historic preservation programs which have been approved by the Secretary of the Interior; or

(4) Individually listed on a local inventory of historic places in communities with historic preservation programs that have been certified either:

a. By an approved state program as determined by the Secretary of the Interior; or

b. Directly by the Secretary of the Interior in states without approved programs.

Holiday Decorations. Temporary decorations, lighting or displays which are clearly incidental and customary and commonly associated with any national, state, local, religious or commonly celebrated holiday and which contain no commercial message.

Home Occupation. An occupation, profession, activity, or use conducted within a residential dwelling unit that is incidental and secondary to the use of a residential dwelling unit, which does not alter the exterior of the property or affect the residential character of the environment and which meets the provisions of this article.

Home Occupation, Rural. An accessory use to a farming operation or a nonfarm household located in a rural area, designed for gainful employment involving the sale of agricultural produce grown on the site, conducted either from within the dwelling and/or from accessory buildings located within 500 feet of the dwelling occupied by those conducting the rural home occupation.

Homeowners' Association. An association of homeowners or property owners within a development, typically organized for the purpose of enforcement of private covenants and/or carrying out the maintenance of common areas, landscaping, parks, building exteriors and streets.

Household Pet. Any nonvenomous species of reptile and any domestic dog, cat, rodent, primate or bird over the age of four months, which is typically kept indoors. For the purposes of this definition, guide or assistance animals shall not be considered household pets.

Illumination. The use of artificial or reflective means for the purpose of lighting a sign.

Imitating Sign. Signs which purport to be, are an imitation of, or resemble an official traffic sign, signal or equipment which attempt to direct the movement of pedestrian or vehicular traffic using such words as "Stop," "Danger" or "Caution" to imply a need or requirement to stop, or a caution for the existence of danger, such as flashing red, yellow and green (see *Flashing or animated*).

Impervious. Any hard-surfaced, man-made area that does not readily absorb or retain water, including but not limited to building roofs, paved parking and driveway areas, compacted areas, sidewalks, and paved recreation areas.

Incidental Sign. Nondescript signs, emblems or decals attached to a permanent structure informing the public only of those facilities or services available on the premises, such as a credit card sign or a sign indicating hours of business.

Indirect Lighting. Reflected light or lighting directed toward or across a surface.

Individual Letters (see *Channel letters*).

Infill. A lot, or grouping of lots or tracts of land, with at least 60 percent of their perimeter boundary adjacent to existing development. If a right-of-way at least 120 feet in width or streets designated on the comprehensive transportation plan, as major collectors or arterial streets are adjacent to the subject lot, lots across such a street shall be excluded for the purposes of determining infill and at least 60 percent of

the remaining boundaries of the site shall be adjacent to existing development for the lot to be determined to be infill.

Inflatable Sign or *Inflatable Object*. Any object filled with air or other gas, including balloons, which characterize a commercial symbol or contain a message.

Intensity. An expression of the level or nature of development in nonresidential developments, or zones or specific land uses based on combinations of building coverage and height, impervious surfaces, expected traffic, hours of operation, noise, or similar impacts on surrounding areas.

Internal Illumination. A light source that is contained within the sign itself, or where light is visible through a translucent surface.

Irrigation System. An underground, automatic sprinkler system or above-ground drip system explicitly designed for watering vegetation.

Kiosk. A freestanding structure upon which temporary information and/or posters, notices, and announcements are posted.

Landscape Plan. A scaled graphic plan showing the treatment of all open space areas, parking lots, parking areas, areas adjacent to the public right-of-way, perimeter treatment, and other landscaped areas.

Landscaping. Any combination of living plants, such as trees, shrubs, vines, ground covers, flowers, or grass; natural features, such as rock, stone, bark chips, or shavings; and structural features, including but not limited to, fountains, reflecting pools, screening walls, solid fences, and benches.

Lawn. A stretch of open, turf-grass covered land; artificial turf shall not be considered lawn or turf-grass.

Leading Edge. The point of a sign, including its support structure, nearest to the public right-of-way.

Legal Description. A land description recognized by law, including the measurements and boundaries.

Legible. A sign capable of being read with certainty without visual aid by a pedestrian of normal visual acuity.

Live Plantings. Trees, shrubs and organic ground cover which are in healthy condition.

Livestock. Animals typically related to agricultural or farming uses, including, but not limited to, chickens, swine, sheep, goats, horses, cattle, yaks, alpacas, and emus.

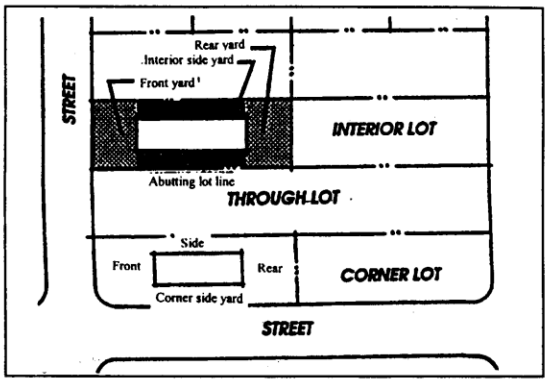
Living Fence. A permanent hedge tight enough and strong enough to serve almost any of the functions of a manufactured fence, but it offers agricultural and biological services.

Living Unit. Any habitable room or group of rooms forming a single habitable unit, used or intended to be used for living and sleeping, but not for cooking or eating.

Loading Space or Zone. An off-street space or berth used for the loading or unloading of cargo, products, or materials from vehicles.

Local street (see *Street*).

Lot. A parcel of land, established by a subdivision plat, having the required minimum dimensions, which shall be located on either a public right-of-way or on a legal and perpetual access and which is occupied or designed to be occupied by one or more principal buildings, structures, or uses.



Types of Lots

Lot Area. The total square footage or acreage contained within lot lines.

Lot, Corner. A lot abutting on and at the intersection of two or more streets.

Lot Coverage (see *Coverage*).

Lot Depth. The average distance between the front and rear lot lines.

Lot, double Frontage or Through. A lot that fronts upon two parallel streets or that fronts upon two streets that do not intersect at the boundaries of the lot. The lot line abutting the street which provides primary access shall be considered the front lot line.

Lot, Interior. A lot other than a corner lot, with frontage on only one street.

Lot Line. A line dividing one lot from another lot or parcel, or from a street or alley.

Lot Line, Front. The property line dividing a lot from a street or public or common space on which the building and lot orients. On a corner lot, generally the shorter street frontage shall be considered as a front lot line, except that the context of the block and abutting lots may allow the following arrangements:

(1) *Standard Corner.* The building orients to the same front as all other buildings on the same street, and an expanded side setback applies on the other street side of the lot. Side and rear setbacks apply to the remaining sides.
(2) *Reverse Corner.* The building orients to the end-grain of the block (not the same as other buildings on the interior of the block), and the front setback and frontage design applies to that street. The other street-side setback is the greater of (a) the stated street-side setback for that building type or (b) 10 feet in front of the forward-most point of the front building line of the abutting lot. Side and rear setbacks apply to the remaining sides.
(3) *Corner Orientation.* The building orients to both streets, with the front setback and frontage design applying on both street sides. The two remaining lot lines are treated as side setbacks and there is no rear setback.

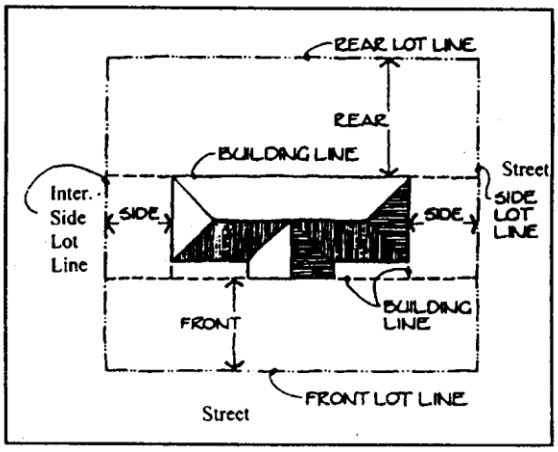
Standard Corner *Reverse Corner* *Corner Orientation*

Lot Line, Interior Side. A side lot line which is adjacent to a side lot line of another lot.

*Lot Line, Rear. T*he line opposite the front lot line. Where the side lot lines meet in a point, the rear lot line shall be assumed to be a line not less than ten feet long, lying within the lot and parallel to the front lot line.

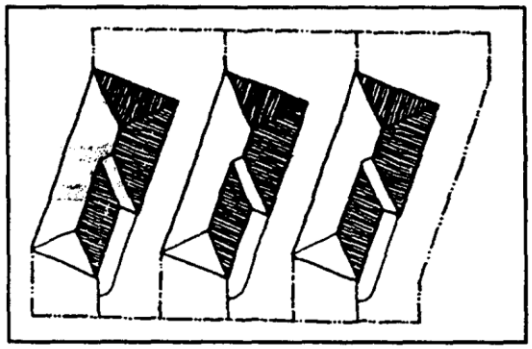
Lot Line, Side. Any lot lines other than the front or rear lot line.

Lot Line, Street Side, A side lot line which separates the lot from a street.



Lot and Building Lines

Lot line, zero. The location of a building on a lot in such a manner that one or more of the building's sides rests directly on a lot line, provided that separations or setbacks between buildings meet all applicable building and fire code provisions.



Zero Lot Line Development

Low-water Adaptive Plants. Plants which have or can adapt to low levels of irrigation water.

Maintenance of Landscaping. Regular watering, mowing, pruning, fertilizing, clearing of debris and weeds, removing and replacing of dead plants, and the repair and replacement of irrigation systems.

Maintenance of a Sign. Cleaning, repairing, painting, or replacement of defective parts in a manner that does not alter the dimension, material or structure.

Manufactured Home (see *Dwelling or Residence, Single-Family in the description of uses*).

Mechanical Equipment. Any and all equipment ancillary to the use or function of a building and/or structure, including, but not limited to, heating or cooling equipment, pool pumps and filters, electrical equipment, transformers, exhaust stacks, and roof vents.

Menu Board. A permanently mounted sign which lists the products or services available at a drive-in or drive-thru facility and not legible from the right-of-way.

Mid-range Expected Service Area. The growth area capable of accommodating the estimated increase in development in the city in the next five years.

Mineral Owner. Any person having title or right of ownership in subsurface oil and gas or leasehold interest therein.

Mobile Home. A detached, single-family housing unit that does not meet the definition of single-family dwelling or residence set forth in these definitions and which has all of the following characteristics:

(1) Designed for a long-term occupancy and containing sleeping accommodations, a flush toilet, a tub or shower bath and kitchen facilities and has plumbing and electrical connections provided for attachment to outside systems;

(2) Designed to be transported after fabrication on its own wheels, on a flatbed or other trailers or on detachable wheels;

(3) Arrives at the site where it is to be occupied as a complete unit and is ready for occupancy except for minor and incidental unpacking and assembly operations, location on foundation supports or jacks, underpinned, connections to utilities and the like;

(4) Exceeding 8 feet in width and 32 feet in length, excluding towing gear and bumpers; and

(5) Is without motive power.

Mobile Home Accessory Building or Structure. A building or structure that is an addition to or supplements the facilities provided in a mobile home. It is not a self-contained, separate, habitable building or structure. Examples are awnings, cabanas, garages, storage structures, carports, fences, windbreaks, or porches and patios that are open on at least three sides.

Mobile Home Park or Community. A site or tract of land held under one ownership, which is suited for the placement of mobile homes.

Mobile Home Park or Community, Existing, A mobile home park or community for which the construction of facilities for servicing the lots on which the mobile homes are to be affixed (including, at a minimum, the installation of utilities, the construction of streets and either final site grading or the pouring of concrete pads) are completed before the effective date of the ordinance codified in this Development Code.

Mobile Home Park or Community, Expansion to. The preparation of additional sites by the construction of facilities for servicing the lots on which the mobile homes are to be affixed (including the installation of utilities, the construction of streets and either final site grading or the pouring of concrete pads).

Mobile or Micro Home Site. A plot of ground within a mobile home community, or other small format housing project, designed for the accommodation of one mobile home or similar small-format dwelling unit and its accessory structures.

Model Home. An unoccupied dwelling unit built on a site in a development for display and/or sales purposes and which may include an office solely for the development in which it is located, and which typifies the units that will be constructed in the development.

Monument Sign. A freestanding sign supported primarily by an internal structural framework or other solid structure features where the base of the sign is in contact with the ground.

Mulch. A natural planting material such as pine straw, coconut fiber, ground pine post pealing, or tree bark used to control weed growth, reduce soil erosion and water loss.

Multiple Use. A site, tract of land or development that contains more than one type of land use, including, but not limited to, residential, office, retail, or industrial uses.

Native Grass. A native Colorado grass.

Natural Area. Aquatic or terrestrial habitats or areas which exist in their natural condition and which have not been significantly altered by human activity.

Natural Area Corridor. An aquatic or terrestrial corridor that connects one or more natural areas or habitats together.

Natural Feature. Features which give an area its general appearance and ecological character and which attract or support the wildlife species that use or inhabit the area.

Neighborhood. The land area which is in the vicinity of the lot, tract, outlot, or parcel of land in question and which will be affected to a greater extent than other land areas in the city by uses which exist on the lot or are proposed for it. A neighborhood also includes lots which are adjacent to one another and have a community of shared interest.

Neon. A sign illuminated by a light source consisting of a neon or gas tube that is bent to form letters, symbols or other shapes.

New Construction. Structures for which the start of construction commenced on or after the effective date of the ordinance codified in this article.

Nits. A unit of measurement of luminance, or the intensity of visible light, where one nit is equal to one candela per square meter.

Nonconforming. Any building, structure, site, or use that does not conform to the regulations of this Development Code, but which was lawfully constructed, established and/or occupied under the regulations in force at the time of construction or initial operation.

Nonconforming Mobile Home Communities. Mobile home communities lawfully established and properly licensed by the city under the 1976 Code, or which were developed and used prior to and as of September 5, 1972, as a place where mobile homes were located for residential occupancy and, as of that date, the area must have been in compliance with any and all applicable city or county ordinances and regulations related to mobile home use of land.

Non-deciduous. Shrubs or trees, also called evergreens that keep their foliage year-round.

Official Map. The map establishing the zoning classifications of all land in the city and showing all amendments to zoning classifications as they may be adopted.

Off-premises Sign. A sign or device that advertises a business establishment, good, facility, service, or product which is not sold or conducted on the premises on which the sign or device is located and which may be designed to change copy on a periodic basis.

Off-street Parking Areas (see *Parking*).

Oil. Crude petroleum oil and any other hydrocarbons, regardless of gravities, which are produced at the well in liquid form by ordinary production methods, and which are not the result of condensation of gas before or after it leaves the reservoir.

Opacity. The degree or extent that light is obscured.

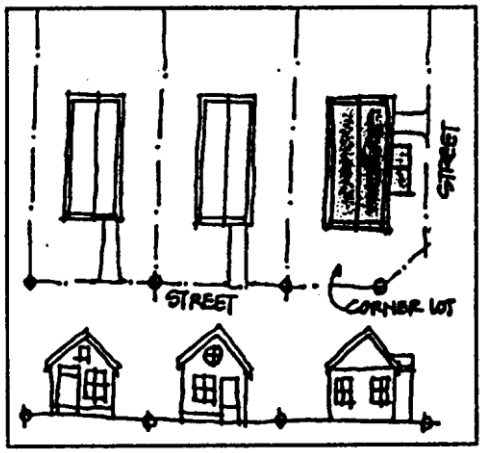
Open Space, Common. A common area permanently set aside for the common use and enjoyment of residents or occupants of a development or members of a homeowners' association, which open area may be landscaped and/or left with natural vegetation cover and which may include swimming pools and other recreational leisure facilities; areas of scenic or natural beauty and habitat areas; hiking, riding, or off-street bicycle trails; and landscape areas adjacent to roads which are in excess of minimum required rights-of-way.

Open Space, Private or On-lot. An outdoor area not intended for habitation, directly adjoining a dwelling unit or building, which is intended for the private enjoyment of the residents or occupants of the adjacent dwelling unit or building and which is defined in such a manner that its boundaries are evident. Private or on-lot open space may include lawn area, decks, balconies, and/or patios.

Open Space, Required. That portion or percentage defined by the zoning standards of a lot required to be open and unobstructed. The area must not be covered by any structure or impervious surface, such as sidewalks or driveways, with the exception of required amenities, identity features, or useable open space required pursuant to this code.

Open Space, Usable. That portion of a lot or site available to all occupants of the building or site for recreational and other leisure activities that are customarily carried on outdoors.

Oriented. To locate or place a building or structure in a particular direction on a lot or site which shall generally be parallel to the adjacent street.



Buildings Oriented to the Street

Ornamental Tree. A deciduous tree planted primarily for its ornamental value or for screening and which will typically be smaller than a shade tree approximately 15 to 25 feet in height.

Outdoor Display. The display of products for sale outside a building or structure in areas to which customers have access..

Outdoor Storage. The keeping, outside a building, of any goods, material, merchandise, or vehicles in the same place for more than 24 hours. Outdoor storage shall not include the storing of junk or the parking of inoperable motor vehicles. Storage of commercial recreational vehicles/equipment, boat, and personal vehicles are excluded from this definition.

Outlot. A tract of land platted in a subdivision for a specific purpose, which shall be shown on the face of the plat. Specific purposes may include, but are not limited to, drainage areas, stormwater detention or retention areas, parks, open space, or land areas reserved for other public facilities.

Overlay District. A zoning district classification which encompasses a defined geographic area and imposes additional requirements above that required by the underlying zoning. Overlay districts may be combining, where they join property included in two or more adjoining districts based on common attributes or policies; or overlay districts may be separating, where they distinguish property in a single district based on a specific attribute or context that requires different regulations.

Parcel. A unit or contiguous units of land in the possession of, or recorded as the property of one person, partnership, joint venture, association or corporation, or other legal entity.

Park. Any dedicated and accepted public or private land available for recreational or scenic purposes.

Parking. The parking or leaving of an operable, licensed vehicle, current in its registration, for a temporary period.

Parking Areas or Lots. Areas designed, used, required, or intended to be used for the parking of motor vehicles, including driveways or access ways in and to such areas but excluding public streets and rights-of-way.

Parking Bay. A group of parking stalls or vehicle parking spaces to accommodate 15 or more vehicles.

*Parking Block***.** A group of parking bays surrounded by landscape edges, internal access streets, public streets or buildings and sidewalks, typically used to break larger parking areas into smaller distinct components. Parking blocks are used to minimize the visual impact of parking, improve organization of the development and circulation within the site, and/or preserve opportunities for the site to accept infill or redevelopment in a more logical pattern without disruption of streets and utilities.

Parking, Shared. The development and use of parking areas on two or more separate properties for joint use by those properties.

Parking Slab. A paved parking space located off-street and designed to accommodate standard-sized motor vehicles as provided in the off-street parking and loading requirements chapter of this Development Code.

Parking Space. A space or stall within a parking area established in conformance with this Development Code.

Parking Space, Storage. A space for the storage of operable, licensed vehicles, current in registration, including recreational vehicles or equipment, for a period of 30 days or longer.

Parkway. The strip of land typically located between the sidewalk and the curb, also referred to as a *tree lawn*.

Path or *Pathway*. A designated route or path for non-motorized use such as for walking or bicycling. Paths may include both sidewalks and trails.

Pennants. Any long, narrow, usually triangular flag typically made of lightweight plastic, fabric, or other material, and not containing a message, image or representative symbol, usually found in a series on a line and designed to move in the wind.

Perennials. Non-woody plants, which may die back to the ground each year but continue to grow on an annual basis. Perennials shall also include cold weather bulbs and tubers and ornamental grasses that grow each year and shall count toward ground cover requirements.

Perimeter Treatment Plan. A plan intended to provide visual and noise protection for the outer edges of developments, which border arterial streets, major collector streets, or other sensitive borders. Perimeter treatment also provides an attractive and varied streetscape for people traveling along thoroughfares.

Permanent Sign. A sign attached to a building, structure or the ground in a manner that precludes ready removal or relocation of the sign.

Permeable. A material that allows liquids or gases to pass through it.

Permitted Sign. A sign having a legal permit issued in accordance with the provisions of this title.

Permitted Use. A use allowed in a zoning district and subject to the restrictions and review procedures which apply to that district.

Person. Any person, firm, association, organization, partnership, business, trust, corporation, company, contractor, supplier, installer, user, or owner or any representative, officer or employee thereof.

Pervious. A surface that allows water to pass through; a surface that presents an opportunity for precipitation to infiltrate into the ground.

Planned Unit Development (PUD). A development planned, designed, and constructed with specific standards as an integral unit and which typically consists of a combination of uses district, and provides for an equivalent level of standards, and broader community benefits in exchange for flexibility in the standards.

Planting Median. An area in the approximate center of a city street, road, or state highway that is used to separate the directional flow of traffic or the center of two parking bays that provide vegetation and pedestrian accessibility to the principal building or structure by way of a paved sidewalk.

Plat. A subdivision map or plan of property.

Plat, Final. A completed map of a subdivision setting forth fully and accurately all legal and engineering information, survey certification and any accompanying materials as required by this title.

Plat, Preliminary. A proposed subdivision map and any accompanying materials as required by this title, which provide sufficiently detailed information so that preliminary agreement as to the form and content of the plat, coordinating the planning, design, and engineering standards of this title, may be reached between the developer and the city.

Pole Sign. A sign that is affixed, attached, or mounted on a freestanding pole or structure that is not itself an integral part of or attached to a building or structure.

Pollinator Gardens. Gardens designed for the purpose of providing habitat for or attracting bees, butterflies, moths, hummingbirds, or other beneficial creatures that transfer pollen from flower to flower, or in some cases, within flowers.

Portable Sign. A sign that is not permanently affixed to a building, structure or the ground and that is easily moved, such as a sandwich board sign.

Practicable. Capable of being done within existing constraints including environmental, economic, technological, or other pertinent considerations.

Premises. The land, site or lot at which, or from which, a principal land use and activity is conducted.

Primary Entrance. The entrance to a building or structure which is intended to be the main pedestrian or public entrance and which shall typically be located on the front of the building or structure, and therefore includes enhancements and human-scale details to show the priority and importance of the space to the public.

Principal Building or Structure (see *Building*).

Prohibited Activities Sign. Signs located on a property posting said property for warning or prohibition, such as "no hunting," "no swimming," or "no parking."

Projecting Wall Sign. Any sign attached to a building and that extends more than 20 inches from the surface to which it is attached, but no more than four feet from the wall of the building. Signs projecting more than four feet from the building shall be considered freestanding signs.

Promotional Association. An association that is incorporated within the state that organizes and promotes entertainment activities within a common consumption area and is organized or authorized by two or more people who own or lease property within an Entertainment District.

Public. A person, structure, activity, or purpose owned or operated by a governmental agency or by a public nonprofit corporation with tax-exempt status under the federal Internal Revenue Code.

Public Hearing. A hearing held to allow interested persons to present their views before the zoning board of appeals, planning commission or city council. A public hearing is different from an open meeting which does not allow participation by the public.

Public Improvement. Any improvement required by title for which the city or a quasi-public agency agrees to assume responsibility for maintenance and operation, or which may affect an improvement for which the city or a quasi-public agency is already responsible. Such facilities include, but are not limited to, streets, parks, trails, drainage facilities, water and sewer facilities, gas, electricity, telephone, cable television, and other utility facilities.

Public Sign. Signs required or specifically authorized for a public purpose by any law, statute, or ordinance, including public directional signs on the right-of-way; signs which identify the city by name; signs that direct travelers to public buildings, parks or attractions; interpretative signs; way-finding signs, municipal uniform traffic control devices; and the like.

Rain Garden. A soil absorption or filter system designed to be depression storage or a planted hole that allows water filtration and absorption of rainwater runoff from impervious urban areas, such as roofs, driveways, walkways, parking lots, and turf-grass or sod areas. It is a type of bioretention facility designed to provide stormwater infrastructure improvements with vegetation. Typically shallow vegetative depressions with gentle slide slopes designed as individual stormwater receiving areas or linked to conveyance systems. Soils may or may not be amended in these facilities.

Recreational Equipment. Equipment intended for outdoor recreational use, including, but not limited to, snowmobiles, jet skis, all-terrain vehicles (ATVs), canoes and boats, and including the trailers for transporting such equipment.

Recreational Vehicle. A vehicle which is designed, intended and used for the purposes of temporary living accommodation for recreation, camping and travel use, including, but not limited to, travel trailers, truck campers, camping trailers and self-propelled motor homes, horse trailers and bus campers. For the purposes of this definition, neither a pop-up trailer nor a truck topper accessory (also known as a camper shell) which is not higher than eight inches above the truck cab when installed shall be considered a recreational vehicle. A horse trailer used primarily for transport of horses and/or livestock to or from the site it is stored upon shall not be considered a recreational vehicle under this definition.

Recyclable Material. Reusable material, including, but not limited to, metals, glass, plastic, and paper, which are intended for reuse or reconstitution for the purpose of using the altered form. The term "recyclable material" shall not include refuse or hazardous materials or the processing of recyclable materials.

Redevelopment District. All land located within the boundaries of the urban renewal area of the city, as it may be amended from time to time by the city council.

Residential Complex, Subdivision or Multi-family Entry Sign. An on-site sign that identifies a specific residential complex or subdivision.

Right-of-way. A right granted by a property owner and which is intended to be occupied by a street, sidewalk, railroad, utilities, and other similar uses.

Right-of-way Landscaping. Landscaping located within the public or private rights-of-way adjacent to a privately owned lot, outlot, or tract, including parkways.

Riparian Zone. An area where the presence of a surface and/or high subsurface water level permits the existence of increased vegetative diversity and abundance as contrasted to surrounding areas.

Roof Sign. A sign that is mounted on the roof of a building or structure such as a portico which is wholly dependent upon a building for support and which projects above the parapet of a building with a flat roof, or above the peak of the roof on that portion of the roof on which the sign is placed.

Satellite & Communication Equipment. A reflective surface configured in the shape of a shallow dish, cone, horn, or cornucopia which shall be used to transmit and/or receive radio or electromagnetic waves between terrestrially and/or orbitally based uses, including, but not limited to, satellite earth stations, television reception only satellite dish antennas, and satellite microwave antennas.

Screening. A method of reducing the impact of visual and/or noise intrusions through the use of plant materials, earthen berms, solid fences, and/or walls, or any combination thereof, intended to block that which is unsightly or offensive with a more harmonious element.

Searchlight, Strobe Light or Beacon. A stationary or revolving light that flashes or projects illumination, single color or multicolored, in any manner that is intended to attract or divert attention; excluding any device required or necessary under the safety regulations described by the Federal Aviation Administration or similar agencies.

Seasonal Use. A use intended for a period of limited duration, including, but not limited to, the sale of seasonal goods and products such as pumpkins, Christmas trees, produce and living plants.

Setback. The minimum distance a building, structure or use may be erected from a street, alley, or property line. Setbacks are also called required yards.

Setback, Front. The area extending across the full width of the lot, between the front lot line and the nearest line or point of the area allowed for construction or establishment of the building, structure, or use. Where expressed as a range, the front setback shall be interpreted as a “build to range,” within which distance the front building line of the principal building shall be established.

Setback, Interior Side. The area extending from the front yard to the rear yard, between the side lot line adjacent to another lot and the nearest line or point of the area allowed for construction or establishment of the building, structure, or use.

Setback, Oil and Gas (see Section 24-1102 of this title).

Setback, Rear. The area extending across the full width of the lot between the rear lot line and the nearest line or point of the area allowed for construction or establishment of the building, structure, or use.

Setback, Side. The area extending from the front yard to the rear yard, between the side lot line and the nearest line or point of the area allowed for construction or establishment of the building, structure or use.

Setback, Street Side. The area extending from the front yard to the rear yard, which separates the lot from an adjacent street.

Shade Tree. A large woody plant, usually deciduous, that normally grows with one main trunk and has a mature height at least 30 feet, a canopy height above 12 feet, and screens and filters the sun.

Shrub. A woody plant which consists of a number of small stems from the ground or small branches near the ground and which may be deciduous or evergreen.

Sidewalk. A paved, surfaced or leveled area, paralleling and usually separated from the street, used as a pedestrian path.

Sign. Any device, surface, object, structure, building architecture or part thereof using graphics, symbols or written copy for the purpose of advertising, identifying or announcing or drawing attention to any

establishment, product, goods, facilities, services or idea, whether of a commercial or noncommercial nature.

Sign Allowance. The amount of signage that is allowable under the provisions of this article.

Sign Alteration. Any change of copy (excluding changeable copy signs), sign face, color, size, shape, illumination, position, location, construction, or supporting structure of any sign.

Sign Area. The entire face of a sign and any backing, frame, trim or molding and which may include the supportive structure.

Sign Backing. The surface, pattern or color of which any sign is displayed upon, against or through and that forms an integral part of such display and differentiates the total display from the background against which it is placed.

Sign, Exposed Incandescent or High Intensity Discharge Lighting. Any sign or portion of a sign that utilizes an exposed incandescent or high intensity lamp, with the exception of neon, in such a fashion as to project light directly onto adjoining property or right-of-way.

Sign Face. The area of a sign on which the copy is placed, or, for individual cutout letters, painted letters, channel letters or symbols, the perimeter of the individual elements shall be considered the area of the sign.

Sign Frame. A sign cabinet or that portion of the sign that holds the sign face in place.

Sign Height. The vertical distance measured from the grade, as defined herein, to the highest point of the sign or sign structure.

Sign, Interior to a Building. Signs inside buildings that are not legible from the public right-of-way or other publicly accessible exterior areas of the building. .

Sign, Interior to Development. Any sign that is located so that it is not legible from any adjoining property or the public right-of-way and not oriented in such a way as to attract the attention of those traveling along the right-of-way.

Sign Permit. A permit issued by a building official and which is required for any sign specified by this code.

Sign Setback. The minimum distance required from the apparent centerline of the right-of-way, to any portion of a sign or sign structure.

Sign Structure. The supports, uprights, bracing or framework of any structure for the purposes of displaying a sign.

Sign, Wall. A sign attached parallel to and extending less than 20 inches from the wall of a building. The definition of the term "wall sign" includes painted, individual letter, cabinet signs and those signs located on the roof of a building which are not roof signs as defined herein.

Sign, Window. Any type of sign that is painted or attached to or within 12 inches of any exterior window.

Site Plan. A set of drawings that the property owner, builder, or contractor uses to make improvements to a property through graphic representation, whether computer-generated or hand-drawn, of the arrangement of buildings, parking, drives, landscaping, and any other structure that is part of a development project.

Sky Dancers. Freestanding tubes which often simulate the shape of a person into which air is forced to inflate and animate and which do not characterize a commercial message or contain a message.

Slope. The ratio between elevation change to horizontal distance, expressed as a percentage.

Soil Amendments. Elements added to the soil, such as compost, natural fertilizer, manure, or chemical fertilizer, to improve its capacity to support plant life.

Solid Fence. A fence that is opaque and provided the fence is composed of solid wood, composite, vinyl, or masonry.

Species of Special Concern. Species of wildlife and plants which the state division of wildlife has identified and listed as state species of special concern.

Stacking Space. An area for motor vehicles to line up in while waiting to go through a drive-thru facility, a designated passenger drop-off/pick-up area or a parking lot or area.

Stormwater Management Plan. A plan for the management of stormwater drainage and control prepared in conformance with the regulations for stormwater management, adopted by the state department of public health and environment; and further, including a plan for erosion and sediment control pursuant to the requirements of chapter 12 of title 3 of this Code, including its references.

Story. That portion of a building included between the surface of any floor and the surface of the floor next above it or, if there is no floor above it, the space between the floor and the ceiling above it.

Street. A way for vehicular, pedestrian or bicycle traffic whether designated as a street, highway, thoroughfare, parkway, throughway, road, avenue, boulevard, lane, place or however otherwise designated.

Street, Arterial. Streets that permit relatively unimpeded traffic movement throughout the city and connecting to outside communities.

Street, Arterial Major. Arterial streets which generally carry traffic volumes greater than 20,000 vehicles per day when the property which the arterial street serves is fully developed and which permit rapid and relatively unimpeded traffic movement throughout the city, connecting major land use elements as well as connecting to outside communities.

Street, Arterial Minor. Arterial streets which generally carry traffic volumes greater than 10,000 vehicles per day when the property which the arterial street serves is fully developed and which permit relatively unimpeded traffic movement and are intended for use on routes where four moving lanes and one turn lane are required but where a major arterial cross-section is not warranted.

Street, Collector. Streets that collect and distribute traffic between arterial and local streets and serve as main connectors within the city, linking one neighborhood with another and which carry traffic with an origin or destination within the community.

Street, Collector Major. Collector streets which generally carry traffic volumes greater than 7,000 vehicles per day when the property which the collector serves is fully developed and which permit relatively unimpeded traffic movement and are intended for use on those routes where four moving lanes are required but where a larger classified street is not warranted.

Street, Collector Minor. Collector streets which generally carry traffic volumes up to 7,000 vehicles per day and collect and distribute traffic between arterial and local streets and which serve as main connectors within communities, linking one neighborhood with another.

Street, Design Type. A reference to the design attributes of a specific segment of the street, regardless of the functional class, and including lane widths, number of lanes, parking, streetscape, and sidewalks. Street design types allow the design of segments of streets to transition and relate better to the context and anticipated abutting land uses, without disrupting the overall role of the street in the functional classification system.

Street, Functional Classification. A system of categorizing streets based on their role in the overall street network, considering traffic volumes, traffic speeds, and continuity of the street.

Street, Local. Streets that provide direct access to adjacent property and which carry traffic with an origin or destination within the immediate neighborhood.

Street, Local Low Volume. Local streets which carry traffic volumes of up to 500 vehicles per day and which provide direct access to adjacent property.

Street, Private. A private roadway used to provide vehicular and emergency access.

Street Tree. A tree planted in close proximity to a street in order to provide shade over the street and to soften the street environment.

Streetscape. The scene that may be observed along a street, including both natural and non-natural components, including vegetation, buildings, paving, plantings, lighting fixtures and miscellaneous structures.

Structure. Anything constructed or erected on or in the ground, the use of which requires a more or less permanent location on or in the ground, and, including, but not limited to, walls, retaining walls, fences, parking lots, parking slabs and oil and gas production facilities.

Subdivision. The division of a lot, tract or parcel of land into two or more lots, tracts or parcels, or other division of land in compliance with the requirements of this title.

Symbol. A graphic device which stands for a concept or object.

Temporary Sign. Any sign, not intended for permanent installation such as, but not limited to, a banner, balloon, pennant, searchlight or beacon. Generally, these signs are intended to be used for a limited period of time or for a purpose announcing a special event or presenting other miscellaneous or incidental information or instructions.

Temporary Structure. A structure without any foundation or footings and which is intended to be removed at some point in the future.

Temporary Use. A use which shall generally be permitted to exist and be operated for no longer than 90 days in 12 consecutive months and which may occur as an accessory or principal use.

Time or Temperature Sign. A sign or portion thereof on which the only copy that is capable of being changed is an electronic or mechanical indication of time and/or temperature.

Tract. A parcel or parcels of land designated on a plat and intended to be further subdivided before development at some point in the future, but which may be initially created under single ownership through a subdivision process.

Travel Trailer or *Recreational Vehicle*. A portable structure, mounted on wheels and designed to be towed by a motor vehicle, or propelled by its own motive power, that may contain cooking or sleeping facilities and is intended to provide temporary living quarters for recreational camping or travel. A travel trailer also does not comply with either the National Manufactured Housing Construction and Safety Standards Act of 1974 or the uniform building code standards. Travel trailers are not permitted in residential zones as living quarters except as guest quarters for no longer than seven consecutive days.

Tree. A large woody plant with one or several self-supporting stems or trunks and numerous branches and may be deciduous or evergreen.

Turf-grass. A blend or mix of grasses most tolerant to the Colorado climate, whether in sod or seed form when planted, intended to be regularly maintained as a lawn in urbanized areas. Artificial turf shall not be considered lawn or turf-grass.

Universal Design. The design of buildings, products, or environments, to make them accessible to all people, regardless of age, disability, or other factors. The term "universal design" was coined by the architect Ronald Mace to describe the concept of designing all products and the built environment to be aesthetic and usable to the greatest extent possible by everyone, regardless of their age, ability, or status in life.

Urban Heat Island. An urban area that is significantly warmer than its surrounding rural areas due to modifications of land surfaces such as development and other human activities. The temperature difference is usually more significant at night than during the day.

Use. The type of activity for which land or a building or structure is designated, arranged or intended and also means the activity which regularly takes place upon the land or in a building or structure on the land. Not all uses shall be considered legal or permitted uses.

Use, Principal. The primary use of a building, structure or lot.

Utility Box or Pedestal. Devices designed and intended to house equipment necessary for the delivery of utility services to commercial and/or industrial customers, including, but not limited to, electric transformers, switch boxes, telephone pedestals and boxes, cable television boxes, traffic control boxes and similar devices.

Utility Line Clearance Zones. The minimum clearance horizontal or vertical standard determined by the utility holder. Obstructions and encroachments are prohibited.

Utility Stand. Part of a mobile home space which is used for the placement of the utility connections.

Vacant means a site or area that is not put to any use other than gardening.

Vacation. The legal abandonment of a right granted by a property owner, which was intended for a particular purpose, such as for streets or utility lines.

Variance. A modification of the strict terms of this Development Code as provided in this code.

Vehicle Signs. Signs which are attached to or located on licensed vehicles, trailers or semi-trailers and contain or display signage for the primary purpose of advertisement, excluding bumper stickers on the bumper and similar-sized adhesive decals.

Vested Property Right. The right to undertake and complete a development and use of property under the terms and conditions of an approved site specific development plan.

Weed. Any plant not typically propagated by the horticultural trades and not typically installed for the purposes of landscaping; or which presents a particularly noxious allergenic or growth characteristic. Weed does not include native and naturalized plants, other than designated noxious weeds, grown in areas managed primarily for ecological services.

Wildlife. Wild, native vertebrates (including fish), mollusks and crustaceans and any species introduced or released by the division of wildlife, whether alive or dead, including any part, egg or offspring thereof.

Wind Sign (see *Pennants, Ground kites* and *Sky dancers*).

Work Vehicle. A vehicle outfitted with equipment such as, but not limited to, storage racks, hoists, cranes, vises, heavy equipment or other business and construction equipment, whether attached or removable, or which may have attached trailers carrying such work equipment. A horse trailer used primarily for transport of horses and/or livestock shall not be considered a work vehicle under this definition.

Xeric Landscaping or *Xeriscape.* A landscape design strategy coined by Denver Water in 1981 to help make water-efficient landscaping an easily recognized concept. Xeriscape is a combination of the word "landscape" and the Greek word "xeros," which means dry. For the purposes this code, it shall mean the use of low-water or very low-water plants in place of plants that typically require more water to survive. Xeric landscaping does not mean the same as hardscaping or the use of rocks or rock mulch.

Yard. The area of a lot between the property line and the foundation of a building, structure or use. The term "required yard" means that area also described as a required setback area where construction of buildings, structures and uses is limited in placement.

Yard, Front. The portion of a lot between the front façade of a primary structure and the right-of-way. A yard may contain more land area than a setback area.

Yard, Interior Side. An open-space area between the interior side property line and the building setback line, extending between the front building setback line and the rear building setback line.

Yard, Rear. The space or area of a lot between the rear property line and the principal building, extending the lot's full width, and measured perpendicular to the building at the closest point to the rear property line.

Yard, Street-side. The area extending between the front yard and the rear yard or rear street yard and situated between the side street property line and the face of the principal building which is parallel to, or most nearly parallel to, the side street property line.

24-1302 Architecture & Design Terms

This glossary of architecture and design terms explains concepts, strategies, and techniques that are used to affect building and site design.

a. **Architectural Style.**

When used generally, architectural style refers to a distinctive manner of expression, fashion or composition of building elements at a specific time.

When used specifically, architectural style refers to a prevalent or historical style that is documented with common or typical patterns in assembling building elements and form, and where variations within the style follow common rules of application for materials, massing or composition of the details. (i.e. Art Deco, Colonial Revival, Craftsman, Mid-Century Modern, Mission, Spanish Colonial Revival, Tudor Revival, Victorian, etc. See *Colorado's Historic Architecture & Engineering Guide*, www.historycolorado.org/colorados-historic-architecture-engineering-guide)

b. **Building Elements.** Buildings are made up of vertical elements, horizontal elements, details, and ornamentation that break up the building elevations into distinct components and establish the form and scale of the building. Building elements include:

1. *Awning*. A sloped or rounded framed projection attached to a wall and extended over a window or door to provide protection from the elements.
2. *Bay (window)*. A bump out in the facade typically associated with an element of the interior floor plan but located to provide balance and relief to the massing on the exterior facade. A bay is usually associated with a window.
3. *Belt Course*. A continuous row or layer of stones, brick or other primary building material set in a wall and in line with changes in stories, changes in materials, or window sills. Belt courses make a visually prominent horizontal line to break up a wall plane by using a distinct material and//or implementing a pronounced and distinct pattern of the material.
4. *Bracket.* A projecting support placed under an eave or other projection with design qualities and details that add emphasis to the roof structure or massing element.
5. *Canopy.* A flat roofed projection attached to a wall and extended over a window, door, or walkway, or a freestanding structure over walkway or service area that gives protection from the elements.
6. *Clerestory Window*. A window high on a wall section above eye level and used to permit light or air into areas that otherwise do not have windows due to functional constraints of the building.
7. *Column*. A supporting pillar, especially one consisting of design qualities and details that add emphasis and ornamentation to a portion of the facade, or any roof structure or area it supports.
8. *Cornice.* An ornamental topping projecting from the wall with design qualities and details that crowns a structure along the top near the roof, with an emphasis that is compatible with but more elaborate than other similar details and ornamentation on the building.

9. *Eaves.* An overhang of the roof structure, where larger eaves can increase the prominence of the roof as a "cap" to the building and protect portions of the facade (particularly windows) from the elements.
10. *Entry Feature*. A structural component of the building or building footprint used to emphasize and add interest to the entry into the building, provide active social space protected from elements, contribute human scale to the building elevation, and create transitions from public to private space.
11. *Facia.* The exposed vertical edge of the roof often with design qualities and details that add emphasis and ornamentation to the roof structure.
12. *Foundation*. The base upon which the entire structure sits, designed with stronger, heavier materials, and often includes details and ornamentation to emphasize a buildings connection to the ground, a sense of permanence, and transition to the main wall plane for vertical articulation.
13. *Gable.* The triangular and vertical portion of a wall plane between intersecting roof pitches.
14. *Lintel.* A horizontal beam, typically over a door, window or storefront to support the structure above it and add accent to the door, window, or storefront.
15. *Parapet*. A vertical extension of the wall plane above the roof, typically used to hide a flat or low-sloped roof and the rooftop equipment, or function as a firewall for attached structures, and usually including ornamentation to provide a visually prominent "cap" to the building.
16. *Pediment*. A gable or ornamental tablet or panel, typically triangular or arched, placed above a point of emphasis on a facade and often supported by columns or pilasters.
17. *Pilaster*. A projecting vertical element on a wall plane used to give the appearance of a supporting column and used to articulate the extent of a wall plane or other component of a facade.
18. *Sidelight*. A window with a vertical orientation along an opening (door or window) that is narrower than the opening but provides emphasis to the importance of the opening with expanded transparency, additional trim and ornamentation, or other architectural details.
19. *Transom.* A window above an opening (door or window) built on a horizontal crossbar that may provide light and/or swing open to add ventilation.

c. **Building Form.** Building form refers to the outward three dimensional envelope of a building or space affected by the mass, shape, composition, and articulation of building elements.

1. *Mass.* Mass is the volume (height x width x depth or height x building footprint) defined by a structure relative to its surroundings.
2. *Shape.* Shape affects the massing and refers to the simplicity or complexity of the outer dimensions of surface planes (wall planes or roof planes), and their orientation (horizontal / vertical; symmetrical / asymmetrical).
3. *Composition.* Composition is how the different building elements or materials are arranged to either distinguish or coordinate a particular shape or mass.
4. *Articulation.* Articulation is using architectural elements to clearly call out a different portion of the composition, shape, or mass and break the building form into smaller, identifiable pieces.
   (a) *Horizontal Articulation*. Breaking the mass down through different levels of height on the building, particularly for taller buildings, or by a step back or other voids in the massing.
   (b) *Vertical Articulation*. Breaking the mass down through different bays or structural components along the length of the building elevation, particularly for longer, larger footprint buildings.
5. *Altering Form.* Techniques to alter the form of a building and affect the scale include:
   (a) Main mass and wing or secondary masses;

(b) Stepping back in the wall plane, usually larger differences (i.e. 4 feet +) at upper story(ies);
(c) Cantilever or overhangs, usually a smaller distance (i.e. 1 to 4 feet) over a lower story;
(d) Off-sets or breaks in a wall plane in relation to interior floor plan or outside space, not to the level of creating a wing or secondary mass;
(e) Dormers, including a window and sub-roof within roof structure;
(f) Projections of an element of the facade composition such as a bay window, entry feature, or eaves; and
(g) Articulation and composition of the facade in relation to, or in addition to any of the above techniques.

d. **Scale.**

Scale refers to the perceived or relative size of a form in relation to something else – usually a person, a social space (courtyard, lot, streetscape, etc.), or another building. For example, "human scale" refers to how spaces or objects relate to and are experienced or perceived by people at a close range and a slow pace. Scale can be affected by the mass, shape, composition, or articulation of the form to make an otherwise larger form seem smaller or more relatable based on how the components are perceived.

e. **Compatibility.** Compatibility refers to the similarity of buildings and sites to adjacent properties or to prevalent patterns and themes in an area. In general, the elements of compatibility will include combinations of the following:

1. Similar proportions of building masses, particularly nearest the property lines and other adjacent buildings;
2. Similar orientation of the building including the relationship to streetscapes, the shaping of open spaces, and the locations and arrangements of the building footprint;
3. Similar window and door patterns, including location, size, and proportions;
4. Similar roof lines (planes, pitches, profiles and details);
5. Similar building materials, particularly primary building materials, or where materials differ they share common textures or color palates;
6. A common architecture style, including the facade composition and materials; however, many styles can allow differences in design within the style.

Note: Compatibility does not necessarily mean the same, but rather a sensitivity to the context, adjacencies, and character of the area. While not all of the above elements are necessary for compatibility, the greater the number that are similar, the greater the compatibility will be; significant departures from any one element should be compensated with either greater similarity of other elements or by similarity of more elements. Where things are not compatible, transitions should occur through space and landscape buffer designs.

City of Greeley Colorado

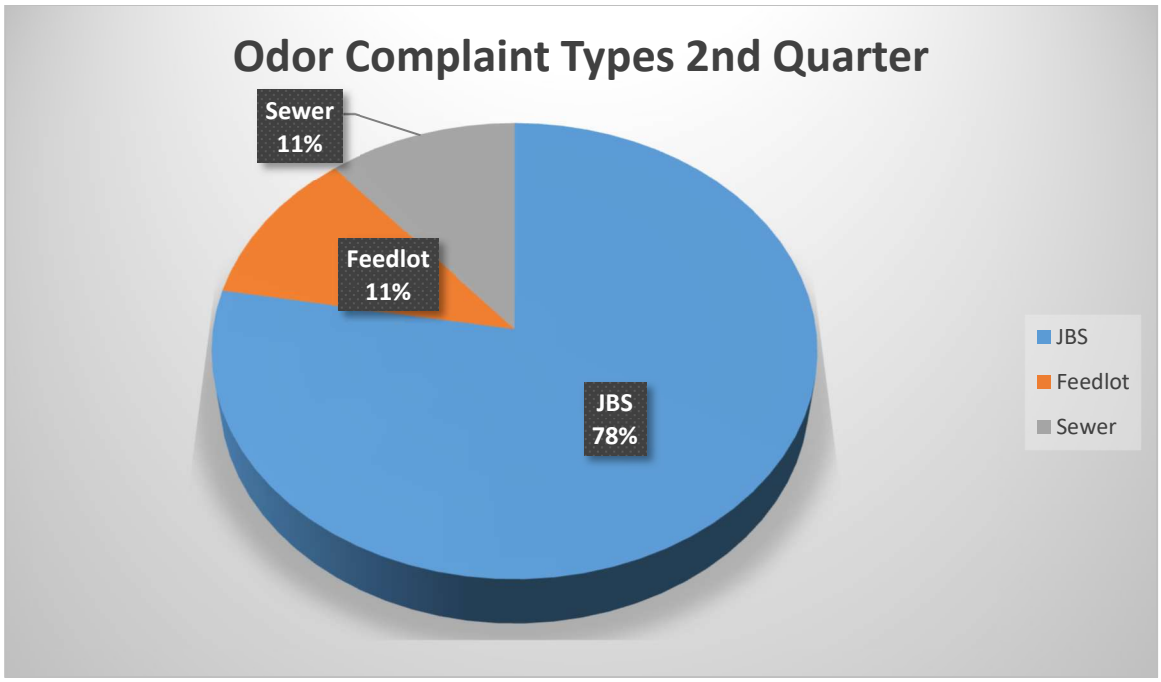
DATE: July 20, 2021
TO: Air Quality & Natural Resources Commission
FROM: Code Compliance
RE: 2nd Quarter Odor Report 2021

Attached is the Odor report for the 2nd Quarter of 2021.

City of Greeley Odor Report

2nd Quarter 2021

In the second quarter of 2021, 9 odor complaints were received.

- None of the complaints investigated had detectable odor and no violations were found
- 7 of the 9 referenced JBS specifically
- Other complaint types:
    - 1 for feedlot
    - 1 for sewer
- 2 of the 9 calls came in during business hours and inspections were conducted. The only ones that were able to be officially investigated were after April 26th of this year due odor certifications expiring last year and no classes being held in Denver due to COVID

- 4 of the 7 calls asserting JBS odor came from the same person on 4 separate occasions
    - 2 of the final 3 JBS calls came from a separate person on the same day as the above mentioned calls and the last JBS call from a totally different day for a total of 5 different days that an odor was called in
- For the year, there have been 22 odor complaints.