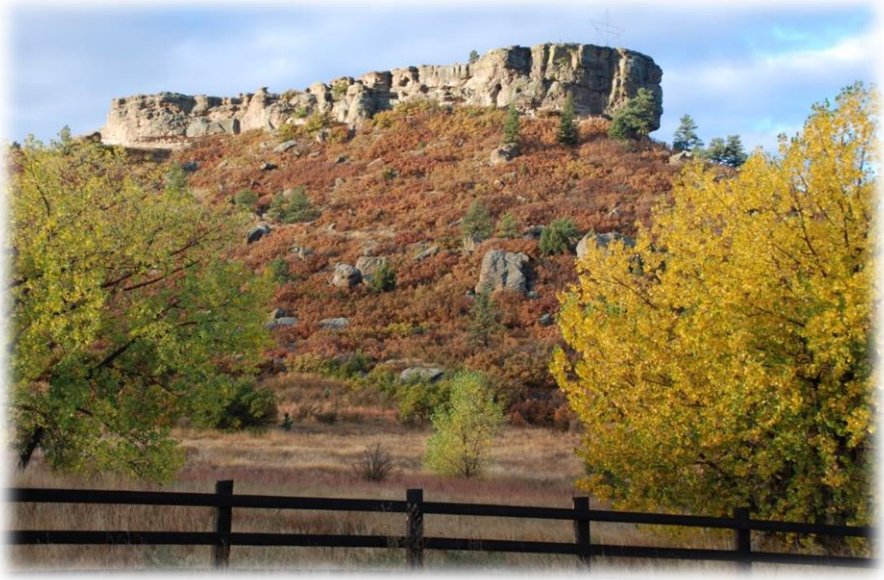
Wastewater Master Plan

2016



Engineering Division

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Acknowledgments

The development of the Castle Rock Water Wastewater Master Plan was a collaborative effort led by Castle Rock Water Engineering staff. The following staff members made significant contributions of time and input on this document:

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Definitions and Acronyms

CCTV	Closed Circuit Televising
CDPHE	Colorado Department of Public Health and Environment
CIRSA	Colorado Insurance Risk Sharing Agency
CIP	Capital Improvement Project
CMOM	Capacity, Management, Operations, and Maintenance
COS	Cost of Service
DoIT	Division of Innovation and Technology
EPA	Environmental Protection Agency
FTE	Full-time Equivalent
GASB34	Governmental Accounting Standards Board Statement 34
GIS	Geographic Information System
Gpd	Gallons per Day
Gpm	Gallons per Minute
I/I	Infiltration and Inflow
in, In	Inch
IGA	Intergovernmental Agreement
KPI	Key Performance Indicator
Lf, LF	Linear Feet
mg, MG	Million Gallons
MGD	Million Gallons per Day
MS4	Municipal Separate Storm Sewer System
N/A	Not Applicable
O&M	Operation and Maintenance
PCWRA	Plum Creek Water Reclamation Authority
PMP	Pavement Maintenance Program
PS	Pump Station
PWSD	Pinery Water and Sanitation District
PVC	Polyvinyl Chloride, a Common Pipe Material
RCNLD	Replacement Cost New Less Depreciation
SCADA	Supervisory Control and Data Acquisition
SDFs	System Development Fees
SewerCad	Sanitary Sewer System Model Software
sf, SF	Square Foot
SFE	Single Family Equivalent
SSO	Sanitary Sewer Overflows
TM	Technical Memorandum
Town	Town of Castle Rock
UP	Utility Plan
USEPA	United States Environmental Protection Agency
WW	Wastewater
WWMP	Wastewater Master Plan
WWTP	Wastewater Treatment Plant
yr, YR	Year

Executive Summary

The Town is a growing community. Currently the Town of Castle Rock wastewater collection system, which serves a population of over 62,000, has more than 8,200 sanitary sewer manholes, is over 270 miles in total length and transports on average in excess of 3.73 million gallons of wastewater each day to the Plum Creek Water Reclamation Authority (PCWRA). At an estimated build out population, the collection system could serve as many as 155,000 residents. At peak times, Wastewater flow to be conveyed to the PCWRA for treatment via interceptors could triple at future build-out conditions. The 2016 Wastewater Master Plan (WWMP) update highlights critical findings and recommendations resulting from a reassessment of wastewater program needs for the Town of Castle Rock.

This 2016 update builds on the previous master planning efforts and was completed with the following goals in mind:

- Identify collection system deficiencies and/or future facility requirements.
- Develop tools to update the plan as growth conditions change or new development occurs.
- Develop a plan for recommended projects that balances infrastructure requirements with fiscal responsibility.
- Develop cost estimates as a basis for input into the annual rates and fee analyses.

The following principles serve as the base for the Town's wastewater programs:

- **Principle 1: Protect People, Property and the Environment**
- **Principle 2: Plan for the Future**
- **Principle 3: Encourage Coordination of Infrastructure Needs**
- **Principle 4: Operate the Wastewater Enterprise Fund as a Business, Balancing Revenue and Expenses**
- **Principle 5: Provide for Effective Long-term Operation and Maintenance of Collection System Facilities**
- **Principle 6: Ensure Wastewater Planning is Consistent with, and Considered Part of, a Fully Integrated Total Water Management Approach**

Castle Rock Water employs a cost of service (COS) methodology to ensure the Wastewater program is a self-sustaining enterprise, adequately financed with rates that are based on sound engineering and economic principles. Moreover, rates should be equitable and proportionate to the costs of providing service to a given type of customer. Further, there is an expectation that growth pays for growth and

that system development fees and developer infrastructure requirements should reflect and support this development model.

Part of the 2016 Plan update was to revisit the capital plan and the cost estimates used. Annually, Castle Rock Water does a rate study and revises the cost of service model in order to recommend changes, if any, to the fee schedule. In the 2010 Wastewater Master Plan, the overall, long-term capital plan totaled just under $80 Million; for the latest update, that total is just over $80 Million. Further, the capital plan is devised to try to spread out capital costs in order to minimize any unexpected jump in rates or fees in any one year. For example, there is an almost 6 percent increase in system development fees between 2016 and 2017, but thereafter, the planned increases are around 2.7 percent. For the monthly wastewater user charges and volumetric fees, there is no planned increase from 2015 rates for the out years 2016-2021. Increases in system development fees primarily affect new development, and supports the policy that growth pays for growth. Increases in wastewater user charges reflect operations and maintenance costs and the costs of capital rehabilitation and replacement, while increases in volumetric rate fees affect those who may not use water wisely or do not practice conservation within the household.

1. Introduction

This 2016 Wastewater Master Plan (WWMP) update highlights critical findings and recommendations resulting from a reassessment of wastewater program needs for the Town of Castle Rock. In 2003, the Town prepared a Wastewater Master Plan that examined the existing wastewater system infrastructure and identified new wastewater program requirements, as well as capital improvement projects required to provide service to existing residents and to address future development through expected build out of the Town. In 2010, the Wastewater Master Plan was updated; the hydraulic modeling was updated to reflect changes in infrastructure and revisions to growth projections. That update was designed to be used as a companion document to the original 2003 WWMP. Similarly, this 2016 revision builds on the previous master planning efforts but is also a standalone document.

The 2010 wastewater master plan update was completed with the following goals in mind:

- Analyze the Town's existing wastewater collection system for existing and future growth conditions in order to identify collection system deficiencies and/or future facility requirements.
- Develop tools and a hydraulic model that staff can use to update the plan as growth conditions change or new development occurs.
- Develop a plan for phased implementation of recommended projects that balances infrastructure requirements with fiscal responsibility and requirements.
- Develop cost estimates for both capital improvement projects and operation and maintenance programs as a basis for input into the annual rates and fee analyses.

The 2010 plan built on several previous planning efforts including the 1998 Sanitary Sewer Facility Plan by HDR Engineering, the 2003 Wastewater and Reclaimed Water Master Plan by CH2M Hill, and sanitary sewer system modeling performed by URS and CH2M Hill, to provide guidance for the wastewater program into the future. The 2010 plan update considered changes to the wastewater program as a result of substantial reductions in the Town's growth rate. Similarly, due to rapid growth in the last few years that is expected to continue for several more years, for the 2016 update it was important to revisit the growth plan, the hydraulic model, the capital plan, including cost estimates, and also the impacts to rates and fees. Castle Rock Water revises the capital plan each year, reviews cost estimates, and completes a rates and fees study each year to fully plan for future financial obligations and to ensure that growth pays for growth.

The Town is a growing community, and this continued growth creates increased wastewater flows that must be accommodated. Additionally, system components are deteriorating from age and use which results in the need for infrastructure rehabilitation or replacement. In fact, many collection system components, particularly in the Downtown area, predate the 1940's. Wastewater improvements are required to replace

undersized pipes, rehabilitate aging infrastructure, provide collection for new developments, and accommodate additional treatment capacity. At an estimated build out population, the collection system could serve as many as 155,000 residents. At peak times, Wastewater flow to be conveyed to the PCWRA for treatment via interceptors could triple at future build-out conditions. Infrastructure must be sized to accommodate local and/or system wide peak conditions, which can be influenced by infiltration and inflow (I/I). Minimizing I/I throughout the collection system can potentially reduce the need for future capital investment.

Currently the Town of Castle Rock wastewater collection system, which serves a population of over 62,000, has more than 8,200 sanitary sewer manholes, is over 270 miles in total length and transports on average in excess of 3.73 million gallons of wastewater each day to the PCWRA. Over the course of the last ten years, much emphasis was placed on building infrastructure and expanding facilities to meet future demands. However, with an aging infrastructure, future priorities will most likely shift more towards rehabilitation and/or replacement of aged or undersized wastewater collection system components. Additionally, planned expansions and upgrades at the PCWRA will have to be undertaken to provide for additional treatment capacity, meet changing regulatory requirements, and ensure best quality effluent for future renewable water supplies.

The 2016 Wastewater Master Plan update was completed with the following principles in mind:

➢ Principle 1 – Protect People, Property and the Environment

Community wastewater systems have been around for a long time, primarily developing from recognition by public health officials that many infectious diseases were caused by drinking water supplies contaminated by wastewater that was not adequately managed and treated. Similarly, as community water treatment systems developed, responsible parties came to better understand the need for protecting their source water, both for domestic and recreational uses. Along the way, the Clean Water Act created discharge standards for wastewater treatment facilities. Municipalities further recognized the benefit of keeping wastewater separate from stormwater, and created separate collections systems. Now, as it becomes clear that wastewater is and will be an important source for future drinking water supplies, collection and treatment have become even more important. In line with the principle of protecting people, property and the environment, Castle Rock Water has implemented projects and programs to ensure we are good stewards.

- ***Sewer Rehabilitation Program*** - A sanitary sewer overflow (SSO) occurs when wastewater escapes the collection system; generally either by a system failure (break/leak) or a line blockage. To minimize system failures and blockages, Castle Rock Water operations crews operate year round to clean

and video inspect sewer mains. The Engineering group addresses system deficiencies by repairing/replacing or lining deteriorated sewer mains as part of the Sewer Rehabilitation Program. Castle Rock Water tracks SSOs over the course of the year to calculate an SSO rate that is compared to national rates as a key benchmark. The goal is to minimize or eliminate overflows at a level that keeps us in the top quartile nationally each year. A significant development since the 2010 master plan is that Castle Rock Water invested in a CCTV inspection truck and software program, and an additional crew person, with the goal of increasing the percentage of the system that can be inspected yearly, with a target goal of 20-33 percent each year. Previously, about 5 percent per year was being inspected. Targeted inspection of older areas of town, and areas that are on the planning horizon for pavement rehabilitation, is a key component of the sewer rehabilitation program.

- ***Manage Infiltration/Inflow*** - Another key programmatic goal of Castle Rock Water is to keep inflow and infiltration (I/I) at levels that ensure the sewers do not become surcharged during wet weather events. Surcharged sewer mains can back up into houses, causing property damage, mental distress, and legal claims. Surcharged sewers can also overtop manholes, creating an SSO, where the wastewater then has the potential to reach and contaminate water bearing creeks and streams that are themselves usually a water source for Castle Rock and downstream entities. In this respect, managing I/I and SSOs is also source water protection. An essential component of minimizing I/I is good construction methods when new sewer systems are being constructed. Public Works inspectors ensure new mains are properly constructed and tested prior to use, and that builders are using best management practices to keep stormwater out of incomplete sewers under construction. Aging sewer mains, often more susceptible to I/I, can be relined to reduce I/I that can enter sewer mains at old or defective pipe joints, again highlighting the importance of the sewer inspection and repair programs. Extreme precipitation events can significantly increase I/I. Proper design of sewer system collection and treatment facilities allocates some reserve capacity to I/I as a safety factor, but good design ensures manholes are out of stormwater flow paths; good construction ensures pipes and manholes are water-tight and above grade. A particularly detrimental effect of I/I is that it can hydraulically overload the wastewater treatment facility, contributing to inefficient treatment, and potentially requiring costly capital expansion to handle peak loads.

- ***Capacity Modeling*** – Fundamental to good planning and system operation is maintaining a complete and calibrated hydraulic model of the collection system. The model was fully developed for the 2010 master planning effort, and has been updated to incorporate new infrastructure and increased wastewater demands. By keeping the model up to date, Castle Rock Water can proactively plan for capital replacement and upsizing projects. Predictive modeling, coupled with in the field flow monitoring, helps ensure that

adequately sized sewer mains are constructed in time to avoid capacity issues and surcharged mains and manholes. Staff utilize the hydraulic model to ensure new development is not exceeding the capacity of existing or planned downstream collection components; if such is the case, new development must then plan and construct sufficient capacity. From a fiscal standpoint, this helps ensure growth pays for growth.

- ***Planning and Coordination*** – Castle Rock Water coordinates sewer rehab projects with the Public Works Department and the Parks and Recreation Department and/or developer projects to avoid unnecessary pavement street cuts and to demonstrate fiscal responsibility.

- ***Source Water Protection*** – Castle Rock Water considers and plans for the most cost effective way to handle water treatment plant solids from discharging into the collection system, given due consideration to the PCWRA discharge permit, best available technologies at a reasonable cost, and being protective of wastewater as a renewable resource. Currently, water treatment plant solids are discharged to the sanitary sewer for treatment at the PCWRA. Due to changing discharge regulations in the future, Castle Rock Water may have to plan for residuals management at the water treatment plants instead of discharge. Other Castle Rock Water programs that contribute to Source Water Protection include the MS4 (Municipal Separate Storm Sewer System) program managed by the Stormwater Division, which includes erosion control management, an annual creek clean-up day, and an annual hazardous materials collections event. Similarly, the industrial pretreatment program and fats, oil and grease (FOG) program managed by the PCWRA help eliminate potentially harmful or detrimental discharges to the collections system that could interfere with future reclamation and reuse of the effluent.

- ***Odor Control*** - While odor issues may not have health implications for the public, they can contribute to quality-of-life issues. Also, lack of control of hydrogen sulfide (H2S, the principle component of wastewater gas emissions; very odorous and offensive) can lead to corrosion and premature deterioration of collection system infrastructure, resulting in costly repairs. Hydrogen sulfide is also a hazardous gas, lethal at certain exposure limits, particularly in confined spaces, so it is a safety hazard for operations staff. Castle Rock Water employs chemical addition at most of the Town's lift stations to reduce the odor producing potential of the wastewater, and also has several facilities dedicated to odor control using active and/or passive treatment methods.

- ***Wastewater Treatment*** – While Castle Rock Water performs the day-to-day functions of wastewater collection and conveyance, wastewater treatment is performed by two plants, Plum Creek Water Reclamation Authority (PCWRA) and the Pinery, that serve the Town. The Pinery treats flows that generate in the Cobblestone Ranch neighborhood, and would also serve the future

Canyons South development. All other wastewater flows in Town are conveyed to the PCWRA. Over a 100 years ago, wastewater treatment was promoted as a way to protect public health. Beginning in the early 1970s, treatment goals evolved to focus not just on public health, but on the aesthetics and environmental concerns in order to achieve more effective and widespread treatment in an effort to improve the quality of surface waters. In the 1980s, additional treatment focus was placed on removing compounds with the potential for long-term health effects. Increasingly, treatment is moving towards more advanced treatment to meet ever more stringent regulatory requirements that protect public health, preserve water quality and recognize that wastewater is a valuable, renewable resource.

➢ Principle 2 – Plan for the Future

Central to any master plan is that it has to be a plan for the future, and fundamental to good planning is having the right people and tools to develop, analyze and understand the model results. In 2010 Castle Rock Water purchased modeling software and trained staff to develop a wastewater hydraulic model that could be used and updated as growth conditions change. Key components of the Castle Rock Water planning process include:

- Update the hydraulic model at least annually as assets in the system change.

- Analyze the Town's existing wastewater collection system at least annually for existing and future growth conditions, in order to identify collection system deficiencies and/or future facility requirements. Adjustments to the capital plan, the master plan, and budgets should be made accordingly.

- Maintain the tools and resources necessary to identify sewer infrastructure that has reached the end of its useful life and have a plan for replacement. Tools and resources include the hydraulic model, collection system video inspection equipment, the Granite sewer database and pipe scoring system, the database of SSOs, and the Cartegraph OMS asset management program. The video inspection program is most useful in identifying pipe defects. The asset management program can be used to track SSOs and areas that might be requiring more maintenance, and eventually will be used to incorporate pipe condition scoring and costs in order to develop a predictive model for sewer pipe rehabilitation.

- Plan to fully utilize the asset management program to maximize the life of assets and minimize life-cycle costs.

- Explore expanding the service area to eliminate septic tanks and/or serve outside the Town service area where it makes sense, and with regards to

the impact to the PCWRA service area and capacity. Expansion also needs to consider the potable water demands required to support new service areas.

- Measure and maximize recovery of wastewater flows in Cherry Creek and Plum Creek in order to be proactive with respect to reclaimed waste water as a renewable resource. Wastewater flows to the PCWRA are measured at the PCWRA, and treated effluent is currently discharged into the East Plum Creek. The Town has storage capacity in Chatfield Reservoir for the Plum Creek treated effluent flows, but hopes to take full beneficial capture and reuse of those flows in the near future. Wastewater flows contributory to the Cherry Creek Basin are captured and treated by the Pinery Water and Wastewater District, but then flow to the Rueter-Hess Reservoir for storage until such time that the Town can beneficially treat and reuse the flows.

- Develop a plan for phased implementation of recommended projects. Key to accomplishing this is to revisit the hydraulic model regularly to identify capacity issues, and regular inspection and condition assessment of critical infrastructure, such as interceptors and force mains. Staff shall review sewer inspection information to identify pipe defects to be corrected under the Sewer Rehab Program. Staff shall particularly target the older areas of town where clay pipe predominates, but shall also tailor the phasing of the Sewer Rehab Program to be in advance of major road or pavement rehabilitation projects. Planning efforts shall also take into consideration the timing of projects to spread the costs and normalize impacts to rates and fees. Generally, five-year capital plans are used for budgeting purposes and the annual rates and fees analysis, but are revisited annually to include any cost estimates used for budgeting purposes.

➢ Principle 3 – Encourage Coordination of Infrastructure Needs

Castle Rock Water works closely with other departments (Parks and Recreation, Public Works) and divisions (Stormwater, Meter Services, Operations) to ensure that major and minor capital projects are not planned or executed in a vacuum. This helps ensure that all Town monies are spent wisely. Water and wastewater rehabilitation projects are scheduled in advance of major roadway maintenance or trail projects. For example, in 2014 the North Meadows Extension (now named Castle Rock Parkway) was under construction by the Public Works Department. The Town's major sewer interceptor needed to be relocated to make way for the interchange at State Highway 85. Although the interceptor would not have capacity issues for many more years, Castle Rock Water took the opportunity during relocation to upsize the affected segment from 27-inch to 36-inch diameter, and was able to take advantage of the economies gained by being part of a huge capital project. This also helped ensure that coordination of all Castle

Rock Water (gas, electric, fiber, etc.) was accomplished. Other multidisciplinary projects that Castle Rock Water is planning in cooperation with Public Works and Stormwater are the North Craig and Gould Infrastructure Improvements Project and the Gordon Drive Improvements Project. Key components to coordinated project planning include:

- Evaluate capital improvement and capital replacement projects based on minimizing life cycle costs;
- Ensure the most cost effective approach to expansion of PCWRA is undertaken and that the timing of the expansion meets the needs of the Town's growth;
- Develop projects which minimize the operational costs of facilities in accordance with identified Key Performance Indicators (KPIs), or achieve payback in less than five years;
    - Key Performance Indicators for the wastewater program include:
        - Sewer Overflow Rate (total number of sewer overflows per miles of total collections system piping)
        - Operational Cost (total O&M costs per average daily wastewater flow)
        - MGD processed per employee
- Fully utilize asset management planning to maximize the life of assets and minimize the life-cycle costs;
- Incorporate an energy management plan into wastewater operations to minimize energy costs;
- Continue to coordinate sewer rehab projects with the Public Works Pavement Maintenance Program (PMP) and other Town projects; and
- Coordinate system operations and upgrades with PCWRA to minimize operational costs of PCWRA, and ensure best water quality effluent in order to fully utilize the Town's renewable water sources.

➢ Principle 4 – Operate the Wastewater Enterprise Fund as a Business, Balancing Revenue and Expenses

The Town of Castle Rock has over a half-billion dollars' worth of water, wastewater and stormwater infrastructure to operate, maintain and plan for future rehabilitation or replacement. Overall, the Town is a fairly young municipality and new development is typically responsible for constructing the infrastructure required to support their development. Nevertheless, the Town must plan for growth, from a capacity standpoint, and replacement, from an age and condition standpoint. Annually the utility conducts a comprehensive rates and fees study for all four enterprise funds – water, wastewater, water resources, and stormwater. The purpose of the rates and fees study is to provide the Town with a thorough review of annual revenue requirements and determine cost-of-service (COS) based rates for each fund. The projection period developed for each utility financial plan is driven by the length of the Capital Improvement Program (CIP) and currently ends in 2055. Strategies for balancing revenue and expenses include:

- Develop realistic cost estimates for both capital improvement project and operation and maintenance programs as a basis for input into the rates and fee analyses. Revisit costs and timing each year as part of the budget process;
- Regularly revisit the hydraulic model to reassess system capacity;
- Develop a plan for phased implementation of recommended projects based on factors such as condition, capacity, risk, and coordination with other projects;
- Evaluate capital improvement and capital replacement projects based on minimizing life cycle costs;
- Ensure the most cost effective approach to expansion of PCWRA and that the timing of the expansion meets the needs of the Town's growth;
- Develop projects which minimize the operational costs of facilities in accordance with the KPIs or achieve payback in less than five years.

➢ Principle 5 – Provide for Effective Long-Term Operation and Maintenance of Collection System Facilities

The expected lifetime of many collection system assets is on the order of fifty years or more, provided that proper operation and maintenance has occurred. Pumps and motors have a shorter lifespan, but will quickly fail without routine operation and maintenance. Providing for adequate operations and maintenance dollars in the annual budget is not just the cost of doing business, it can be considered insurance for the future. Additionally, and perhaps more importantly, the utility must plan for and maintain adequate personnel to get work done. Effective long-term operation requires Castle Rock Water to:

- Institute a Sewer Rehab Program that addresses critical assets, uses tools to identify infrastructure at risk, and utilizes best available technologies at reasonable cost;
- Plan and coordinate projects with other Town projects to achieve the best value;
- Proactively maintain the collection system so that sanitary sewer overflows are minimized and occur at a rate that keeps us in the top quartile nationally each year;
- Maintain the collection system with the goal of minimizing I/I to levels that ensure the sewers do not become surcharged during wet weather events, leading to SSOs, and that the peak hydraulic loading to the PCWRA is not excessive; and
- Ensure appropriate staffing levels are maintained to promote levels of service and achieve KPIs.

➢ Principle 6 - Ensure Wastewater Planning is Consistent with, and Considered Part of, a Fully Integrated Total Water Management Approach

Castle Rock Water's goal is to provide a sustainable, reliable and renewable water supply, now and into the future, for all of Castle Rock's citizens and businesses, when and where they want it, and at prices that remain reasonable, viable and competitive with surrounding communities. Securing adequate water supplies for the Town's current population base and our projected future demands is critical for our residents. Water is the life-blood of any community and it is incumbent upon Castle Rock Water to meet the mission of having affordable water available when customers turn on the tap. The 2016 Water Resources Strategic Master Plan lays out how Castle Rock Water is going to meet that goal over the next 20-30 years.

Key components of the Town's water supply strategy include:

- Continue to develop a water supply portfolio that consists of 75% renewable water sources and 25% non-renewable sources by 2050. After 2050, continue development of renewable sources working towards a 100% renewable supply to complement the existing non-renewable supply.
- Implement the ideas that were delineated in the 2015 Water Efficiency Master Plan: If this plan is embraced by our customers, the Town may eventually see a per capita demand of approximately 100 gallons per person per day by 2050. This would account for an additional 18% savings in water use and would essentially act as a new source of supply.
- Fully develop and utilize the Town's current renewable water rights which include senior and junior native surface water rights, lawn irrigation return flows (LIRF), and water reuse in both the Cherry Creek basin and Plum Creek basin.
- Fully utilize our reusable water: Water that the Town pumps and uses from the Denver Basin aquifer, WISE supplies and future imported supplies can be reused to extinction. The Town is planning to permit and construct surface diversions on East Plum Creek that will give us the ability to re-capture these supplies. Usage of these supplies represents approximately 35% of our future projected water supply.
- Work in partnership with other entities to import additional supplies and to reduce the cost impact to our customers.
- Manage our reservoir storage program to optimize the placement of supplies during periods when they are not needed by our customers.
- Continue to maintain, develop and protect the Town's Denver Basin groundwater supply. This supply will help meet the demands of our customers in the short term and provide reliability and drought protection in the long term.
- Continue to maintain, develop and protect the Town's surface water supplies. Updating the Town's source water protection plan is a key component of this strategy, as is the stormwater Municipal Separate Storm Sewer System (MS4) program.

- Work within a sustainable financial plan that generates the capital funds required for the transition to a sustainable, renewable supply and maintains our existing supplies and supply infrastructure.

The potential water resources available to the Town fall within four primary categories as shown in **Table 1-1**: existing Town-owned groundwater, Town-owned local surface water, imported surface water, and reusable supplies in both the Plum Creek and Cherry Creek basins. Some of the water used by the Town that is collected and conveyed to the Plum Creek Water Reclamation Authority (PCWRA) treatment plant for treatment and discharge to East Plum Creek can, by law, be treated and reused by the Town. Similarly, a portion of the water used for lawn, park, and golf course irrigation that returns to East Plum Creek can also be reused by following the proper procedures. For more details, refer to the 2016 Water Resources Strategic Master Plan.

Table 1-1: Castle Rock's Projected Future Water Supply for Year 2055

Water Source	Minimum Raw Water Supply		Maximum Raw Water Supply	
	Volume (Acre-Feet/Year)	% of Annual Supply	Volume (Acre-Feet/Year)	% of Annual Supply
Denver Basin Groundwater	2,835	25%	3,980	21%
Local Renewable Surface Water				
Junior Local Plum Creek Alluvial Rights [1]	8,300		8,300	
Senior Plum Creek Native Water Rights	1,440	13%	1,440	7%
Cherry Creek Alluvial Rights [1]	55		55	
South Platte Water Right [2]	200		200	
Spot Water Purchases at Chatfield	Variable		Variable	
Reusable Water				
Plum Creek LIRFs	365	3%	655	3%
Cherry Creek LIRFs	200	2%	300	2%
Water Reuse Program[3]	4,090	36%	7,630	40%
Imported Surface Water[4]	2,450	22%	5,170	27%
Total	11,380	100%	19,135	100%

Notes:
1. Junior water rights that are not reliable and require augmentation during a call. Not included in total supplies available.
2. This is a junior water right at the Chatfield Reservoir. Chatfield Reservoir storage will firm up the yield during a dry year. Location is also an alternate location for capturing and accessing the Town's reuse rights and junior Plum Creek rights. Not included in the total water supplies available.
3. Includes reuse supplies in both the Plum Creek basin and Cherry Creek basin.
4. Includes WISE, Box Elder, and other future supplies that may come in partnership with SMWSA and PWSD.

2. Summary of Completed Projects

This section contains a summary of work that has been completed by the Town since the adoption of the 2003 WWMP. This includes a review of program development, capital project construction, and maintenance. The 2003 CH2M Hill Wastewater and Reclaimed Water Master Plan identified capital improvement projects for three time frames: 2004-2009, 2010-2014, and 2015 to ultimate build-out. Table 2-1 provides the status of Town projects completed since the 2003 Master Plan.

Table 2-1
2004-2016 CIP Completed Projects

CIP Name	Construction Description	Year	Actual Cost
Kellogg Ct. Expansion	946 LF of 8"; 1,176 LF of 12"	2004	$343,700
North Front St. Bottleneck	1,500LF of 12"	2004	$469,000
Sellars Gulch Lift Station/Force Main/S. Gilbert St. Relief Gravity Main	5,596 LF 15" PVC; 2,686 LF 12" FM; 2.65MGD LS; 1,430 LF of 18" gravity main	2004	$3,900,000
East Plum Creek Interceptor	8,120 LF of 18" PVC	2005	$2,300,000
Craig & Gould Infrastructure Improvements	Craig & Gould from South to Fifth, Gilbert to Front; replace/rehab sewers	2005	$2,086,710
Woodlands Interceptor Phase I and Phase II	4,459 LF of 24"; 1466 LF of 24" with I-25 Bore; Liggett Rd Bore	2007	$2,500,000
Gilbert St. South Relief Main Phase I and Phase II	3875 LF of 18" PVC	2007	$1,010,406
Founders Parallel Force Main Phase I and Phase II	11000 LF of 16" Force Main	2008	$2,016,300
Plum Creek Interceptor Upsize	1739 LF of 54"	2008	$800,000
Kinner St. Phase I Upsize	83 LF of 21" PVC	2008	$25,000
N. Gilbert St. Sewer Replacement	Replace 1,020 LF of old clay pipe with new 8" PVC pipe, 6 manholes and 10 service connections	2009	$205,600
Turnstone Sewer Upsize	Upsize 80 LF of 8in sewer to 12"	2010	$45,510
Manhole Rehab Sapphire Point	Rehab 6 manholes to reduce I/I	2010	$19,100

Craig and Gould Ph1	Replace 1,000 LF of old clay pipe with new 8" PVC	2010	$256,320
Sewer Rehab	2,450 LF of CIPP in Young American and Downtown, replace drop structures; Hillside Sewer	2010	$95,000
Sewer Rehab	Various point repairs around Town	2011	$257,000
Sewer Rehab	Fifth St. Sewer Replacement	2012	$72,000
Front St. Railroad/7th St Sewer Replacement	Install 120 LF of casing pipe and new 8" sewer main under railroad from Front St. to 7th Street	2012	$78,000
Meadows 5 LS Overflow	Construct emergency overflow	2012	$149,000
Sewer Rehab	Emergency Point Repairs and 10,000 Linear feet of CIPP Glovers area	2013	$326,690
Sewer Rehab	Point Repairs, Castle North	2014	$172,000
Plum Creek Interceptor Upsize at NM Extension	Replace 2,913 LF of 27" with new 36" Pipe, 10 new manholes as part of North Meadows Extension Road Project	2014	$700,000
Meadows 5 LS Panel Upgrades	Replace old electrical and control panels	2015	$43,000
MCLS Mixing System	Install mixing system in wetwell	2015	$45,000
Meadows 5 LS Pump Replacement	Replace worn pumps and corroded header pipes	2016	$41,947
Sewer Rehab	9,200 Linear feet of CIPP in the Castle North neighborhood; Barbi Ct. point repair	2016	$225,990
		TOTAL	$18,163,273

2011 – 2015 Planning Period – Capital Improvement Projects:

- ***Craig and Gould North Infrastructure Improvements*** – This is a project to rehab and replace the aging infrastructure in the Craig and Gould North neighborhood, north of Fifth Street, in advance of storm and topside street improvements needed in the neighborhood. The project has been divided into three phases. Phase 1 improvements were complete in 2010 at a cost of $256,320. Follow on phases were delayed to the 2016-2021 planning horizon to accommodate planning and budgeting efforts by the Public Works Department.
- ***State Highway 85 Crossing at Castleton*** – This project was under design in 2016, and is a project to upsize a portion of the Plum Creek Interceptor (manhole SMH285 to SMH286) that crosses under State Highway 85 at the intersection with Castleton Drive. The existing 24-inch sewer is at minimum slope and is a potential bottleneck in the Plum Creek Interceptor. The existing sewer is located under an 84-inch box culvert. Initial plans were to upsize the existing sewer to at least 36 inches. Due to conflicts with existing utilities and private development, upsizing the pipe in place is almost impossible. A parallel interceptor in an alternate alignment is currently under design; see Plum Creek Interceptor Upsize in Section 5.
- ***Plum Creek Interceptor Emergency Upsize*** – This was a project to upsize several short segments of the existing 27-inch sewer interceptor that was at minimum slope to at least 36 inches in diameter, in order to gain extra capacity in the flatter sections of the interceptor. The two segments run from SMH1852 to SMH6008 and from SMH1854 to SMH1855, east of State Highway 85 and north of Atrium Drive, just prior to Plum Creek Water Reclamation Authority (PCWRA). This project was completed with the North Meadows Extension Road Project in 2014, at a cost of $700,000.

In some instances projects were not completed as identified in the original 2003 WWMP because a cost saving alternative was constructed instead, or updated hydraulic modeling indicated the project was no longer needed, or the scope had changed. Table 2-2 provides a list of Town projects that were not completed since the 2003 Master Plan. A description of the project alternative follows.

Table 2-2
2004-2015 CIP Not Completed

CIP Name	Construction Description	Estimated Cost from 2003 MP
South Castleton Drive Upsize	2170 LF of 15"	$606,000
Kinner St. Bottleneck	2394 LF of 30"; 58LF of 36"	$982,000
Lanterns Heckendorf Ranch LS	2000 LF of 8" FM, 1.43 MGD Lift Station	$804,000

Plum Creek Interceptor Emergency Upsize	848 LF of 36" PVC: 250 LF of 30" PVC	$461,000
Mikelson Boulevard Upsize	2000 LF of 8” and 10” sewer to 12”	$493,000

The South Castleton Drive Upsize was a project to replace 2,170 linear feet of 12-inch sewer pipe with larger 15-inch diameter pipe. This project would have started near the Douglas County Justice Center and terminated at State Highway 85. Based on the Town’s 2015 modeling effort, this project dropped completely out of the CIP list due to changes in the wastewater flow rate from the Justice Center used in the 2010 modeling effort. Previous estimates of the Justice Center flow rates were based on water use meter calculations that were too high due to incorrect meter size in billing records. Once water use for the Justice Center was corrected in the hydraulic model, the sewer capacity was no longer an issue. The project is no longer needed and has been eliminated from the capital plan.

The Kinner Street Bottleneck project, with almost 2,500 linear feet of 30 and 36-inch pipe, was not completed. A 95 percent design was completed for the project and then growth substantially slowed. Castle Rock Water staff reassessed the project and identified a cost saving alternative to alleviate the near-term capacity issue. A short 84 linear foot (Kinner Street Phase 1) project was constructed to alleviate the immediate bottleneck situation in the Kinner Street sewer segment. This fix was completed for $25,000 instead of $982,000. However, due to the age of this sewer line, its location, and its criticality in the interceptor system, risk and consequence of failure is considered high and it has been identified as a future CIP in year 2021 for rehabilitation, at a budgetary cost of $2.12 Million. Timing of the project will be reevaluated each year as part of the budgeting process and/or based on new condition assessment information.

The Lanterns-Heckendorf Ranch Lift Station project was replaced by the *East Plum Creek Interceptor Project* that was completed in 2005 at a cost of $2.3 million. The Gravity Interceptor Project was much more desirable than a lift station from a long term operations and maintenance costs perspective, and is much more reliable.

The Plum Creek Interceptor Emergency Upsize project was only partially completed, but has evolved into the scope of other projects. A portion was constructed in coordination with the construction of the Lowe’s Home Improvement Center complex to minimize future disruption from the sewer project construction. Another segment, the Plum Creek Interceptor Upsize at North Meadows Extension, was completed in 2014 as part of the North Meadows Extension (Castle Rock Parkway) roadway project at a cost of $700,000. The Plum Creek Interceptor at PCWRA project is north of this completed section and is planned in the future beyond 2026. This segment

will be coordinated with PCWRA and any future plant expansion, or even roadway improvements. The portion of the interceptor north of the Lowe's section and south of the North Meadows Section (Plum Creek Interceptor North Upsize) is planned for 2025. Accelerated development or major roadway projects could affect timing of either of these remaining projects.

Mikelson Boulevard Upsize – In the 2003 Master Plan, this project was identified to upsize almost 2,000 linear feet of eight and ten-inch sewer to twelve-inch. The revised 2010 modeling effort indicated that less than 100 feet of eight-inch gravity sewer pipe, at the force main outfall, needed to be upsized to ten-inch. The modeling indicated that a short stretch of sewer was only surcharging when pumps at the Castlewood Ranch Lift Station #2 ran. This project was ultimately renamed the Turnstone Sewer Upsize Project and was completed in July 2010. The total actual project costs were $45,359 instead of $493,000. This project particularly emphasizes the value that a calibrated hydraulic model and professional staff add to the capital planning effort.

As new development occurs in the Town, the development community routinely constructs new wastewater facilities required to serve the proposed development. These improvements are accounted for in the Town's wastewater model and categorized as developer contribution projects. Upon completion, these improvements are then conveyed to the Town. Many developer contribution projects have been completed since the 2003 WWMP. Table 2-3 provides a list of developer contribution projects completed since the 2003 Master Plan.

Table 2-3
Completed Developer Wastewater Projects 2004-2016

	2004-2010
CIP Name	**Construction Description**
Castle Oaks Expansion – Phase I	2.3 MGD Lift Station
	13,500 LF of 12-inch DIP Force Main
	1,890 LF of 8"; 2,900 LF of 15"; 7,165 LF of 18" gravity pipeline
Lanterns-Heckendorf Ranch Expansion	4,530 LF of 10"; 1,980 LF of 12"; 4,530 LF of 18" gravity pipeline; 50 LF of 21"
Crystal Valley Ranch Expansion – Phase I	4,430 LF of 10"; 5,620 LF of 12" gravity pipeline
Meadows Expansion – Phase I	3,063 LF of 12"; 6,560 LF of 21"; 1,990 LF of 24" gravity pipeline
Meadows Expansion – Phase II	0.5 MGD Liftstation
	200 LF of 10" Force Main
	1,900 LF of 8" Gravity Pipeline
Meadows Expansion – Phase III	2,270 LF of 12" gravity pipeline
Castle Oaks Expansion – Phase II	2,870 LF of 8" gravity pipeline
Crystal Valley Ranch Expansion – Phase II	1,510 LF of 8" gravity pipeline

3. Master Plan Elements

Collection System

Collection Pipes

The Town has over 270 miles of wastewater collection pipes, ranging in size from 4 inches to 54 inches, and over 8,000 manholes, some dating back to the 1930's. Table 3.1 provides a summary of the sizes and types of collection system pipes in the Town's wastewater system. In older parts of the Town where the pipes, mostly VCP (clay) may have reached the end of their useful life (typically 40-50 years depending on pipe material), aggressive rehabilitation and replacement efforts may be required to ensure continuity of service and the desired level of service. The Town has a program to video inspect the collection pipes to identify pipe deficiencies that may warrant rehab or replacement. Staff consider the age of pipe, the pipe material, a pipe condition score based on visual inspection by CCTV, and whether there are planned street and pavement improvements that warrant sewer pipe replacement and/or rehabilitation. Development upstream of existing pipes can contribute flows that exceed the capacity of collection pipes, necessitating replacement to a larger size. The Town uses a criterion of 75% of capacity at peak wet event to determine if a pipe is a candidate for upsizing.

Table 3-1 Collection System Pipe Summary

Gravity Mains

Pipe Material	Size, Inches	Length, Miles
DI	6 to 12	0.57
(Ductile Iron)	24	0.58
PVC	4 to 6	1.66
(Poly vinyl chloride)	8	197.13
	10	8.36
	12 to 18	27.71
	21 to 27	4.01
	>27	0.67
VCP	6, 8	6.83
(clay)	10 to 12	1.86
	15 to 21	1.04
RCP (concrete)	8 - 24	0.67
CIPP (cured in place liner)		6.47
Steel	10 to 27	0.20
Total Miles		257.76

Force Mains, linear feet, by size, inches	4"	6"	8"	10"	12"-15	16" - 21"
Ductile Iron (DI)					2,680	
PVC	4,664	5,919	9,645	11,147	12,674	12,162
Unknown	3,284*				Total	62,175 feet (11.78 Miles)

*Castlewood Ranch Liftstation #2 Force Main: record drawings do not indicate the material, but staff thinks it might be ductile iron pipe.

Wastewater Facilities

Lift Stations

Lift Stations are wastewater pumping facilities. If wastewater flow from a service basin cannot flow by gravity to the downstream treatment facility, then it must be collected and pumped to a gravity point that flows to the wastewater treatment plant. Lift stations are generally discouraged because of the high initial costs to build and the ongoing operating and maintenance costs associated with building facilities and pumping wastewater to a higher point in the collection system. As development in the Town's service area extends to the more challenging areas to serve, more lift stations are likely due to topographical constraints, unless other options can be developed. For example, the Plum Creek Ridge development (at Gilbert St.) installed an elevated hanging sewer main over Sellars Creek. This was preferable to a lift station for a small service area or an inverted siphon with insufficient flushing flows. Castle Rock Water levies a cost of service payment from areas served by lift stations to compensate for the additional operations and maintenance costs incurred over a twenty-year period. There are currently 10 lift stations, with several more anticipated in future undeveloped areas of Town, such as Bella Mesa (Founders Village F24) and Canyons South (two to three proposed, with flows to the Pinery Wastewater Treatment Plant). Table 3.2 summarizes the Town's existing wastewater facilities. See Figure 3.1 for the Town's current lift stations, grinders, flumes and odor control facilities. See Figure 5.2 in Section 5 for general locations of proposed developer lift stations.

Elevated sewer over Sellars Creek at Gilbert Street. An elevated sewer was preferred to a lift station to serve a small area.

Town of Castle Rock
Utilities Department
Wastewater Facilities Inventory

Table 3.2

Lift Stations

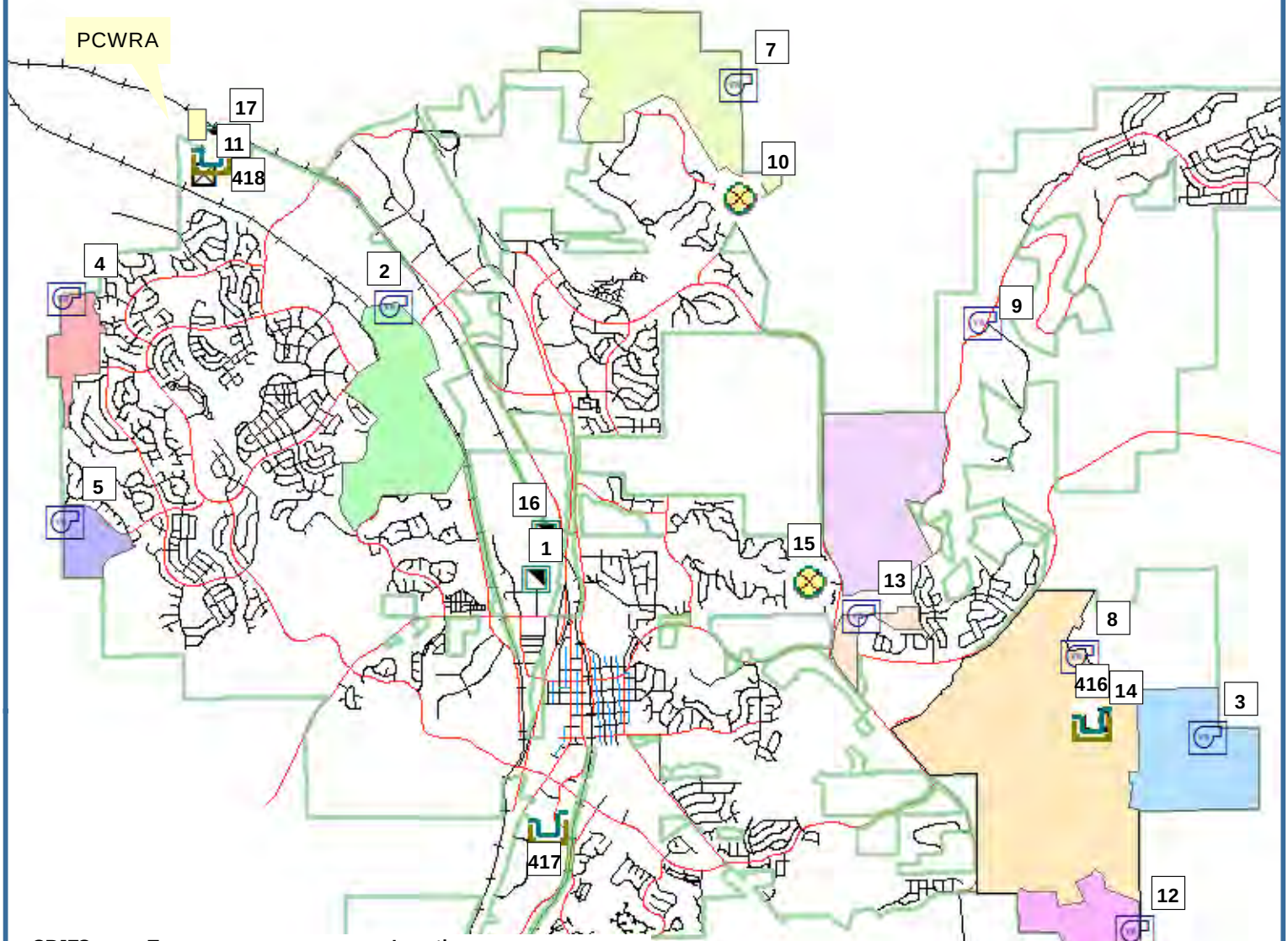
ID	Physical Address	Year Built	Capacity (mgd)	Wet Well (gallons)	Wet Wells	Pumps	HP	GPM	Total Dynamic Head (ft)	Ultimate Capacity (mgd)	Total Dynamic Head (ft)	Force Main Size	Force Main Length (ft)	Flume	Discharge Flow Meter	Standby Power	Type	Standby Power (kW)	Standby Power LS Capacity	Overflow Basin (gal)	Comments	SFE Capacity	2016 SFE Used	Build Out Capacity
Maher Ranch Lift Station	7012 Fire Opal Ln	2003	0.85	2,800	8' dia x 23.2'	2	60	590	174	0.85	174	8" PVC	4,857	No	Yes	Yes	Diesel	140	Full Flow	None		864	844	864
Mitchell Creek Lift Station	5708 Wagon Wheel	2004	4.30	75,500	(1) 16.8'x24.8'x16.1' (1) 12.2'x16.8'x16.1'	3	125	2986	152	4.30	152	10" PVC 16" PVC	11,296 11,296	No	Yes	Yes	Diesel	400	Full Flow	128,000	Trimmed impellars may need to be replaced to pump build out flows.	2495	2054	2495
Seller's Gulch Lift Station	2970 Crystal Vly Pkwy	2005	2.56	3,100	(1) 6'x16'x18' (1) 24'x37.5'x11.3'	3	30	1800	54	2.56	54	12" DIP	2,480	Yes	Yes	Yes	Natural Gas		Full Flow	55,000		3021	419	3021
Meadows Filing 5 Lift Station	5193 Rocky Mountain Drive	1989	0.24	424	6' dia x 23.1'	2	10	167	81	0.24	81	6"	1,150	No	No	Yes	Diesel	45	Full Flow	12,351	The head is estimated from 35 feet of elevation head and an additional 15% for the dynamic head.	111	143.5	111
Meadows Filing 15 Lift Station	5300 Summerville	2005	0.31	1,672	(1) 7' dia x 14.9' (2) 8' dia x 17.8'	2.00	15	215	81	0.31	81	4" PVC	670	No	Yes	Yes	Natural Gas		Full Flow	7,520		223	223	223
Meadows Filing 17 Lift Station	1465 Meadows Parkway	2005	1.18	21,127	(2) 11.5'x21'x14'	2	50	820	95	1.18	95	8" PVC	1,526	No	Yes	Yes	Natural Gas		Full Flow	83,000		1346	688	1346
Castle Oaks Lift Station	3013 Castle Oaks Drive	2005	1.18	16,400	(2) 8'x14'x19.25'	4 - 2 pair in series	55	820	331	2.28	386	12" DIP	11,719	Yes	Yes	Yes	Diesel	350	Full Flow	380,000	Initial SFE capacity of the pumps is 1250. The pumps will need to be replaced with larger pumps beyond 1250 SFES.	1250	921	2760
Castlewood Ranch Lift Station #1	2210 Lost Canyon Ct	2004	0.15	885	5' dia x 14.7'	4 - 2 pair in series	15.00	105	177	0.15	177	4" PVC	2,875	No	Yes	Yes	Natural Gas		Full Flow	None		110	94	110
Castlewood Ranch Lift Station #2	7254 Weaver Ct.	2004	0.54	1,400	8' dia x 15.2'	2	26	315	95	0.54	95	8" PVC	1,237	No	Yes	Yes	Natural Gas		Full Flow	None		505	477	505
RWTP Temporary Lift Station	1282 Castle Oaks Drive	2005	0.13	1,500	5' dia x 19.9'	2	10	90	117	0.13	117	4" PVC	170	No	Yes	Yes	Part of RWTP Back-up power			33,000	This is a temporary lift station. The flows to this lift station will eventually be routed to the Castle Oaks lift station. The ultimate flow will come directly from the RWRWTC backwash pumps and be pumped into the Founders Force Main	183.6	183.6	183.6
Total Treatment Capacity			**11.43**							**12.53**												**10109**	**6047**	**11619**

Flow Metering Stations

ID	Physical Address	Year Built	Type	SCADA	Service Area
Meadows Flume	4255 N US Highway 85	1987	Parshall	Y	Meadows
Main Flume	Old wastewater plant	1990	Parshall	Y	Downtown, Plum Creek, Crystall Valley Ranch, Citadel
North Flume	North of old wastewater plant, near PCWPF	1987	Parshall	Y	Founders, Woodlands
PCWRA	4255 N US Highway 85	1989	Parshall	Y	Town except Cobblestone Ranch

Grinder Facilities

ID	Physical Address	Year Built	Number of Grinders	Standby Power	Comments
Meadows Grinder	5880 Plum Creek Dr.	2004	1	No	
Mitchell Street	6120 Vista Canyon Pl	2009	1	No	



OBJEC	Type	Location
1	Flume	Main Flume
2	Lift Station	Meadow s 17 Lift Station
3	Lift Station	Castlew ood 2 Lift Station
4	Lift Station	Meadow s 5 Lift Station
5	Lift Station	Meadow s 15 Lift Station
6	Lift Station	Sellars Gulch Lift Station
7	Lift Station	Maher Ranch Lift Station
8	Lift Station	Mitchell Creek Lift Station
9	Lift Station	Castle Oaks Lift Station
10	Odor Control	Maher Ranch Odor Control
11	Grinder	Meadow s Grinder
12	Lift Station	Castlew ood 1 Lift Station
13	Lift Station	Ray Waterman Lift Station
14	Grinder	Mitchell Street Depressed Sew er & Grinder
15	Odor Control	Woodlands Odor Control
16	Flume	North Flume
17	Flume	Meadow s Flume
416	Inverted Siphon	Castlew ood Ranch
417	Inverted Siphon	Plum Creek
418	Inverted Siphon	Meadow s

CASTLE ROCK
LIFT STATION BASINS
AND WASTEWATER FACILITIES
FIGURE 3.1

Flow Measuring Stations

The Town has three flow measuring stations that measure and monitor flows from three main areas of the Town, as summarized in the table below. There are also flow meters in many of the lift stations. The Pinery Water and Wastewater District (Pinery) also has a flow measuring station to monitor flow from the Cobblestone Ranch area. The flow measuring stations and meters are essential elements of the Town's data collection efforts. The data collected from the stations is invaluable in the calibration of the wastewater hydraulic model and understanding the influence that infiltration/inflow (I/I) has on the capacity of the collection system and the PCWRA and Pinery wastewater treatment plants. Monitoring of the data can also indicate changes in the collection system that may warrant further investigation. Meter volumes are reported daily through the supervisory control and data acquisition (SCADA) equipment installed in Town facilities, and monitored for changes or issues.

Table 3-3 Flow Measuring Stations

Name	Local Measured	Type	Install Date	SCADA
Town North	Founders, Woodlands	Parshall	1987	Yes
Town Main	Downtown, Plum Creek, Crystal Valley, Citadel	Parshall	1990	Yes
Meadows	Meadows		1987	Yes
PCWRA	All of Castle Rock except Cobblestone Ranch, Silver Heights*, Castleton District*, and future Canyons South	Parshall	1989	at PCWRA in 2017
Pinery WWD	Cobblestone Ranch and future Canyons South			at Pinery
	*No flow measuring device; wastewater flows are assumed based on water use			

Grinder Facilities

Typically, the Town has grinder facilities upstream of lift stations and siphons. The grinders comminute solids in the wastewater that could potentially clog wastewater pumps or settle out in siphons, potentially blocking flow. They also eliminate the need for bar screens, which require manual cleaning, upstream of the lift station or wastewater plant. The Town has two grinder facilities upstream of wastewater siphons. Siphons are collection pipes that use accumulated pressure head in the pipe to force the wastewater through a pipe against gravity. Siphons are discouraged because of the tendency of solids to collect in the low point of the siphon and the increased maintenance that results if an adequate flushing velocity can't be achieved.

Table 3-4 Grinder Facilities

Name	Location
Mitchell Creek LS	Lift Station
Mitchell St	Siphon
Meadows	Siphon
Castlewood LS #1	Liftstation
Sellers Gulch	Liftstation
Meadows 17	Liftstation
Castle Oaks	Liftstation

Odor Control Facilities

The Town has several facilities dedicated to mitigating the odors from sewer mains and lift stations. All of the Town's lift stations have facilities for chemical addition to control odors and mitigate corrosion potential in the collection system. In 2006, the Town constructed the Woodlands Odor Control Facility with a proprietary granular media and carbon adsorption to neutralize and reduce odors from a gravity sewer main situated along a popular walking trail near homes. In this case, the gravity sewer predated the trail and the homes, and could not be relocated. Castle Rock Water staff routinely monitor the facility for maintenance purposes, and samples are collected in order to gauge treatment efficacy and determine when the media is no longer neutralizing odors and should be replaced.

There is also the Maher Ranch biofilter for odor control in the Sapphire Point neighborhood, installed downstream of the force main outfall to gravity sewer. That facility relies on a natural bioremediation process to treat hydrogen sulfide in off-gases from the wastewater and reduce the odor potential.

Table 3-5 Odor Control Facilities

Location	Type	Process	Year Installed
Woodlands Odor Control	Forced Air Media Treated	Sulfa Treat Media and GAC	2007
Maher Ranch Biofilter	Biofilter, Forced Air	Biologically Treated Wood Chips	2002

Treatment

Plum Creek Water Reclamation Authority

The Town is a member of Plum Creek Water Reclamation Authority (PCWRA), which provides wastewater treatment services to the Town, Castle Pines, Castle Pines North, Silver Heights, and the Castleton Metropolitan Districts. The existing wastewater treatment plant (WWTP) was expanded in 2005 to accommodate future growth, and the Town contributed to the expansion. Presently the PCWRA has total treatment capacity for 6.44 MGD, compared to the 2016 Town average daily flow of 3.73 MGD. PCWRA is required to prepare a Utility Plan (UP) which functions as a master plan for the authority. The PCWRA UP was updated in 2015 (Plum Creek Water Reclamation Authority, Utility Plan Update and Preliminary Engineering Services, Technical Memorandum No. 1, Treatment Analysis, February 2015; Technical Memorandum No. 2, Energy Recovery Feasibility Analysis, February 2015). More detailed information concerning wastewater treatment, capacity analysis and future capital investment can be found in the plan.

A project is underway in 2016 to outfit a third oxidation ditch at the PCWRA. This will not increase overall treatment capacity, but will improve firm treatment capacity from 4.2 MGD to 6.44 MGD. However, due to rapid growth in the PCWRA service area, anticipated changes in regulatory limits, and peak loading levels that are straining treatment capacity, there are near term plans in the next five years for expansion of the facility up to 10 MGD, allocating a total of 7.7 MGD for the Town of Castle Rock (increase from current allocation of 4.57 MGD). Additional future expansions will be required as the Town continues to grow, but timing is based on the pace of growth.

The five year capital plan for the Town's commitment to PCWRA is shown in Table 3-6.

Table 3-6
PCWRA Five Year Capital Plan

Town of Castle Rock PCWRA Capital Plan						
Project	**2016**	**2017**	**2018**	**2019**	**2020**	**Total**
Ditch Three	$233,469	$ 233,469	$233,469	$233,469	$ 233,469	$1,167,345
Manganese Control	$200,000	$ 200,000	$200,000	$200,000	$ 200,000	$1,000,000
Rehab & Replacement	$213,000	$ 284,000	$284,000	$284,000	$ 355,000	$1,420,000
Capital Expansion	$ 60,000	$1,500,000			$23,500,000	$25,060,000
Total	**$709,469**	**$2,217,469**	**$717,469**	**$717,469**	**$24,288,469**	**$28,650,435**

Pinery Water and Wastewater District

Although the Town provides water service to the Cobblestone Ranch neighborhoods, the wastewater flows are treated by the Pinery Water and Wastewater District (Pinery). The Cobblestone Ranch developer invested in infrastructure improvements and treatment capacity with Pinery to cover their requirements through build-out. Cobblestone Ranch reserved capacity is 0.29 MGD, annual average, and 0.32 MGD, max monthly average. The Town of Castle Rock and The Pinery have an Intergovernmental Agreement (IGA) that covers system development fees, rates, return flows and reimbursement for treatment. There is also an agreement for the operation of a water interconnect between the two entities, to be used in times of emergency water crisis by either party. The future Canyons South development would also send all flows to The Pinery for treatment under similar IGAs. The future Canyons South has reserved capacity of 0.24 MGD, annual average flows, and 0.27 MGD, max monthly average flows.

4. Hydraulic Modeling

Modeling Update Effort

During the course of updating the 2010 Wastewater Master Plan, Castle Rock Water invested a substantial amount of effort into developing the comprehensive wastewater model for the Town. By creating and updating the model with in-house staff, Castle Rock Water is now much less reliant on outside consultants for its models and is now much more self-sufficient. This allows Castle Rock Water to be better situated to respond to changing growth and demand scenarios. For instance, successful water conservation efforts drive down the average daily winter use rates on which demand curves are based, yet more sensitive flow metering devices better capture low flow and very high flow water usage that may drive up average winter demand readings. Castle Rock Water can now more quickly identify system deficiencies that may result from growth, and can perform multiple "what if scenario" analyses when presented with new planned developments. As a result, Castle Rock Water can better plan for future capital improvement projects with the goal of providing adequate and reliable service to the Town's residents without investment in unnecessary infrastructure.

The Town's sanitary sewer hydraulic model was created in 2009 using MWH Soft InfoSewer software. The model is designed to estimate the flow rates of wastewater using diurnal curves and wastewater loading estimates based on actual winter use, with loading applied to nodes in the model that represent sub-basins. The curves show the estimated high and low flow rates in the system in a 24-hour period. Future loading estimates are determined using Single Family Equivalent (SFE) projections for building in the sub-basins. Since the pace of growth varies, growth projections are generally updated annually.

Wastewater Demand Rates

Demand per SFE is based on actual average winter use for developed parcels, and is based on 200 gallons per day per SFE for undeveloped parcels. The graph below shows the historic average daily wastewater demand per account for 2007 through 2016. The average is 196 gallons per day per SFE, which provides good support for the planning criterion of 200 gallons per day per SFE. For future industrial or commercial parcels, the Town's land use planning criteria and parcel size were used, or an estimate of 200 gpd/SFE for the number of SFEs expected was used. All demands within a sub basin are totaled and the demand applied to a logical manhole (node) in the model. As land development occurs and better data becomes available (demand based on actual use), revisiting the hydraulic model on a regular basis helps determine the needed capital improvement projects, their timing, and their criticality. As water conservation goals are met, particularly with respect to indoor water saving fixtures and consumption patterns, decreasing average wastewater flows per capita are realized. Similarly, improvements in reducing the amount of inflow and infiltration into the collections system from groundwater and storm runoff reduce the hydraulic loading on the system. The result is that collection system mains

that, in past modeling efforts, were predicted to reach capacity and need upsizing, no longer show up in the model as having capacity issues or are pushed farther out in the planning period. The planned capital projects go away. Examples from the 2010 Master Plan include several reaches of the Dawson Ridge Interceptor. However, additional future unplanned developments, or changes in density or consumption, that would place additional loading on these sewer mains would prompt revisiting these projects.

The shape of the curve does indicate that infiltration/inflow (I/I) is contributory to flows to the PCWRA during wet years. The 2009 high (wet) year wastewater demand of 206 gal/day-sfe is 110% of the low (dry) year 2013 demand of 187 gal/day-sfe. This, too, provides support for the planning criterion of accounting for an additional 10% of wastewater flow due to I/I. See Figure 4.1 for historical average day wastewater demands.

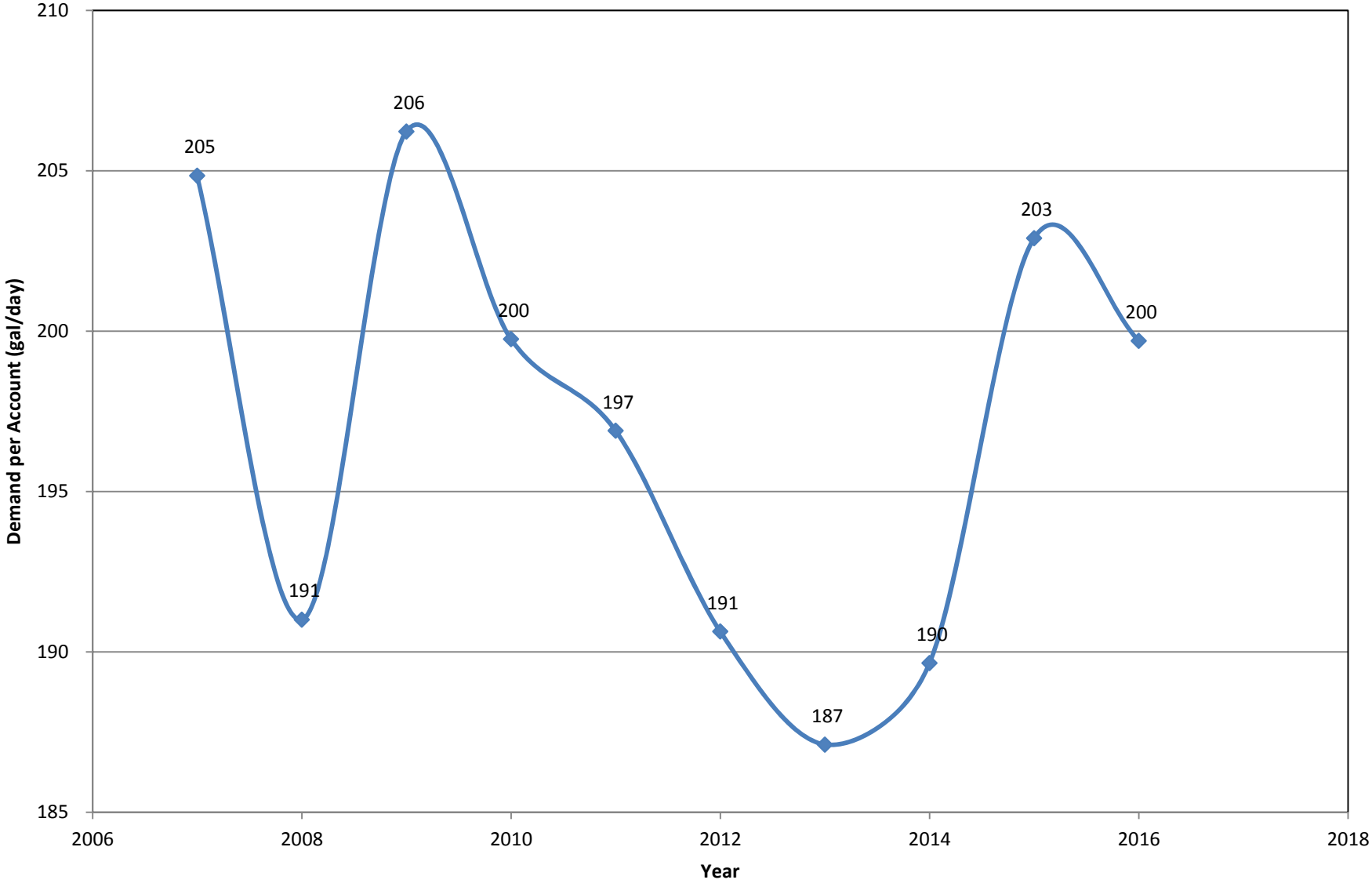

Historic Average Wastewater Day Demand per Account
Demand per Account (gal/day)
210
205
200
195
190
185
205
191
206
200
197
191
187
190
203
200
2006
2008
2010
2012
2014
2016
2018
Year

Figure 4.1

The Diurnal Curve

The diurnal curve was developed using data from the winter of 2009 to develop a typical maximum day demand. Typical demands in the Town were developed using winter 2009 customer billing information. This data represents a realistic distribution of demands throughout Town. Next, the December 2008, January 2009, and February 2009 SCADA data was used to generate a dry weather diurnal curve. Diurnal curves for each of the Town's three flumes (Meadows, Town Main and Town North) were generated using the data collected from the SCADA system.

A wet weather intensity curve was generated using operational SCADA data from June 2009, which was a wet month, and a 2009 maximum day flow rate of 4.14 MGD. This operational data was combined with the estimated dry diurnal curve to generate the wet weather intensity curve.

The estimated inflow loading was evenly distributed throughout the Town's collection system. Calibration was completed by matching the model output with the operational data collected. This method accounts for the effect of inflow/infiltration (I/I) on the collection system. The hydraulic model used for this master planning effort was based upon the calibrated maximum day-peak wet hour demand model. The model is an extended period model using the diurnal curve shown above and simulating a maximum day demand over 37 consecutive days. The diurnal was reevaluated for the 2016 modeling effort but did not significantly change, so changes to the diurnal pattern in the hydraulic model were not required. The resulting curves are shown in Figure 4.2. The diurnals all follow the same pattern so a single representative diurnal curve was generated for use in the model.

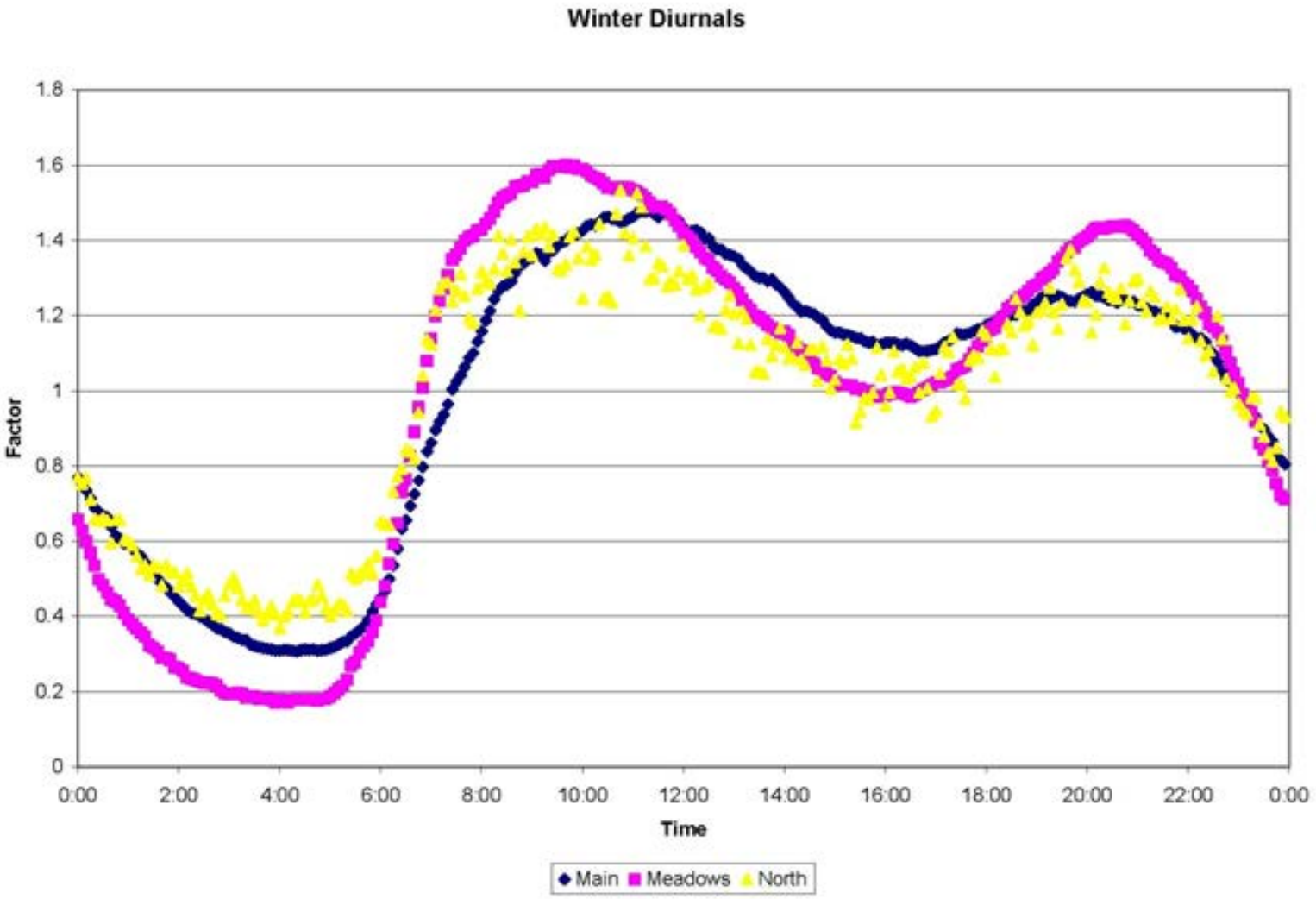

Winter Diurnals
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Factor
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Time
Main
Meadows
North

Figure 4-2

Historical Wastewater Flow

In 2009 the winter average flow rate was 2.8 MGD and the 2009 overall average was 3.0 MGD. The 2009 minimum and maximum flow rates were 2.6 MGD, and 4.1 MGD respectively. In 2016, the winter average flow rate was 3.51 MGD and the overall average was 3.73 MGD. The 2016 minimum and maximum flow rates were 3.23 MGD and 5.37 MGD, respectively. The changes reflect growth in the Town, newer infrastructure, sewer rehabilitation to reduce I/I, and changes in water use and conservation. The 2016 ratio of maximum to minimum is 1.66, while the 2009 ratio was 1.58, yet the ratios of minimum to minimum and average to average did not change and are both equal to 1.23, yet the ratio of 2016 max to 2009 max was 1.31. The ratio of average to minimum for both time periods is the same at 1.16. This would seem to indicate that hydraulic loading is increasing proportional to population, as would be expected. The increase in the ratio of maximum to minimum would seem to indicate I/I could be an issue. Castle Rock Water has been able to trace significant I/I events back to new development where uncapped collection system points allow rainwater runoff to drain to the collection system. New development in Town was very high in 2016, compared to the weak growth that was the case in 2009.

Pipe Sizes

In the new model, all gravity sewer mains greater or equal to 10 inches in diameter were included. Additionally, select eight-inch diameter sewer mains were included if they served a fairly large sub basin or if there was a reason to suspect that future development upstream could create capacity issues. The criterion for determining if a pipe segment needs upsizing remains at greater than 75 percent capacity during a peak wet event.

System Diurnal Curve and Peak Wet Day

Based on flow data collected from the Town's SCADA system, a single diurnal curve for the Town and a wet weather intensity curve were developed; these curves were applied to average day demands and then extended period simulations were run in the model for both existing conditions and future conditions for the different planning horizons.

Reconciling Record Drawings/Model Data and Filling in the Gaps

To update the model, new mains are added; all ten-inch diameter and larger pipes are included in the model. Typically, smaller pipes only serve cul-de-sacs or older, smaller sub basins. However, an eight-inch pipe could be susceptible to surcharging during a peak wet event, so the model includes smaller eight-inch pipes where it makes sense (serves a larger sub basin or could have significant upstream development). Smaller pipes are often excluded from the modeling effort because they significantly increase the number of pipes in the model. In the 2010 model development, data was manipulated so that data discrepancies were eliminated and information was converted to a new uniform vertical datum. Additionally, survey data from the 2002 Glosso-Murray Sanitary Sewer Survey effort was used to verify invert and pipe slope data. GIS specialists keep the

utilities mapping up-to-date as new development occurs, and new development information is included in the hydraulic model for regular updates. Castle Rock Water revisits the hydraulic model each year in support of developing the Capital Improvement Plan, and for annual updates to the rates and fees model. Castle Rock Water may revisit the model throughout the year as utility plans and/or development agreements for newly planned developments are being reviewed. This allows Castle Rock Water to determine if a development is responsible for the upsizing of existing infrastructure to serve their project, in line with the principle that growth pays for growth.

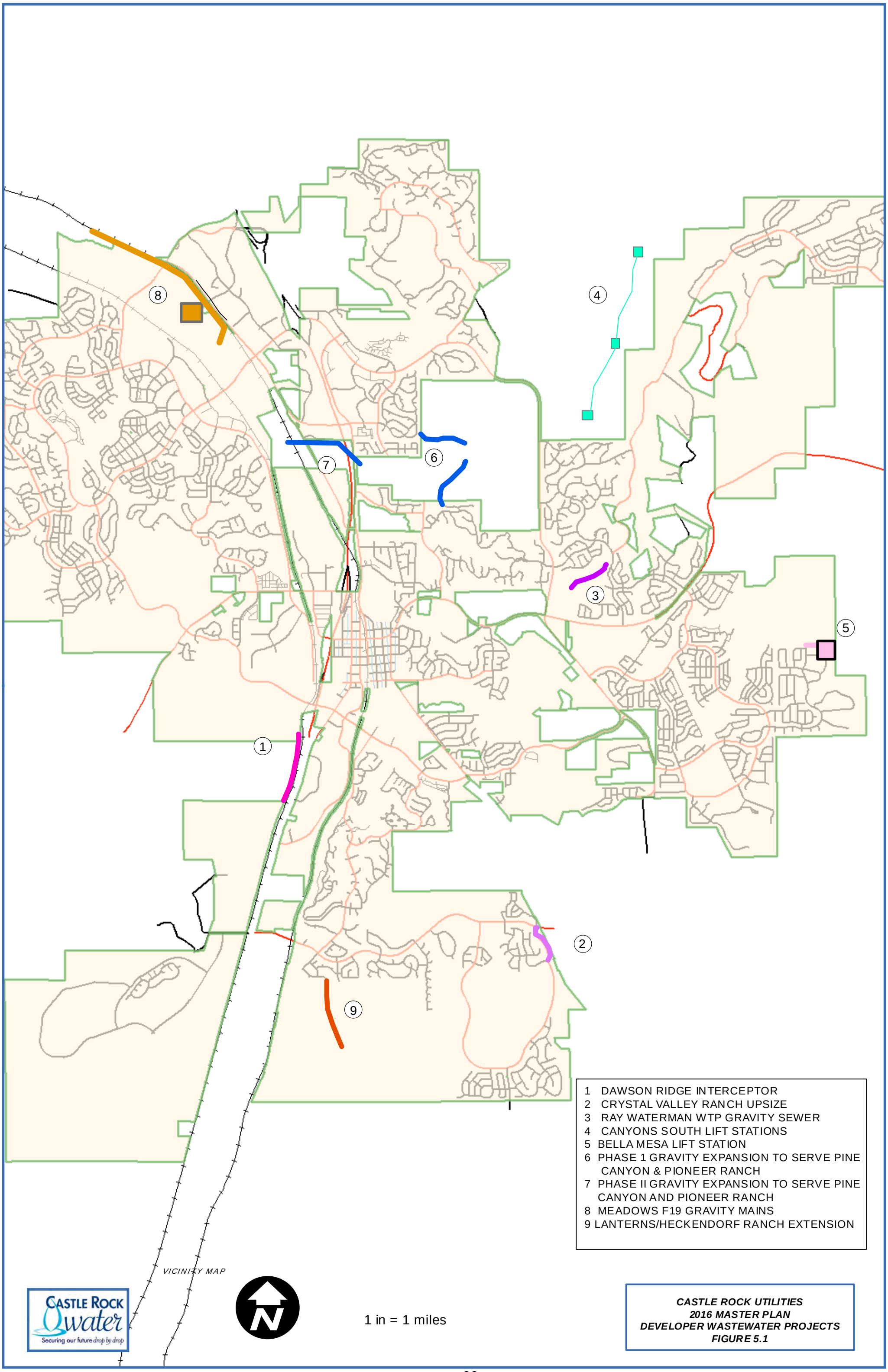
5. Capital Improvement Program

The hydraulic model of the collection system is used to identify capital improvements based on the projected growth. These improvements generally consist of sanitary sewer replacements/upsizing to accommodate future growth. Other improvements consist of replacing aging infrastructure, repairing failed components of the system, and addressing problems associated with inflow and infiltration. The CCTV Inspection Program and Asset Management Program are both useful for identifying areas for rehab based on condition and not capacity. Using the updated model, revised growth estimates, and criteria for upsize and/or replacement, the extended period simulation hydraulic model was run for three planning horizons. Within each planning horizon, capital improvement projects were identified for sections of the system where the capacity criterion of 75 percent was violated.

As new development occurs in the Town, the development community routinely constructs new wastewater facilities required to serve the proposed development. These improvements are accounted for in the Town's wastewater model and categorized as developer contribution projects. Upon completion, these improvements are then conveyed to the Town. Based on planning numbers, utility reports and hydraulic modeling, several projects have been identified as necessary to support future development. Table 5-1 lists future projects anticipated to be completed by the development community. See Figure 5.1 for the general location of the proposed developer CIP projects.

Table 5-1
Developer Wastewater Projects: 2017-Future

Meadows Highway 85 Sewer Main to Serve Filing 19	8” and larger gravity pipelines to PCWRA; originally identified in previous master plans as a lift station, force main and gravity mains to serve the area
Gravity Expansion at SMH261 – Phase I (to serve Pine Canyon and Pioneer Ranch)	4,270 LF of 8" gravity pipeline
Gravity Expansion at SMH261 – Phase II (to serve Pine Canyon and Pioneer Ranch)	1,700 LF of 10” gravity pipeline
Bella Mesa Lift Station and Force Main (Founders Filing No. 24)	Proposed lift station and associated force mains/gravity mains
Canyons South	Two to three proposed lift stations and associated force and gravity mains
Lanterns Heckendorf Ranch Expansion	New gravity pipelines to serve area
Crystal Valley Ranch Upsize	Upsize 1,900 LF of 12” sewer to 15” (from SMH 6562 to SMH 6351); timing depends on rate of development; conservation efforts could mitigate the need to upsize; project evaluated as development proceeds; modeling will be reevaluated as development in the basin occurs, planning levels change, or new development is added to the service area basin.
Ray Waterman Treatment Plant (RWTP) Gravity Sewer	Development near the Ray Waterman Treatment Plant should install a gravity sewer main that connects to existing downstream gravity sewer. Upon completion of the missing section, the temporary lift station serving the RWTP and the King Soopers/Founders Marketplace shall be abandoned.
Dawson Ridge Interceptor Upsize	Modeling indicates that should Dawson Ridge eventually grow to its fully platted zoning level, 1,400 linear feet of 12 inch sewer will need to be upsized to 15 inch.



1 DAWSON RIDGE INTERCEPTOR
2 CRYSTAL VALLEY RANCH UPSIZE
3 RAY WATERMAN WTP GRAVITY SEWER
4 CANYONS SOUTH LIFT STATIONS
5 BELLA MESA LIFT STATION
6 PHASE 1 GRAVITY EXPANSION TO SERVE PINE CANYON & PIONEER RANCH
7 PHASE II GRAVITY EXPANSION TO SERVE PINE CANYON AND PIONEER RANCH
8 MEADOWS F19 GRAVITY MAINS
9 LANTERNS/HECKENDORF RANCH EXTENSION

CASTLE ROCK UTILITIES
2016 MASTER PLAN
DEVELOPER WASTEWATER PROJECTS
FIGURE 5.1

A major factor that impacts the wastewater program is the growth rate for new housing. When the previous plan was developed in 2003 the Town was experiencing explosive growth in single family residential housing. At its peak, the Town issued 1,500 single family building permits in 2005. This resulted in the need for an aggressive Capital Improvement Program that could respond to the increase in homes and subsequent wastewater flows. From 2004 – 2010 the wastewater program has generally budgeted approximately 2.1 Million dollars per year for CIP projects. However, beginning in about 2006 there was a decline in growth in the Town and in 2009 the Town only issued 275 single family building permits. That decline necessitated the reduction of the annual CIP budget to approximately less than $860,000 per year for the 2011 – 2015 planning horizon. The last several years have been high-growth years, exceeding 800 new homes per year. Nevertheless, for planning and budgeting purposes, Castle Rock Water tries to be conservative in estimating future growth, especially with respect to input in the annual cost of service rates and fees study. Planning data was collected from the Town's Development Services Department, and the five-year growth scenario is based upon the assumed growth pattern shown below.

Town's Five-Year Growth Projections in SFEs

Year	2017	2018	2019	2020	2021
Projected SFEs	800	800	800	800	800

As a result of the recent updated modeling effort, several Town projects that were previously identified in the 2010 - 2015 planning horizon have either been modified in scope or dropped out of the CIP altogether. This is primarily due to the incorporation of revised growth estimates, and an extensive effort to resolve inconsistencies and errors in the wastewater system model through field verification and calibration to SCADA data. As a result, the updated model supports a scaled-back Capital Improvement Program that eliminated almost $8 Million in expenditures over the planning period of 2011 to 2025, with almost $5 Million saved in the immediate five-year planning period of 2011-2015.

In most cases the remaining capital improvement projects are very similar to those identified in the 2003 Master Plan, with revisions to the overall length of the project and/or the ultimate size of the pipe required to meet build-out projections. Typically the most significant change to a CIP was in the timing of the project due to the slowdown in growth, but also due to successful water conservation efforts that have reduced the daily per capita consumption. Because of the slower growth rate many projects have now been delayed well into the future, with many projects occurring in the 2021 - build out planning horizon. Successful water conservation efforts to minimize and reduce indoor consumption result in reduced sizes for future projects, and delay the timing of upsizing.

In addition to project specific capital improvements to the system, the Town also has several recurring programs that are funded annually, as well as continuing

obligations for PCWRA improvements. Table 5-2 shows the recurring programs, capital improvement projects and PCWRA obligations for the next five-year planning period. See Figure 5.2 for a map of Castle Rock Water CIP project locations.

Table 5.2
Town of Castle Rock
CIP Project List
CIP Projections thru 2050

	B	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1															
2		**2016**	**2017**	**2018**	**2019**	**2020**	**2016-2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2021-2025 Subtotal**	**2026-2050**	**Total 2016 - 2050**
3	**Recurring Projects**														
4	Lift Station Rehab/Replacement	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	**$ 125,000**	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	**$ 125,000**	**$ 625,000**	**$ 875,000**
5	Sewer Line Rehab/Replacement	$ 350,000	$ 350,000	$ 350,000	$ 350,000	$ 350,000	**$ 1,750,000**	$ 350,000	$ 350,000	$ 350,000	$ 350,000	$ 350,000	**$ 1,750,000**	**$ 8,750,000**	**$ 12,250,000**
6	Security Improvements	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	**$ 125,000**	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	**$ 125,000**	**$ 625,000**	**$ 875,000**
7	SCADA System Improvements (Existing Improvements in SCADA Div	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	**$ 125,000**	$ 25,000	$ 25,000	$ 25,000	$ 25,000	$ 25,000	**$ 125,000**	**$ 625,000**	**$ 875,000**
8	Lift Station Pump and Motor Replacements	$ 30,000	$ 35,000	$ 40,000	$ 50,000	$ 50,000	**$ 205,000**	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	**$ 250,000**	**$ 1,250,000**	**$ 1,705,000**
9	WW Facility VFD replacement		$ 110,000	$ 110,000	$ 110,000	$ 110,000	**$ 440,000**	$ 110,000	$ 110,000	$ 110,000	$ 110,000	$ 110,000	**$ 550,000**	**$ 2,750,000**	**$ 3,740,000**
10	PCWRA Capital Buy-in (Debt Service + Capital Exp/Replacement)	$ 2,311,545	$ 2,404,007	$ 2,500,167	$ 2,600,174	$ 2,704,181	**$ 12,520,074**	$ 2,002,051	**$ -**	**$ -**	**$ -**	**$ -**	**$ 2,002,051**	**$ -**	**$ 14,522,125**
11															
12	**Capital Improvement Projects**														
13	Castle Oaks Lift Station Improvements		$ 200,000				**$ 200,000**						**$ -**	**$ -**	**$ 200,000**
14	Lift Station Mixing Improvements		$ 32,000	$ 32,000	$ 32,000	$ 32,000	**$ 128,000**	$ 32,000					**$ 32,000**		**$ 160,000**
15	Craig & Gould North Infrastructure Improvements				$ 250,000	$ 105,000	**$ 355,000**						**$ -**	**$ -**	**$ 355,000**
16	Gordon Dr Sewer Improvements		$ 35,000	$ 390,000			**$ 425,000**						**$ -**		**$ 425,000**
17	Kinner Street Sewer						**$ -**	$ 2,117,000					**$ 2,117,000**	**$ -**	**$ 2,117,000**
18	Plum Creek Interceptor Upsize	$ 170,274	$ 1,328,000				**$ 1,498,274**						**$ -**	**$ -**	**$ 1,498,274**
19	Plum Creek Interceptor PCWRA Upsize						**$ -**						**$ -**	**$ 640,852**	**$ 640,852**
20	Plum Creek Interceptor North Upsize						**$ -**					$ 763,098	**$ 763,098**	**$ -**	**$ 763,098**
21	Plum Creek Interceptor South Upsize - Phase I						**$ -**						**$ -**	**$ 440,000**	**$ 440,000**
22	Plum Creek Interceptor South Upsize - Phase II						**$ -**						**$ -**	**$ 1,360,000**	**$ 1,360,000**
23	Plum Creek Interceptor Old WWTP Upsize						**$ -**					$ 171,000	**$ 171,000**	**$ -**	**$ 171,000**
24	Malibu Street Upsize						**$ -**			$ 387,000			**$ 387,000**	**$ -**	**$ 387,000**
25	Prairie Hawk Interceptor						**$ -**		$ 417,000				**$ 417,000**	**$ -**	**$ 417,000**
26	Meadows 17 Lift Station Access Road paving (1060x15x4)		$ 65,400				**$ 65,400**						**$ -**		**$ 65,400**
27	Castlewood Lift Station #1 Access Road Paving (200x15x4)	$ 12,000					**$ 12,000**						**$ -**		**$ 12,000**
28	Castlewood Lift Station #2 Access Road Paving (450x15x4)		$ 27,000				**$ 27,000**						**$ -**		**$ 27,000**
29	Maher Lift Station Access Road Paving (500x15x4)	$ 30,000					**$ 30,000**						**$ -**		**$ 30,000**
30	**Plum Creek Water Reclamation Authority Projects**														
31	Ditch Three at PCWRA (Meadows Capital Reserve?)	$ 233,469	$ 233,469	$ 233,469	$ 233,469	$ 233,469	**$ 1,167,345**						**$ -**		**$ 1,167,345**
32	Manganese Control at PCWRA (Meadows Capital Reserve?)	$ 200,000	$ 200,000	$ 200,000	$ 200,000	$ 200,000	**$ 1,000,000**						**$ -**		**$ 1,000,000**
33	Rehab/Replacement at PCWRA	$ 213,000	$ 284,000	$ 284,000	$ 284,000	$ 355,000	**$ 1,420,000**	$ 250,000	$ 250,000	$ 250,000	$ 250,000	$ 250,000	**$ 1,250,000**	**$ 6,250,000**	**$ 8,920,000**
34	***PCWRA Capacity Expansion***	***$ 60,000***	***$ 1,500,000***			***$ 23,500,000***	**$ 25,060,000**						**$ -**		**$ 25,060,000**
35															
36	**Total Sewer Fund**	**$ 3,685,288**	**$ 6,878,876**	**$ 4,214,636**	**$ 4,184,643**	**$ 27,714,650**	**$ 46,678,093**	**$ 4,986,051**	**$ 1,252,000**	**$ 1,222,000**	**$ 835,000**	**$ 1,769,098**	**$ 10,064,149**	**$ 23,315,852**	**$ 80,058,094**
37															

1 KINNER STREET SEWER
2 GORDON DRIVE SEWER
3 MALIBU SEWER UPSIZE
4 CRAIG AND GOULD NORTH
5 PRAIRIE HAWK INTERCEPTOR
6 PLUM CREEK @ OLD WWTP
7 PLUM CREEK INTERCEPTOR SOUTH
8 PLUM CREEK INTERCEPTOR UPSIZE
9 PLUM CREEK INTERCEPTOR NORTH
10 PLUM CREEK @ PCWRA

VICINITY MAP

CASTLE ROCK Qwater
Securing our future drop by drop

1 inch = 1 miles

CASTLE ROCK UTILTIES
2016 MASTER PLAN
WASTEWATER PROJECTS
FIGURE 5.2

2016 – 2021 Planning Horizon - Capital Improvement Projects:

- ***Craig and Gould North Infrastructure Improvements*** – This project is to rehab and replace the aging infrastructure in the Craig and Gould North neighborhood, north of Fifth Street, in conjunction with storm and topside public street improvements. Phases 2 and 3 have been delayed to the 2019 and 2020 planning years to accommodate planning and budgeting efforts by the Public Works Department. Estimated Costs: $355,000.

- ***Plum Creek Interceptor Upsize –*** This project incorporates the State Highway 85 crossing at Castleton (see Section 2) into a larger capital replacement project. The State Highway 85 Crossing at Castleton Project proved to be difficult to complete in the current alignment, due to existing utilities, topography, and private facilities. An alternative alignment has been identified that will parallel and divert flow before the undersized Castleton segment. A total of 2,400 LF of 27" sewer to be installed; estimated costs: $1,328,000.

- ***Gordon Drive Sewer Improvements*** – This project plans to rehab or replace 1,450 linear feet of old clay pipe in conjunction with a major planned stormwater and street improvement project. Design is planned for 2017 and construction for 2018. Estimated costs: $425,000.

- ***PCWRA Projects –*** The PCWRA is a regional reclamation facility that serves the Town of Castle Rock, Silver Heights, Castleton District, Castle Pines, and Castle Pines North. The facility was expanded in 2005, and that expansion should meet the Town's wastewater needs through 2020. The Town's five-year costs for the capital buy in at PCWRA are over $12.5 Million. The Town contributes approximately 71 percent of the total wastewater load to the PCWRA facility, and therefore is responsible for its proportionate share of expenses for expansion, operations, maintenance and upgrades.

    - ***Ditch Three*** - A third oxidation ditch was constructed with the 2005 improvements, but not equipped. The third oxidation ditch needs to be equipped before 2018 to provide sufficient treatment capacity for current wastewater flows, based on upcoming regulatory requirements. A capital improvement project to equip the third oxidation ditch is underway and should be complete by April 2017. The addition of the third oxidation ditch to the treatment train will not significantly increase the overall plant treatment capacity, but does improve firm capacity. Expected Town cost: $1,167,345.
    - ***Manganese Control*** – PCWRA is under a permit compliance schedule to meet a dissolved manganese (Mn) limit of eighty micrograms per liter in 2019, which will maintain or improve overall water quality. Expected Town cost: $1,000,000.

- ***Rehab and Rehabilitation*** – The facility is subject to permit and monitoring requirements, reporting to the Colorado Department of Public Health and Environment, and must be in good working condition at all times. Equipment and infrastructure require maintenance, replacement and/or upkeep to remain in good working order, especially as the facility ages. Expected five-year cost: $1,420,000.
- ***Capital Expansion***: The existing PCWRA must be expanded to be able to treat future wastewater flows. Approximately $25M has been included in the CIP planning budget for this project, based on 2.6 MGD of additional treatment capacity estimated to be needed based on the Town's projected growth and influenced by peak loading events. During the design of the capital expansion, consideration will be given to the inclusion of advanced treatment processes to remove phosphorus that could allow treated effluent to be conveyed to the Rueter Hess Reservoir for storage. Other options for advanced wastewater treatment could include planning for indirect or direct potable reuse, which would also require additional advanced treatment at the Town's Plum Creek Water Purification Facility (PCWPF).

2021 – 2025 Planning Horizon - Capital Improvement Projects:

Six projects have been tentatively identified as required in this timeframe to meet build-out conditions. Growth rates in the next decade will largely determine the timing for these projects, and several could be driven by road improvement projects and/or commercial development. Other capital projects are often identified for major rehabilitation or replacement of existing facilities. For example, in 2017 a major project is planned to replace pumps and failing seals at the Castle Oaks Lift Station. Castle Rock Water is also retrofitting most of the lift station wet wells with mixing systems to reduce the accumulation of FOG (fats, oils and grease) that interfere with efficient pumping.

- ***Kinner St. Sewer*** – This project is to upsize nearly 3,000 linear feet of existing 18 and 21-inch sanitary sewer main to 21 and 24 inches, respectively. This project involves a crossing of Interstate-25, East Plum Creek, and Wolfensberger Road. Development in and around Kinner Street and Wolfensberger Road could dictate that this project be completed sooner than anticipated. Estimated costs: $2.12 M; to be completed in 2021.

- ***Prairie Hawk Interceptor*** – This project is to upsize over 1,600 linear feet of twelve-inch sewer to 18 or 21 inches. The project begins at manhole SMH1362 and ends at manhole SMH1249, near Atkinson Way. Modeling indicates this project could be delayed to the future; however,

development in the area could drive completing sooner. Estimated costs: $417,000.

- ***Malibu Street Upsize*** – This project replaces 1,130 linear feet of existing 15-inch old clay sewer pipe to 24-inch diameter new PVC sewer main. Timing for this project, in an industrial area of Town, could be driven by road improvements and/or development in the corridor. Estimated costs: $387,000.

- ***Plum Creek Interceptor North Upsize*** – This project upsizes over 2,415 linear feet of existing 27-inch diameter gravity main to the ultimate size of 36 inches. The project begins near the Atrium Drive entrance to the Factory Shops and ends north of Castlegate Drive. This project was investigated in 2015 for fast track completion due to the Promenade development; however, a lack of information surrounding CDOT plans for the corridor led to the decision to delay, since hydraulic capacity is not an issue. Modeling indicates the project could be delayed to beyond 2026; however, State Highway 85 improvements could force the project to be completed sooner, so it remains in the ten-year planning window. Estimated costs: $764,000.

- ***Plum Creek Old WWTP Upsize*** – This is a project to upsize almost 300 linear feet of sewer main from 18 inches to 27 inches, which runs through the old WWTP, and replace/rehab four manholes. The project is required to gain extra capacity in sections of gravity main that are at minimum slope. Estimated costs: $171,000.

2026 – Build-out Planning Horizon - Capital Improvement Projects:

- ***Plum Creek Interceptor PCWRA Upsize*** – This project upsizes 2,270 linear feet of the existing 27-inch interceptor to 36 inches in the area east of State Highway 85, beginning north of Castlegate Parkway and continuing to the PCWRA influent manhole. Estimated Costs: $641,000.

- ***Plum Creek Interceptor South Upsize Phase 1*** – This project upsizes over 1,500 linear feet of existing 24-inch gravity main to 27 inches. A parallel gravity main to complement the existing interceptor may be an option. Estimated costs: $440,000.

- ***Plum Creek Interceptor South Upsize Phase II*** – This project upsizes over 4,300 linear feet of existing 24-inch gravity main to the ultimate diameter of 36 inches. The project includes a probable bored crossing of the railroad. Estimated costs: $1.36 Million.

6. Recurring Capital Improvement Projects

Several programs are funded yearly and are shown in Table 5-2. A description of each follows:

- ***Lift Station Upgrades*** – This is a program to cover improvements to existing lift stations improvements, lift station pump, motor and variable frequency drive (VFD) replacement, and lift station access drive paving. This program is funded at almost $500,000 in 2017 and then funding averages $210K per year thereafter. A major project in 2017 will replace and upsize the pumps at the Castle Oaks Lift Station to be prepared for future condition flows that are almost double the current demand.

The mixing system in action - after just a few hours, the blanket has been significantly reduced.

In 2015 a mixing system was installed in the wet well at the Mitchell Creek Lift Station to reduce the accumulation of fats, oil and grease (FOG) into a sludge blanket, thereby reducing O & M time spent removing the FOG blanket. The project was so successful that similar projects are planned at other lift stations. The Castle Oaks Lift Station will be completed in 2016.

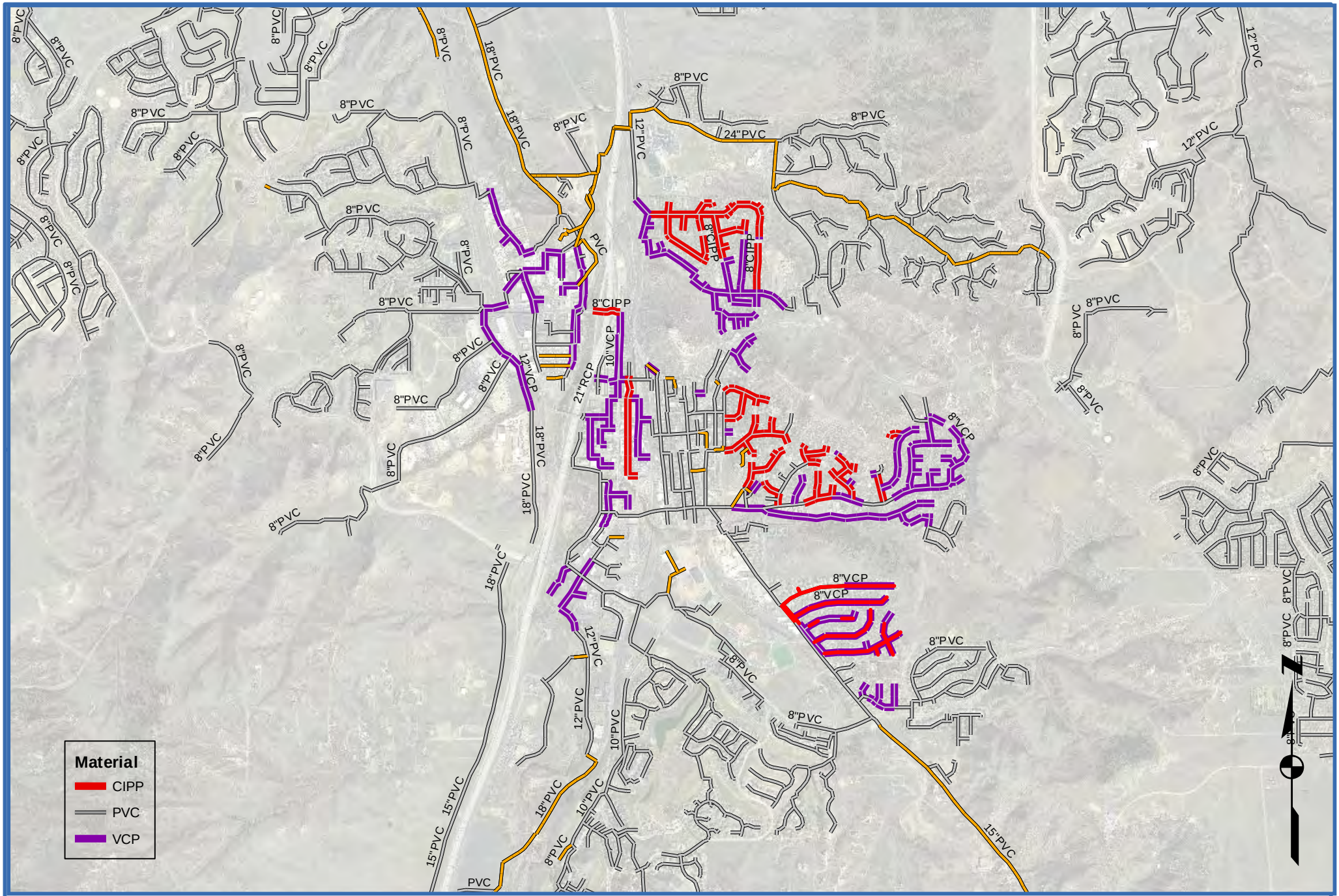
- ***Sewer Line Rehab and Replacement*** – A program to cover the repair, rehabilitation and replacement of aging infrastructure, this program is funded at $350,000 per year. Typical rehab projects include point repairs, cured in place pipe (CIPP) lining of old or damaged sewer mains, and complete replacement of sewer mains that can't be rehabilitated.

The service life of clay pipe can be extended many years by the in-situ method of cured-in-place pipe (CIPP) lining, which has a minimum expected life of 50-75 years. The lining effectively seals joints and is a very effective deterrent to root intrusion. Rehabilitation now by the installation of a CIPP liner, before the pipe deteriorates to a failed condition that might require a street-cut to repair, is more cost effective, can be completed with minimal disruption to service and results in less future maintenance. Over 20,000 linear feet of old clay pipe have been

rehabilitated with CIPP lining. Over 9,200 linear feet was lined in the Castle North neighborhood under the 2016 Sewer Rehab Program. The remaining CIPP work in out years will be in the Downtown area (east and west of I-25) and the Young American area. Any clay pipe that is to be upsized, such as the Malibu Street Sewer, will be replaced instead of rehabilitated. See Figure 6.1 for a location map of existing clay pipe and pipe that has been rehabilitated with CIPP.

Pre-CIPP: Barbi Court sewer line pre-rehab; notice the cracks at the joint and minor root intrusion

Post CIPP: Same pipe after rehab with cured in place pipe; the liner seals cracks and joints and eliminates I/I and future root intrusion.


Material
CIPP
PVC
VCP
8"PVC
8"CIPP
8"VCP
10"VCP
12"VCP
18"PVC
21"RCP
24"PVC
15"PVC
12"PVC
10"PVC
2,600 1,300 0 2,600 5,200
Feet
1 inch equals 0.5 miles
VICINITY MAP
FIGURE 6.1
CASTLE ROCK UTILITIES
SEWER PIPE MATERIALS
2016, VCP AND CIPP

- ***Security and SCADA Improvements*** – A program to cover security and SCADA installations/improvements, such as fences, gates, alarms, and communications, at wastewater facilities. This program is funded $50,000 per year.

Electrical and SCADA panels were replaced at the Meadow 5 Lift Station; parts for the old panels were obsolete and impossible to replace.
Project Cost: $49,000

- ***Plum Creek Water Reclamation Authority Capital Buy-in*** – This program covers the Town of Castle Rock's share of PCWRA debt, which includes two Colorado Water Resources and Power Development Authority (2001 and 2002) loans and Clean Water Revenue Bonds Series 2005, for capacity expansion and treatment. The program also provides funding for capital repair and replacement. The 2005 plant expansion should meet the Town's wastewater needs through 2020. Smaller plant improvements are planned to maintain or improve effluent water quality and improve operational flexibility. Future capital improvements could be required to meet changing effluent water quality standards, as directed by either CDPHE or the EPA. Planned future projects include equipping the third oxidation ditch at the PCWRA (this project is underway and scheduled to be complete by April 2017), which will increase firm treatment capacity from 4.4 MGD to 6.44 MGD, the design condition.

7. Operations and Maintenance Costs

Total operations and maintenance costs for wastewater collections and treatment activities totaled $3,386,524 for 2016. These costs, broken down by major function, are shown in the table below. These annual costs result in a key performance indicator (KPI) of $2,508 per MGD of wastewater collected and treated, which puts the Town near the national median.

Function/Yearly Total	2016	2015	2014
Facility Maintenance	$276,224	$308,122	$350,201
Field Services	$627,097	$495,294	$537,735
Plant Operations	$2,362,159	$2,544,389	$2,522,186
SCADA	$121,044	$85,680	$70,613
TOTAL	$3,386,524	$3,433,485	$3,480,737

Manpower/Staffing

The wastewater fund has 4.30 full-time equivalents (FTEs) in the Field Services Division of Castle Rock Water. These positions are responsible for the day-to-day operation and maintenance of ten lift stations, and over 270 miles of sewer pipe that serve more than 20,000 wastewater service accounts. The Facilities Maintenance division of Castle Rock Water has 2.0 FTEs dedicated to the wastewater fund. Plant mechanics are responsible for most preventive maintenance and repair of electrical/mechanical equipment at lift stations and other wastewater facilities. The wastewater fund also funds 2.46 FTEs in the Engineering/GIS Division. Engineering provides support to operations and manages the capital programs and projects. GIS provides mapping and asset management support. Customer Relations, Billing, SCADA and Administration are also partially funded from the wastewater fund and total 5.0 FTEs. Overall, there are 13.75 FTEs funded from the wastewater fund. Based on total wastewater flows and total wastewater funded employees, the Town scores a KPI of 0.22 for MGD processed per employee, placing the Town in the top quartile nationally based on AWWA performance tracking programs.

Energy

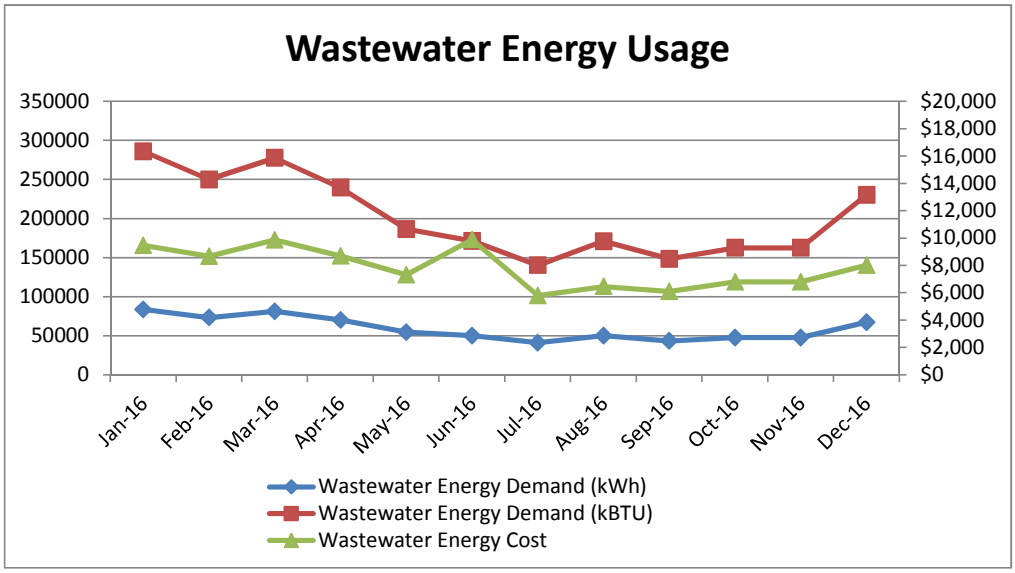
Wastewater energy costs average just over $7,800 per month, and do not include any energy costs incurred at the wastewater treatment plants. Wastewater energy costs are due mostly to the pumping costs and heating/cooling costs incurred at the ten lift stations. The lift stations are heated in the winter to ensure pipes don't freeze. The pumps and other electrical components generate heat that must be offset in the summer months by air conditioning and cooling. Figure 7.1 shows the energy demand and costs by month for 2016.

Figure 7.1

CASTLE ROCK WATER
WASTEWATER ENERGY DEMAND FOR 2016

Month	Wastewater Energy Cost	Wastewater Energy Demand (kWh)	Wastewater Energy Demand (kBTU)
Jan-16	$ 9,465	83,834	286,053
Feb-16	$ 8,673	73,308	250,137
Mar-16	$ 9,869	81,424	277,830
Apr-16	$ 8,698	70,258	239,730
May-16	$ 7,323	54,676	186,562
Jun-16	$ 9,889	50,258	171,487
Jul-16	$ 5,803	41,052	140,075
Aug-16	$ 6,462	50,173	171,197
Sep-16	$ 6,094	43,498	148,421
Oct-16	$ 6,809	47,670	162,657
Nov-16	$ 6,809	47,670	162,657
Dec-16	$ 8,016	67,547	230,480
Totals for 2016	**$ 93,911**	**711,368**	**2,427,288**
Totals for 2015	**$ 104,417**	**806,646**	**2,752,390**
Increase (-Decrease)	**$ (10,506)**	**(95,278)**	**(325,102)**
% Increase (-Decrease)	**-10%**	**-12%**	**-12%**

1 kWh = 3412.14 BTU



Equipment

In the 2010 master plan, Castle Rock Water identified a need for CCTV equipment to allow for increased capability to clean and inspect the wastewater infrastructure. In 2012 the business case was developed and funding approved for the purchase of a new van, CCTV equipment and software, at a cost of $185,000, to do all CCTV inspections in-house. An additional full-time staff member was also approved and hired to complement that staffing level. The goal in funding the CCTV truck is to meet the target of fully inspecting the collection system every three years. In 2015, a tracked wheel easement machine was purchased to improve the ability of staff to reach manholes located in open space and off road areas. The easement machine can safely traverse slopes that trucks can't safely or easily maneuver along. This allows staff to perform maintenance and inspections on out of the way sewer mains without taking the large vactor truck out.

New easement machine to reach out of the way manholes and sewer mains.

Asset Management

In the 2010 master plan, Castle Rock Water identified a need to invest in asset management software/hardware that would integrate with the Town's GIS system, in order to capture data that would facilitate the ongoing maintenance and operation of the collection system. Additionally, the software would assist in

record keeping of the vast amounts of data collected from the yearly cleaning and CCTV effort, and assist in prioritizing the allocation of rehabilitation funds for the collection system.

Capacity Management Operation and Maintenance, otherwise known as CMOM, is a highly structured program of best management principles, tools, and goals to manage the collection system to best prevent sanitary sewer overflows (SSOs). At this time, the program has not been formally promulgated by the EPA as a federally mandated requirement, but guidance has been available for several years. An asset management system is a critical component of a successful CMOM program.

In 2014, Castle Rock Water staff, working in conjunction with the Town of Castle Rock's Division of Innovation and Technology (DoIT), evaluated several potential commercially available asset management software programs. The decision was made to invest in Cartegraph OMS, an ARCGIS centric program that could be used across many different user classes in Castle Rock Water, including the wastewater collections program. Functional integration with the proprietary CCTV software, which can generate sewer pipe scores based on classification of defects, is achievable although not yet realized, and will assist in prioritizing sewer rehabilitation projects. The asset management program is also being used to track lift station operations and maintenance, physical assets (installation cost, service life and replacement costs) and work-order histories.

Operations and Maintenance Policy and Programs

Several policy and programs drive the Operations and Maintenance costs. Foremost, levels of service drive day-to-day operations. Expected levels of service are that less than one percent of customers will experience a sewer service backup or failure on a monthly basis. CIRSA, the Town's insurance underwriter, has the expectation that one third of the collection system is adequately cleaned and inspected each year, and that is the target goal for the CCTV inspection program. EPA direction on Capacity Management, Operations and Maintenance (CMOM), although not promulgated yet as a rule, has similar expectations and goals, but additionally has minimum manpower expectations and is considered best management practice. PCWRA has requirements to minimize slug-loading at the treatment plant, which has implications for the manner in which the lift stations, water treatment plants residuals, and collection system are operated and maintained.

Castle Rock Water has scheduled Operations and Maintenance (O&M) for all ten of the force mains. Each of these force mains are cleaned (pigged) once a year, with the exception of Castlewood 1, which is pigged quarterly or when flow decreases to an unacceptable level. Associated with each force main is a lift station, two of which have odor control facilities downstream. The odor control facilities are inspected twice weekly. There are injection points for bioxide (a chemical odor neutralizer) at four of the ten lift stations: Castle Oaks, Mitchell

Creek, Meadows 17, and Castlewood 1. Castle Rock Water has three siphons, two with grinders, that receive scheduled cleaning, maintenance and inspection. Additionally, the Town has identified 61 stream crossings by sewer mains/force mains; these stream crossings are inspected twice per year for integrity.

The Collections O & M budget for 2017 is just over $100,000, distributed as shown in the table, and excludes personnel costs, energy costs, and treatment costs:

Operating Supplies	$25,000
Parts	$ 8,000
Capital Equipment Purchases	$25,000
Purchased Equipment Repair Services	$18,000
Purchased Line Repair Services	$25,000

These funds, along with the resources of the vactor-truck, the CCTV van, and Castle Rock Water full-time personnel, combine to keep the O & M Collections Program effective and productive. The Town's 2016 sanitary sewer overflow rate of 0.76 SSOs per 100 miles of pipe puts the Town in the top quartile nationally based on AWWA key performance indicators.

8. Financing

Castle Rock Water, as part of its 2016 Utilities Rates and Fees Study, authorized Arcadis Consulting (Arcadis) to review its wastewater rates and development impact fees. The purpose of this study was to provide the Town with a thorough review of its wastewater rates and development impact fees and the underlying assumptions, and provide updated rates and fees for 2017 through 2021. This section contains summary information referenced directly from the Arcadis studies. For more detailed information on the 2016 rates and fees study, please see those reports. Castle Rock Water currently charges wastewater customers a monthly service charge that consists of a customer charge and demand charge, plus a uniform volume rate for wastewater flow that has been estimated using the average winter monthly consumption of water (AWMC).

Rate Analysis Results

Cost-of-Service Methodology

The basic philosophy behind a cost of service (COS) methodology is that utilities should be self-sustaining enterprises that are adequately financed with rates that are based on sound engineering and economic principles. In addition, rates should be equitable and proportionate to the costs of providing service to a given type of customer. Moreover is the expectation that growth pays for growth and that system development fees should reflect and support this development model.

Revenue Requirements

Wastewater rates are based on the Town's projected revenue requirements to operate and maintain the Town's wastewater system, along with the wastewater CIP. The Arcadis 2016 Rates and Fees Report projects that Castle Rock Water's 2016 total wastewater revenue required from rates is estimated to be $9.3 Million. The wastewater fund financial plan projects the fund's sources and uses of funds. The wastewater utility financial model includes four sub-funds:

- Operating
- Debt Service
- Capital Reserve
- Rate Revenue Stabilization Reserve

Arcadis prepared a long-term financial plan to project the revenues required for each of the Town's Castle Rock Water funds. The financial plans allow the integration of debt, accumulation/use of reserves, and other assumptions to finance the Town's utility system operations and maintenance (O&M) expenses and capital improvements for each respective utility. Using ratemaking terms, the financial plan calculates for each utility fund the annual user charge revenue requirements. These are based on the cost of providing utility service. The projection period developed for each utility financial plan was driven by the length of the Capital Improvement Program (CIP). The projection period for the

wastewater fund is 35 years, from fiscal year 2016 through fiscal year 2050. In the Arcadis report, revenue requirements and capital improvement programs are presented only for the 2016 through 2021 study period.

The Town's proposed wastewater fixed charges and wastewater volumetric rates for 2017 through 2021 are shown in Table 8-1. Castle Rock Water currently charges wastewater customers a monthly service charge that consists of a customer charge and a demand charge, plus a uniform volume rate for wastewater flow that has been estimated using the account's average winter monthly consumption (AWMC). The proposed 2017-2021 wastewater rates will be charged in the same manner.

Table 8-1
Proposed 2017 – 2021 Wastewater Monthly Service Charges

Water Meter Size	*Existing 2016*	*2017*	*2018*	*2019*	*2020*	*2021*
¾"	$9.30	$9.30	$9.30	$9.30	$9.30	$9.30
1"	$14.80	$14.80	$14.80	$14.80	$14.80	$14.80
1½"	$21.46	$21.46	$21.46	$21.46	$21.46	$21.46
2"	$30.96	$30.96	$30.96	$30.96	$30.96	$30.96
3"	$51.72	$51.72	$51.72	$51.72	$51.72	$51.72
4"	$120.58	$120.58	$120.58	$120.58	$120.58	$120.58
6"	$190.48	$190.48	$190.48	$190.48	$190.48	$190.48

Wastewater Volumetric Rate **($/1,000 gallons)**

	Existing 2016	*2017*	*2018*	*2019*	*2020*	*2021*
All Customers per gal	$6.59	$6.59	$6.59	$6.59	$6.59	$6.59

Wastewater System Development Fees

Arcadis applied a combined approach for calculating the Town's System Development Fees (SDFs) for its wastewater system. The equity buy-in component; however, is divided into buy-in for the Town's existing wastewater system and a buy-in for treatment-related assets by the Plum Creek Water Reclamation Authority (PCWRA). PCWRA is the primary treatment entity for the Town's flows and has invested significant capital in plant expansions. The Town owns 71 percent of the capacity at PCWRA and actively participates in its management through the Board of Directors. The Pinery Water and Wastewater District provides for wastewater treatment of flows from the existing Cobblestone Ranch area of town, and may provide service for future annexations. The Town collects wastewater treatment fees from residents in The Pinery service area and reimburses The Pinery for treatment. The Town retains the rights to the return

flows from wastewater treated for the Town by The Pinery. Those return flows currently are captured in the Rueter-Hess Reservoir for future reclaim by the Town. For a more detailed description of the full rates and fees analysis, please see the 2016 Utilities Rates and Fees Study. The Arcadis Report recommends the Town escalate the 2016 SDF by 2.96 percent, beginning in 2017.

Table 8-2 shows proposed fees based on meter size.

Table 8-2
Existing and Proposed Wastewater SDFs

Meter Size	SFE	Meter Capacity (GPM**)	Existing 2016	2017	2018	2019	2020	2021 and thereafter
5/8" x ¾"	.67	20	$2,173	$2,303	$2,367	$2,433	$2,502	$2,572
¾" x ¾"	1.00	30	$3,243	$3,437	$3,533	$3,632	$3,734	$3,839
1"	1.67	50	$6,416	$5,740	$5,900	$6,065	$6,236	$6,411
1.5"	3.33	100	$10,799	$11,445	$11,765	$12,095	$12,434	$12,784
2" C2	6.67	200	$21,631	$22,925	$23,565	$24,225	$24,906	$25,606
2" T2	8.33	250	$27,014	$28,630	$29,430	$30,255	$31,104	$31,979
3" C2	16.67	500	$54,061	$57,295	$58,895	$60,545	$62,246	$63,996
3" T2	21.67	650	$70,276	$74,480	$76,560	$78,705	$80,916	$83,191
4" C2	33.33	1,000	$108,089	$114,555	$117,755	$121,055	$124,454	$127,954
4" T2	41.67	1,250	$135,136	$143,220	$147,220	$151,345	$155,596	$159,971
6" C2	66.67	2,000	$216,211	$229,145	$235,545	$242,145	$248,946	$255,946
6" T2	83.33	2,500	$270,299	$286,405	$294,405	$302,655	$311,154	$319,904

References

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CH2M Hill, 2003. Town of Castle Rock Wastewater and Reclaimed Water Master Plan

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Carollo Engineers, Plum Creek Water Reclamation Authority, Utility Plan Update and Preliminary Engineering Services, Technical Memorandum No. 1, Treatment Analysis, Final, February 2015.

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