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REPORT

July 2022

CITY OF

Rutland

VERMONT

CSO Long Term Control Plan



July 19, 2022

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EXECUTIVE SUMMARY

Weston & Sampson, in conjunction with the City of Rutland, have been involved in a long-term process in understanding the characteristics of their Combined Sewer System (CSS). After an initial effort in 2017 to collect data and build a hydrologic and hydraulic (H&H) model of the wastewater collection system, additional information was required in order to determine what measures should be taken to reduce the amount and number of occurrences of combined sewer overflow (CSO) events and help advance the City toward meeting the goals of the Vermont Combined Sewer Overflow Rule. This long-term control plan (LTCP) represents the outcome of this five-year study.

The City of Rutland owns and operates a combined sewer system that serves the City of Rutland, portions of the Town of Rutland, and portions of the Town of Killington which are located near the Killington Mountain Resort. Portions of the sewer service area include combined sanitary sewer and stormwater collection systems, mostly located in Rutland City. Originally built in the 1860's, the system initially directly discharged sewage into the receiving waters, East Creek and Otter Creek. Since the early 1960's, the City has worked to improve water quality by constructing a Wastewater Treatment Facility (WWTF), then steadily increasing the amount of combined sewage that can be conveyed through the system and separating stormwater drainage lines from the sanitary sewer system. As a continuation of this effort, the City is developing and prioritizing alternatives to further reduce the occurrence of Combined Sewage Overflow (CSO) events in accordance with State of Vermont regulations and policies.

On May 18, 2018 an Administrative Consent (1272) Order was issued from the VT DEC to the City of Rutland. This Order consists of two primary requirements: (1) to implement the 9 Minimum Controls to reduce the quantity of CSO discharges and reduce the pollutants discharged to the extent practicable and (2) to develop this Long-Term Control Plan.

Project Goals

Discharge of combined sewage into waters of the state poses a threat to public health and impacts the natural environment as well as the tourist-based economy. The goals of this Long-Term Control Plan (LTCP) are to:

- Better understand the hydraulic and hydrologic performance of the sewer system,
- Reduce the amount of CSO activations in the City of Rutland's sewer system by designing alternatives sized for the 5-year, 1-hour and 5-year, 24-hour storm event,
- Better understand the current water quality of the East and Otter Creeks and how CSO discharges currently impact it, and
- Prepare conceptual project costs for the alternatives chosen and prioritize implementation based on a matrix,
- Engage with the public throughout this process.

In order to accomplish these goals, it is recognized that full implementation may take several National Pollutant Discharge Elimination System (NPDES) permit cycles. As such, the current effort is to identify projects that the City can undertake over the next 5-year period to advance CSO abatement efforts.

Existing Wastewater System

The existing wastewater collection system consists of over 450,000 feet of gravity sewer, more than 1,500 sewer manholes, 11 sewage pump stations and four active regulator structures (CSOs). Historically, there were eight CSO outfalls, serving 9 regulators (overflow points), in the City's wastewater collection system. Three of these CSOs have been removed as part of past CSO abatement efforts, and one outfall designation is the ultimate discharge point for two other regulators. There are currently 6 CSO regulators, with 4 points of discharge: one discharge on the Otter Creek and three discharges on the East Creek. Since the mid 1980s, the City of Rutland has undertaken in excess of $17M worth of CSO abatement projects including the following:

- Addition of a second headworks at the Wastewater Treatment Facility (WWTF) to allow screening of increased wet weather flows;
- Installation of a second 20" sewage force main from the River Street Pump Station (RSPS), the City's main lift station feeding all wastewater to the WWTF;
- Numerous improvements to the RSPS to increase pumping capacity, control system redundancy and hazard event mitigation;
- Installation of additional primary settling capacity at the WWTF; and
- Modifications to overflow regulators to allow for increased storage of CSO volume within the wastewater collection system.

System Modeling

A 15-week wastewater collection system flow metering program was undertaken in 2020 This program provided valuable flow data and depth measurements within the system which allowed for calibration of the H&H Model developed as part of an earlier effort. Once the model was validated, using a June 28, 2020 5-year, 1-hour event, the model could be used to approximate what the total CSO discharge volume would be during a selected evaluation storm, agreed upon by the City and the Vermont ANR: a 5-Year, 24-Hour storm. The validated H&H model predicted a total CSO activation volume of 11.84 million gallons (MG) under the conditions created within the wastewater collection system by this theoretical storm event.

Development of CSO Abatement Projects

The general types of projects that were identified which would allow the City of Rutland to achieve "0" CSO discharge below the evaluation storm fell into three primary categories: (1) storage improvements, (2) capacity improvements and (3) combined sewer separation. Twenty-two projects were identified and modeled to confirm that the aggregate total CSO abatement would meet the stated goals of this program. Conceptual designs were completed for all of these projects, and the resulting anticipated project cost, should the City undertake all of these improvements, exceeds $135M.

Understanding that it is unrealistic for the City to take on $135 million worth of CSO abatement projects in the next five-year planning period, Weston & Sampson proposed that the list of all CSO abatement projects be sorted in order by cost-effectiveness. Projects were ranked in order by their cost-effectiveness in total dollars of project cost per gallon of combined sewage removed from receiving waters. By looking at the list of projects in terms of cost-effectiveness, the City could identify which projects should be undertaken first. Additional weighting factors were also considered by the City, such as (1) proximity to other capital projects, (2) state of preparedness to construct and (3) which projects need to be combined in order to achieve the stated reduction in CSO discharge (ie. Capacity

improvements at the WWTF can not be realized until the RSPS is upgraded to get the needed flow to the WWTF). These factors were considered heavily in the City's selection of projects to advance from the preliminary abatements project list of 22 projects to the final 5-Year Project Implementation Schedule.

Proposed 5-Year Project Implementation Schedule

The City of Rutland has identified 8 separate CSO Abatement Projects that they wish to advance, at some level, over the next 5 fiscal years. These projects include:

1. CSO Check Valves: Installation of check valves on outfalls from CSO regulators will prevent river water from backing up into the wastewater collection system and occupying valuable transmission and treatment capacity, resulting in less capacity to abate overflows. In addition, installation of these check valves is critical to the success of the proposed storage projects which will equalize and store combined sewage so until the WWTF can treat this stored volume.

2. Vernon St. Sewer Separation: While this combined sewer separation project is not one of the highest ranked projects using cost effectiveness, it has been designed and could be bid and constructed in the next several years. Additionally, this project is located in an area identified by the City as in need of potable water utility replacement and pavement restoration. Finally, previously completed work (the Adams Street swirl concentrator project) has built a treatment and outfall that this project can tie into, simplifying the remaining work needed to bring this project into a state that can be issued for construction bids.

3. South Main Street Separation: This combined sewer separation project is more highly ranked than Vernon Street in order of cost-effectiveness. Originally envisioned as the completion of a partially-completed sewer separation project, stakeholder input revealed a secondary benefit to the work (alleviating flooding on Clover Street), and City research determined that a fee-simple access to Moon Brook was possible on Clover Street. The limited amount of storm drain and other infrastructure needed to fully separate over 20 acres of combined sewershed makes this project an attractive one for the five-year plan.

4. Connor Park Storage (Phase 1): The proposed CSO storage facility in Connor Park ranks toward the higher side of the cost-effectiveness scale and will serve to eliminate discharge of approximately 1.1 MG of combined sewage from the surface waters, beneath the evaluation storm event. Additionally, this storage project works in conjunction with improvements at the RSPS and the WWTF to maximize treatment of combined sewage using the existing infrastructure.

5. WWTF Improvements: As noted previously, the City of Rutland has expended in excess of $17M over the past 30 years to address CSO discharges from their wastewater system. A large portion of this has been in an effort to maximize treatment capacity of combined sewage at their WWTF. Examples of these projects include: upgrades to the RSPS, a second force main to the WWTF, construction of a second headworks, installation of additional grit removal facilities and construction of a third primary clarifier. By undertaking construction of a diversion structure and a storm flow disinfection facility (adjacent to their existing chlorine contact chambers) the City will have maximized their use of the existing treatment system, one of the EPAs 9 Minimum Controls.

6. RSPS Improvements: In order to maximize treatment at the WWTF, combined sewage equal to that treatment capacity must be able to be conveyed to that location. Upgrading the controls and slightly increasing pumping capacity during storm events will accomplish this. Project 5 and Project 6, while separate projects, will only realize their CSO removal potential when both have been completed.

7. Otter Creek Interceptor Upgrade: Closely related to improvements proposed for the WWTF and RSPS the Otter Creek interceptor improvements will increase flow capacity from the southern portion of Rutland's wastewater collection system to the RSPS. The existing 24-inch VC interceptor sewer acts as a "bottle neck", restricting flow to the pump station and reducing the ability of the existing infrastructure to treat to its fullest capability. Increasing the size of this interceptor will allow for the WWTF treatment capacity to be maximized. While this is also a separate CSO abatement project, Project 5 will only realize its full CSO abatement potential once this work has been completed.

8. Calvary Storage: The Calvary cemetery overflow CSO 001 has a lower cost-effectiveness ranking, however, this project will facilitate interceptor maintenance operations and help to reduce grit deposition in this portion of the wastewater collection system. By reducing grit deposition, system flow capacity can be maintained and downstream facilities, like the RSPS, will see a longer service life resulting from better grit management.

For each fiscal year in the 5-Year Project Implementation Schedule, there is a total added cost related to CSO abatement project design and construction which can be added to the City's current projected wastewater budget for each of these coming years. The total 5-year Implementation cost for CSO abatement projects would be approximately $13.16M.

Additional Recommendations

In addition to the list of eight projects selected for advancement by the City of Rutland over the next five fiscal years, there are several supplemental projects and recommendations to be considered which will help support these selected projects and help the City gain a more refined understanding of how their wastewater collection system behaves during different storm events. The more data that is gathered, the better the understanding of their system will be over time, and the better able the City will be to spend funds where they will have the largest impact on this issue. Additional recommended projects include:

- *Additional Flow Metering* - Weston & Sampson recommends that a more focused metering program take place in the vicinity of the collection system where data was gathered for sewer Flow Meters No. 4 and 5, referenced earlier in this report. Approximately 500,000 gallons of extraneous flows enters the system somewhere between these two meters during larger precipitation events. The flow metering program used to refine and increase the resolution of the current hydraulic model did not identify the source of these flows. If the source of these flows can be identified and remediated, it may preclude the necessity for design and construction of the Phase 2 Connor Park storage improvements, potentially saving the City millions of dollars.

- *Additional Permanent Rain Gauge Installations* - Additional rain gauge data from several locations around the City will help to refine our understanding of which overflows react when certain areas of the city are affected by a precipitation. The Vermont ANR, Water Investment Division has also given this recommendation. Weston & Sampson believes that three additional permanent rain gauge locations, with telemetry so that data could be gathered automatically, would be beneficial.

- *Completion of a Flow Restoration Plan* - The Storm Water Management Section of the Vermont Agency of Natural Resources as has requested that a Flow Restoration Plan for the Moon Brook be undertaken by the City of Rutland. Several of the storm water separation projects identified in this report will ultimately have discharges to the Moon Brook. Until conditions within the Brook are better understood and requirements of the Flow Restoration Plan are defined and accepted by the State of Vermont, storm water separation projects which discharge to this tributary should be deferred.

- *Projects Affected by Railroad Rights-of-Way* - Vermont Railway is looking to negotiate a "Master License Agreement" with the City of Rutland. The outcome of this negotiation will have significant financial impacts on any work done in or under a railroad right-of-way, Weston & Sampson recommends that any of the combined sewer separation projects that impact a railroad right-of-way be deferred until the Master License Agreement has been successfully negotiated.

- *Small-Scale Projects* - In addition to the larger projects recommended in the City's 5-year Project Implementation Schedule, there are many isolated areas throughout the City that have one or two catch basins (CBs) that are connected to the sanitary sewer. These smaller projects can be undertaken piecemeal by the City, when time and budget allows, or can be incorporated into other infrastructure projects that affect those areas. Over time, these small projects may have a significant beneficial impact on the amount of stormwater that enters this combined system.

Weston & Sampson very much appreciates the opportunity to have been a part of developing this report and we look forward to continuing our support of Rutland in their efforts to reduce CSO discharges into the East and Otter Creeks.

We wish to acknowledge the assistance provided to us during the development of this report by the City of Rutland Department of Public Works and their wastewater collection system and treatment staff.

1.0 INTRODUCTION & PROJECT PLANNING

The City of Rutland, Vermont owns and operates a combined sewer system that serves the City of Rutland, portions of the Town of Rutland, and portions of the Town of Killington which are located near the Killington Mountain Resort. Portions of the sewer service area include combined sanitary sewer and stormwater collection systems, mostly located in Rutland City. Originally built in the 1860's, the system initially directly discharged sewage into the receiving waters, East Creek and Otter Creek. Since the early 1960's, the City has worked to improve water quality by constructing a Wastewater Treatment Facility (WWTF), then steadily increasing the amount of combined sewage that can be conveyed through the system and separating stormwater drainage lines from the sanitary sewer system. As a continuation of this effort, the City is developing and prioritizing alternatives to further reduce the occurrence of Combined Sewage Overflow (CSO) events in accordance with State of Vermont regulations and policies.



Photo 1- Flow Metering Manhole

1.1 Project Goals

Discharge of combined sewage into waters of the state poses a threat to public health and impacts the natural environment as well as the tourist-based economy. The goals of this Long-Term Control Plan (LTCP) are to:

- Better understand the hydraulic and hydrologic performance of the sewer system,
- Reduce the amount of CSO activations in the City of Rutland's sewer system by designing alternatives sized for the 5-year, 1-hour and 5-year, 24-hour storm event,
- Better understand the current water quality of the East and Otter Creeks and how CSO discharges currently impact it, and
- Prepare conceptual project costs for the alternatives chosen and prioritize implementation based on a matrix,
- Engage with the public throughout this process.

1.2 State of Vermont CSO Regulations

Since the federal Clean Water Act was enacted in 1972, it was recognized that improvements to municipality's WWTFs would greatly improve water quality. The State of Vermont implemented a Combined Sewer Overflow Control Policy in June 1990, followed by a Federal EPA CSO Control Policy in April 1994. The most recent iteration of the Vermont CSO Rule (Environmental Protection Rules, Chapter 34) was issued in September 2016. Each of these policies progressively increased the standards for mitigation to better protect the surface waters of the state. As of the 2016 Vermont CSO Rule, the requirements for compliance are broken into two phases:

Phase 1

- Implement technology-based controls known as the Nine Minimum Controls (NMC), which include:
    1. Proper operations & maintenance of the collection system and CSO outfalls,
    2. Maximizing the use of the collection system for storage of combined sewage without endangering the public,
    3. Review and modify pre-treatment requirements to assure that CSO impacts are minimized,
    4. Maximize the flow of combined sewage to the WWTF for treatment,
    5. Prohibit CSO discharges during dry weather,
    6. Control the solid and floatable materials in CSOs,
    7. Establish pollution prevention programs to minimize contaminants in CSOs
    8. Provide public notification of CSO events, and
    9. Monitor to characterize CSO impacts and the efficacy of CSO controls
- Conduct a CSO Long Term Control Plan if receiving waters are not in compliance with the Vermont Water Quality Standards (VWQS)
- Assess improvements to the collection system to prevent discharge of the 5-year, 1-hour and 5-year, 24-hour storm event
- Establish and maintain a precipitation monitoring system
- Establish and maintain a CSO flow monitoring system

Phase 2

- Continue implementation of the NMC,
- Implement the recommendations of the LTCP

It is recognized that Phase 2 may take several National Pollutant Discharge Elimination System (NPDES) permit cycles to fully implement all the CSO controls outlined in the LTCP. One significant difference in the EPA's CSO rule compared to Vermont's CSO rule is that the EPA does allow a small number of CSO events to occur within a given year, while Vermont does not. The ultimate goal of Vermont's program is complete CSO elimination.

1.3 Location

The City of Rutland Vermont is located in Rutland County, the west-central portion of the state. The main waterbody that passes through the City is the Otter Creek, with several smaller creeks and brooks draining into Otter Creek in the area: East Creek, Moon Brook, Tenney Brook and Mussey Brook.

Several of those smaller creeks have been identified by the VT DEC as being impaired, requiring the development of a Total Maximum Daily Load (TMDL) to address those impacts and improve stream health. In particular, stormwater and temperature TMDLs exist for Moon Brook and Mussey Brook. Both of these waterbodies are considered impaired for E. Coli, but a TMDL has not been issued for that particular parameter. Temperature TMDLs are typically addressed by projects relating to streambank restoration (e.g. shade tree planting); the mitigation measures outlined in this LTCP will not have a measurable effect on stream temperature.

Urbanized watersheds affect streamflow due to the high amount of impervious cover present. Pavement prevents infiltration of rainfall, reducing stream baseflow. Pavement also generates high flow rates of runoff during larger storm events that cause erosive conditions in streams. Stormwater TMDLs are managed with the intent to increase baseflow for small storm events and reducing the peak flow for larger storm events.

In the projects that are considered in this report, none result in the creation of a new stormwater outfall on Mussey Brook. Several projects are proposed in the Moon Brook watershed, and close coordination with all relevant stakeholders will be necessary to ensure that CSO mitigation does not result in adverse stormwater impact to Moon Brook.

Vermont's Watershed Planning Program is charged with developing and implementing watershed management plans, called Tactical Basin Plans, which summarize existing water quality conditions and attainment of surface water uses, with identified priorities for surface water protection and restoration of degraded waters. The "Vermont Water Quality Standards", as well as the "Vermont Clean Water Act (2015)", require the development of Tactical Basin Plans for each of Vermont's 15 river basins to be adopted on a five-year recurring cycle.

Tactical Basin Plans identify and prioritize the projects or actions needed to protect or restore specific waters and identify appropriate funding sources to complete the work, based on monitoring and assessment data. Since these tactical plans will guide all watershed work supported by the Water Investment Division of the ANR, the issues identified in these plans are the ones that will be prioritized for management actions, including funding.

Designated as part of the Watershed Planning Program's Basin 3 - Otter Creek, Little Otter Creek and Lewis Creek, the streams noted at the beginning of this section ultimately discharge to Lake Champlain. Rutland's wastewater collection system, WWTF discharge and CSOs impact waters within Basin 3.

Chapter 4, Section D of the 2019 Tactical Basin Plan begins with a discussion regarding phosphorous control. By eliminating uncontrolled discharges of combined sewage into receiving waters, this LTCP will help reduce the amount of phosphorous introduced into the receiving waters via overflow. Additional discussion regarding Rutland City specifically includes the Northwest Neighborhood sewer separation project, a recently-completed separation project that has reduced the duration and volume of CSO discharge events. In the Basin 3 Implementation Table Summary, one strategy listed is "Support municipalities pursuing P optimization, expansion projects, and upgrades". This LTCP is a piece of this strategy that the City of Rutland can offer to help with the overall health of the Otter Creek.

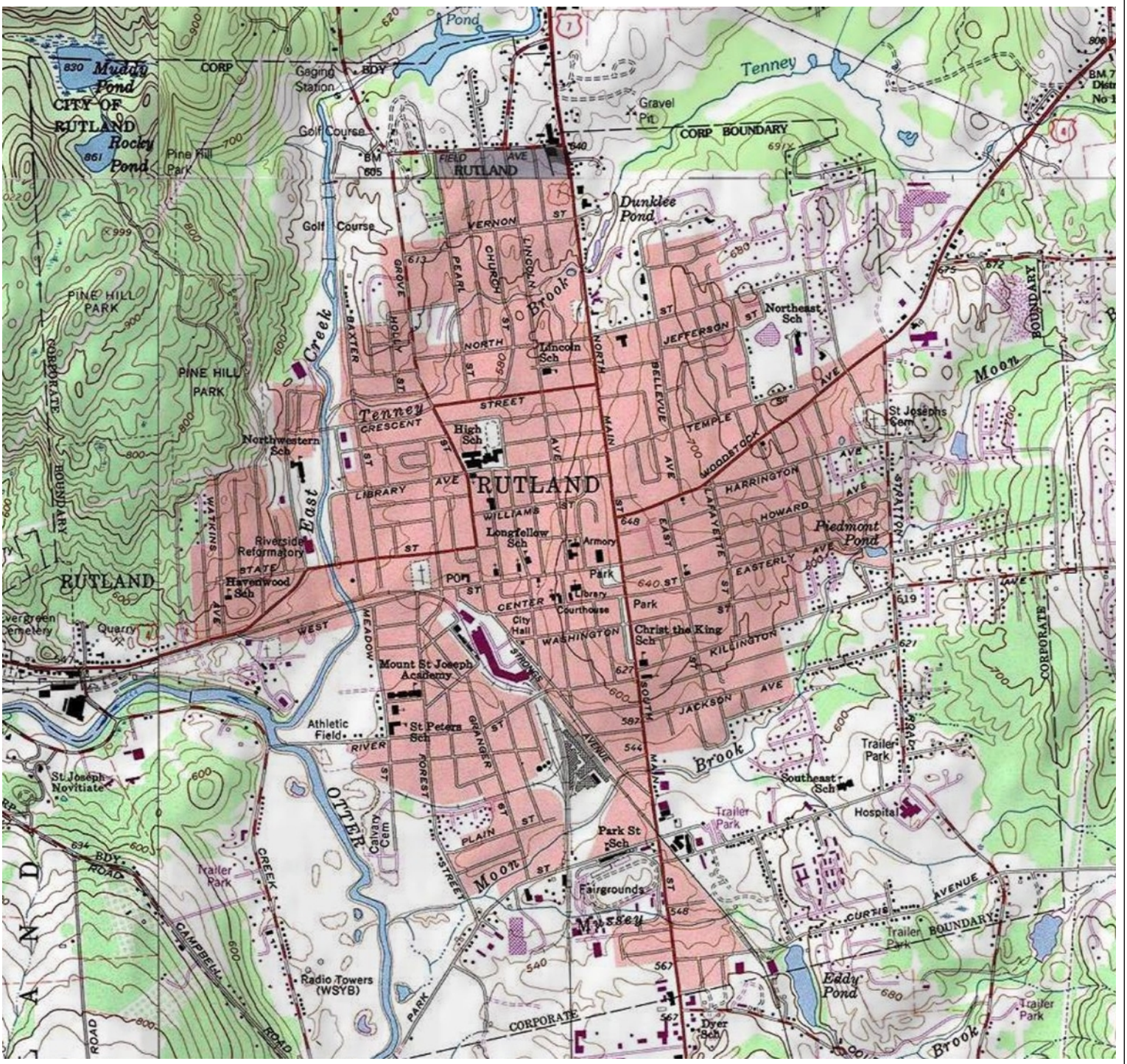
The Rutland wastewater collection system serves residential, commercial and industrial users within the service area. In addition to extending outside of the City limits to service the Town of Rutland, a large section of gravity sewer infrastructure extends from the City of Rutland, through the Town of Mendon, to the Killington Mountain Resort area. This sewer system, the "Alpine Pipeline" services the Killington Mountain Resort and homes and businesses along its path through Mendon to the City, along State Route 4. Please refer to **Figure 1**, **"Locus Map",** for a map depicting the City of Rutland and its boundaries as well as the geological and geographical features of this area.

VERMONT

Figure 1 - Locus Map

Vermont Agency of Natural Resources

vermont.gov





LEGEND

NOTES

Map created using ANR GIS mapping techology.

1: 27,668

October 7, 2021

1,406.0 0 703.00 1,406.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere 1" = 2306 Ft. 1cm = 277 Meters

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THIS MAP IS NOT TO BE USED FOR NAVIGATION

DISCLAIMER: This map is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. ANR and the State of Vermont make no representations of any kind, including but not limited to, the warranties of merchantability, or fitness for a particular use, nor are any such warranties to be implied with respect to the data on this map.

1.4 Environmental Resources Present

Refer to **Figure 2, "Environmental Resources Map"** for a Natural Resource Atlas map illustrating the known environmental resources present in the project area. For the purposes of this report, the "project area" is the Rutland gravity sewer service area. This service area is better defined in Section 2 of this report. The primary environmental resources of concern in the sewer service area are wetlands, flood hazard areas (floodways and 500-year floodplains), and hazardous waste sites (VCGI layers Hazardous Site, Hazardous Waste Generators, Brownfields, Salvage Yard, Aboveground Storage Tanks, Underground Storage Tanks (working), Dry Cleaners, Architectural Waste Recycling Service Area). The entire project area is part of the Urban Soil Background Area.

Wetlands that are listed on the Vermont State Wetland Inventory (VSWI) in this area are primarily located along streams. Depending on localized site conditions there may be additional wetland areas other than those illustrated in the mapping. During the final design process for any of these projects, site-specific wetland delineations will be conducted to confirm the presence or absence of these features.

Flood hazard areas are particularly extensive near the confluence of East Creek and Otter Creek. Due to the nature of the City's collection system, this area is also where all sewage is routed. The area is also where most of the viable green space for projects can be located. As none of the proposed projects in this plan involve the construction of new buildings within the floodplain or floodway, there will be no adverse impact to the ability of the floodplain to accommodate large volumes of water. With the implementation of particular projects, the ability for floodwaters to back into the collection system and cause surcharging will be reduced.

Hazardous waste sites are scattered throughout the sewer service area, particularly along the main City travel corridor of West Street. This has the potential for subsurface soils in the work areas to be contaminated. Excavated contaminated soils pose a potential threat to public health and the environment and require special management. Generally speaking, environmental due diligence involves the following approach:

- Screening for sites on the ANR Natural Resource Atlas,
- Perform historic map and photo review of suspect sites,
- Investigate known sites to determine if contamination has already been identified in the Right of Way,
- Compile a list of sites known to have contaminated the Right of Way,
- Determine if additional investigation is required prior to construction or instruct contractors to be prepared during construction to manage contaminated soils.

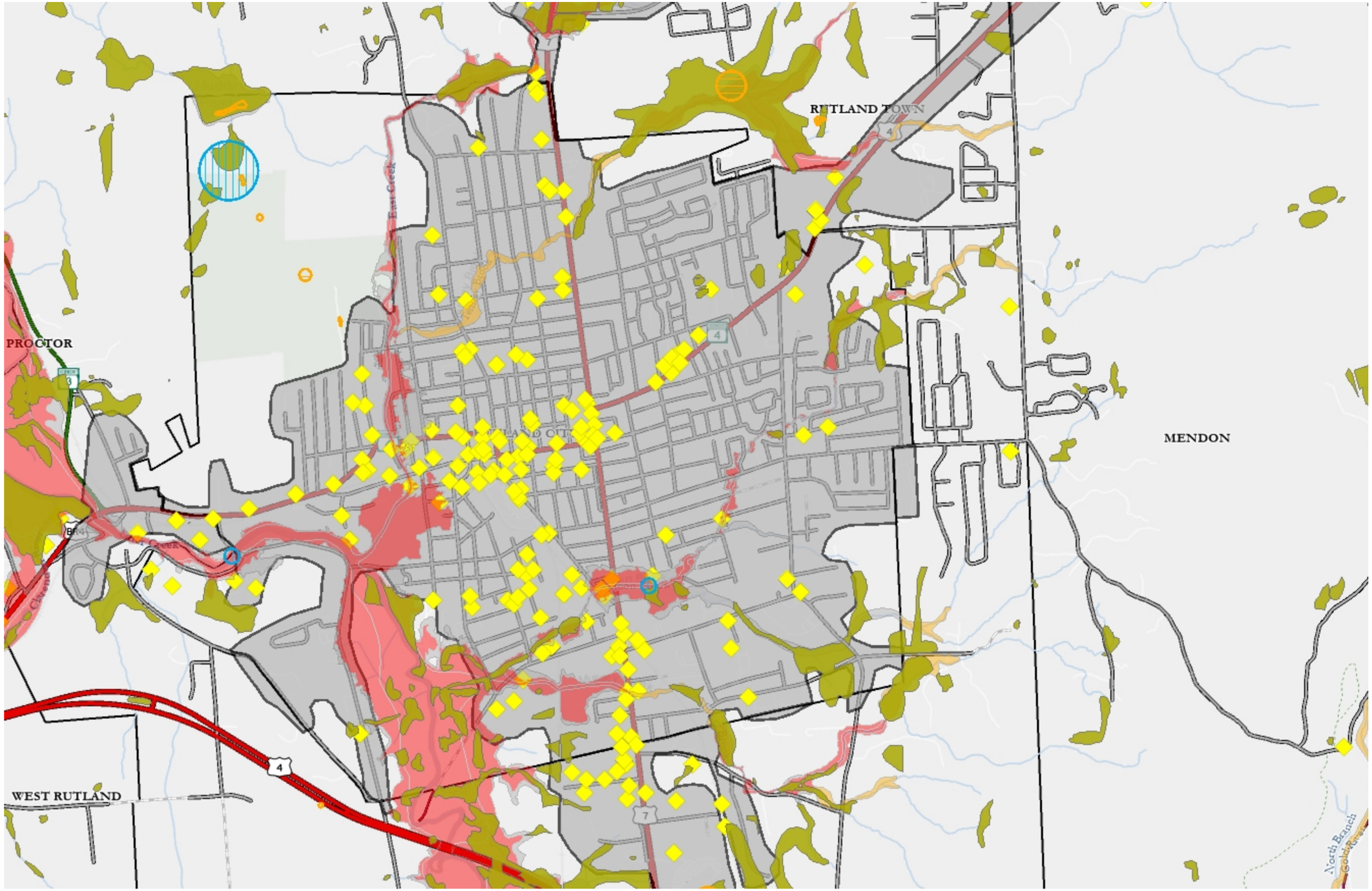
The VT DEC is currently developing guidance for investigating sites impacting linear projects, once this document is published it can be used to better define scope of work and costs associated with management of these environmental conditions.

VERMONT

Figure 2- Environmental Resources Map

Vermont Agency of Natural Resources

vermont.gov





LEGEND

Uncommon Species and Other Feature
- Animal
- Plant
- Natural Community

Wetland - VSWI
- Class 1 Wetland
- Class 2 Wetland
- Buffer

Flood Hazard Areas (Only FEMA-digitiz
- AE (1-percent annual chance floodplains with e
- A (1-percent annual chance floodplains without
- AO (1-percent annual chance zone of shallow f feet)
- 0.2-percent annual chance flood hazard zone

Hazardous Site

Sewer Service Area

Roads
- Interstate
- US Highway; 1
- State Highway
- Town Highway (Class 1)
- Town Highway (Class 2,3)
- Town Highway (Class 4)
- State Forest Trail
- National Forest Trail
- Legal Trail
- Private Road/Driveway
- Proposed Roads

Stream/River
- Stream
- Intermittent Stream

Town Boundary

1: 27,355

1in = 2280 ft.
1cm = 274 meters

1,390.0 0 695.00 1,390.0 Meters

WGS_1984_Web_Mercator_Auxiliary_Sphere

© Vermont Agency of Natural Resources. November 9, 2021

DISCLAIMER: This map is for general reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable. ANR and the State of Vermont make no representations of any kind, including but not limited to, the warranties of merchantability, or fitness for a particular use, nor are any such warranties to be implied with respect to the data on this map.

THIS MAP IS NOT TO BE USED FOR NAVIGATION

NOTES

Map created using ANR's Natural Resources Atlas

1.5 Population Trends

The City of Rutland has been slowly but steadily losing population and households over the past 30 years, with 16,495 residents as of the 2010 census, and 15,807 residents as of the 2020 census. Age distribution in Rutland tends to be substantially older than the United States and Vermont population. In Rutland City, 21.4% of the population is 65 or older, compared to 16.5% nationally and 20% statewide. The percentage of persons in poverty in Rutland City is 12.6%, compared to 11.4% nationally and 10.2% statewide. Refer to the US Census Bureau's "quick facts" information attached in **Appendix A, "Rutland Population Information and Projections".**

State of Vermont has projected population changes by county through 2030. In this report, released in August 2013 by the Vermont Agency of Commerce and Community Development, populations in Rutland County are expected to decrease by approximately 5.1% between 2010 and 2030. The Rutland City population is expected to decrease by 10.1% over the same period. An excerpted copy of these projections for Rutland County are attached in **Appendix A.**

The growth trends specified here will not have an appreciable impact on the design parameters for this project. Wet weather events and wastewater system configuration are the primary causes for CSO discharges which are independent of population size. While populations are decreasing in the City, the amount of impervious area is not decreasing, therefore the amount of combined sewage is not anticipated to decline significantly as a result of population decrease.

1.6 Community Engagement

As part of the process of developing this Plan, two public meetings have been included in the scope of work. The first meeting was held on August 2, 2021 at the Rutland City Hall and provided interested stakeholders an overview of the recently completed sewer system Hydraulic and Hydrologic (H&H) model, the goals of the current CSO long-term control planning efforts and the CSO abatement alternatives which are being considered for further development.

A second public hearing was held on January 11, 2022. At this meeting, proposed abatement alternatives were discussed in more detail, along with project costs and recommendations for prioritization of work. Please refer to **Appendix B, "Community Engagement",** for a copy of the August 2, 2021 and January 11, 2022 public meeting presentations and a brief meeting summary.

2.0 EXISTING CONDITIONS & FACILITIES

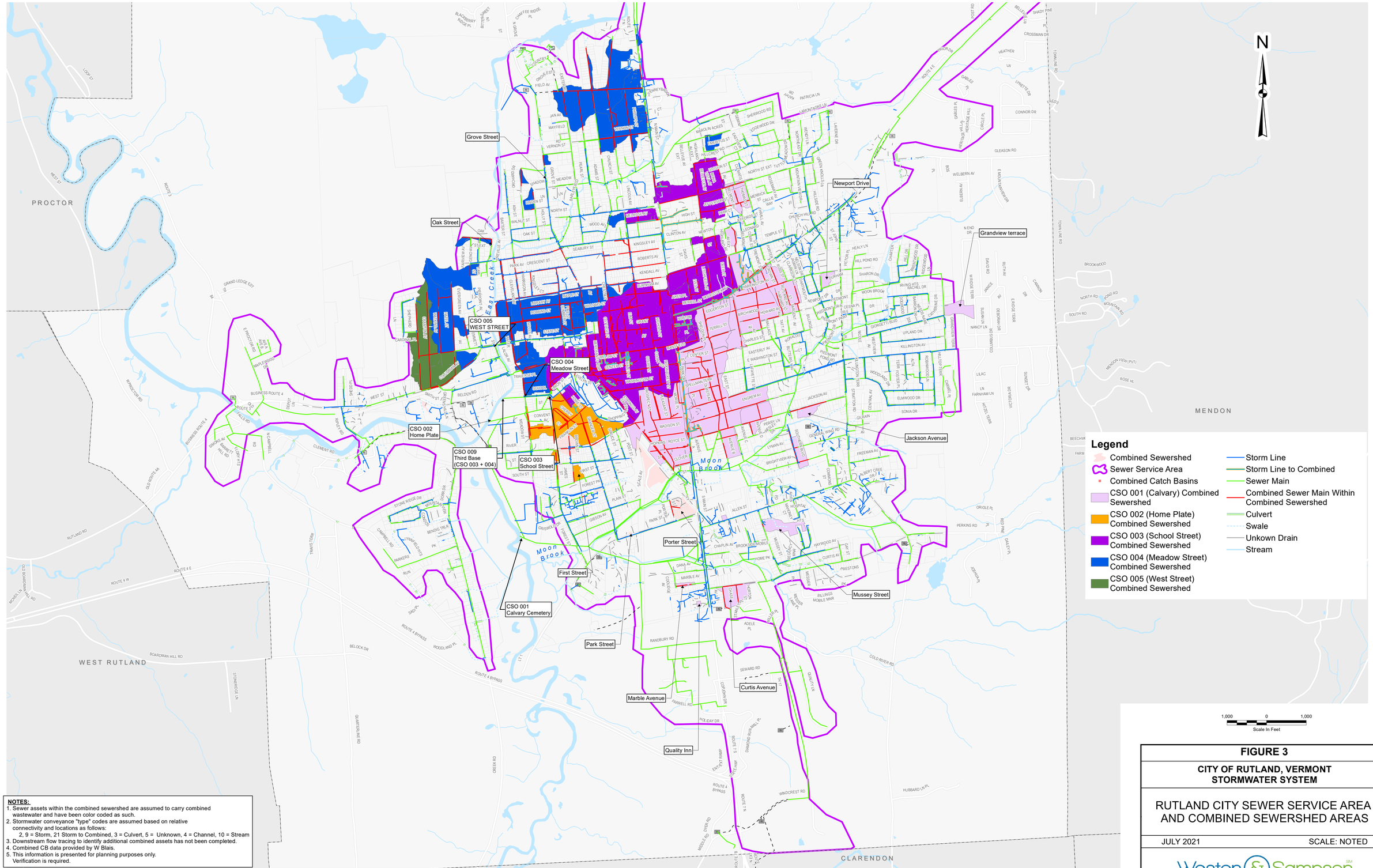
The Rutland City sewer system history dates to the 1860's. Initially it was designed with two gravity sewer drainage areas, with the central and northwest portion of the City sewers discharging directly to the East Creek and the southern and eastern portions discharging directly to the Otter Creek. In the early 1960's, the River Street Pump Station (RSPS) was constructed, and two 24-inch asbestos cement (AC) interceptor sewers were constructed to convey untreated wastewater to the RSPS. A single 1,500-foot AC force main conveyed wastewater to a primary sewage treatment plant, located on the opposite side of the East Creek from the RSPS, on Greens Hill Lane.

Since the 1960's, there have been several improvements to the City's wastewater collection and treatment systems, including upgrade of the primary treatment facility to secondary and then tertiary levels of treatment, improved conveyance of sewage from the RSPS to the WWTF, increases in treatment capacity to accommodate combined sewage, improved storage and equalization within the wastewater collection system to dampen flows and minimize CSO events, separation of some combined sewers into separate storm drain systems, and the decommissioning of some CSO discharge points. The City continues to improve upon its infrastructure with the most recent improvements consisting of a replacement 20-inch sewage force main on the RSPS, the separation of combined sewers in the Northwest Neighborhood region of the City and rehabilitation of the primary anerobic digesters at the WWTF. The Northwest Neighborhood project represents a project that directly improves the effectiveness of the City's sewer system, separating stormwater runoff into drains discharging into the East Creek. The RSPS force main replacement project had a noted increase in the pump station's pumping capacity; the low roughness factor of the new HDPE pipe compared to the 40-year old ductile iron pipe it replaced allows more combined sewage to be conveyed to the WWTF.

As noted earlier, the City has a long history of CSO abatement projects. Their goal through past efforts has been to maximize treatment of combined sewage to the extent possible by maximizing both primary and secondary treatment at their WWTF and supplementing with combined sewer separation projects. To date the City has expended in excess of $17M in this continuing effort since the 1980s. Refer to **Appendix C, "CSO Abatement Project History",** for a summary of the efforts made to date to address CSO discharges, their costs, and year completed.

2.1 Map

An overall map of the City's wastewater collection system is provided in **Figure 3, "Rutland City Sewer Service Area and Combined Sewershed Areas"**. This map illustrates the extent of the sewer service area, the collection system, and CSO discharge points. Also included are delineations of the CSO drainage areas and the areas that are part of the combined sewershed.



NOTES:
1. Sewer assets within the combined sewershed are assumed to carry combined wastewater and have been color coded as such.
2. Stormwater conveyance "type" codes are assumed based on relative connectivity and locations as follows:
   2, 9 = Storm, 21 Storm to Combined, 3 = Culvert, 5 = Unknown, 4 = Channel, 10 = Stream
3. Downstream flow tracing to identify additional combined assets has not been completed.
4. Combined CB data provided by W Blais.
5. This information is presented for planning purposes only. Verification is required.

Service Layer Credits:

FIGURE 3

CITY OF RUTLAND, VERMONT
STORMWATER SYSTEM

RUTLAND CITY SEWER SERVICE AREA AND COMBINED SEWERSHED AREAS

JULY 2021 SCALE: NOTED

Weston & Sampson

2.2 Description of System

The following paragraphs provide a detailed description of the current wastewater collection system; which consists of over 450,000 feet of gravity sewer, more than 1,500 sewer manholes, 11 sewage pump stations and four active regulator structures (CSOs):

Wastewater Collection System

Originally constructed in the 1860's, the collection system was expanded to its current service area by the mid 20th century. In addition to serving the City, this collection system extends into the Town of Rutland, and the towns of Mendon and Killington via the Alpine Pipeline collection and pumping system, constructed in the mid-1980s. Sewer pipe sizes range from 8" up to large arch conveyances, with a range of materials including polyvinyl chloride (PVC), ductile iron (DI), vitrified clay (VC), and AC pipe. Sewer manholes are generally constructed of precast concrete and brick and are located at changes in pipe alignment and grade to provide access for maintenance.

All wastewater in the collection system eventually drains to the River Street Pump Station located to the south of Connor Park, where it is conveyed via two 20-inch sewage force mains to the WWTF.

Wastewater Pump Stations

Rutland operates and maintains 11 Wastewater pump stations, including the River Street Pump Station (RSPS) as part of their wastewater infrastructure. From a review of the modeling performed (see following sections), we do not believe that these pump stations contribute to overflow events, these structures are not located in combined sewersheds (refer to Figure 3). Overflow events are primarily driven by gravity system configuration and a lack of storage in the interceptors. The following is a brief description of each of the pump stations and their general service area:

River Street Pump Station
The RSPS is the City's main pump station and is currently capable of discharging 22.5 million gallons per day to the WWTF, located on the opposite side of the East Creek. This pump station the main pump station which is at the intersection of the City's two main sewer interceptors, East Creek Interceptor and Otter Creek Interceptor. It is a dry-pit pump station with five 175 horsepower (hp) centrifugal wastewater pumps, which can be valved to discharge to either of the two sewage force mains which convey sewage to the WWTF. Each of the interceptors has a dedicated wet well and there is an equalization valve which can be used to allow for balancing of flows between the two wet wells, or isolation of the two. This pump station was constructed by the City in 1962 and officially commissioned in 1963.

Belden Pump Station
The Belden Pump Station serves the Belden Road commercial area near the Rutland WWTF. It is a submersible pump station with two 5 Hp pumps which discharge to the West Street trunk sewer. The pump station was designed in 1981 and was originally private infrastructure. The City took over Belden Road, the water and sewer utilities and this pump station in 1988. The pump station was upgraded in 2000 to accommodate construction of two new buildings on Belden Road.

St. Joseph's Pump Station

St. Joseph's Pump Station receives flow from the College of St. Joseph campus and the residences located near the campus. This pump station is a dry pit pump station with two 20 Hp dry-pit centrifugal wastewater pumps. The force main discharges to the Dorr Drive Pump Station at the intersection of Dorr Drive and River Street. This is a City-constructed pump station which was commissioned in 1973.

Dorr Drive Pump Station

The Dorr Drive Pump Station handles flows from the College of St. Joseph campus and the southern end of Dorr Drive. This pump station is a dry-pit configuration with two 20 Hp pumps which discharge to the Otter Creek interceptor sewer between the River Street Pump Station and CSO 001. This is a City-constructed pump station which was commissioned in 1965.

West Street Pump Station

The West Street Pump Station is a single 3 horsepower submersible pump which is part of the West Street siphon chamber and CSO 005 (refer to Figure 3). It was installed in 2017 to act as a backup to the siphon at this CSO location, so that when the siphon chamber becomes hydraulically overloaded this pump will discharge wastewater across the West Street Bridge to the interceptor sewer on meadow Street, reducing overflow occurrences. The City has observed that frequency of overflows has decreased since this project was built. Ongoing monitoring will provide further documentation as to its effectiveness.

Laverne Pump Station

The Laverne Pump Station is a small private pump station that was commissioned in 1988 and deeded to the City in 1992. It consists of two 5 Hp centrifugal submersible wastewater pumps and discharges to the trunk sewer on North Street extension.

Northeast Drive Pump Station

The Northeast Drive Pump Station is also a small pump station that was constructed by the City in 1967. It consists of two 5 Hp centrifugal submersible wastewater pumps and discharges to the trunk sewer on North Street extension. This pump station was relocated and reconstructed in order to allow for a larger gravity drainage service area in 1996.

Marolin Acres Pump Station

The Marolin Acres Pump Station is a formerly private pump station serving a neighborhood the northeastern corner of the City. It consists of two 5 Hp submersible pumps and discharges west, ultimately to the Tenney Brook trunk sewer. This pump station was designed and permitted in 1999. Records indicate that the City took over ownership and operation of this pump station in 2006.

Country Club Pump Station

The Country Club Pump Station serves the Rutland Country Club on Grove Street, as well as several homes on Field Avenue and Grove street. This pump station consists of two 5 Hp centrifugal submersible pumps which discharge to the Field Avenue trunk sewer at the high point of Field Avenue. This pump station, located on Grove St., was constructed by the City in 1972. In 1988, this pump station was reconstructed and relocated to be further away from the road.

Meadow Lake Drive Pump Station

The Meadow Lake Pump Station is located on Route 4 in the Town of Mendon and is part of the Alpine Pipeline wastewater collection system which serves the Killington Mountain resort area in Killington, and connected users along the Route 4 corridor between Killington Mountain Resort and Rutland City. This pump station is a dry pit configuration and consists of two 75 Hp centrifugal pumps which discharge to the Campbell Pump Station on Route 4 across from the Home Depot Plaza. This pump station was commissioned in 1985 and is owned by the Alpine Pipeline Company, a local private sewer utility. While this pump station is a private pump station, the City has a maintenance agreement with the Alpine Pipeline Company since the pump station was commissioned in 1985.

Campbell Pump Station

Campbell Pump Station, located in Rutland town, is also part of the Alpine pipeline infrastructure and consist of two 125 Hp centrifugal dry pit pumps. Wastewater from the Alpine Pipeline system is discharged by the Campbell Pump Station on Route 4 to Stratton Road interceptor sewer. This pump station is also a private pump station and the City has had a maintenance agreement with the Alpine Pipeline Company since the pump station was commissioned in 1985.

CSO Outfalls

Historically, there were eight CSO outfalls, serving 9 regulators (overflow points), in the City's wastewater collection system. Three of these CSOs have been removed as part of past CSO abatement efforts, and one outfall designation is the ultimate discharge point for two other regulators. The existing active CSO structures are as follows:

CSO 001 - Calvary Cemetery

This discharge point is the only overflow on the Otter Creek. Combined sewage from the southern portion of the sewer service area is conveyed by a 6' x 4' concrete box culvert that runs through a farm field from Forest Street to this overflow structure. This consists of a 4' wide wooden stop-log weir that allows overflows when the hydraulic grade exceeds 528.01 feet in elevation above mean sea level (MSL). When wastewater upstream of the weir exceeds this elevation, wastewater crests the weir and moves a large wood flap gate to allow discharge to the receiving water. In 1992, as part of the Rutland CSO Phase I project, stop logs were added upstream of the flap gate to provide additional storage in the collection system. In 2018, two additional stop logs (or 7") were added to the overflow weir to further increase storage in the system. This structure is located at the back of the Calvary Cemetery, thus the name.

CSO 002 - Home Plate

This discharge point on the East Creek and was constructed in the 1920s. Similar in design to CSO 001, this structure was modified in 1992 by constructing a parallel regulator structure (4' wide overflow weir and wooden flap gate). At this time a set of 4' wide wooden stop-logs were added to both regulators in this structure, elevating upstream water to 521.01 above MSL before overflow, thereby increasing collection system storage and equalization capacity during CSO events. This structure is located behind the baseball field backstop in Connor Park off Meadow Street, thus the name.

CSO 003 - School Street

This discharge point is located at the intersection of Forest Street and School Street. As seen in the photograph to the right, dry weather flow in the 60-inch diameter sewer flows into a 5' by 6½' rectangular opening. When sewer flows exceed 12 inches, wastewater crests a concrete weir and discharges westerly down School Street. This sewer is a dedicated CSO discharge conduit, no sewer connections or catch basins discharge to this pipe below the overflow point. It runs past the Meadow Street intersection and towards the "Third Base" outfall described below.

CSO 004 - Meadow Street

This discharge point is located at the intersection of Meadow Street and School Street. The Meadow Street combined sewer is a 36-inch pipe at a similar elevation to the School Street CSO discharge conduit described above. A 16-inch siphon is used to convey dry-weather flows southward under the School Street conduit. When the siphon reaches capacity, a hole cut in the side of the conduit, parallel to the invert and approximately 10" above the invert, acts as an overflow weir; allowing combined sewage during storm events to discharge into the School Street CSO conduit and ultimately to the Third Base outfall.

Photo 2 - School Street Overflow

CSO 005 - West Street

This discharge point was originally designed as an overflow for an inverted siphon (12-inch primary barrel and 10-inch diameter relief barrel) conveying wastewater beneath the East Creek to the Meadow Street trunk sewer, running parallel to the West Street bridge. In 2017, a pump station was installed to reduce the volume of combined sewage discharged during storm events. When the siphon chamber begins to back up, wastewater is pumped from the structure through an abandoned water main on the West Street bridge to Meadow Street, effectively eliminating many of the potential discharge events.

CSO 009 - Third Base

This outfall collects CSO overflows from the School Street and Meadow Street overflow locations and is so named as it lies upstream of CSO 002 (Home Plate) along the third base line of the baseball field.

Please refer to Figure 3 for the locations of the active CSO regulators.

Wastewater Treatment Facility



Photo 3 - Rutland WWTF

The City of Rutland Vermont owns and operates and advanced secondary conventional activated sludge (CAS) wastewater treatment facility (WWTF). This facility, constructed in 1962 as a primary treatment facility, has been since upgraded to provide full secondary treatment and phosphorus removal. In addition to the treatment of domestic wastewater, the City has undertaken upgrades over the years to maximize the treatment of stormwater from their combined wastewater collection system at this facility including a complete second headworks and a third primary clarifier. Currently, this WWTF can process up to 16 MGD of wastewater to a secondary level of treatment and can process up to 28 MGD via primary treatment and disinfection. Secondary treatment at the WWTF is currently limited to a total of 22.5 MGD as this is the hydraulic limitation of the RSPS and the biological unit process structures at the WWTF. In addition, the Rutland WWTF is designated as a sludge disposal facility for wastewater treatment facilities within the Rutland Regional Sludge and Septage Management District.

The following is a brief history of improvements undertaken at this WWTF since its original commissioning in 1963:

Construction of the River Street Pump Station and Primary WWTF (1962) - as noted earlier in this report, the RSPS was constructed concurrently with the primary wastewater treatment facility, which included two anaerobic digesters. This critical piece of infrastructure is a collection point for all sewage generated within the City service area and conveys wastewater to the WWTF.

Secondary Treatment Upgrade (1984) - this project increased the design average daily flow to 6.8 MGD, with a maximum flow of 10.9 MGD the facility can handle a peak instantaneous flow through secondary treatment of 16.0 MGD. Two additional anaerobic digesters (one primary, one secondary) were built at this time. This upgrade provided capabilities for greater than 90% removal of BOD and suspended solids at design loadings.

Phosphorus Removal Upgrade (1992) - this project provided tertiary treatment to lower phosphorus levels in the treated effluent and included construction of two large rapid mix chambers, downstream of the aeration basins, and a chemical storage in feed building and an additional anaerobic digester (bringing the total amount of anaerobic digesters to five) to help stabilize and reduce the volume of additional biological solids generated through the phosphorus removal process.

CSO Abatement Facilities - Phase 1 (1992) - this project, constructed concurrently with the Phosphorus Removal Upgrade, provided a second complete headworks at the WWTF with a hydraulic capacity of 8.0 MGD, effectively increasing the biological treatment capacity of this facility to 16.0 MGD. This project

was constructed to increase treatment capabilities and reduce the number and duration of CSO's during wet weather events; and included modifications to CSO 001 and CSO 002 to increase capacity within the collection system for storm flow storage and equalization, as noted in Section 2.2.3 above.

Liquid Biosolids Receiving Improvements (1997) - This upgrade provided receiving and storage facilities for regional biosolids generated within the Rutland Regional Sludge and Septage Management District. An offloading facility was constructed along with piping to allow existing waste sludge pumps to move the solids into the WWTF anaerobic digestion system.

CSO Abatement Facilities - Phase 2A (2005) - This project included construction of a third primary clarifier. The goal of this project was to increase primary treatment capabilities, and therefore hydraulic throughput at the WWTF, in order to reduce the number and duration of CSO's during wet weather events. With this upgrade, biological treatment capacity was increased to 22.5 MGD. The third primary clarifier now allows up to a total of 28 MGD of flow during a peak wet weather event through primary treatment only. Note that additional work is required to address the difference between these two flows and will be discussed in subsequent sections of this report. Therefore, the current maximum hydraulic capacity of the WWTF remains at 22.5 MGD.

2.3 CSO Abatement History

The City has a long history of implementing CSO abatement projects. Their goal of past efforts has been to maximize treatment of combined sewage to the extent possible by maximizing both primary and secondary treatment at their WWTF and supplementing with combined sewer separation projects. As of 2018, the City has expended in excess of $17MM in this continuing effort since the 1980s. Refer to Appendix C for further detail on project history.

Major CSO Projects Completed to Date

The City of Rutland has conducted numerous studies and construction projects to reduce the number and volume of CSO discharges. The following is a summary of the efforts made:

CSO Study, Volume 1 & 2 (1989) - This study, prepared by Dufresne-Henry, Inc., initiated a major effort to better understand the performance of Rutland's combined sewer system and its impact on East Creek and Otter Creek. Tasks performed included an analysis of the then-active CSO discharge locations, which include the following locations:

001 – Otter Creek/Calvary
002 – Ballfield/Home Plate
003 – School Street
004 – Meadow Street
005 – West Street Siphon
006 – Ronaldo Court
007 – Lalor Avenue
008 – State Street

The report determined that CSO 001 addressed flows from approximately 25% of the sewer service area, CSOs 002, 003 and 004 addressed approximately 65% of the sewer service area, and CSOs 005, 006, 007 and 008 addressed approximately 10% of the sewer service area. At that time, the total sewer service area was 957 acres, with 496 acres of separated sewers.

Field monitoring of two CSO discharge locations (001 and 003) was conducted for overflow quality and quantity, as well as upstream and downstream water quality at each discharge. The results of this analysis were highly variable; however, a general trend of higher pollutant concentrations in CSO 001 vs. 003 were observed.

The EPA Storm Water Management Model (SWMM) was developed for the Rutland wastewater collection system using data from this study. At the time, it was predicted that the combined sewer system would surcharge during a 5-year storm event. None of the CSO discharge locations were able to pass a 5-year storm event. Based on these results, abatement alternatives for a 1-year storm event were suggested to be studied.

Volume 2 of this report was a data appendix and was an integral part of the report and recommendations contained in Volume 1.

CSO Study Volume 3 (1989) - This report, also completed by Dufresne-Henry, Inc., augmented the Volume 1 report with computer modeling and the development of abatement alternatives. The following were evaluated:

- Non-structural measures such as disconnection of roof drains and the use of street cleaning. Capital Cost: $100,000 (1989), O&M Cost: $100,000
- A number of combined sewer separation projects. Capital Cost: $23.2 MM, O&M Cost: $25,000
- Full storage of the 1-year storm event (10.2 million gallons (MG). Capital Cost: $21.4 MM, O&M Cost $100,000
- Treatment and disinfection of combined sewage with a 30 MGD swirl concentrator at CSO 001 and a 100 MGD swirl concentrator at CSO 002. Capital Cost: $4.8 MM, O&M Cost: $65,000

While these projects were developed and evaluated, not all of them were brought forward to construction, due to cost and/or the need for additional data on which to base a design.

CSO Basis of Design Report (1992) - After the adoption of the State CSO rule in 1990, this report was developed. Recommendations included:

- Increase WWTF capacity from 13 MGD to 16 MGD by adding a second 20-inch force main to the River Street Pump Station (RSPS) and constructing a foul flow screening and grit removal building (second headworks) at the WWTF,
- Provide CSO treatment facilities (swirl concentrators and disinfection facilities) for CSO 001 and 002 for a 2.5-inch, 24-hour storm event.
- Elimination of CSO 006, 007, and 008 from the combined system.

Of these recommended projects, the first two recommendations were designed and completed. The remote swirl concentrators and off-site disinfection facilities were not undertaken due to capital cost,

large operation and maintenance cost and the logistical issues presented by having large chlorine stores for disinfection facilities at remote sites throughout the City.

Phosphorus Removal Upgrade (1992) - This upgrade added advanced secondary treatment facilities to allow reduction of phosphorus in the effluent to below 1 mg per liter. The primary purpose for this upgrade was to reduce diurnal dissolved oxygen fluctuations within Otter Creek and to allow the wastewater treatment facilities Ultimate Oxygen Demand limitation to be increased to 250 lbs per day. A secondary benefit, more related to CSO abatement, was the addition of a third secondary digester which could help stabilize and reduce the volume of additional primary sludge generated by additional storm event flows directed to the WWTF.

CSO Abatement Facilities - Phase 1 (1992) - This upgrade saw construction of a second 20-inch diameter sewage force main from River Street pump station and construction of a second headworks facility with a capacity of 8.0 MGD. Hourly peak flow treatment was increased to 16 MGD. The second headworks was designed to manage additional storm flow directed to the treatment facility. In addition, modifications were made to overflow structures to increase storage capacity within the Wastewater collection system and minimize CSO discharges. See Section 2.2.3 for a detailed description of the work completed at CSO 001 and CSO 002 as part of this project.

CSO Abatement Facilities - Phase 2A (2004) - this upgrade increased design average daily flow through secondary treatment to 8.0 MGD. The peak hydraulic flow at the WWTF was increased to 28 MGD. Improvements at the plant included construction of a new influent channel and weir box for equal flow splitting to three primary clarifiers, construction of a third primary clarifier and additional chlorine contact tankage. Pumps at the River Street pump station were upgraded to provide additional hydraulic capacity, which now peaks at 22.5 MGD.

CSO Check Valves (2018) – The City commissioned the design of check valves for CSO 001 and CSO 002 which, through previous studies, had been shown to allow river water back into the wastewater collection system during periods when the river water levels were elevated. These "backflow" occurrences, while not frequent, increased the load on the WWTF and RSPS and reduced treatment efficiency. During the evaluation of alternatives for this work, Weston & Sampson noted that more information would be required in order to predict more accurate design flows to be used in the design of this project. At this recommendation, the City decided to postpone design of the check valves until a Hydraulic Model of the wastewater system could be developed and calibrated. These check valves are included in this LTCP for further consideration.

Sewer Separation Projects - Many neighborhoods have been disconnected from the combined sewer system. Since 1989, the following projects have been implemented:

- Eastview Court
- Hillcrest Road
- Shedd Place
- State Street
- North Main Street
- Disconnection of GE building roof drains
- High Street
- Downtown Shopping Plaza

- Stratton Road
- Crescent Street
- Main Street South
- Northwest Neighborhood

Flow Metering Program

The 2020 flow metering program was designed to collect system flows in the direct vicinity of the CSO discharge points to provide better data resolution and coordination with the City of Rutland CSO monitoring program. The 2020 flow metering program builds upon the 2017 program through implementation of the following tasks:

- Metering program replaced City depth measuring devices at the School Street CSO and Forest Street with depth velocity meters.
- Increased the rain gauge data collection to a total of three (3) distributed throughout the City to account for storm path variances.
- Flow monitoring upstream of the Meadow Street 16 inch sewer inverted siphon.
- Conduct additional model calibration based on the results of the coordinated flow metering and CSO monitoring programs.

A flow metering program was conducted to collect system flows for use in the combined sewer system model. Ten (10) area velocity flow meters at nine (9) locations and three (3) rain gauges were installed at the locations listed in Table 1, "Flow Meter and Rain Gauge Locations", by Flow Assessment Services, LLC of Auburn, NH.

Table 1: Flow Meter and Rain Gauge Locations

Site	Location	Meter/Rain Gauge
1	Forest Street R.O.W	Area Velocity Flow Meter installed in an existing 72"x48" custom shaped line. (Double Meter)
2	Calvary Cemetery	Area Velocity Flow Meter installed in an existing 24" diameter line.
3	Union Street at Forest Street	Area Velocity Flow Meter installed in an existing 36" diameter line. (Drain Line)
4	31 Forest Street	Area Velocity Flow Meter installed in an existing 60" diameter line.
5	176 West Street	Area Velocity Flow Meter installed in an existing 55"H x 53"W custom shaped line.
6	School Street near Forest Street	Area Velocity Flow Meter installed in an existing 60" diameter line.
7	3 Meadow Street	Area Velocity Flow Meter installed in an existing 36" diameter line.
8	98 Park Street	Area Velocity Flow Meter installed in an existing 42" diameter line.

9	1 Scale Avenue	Area Velocity Flow Meter installed in an existing 60" diameter line.
RG1	67 Library Avenue	Tipping Bucket Rain Gauge
RG2	101 Allen Street	Tipping Bucket Rain Gauge
RG3	10 Court Street	Tipping Bucket Rain Gauge

See, Figure 4, "2020 Flow Meter Program" for a depiction of the locations of these features.

Please note that CSO 005 West Street was not included in the flow metering program as documentation of CSO activations have been diminishing due to system improvements made by the City. Within the last year more CSO 005 activations have been occurring on higher intensity storm events and require further evaluation and remediation and is discussed in subsequent sections.

The area velocity flow meter senses both depth and velocity. This depth and velocity information is stored in the meter's memory. The recorded data is uploaded from the flow meters with a laptop computer. During the installation, maintenance visits and removal, the depth and velocity information is confirmed, and calibration measurements were noted.

The flow metering period was from April 13, 2020, to July 30, 2020, 15 weeks. During this period of flow data collection, Flow Assessment Services made weekly visits to each flow meter to clear debris, adjust the equipment to collect the optimum reading, adjust the calibration of the unit, and ensure the functionally of the flow meter.

Flow rates are not directly measured by the meters but are calculated based on the depth of flow and size of pipe. Utilizing this data, the flow rate was calculated and presented in tabular form along with depth of flow and velocity data. Therefore, there is a need for continuous and regular inspection of the flow meter to ensure the quality of the readings. An accumulation of an inch of debris at the bottom of the pipe would affect the depth of flow and size of pipe inputs that the system uses to calculate the flow rate.

Analysis of Flow Metering and Rainfall Data

The 2020 flow metering program experienced minimal technical difficulties and provided reliable data throughout the 15-week period. Minor debris removal was performed during site inspections and adjusted for in the calculations while one of the Site 2 meters was replaced after a week of malfunctioning. The flow metering and rain data collection metrics for the 15-week period are as follows:

- Total rainfall of 6.9 inches (versus 12.8-inch average, a drought condition).
- 8 days with CSO activations.
- Average rainfall during CSO activations: 0.42 inches.
- Average intensity of CSO activations 1.39 in/hr.
- Majority of the rain events recorded were a 1 year events or less.
- One significant storm event (June 28, 2020, a 5-year, 1-hour event).

Although the rainfall experienced during the 15-week metering period was well below average the metering program did document a storm event that matched the 5 year – 1 hour storm event intensity.



FIGURE 4

CITY OF RUTLAND, VT
LONG TERM CONTROL PLAN

2020 Flow Metering Program

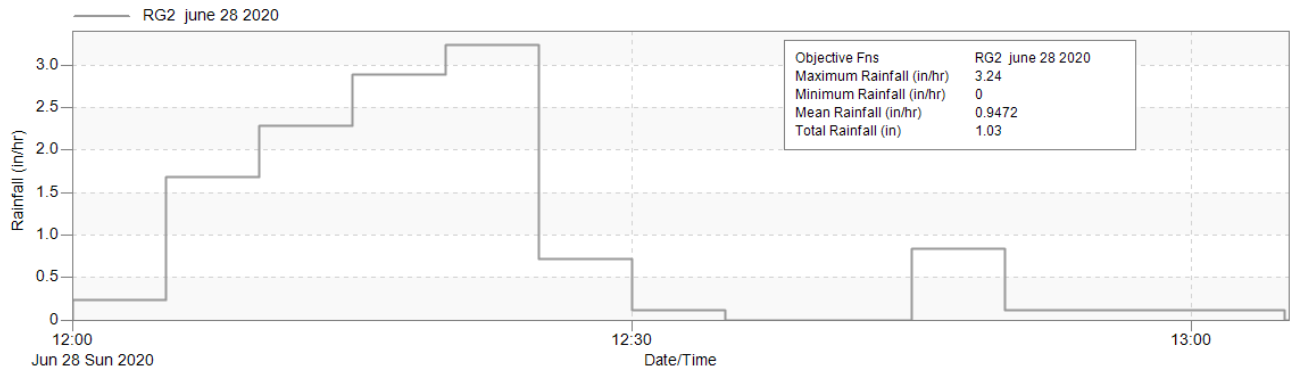
NOVEMBER 2021 SCALE: NOTED

Weston & Sampson

Path: \\wse03.local\wse\Depts\GIS\data\Client\Rutland VT\Project\ENG20-0028 CSOLTCP\Rutland VT Fow Meters 2020_B.mxd **User:** GannonR **Saved:** 11/2/2021 1:16:23 PM **Opened:** 11/2/2021 1:16:49 PM

The required 5 year – 1 hour evaluation rainfall as documented by the VT CSO Rules is 1.2 inches of rainfall at an intensity of 1.2 inches/hour. Refer to **Figure 5, "June 28, 2020 Rainfall Hyetograph".**

Figure 5
June 28, 2020 Rainfall Hyetograph



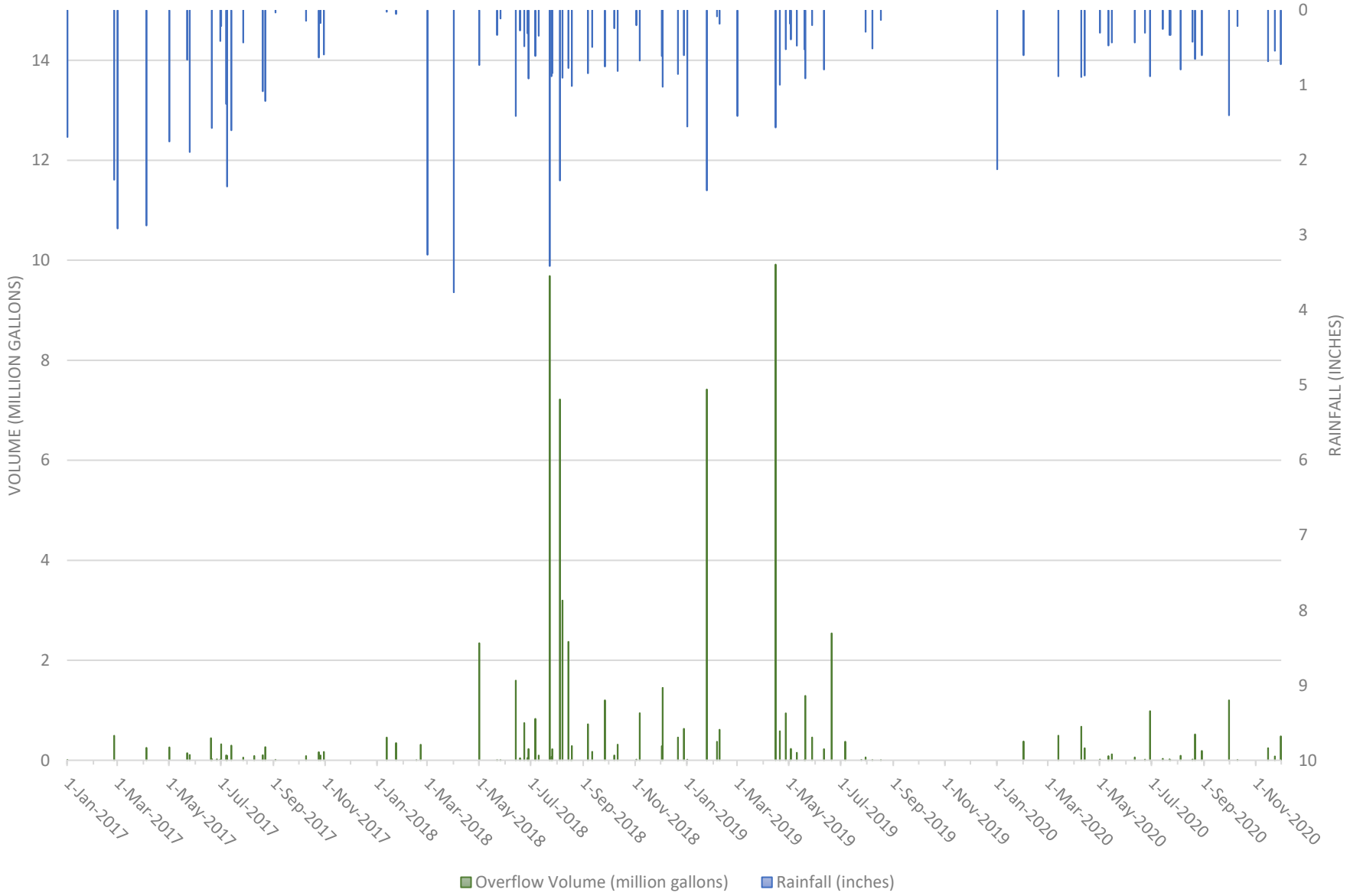
The data collected during this period was used to increase the resolution of the hydrologic & hydraulic (H&H) model. In addition to the 2020 flow metering results to improve model resolution, the City provided Weston & Sampson with recent flow metering data and a three year history of CSO events and recorded volumes at each location. A graphic depiction of total monthly combined sewage overflow volumes during this monitoring period compared with total monthly rainfall is presented in **Figure 6, "Overflow Event Summary".** A copy of the detailed CSO event history used to develop this figure is included in **Appendix D, "CSO Activations".**

Hydrologic and Hydraulic Model Development

The City of Rutland contracted with Weston & Sampson in 2016 to develop a H&H computer model using the PC SWMM platform. The purpose of the model is to provide the user with an interactive tool that simulates storm events and illustrates the performance of the combined sewer system. This includes being able to predict the quantity and duration of CSO discharges. The 2016 model workplan included:

- A detailed inventory of the wastewater infrastructure components.
- The City collected GPS manhole data on selected portions of the combined sewer system, those areas that are lower in the service area that included larger trunk sewers. The data included information on pipe sizes, condition, and depths.
- Conduct a thorough QA/QC process to provide a network that could be used by PC SWMM to route system flows.
- Create hydraulic model of system components.
- Create hydrologic model of combined sewer flows.
- Calibrate and analyze wastewater model.
- Identify deficiencies to be addressed in subsequent phases of work.

Figure 6 - Overflow Event Summary
2017-2020



This Long-Term Control Plan refines the 2016 Rutland City wastewater model to evaluate the effectiveness of CSO reduction projects. The 2020 wastewater model builds upon the 2016 model through implementation of the following tasks:

- Update metering to coordinate with existing City CSO monitoring program.
- Update model with detailed River Street Pump Station operating parameters.
- Update model with TV Inspection results as applicable.
- Update the completed model scenarios to include the 5 year – 1 hour and 5 year – 24 hour rain events.

2.3.1.1 Flow Meter Data Validation

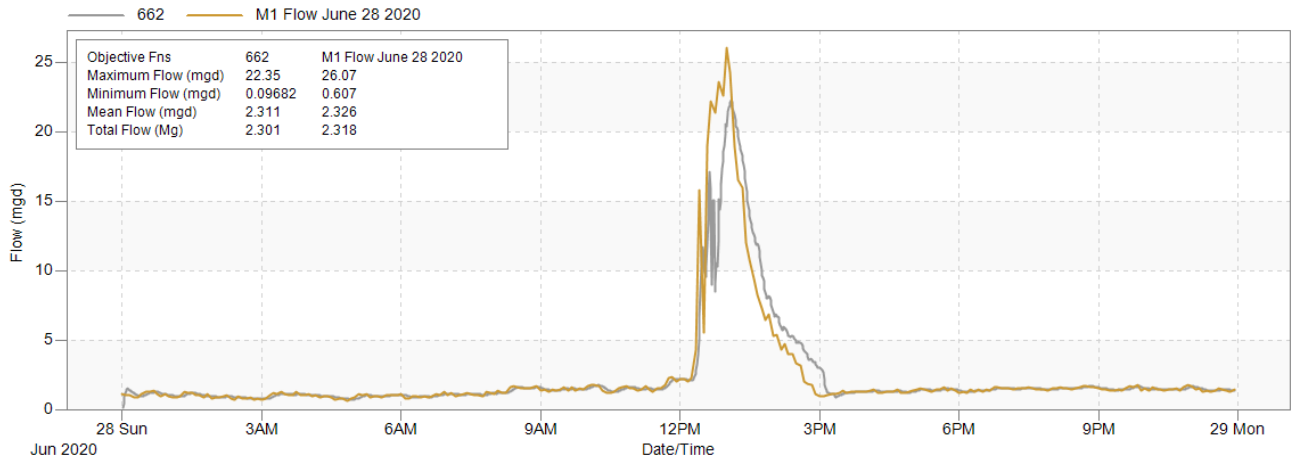
The June 28, 2020 storm (5-year, 1-hour) event was a data set that was used for hydraulic model validation and as a design storm to analyze CSO abatement projects. The hydraulic model validation process confirms the validity of the hydraulic system's data (pipe sizes, manning's n values, inverts, and loss coefficients).

The process of hydraulic model validation begins with introducing the flow hydrographs generated from the flow metering for the June 28, 2020 rain event and reviewing the results for accuracy, thus creating a validation model. Upon review of the validation model, adjustments are made to the hydraulic parameters to achieve a calibrated model for the hydraulic parameters. The results of the validation model are described below.

Meter 1 Validation

The hydraulic model system data for Meter 1 appears appropriate as model flows in conduit 662 compare well with meter 1 flow refer to Figure 7, "Meter 1 - June 28, 2020 Flow Comparison". The model generates flows that are approximately 86% accurate when compared to meter flow patterns. Flow for meters 8 & 9 (located upstream of meter 1) are included in the meter 1 flow data.

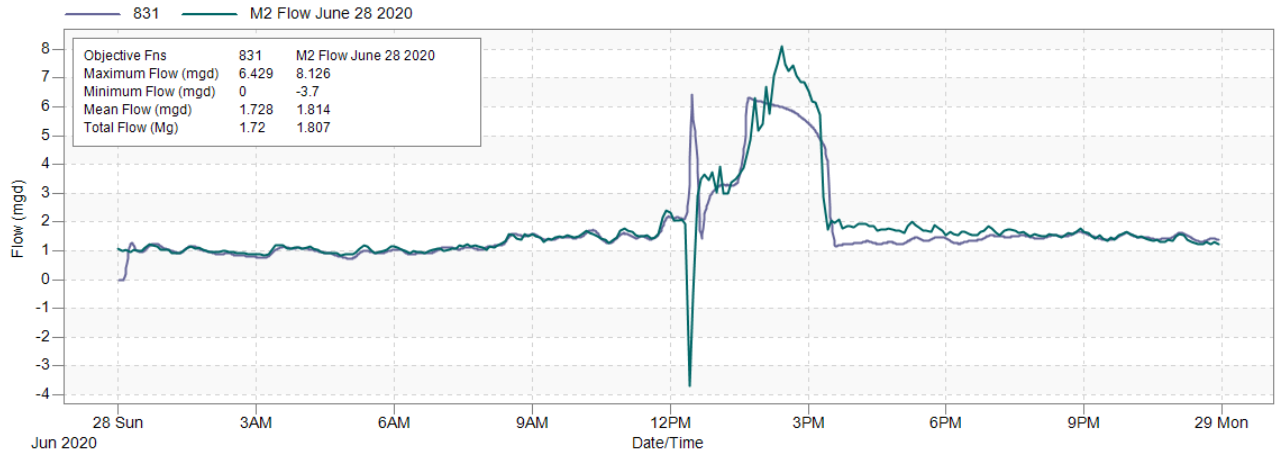
Figure 7
Meter 1 - June 28, 2020 Flow Comparison



Meter 2 Validation

The hydraulic model system data for Meter 2 appears appropriate as model flows in conduit 831 compare well with meter 2 flow, refer to **Figure 8, "Meter 2 - June 28, 2020 Flow Comparison**". The model generates flows that are approximately 76% accurate when compared to meter flow patterns. There is evidence of some model instability with backflow from the River Street Pump Station wetwell.

Figure 8
Meter 2 - June 28, 2020 Flow Comparison



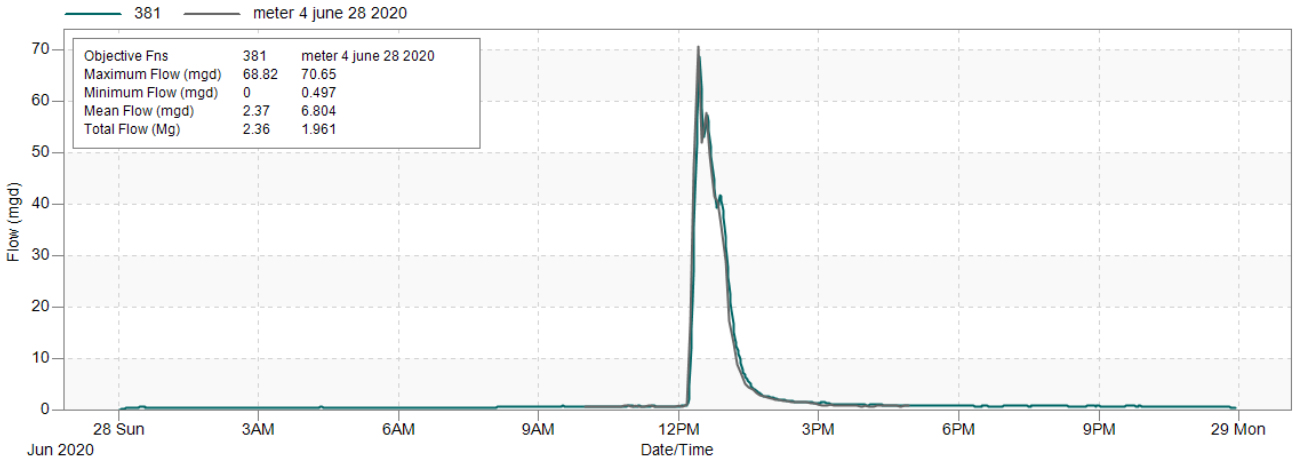
Meter 3 Validation

Meter 3 was installed on a 36-inch drain line to monitor the stormwater flow component that directly discharges to the Third Base outfall (CSO 009), downstream of Meadow Street (CSO 004) and School Street (CSO 003) and does not require validation comparison.

Meter 4 Validation

The hydraulic model system data for meter 4 appears appropriate as model flows in conduit 381 compare well with meter 4, refer to **Figure 9, "Meter 4 - June 28, 2020 Flow Comparison**". The model generates flows that are approximately 97% accurate when compared to meter flow patterns.

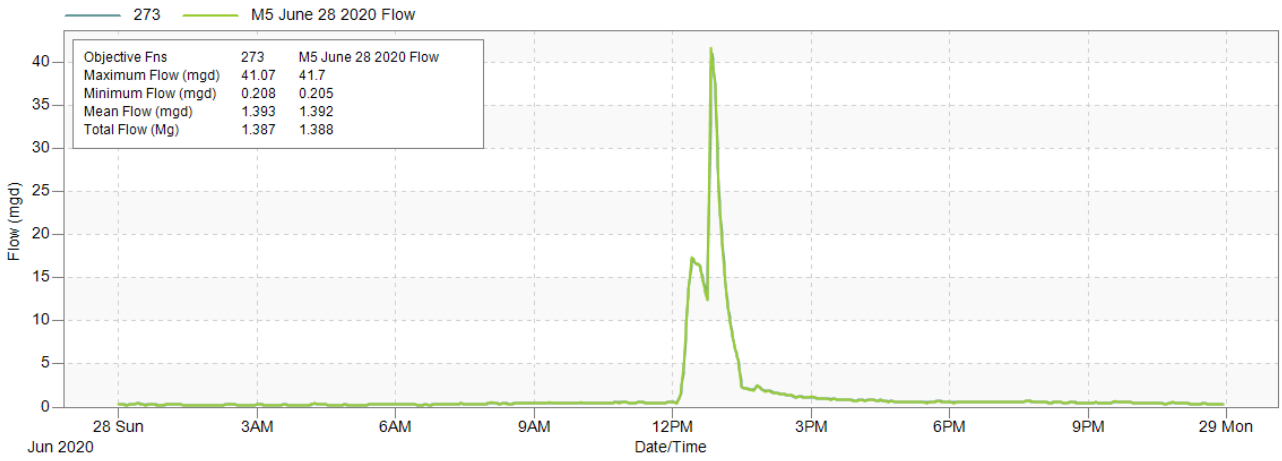
Figure 9
Meter 4 - June 28, 2020 Flow Comparison



Meter 5 Validation

The hydraulic model system data for Meter 5 appears appropriate as model flows in conduit 273 compare well with meter 5 flow, refer to Figure 10, "Meter 5 - June 28, 2020 Flow Comparison". The model generates flows that are approximately 99% accurate when compared to meter flow patterns.

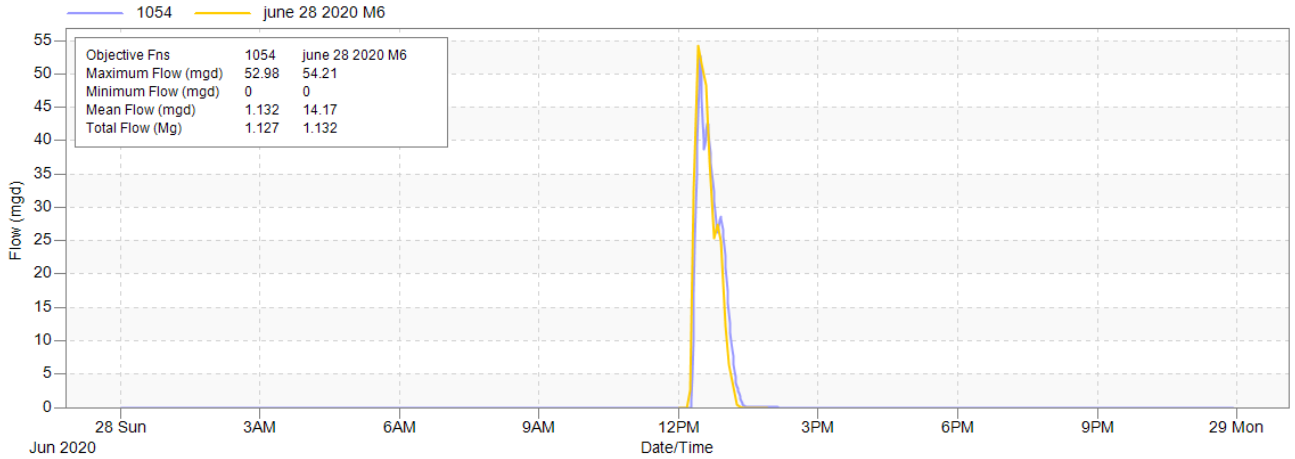
Figure 10
Meter 5 - June 28, 2020 Flow Comparison



Meter 6 Validation

The hydraulic model system data for Meter 6 appears appropriate as model flows in conduit 273 compare well with meter 6 flow, refer to Figure 11, "Meter 6 - June 28, 2020 Flow Comparison". The model generates flows that are approximately 92% accurate when compared to meter flow patterns. Meter 6 was installed on the 60-inch CSO 003 conduit and identifies the flow to East Creek from School Street.

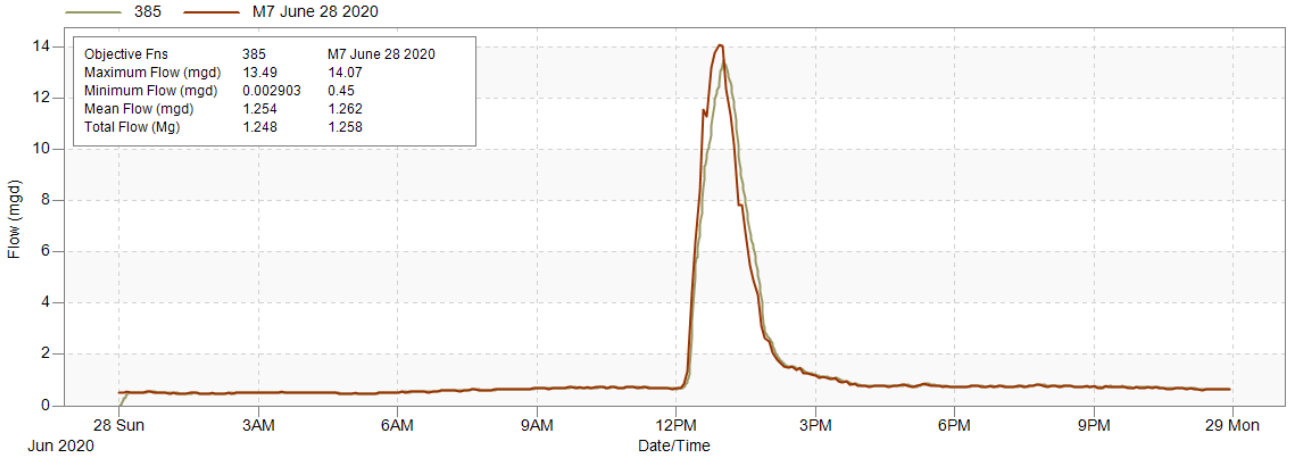
Figure 11
Meter 6 - June 28, 2020 Flow Comparison



Meter 7 Validation

The hydraulic model system data for Meter 7 appears appropriate as model flows in conduit 385 compare well with meter 7 flow, refer to **Figure 12 "Meter 7 - June 28, 2020 Flow Comparison"**. The model generates flows that are approximately 96% accurate when compared to meter flow patterns.

Figure 12
Meter 7 - June 28, 2020 Flow Comparison



2.3.1.2 Hydrologic Model Calibration

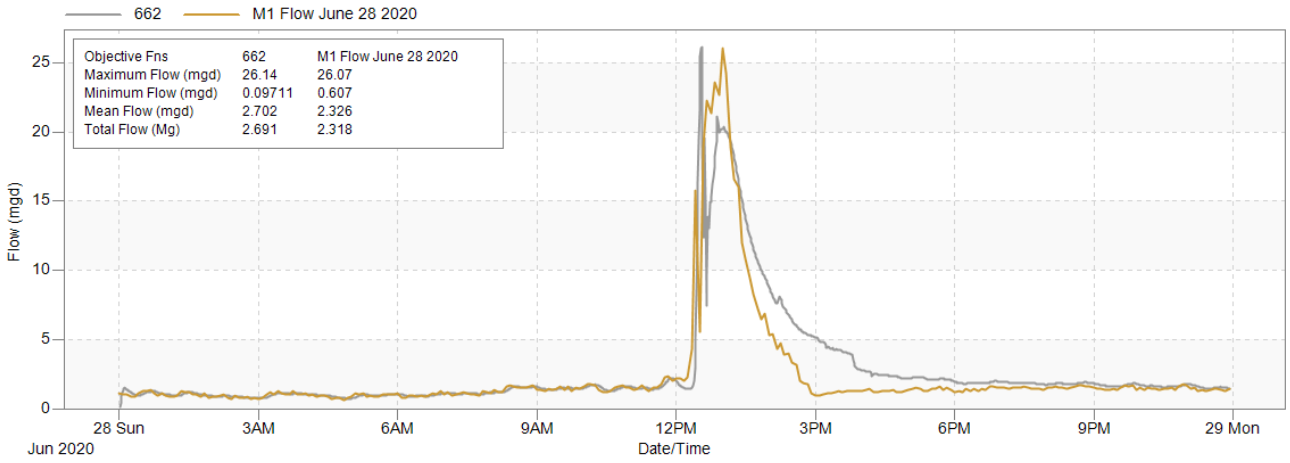
The June 28, 2020 rain event observed during the 15 week metering program in 2020 classifies as meeting a 5 Year – 1 Hour event. This event will be utilized to provide for the 5 Year – 1 Hour design model and to establish validated hydrologic data for use in the theoretical 5 Year – 24 Hour design model.

The EPASWMM runoff method for determining runoff hydrographs was used to determine the stormwater runoff entering the combined sewer system. The limits of combined sewersheds throughout the city were provided by the City of Rutland as part of the 2016 H&H model development and was used as contributing areas generating runoff to the sewer system. Stormwater runoff hydrographs were created at the flow meter locations of Meter 1, Meter 4, Meter 5, and Meter 7 for the 5 year – 1 hour (June 28 2020) event. Subcatchments were developed at these locations with the following attributes: subcatchment area, runoff flow length, subcatchment width, subcatchment slope, percent impervious, and runoff n values. These attributes were entered into the model and adjusted to provide a best match to the metering data.

<u>Meter 1 - 5 Year – 1 Hour Model Calibration</u>

The hydraulic and hydrologic model data for meter 1 appears appropriate as model flows in conduit 662 compare well with meter 1 flow, refer to **Figure 13 "Meter 1 - "5-Year, 1-Hour Design Calibration"**. The model generates flows that are approximately 80% accurate when compared to meter flow patterns.

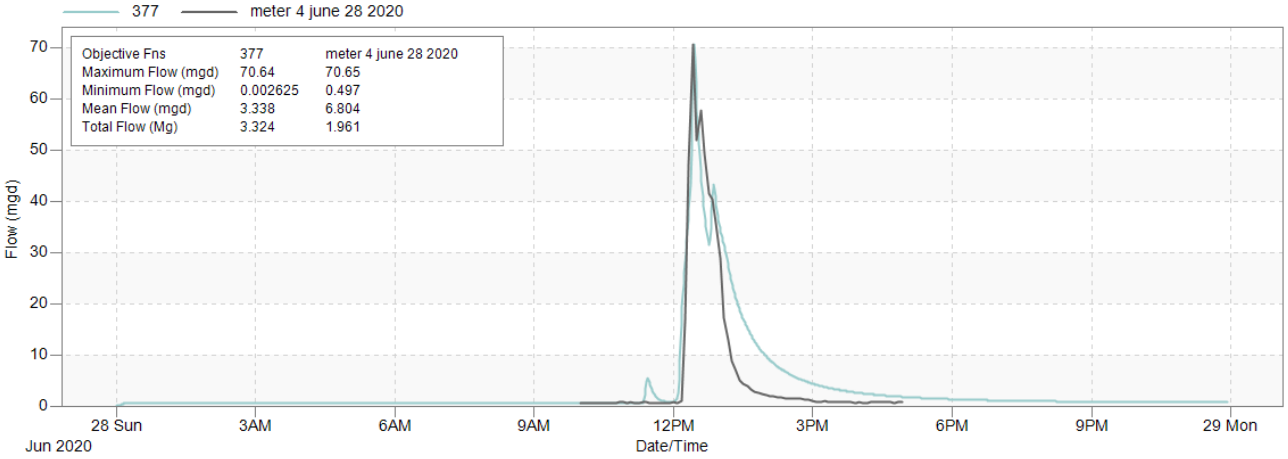
Figure 13
Meter 1 – 5-Year, 1-Hour Design Calibration



Meter 4 - 5 Year – 1 Hour Model Calibration

The hydraulic and hydrologic model data for Meter 4 appears appropriate as model flow maximums in conduit 377 compare well with Meter 4 flow, refer to **Figure 14, "Meter 4 - 5-Year, 1-Hour Event Calibration"**. The model generates flows that are approximately 88% accurate when compared to meter flow patterns.

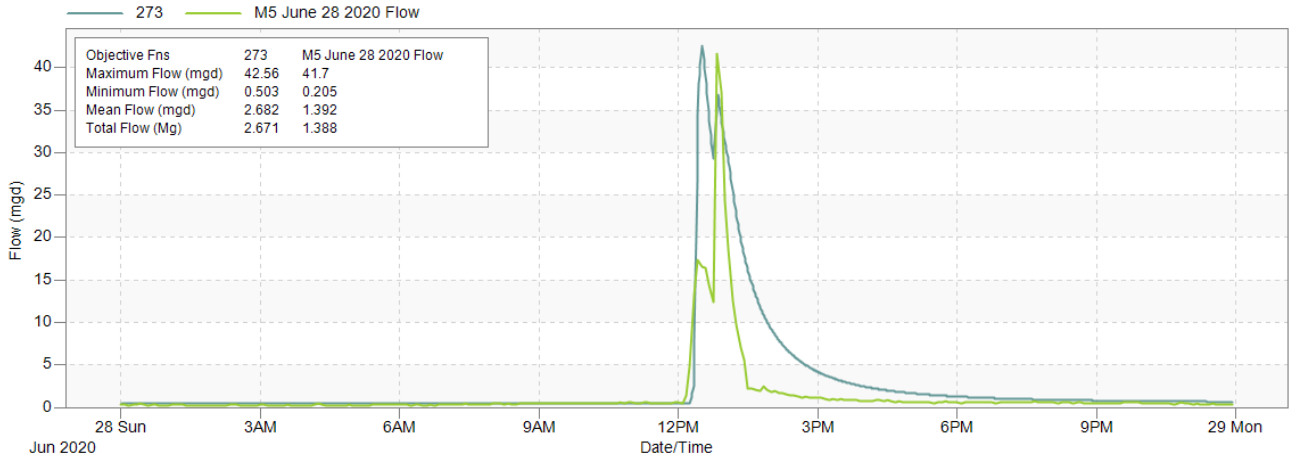
Figure 14
Meter 4 – 5-Year, 1-Hour Event Calibration



Meter 5 - 5 Year – 1 Hour Model Calibration

The hydraulic and hydrologic model data for Meter 5 appears appropriate as model flow maximums in conduit 273 compare well with Meter 5 flow, refer to **Figure 15 "Meter 5 - 5-Year, 1-Hour Event Calibration"**. The model generates flows that are approximately 76% accurate when compared to meter flow patterns.

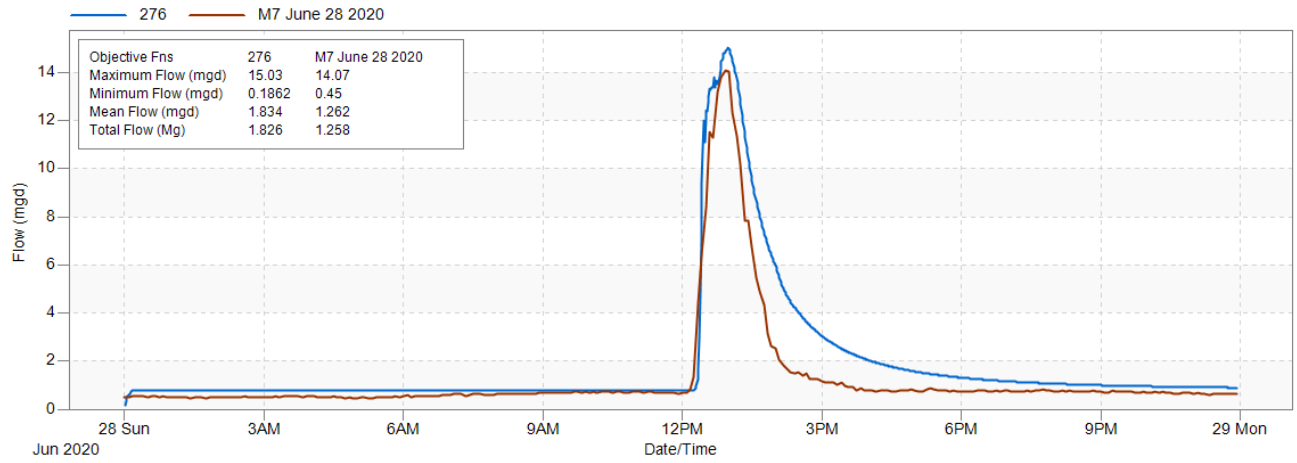
Figure 15
Meter 5 – 5-Year, 1-Hour Event Calibration



Meter 7 - 5 Year – 1 Hour Model

The hydraulic and hydrologic model data for Meter 7 appears appropriate as model flows in conduit 276 compare well with Meter 7 flow, refer to **Figure 16, "Meter 7 – 5-Year, 1-Hour Event Calibration**". The model generates flows that are approximately 92% accurate when compared to meter flow patterns.

Figure 16
Meter 7 – 5-Year, 1-Hour Event Calibration



Summary Hydrologic Model Validation

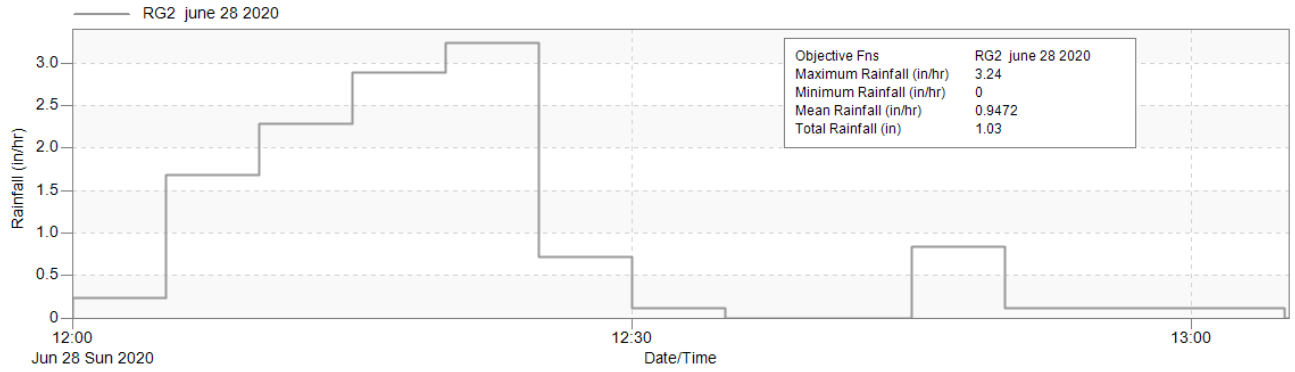
The hydrologic model was found to be sufficiently valid for its use in evaluating the effects of CSO mitigation projects. Meters 1, 4 and 7 had a high level of correlation, and meter 5 had a medium level of correlation, demonstrating the model's efficacy for use in evaluating design alternatives.

It should be noted in the flow comparison graphs for the hydrologic model show that the volume of flow is higher than metered but the peak flow occurrence more closely match. This does not adversely affect the model's suitability for use in evaluating CSO mitigation projects and provides an additional level of conservativeness to the analysis. The total amount of CSO discharge predicted for the two storm events presented in subsequent sections will be slightly higher than observed conditions, providing an additional level of conservativeness for the development of abatement options.

2.3.1.3 5-Year,1-Hour Hydraulic Model Evaluation

The 5-year, 1-hour hydraulic design model was created, calibrated and analyzed for the June 28, 2020, rain event observed during the 2020 flow metering program. The 5 year 1 hour design storm hyetograph analyzed is shown in **Figure 17, "5-Year, 1-Hour Rainfall Hyetograph"** below.

Figure 17
5-Year, 1-Hour Rainfall Hyetograph

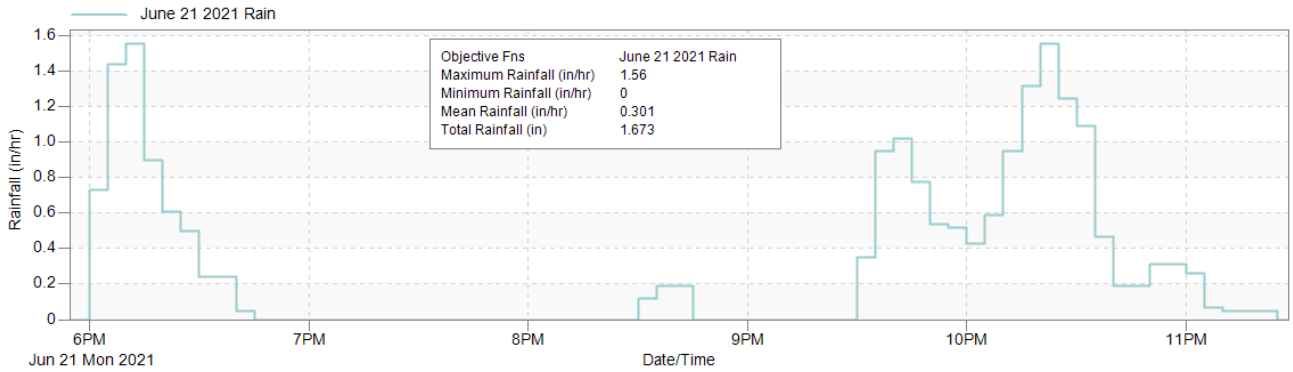


West Street CSO Evaluation and Results

The West Street sewershed area data was collected and incorporated into the 2016 hydraulic model and is included in the 2020 model. The West Street system was not part of the flow metering programs but has been documented through the City's CSO discharge monitoring program. On June 21, 2021 the City's CSO monitoring estimated approximately 38,300 gallons of overflow for this location. This storm event will be used to calibrate hydrologic data for the subcatchment area, analysis of the 5-year 1-hour event, and to apply the calibrated data to the 5-year, 24-hour event.

Figure 18, "June 21, 2021 Rainfall Hyetograph", shows a total rainfall 1.67 inches over 5.75 hours with two distinct periods of peak intensity of 1.56 in/hr. Although not identical to the rainfall total and intensity of the 5-year, 1-hour event it is comparable for use in modeling for the 9:30 to 10:30 window.

Figure 18
June 21, 2021 Rainfall Hyetograph



The EPA Stormwater Management Model (SWMM) runoff method for determining runoff hydrographs was used to determine the stormwater runoff entering the combined sewer system. The boundary of the CSO 005 combined sewershed was provided by the City of Rutland and was used as the subcatchment area generating runoff to the sewer system. A 5-year, 1-hour stormwater runoff hydrograph was generated based on subcatchment data discussed above. The hydrologic values for the area were adjusted as necessary to match the volume results estimated by the City CSO monitoring program to validate and calibrate the model.

The 5-year, 1-hour model hydrograph for the West Street CSO shows a peak intensity of 5.76 million gallons per day (MGD) and volume of 277,500 gallons as shown in **Figure 19, "June 21, 2021 CSO 005 Runoff Hydrograph".** The model shows an overflow of 39,900 gallons as seen in **Figure 20, "June 21, 2021 CSO 005 Activation Volume"** compared to 38,300 gallons estimated by the city reporting. The results are an acceptable margin of difference between the city activation volume report for July 21, 2021 and the model results and will be used for CSO abatement project analysis.

Figure 19
June 21, 2021 CSO 005 Runoff Hydrograph

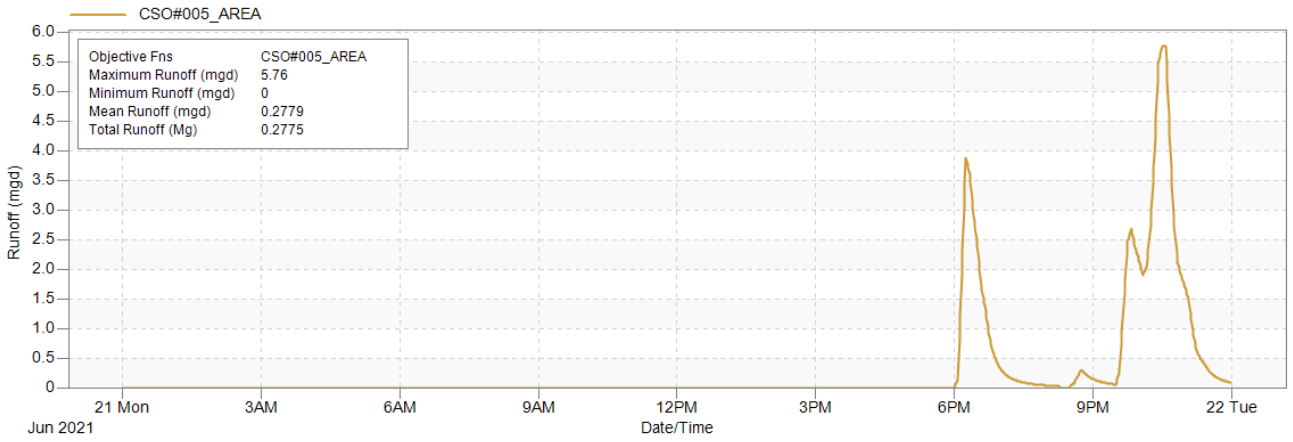
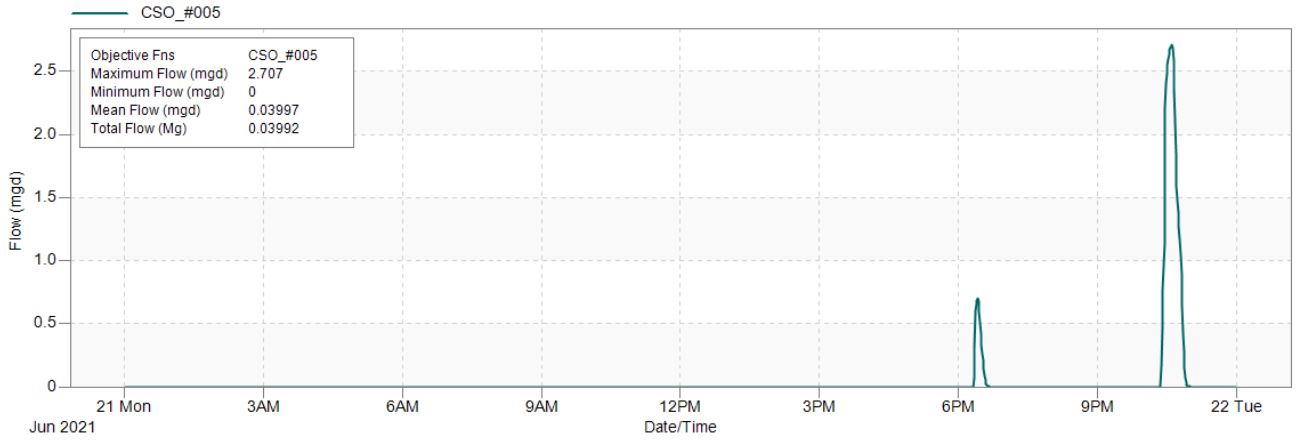


Figure 20
June 21, 2021 CSO 005 Activation Volume



The evaluation of the combined system during the 5-year/24 hour and 5-year/1-hour events is meant to provide an understanding of how the system performs and what areas to focus on to address CSO overflow events

5-Year, 1-Hour Design Model Results

The 5-year, 1-hour hydraulic model was analyzed to evaluate the projected CSO activation flow volumes to establish potential remediation projects for CSO abatement. The conveyed flow through the combined sewer system for the observed 5-year, 1-hour metering event and CSO model results are shown in **Table 2, "5-Year, 1-Hour Model Results"**, with 1.94 million gallons of combined sewage to be mitigated.

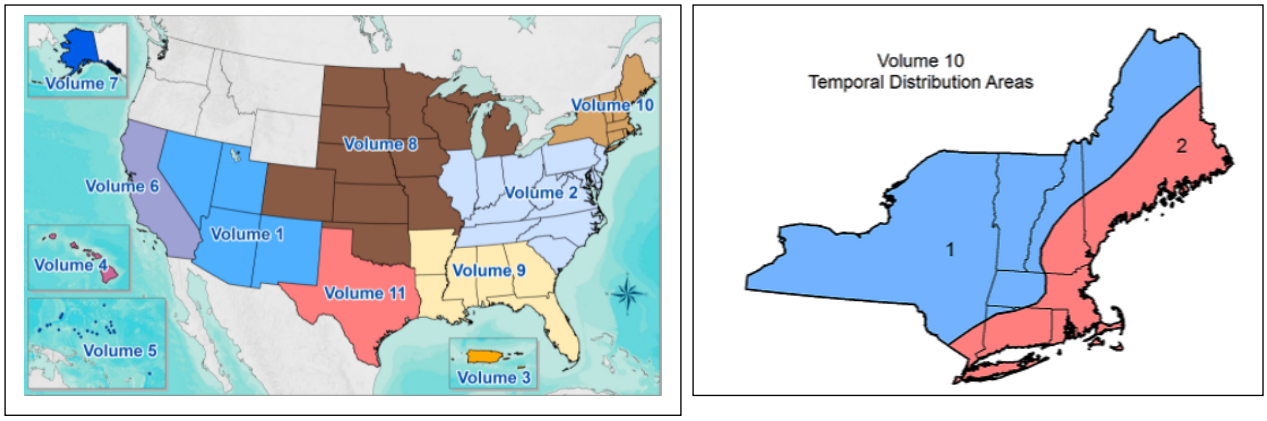
Table 2: 5-Year, 1-Hour Model Results			
Flow Source	Metered Flow Observed (MG)	Outfall Location	Modeled Flow (MG)
Meter 1	2.32	River St. Pump Station	4.15
Meter 5	1.39	Calvary CSO 001	0.58
Meter 4 (net)	0.98	Home Plate CSO 002	0.10
Meter 7	1.26	School Street CSO 003	1.13
		Meadow Street CSO 004	0.14
Total	**5.95**		**6.09**
CSO Activation Volume			**1.94**

2.3.1.4 5-Year, 24-Hour Hydrologic Model Development

The Vermont Department of Environmental Conservation requires that CSO abatement improvements be developed to prevent activation for the 5-year, 24-hour storm (3.1 inches total depth) and the 5-year, 1-hour storm (1.2 inches total depth). A 5-year, 1-hour storm was observed during the 2020 flow metering program and used in calibration and model development. The 5-year, 24-hour storm requires a theoretical analysis as this event did not occur during the 2017 or 2020 metering programs.

The VT DEC has not provided guidance on the required storm distribution pattern. For the purposes of this analysis, we evaluated the NOAA Atlas 14 temporal distribution patterns. Refer to **Figure 21, "Temporal Distribution Areas"** for the relevant temporal distribution area for Vermont from Atlas 14.

Figure 21
Temporal Distribution Areas

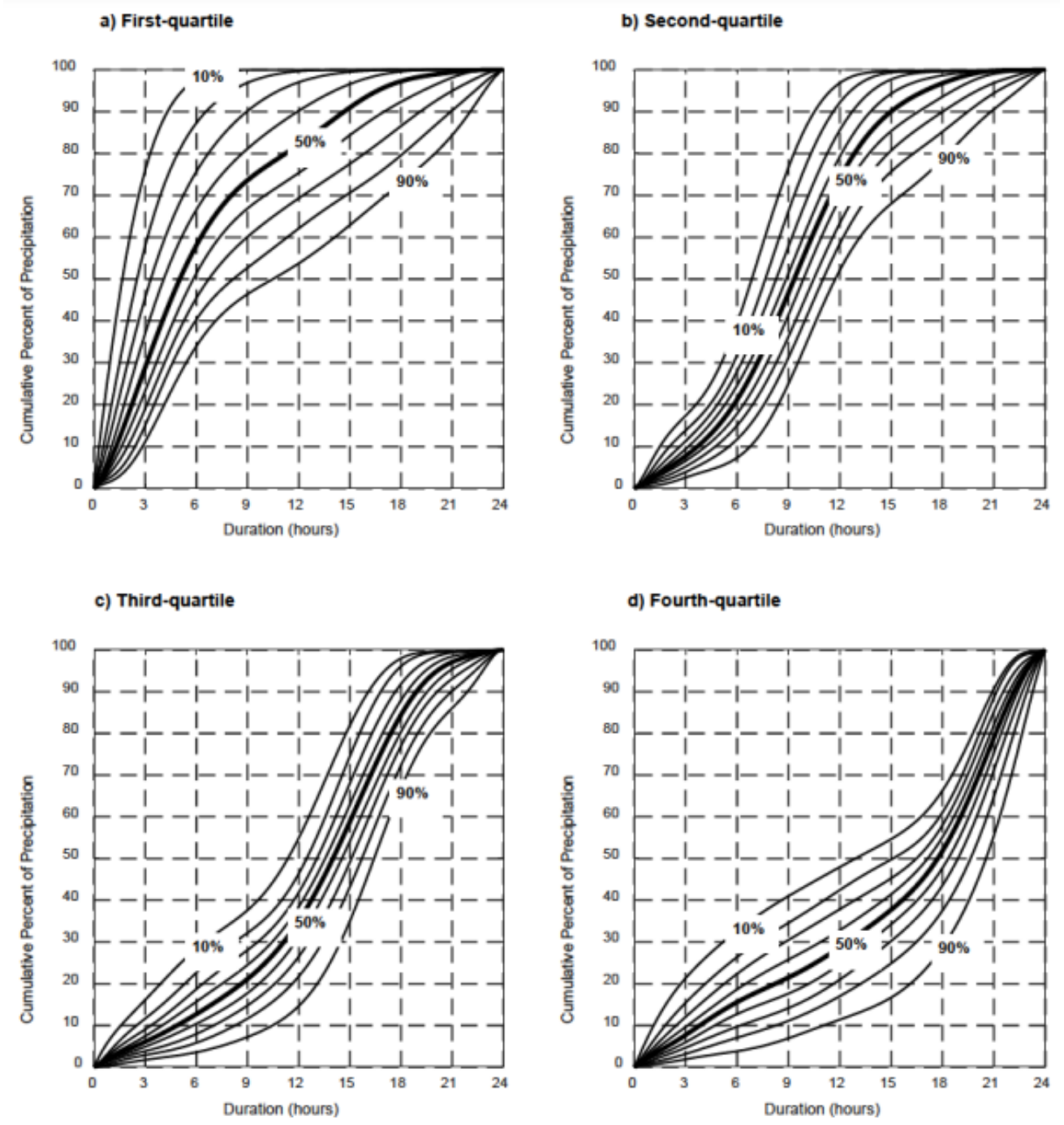


The data set for temporal rainfall are broken into four quartiles:

1st quartile – Rain occurring in hours 1-6
2nd quartile – Rain occurring in hours 6 - 12
3rd quartile – Rain occurring in hours 12 - 18
4th quartile – Rain occurring in hours 18 - 24

Refer to the figure on the following page for a depiction of the temporal distribution curves.

Figure 22
Volume 10 Region 1 Temporal Distribution Curves (24 Hour)



The temporal distribution curves represent averages of many cases and illustrate the temporal distribution patterns with 10% to 90% occurrence probabilities in 10% increments.

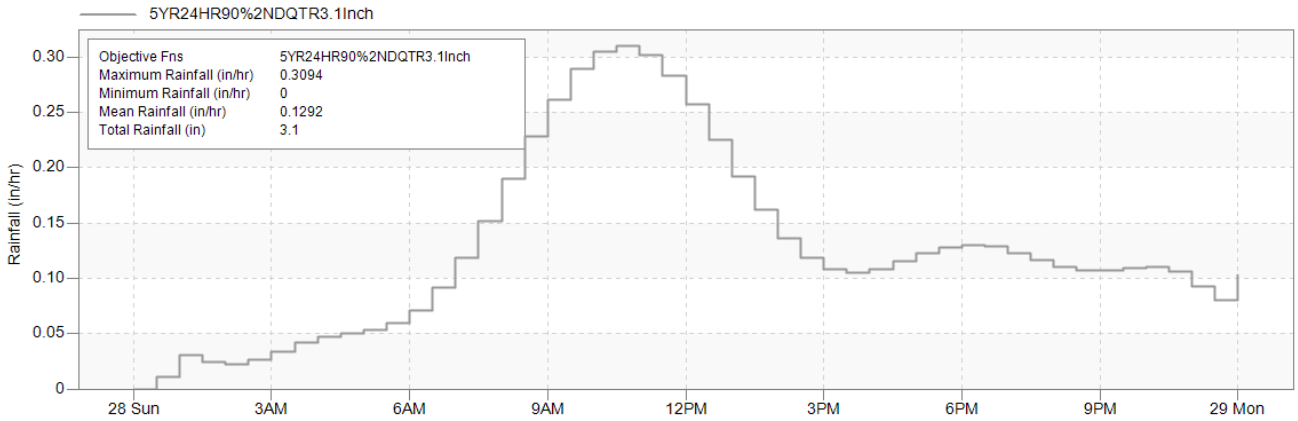
The 10% curve indicates that 10% of the corresponding precipitation events were more intense than the median value.

The 90% curve indicates that 10% of the corresponding precipitation events were less intense than the median value.

The 50% curve represents the median temporal distribution.

The second quartile 90% occurrence curve distribution pattern was selected for the 5 year 24 hour analysis. This pattern was chosen instead of an average event to provide a conservative value whose timing is similar to an SCS unit hydrograph. For this 3.1 inch storm the rainfall hyetograph distribution is shown in Figure 23, "5-Year, 24-Hour 90% Second Quartile Storm (3.1 Inches).

Figure 23
5-Year 24-Hour 90% Second Quartile Storm (3.1 Inches)



The 5-year, 24-hour hydrologic model was created by applying the 5 year 24 hour NOAA Atlas 14 hyetograph (90% second quartile) to the previously calibrated 5-year, 1-hour hydrologic model. Hydrologic model subcatchment area hydrographs resulting from this analysis are illustrated below.

Figure 24
5-Year 24-Hour Runoff Hydrograph - Meter 1 Subcatchment

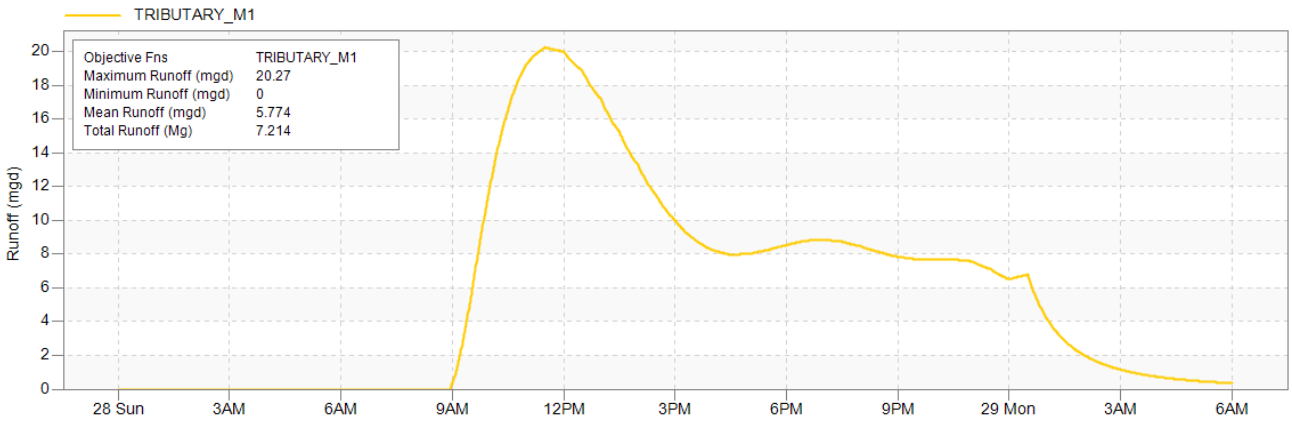


Figure 25
5-Year, 24-Hour Runoff Hydrograph - Meter 4 Subcatchment

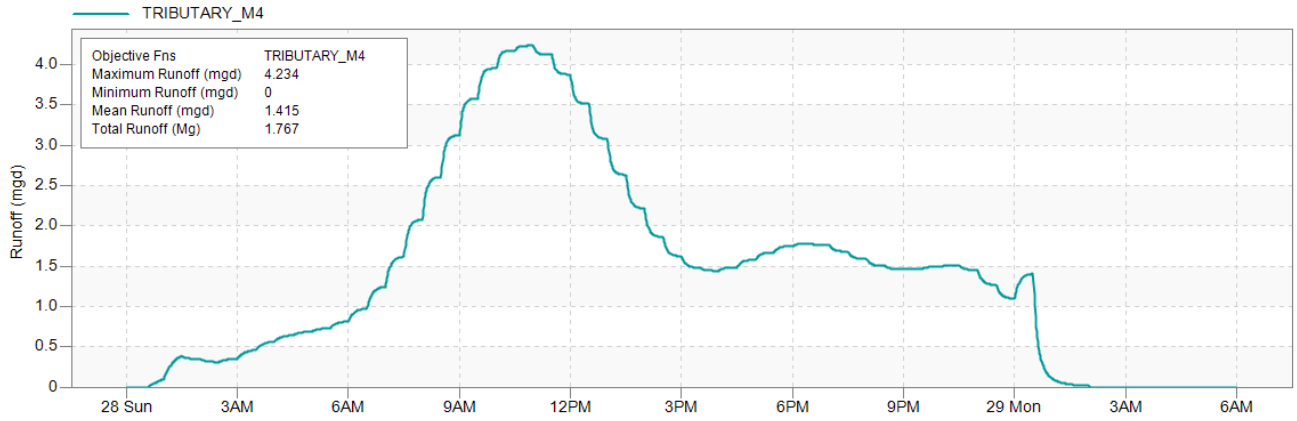


Figure 26
5-Year, 24-Hour Runoff Hydrograph - Meter 5 Subcatchment

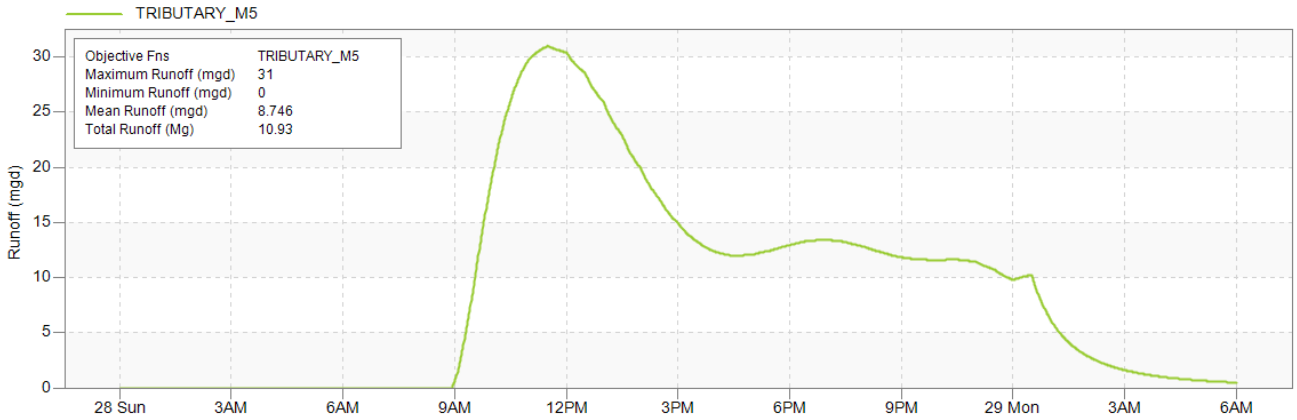
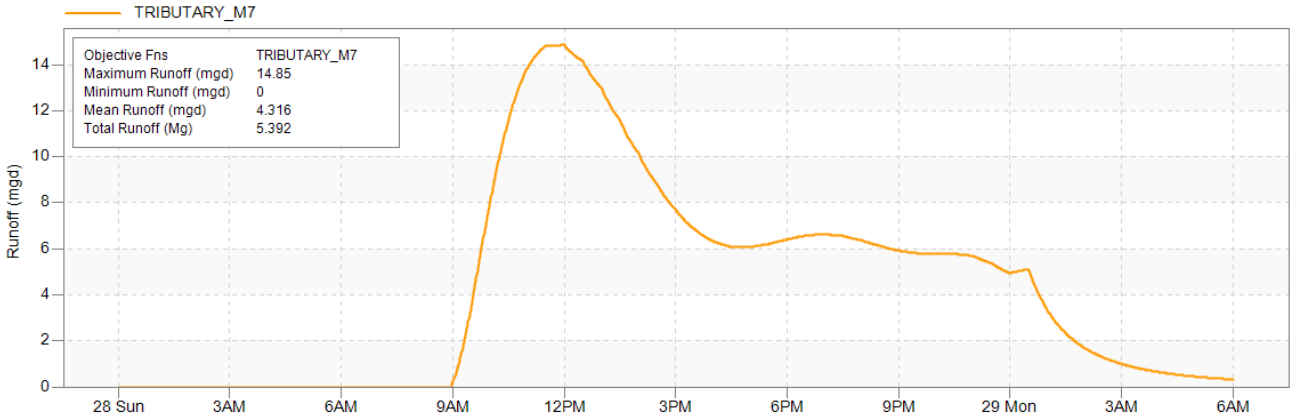


Figure 27
5-Year, 24-Hour Runoff Hydrograph - Meter 7 Subcatchment

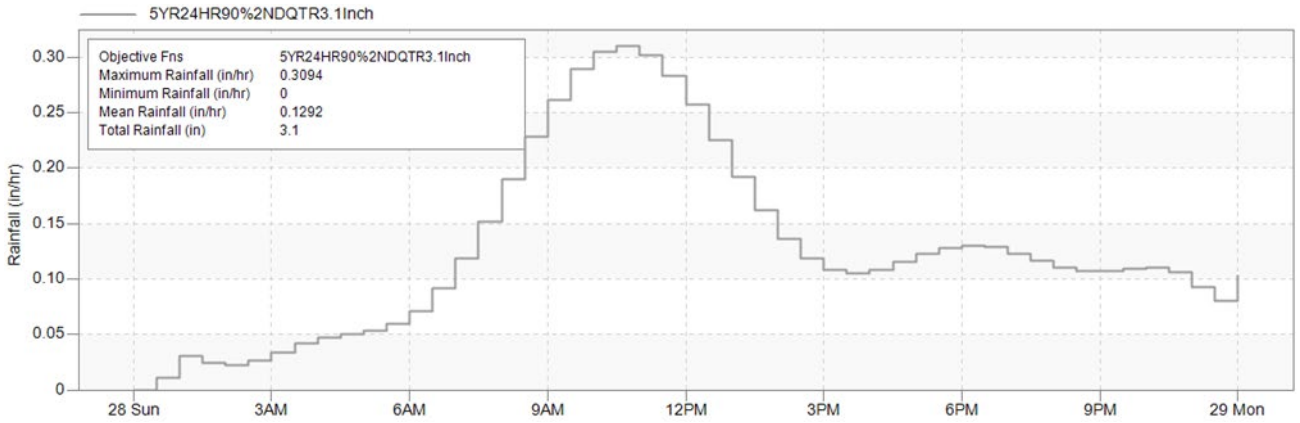


West Street CSO

As discussed above, the West Street CSO system was not part of the flow metering programs but has been documented through the City's CSO monitoring program. The calibrated 5-year, 1-hour model was adjusted to create the 5-Year, 24-Hour model.

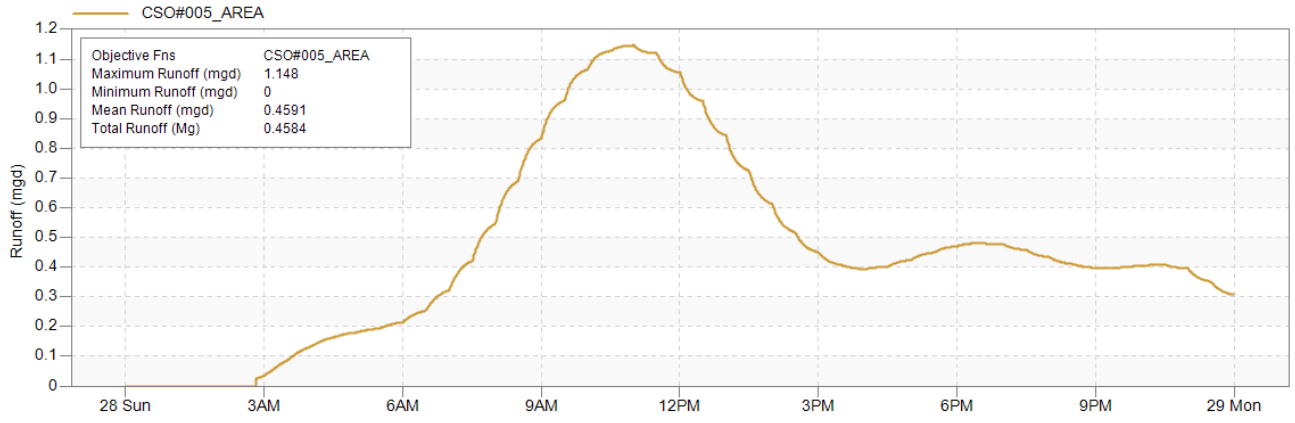
The metrics for the 5-Year, 24-Hour rainfall hyetograph shows a total rainfall of 3.1 inches over 24 hours with a peak intensity of 0.31 in/hr, refer to Figure 28, "5-Year, 24-Hour Rainfall Hyetograph":

Figure 28
5-Year, 24-Hour Rainfall Hyetograph



The 5-Year, 24-Hour model results combined sewershed runoff hydrograph for the West Street CSO #005 shows a peak intensity of flow at 1.15 MGD and a total runoff volume 458,400 gallons as shown in Figure 29, "5-Year, 24-Hour CSO 005 Runoff Hydrograph".

Figure 29
5-Year, 24-Hour CSO 005 Runoff Hydrograph



The 5-year, 24-hour model results for the West Street CSO 005 shows that an overflow activation does not occur, and the overflow volume is zero. CSO 005 abatement projects for the 5 Year 24 Hour event are not required.

2.3.1.5 5-Year, 24-Hour Hydraulic Model Evaluation

The 5-year, 24-hour hydraulic model was used to quantify CSO activation flow volumes to evaluate CSO abatement projects. The conveyed flow through the combined sewer system for the 5-year, 24-hour event and CSO model results are shown in **Table 3, "5-Year, 24-Hour Model Results"** with 11.84 million gallons of overflow remediation required.

Please note that CSO 005 West Street was not included in this summary as the analysis determined that no CSO activation occurred for the 5-year, 24-hour storm event.

Table 3: 5-Year, 24-Hour Model Results

Flow Source	Metered Flow Observed (MG)	Outfall Location	Modeled Flow (MG)
Meter 1	8.5	River St. Pump Station	16.76
Meter 5	11.56	Calvary CSO 001	5.00
Meter 4 (net)	1.8	Home Plate CSO 002	0.26
Meter 7	6.36	School Street CSO 003	5.48
Meadow St. Interceptor	0.14	Meadow Street CSO 004	1.1
Total	**28.22**		**28.6**
CSO Activation Volume			**11.84**

Water Quality Impacts

Combined sewer systems are sewers that collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe. These systems are heavily influenced by precipitation events and have overflows, or regulators, to prevent precipitation induced surges from surcharging streets and buildings and creating an immediate public health hazard. Water discharged from these combined sewage overflows contains not only stormwater but also untreated human and industrial waste, toxic materials and debris.

2.3.1.6 Purpose

The State of Vermont's goal is for CSO communities to develop and implement cost-effective LTCPs that achieve compliance with applicable water quality standards and with other CWA requirements, and for states to review and revise water quality standards as appropriate to ensure they are attainable. By phasing the implementation of CSO controls and evaluating their efficacy as they are installed, communities and states can manage the complexities of: (1) improving the quality of urban waters affected by many sources; (2) financing the high costs of structural CSO controls; and (3) integrating LTCP development and implementation with water quality standard reviews.

Many CSO communities undertake collection system and receiving water monitoring and modeling activities to better understand the dynamics of the combined sewer system (frequency, duration, flow rate and volume of CSO discharges) and their impact on receiving water quality. As water quality sampling pertains to Rutland's CSO LTCP, it is to provide a better understanding of the pollutant load and how it compares to the receiving waters, which are heavily affected by upstream stormwater and agricultural runoff. While the ultimate goal of this LTCP is to identify all projects which, if undertaken, will eliminate CSOs that would occur during precipitation events having less impact on the system than the designated evaluation storm; it is important to have an understanding of current water quality impacts so that the positive impacts of future CSO abatement efforts can be evaluated.

To this end, the City of Rutland has conducted water sampling within the sewer system and upstream of the overflow locations in the receiving waters as part of the development of this LTCP.

2.3.1.7 Approach to Determining Water Quality Impacts

There are two tributaries which pass through Rutland which are impacted by CSOs: the East Creek and the Otter Creek. The confluence of these two waterways occurs just upstream of the WWTF outfall on the East Creek. As noted earlier, CSO 001 is located on the Otter Creek and CSO 002, 003, 004, and 005 are located on the East Creek. These are the regulators which activate most often. Based on this system configuration, Weston & Sampson recommended the following general approach to determining water quality impacts of CSO discharges on both of these receiving waters:

- Develop a method to approximate river flow using real-time river level data for both the East Creek and the Otter Creek. To create this reference tool, we recommended graphing flow vs. river water level for both the East Creek and Otter Creek. Flow measurements will be generated by creating several velocity profiles for both rivers.

- Install water level loggers at strategic locations on both the East Creek and Otter Creek to obtain water levels and corresponding dates and times for use in this effort.

- Select upstream river water sampling locations on both the East Creek and Otter Creek so that water quality data from the rivers can be obtained, corresponding to an overflow event, and background water quality can be profiled. These locations will need to be upstream of any CSOs.

- Select locations within the wastewater collection system where combined sewage samples can be obtained in order to determine combines sewage quality during a precipitation event resulting in an overflow. For the purposes of this report, we selected one location just above CSO 001 to represent discharges from the Otter Creek Interceptor to the Otter Creek, and one location on the East Creek Interceptor just upstream of CSO 002 to represent discharges from that portion of the system to the East Creek.

- Use background water quality data from both tributaries, water quality from the combined sewage, actual CSO discharge volumes and approximated river flows during each precipitation event, resulting in a CSO discharge, to approximate the increase in mass loadings to the receiving waters of individual pollutants.

Ideally, sampling was to have taken place during a precipitation event which impacted the entire collection system, so that water quality both in the streams and in the sewer could be approximated during a significant precipitation event, causing an overflow. The effects on receiving water quality from several events were to be summarized in order to approximate general impacts to receiving water quality.

2.3.1.8 Sampling Locations and Significance

The water quality sampling locations selected for this effort were as follows:

Sampling Location 1: Otter Creek, south of CSO 001 (Calvary Cemetery), on the eastern riverbank adjacent to Billings Meadow. This location was selected to represent water quality upstream of any CSO discharges in the Otter Creek during a precipitation event.

Sampling Location 2: Otter Creek Interceptor at Billings Meadow – Sewer Manhole A25-1 - (Sewer manhole at Forest Street pull off). This location was selected to represent combined sewage quality within the southern, and more industrial section, of the wastewater collection system, during a precipitation event; and be somewhat representative of CSO quality leaving from CSO 001 on the Otter Creek.

Sampling Location 3: East Creek Interceptor at Meadow Street Park – Sewer Manhole # R1-3A. This location was selected to represent combined sewage quality within the northern, and more commercial and residential sections of the City, during a precipitation event; and be somewhat representative of CSO quality leaving from CSOs 002, 003 and 005 on the East Creek.

Sampling Location 4: East Creek, North of CSO 005 (West Bank). This location was selected to represent background water quality upstream of any CSO discharges in the East Creek during a precipitation event.

Sampling procedures used by the City for this program are described in detail in Appendix E, "Water Quality Data", Pages E-1 and E-2, "CSO Long Term Control Plan Water Quality Sampling". Locations of sampling points, river level monitoring stations and sewer water quality sampling locations are shown on Figure E-1, "Water Quality Sampling and River Level Gaging Stations".

2.3.1.9 Water Quality Parameters

Samples from each sampling run were composited, delivered to a laboratory and analyzed for the following constituents, which were discussed with, and agreed to by, the Vermont ANR and City of Rutland prior to the start of this program. The Vermont ANR Watershed Management Division concurred with these parameters on October 8, 2020:

- Indicator bacteria (E. Coli)
- Total Suspended Solids (TSS)
- Biochemical Oxygen Demand (BOD)
- Dissolved Oxygen (DO)
- pH
- Settleable Solids
- FOG

- Total Phosphorus
- Total Nitrogen
- EPA Toxic Metals
- Arsenic
- Barium
- Cadmuim
- Chromium
- Lead
- Mercury
- Selenium
- Silver
- Zinc
- Copper

As noted earlier in this section, the intent of this program was to use both river and sewer quality data and flows to determine mass loadings for pollutant constituents in the wastewater collection system and in the rivers upstream of the sample locations. Two successful sampling runs were completed by the City of Rutland. One on May 26, 2021 and the other on June 21, 2021. Challenges encountered during the sampling program are described later in the section. Water quality data from the combined sewer sampling locations and from sampling points upstream of combined sewer discharges in the East Creek and Otter Creek are summarized in Tables E-1 and E-2, "CSO Sampling/Test Result Data" in Appendix E.

2.3.1.10 Approximation of River Flows

CSO regulators are located on both the Otter Creek and East Creek upstream of upstream of their confluence. Downstream of the confluence, there are no CSO regulators. In order to determine the total mass loading of pollutants in the background flows in each of the tributaries, the City needed to be able to approximate flow In each river concurrent with the upstream surface water sampling, described in the paragraph above. It was important that this sampling and flow measurement also be concurrent with a precipitation event resulting in a CSO discharge, in order for this data to be representative of stream and sewer conditions during a precipitation/CSO event. Two locations were identified where the City could measure depth of flow and velocity for both the East Creek and Otter Creek. The East Creek flow monitoring location was at the West Street Bridge. The Dorr Drive Bridge provided a good location for depth and velocity profiles for the Otter Creek. Both bridges are located just above the confluence of the two tributaries. Both bridges are perpendicular to the flow of each tributary, allowing safe access for stream depth and velocity measurements from the bridge decks.

For each measurement location, the City measured water depth at selected stations, then took velocity measurements at the same stations. Velocities were obtained using an OTT MF pro electromagnetic velocity probe and recorder and data was collected using recommendations from the USGS's, *"Discharge Measurements at Gaging Stations".* A cross-section of each tributary depicting where the City obtained measurements is included as Figures E-2, "Otter Creek Cross-section", and E-3, "East Creek Cross-section", of Appendix E. The City of Rutland measured depths and velocities on November 24, 2020 and May 3, 2021 for the East Creek. Data was collected on December 2, 2020 and May 3, 2021 for the Otter Creek. Depth and velocity readings collected by the City of Rutland are summarized in Tables E-3, E-4 and E-5, "Stream Velocity Measurement – Stationing", of Appendix E.

2.3.1.11 River Level Gaging

Solinst Model 3001 Leveloggers (pressure sensors) were installed in monitoring wells along the riverbank at four locations: two on the East Creek and two on the Otter Creek upstream of their confluence. A graphic from the Solinst user manual is attached in Figure E-4, "Level Logger Field Measurement", of Appendix E showing how the loggers were installed. At each location, 2" PVC groundwater monitoring well screens were driven several feet into the side of the riverbank, to well below the water level. A logger was suspended using nylon Mason Line in each well and the depth from top of well was recorded. A barometric pressure logger was located at the River Street Pump Station, central to the location of the river gages. The purpose of these gages was to record changing water levels in both tributaries so that we could ultimately correlate river levels with measured flow for each. In this way we would be able to approximate river flow based on static water level at each station, for use in pollutant loading calculations. Liquid head at each gaging station was recorded every 5 minutes during the monitoring period, which extended from November 2020 through June 2021. Subtracting barometric pressure (in feet of water) from the readings obtained from the level loggers, we were able to calculate the height of water above each gage for each data point.

Using the limited velocity and river level information that was obtained, we graphed static water level above the gauge versus calculated flow (using the City's river velocity measurements and water depths). River level measurements were selected that corresponded with the date and time that the flow measurements were obtained. With this information graphed, flow could be approximated in both tributaries based on static water level readings. With only two data points for each tributary, we approximated flow patterns by connecting these points with a straight line. It should be noted that typical river flows are governed by stream bed geometry and do not typically follow a straight-line regression. Additional flow and level data from more widely ranging stream flow conditions should be obtained at each location in the future to provide greater accuracy in future analyses. Graphs of river flow vs. relative water level (with respect to the level gage) are included in Appendix E as Figures E-5 and E-6, "Measured Flow vs. Gaging Station Level".

2.3.1.12 Water Quality Impact Assessment Challenges

Wastewater sampling equipment was procured by the City of Rutland for this program as a small purchase through the Vermont Clean Water SRF Loan Program. Once the procurement for this equipment was completed, and the equipment delivered, Weston & Sampson assisted with assembly of the equipment and training for the City DPW staff who would be undertaking this work. The City and Weston & Sampson worked together to develop Sampling Guidelines to gain the most information possible during the sampling period. Sampling test runs were completed in November 2020, and data was to be collected during the spring 2021 wet weather season. Sampling procedures were adjusted in advance of each attempted run/precipitation event in order to gain the best data. If a precipitation event was predicted to occur late at night, the City used a 6-hour collection period with samples being pulled at each location every 30 minutes, ensuring that they were able to extend the sampling window to capture the full event. If the precipitation event occurred during work hours, the City was able to tighten that window (i.e. sample every 10 minutes), resulting in a 4 hour collection period).

Spring 2021 was unusually dry and fell at the end of a 71-week drought in Vermont (officially beginning on June 23, 2020 and ending on October 26, 2021). In November 2020, Federal officials declared 10 counties in Vermont, including Rutland County, to be a natural disaster area due to the 2020 drought. The USDA reported that corn and hay yields were down by as much as 75 percent, streams and farm ponds ran dry, and farmers were forced to haul water and feed animals harvested hay when pastures dried up. Parts of Vermont were declared abnormally dry as early as June 2020, according to the

National Drought Monitor, and advanced to moderate drought and severe drought as the summer progressed.

City staff made many attempts to obtain samples that corresponded with precipitation events, but were not able to achieve many data points, since predicted isolated thunderstorms which finally did arrive in the area ultimately missed the City altogether.

Two precipitation events were able to generate samples and results during a precipitation event: (1) May 26, 2021 and June 21, 2021. The May 26th event did not actually result in an CSO discharge, but the river levels rose and the wastewater collection system was impacted. The June 21st precipitation event did result in a CSO discharge. Water quality analysis data for the June 21, 2021 sampling date was used to calculate approximate water quality impacts resulting from that single overflow event.

In addition to the impacts of the drought, the City discovered that the river level monitoring equipment installed at the Dorr Drive Pump Station (River Level Logger No. 3) had been stolen at some point during the monitoring period. This level logger provided river level information that corresponded with flow measurements taken at the Dorr Drive Bridge for Otter Creek flow calculations. Since this river level information was not available, we used river level data from River Level Logger No. 4, just downstream of CSO 001 in an attempt to correlate river flow at the Dorr Drive Bridge with water levels recorded at this location further upstream. Because this level logger was over a 1/2 mile upstream of the gauge we were not confident in the accuracy of this method. For the purposes of this report, our water quality impact calculations are based on Otter Creek flow data from USGS Gaging Station No. 04820000 located at the center of the City. This station is located downstream of the East Creek/Otter Creek confluence, so we approximated Otter Creek Flow upstream of the confluence, corresponding with the June 21, 2021 over flow event, by subtracting our calculated flow from the East Creek (corresponding with this same date, and at the time of the overflow event) from the USGS reported flow for the Otter Creek.

Additionally, River Level Logger No. 2, near CSO 003 had been tampered with at some point during the monitoring period. The City was able to locate the monitor and retrieve it from the Creek bed, but data from this monitoring location was compromised and not usable for this effort.

Due to the prolonged drought which occurred during the study period, there were few significant storm events that the City's monitoring program was able to capture. However, there is sufficient data available from this effort to make general assumptions regarding pollutant mass loadings and to allow for prediction of water quality impacts during design precipitation events. The results of the water quality sampling program will be described in greater detail in subsequent sections of this report. Water quality data and a summary by location is included in Appendix E.

2.3.1.13 Water Quality Impact of CSOs

As noted above, there was only one sampling date where the City was able to gather both upstream river water quality data and combined sewage quality data which corresponded with a precipitation event resulting in an overflow. This occurred on June 21, 2021. Overflows were recorded between 6:00 PM and 9:00 PM on that date. Overflows were metered at CSO 001, 002, 003/004 and 005.The estimated volume of CSO discharge from each of these four locations is summarized on the "Authorized Wet Weather Combined Sewer Overflows" page of the Vermont ANR Watershed Management website. This CSO inventory is managed by the Vermont Agency of Natural Resources and tabulates reported

overflows from communities throughout the State of Vermont. A printout from this website corresponding with this overflow event is attached as Table E-6, "Wet Weather Combined Sewer Overflows", in Appendix E.

Using information gathered from the River flow monitoring program by the City, Weston & Sampson calculated the mass loadings for each of the individual pollutants listed in Paragraph 1.1.1.4 above in both the upstream flow for each river and for the combined sewage in the northern and southern sewer interceptors. These calculated loadings are representative of conditions within both the collection system and the receiving waters at the time of the June 21, 2021 CSO discharge event. These calculations are summarized on Table E-7, "CSO Event Loading Calculation", of Appendix E.

From this limited data, we can make the following general observations:

- E. Coli loadings increase substantially (8:1 for Otter Creek and 80:1 for the East Creek)
- BOD and TSS loadings increase significantly (35% to 125%)
- Settlable Solids loadings increase significantly (10% to 25%)
- Total Phosphorus loadings increase significantly (20% to 30%)
- Metals loadings do not increase significantly with the exception of Lead (14% to 72%)

This information is being provided to illustrate the relative impacts on the receiving waters of CSO discharges in both the Otter Creek and East Creek. However, as noted earlier in the section, the prolonged drought, vandalism and theft of river gaging equipment and limited river flow measurements have resulted in our being able to generate this impact analysis for only one overflow event. This single data point is not refined enough, for the reasons described above, to accurately characterize Rutland CSO discharge impacts on the receiving waters.

Now that this program has been established, there are procedures that can be easily followed to obtain more data and further refine our understanding of the effects of these discharges on the East and Otter Creeks. Weston & Sampson recommends that additional flow monitoring and river flow measurements be obtained to provide additional data points which can be used to refine and increase the resolution of this analysis in the future. Such information will help with future CSO abatement recommendations and will allow the City to establish a baseline so that the positive effects of completed CSO abatement projects can be observed.

2.4 Condition of Existing Facilities

The following provides a summary of the efforts the City has undertaken to comply with the EPA's Nine Minimum Controls (NMC) for the last full calendar year of 2020:

1. Proper operations & maintenance of the collection system and CSO outfalls,

The Wastewater Treatment and Wastewater Collection divisions operate and maintain the City's collection system, which includes all CSO outfalls, pump stations and sewer mains. One hundred percent of the system's catch basins, swirl separators, and sedimentation basins were inspected and cleaned. Problematic areas that are prone to the collection of grease were remedied. In addition, routine maintenance occurred with respect to the City's siphons.

2. Maximizing the use of the collection system for storage of combined sewage without endangering the public,

The City currently monitors four active CSO outfalls that incorporate weirs and/or flap gates. These outfall structures activate to relieve the combined sewer system during wet weather events. The regulators were have been modified over the years to improve storage capacity within the existing infrastructure while preventing wastewater from backing up into streets and/or residential and commercial buildings. Due to the large area that the Rutland wastewater collection system services, and the relatively small diameter of the main sewer interceptors, there are few opportunities for storage and equalization of wet weather flows within this system, as it exists.

To further maximize what small amount of storage capacity exists within Rutland's combined wastewater collection system, the City undertakes an aggressive inspection and flushing program each year. The City currently has a flushing crew dedicated to system maintenance. This crew works 5 days per week, for three seasons, focusing primarily on the following problem areas:

- Cleaning catch basins (to prevent grit from entering the wastewater collection system),
- Flat sloped sewer mains (where grit collects more quickly), and
- Flushing areas with recurring grease blockages from the food service industry.

Beyond the high priority high priority areas which require continual maintenance, the City inspects the collection system annually to identify other sections of their wastewater collection system which require maintenance. Meadow Street, from West Street to School Street was identified as a priority in 2020. This minimally sloped line was flushed and 50 cubic yards of grit were recovered. A portion of the Moon Brook trunk sewer was inspected by the City in the fall of 2020. As a result, the City hired a video inspection to further inspect 4,700 linear feet of both the Moon Brook and Muzzy Brook trunk sewers. The goal of the video inspection was to determine if that section of the collection sewer was in need of cleaning. This inspection work was completed in the Spring of 2021 and the City is currently budgeting for removing the accumulated sediment in these sections of trunk sewer.

Rutland's aggressive system inspection and flushing program helps to ensure that system capacity is maximized and the possibility of sewer back-ups is minimized.

3. Review and modify pre-treatment requirements to assure that CSO impacts are minimized,

The City monitors the wastewater of industrial and large commercial customers. A High Strength Surcharge is invoiced quarterly to these customers, based upon Total Suspended Solids (TSS) and Ultimate Oxygen Demand (UOD) standards. A sixth customer was added to this list in 2020. As a result of this program, these customers have modified their habits internally, resulting in a reduction in the strength produced.

There are numerous customers within the City of Rutland and Rutland Town that have pretreatment facilities on site. General Electric submits a Toxic Organic Management Plan to the City on a monthly basis. This report is an analysis of their industrial wastewater treatment facilities at both their Windcrest Road and Columbian Avenue locations.

4. Maximize the flow of combined sewage to the WWTF for treatment,

The City of Rutland has a long-standing history of implementing projects that increase the flow of combined sewage to the wastewater treatment plant in conjunction with combined sewer separation projects. The most recent improvement was replacement of one of the two 20-inch sewage force mains with high-density polyethylene pipe. This pipe is durable and had a much low coefficient of friction than the former ductile iron force main. This will allow for increased flow rates from the RSPS to the WWTF without increasing pump size or motor horsepower. Refer to Section 2.3.1 for additional information.

5. Prohibit CSO discharges during dry weather,

There were no dry weather combined sewer overflow events in 2020.

6. Control the solid and floatable materials in CSOs,

The City limits solid and floatable materials within CSO's through the maintenance of the collection system and streets. In 2020, every catch basin in both the combined and sanitary systems was cleaned at least once. The City's downtown had its streets swept weekly. The remaining City streets were swept at least 3 times between the start of May and the end of October.

7. Establish pollution prevention programs to minimize contaminants in CSOs,

The City has routinely inserted stormwater education materials in utility bills since 2017. In addition, the City maintains a stormwater web page (www.rutlandcity.org/stormwater) that educates residents on the adverse impacts of stormwater pollution and what they can do to mitigate it.

8. Provide public notification of CSO events, and

In 2020, the City notified the public of CSOs by way of social media and through the Department of Environmental Conservation's "Combined Sewer Overflows and Untreated Discharges" reporting web page.

9. Monitor to characterize CSO impacts and the efficacy of CSO controls.

The City operates two tipping bucket rain gauges, one at the WWTF and another at the Streets Department located on Spruce Street. The first records data for later download and the second transmits data for near real-time monitoring through a web-based platform. Both devices comply with the specification in the CSO Rule and the 1272 Order.

The City has installed ultrasonic level sensors with telemetry devices at all CSO overflow structures. With this equipment the City is able to estimate the duration and magnitude of the overflow. In addition, the City has recently purchased eight area-velocity meters. These devices were installed in the fall of 2020 and are also monitored utilizing telemetry equipment. The data gathered from the newly installed meters has been incorporated in the H&H Model in order to fine tune its accuracy and increase the resolution of the model output. Lastly, the City currently owns two level sensors that can be installed on the bottom

of sewer manholes. These sensors can be relocated throughout the City to collect supplemental data as needed, to provide further flow data and model resolution.

2.5 Financial Status of Existing Facilities

The City of Rutland operates their wastewater facilities as an Enterprise Fund, where revenue is generated by the wastewater system use and monies are spent only for wastewater system-related operation and maintenance. This Enterprise Fund encompasses wastewater treatment facilities, the wastewater collection system, and nine municipal wastewater pump stations.

Revenue is generated for the Wastewater Enterprise Fund through metered water use. All sewer customers within the City limits are also water system customers. Metered water use is the basis for sewer billings for these customers, and the revenue generated for the system. Customers in Rutland Town, which surrounds Rutland City, are a mixture of combined water/sewer users and sewer only users. For customers who discharge wastewater only and do not consume City water, the City requires installation of water meters on their private water sources (groundwater wells) so that their sewer use is also based on water consumption, for billing consistency. The Alpine Pipeline, which extends through Rutland Town to Mendon and Killington, is set up much the same way. This private sewer utility services a rural area where wells and small private water systems are the source of water. Water meters are used in these towns for the purpose of sewer billing as well.

For industrial customers in the City which use water for purposes not requiring wastewater disposal, such as evaporative cooling, a separate water meter is installed on the product line so that water leaving the site as a product does not artificially inflate the wastewater number for billing.

Sewer rates are adjusted annually based on the proposed budget, approved by the Rutland Board of Aldermen acting as sewer commissioners. For years where the Enterprise Fund runs a surplus, the surplus is retained within the enterprise fund.

As part of this Enterprise Fund the City maintains a capital reserve fund for maintenance and capital improvements projects. The capital reserve fund is split into two pieces, one for the wastewater treatment facilities and one for the wastewater collection and pumping systems. Money is put into the capital reserve fund annually for the wastewater treatment facilities at a rate of at least 5% of the annual revenue. For many years money has been put into the sewer collection system capital improvements budget at a fixed amount of $65,000 per year.

As of July 1, 2020, the start of Fiscal Year 2021, the wastewater treatment facilities capital reserve balance was $640,089. The capital reserve fund balance for the wastewater collection system was $427,526.

Debt service for past capital improvements projects is budgeted annually. Debt payments for past projects are budgeted based on loan amortization, interest, and fees. Most of the City's wastewater-related debt is primarily for past WWTF improvements.

The City of Rutland carefully monitors the Enterprise Fund and sewer use rates are equitable when compared to other larger municipalities in the State. With the approved FY 2022 budget, 80% of the projected revenue generated by sewer billings for the City's wastewater system will come from the City of Rutland, 15% will come from the Town of Rutland and approximately 4% from customers on the Alpine Pipeline.

A copy of the Fiscal Year 2022 Sewer Rate Study, which provides the fiscal year 2022 wastewater budget, is provided in **Appendix F, "City Wastewater Financial Data".**

2.6 Evaluation Criteria

Vermont's CSO LTCP guidance requires that CSO abatement improvements be evaluated against two storm events: 5-year, 24-hour storm and the 5-year, 1-hour storm. Based on the flow monitoring performed in 2017 and 2020, two storm events were selected to serve as the basis for analyzing system performance, see **Table 4, "Evaluation Storms":**

Table 4: Evaluation Storms

Date of Event	Recurrence Interval	Intensity (inches/hour)	Total Depth (inches)
Theoretical Event*	5-year, 24-hour	0.31	3.1
6/28/2020	5-year, 1-hour	3.24	1.2

**Note: NOAA Atlas 14 rainfall and distribution.*

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3.0 NEED FOR PROJECT

3.1 Health, Sanitation & Security

CSO discharges result in impacts to human health. Raw wastewater contains contaminants that adversely impact human health such as Escherichia coli (E. coli), Legionella pneumophila, Salmonella typhi, Crypotsporidium, Giardia Lamblia, Hepatitis, and Rotavirus. Recreational users of waters of the state downstream of a CSO discharge are at risk of these pathogens In addition to the human health impact of CSO discharges, the high levels of Biochemical Oxygen Demand (BOD) deplete the oxygen in receiving waters, resulting in the die-off of fish. The control of CSO discharges improves water quality.

Specific to Rutland,, there have been no reported instances of sewer surcharging noted in streets or buildings as a result of storm events since 2017. Additionally, the City is unaware of any documented swimming hole closures downstream of the CSO outfalls on either the East Creek or the Otter Creek.

1272 Order

On May 18, 2018 an administrative consent (1272 Order) was issued from the VT DEC to the City of Rutland. This Order consists of two primary requirements: (1) to implement the 9 Minimum Controls to reduce the quantity of CSO discharges and reduce the pollutants discharged to the extent practicable and (2) to develop this Long-Term Control Plan. Refer to **Appendix G, "1272 Order"** for a copy of this document.

TMDLs

Several creeks in the City have been identified by the VT DEC as being impaired, requiring the development of a Total Maximum Daily Load (TMDL) to address those impacts and improve stream health. In particular, stormwater and temperature TMDLs exist for Moon Brook and Mussey Brook. Both of these waterbodies are considered impaired for E. Coli, but a TMDL has not been issued for that particular parameter. Temperature TMDLs are typically addressed by projects relating to streambank restoration (e.g. shade tree planting); the mitigation measures outlined in this LTCP will not have a measurable effect on stream temperature.

Urbanized watersheds affect streamflow due to the high amount of impervious cover present. Pavement prevents infiltration of rainfall, reducing stream baseflow. Pavement also generates high flow rates of runoff during larger storm events that cause erosive conditions in streams. Stormwater TMDLs are managed with the intent to increase baseflow and reducing the peak flow for larger storm events.

In the projects that are considered in this report, none result in the creation of a new stormwater outfall on Mussey Brook. Several projects are proposed in the Moon Brook watershed, and close coordination with all relevant stakeholders will be necessary to ensure that CSO mitigation does not result in adverse stormwater impact to Moon Brook.

3.2 CSO Discharge Analysis

The discussion in this section is based on an analysis of the two evaluation storms required by the State of Vermont, the 5-year, 1-hour (1.2 inch total depth) and 5-year, 24-hour storm (3.1 inch total depth) events.

Precipitation

Precipitation is measured at the WWTF facility on Greens Hill Lane and is part of the regular reporting requirements of the City's NPDES permit. Anecdotal observations of the collection system and discharges have indicated that rainfall can occur on a very localized area; triggering CSO discharges in one part of the system while other outfalls remain inactivated. To aid in model calibration, additional precipitation meters were installed during the 2020 flow monitoring study. Refer to Figure 4 for these locations.

Historical CSO Discharges

The City of Rutland constructed sewers which flowed to the Otter Creek and East Creek, as was the practice during the late 19th century and at the beginning of the 20th century, when most of the City wastewater system was constructed. In the early 1960s, the City constructed the RSPS, a treatment facility and interceptor sewers to pick up all of the river discharges, to prevent untreated wastewater from entering the rivers. When these improvements were implemented, combined sewer overflow regulators were designed and constructed. The purpose of these regulators was to allow excess storm-related flows to discharge to the receiving waters instead of backing up onto streets or into residences, causing property damage and posing a public health threat. This practice was also an industry standard at the middle of the 20th century.

While the City of Rutland has continued to steadily improve the capacity of their treatment facilities, reported CSO events have been greatly minimized and reduced in frequency, but not completely eliminated. Please refer to Appendix D for a summary of activations from 2017 to 2020. Additional activation history for the City of Rutland can be found on the VT ANR website at:

https://anrweb.vt.gov/DEC/WWInventory/SewageOverflows.aspx

CSO Water Quality

The City of Rutland has conducted water sampling in the sewer system and upstream of the overflow locations in the receiving waters to better understand the impacts to receiving water quality. Refer to Appendix E for a summary of the water quality testing results. A detailed discussion of how the mass loading impacts on the receiving waters was calculated is included in Section 2 of this report.

3.3 Aging Infrastructure

The City of Rutland's collection system dates from the 19th century, with parts of the system not updated since it was originally constructed. Combined sewage contains high levels of sand, trash, grit, and other materials that scour the piping. Most recently, the 1970's era force main of the River Street Pump Station was replaced as grit in the combined sewage scoured the ductile iron pipe invert to the point of failure.

The LTCP provides a capital plan to ensure that infrastructure remains functional and is retired or replaced prior to failure, which could result in the discharge of untreated sewage into waters of the state.

3.4 Reasonable Growth

As discussed in Section 1.3 above, population over the next 20 years is anticipated to decrease, therefore, the proposed project does not necessarily need to take population growth into account for sizing. As the City has very little open space, the amount of impervious surfaces is not anticipated to increase to an appreciable extent. Many of the project areas for sewer separation discussed below are in residential areas that are fully built out, and the downtown core is highly impervious already.

However, climate change will result in storm events occurring with increasing frequency and intensity, which puts additional pressure on the existing system. Projects to convey stormwater runoff should be designed to account for higher intensity, higher volume storm events to ensure that conveyances do not surcharge into public streets or private property.

4.0 ALTERNATIVES CONSIDERED

4.1 Design Criteria

As mentioned in Section 2.6 above, the intent of the CSO mitigation alternatives is to eliminate discharges from the combined sewer system. There are three basic approaches to managing CSOs: increasing sewer and WWTF capacity to treat additional combined sewage, install CSO treatment systems that remove pollutants before discharging to waters of the state, and separating the stormwater infrastructure from the combined system to reduce the amount of flow in the combined sewers. These approaches are considered in more detail below.

4.2 Alternatives Approach

Increasing Collection System Storage & Maximizing WWTF Treatment Capacity

This approach involves capturing as much stormwater flow as possible and conveying it to the WWTF for treatment. The original approach of Rutland's CSO abatement plan, developed in the late 1980s, was to make the following improvements to the wastewater collection and treatment systems:

Phase I:

- Add additional pumping capacity at the RSPS;
- Construct additional preliminary treatment facilities (headworks) at the WWTF.

Phase II:

- Construct off-site treatment and disinfection facilities at two of the CSO regulators (CSO 001 and 002);
- install a third primary clarifier at the WWTF.

The Phase II improvements treatment and disinfection facilities were to be based on swirl concentrators that would provide primary treatment and disinfection of overflows before they enter receiving waters. Since the completion of the phase one facilities improvements in 1993, the City of Rutland has reassessed their abatement approach due to concerns about operation of off-site overflow treatment facilities. These concerns included (1) added operational and maintenance expenses associated with multiple treatment facilities and (2) the possible public health and environmental risk of large-volume sodium hypochlorite, or chlorine gas, storage at multiple locations around the City.

Based on these concerns the City modified their abatement program approach so that Phase II was split into Phases 2A and 2b. Phase 2A, constructed in 2005, included improvements to the WWTF primary treatment facilities and added pumping capacity at the RSPS. Phase 2B, which was to include the design of in-line storage conduits in the trunk sewers upstream of CSO 001 and CSO 002 has not yet been undertaken.

Using the H&H model, developed in 2018, the City has been able to refine its understanding of the behavior of this collection system during wet weather events. Using this understanding we are able to recommend a slightly modified approach for Phase 2B abatement improvements. As before, the intent of these improvements will be to increase storage capacity and equalization within the wastewater collection system upstream of the two major overflow regulators, and to divert as much flow as can be treated to the WWTF, thereby maximizing storage and treatment capacity within this system.

As noted above, the City of Rutland completed the first phase of upgrade (2005) to its WWTF to provide preliminary treatment for up to 28 MGD of combined sewage flow. Currently, up to 22.5 MGD can pass through secondary treatment and disinfection. Additional facilities need to be added to allow for flows above 22.5 MGD to receive primary treatment and disinfection, by-passing secondary treatment with these storm-related flows. Primary treatment consists of primary settling of coarse material (typically sand, grit and trash washed into storm drains during rainfall).

In addition to improvements at the WWTF, capacity improvements are needed at the RSPS to allow for up to 28 MGD of wastewater to be conveyed from the collection system to the WWTF. While the RSPS, in concept, currently has the capacity to convey these flows, the hydraulic model has identified a hydraulic restriction at the Otter Creek Interceptor between CSO 001 and the pump station wet well. This interceptor consists of a 24-inch diameter AC gravity sewer which has limited capacity due to its relatively small diameter. Increasing the size of this interceptor sewer will allow for flows during storm events to reach the pump station so that they can be conveyed to treatment.

Three separate projects have been identified which will serve to "maximize flow to the publicly owned treatment works for treatment", which meets the intent of the US EPA's "Guidance for Nine Minimum Controls" and is consistent with past CSO abatement work that the City has already invested in. These projects are discussed later in this chapter.

Installation of CSO Treatment Systems

This approach involves allowing CSO discharges to continue, however, the flows are partially treated to mitigate the impacts to water quality. As noted above, preliminary treatment is used; in this instance trash and grit are often removed via hydrodynamic ("swirl") concentrators, along with disinfection (typically a chlorination and dechlorination system).

This alternative was not investigated as part of this project for several reasons. First, in order for this alternative to be considered viable, the downstream water quality must meet or exceed Vermont Water Quality Standards. In the case of Rutland City, the receiving waters do not meet the VWQS, even upstream of the CSO discharge points. As a result, it is impossible for a CSO treatment system to be able to meet the standards required. In addition to this regulatory hurdle, these systems are costly on a capital basis as well as the O&M required. These systems require constant monitoring and maintenance, from cleaning of the swirl concentrator chambers to restocking chemicals in the treatment system. In addition, as these systems will only be used occasionally in a given year, they are prone to requiring maintenance above and beyond that of other systems that are used and exercised regularly.

Separation of Stormwater Infrastructure from Combined Systems

This approach removes stormwater runoff from the combined sewer system, thereby reducing the amount of combined sewage in the system and reducing the stress on storage, conveyance and treatment facilities downstream. The primary sources of stormwater inflow include catch basins, roof drains and sump pumps. Smaller, yet still significant contributors to stormwater infiltration include groundwater intrusion (via cracks in the combined sewer piping). This is called rainfall derived infiltration (RDI) and is influenced by precipitation, as opposed to groundwater infiltration which is continuous while groundwater elevations remain above the leaking sewer line.

Catch Basins

These structures can drain large amounts of surface area and quickly add to the combined flow of a sewer. In lower density areas of the City (e.g. outside the downtown core) a single catch basin can capture more than an acre of runoff. Depending on the soil type of the area, this can account for a large amount of volume. To redirect the stormwater contribution from catch basins, new pipe infrastructure is required. This new pipe can be used as a dedicated storm drain, in which case the combined catch basins are connected to it, or the new pipe can be a sanitary sewer, and the existing connections relocated from the old, combined sewer to the new sanitary sewer. Depending on the particular needs of a community, the state of the infrastructure, and the general topography of the area, one approach may be preferrable to another. For the case of the City of Rutland, previous projects involved building new storm drains and connecting existing catch basins to it. This approach will be used for this project.

Roof Drains

In more dense areas (i.e. the downtown area of the City), roof drains are a significant contributor to stormwater runoff into combined sewers. Large, flat roofs require a drainage system that pipes runoff away from the building. Gutters are often collected as well to prevent excess water flow onto driveways, walking paths and parking lots. However, many of these structures were built many years ago without record drawings to determine the size, layout, depth and material of this infrastructure. Roof drains may connect to easily verified locations such as catch basins, but quite often the drains are discharged directly into pipes, with no method to determine their location other than excavation.

As a result, merely separating catch basins from the combined sewer system will not necessarily remove all stormwater in combined sewers. The percentage of stormwater flow from roof drains compared to catch basins can vary dramatically, however, in Weston & Sampson's experience roof drains can contribute from 20 – 25% of the stormwater flow in a combined system and can be even higher in denser neighborhoods.

Due to these reasons, sewer separation projects that have been considered focused on outlying neighborhoods before considering areas in downtown. The project identification effort was able to define a set of projects that met the target areas without the need to include downtown in the analysis. This was to avoid costly excavation and disruptive construction at the heart of the City, which has the greatest density of utilities, sidewalks, traffic, businesses and pedestrians. A separation project in this area would be the most difficult and least cost-effective.

Sump Pumps

Often in areas with basements, sump pumps are used to keep the space dry. Discharge for sump pumps are prohibited to be connected to sanitary or combined sewers, however, depending on the age of a house this may still be the case. The volume and flow rate of water added to combined sewers from sump pumps is lower than a storm event's peak rate and total volume. Furthermore, the the pump's run cycle often extends beyond the storm duration. As a result, while sump pump discharges into combined sewers does result in reducing the capacity for dry weather flows to be conveyed, their contribution is not a primary driver for CSO events. A comprehensive sump pump elimination program was not considered in this LTCP as it focuses on the major drivers of overflows (i.e. lack of system storage, WWTF capacity, approach.

4.3 Overview & Evaluation of Alternatives

In this section the general alternatives approach is expanded to specific projects which can be implemented to reduce CSO discharges. These projects fall into three primary categories: (1) storage improvements, (2) capacity improvements and (3) combined sewer separation. The following are individual projects that have been identified using the H&H model:

Project 1.1 - River Street Pump Station (RSPS) Functional Improvements

The existing RSPS consists of five vertical turbine centrifugal wastewater pumps with 150 horsepower motors; each driven by a variable frequency drive. Piping within the pump station allows for flow to be directed to either the 1961 Headworks at the WWTF, the 1992 Foul Flow Building or both at the same time. Flow to these two preliminary treatment facilities (screening and grit removal) facilities is controlled through a valve vault where the two sewage force mains are interconnected, at the Greens Hill Lane entrance to the WWTF.

This pump station currently has a maximum hydraulic capacity of 22.5 MGD. The wastewater pump motors were increased to 150 horsepower during the Rutland CSO Abatement Facilities Phase 2A project in 2005. Valves within the pump station can be actuated such that any one of the five pumps can discharge to either of the two 20" sewage force mains. Two pumps are connected to the East Creek Interceptor wet well and two other pumps are connected to the Otter Creek Interceptor wet well. There is a fifth pump which serves as a swing pump and can be valved so that its suction is from either wet well.

A review of the hydraulic profile, from the 2005 CSO Phase 2A drawings and the CSO Phase 2A Basis of Design Report, both prepared by Dufresne-Henry, Inc., indicates that the maximum hydraulic throughput through preliminary treatment is 12.0 MGD through the 1961 headworks and 16.0 MGD through the Foul Flow Building.

In 2021 a project was completed whereby the oldest of the two operating sewage force mains, from the RSPS to the WWTF, was replaced with high-density polyethylene. The WWTF staff have provided recent anecdotal evidence that the maximum hydraulic capacity of the new HDPE sewage Force main is 19.0 MGD. The City has also determined that the maximum capacity of the existing remaining ductal iron force main is 17.0 MGD. There appears to be more than enough hydraulic capacity within the existing sewage force mains to be able to maximize treatment of combined sewage at the WWTF without any physical improvements to the pumping system.

Because of the pumping system's configuration, when both of the sewage force mains are in use at the same time, the HDPE force main must discharge to the 1961 Headworks, and the D.I. force main needs to discharge to the Foul Flow Building. A review of the existing Fairbanks-Morse pump curves indicates that, with three pumps running, approximately 16 MGD can be pushed through the ductile iron Force main to the Foul Flow Building. Similarly, the new HDPE force main will allow flows of up to 12 MGD using two pumps at the RSPS discharging to the 1961 head works.

Discussions with the pump manufacturer revealed that three pumps can easily pump the 16.0 MGD needed at the Foul Flow Building; however, two pumps moving 12.0 MGD to the 1961 Headworks through the HDPE force main results in an operating point that is at the end of the pump curve. The manufacturer of the RSPS pumps has reviewed the curves and determined that it is possible to slightly overspeed these pumps using the VFDs discharging to the 1961 Head Works to achieve the necessary

of 12 MGD of combined sewage during a storm event. This additional pumping capacity can then be achieved with existing equipment and additional controls.

Control system modifications would be required at the RSPS to allow for sequencing of the pumps automatically, to meet the maximum flows for each of the respective headworks. Weston & Samson has communicated with LCS Controls of Rochester, Vermont (the City's current Instrumentation & Controls contractor) and they have indicated that modifications can be made within the existing control system to allow for additional signal input from high water floats in each of the two-pump station wet wells which will activate all five pumps during a significant wet weather event. The WWTF operations staff would need to actuate valves within the RSPS to ensure the proper number of pumps are connected to the two force mains in advance of an impending storm, to allow for flows to be directed in the manner needed. Once the storm has passed, and wet well levels have dropped below a pre-set operating point, the control system will allow the pumps to fall back to their normal control scheme.

It is anticipated that this work could be completed for costs on the order of $20,000, the bulk of which would be programming labor. These improvements to the RSPS will allow for treatment capacity at the WWTF to be maximized during a storm event.

Currently, the RSPS has no constructed means to allow bypassing of any of the pumps or the two wet wells. In order to maintain full capacity of the RSPS there will need to be maintenance completed from time to time requiring that one wetwell or one pump at a time be taken off-line. In order to maintain full capacity during these maintenance operations, which could theoretically occur during a precipiptation event, temporary suction lift wastewater pumps (Godwin type) would need to be installed allowing flow to be pumped exterior to the pump station from the wet well to one of the 20" diameter sewage force mains that convey flow to the WWTF.

To facilitate installation of a temporary bypass pumping system during a maintenance operation or emergency, the City will need to install a hard piped connection above grade with a valve. In June of 2021, the older of the two sewage force mains was replaced with a high-density polyethylene pipe. At the metering pit adjacent to the RSPS, a capped wye was installed on the new force main and left buried in anticipation of such a future bypass connection. Piping installation and materials for this work would be approximately $37,000.

As noted earlier, the RSPS was commissioned in 1961. Interior piping connections at the dry pit side of the wet well are showing their age and and should be replaced. Once the emergency bypass piping above has been installed, temporary bypass pumps could then be used to facilitate replacement of these connections. The City has identified these connections to the wet well as a possible failure point in this most critical piece of infrastructure. Without the RSPS operating at full capacity, CSO discharges may increase in in frequency and volume. Replacement of the wetwell suction piping connections, installation of emergency bypass piping to facilitate quick installation of an emergency bypass pumping system, and additional pump station controls to allow maximizing flow during a wet weather event are all necessary in order to maximize pumping capacity and allow for maximizing treatment at the WWTF, discussed in the following paragraphs.

Replacement of the wet well suction piping connections is anticipated to cost approximately $189,000. Lumping all three tasks into one project will result in a total anticipated combined project cost of $640,000.

A detailed summary of anticipated costs for this work is included in **Appendix H, "WWTF Capacity Improvements"**.

Project 1.2 - WWTF Capacity Improvements

As discussed in the preceding paragraphs, improvements have already been completed at the WWTF to increase treatment capacity. The existing WWTF configuration allows for passage of 22.5 MGD through secondary (biological) and tertiary (phosphorus removal) treatment prior to disinfection. The 2005 Rutland CSO Abatement - Phase 2A project included addition of a third primary clarifier expanding the hydraulic capacity through primary treatment to 28 MGD. Additional improvements to the WWTF are necessary to allow for disinfection of the difference in maximum flows through primary and secondary treatment (5.5 MGD).

In order to meet minimum CSO discharge requirements of primary treatment and disinfection, flows above 22.5 MGD will need to be intercepted between the existing primary clarifiers and the aeration basins and diverted to disinfection. Current disinfection facilities include primary chlorine contact tankage, chemical addition, mixing and dechlorination. The existing disinfection facilities are sized to accommodate a maximum of 22.5 MGD. Adding additional flow to these facilities will exceed their capacity for effective disinfection. Therefore, we recommend a smaller second chlorine contact chamber followed by a second dechlorination chamber, which would be dedicated solely to flash disinfection of the additional 5.5 MGD of primary effluent during a peak wet weather event. Between storms, this structure can be taken offline and dewatered to prevent algae growth.

Primary effluent flow will be intercepted between the primary clarifier effluent launder and the aeration basin influent launder by constructing a cast-in-place concrete flow splitter structure with weir gates, similar to but smaller than the weir gates used currently to split flow equally between the three existing primary clarifiers. Weir gates will be adjusted such that flows in excess of 22.5 MGD will be diverted from this structure to a newly constructed 5.5 MGD storm flow chlorine contact chamber via a 24-in diameter SDR 35 gravity sewer line.

Sodium hypochlorite, currently used for disinfection of the tertiary effluent at the WWTF, can also be applied to primary effluent. Chlorine reacts in water to produce the disinfectants HOCL (hypochlorous acid) and OCL- (hypochlorite ion). These compounds contribute to free residual chlorine concentrations. As chlorine is added to the primary effluent it reacts with ammonia and organic matter to form chloramines and chloro-organic compounds. The addition of more chlorine oxidizes some of the chloro-organic compounds and chloramines, resulting in the conversion of monochloramines to dichloramines and trichloramines. As more chlorine is added, the residual chloramines and chloro-organic compounds are reduced to a minimum value and free chlorine residuals result. The point at which the formation of residual chlorine compounds occurs is known as the "breakpoint". "Breakpoint chlorination" describes the process whereby sufficient chlorine is added to (in this case) the primary effluent to obtain a free chlorine residual. Once disinfected, the primary effluent will need to be dechlorinated, which can be accomplished through the use of Sodium Bisulfate, currently used at the WWTF for dechlorination of tertiary effluent.

Preliminary design criteria for these improvements are based, in part, on the US EPA's **"Combined Sewer Overflow Technology Fact Sheet for Chlorine Disinfection".** For planning purposes, we are recommending a conservative 20-minute contact time for breakpoint chlorination to be followed by a 2-

minute contact time for dechlorination using sodium bisulfite, currently stored on site. The Vermont has requested that this contact time be increased to 30 minutes. For the purposes of this report, we have prepared a preliminary design incorporating a 30-minute contact time for chlorine, followed by a 2-minute dichlorination contact time. A chlorine contact chamber, similar in configuration and depth to the existing facilities, would be constructed adjacent and to the west of the existing first stage chlorine contact chamber. This primary effluent chlorine contact chamber will have a mechanical mixer in a mixing structure where sodium hypochlorite will be fed using a dedicated centrifugal chlorine feed pump, to be located in the existing Chemical Building. Chlorinated primary effluent will flow through the chlorine contact chamber and over a weir into a single dechlorination chamber. Sodium bisulfite, for dechlorination, will be introduced at this weir to provide mixing as chlorinated effluent spills into the dechlorination chamber. Dechlorination typically takes place immediately upon contact with these chemicals. Effluent from the dechlorination chamber will flow by gravity through a 24-inch SDR-35 PVC gravity effluent line to the existing plant outfall manhole. Metering will take place at the dechlorination chamber effluent weir using an ultrasonic flow meter.

The WWTF currently stores approximately 2 months of sodium hypochlorite on site. Additional chlorine needed for primary effluent disinfection can be accommodated by increasing the frequency of deliveries. This would happen primarily during warmer months, and not during the winter. The same would apply to the sodium bisulfite tanks. Using the existing storage tanks and adding additional chemical pumps as described above would be sufficient to provide the disinfection and dichlorination required for this proposed alternative.

Supporting ancillary improvements include the following:

- Relocation of the existing 12-inch plant gravity sewer in the vicinity of the proposed primary effluent contact chamber, to accommodate construction of the proposed 24-inch primary effluent gravity line and the proposed contact tankage. The existing gravity sewer can be relocated slightly to the West and will allow side streams from unit processes around the wastewater treatment facility to be conveyed by gravity to the existing plant sewage pump station, just south of the existing chlorine contact chambers.

- A short section of 18-inch diameter storm drain and catch basins, currently located just to the west of the existing chlorine contact chambers, will need to be relocated slightly further to the West to facilitate construction of the proposed primary effluent disinfection chamber.

- Additional chemical feed lines from the Chemical Building to the proposed primary effluent disinfection chamber will need to be constructed. These chemical lines have not been depicted on Figure 1, for clarity.

- Centrifugal chemical feed pumps, along with associated piping and carrying water piping, valves and rotameters will need to be installed in the Chemical Building to provide direct feed of sodium hypochlorite and sodium bisulfite to their respective chambers at the proposed primary effluent disinfection structure.

- Installation of buried power and signal wiring to support the mixing equipment as well as disinfected primary effluent flow measurement; and interconnection to existing power and control systems at the existing Chemical Building.

- Construction of drainage piping and valves from this structure to the plant sewer pump station to allow for dewatering the proposed tankage after a storm event, allowing these facilities to be taken off-line until needed again.

A detailed summary of anticipated costs and a conceptual plan for the work is included in **Appendix H, "WWTF Capacity Improvements"** of this report.

Project 2 - Otter Creek Interceptor Capacity Increase

In 1962, the Rutland WWTF, River Street Pump Station (RSPS) and two major interceptors were constructed to allow treatment of sewage that, up until that point, had been discharged into the East and Otter Creeks. The East Creek Interceptor flows parallel to the East Creek and conveys sewage from the northern and downtown portions of the sewered area to the RSPS. This interceptor, which passes by CSO 002, was increased in size as part of the 2005 Rutland CSO Abatement Facilities - Phase 2A project. The existing 24-inch Vitrified Clay (VC) gravity interceptor was replaced with a 36-inch diameter SDR-35 PVC gravity interceptor between CSO 002 and the East Creek Wet Well at the RSPS. The East Creek Interceptor does not create a significant hydraulic restriction, according to the H&H Model.

The Otter Creek interceptor is constructed of 24-inch diameter asbestos cement (AC) pipe and runs north along the Otter Creek from CSO 001, at the Calvary Cemetery, to the RSPS. This interceptor sewer was constructed within an existing power utility easement, currently owned by Green Mountain Power and lies within its own "perpetual" maintenance easement. Because of its size, and the volume of combined sewage which comes to this interceptor from the southern portion of Rutland's sewered area, it creates a hydraulic restriction which results in overflow of sewage at CSO 001 during peak wet weather events. Using the hydraulic model, we were able to identify the optimal size of a replacement conduit which would allow sufficient flow to the RSPS. This interceptor should be increased in size from 24 inches to 36 inches. This additional capacity of this larger pipe, while not alleviating all overflows from CSO 001, will allow sufficient flow to the RSPS and then the WWTF to maximize treatment within the system. Once the interceptor has been increased to 36 inches in diameter, the capacity of the RSPS then becomes the hydraulic restriction for this system. Increasing flows beyond the current 28 MGD capacity at the RSPS is not warranted since the maximum hydraulic capacity of the Rutland WWTF is 28 MGD and the WWTF site does not have room for cost-effective expansion or increased biological treatment capacity. Therefore, we recommend that the Otter Creek Interceptor be increased from its current size to 36-inch diameter along its same grade and alignment and that additional storage be constructed upstream of CSO 001. Additional storage constructed upstream of CSO 001 is consistent with recommendations from the 1989 "Rutland CSO Study", is confirmed by recent H&H modeling efforts and will be discussed in detail later in this chapter.

Much of the existing Otter Creek interceptor was constructed at depths in excess of 20 feet. In addition, the entire length of this interceptor, 2,500 feet, was constructed below normal groundwater level in order to provide gravity flow to the lowest point in the collection system, the RSPS. Replacement of this line will be difficult. Weston & Sampson evaluated replacement of this interceptor with a storage conduit, to "kill two birds with one stone"; however, we do not recommend installation of a storage conduit in this location for the following reasons:

- The storage conduit would be much larger in diameter than the minimum required 36-inch diameter pipe, requiring a much wider excavation.

- The storage conduit would need to follow the same grade in alignment as the existing interceptor sewer in order to stay within the existing power line easement and sewer line easement, requiring much greater excavation volume than a pipe, and much of that below ground water.

- Construction of a large storage conduit would also disrupt the power lines which run parallel to the interceptor in this easement.

- Construction of a large diameter storage conduit would require significantly more time than installation of pipe using conventional open trench installation techniques. This additional time would add to the amount of time sewage bypass pumping would be required and the amount of time temporary dewatering facilities would have to be maintained. This would serve to drastically increase the cost of the new interceptor.

- Installation of a storage conduit upstream of CSO 001 would allow for construction further away from the river, and at a point upgradient where the excavation would be less impacted by groundwater.

- Existing pipe alignment upstream of CSO 001 will allow for a much shallower excavation due to pipe slope and existing topography.

- Work upstream of CSO 001would not be within an existing power line easement.

Weston & Sampson investigated the alternative pipe installation methods to determine the most cost-effective manner of replacing the Otter Creek Interceptor. Jack and bore was not feasible due to the fact that all pipe installation would need to take place below ground water level and there would need to be several large jacking pits needed to accommodate this method. These factors would complicate the installation and result in excessive installation costs. Pipe bursting was deemed to be unfeasible for the following reasons: (1) pipe bursting is not recommended below groundwater as it adds hydraulic pressure in addition to soil pressure which the bursting head must overcome in order to expand the existing pipe, and (2) while pipe bursting is recommended for AC pipe, it is limited by how many sizes larger the new pipe needs to be. It is not recommended to use pipe bursting where the pipe size will increase greater than two pipe sizes. To increase from 24-inch to 36-inch diameter pipe, using standard pipe sizes, is an increase of 3 pipe sizes; and would require displacement in excess of 6 inches of soils in all directions around the pipe, in addition to the thickness of the AC pipe that is being burst.

Given the above, the most cost-effective means of replacing the Otter Creek Interceptor is by conventional trench excavation.

In order to install a replacement interceptor, the construction project would need to include the following major components:

- The replacement sewer pipe would need to be 36-inch diameter DR-18 PVC gravity sewer pipe. This pipe has a much thicker wall dimension than SDR-35 PVC and is required due to the soil load on this pipe caused by the depth of bury, which exceeds 28 feet at points along the route.

- A temporary sewage by-pass system would need to be installed to convey sewage from upstream of CSO 001 to the RSPS so that the existing Otter Creek Interceptor can be taken off-line for replacement. The temporary by-pass pumping system will need to be sized at a minimum to match the surcharged hydraulic capacity of the existing Otter Creek Interceptor, so that additional overflows do not result from the construction operations during wet weather.

- The by-pass pumping system would include construction of a temporary pre-cast concrete wet well adjacent to CSO 001 and upstream, above grade self-priming centrifugal pumps with diesel backup with a total combined hydraulic capacity of 13 MGD (matching the hydraulic capacity of the Otter Creek interceptor), a buried section of temporary force main to pass beneath River Street, a temporary interconnection at the existing junction manhole just outside of the Otter Creek wet well at the RSPS and construction of a temporary bulkhead inside CSO 001 to prevent sewage from passing into the work zone.

- Demolition and disposal of existing precast concrete manholes.

- Replacement of pipe at the same grade and alignment as the existing interceptor using 36-inch diameter DR-18 PVC gravity sewer pipe.

- Construction, maintenance and then removal of temporary dewatering ponds placed at several locations along the pipe alignment.

- Conventional open trench excavation pipe installation with stone bedding and continuous dewatering.

- A deep excavation across the ball field to the south of River Street along with post-construction restoration of this ball field.

- A deep excavation across River Street for the proposed interceptor.

- Connection of the Otter Creek Interceptor to the existing junction manhole outside of the Otter Creek Wet Well at the RSPS.

- We recommend that the narrow portion of the easement, close to River Street, be increased to 40 feet to match the rest of the interceptor easement. This will facilitate construction.

Weston & Sampson reached out to Godwin Pumps of Feura Bush, NY to confirm preliminary sizing, layout, and operating requirements of such a pumping system. Cost for the temporary pump system, commissioning and its removal upon completion of construction are included.

During our development of this project, we found that the US EPA currently recommends that asbestos cement pipe, both water and sewer, not be abandoned in place. This material is considered hazardous and is supposed to be removed and disposed of in a proper landfill. The State of Vermont has allowed exceptions; however, they have been few and hard to get permitted. AC pipe cannot be crushed and left in place when replaced with newer piping materials. In 1991, the EPA took the position that "crushing" AC pipe with mechanical equipment would cause the crushed material to become regulated

asbestos containing material and that pipe crushed and left in place would cause the location to be considered an "active waste disposal site", and therefore subject to the "Standard for Active Waste Disposal Sites" (40 CFR 61.154). Studies have indicated that in normal use, AC pipe does not pose a threat to public health. However, if AC pipe is tapped, cut, crushed and removed from the ground for disposal, National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations apply.

Since AC pipe is considered a Category II nonfriable asbestos-containing waste, it must be disposed of at an approved landfill. Weston & Sampson reached out to Casella Waste Management of Rutland, VT to get information on the disposal and related costs, should this project be undertaken. Disposal of AC pipe removed, will work out to approximately $1,000/ton of pipe. This number includes transportation and disposal in a Hazardous Waste Landfill in New York. There is currently no place to dispose of this pipe in the State of Vermont. From our calculations, there will be approximately 100 tons of pipe to be disposed of as part of this operation. We have included this disposal cost in the opinion of project cost.

Refer to **Appendix I, "Otter Creek Interceptor Capacity Improvements"** for a conceptual design and detailed opinion of cost for this proposed project.

Additional Storage in Collection System

The existing collection system has been built during a period spanning over 100 years, adding features as population growth and water quality regulations necessitated them. This piecemeal approach has resulted in a sub-optimal configuration for the storage and prevention of CSO discharges. Storage volume within the collection system is inadequate. Discussed above are the undersized interceptor sewers that convey sewage from the Calvary Cemetery overflow and the Home Plate overflow. While increasing the size of these components will aid in preventing overflows, more storage will be required. As the collection system is effectively divided into two halves (areas draining towards Calvary Cemetery and areas draining towards Home Plate), storage will need to be provided in both areas.

Using the H&H Model, Weston & Sampson was able to determine the amount of storage needed for each interceptor, which when used in conjunction with upstream separation projects, will eliminate CSOs that would occur below the selected evaluation storm. Several iterations of this model were run using different storage volumes at each location to try and determine the volume with greatest effectiveness, while balancing cost effectiveness with upstream combined sewer separation.

Project 3 - Calvary Storage

Upstream of the Calvary overflow, a 6-foot by 4-foot pre-cast concrete box sewer extends just past Forest Street. This structure passes through an agricultural field, connecting the wastewater collection system on Forrest Street to the Otter Creek Interceptor and to CSO 001. As noted in the previous section, storage for this half of the wastewater collection system will be more effective if constructed upstream of CSO 001 . This is driven primarily by the capacity of the river street pump station .

Weston & Sampson reviewed several alternatives for storage vaults or conduits in this field . Since the required storage volume needed to alleviate CSO discharges during the evaluation storms is relatively small, approximately 234,000 gallons of additional storage, Weston & Sampson recommends construction of two additional large-diameter PVC interceptor lines adjacent to, and following the same slope and alignment as, the existing concrete box conduit. A diversion vault would be constructed at the upstream end, adjacent to Forest Street. Inside this diversion structure, manually operated slide gates could be constructed at the inlet end of each conduit, including the existing concrete box culvert

. During dry weather flows, a single conduit could be used, which would result in sufficient velocities to scour the invert and prevent grit accumulation. During a storm event, flows would overflow these slide gates and spill into all three conduits (two 48-inch diameter PVC conduits and the existing 6-foot by 4-foot pre-cast concrete box). A junction box would be constructed at the discharge end of these storage conduits where by flows could also back up from CSO 001 once the hydraulic capacity of the proposed Otter Creek Interceptor (see previous section) has been reached. All three conduits in this field could be surcharged, providing in excess of 500,000 total gallons of storage. During dry weather flows, the City can use the slide gates to divert all dry weather flow into any of the three conduits to help flush them out after a storm.

This approach to providing storage upstream of CSO 001 is attractive because it is relatively inexpensive to construct, will allow for rehabilitation of the existing concrete box sewer and will provide a more efficient invert cross section for dry weather flows, helping to alleviate grit accumulation in this long, shallow-sloped section of the Otter Creek Interceptor. This will allow for maximizing the storage capacity within the existing concrete box, and will allow for the existing concrete box to be taken offline for cleaning periodically.

A small amount of additional land should be secured from its owner to widen the existing easement across the field for construction and then maintenance of the proposed storage conduits. Most of the work described in this section will fall within the 500-year flood zone. Water-tight manhole covers will be installed. No additional fill will be added within this flood plain as a result of this proposed construction work. The Vermont EPR's allow up to 400 feet between manholes as this is the current limit of equipment use used for maintaining collection systems. The diameter of the storage conduits and potential for the amount of grit that could collect in this area warrants keeping the manholes closer together. This will facilitate maintenance and help to ensure capacity storage capacity is maintained. We recommend a maximum spacing for these manholes of 300 feet.

For the reasons discussed in Section 4.3.3, the best location for this storage conduit is adjacent to the existing box sewer that crosses the above referenced field, just upstream of CSO 001.

Construction will include:

- Two 1,300-foot runs of 48" SDR 35 PVC sewer line,
- Rehabilitation of the existing pre-cast concrete box conduit,
- Installation of sewer manholes and water-tight covers,
- Construction of an upstream diversion structure with manual slide gates and secured, water-tight access plates,
- Construction of a downstream junction box connecting all three conduits,
- Temporary dewatering system,
- Interconnection to existing box culvert,
- Interconnection to existing CSO 001.

Refer to **Appendix J, "Calvary Storage Conduit",** for conceptual design plan and opinion of probable cost for this proposed infrastructure.

Projects 4.1 & 4.2 - Connor Park Storage

Connor Park is an ideal centralized location for the installation of a combined sewage storage structure. Located in between the Home Plate CSO discharge and the Third Base CSO discharge, it has the potential to store combined sewage from either sewershed. Based on the hydrologic model, it was determined that 2.04 MG of storage in the School Street sewershed would be required to meet the goals of the LTCP. While additional storage has not been identified as needed for the Home Plate sewershed, future monitoring may illustrate a need. The concept design illustrated in this report could be easily retrofitted to include an additional inlet to the system on the Home Plate side. All features must be located subsurface to ensure that there aree no negative impacts to the playing fields.

This project, while effective in equalizing storm-induced sewage flows through storage, will be a significant undertaking for the City of Rutland. As noted earlier in this report, the recent H&H modeling effort resulted in a significant increase in resolution for predicting how the wastewater collection system will behave during different storm events. This report identifies more than 15 significant projects which will take place over time and may remove more or less than the H&H Model predictions. As such, Weston & Sampson is recommending that the Home Plate Storage project be split into two phases of similar scope. The initial phase would consist of 1.02 MG of storage and the model anticipates a significant improvement with this volume. The effectiveness of this storage, in addition to any upstream separation efforts would be evaluated after a period of time to determine if the full volume of Phase II would need to be constructed. In this way, the City can proceed with these projects in the most cost-efficient manner.

One major reason for this recommendation is that recent flow metering efforts identified a 570,000 gal. (during the evaluation storm event) surge of storm-related flow downstream of Area 5, entering the wastewater collection system between Meters 5 and 4. Because we were unable to specifically identify where this flow was coming from, we could not include it in our assessment of abatement options. We recommend additional study to isolate and, if possible, remove this source. If this could be completed, it could reduce the size of, and possibly eliminate, the need for the Phase II storage structure, noted above.

In the 1989 Rutland CSO Study, a project to connect Third Base to Home Plate was considered as part of a larger CSO mitigation effort for treatment and discharge of combined sewage. This conduit was not constructed, but modifications made in 1992 to the Home Plate CSO structure included a knock-out wall that allowed its installation in the future.

The geometry of such a structure is dependent on the elevations of the CSO weir for Home Plate as well as the slopes and elevations of the Third Base discharge conduit. This area is very flat; collection system pipe slopes are as shallow as 0.25%. The existing elevations of the Third Base conduit and the Home Plate CSO structure set the slope of a new interceptor sewer at approximately 0.25%. If the storage structure was to drain solely by gravity, the maximum depth of a structure would be limited to two feet. This would result in a structure that has a very large horizontal footprint which would have several significant drawbacks, including high construction costs, a large disturbance to existing recreational fields, and a higher level of required maintenance to ensure that the structure is cleaned of grit and trash after storm events. As a result, an 8-foot deep structure with low-head discharge pumps has been selected. Storage for combined sewage is provided by StormTrap DoubleTrap concrete vaults. These vaults are space-efficient (as opposed to a bank of large-diameter pipes) and being modular can be installed relatively quickly. A sloped bottom to the storage vault will convey silt and grit to a sump for easier maintenance.

As the bottom of the storage structure is well below the invert elevations of downstream sewers, discharge pumps will be required. The entire volume of water must be removed relatively quickly to make sure the sewage does not turn anaerobic, which would cause odor issues. A design point of 700 gpm at 15' TDH was selected.

The storage vault will require an additional level of trash and grit removal from the incoming flow to protect the discharge pumps and ensure the full volume of storage is available for water storage. A combination of structural measures and cleaning by City DPW staff is proposed. Several different manufacturers offer products that remove floatable trash and a portion of the grit in combined sewage flow and are primarily filtration-based technologies. StormTrap manufactures a product called "TrashTrap" which consists of a concrete vault with bar screens and nets that capture debris and can be installed either in-line or at the end of the pipe. Hydro International's Storm King is a hydrodynamic separator that is highly efficient in removing floatable trash and grit but is a very large structure that is not optimal for a subsurface configuration. The Hydro-Static Screen is another device offered by Hydro International that uses an upflow-oriented screen to remove trash and is more compact and suitable for subsurface installation. These products have been used to develop the conceptual designs for this alternative, however, other vendors may be able to meet the intent of this design. Equivalent products will be considered in the final design and construction phases of this project when moved forward.

Ongoing operation and maintenance will be needed for this device to ensure its long-term effectiveness. The pre-treatment units have a limited capacity for trash and grit storage and must be checked after storm events that result in the structure is used. Typically, a Vactor truck is used to clean the structures. The City of Rutland uses Ayyeka equipment to remotely monitor key portions of the collection system for CSO compliance, providing telemetry to this structure will provide the City with real-time information regarding its use, and make sure that inspections and maintenance are performed when needed.

One final consideration for this project is the decommissioning of the Third Base outfall. Once upstream sewer separation projects have been implemented and the quantity and flow rate of combined sewage is reduced in the School and Meadow Street sewersheds, it is possible to re-route all of the combined sewer flow to Home Plate. However, to avoid surcharging the Home Plate sewershed area, this work should be carefully planned in the context of the other projects in this plan.

Refer to Appendix K, "Connor Park Storage" for conceptual plans, details, and opinion of probable cost for this structure.

Project 5 – CSO Check Valves

The existing CSO outfalls 001, 002 and 005 have the inverts of their discharge structures below the normal water surface of their respective receiving water. During times of high streamflow, this can result in system surcharging, sending river water through the two sewer interceptors to the River Street Pump Station. Due to the nature of the monitoring equipment used, it is difficult to ascertain precisely when inflow begins or what volume of clean water is introduced into the system; the accuracy of the area-velocity meters diminishes significantly as velocity nears zero (i.e. the moment when stream inflow begins).

To prevent stream inflow, a set of "duckbill" valves for these particular outfalls are proposed. These devices act as a check valve; ensuring flow travels in one direction only. Normally closed, once head

pressure begins to rise on the upstream side of the valve, it begins to open to allow forward flow. Reverse pressure against the valve causes it to close, preventing inflow.

There are two types of valves available that function in this manner. One style is installed at the discharge end of the pipe. While this type can be easy to install on a circular pipe, it does have several drawbacks. First, the size of these valves are quite large, and would protrude into the receiving water. Debris moving downstream during a storm event could snag on this style of valve, risking damage. Also, the Calvary and Home Plate outfalls are not a circular configuration, and therefore additional work would need to be performed to fit the valve to the outfall. The second style of valve, on the other hand, is inserted into the conduit. This prevents the risk of debris damaging or "hanging" the valve open, and can be installed without a significant retrofit to the outfall. Some work will be required.

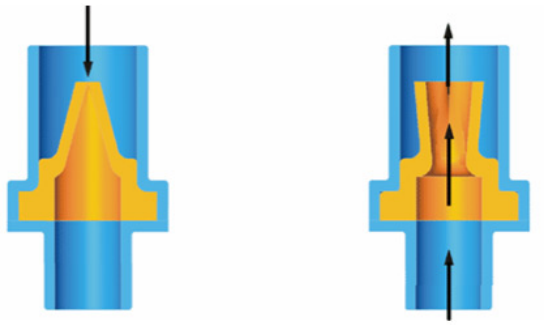


Photo 4 - "Duckbill" Valve Schematic

The check valve for each outfall will need to be sized to handle the maximum hydraulic capacity of the conduit on which it is installed. This is because until all of the projected projects are completed, there will still continue to be overflow events at these outfalls, although less and less frequently as more projects are completed, until all work is done. Additionally, storm events like Hurricane Irene will still result in overflows no matter how much CSO abatement work is undertaken by the City. Sizing the valves to match the maximum hydraulic capacity of the conduit on which they are attached means that the valve will not be the restriction, the conduit will. This will not exacerbate current surcharging conditions and will keep river water out of the system while protecting public health and safety upstream.

While installation of these valves will take place within the 500-year flood plain, thay will be installed within existing buried conduits and constructed facilities will not impact the flood way. Additionally, water-tight access plates above the valves will be installed to facilitate maintenance, removal of debris upstream of the valves, and to prevent possible flooding from entering the system.

As monitoring efforts to date have not been able to distinguish between combined sewer flow and clean water flow, a quantitative benefit cannot be determined at this time. However, City staff believe that clean water can be a significant contributor to combined sewage flow to the River Street Pump Station, preventing the conveyance of sewage to the pump station and incurring the costs of treatment for clean water. A direct result of river water backing up into the interceptors through the CSO regulators is river water being pumped instead of combined sewage being pumped. Combined sewage then is backed up and overflows instead of being conveyed to the WWTF. Ongoing monitoring efforts can help determine the reduction in flow and their effect on achieving the goals of this LTCP.

Refer to **Appendix L, "CSO Check Valves"** for conceptual plans, details, and opinion of probable cost for this structure.

High priority structures for these valves will be CSO 001 and CSO 002, as these two regulators are in close proximity to proposed storage conduit and equalization structures. River water backing up into these structures will eliminate their effectiveness for CSO abatement. We recommend that a check valve be installed at CSO 001 and CSO 002 as one of the initial projects. The total volume of CSO volume

reduced as a result of their installation cannot be approximated with the current system monitoring information; however, their installation will directly affect the effectiveness of several of our identified abatement projects.

"Smart" Controls

This approach, also known as Wet Weather Operational Optimization, uses a combination of unused pipe capacity, remote sensing, and automated valves to prevent CSO discharges. This approach has been undertaken by a few large municipalities such as Cincinnati, Ohio and Kansas City, Missouri. Smart controls themselves do not prevent overflows but ensure that the facilities that do exist are used to their utmost. Storm events are not evenly distributed throughout the City of Rutland, and it has been observed that some overflow events occur at some outfalls but no discharge is recorded at others. Generally speaking, the combined sewershed of Calvary Cemetery (CSO 001) drains the area to the east of Route 7 and the southern portions of the City. The other CSO discharges accept flow from the downtown, northern and western portions of the City.

The possibility of transferring portions of combined sewer flow from one location to another were considered, however, several fundamental issues were found with this approach. First, the available pipe capacity in the existing infrastructure is minimal based on a review of the hydrologic modeling results. A longstanding issue with the City's combined sewer network is the undersized interceptors that extend from the River Street Pump Station northward to Connor Park and southward to Calvary Cemetery. Other municipalities that have successfully implemented smart sewer projects were able to leverage existing infrastructure such as storage cisterns, which the City of Rutland does not have. Quite often, these smart sewer projects show savings when the overall price tag for implementation ranges in the hundreds of millions of dollars per year to install. As with other aspects of a very small City, the percentage financial benefit of using smart sewers does not necessarily equate to significant savings to the taxpayer. Operating a smart sewer would require dedicated municipal staff to collect and analyze data, perform routine inspections and maintenance to the sensor system, as well as additional labor required to maintain the mechanical valves that would be used to shunt flow from one area to another. With a limited existing staff, the Rutland City DPW would not have the time to incorporate these additional duties with their current responsibilities.

Green Stormwater Infrastructure

Green Stormwater Infrastructure (GSI) is a catch-all term that refers to stormwater management techniques that seek to infiltrate runoff into the groundwater table instead of quickly catching it and conveying it to traditional infrastructure (i.e. catch basins connected to storm drains that discharge to waters of the state). Historically, stormwater management meant keeping roads dry and safe for vehicle passage, and curbs that catch runoff and catch basins to drain the runoff from the surface were the primary devices used to accomplish that goal. However, this results in the transport of pollutants, including sediment, phosphorous, petroleum products, trash, and more. "Grey" stormwater infrastructure can be designed to remove some of these pollutants by providing treatment devices such as swirl concentrators, however, their effectiveness is limited and there is a substantial maintenance cost to keep these structures operating effectively.

GSI measures seek to avoid concentrating large amounts of stormwater flow in singular points, instead electing to decentralize and distribute runoff over a larger area for disposal via infiltration. A key requirement for GSI features is suitable subsoil conditions. Areas with sandy soils and a significant depth to the seasonal high groundwater table are necessary for infiltration. If GSI measures are installed

in areas of high groundwater table, for example, runoff will not dissipate and cause localized flooding and/or long-term ponding which would create nuisance conditions such as mosquito breeding. According to the Vermont Stormwater Management Manual, infiltration measures need subsurface soils with an infiltration rate greater than 0.2 inches per hour. Urban soils are often compacted, reducing their infiltration rate. The types of GSI measures available range from small-scale (e.g. infiltrative tree boxes) to moderate-scale (e.g. installation of roadside bioretention areas along the side of a street).

GSI measures can be used as an added-value element to other improvement projects. In particular, combined sewer separation requires excavation of a large portion of the road bed and right-of-way. While this work is occurring, GSI measures can be installed at the same time. However, not all areas of the City are well-suited to such measures. Where well-draining soils are located (i.e. Hydrologic Soil Groups A and B), GSI measures may be considered. In other areas (e.g. HSG C and D soils, "hotspot" areas with soil contamination), GSI measures would not be able to remove runoff from the combined sewers and would not provide all the benefits they offer. In the following sections, GSI measures are provided for projects where HSG A or B soils are present.

Sizing for these structures has been based on the capture and infiltration of the 1-inch storm event. Two types of structures were considered as part of this analysis: tree box filters and curbside bioretention areas.

Tree Box Filters

For this measure, a new street tree is installed in a concrete vault which is filled with a permeable bioretention soil mix. The level of the tree is slightly lower than the road grade adjacent to it, allowing runoff to pond in the tree box and infiltrate into the subsurface. The tree aids in water uptake, with excess water infiltrating into the subsoils below. Larger storms can be accommodated by providing an overflow structure that connects to a traditional storm drain system, or simply allowed to flood into the street, flowing along the curb downgradient to the nearest catch basin.

These structures typically treat at most a quarter acre of surface area. Installed cost has been found to be on the order of $35,000 per unit.

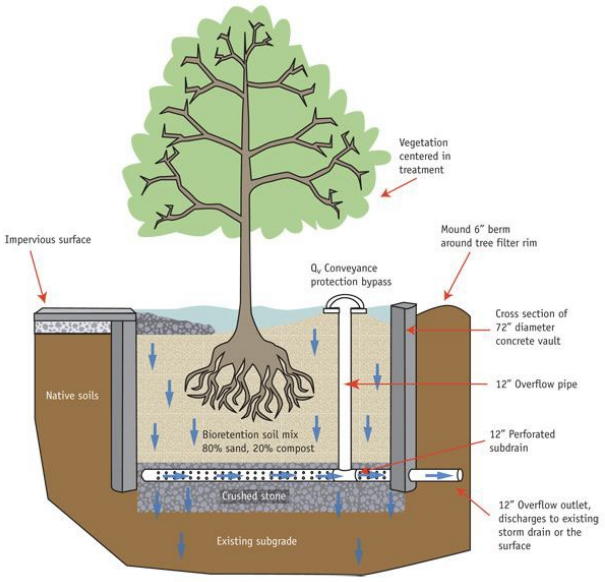


Photo 5 - Tree Box Filter Schematic

Curbside Bioretention Systems

For this measure, a length of curb is removed along with the adjacent sidewalk, if present. This area is then rebuilt with a landscaped area that is slightly lower in grade than the adjacent road. Below the surface, a combination of runoff storage, geotextile fabrics and bioretention soil mix provides removal of pollutants and a temporary ponding volume for accumulated runoff to infiltrate into the subsurface. Select plantings aid in the removal of pollutants and water. For larger storm events that overwhelm the infiltrative and storage capacity, similar measures to the tree box filter (overflow pipes connected to storm drains, allowing to flood and flow to downgradient structures) can be used.

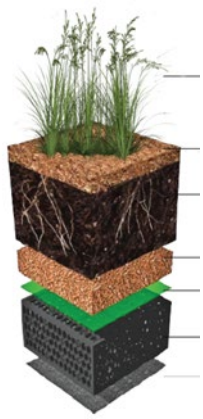


Photo 6 - Bioretention Media Cross-Section

These structures are sized by the volume of runoff that can be temporarily stored prior to discharge into the subsurface. Based on prior experience, costs can be expected to be approximately $1,500 per linear foot.

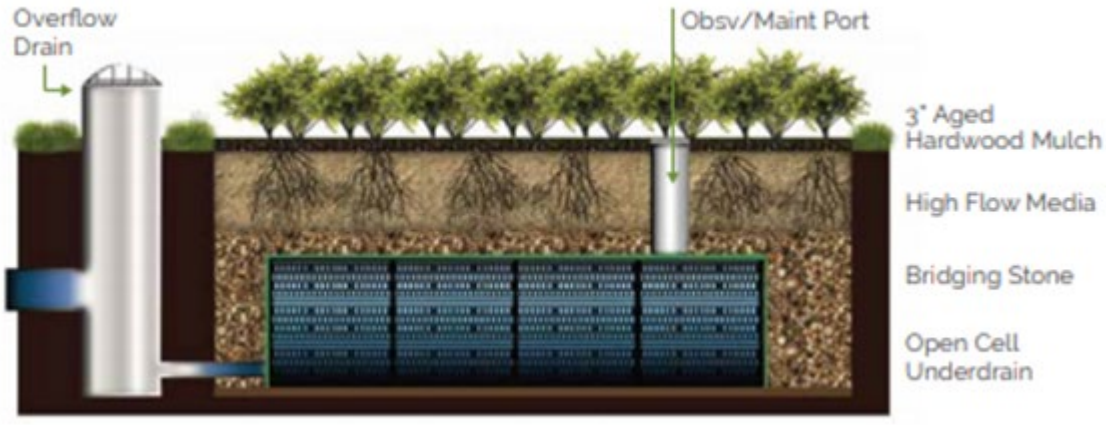


Photo 7 - Bioretention Area Schematic Elevation

Combined Sewer Separation

Based on information provided by the City of Rutland, there is currently approximately 900 acres of combined sewershed in the sewer service area (see **Figure 3**). Based on the hydrologic modeling performed, the amount of area required to be separated was determined in order to eliminate discharges for the two evaluation storms. Due to the nature of combined sewer separation, it is extremely difficult to achieve 100% reduction in CSO flow. Typically, this work occurs within municipal Rights of Way and not on private property. Therefore, these projects do not address sources of private inflow (e.g. sump pumps, roof leaders and yard/foundation drains). As a result, our analysis assumes a maximum effectiveness of 80% CSO removal for a given separation project. Refer to **Table 5, "Combined Sewer Separation Targets"** below for a breakdown of the amount of combined sewershed for each CSO discharge point, and the area reduction targets:

Table 5: Combined Sewer Separation Targets			
CSO Location	Existing Combined Sewershed (ac)	Required Separation (ac)	Separation Including Efficiency Factor (ac)
001 – Calvary Cemetery	270	134	161
002 – Home Plate	52	N/A	N/A
003 – Meadow Street	230	135	169
004 – School Street	310	141	162
005 – West Street	38	N/A	N/A

Storm Sewer Sizing Considerations

The City of Rutland does not have a design standard for storm sewer sizing. Based on previous studies and designs performed for the City (i.e. the Northwest Neighborhood project), we have used the 25-year storm event as the design storm; drains and catch basins are designed such that this event will not result in surcharging. HydroCAD modeling was developed for each of the separated sewersheds to understand the peak flow rates from each area. Pipe sizing (and costing) is based on the expected end-of-pipe flow rate and represents the largest expected size required for a given area. Detailed modeling of each catch basin's subcatchment will be required in the final design phase of any project. This fine-tuning of the modeling will help optimize the design and potentially reduce expected project costs if small pipe diameters can be used farther upstream in each watershed. The design information provided in the following sections includes the HydroCAD modeling results.

Separated Stormwater Quality & Quantity Considerations

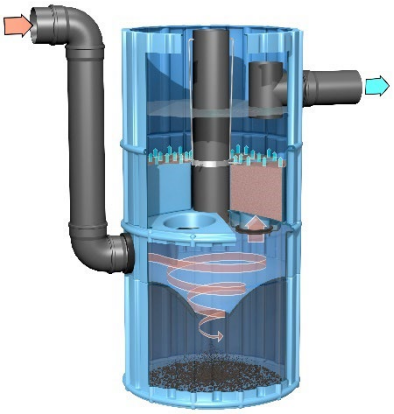


Photo 8 - Swirl Concentrator Schematic

As disconnection of storm sewers will result in new outfalls to waters of the state, the discharges must be controlled to avoid water quality impacts from the stormwater quality (i.e. pollutant load) and quantity (i.e. erosive discharge velocities in the receiving water). As all of the areas to be separated are located in existing neighborhoods with limited rights-of-way, there are limited opportunities to install treatment measures. Some locations (e.g. Rotary Park, White's Park) are suited for treatment systems to be installed at the end of the pipe, prior to discharge. The State of Vermont does not have a specific regulatory program that spells out the treatment and control requirements for these types of projects; the Stormwater Program primarily regulates based on the development of impervious surfaces or the disturbance of earth. Based on correspondence with the interim program managers (Christy Witters and Kevin Burke), the Stormwater Program has in the past required storm sewer separation projects to implement some level of water quality treatment. Any sort of determination would be project-specific and require additional input at the final design phase of any separation project to determine the exact level of treatment and/or storage required.

For the purposes of this report, we have assumed that new outfalls that are proposed in this project will require a water quality treatment device. There are a variety of water quality treatment devices available, one popular technology is the swirl concentrator. This device uses hydrodynamic separation to settle

grit and solids, with baffles to prevent floatable material from being carried downstream. Using current design standards in the Vermont Stormwater Management Manual (2017), a 1-inch storm was used to size these structures.

Where space allows, subsurface stormwater detention (i.e. runoff storage without an infiltrative component) structures are proposed as well. Again, there are several different types of product that are used for this application, including stormwater arches, concrete vaults, "milk crate" style plastic boxes, and networks of corrugated metal pipe. As the VSMM does not include design criteria for the sizing of such structures for neighborhoods that are not subject to operational stormwater permitting, we have sized structures that make the best use of the available real estate and are capable of mitigating the peak flows from a 1-year, 24-hour storm event (2.13 inches total depth). Larger flows are bypassed by a diversion manhole and allowed to continue to the outfall without surcharging these structures.

Identified Storm Sewer Separation Projects

The entire combined sewershed was analyzed to determine which areas were most suitable for catch basin separation. Ideal areas are those located in lower density residential areas (e.g. single family home neighborhoods), with moderate slopes and near to waters of the State to allow the installation of a new storm drain outfall. Discharge points that are located on City-owned land are most ideal as they will not require the additional effort of securing an easement across private property. Large City-owned parcels at the low end of a proposed storm drain are ideal as stormwater quality and quantity control devices can be constructed. Some of the projects proposed below were identified in previous efforts, their design information has been provided for reference. As this effort focused on ensuring that the adequate amount of combined sewershed is separated, detailed sizing calculations of the proposed storm drains are not provided in this report. If a project is chosen for further development, additional study will be required in order to confirm its feasibility. Potential impacts to structures downstream of the new outfalls, utility conflicts, right-of-way access, soils characterization and other factors will need to be considered in detail when a site is selected for implementation.

For the purposes of this report, the following assumptions have been made to obtain an opinion of cost:

a. Easement costs were estimated at 1.75 times the pro-rated assessed value of the property.
b. 25% of the lots crossed with new proposed storm drain will require a replacement water and sewer service.
c. Pavement restoration is limited to the trenching required to install the storm drain.
d. No curb replacement is included.
e. Five test borings during construction are included for each site. A comprehensive boring program for each site is not included.
f. 5% of the total new storm drain installed is assumed to require rock excavation and disposal.
g. 1% of the total new storm drain installed is assumed to be unsuitable material (e.g. geotechnically deficient soils)
h. Trench spoils unable to be placed back in situ for storm drains that are adjacent to mapped hazardous waste sites have been assumed as needing disposal at a landfill.
i. GSI practices have been included in areas of favorable soils (HSGs A and B)
j. Pipe and treatment device sizing are based on HSG C soils with ¼ acre residential lots, using the lag-CN approach for estimating the time of concentration. Each site is considered as a single subcatchment, therefore the flows represent the maximum anticipated pipe size required. More detailed hydrologic modeling will be required for final design.

k. Engineering fees represent Step II and III services only, this report is assumed to satisfy the Step I requirements of the SRF program.
l. ½% of project costs are provided for City administrative and legal purposes.
m. Contaminated soil disposal was assumed for the displaced material in trench excavation when a sewer separation project passes by a property that is listed as hazardous by the VCGI database. Quantity was calculated as the pipe void space and bedding materials cross-sectional area multiplied by the length of road frontage.

The identified projects are listed below.

Project 6 - Field Avenue
Located at the northern edge of the City's collection system, this project is located in the Meadow Street sewershed and discharges to East Creek. It would connect existing combined catch basins on Lincoln Avenue and Adams Street into a new storm sewer installed on Field Avenue and then through the driveway of the 61 Field Ave property. Behind the house at that location, there is a natural drainageway. Previous work (Tenney Brook/East Creek Watershed Stormwater Master Plan) identified this area as having potential for a gravel wetland stormwater treatment system to improve water quality prior to discharge in the East Creek.

This area has been recently paved; if no other factors push this area into a higher priority, this area was requested to be put off into the future to avoid disturbing recent construction.

Refer to **Appendix M, "Field Avenue"** for a site plan of the project area, conceptual treatment design plans, and opinion of cost for this project.

Project 7 - Vernon Street
This area would separate combined CBs along Vernon Street and route a new storm sewer south on Adams Street to a recently completed stormwater swirl concentrator that discharges to Tenney Brook. Located in the Meadow Street sewershed, this project was initiated by the Rutland NRCS as Phase 2 to the swirl concentrator project. In addition to Vernon Street, drainage from Phillips Street, Lincoln Avenue, and Route 7 can be collected in the new storm sewer for treatment prior to discharge. This project, designed by DuBois & King, can be considered a "shovel ready" project that could be implemented quickly if funds become available.

Refer to **Appendix N, "Vernon Street"** for a site plan of the project area, conceptual treatment design plans, and opinion of cost that have been prepared in the previous reports.

Project 8 - Rotary Park
This project is in the School Street sewershed and the new outfall located in Rotary Park discharging to Tenney Brook. Rotary Park has been identified in the Tenney Brook/East Creek stormwater master plan as having potential for stormwater treatment measures and a new discharge into Tenney Brook. A new storm drain would begin to the east on Bellevue Avenue and capture connected catch basins in this area and then run west on North Street Extension. At the intersection of Main Street the drain would turn northward, capturing additional combined catch basins before turning westward into Rotary Park. There is sufficient space in the park to provide a swirl concentrator to remove sediment and a subsurface stormwater detention structure to provide a controlled discharge of small storm events. The Crescent/Route 7 intersection is a known nuisance ponding area that should be addressed. This project

will be investigated further and potentially broken up into two distinct projects (Rotary Park and Crescent Avenue/High Street)

Refer to **Appendix O, "Rotary Park"** for a site plan of the project area, conceptual treatment design plans, and opinion of cost for this project.

Project 9 – Thrall Avenue
This small area consists of around 7 combined catch basins near the Northeast Primary School and is located in the Calvary Cemetery sewershed. An existing storm drain discharges to a low area adjacent to recreational fields. This project would install a separated storm drain to collect the existing connected catch basins and discharge the flow into the existing outfall storm drain that drains to the low area. As this area drains to a local low spot and the limited amount of vertical head available, treatment devices were not found to be feasible for this site.

Refer to **Appendix P, "Thrall Avenue"** for a map illustrating the contributing drainage area from this project that is separated from the combined sewer system and an opinion of cost for the work.

Project 10 – Temple Street
A new storm drain on Temple Street would connect combined CBs that drain portions of Highland Ave, Bellevue Ave Extension, Litchfield Ave and Ives Ave before crossing Route 7. This area is located in the School Street sewershed. This new storm drain would then be routed down Kendall Ave, which is part of the recently-completed Northwest Neighborhood project, which discharges to East Creek. While there was a 42-inch storm drain stub that was furnished at the upper terminus of this project, utility conflicts required the placement of two 18 inch storm drains just downgradient of the stub, reducing the capacity of the sewer to approximately 21 cubic feet per second (cfs). A hydrologic analysis has been conducted to confirm the capacity of the downstream storm sewer.

Refer to **Appendix Q, "Temple Street"** for a site plan of the project area, opinion of cost, and a record drawing of the storm drain stub that was part of the Northwest Neighborhood project.

Project 11 - East Street
This large project, located in the Calvary Cemetery sewershed, would provide a trunk storm drain extending from White's Park up to Edgerton Street, with spur lines collecting runoff from Jackson Ave, Engrem Ave, Killington Ave, Speilman Ave, East Washington Street, East Center Street, Terrill Street, and Edgerton Street. This project would discharge to Moon Brook. With City-owned land at the end of this run, treatment practices can be constructed. A potential exists to connect previously separated sewers on South Main Street if a right-of-way cannot be secured for a discharge in that corridor (see Other Projects section below).

Due to the discharge point on a larger parcel of City-owned land, there is an opportunity to install stormwater quality and quantity devices. A swirl concentrator and subsurface stormwater detention structure have been provided at the end of this storm sewer run to mitigate peak flows and remove sediment from the runoff.

Refer to **Appendix R, "East Street",** for a map illustrating the contributing drainage area from this project that is separated from the combined sewer system, hydrologic modeling, engineering details for the treatment system, and an opinion of cost.

Project 12 - Easterly Avenue
This project, located in the Calvary Cemetery sewershed, would provide a new separated storm sewer that ultimately discharges to Moon Brook on Killington Avenue. While some storm infrastructure already exists in this immediate area, there are combined CBs on Lafayette Ave, East Center Street, Easterly Ave and Howard Ave that can be connected together and routed to this discharge point. Analysis would be made to determine if the existing storm sewers are sufficient to address the additional storm flow, or if those pipes would need to be upsized. After a review of the existing culverts and bridges in the area, it was determined that the discharge on the south side of Killington Avenue would be able to better handle the additional flows from this storm drain. There is a City-owned parcel of land near the Moon Brook crossing of Killington Avenue that could be used to install an outfall. While there is also room to install a swirl concentrator to improve water quality of discharge, there is not sufficient room to install a subsurface detention structure to mitigate peak flows.

Refer to **Appendix S, "Easterly Avenue",** for a map illustrating the contributing drainage area from this project that is separated from the combined sewer system, hydrologic modeling and engineering details for the treatment system as well as an opinion of cost.

Project 13 - Harrington Avenue
There is a cluster of combined CBs around the intersections of Rutland Street and Ross Street that could be routed eastward to an existing storm drain that runs cross-country southward through Newport Drive and Piedmont Drive. This area is located in the Calvary Cemetery sewershed and discharges to Moon Brook. However, City of Rutland staff have noted that the size of the pipe in that area is only 18 inches and cannot convey additional flow without an upgrade. Some relatively recent storm sewer work was performed in the Piedmont Drive area, with a 36-inch storm drain and an offline swirl concentrator installed at the discharge to Moon Brook. Additional improvements to the trunk storm sewer upstream of this work would need to occur before increasing storm flow.

Refer to **Appendix T, "Harrington Avenue",** for a map illustrating the contributing drainage area from this project that is separated from the combined sewer system and opinion of cost.

Project 14 - Convent Avenue
This area would capture a set of combined CBs that are near to Connor Park that can be relatively easily routed to existing storm drain infrastructure. Due to the area topography, additional combined CBs on Cherry Street and Franklin Street cannot be included in this area. This is a project located in the Home Plate sewershed.

Refer to **Appendix U, "Convent Avenue",** for a map illustrating the contributing drainage area from this project that is separated from the combined sewer system and opinion of cost.

Project 15 - Meadow Street
This area has long been considered a candidate for streetscape improvements and separating combined CBs would be a logical addition to the project. A grant from VTrans has been issued previously, so financial assistance to the City is available. This area, located in both the Meadow Street and School Street sewersheds, would also be able to disconnect combined CBs on Traverse Place and further east to the intersection of Pine Street and Forest Street, discharging to East Creek. The challenge in this location is finding a suitable discharge point while maintaining minimum slopes to pipes. The area is very flat, and close to the receiving water. Due to the retrofit of the Third Base outfall (see Section 4.3.4), a new storm drain outfall will be required for the existing drains on School street. If the City is

able to acquire a right-of-way for the installation of a new storm drain outlet between 21 and 27 Meadow Street, the separated catch basins and the existing storm drain can discharge to the East Creek, leaving the Third Base conduit as only conveying combined sewer flows.

Refer to **Appendix V, "Meadow Street",** for a map illustrating the contributing drainage area from this project that is separated from the combined sewer system, hydrologic modeling, engineering details and opinion of cost for this system.

Project 16 – State Street West
This area is located on the west side of East Creek and consists of a low density residential neighborhood in the Meadow Street sewershed. There exists some separated storm drains along State Street. New storm drains extending eastward on State Street and northward on its intersecting streets can be connected to this system. The intersections of State Street, Columbian Avenue, and Pier Point Avenue afford space to install a diversion manhole and swirl concentrator. This area discharges to East Creek.

Refer to **Appendix W, "State Street West",** for a map illustrating the contributing drainage area from this project that is separated from the combined sewer system and opinion of cost.

Project 17 – State Street East
This area is located closer to the downtown area of the City and therefore has more potential for utility conflicts and traffic disruptions than the other projects noted above. However, there is potential in this area to collect connected CBs on Maple Street, Robbins Street, Baxter Street and Cleveland Ave into a short run of storm drain on State Street before discharge to the East Creek. The Tenney Brook stormwater master plan identified this area as having potential for a bioretention area on a parcel of land that contains a solar array, owned by Green Mountain Power. However, the area topography does not allow this feature to be constructed as presented in the report. From the intersection of Cleveland Avenue and State Street, the existing grade rises eight feet. Any storm drain collecting runoff to the north and east must discharge into State Street at an elevation low enough to provide minimum cover over it. Based on a 25-year storm sizing and an outlet discharge elevation of 530 feet (just above the normal water surface level of East Creek), a large conduit installed on a 0.1% slope is feasible. However, the existing grade of the GMP site is 536 feet, so routing runoff into a structure built in this area is not feasible. Furthermore, the shallow slope of the required storm drain on State Street and the minimum head requirements of swirl concentrators preclude the use of that particular water quality treatment device. However, this particular watershed area is located in well-draining HSG A soils, so GSI practices may be used to treat runoff. A set of potential areas were presented in the Tenney Brook stormwater master plan, and those are illustrated in the mapping.

Refer to **Appendix X, "State Street East",** for a map illustrating the contributing drainage area from this project that is separated from the combined sewer system, potential GSI areas, and hydrologic modeling.

Project 18 – South Main Street
The City initiated a sewer separation project for the section of South Main Street (US Route 7) from the Moon Brook crossing up to Mansfield Place, located in the Calvary sewershed. Due to the failure to obtain a right-of-way at the time, the newly installed storm drain could not discharge to Moon Brook, and instead was re-connected to the combined sewer. With two new short runs of storm drain, the immediate area around South Main Street could be separated. Other drainage issues in this area have

been observed, notably ponding/flooding on Clover Street. The City of Rutland has taken ownership of two lots on Clover Street, both of which abut Moon Brook. This provides a fee simple access for a new storm drain. Due to the flat topography of the area, subsurface detention is not possible, however, a swirl concentrator could be used to remove pollutants from stormwater runoff prior to discharge.

Refer to **Appendix Y, "South Main Street",** for a map illustrating the contributing drainage area from this project that is separated from the combined sewer system and opinion of cost.

Project 19 – West Street East

A very significant amount of area within the School Street sewershed can be captured with a storm drain trunk extending from West Street up to North Main Street, discharging to East Creek. However, feasibility of this drain is dependent on the ability to secure an easement to cross under a set of railroad tracks, and providing adequate pipe slope to drain the area. The area from the railroad tracks to East Creek is rather flat, and the ability to adjust the route of the storm drain or the size to accommodate utility crossings is very limited.

Refer to **Appendix Z, "West Street East",** for a map illustrating the contributing drainage area from this project that is separated from the combined sewer system and opinion of cost.

Project 20 – West Street West

This area is located to the North of Columbian Avenue and a set of railroad tracks and is located in the West Street sewershed, discharging to East Creek. If right-of-way access can be obtained from the railroad, then a new storm drain can convey runoff from Cramton Avenue, Watkins Avenue, and Evergreen Avenue. The new drain would connect to the existing separated storm drain on West Street. For the Tenney Brook stormwater master plan, a subsurface retention device (i.e. infiltrative stormwater practice) has been designed on the banks of East Creek, where City-owned land is available for use.

Refer to **Appendix AA, "West Street West"** for a map illustrating the contributing drainage area from this project that is separated from the combined sewer system, conceptual design plans for the subsurface retention device and opinion of cost.

In summary, Tables 6.1 - 6.3 below lists each of the separation projects, the sewershed in which they reside and the amount of area separated:

Table 6.1: Sewer Separation Projects Calvary Cemetary Sewershed

Project ID	Combined Sewershed (ac)
4 – Thrall Avenue	9.08
6 – East Street	79.14
7 – Easterly Avenue	42.78
8 – Harrington Avenue	5.49
13 – South Main Street	17.33
Total Separated Area	**153.8**

Table 6.2: Sewer Separation Projects Meadow Street Sewershed	
Project ID	Combined Sewershed (ac)
1 – Field Avenue	42.49
2 – Vernon Street	29.48
10 – Meadow Street	15.38
11 – State Street West	44.32
12 – State Street East	52.13
Total Separated Area	**183.8**

Table 6.3: Sewer Separation Projects School Street Sewershed	
Project ID	Combined Sewershed (ac)
3 – Rotary Park	23.64
5 – Temple Street	14.83
14 – West Street East	92.31
Total Separated Area	**130.8**

Note that for the Calvary and Meadow Street projects, total amount of separated area exceeds the predicted target area. This will provide flexibility as to which projects may be chosen for implementation.

Small-Scale Projects

In addition to these larger projects, there are currently many isolated areas throughout the City that have one or two CBs that are combined into the sanitary sewer. These areas are quite often found in "newer" (e.g. 1960s/1970s) neighborhoods where there are no curbs and runoff primarily drains via sheet flow. In locations where the road creates a local low point, CBs have been added to prevent ponding. Refer to **Table 7, "Small-Scale Separation Projects"** for a listing of these areas along with the area of combined sewershed they contribute as well as the CSO outfall they are associated with:

Table 7: Small-Scale Separation Projects		
Location	CSO Sewershed	Area (ac)
Grove Street	Meadow Street (004)	0.87
Oak Street	Meadow Street (004)	2.16
Park Street	Calvary Cemetary (001)	0.65
Marble Avenue	Calvary Cemetary (001)	0.97
Curtis Avenue	Calvary Cemetary (001)	8.01
Mussey Street	Calvary Cemetary (001)	6.51
Quality Inn	Calvary Cemetary (001)	0.30
Jackson Avenue	Calvary Cemetary (001)	2.96
Newport Drive	Calvary Cemetary (001)	2.22
Grandview Terrace	Calvary Cemetary (001)	4.99
Porter Place	Calvary Cemetary (001)	5.77
First Street	Home Plate (002)	1.92

The location of these sites is provided on Figure 3. These projects could be implemented by City staff as opportunities arise. Design details for these areas could vary considerably depending on site-specific conditions such as soil type, availability of existing stormwater infrastructure or streams to discharge, and conflicts with other existing utilities. Costs for these projects have not been developed due to their small size, the possibility of these projects being able to be performed by the City without the need for a contractor, and administrative costs through the SRF program may not be cost-effective. The City may wish to include these projects as bid alternates appended to larger projects. Not including these costs in other CSO projects listed above has no effect on prioritization ranking of those larger projects.

While other areas of combined sewershed remain, those areas are located in the downtown core area of the City, where there is high levels of traffic, more underground utilities with greater uncertainty to their locations, and higher amounts of roof drain connections pose additional complications to design and construction, as well as increasing the cost of the projects.

5.0 PROJECT SELECTION & PHASING

The City of Rutland has reviewed all of the proposed projects in Section 4 and weighed the costs and benefits of those projects against the financial impact the City ratepayers could be expected to bear through the issuance of additional bonds. Citizens have approved several large bonds in the past to help maintain the water and sewer infrastructure as well as separating combined sewers to mitigate CSO flows. After the second public hearing held with the Board of Aldermen, the City of Rutland has presented a five-year roadmap of project implementation. Refer to Appendix BB – 5-Year Project Implementation Schedule.

5.1 Affordability Analysis

In the VT DEC's CSO LTCP Guidance Document issued in 2019, two sources were cited for reference, the existing EPA *Combined Sewer Overflows Guidance for Financial Capability* (1997) and *Developing a New Framework for Household Affordability and Financial Capability Assessment in the Water Sector* (2019) prepared for the AWWA, National Association of Clean Water Agencies and the Water Environment Federation. The 1997 EPA document consists of a set of tables that can be filled with data. Ultimately, this data is reduced into a matrix of subjective values to determine affordability. The 2019 document does not provide a new set of factors, calculations, or spreadsheets to be used in lieu of the 1997 EPA procedure, it critiques the 1997 methodology and suggests possible alternative means of determining the various inputs needed in an affordability analysis. Based on discussions with VT DEC, the intent of this analysis is to develop a set of CSO projects to implement that balances the environmental need with the ratepayer's ability to fund those improvements. This balance is weighed by determining the percentage a typical residential sewer user fee is against the median household income (MHI). According to the VT DEC, 1.5 – 2% is considered an "affordable" rate. Once sewer rates start to exceed 2%, the financial impact to ratepayers becomes less and less affordable. The goal of this LTCP is to propose a set of projects that will be implemented in the next five years that maintains an affordable sewer user rate to residents. Appendix BB represents this set of projects.

After reviewing the two guidance documents and the available data regarding the City of Rutland's sewer rates, we developed an approach that incorporates elements of the guidance documents while making use of available data, notably the FY2023 Water and Sewer Rate Study and the FY21 City Annual Report. The Water and Sewer Rate Study provides historical figures from FY15 to FY20 on wastewater rates, revenues, O&M, and debt service. The City Annual Report provides the future costs of debt payments for the projects it has completed. Prior to FY22, the City has five SRF-funded projects it is currently making annual payments towards. In FY22, two new projects were added, the East Creek Sewage Force Main Replacement projects and the Northwest Neighborhood sewer separation project. In FY23, the WWTF Anaerobic Digester Complex Improvements project will begin repayment, and in FY25, the planning costs for this LTCP will begin repayment.

To project anticipated operational costs from FY20 through FY30, expenditures based on FY22 figures were escalated to account for inflation. Calendar year 2021 marked an end to over ten years' of low inflation rates with a 40-year record rate of over 6%. Supply chain issues and COVID-19 related impacts are the likely cause of this spike, and according to analysts the inflation rate will continue to be higher than recent historical rates for several years to come. It is outside the scope of this project to accurately predict what the inflation rates will be until FY30, for the purposes of the report, data from the Bureau of Labor Statistics (published by cpiinflationcalculator.com) was used to determine the FY23 inflation rate

historical levels soon. The annual wastewater cost per ERU was escalated by the inflation factor for each year of the analysis.

Using the schedule provided by the City of Rutland in Appendix BB, the anticipated additional debt load for the design and construction of the chosen projects were added to the City's wastewater expenditures. Per VT DEC SRF program rules, repayment must begin the year following construction completion. Planning costs (i.e. Step II final design services) may be deferred up to two years, after which repayment must begin. As a result, costs associated with the first chosen project, CSO Check Valve installation, do not begin repayment until FY25, the year after anticipated construction completion. The second chosen project, Vernon Street sewer separation, would begin repayment in FY26. The WWTF improvements, River Street Pump Station Upgrade, Otter Creek Interceptor Upgrade, and Calvary storage only include design in the five-year plan, therefore repayment for these projects is scheduled for two years after the scheduled end of the design effort. Annual debt payment for these projects was broken down into a cost-per-ERU figure, which was added to the Annual Cost per ERU.

To summarize, currently the ERU sewer cost as a percentage of MHI is 1.35% (per the FY22 rate study). This percentage was set to increase in the coming years as several wastewater bonds are due for repayment. Coupled with the recent effects of inflation, this rate is predicted to increase to 1.46% in FY24. As CSO projects are implemented, this rate increases steadily until FY29, when the cost reaches 2.18%, above the 2% affordability threshold maximum. Therefore, it can be reasonably concluded that the set of projects chosen by the City of Rutland represent a good faith effort to reduce the number and duration of CSO occurrences in the collection system with a significant financial contribution from the City's ratepayers. Refer to Appendix CC, "Affordability Analysis & Lifecycle Cost Analysis" for more information.

5.2 Life Cycle Cost Analysis

A Net Present Value (NPV) analysis was performed on all proposed projects. This analysis serves to provide a dollar figure that represents the total present value of a project, including the physical components of a project, the operation and maintenance of the project, and the salvage value of the materials at the end of the project's design life.

For the purposes of this report, the required O&M for each project serves as the ongoing annual cost, not including amortization of the capital cost. O&M costs differ depending on the type of project. For sewer separation projects, O&M consists of annual catch basin cleaning. For the WWTF improvements, O&M costs include added chlorine and sodium bisulfite use, chemical feed maintenance and weir gate valve maintenance. For the proposed River Street Pump Station improvements, O&M includes mostly telemetry equipment and level control maintenance. In-system CSO storage projects include labor and disposal costs for inspecting, cleaning and disposing of debris and grit from the storage structures. The Connor Park structure also includes electrical costs related to pumping down the storage structure after each storm. These costs are included in Appendix CC.

These calculations are based on the anticipated construction cost for each project, plus the present worth of 20 years of anticipated annual O&M Cost. Please note that we have assumed that there will be no salvage value for any of the equipment, piping and structures proposed for these improvements. These costs and this analysis are being provided to satisfy SRF program requirements, but do not enter into the selection of alternatives to be carried forward into the 5-year plan.

5.3 Anticipated Volumetric & Cost Benefit

Refer to **Table 8, "Summary of Alternatives Costs and Effectiveness",** on the following page for a summary of projects, their costs, and the amount of combined sewage removed as a result of their implementation.

Rutland Long Term Control Plan

Table 8 - Summary of Alternative Costs & Effectiveness

2/28/2022

Project No.	Project Name	Project Type	Sewershed		Total Cost	Gallons Removed
1.1	River St. Pump Station Upgrade	Capacity	N/A	$	640,000	*See Note 2*
1.2	WWTF Upgrade	Capacity	N/A	$	1,640,000	1,622,000
2	Otter Creek Interceptor Upgrade	Capacity	1	$	10,400,000	1,714,000
3	Calvary Storage	Storage	1	$	3,700,000	129,000
4.1	Connor Park Storage Phase 1	Storage	3	$	7,700,000	1,100,000
4.2	Connor Park Storage Phase 2	Storage	3	$	4,000,000	1,100,000
5	CSO Check Valves	Capacity	N/A	$	520,000	*See Note 1*
6	Field Ave	Separation	4	$	7,440,000	361,000
7	Vernon Street	Separation	4	$	3,245,000	251,000
8	Rotary Park	Separation	3	$	5,600,000	900,000
9	Thrall Ave	Separation	1	$	4,740,000	90,000
10	Temple Street	Separation	3	$	2,710,000	402,000
11	East Street	Separation	1	$	11,780,000	782,000
12	Easterly Avenue	Separation	1	$	4,310,000	423,000
13	Harrington Avenue	Separation	1	$	2,070,000	55,000
14	Convent Avenue	Separation	2	$	1,670,000	*See Note 3*
15	Meadow Street	Separation	4	$	4,810,000	131,000
16	State Street West	Separation	4	$	6,160,000	377,000
17	State Street East	Separation	4	$	17,020,000	443,000
18	South Main Street	Separation	1	$	1,140,000	214,000
19	West Street West	Separation	5	$	6,300,000	38,000
20	West Street East	Separation	3	$	30,680,000	2,542,000

Notes:

1 - Gallons removed for CSO check valve option not quantified in this study
2 - Gallons removed for pump station upgrade part of total for WWTF upgrade project
3 - H&H modeling did not include an estimate of gallons removed in Home Plate sewershed
4 - Vernon Street Step 2 engineering costs and total costs provided by the City of Rutland

Refer to **Table 9, "Ranking Matrix",** below for a ranking matrix that gives projects two rankings: cost per gallon removed and total gallons removed. With this type of analysis, a project's effectiveness provides a weighting factor beyond cost efficiency. A lower ranking matrix score represents a more cost-efficient project that removes a larger quantity of combined sewage from the collection system for the evaluation storm.

Table 9: Ranking Matrix

Project Number	Project	Cost per Gallon Removed	Cost per Gallon Score	Total Gallons Removed	Total Gallons Score	Final Score
1.1 &1.2	WWTF Upgrade & River St. PS	$7.42	19	1,622,000	17	323
5	CSO Check Valves	$3.48	18	-	16	288
2	Otter Creek Interceptor Upgrade	$6.07	15	1,714,000	18	270
8	Rotary Park	$6.22	16	900,000	14	224
20	West Street East	$12.07	11	2,542,000	19	209
4.1 & 4.2	Connor Park Storage	$5.32	12	2,200,000	15	180
12	Easterly Avenue	$10.19	13	423,000	11	143
10	Temple Street	$6.74	14	402,000	10	140
11	East Street	$15.06	9	782,000	13	117
18	South Main Street	$5.33	17	214,000	6	102
16	State Street West	$16.34	8	377,000	9	71
7	Vernon Street	$12.93	10	251,000	7	70
6	Field Avenue	$20.61	7	361,000	8	56
17	State Street East	$38.42	3	443,000	12	36
15	Meadow Street	$36.72	5	131,000	5	25
3	Calvary Storage	$28.68	6	129,000	4	24
13	Harrington Avenue	$37.64	4	55,000	2	8
9	Thrall Avenue	$52.67	2	90,000	3	6
19	West Street West	$165.79	1	38,000	1	1
14	Convent Avenue	-	-	-	-	-

5.4 Public Comments & Considerations

A public hearing was held at the 60% progress level on August 2, 2021. At that time, no members of the public provided questions or comments about the proposed approach.

A second public hearing was held on January 11, 2022. The proposed projects were presented along with their anticipated costs. A preliminary ranking of projects to be included in the 5-year list was presented as well. No members of the public provided questions or comments regarding the projects or their costs.

5.5 Non-Monetary Factors

Due to the nature of the types of projects included in this plan, project implementation will be governed in part by reducing combined sewer flow through sewer separation prior to constructing other projects. In particular, the decommissioning of CSO 005 (Third Base overflow) and conveying combined flow towards Home Plate will be dependent on separation projects being implemented to reduce the flow

6.0 PROPOSED APPROACH

6.1 Project Approach

Based on recent wastewater collection system metering and calibration of a system hydraulic model, Weston & Sampson has identified 22 projects which, in theory, would need to be completed in order for the City to meet the CSO elimination goal stated above. The total value of these projects combined, is approximately $138 million. The extent of the sewer service area, age of the infrastructure and amount of wastewater collection system that remains combined drives the number of projects required to achieve the CSO program goals.

6.1.1 Project Prioritization

Weston & Sampson proposed that the list of all CSO abatement projects be sorted in order by cost-effectiveness. This sorting has been completed in Table 9. In this table, projects are ranked in order by their cost-effectiveness in total dollars of project cost per gallon of combined sewage removed from receiving waters. By looking at the list of projects in terms of cost-effectiveness, the City can identify which projects should be undertaken first.

Reviewing the list of suggested projects, not all of them result in a direct reduction of combined sewage discharge to a receiving water. For example, the CSO check valves, Project 5, will not have a direct reduction in the amount of combined sewage leaving the system, but will prevent river water from entering the wastewater system and consuming transmission capacity and reducing effectiveness of treatment at the wastewater treatment facility. While this project does not have an associated gallons removed value, it greatly facilitates the effectiveness of the other projects that have been recommended.

A third factor impacting prioritization of an individual project is the status or stage of completion of that project or readiness of that project for construction. For example, Vernon Street, a separation project which has already been designed, is ready for construction. While it does not rank in the top projects for cost-effectiveness it impacts other public works projects and is considered a priority by the City.

Finally, projects which complete initiatives begun in the past should also be given a higher ranking than projects in conceptual development. An example of this would be construction of improvements at the WWTF to maximize treatment capacity. Not only is maximizing treatment capacity within the system one of the EPA 9 Minimum Controls, but it follows onto over $17M of work that the city has already undertaken in the past 30 years creating momentum for this approach to CSO abatement.

The factors noted above were considered heavily in the City's selection of projects to advance from the preliminary abatements project list in Table 9 to the final 5-Year Project Implementation Schedule.

6.1.2 Selected Projects

Using the weighting criteria noted above, the City of Rutland has identified 8 separate CSO Abatement Projects that they wish to advance, at some level, over the next 5 fiscal years. These projects include:

1. CSO Check Valves: Installation of check valves on outfalls from CSO regulators will prevent river water from backing up into the wastewater collection system and occupying valuable transmission and treatment capacity, resulting in less capacity to abate overflows. In addition, installation of these check valves is critical to the success of the proposed storage projects which will equalize and store combined sewage so until the WWTF can treat this stored volume.

2. Vernon St. Sewer Separation: While this combined sewer separation project is not one of the highest ranked projects using cost effectiveness, it has been designed and could be bid and constructed in the next several years. Additionally, this project is located in an area identified by the City as in need of potable water utility replacement and pavement restoration. Previously completed work (the Adams Street swirl concentrator project) has built a treatment and outfall that this project can tie into, simplifying the remaining work needed to bring this project into a state that can be issued for construction bids..

3. South Main Street Separation: This combined sewer separation project is more highly ranked than Vernon Street in order of cost-effectiveness. Originally envisioned as the completion of a partially-completed sewer separation project, stakeholder input revealed a secondary benefit to the work (alleviating flooding on Clover Street), and City research determined that a fee-simple access to Moon Brook was possible on Clover Street. The limited amount of storm drain and other infrastructure needed to fully separate over 20 acres of combined sewershed makes this project an attractive one for the five-year plan.

4. Connor Park Storage (Phase 1): The proposed CSO storage facility in Connor Park ranks toward the higher side of the cost-effectiveness scale and will serve to eliminate discharge of approximately 1.1 MG of combined sewage from the surface waters, beneath the evaluation storm event. Additionally, this storage project works in conjunction with improvements at the RSPS and the WWTF to maximize treatment of combined sewage using the existing infrastructure.

5. WWTF Improvements: As noted previously, the City of Rutland has expended in excess of $17M over the past 30 years to address CSO discharges from their wastewater system. A large portion of this has been in an effort to maximize treatment capacity of combined sewage at their WWTF. Examples of these projects include: upgrades to the RSPS, a second force main to the WWTF, construction of a second headworks, installation of additional grit removal facilities and construction of a third primary clarifier. By undertaking construction of a diversion structure and a storm flow disinfection facility (adjacent to their existing chlorine contact chambers) the City will have maximized their use of the existing treatment system, one of the EPAs 9 Minimum Controls.

6. RSPS Improvements: In order to maximize treatment at the WWTF, combined sewage equal to that treatment capacity must be able to be conveyed to that location. Upgrading the controls and slightly increasing pumping capacity during storm events will accomplish this. Project 5

and Project 6, while separate projects, will only realize their CSO removal potential when both have been completed.

7. Otter Creek Interceptor Upgrade: Closely related to improvements proposed for the WWTF and RSPS the Otter Creek interceptor improvements will increase flow capacity from the southern portion of Rutland's wastewater collection system to the RSPS. The existing 24-inch VC interceptor sewer acts as a "bottle neck", restricting flow to the pump station and reducing the ability of the existing infrastructure to treat to its fullest capability. Increasing the size of this interceptor will allow for the WWTF treatment capacity to be maximized. While this is also a separate CSO abatement project, Project 5 will only realize its full CSO abatement potential once this work has been completed.

8. Calvary Storage: The Calvary cemetery overflow CSO 001 has a lower cost-effectiveness ranking, however, this project will facilitate interceptor maintenance operations and help to reduce grit deposition in this portion of the wastewater collection system. By reducing grit deposition, system flow capacity can be maintained and downstream facilities, like the RSPS, will see a longer service life resulting from better grit management.

6.1.3 5-Year Project Implementation Schedule

The City of Rutland has looked at the details of the project costs for each of the 8 projects selected above, and developed an implementation plan for the next 5 fiscal years. Please refer to Appendix BB, "5-Year Project Implementation Schedule", for a detailed breakdown of design and construction phase projects that the City of Rutland is proposing to undertake in the next 5 years.

6.1.4 Environmental Permitting & Limitations

All 22 projects identified in Section 5 are intended to be funded by the SRF program and are subject to its environmental review process. This is initiated by an Environmental Information Document, which summarizes the project's potential environmental permitting needs. This includes a review of water quality impacts, wetlands/water resources, floodplains/floodways/fluvial erosion hazard zones, stream alterations, stream crossings, dam safety, endangered species, compliance with the Fish and Wildlife Coordination Act of 1934, Magnuson-Stevens Fishery Conservation and Management, the Migratory Bird Treaty Act, Historic Preservation (including a review of archaeological resources), Wild and Scenic Recreational Rivers, impacts to nearby local/state/federally-owned lands, farmland (prime agricultural soil impact review), NEPA compliance, socio-economic impacts, and Act 250 review. The various projects identified in this report are located in different areas and have different potential environmental permit reviews required. The following sections provide a brief summary of specific environmental issues above and beyond the EID review process that will be required for the eight chosen projects:

1. CSO Check Valves – This project is located in the 100-year floodplain and will require a review by the Building and Zoning Department to ensure it complies with flood hazard regulations. As this work will not result in the addition of fill, review will be straightforward, primarily concerned with the floodproofing of structures.

2. Vernon St. Sewer Separation – As this project is located in previously developed areas outside identified environmental resources, no additional permitting review will be necessary.

3. South Main Street Separation – This project will result in a new stormwater outfall on Moon Brook, a stream that has been identified as stormwater impaired. As a result, this project must be considered by the Stormwater Program in more detail. Regarding water quality concerns, there is no permit review process that the Stormwater Program has to cover this particular type of project, however, based on conversations with them, they will want to see the final design details of the project and then make an assessment as to what would be considered suitable stormwater treatment. The additional stormwater flow into Moon Brook will need to be analyzed in the context of the Moon Brook Flow Restoration Plan (FRP), a planning-level document that provides a master plan of projects to reduce high-storm flows and increase baseflows in the stream. As this document is a holistic evaluation of the entire Moon Brook watershed, the South Main Street project will have to be evaluated in the overall context of the FRP. This conversation with the Stormwater Program is ongoing.

4. Connor Park Storage (Phase 1) - This project is located in the 100-year floodplain and will require a review by the Building and Zoning Department to ensure it complies with flood hazard regulations. A construction-phase stormwater permit (Construction General Permit (CGP) for erosion prevention and sediment control) may be necessary depending on the final design configuration and determination of the amount of space needed by a contractor to construct the structure. For the purposes of this report, it is assumed a low-risk CGP will be required.

5. WWTF Improvements – As this project is located in previously developed areas outside identified environmental resources, no additional permitting review will be necessary.

6. RSPS Improvements - This project is located in the 100-year floodplain and will require a review by the Building and Zoning Department to ensure it complies with flood hazard regulations. As most of this work will occur in the building or below grade (with no additional fill required), this review will be straightforward.

7. Otter Creek Interceptor Upgrade – Based on feedback from ANR, the project location will likely trigger concerns from the State Historic Preservation Officer (SHPO) regarding archaeology. A Phase 1 review will need to be conducted first to determine if there are any significant features that would require additional consideration before construction could begin. An archaeological assessment has been included in the scope of work for this project. In addition to the archaeological concerns, the project's proximity to the river will require a review by the Rivers Program as well as local review through flood hazard regulations. Due to the anticipated amount of earthwork required, a low-risk CGP will also be required.

8. Calvary Storage - This project is located in the 100-year floodplain and will require a review by the Building and Zoning Department to ensure it complies with flood hazard regulations. As this work will not result in the addition of fill, review will be straightforward, primarily concerned with the floodproofing of structures. As the site is in active agriculture, the prime agricultural soil review part of the EID process will require additional attention. Due to the anticipated amount of earthwork required, a low-risk CGP will also be required.

6.1.5 Annual Operating Budget

For each fiscal year in the 5-Year Project Implementation Schedule, there is a total added cost related to CSO abatement project design and construction which can be added to the City's current projected wastewater budget for each of these coming years. The total 5-year Implementation cost for CSO abatement projects would be approximately $13.16M. Please refer to the affordability analysis in Section 5 for additional details regarding how these costs may affect the City of Rutland.

7.0 CONCLUSIONS & RECOMMENDATIONS

7.1 Five Year Capital Plan

Weston & Sampson has reviewed the list of projects that the city of Rutland has selected for their 5-Year Project Implementation Plan. We concur with the selection and the way in which the City has split different phases of the project between different fiscal years. The projects that the City selected will serve to advance the City's CSO abatement goals the furthest with this first capital plan. A copy of the City's proposed 5-year project implementation schedule is attached in Appendix BB.

7.2 Additional Recommendations

In addition to the list of eight projects selected for advancement by the City of Rutland, there are several supplemental projects and recommendations that should be considered which will help support these selected projects and help the City gain a more refined understanding of how their wastewater collection system behaves during different storm events. The more data that is gathered, the better the understanding of their system will be over time.

7.2.1 Additional Flow Metering

Weston & Sampson recommends that a more focused metering program take place in the vicinity of the collection system where data was gathered for sewer Flow Meters No. 4 and 5, referenced earlier in this report. Approximately 500,000 gallons of extraneous flows enters the system somewhere between these two meters during larger precipitation events. The flow metering program used to refine and increase the resolution of the current hydraulic model did not identify the source of these flows. If the source of these flows can be identified and remediated, it may preclude the necessity for design and construction of the Phase 2 Connor Park storage improvements, potentially saving the City millions of dollars.

7.2.3 Additional Permanent Rain Gauge Installations

Chapter 34 of Vermont's Environmental Protection Rule, "Combined Sewer Overflow Rule", includes a requirement for the installation of permanent rain gages. The purpose of these rain gages is to allow the municipality to correlate precipitation events with CSO events and even total CSO volumes. Currently, the City of Rutland has a permanent rain gauge in place at the City WWTF. Because of the size of the wastewater service area in Rutland, and the nature of the of the precipitation events that affect the City, additional rain gauge data from several locations around the city may help to refine our understanding of which overflows react when certain areas of the city are affected by a precipitation. The Vermont ANR, Water Investment Division has also given this recommendation. Weston & Sampson believes that three additional permanent rain gauge locations, with telemetry so that data could be gathered

automatically, would be beneficial. We believe that the City should budget between $7,500 $10,000 per permanent installation to cover the cost of the equipment purchase and to install installation and telemetry.

7.2.4 Completion of a Flow Restoration Plan

As noted earlier in this report, the VT DEC Stormwater Program has requested that a Flow Restoration Plan for the Moon Brook be undertaken by the City of Rutland. Several of the storm water separation projects identified in this report will ultimately have discharges to the Moon Brook. Until conditions within the Brook are better understood and requirements of the Flow Restoration Plan are defined and accepted by the State of Vermont, storm water separation projects which discharge to this tributary should be deferred.

7.2.5 Projects Affected by Railroad Rights-of-Way

Vermont Railway is looking to negotiate a "Master License Agreement" with the City of Rutland. In this agreement, the railway is seeking to have the City own, or be financially responsible for, any and all issues related to their own utilities within the right-of-way, even if the issue was not caused by the City or its utility infrastructure. Because the outcome of this negotiation will have significant financial impacts on any work done in or under a railroad right-of-way, Weston & Sampson recommends that any of the combined sewwer separation projects that impact a railroad right-of-way be deferred until the Master License Agreement has been successfully negotiated.

7.2.6 Small-Scale Projects

In addition to the larger projects recommended in the City's 5-year Project Implementation Schedule, there are many isolated areas throughout the City that have one or two catch basins (CBs) that are connected to the sanitary sewer. These areas are quite often found in "newer" (e.g. 1960s/1970s) neighborhoods where there are no curbs and runoff primarily drains via sheet flow. In locations where the road creates a local low point, CBs have been added to prevent ponding. These smaller projects can be undertaken piecemeal by the City, when time and budget allows, or can be incorporated into other infrastructure projects that affect those areas. A summary of these small projects is included at the end of Chapter 4.

8.0 REFERENCES

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