



Haverhill

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March 26, 2021

Enforcement and Compliance Assurance Division
U.S. EPA New England – Region 1 (Mail Code: 04-4)
5 Post Office Square – Suite 100
Boston, MA 02109-3912
Attn: Ms. Elizabeth A. Kudarauskas

Subject: City of Haverhill, MA NPDES Permit No. MA 0101621
Consent Decree Submittal (Civil Action No. 16-11698-IT)
2020 Annual Combined Sewer Overflow Report

Dear Ms. Kudarauskas:

In accordance with Part I.F. 4 of the City of Haverhill's NPDES Permit and Paragraph VII.M.51 of our Consent Decree, we are providing this annual report for the 2020 calendar year.

If you require additional information, please call me at (978) 374-2382.

Sincerely,

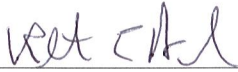
Robert E. Ward
Deputy DPW Director

Enclosure

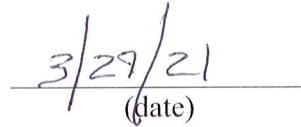
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Net DMR Attachment

Certification Statement

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.



Robert E. Ward
Deputy DPW Director
City of Haverhill


(date)



City of Haverhill

**Department of Public Works
Wastewater Division**

Annual Combined Sewer Overflow Report

Calendar Year 2020

NPDES Permit No. MA 0101621

Purpose

This report was prepared to meet the requirements of Part I, Section F.4 of the National Pollutant Discharge Elimination System (NPDES) Permit No. MA0101621 issued to the City of Haverhill by the U.S. Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (MassDEP). The permit authorizes the City to discharge stormwater/wastewater during wet weather from 13 combined sewer overflow (CSO) outfalls located along the Merrimack and Little Rivers. The report also satisfies the requirements of Paragraph VII.M.51 of the Consent Decree (Civil Action No. 16-11698-IT) between the United States Department of Justice, EPA, the Commonwealth of Massachusetts, and the City of Haverhill.

As required by the NPDES permit, this report includes:

- Locations of CSO outfalls
- A summary of activities and volumes
- Status and progress of CSO abatement work
- Contacts for additional information on CSO's and water quality
- Daily precipitation information, including total precipitation, peak intensity, and average intensity
- Certification that monthly inspections were completed, results recorded, and records maintained
- Information related to compliance with the Nine Minimum Controls (NMC)
- Information pertaining to each combined sewer overflow outfall including the monthly total volume discharged, the total duration of discharges for each month, and the monthly number of CSO discharge events

The Consent Decree requires information related to each combined sewer overflow event for each outfall including date and time the overflow started and stopped, the volume of the overflow for each activation, the amount of precipitation associated with each overflow event, the total volume discharged from each outfall for the year, and the total volume discharged for the year. This report is posted on the City's website to comply with Part I.F.3.g.(4) of the NPDES permit.

CSO Outfalls and Regulators

Discharges from the CSO outfalls are controlled by regulator structures located upstream from the outfalls. During dry weather, sanitary wastewater flow conveyed to CSO regulator structures is directed to the interceptor system to the Wastewater Treatment Plant (WWTP) for treatment. During wet weather events, the regulator structures divert the flow that exceeds the capacity of the downstream piping system from the collection system to a CSO outfall that discharges into the Little River or Merrimack River.

Haverhill currently has 15 CSO regulators structures which are connected to 13 active CSO outfalls. Of the 13 active outfalls, five discharge to the Little River, and eight discharge to the Merrimack River. Since the start of Haverhill's CSO abatement program, the City has closed 13 CSO outfalls. Table 1 lists Haverhill's CSO outfalls and regulators along with their open or closed status. Figure 1 shows the outfall locations.

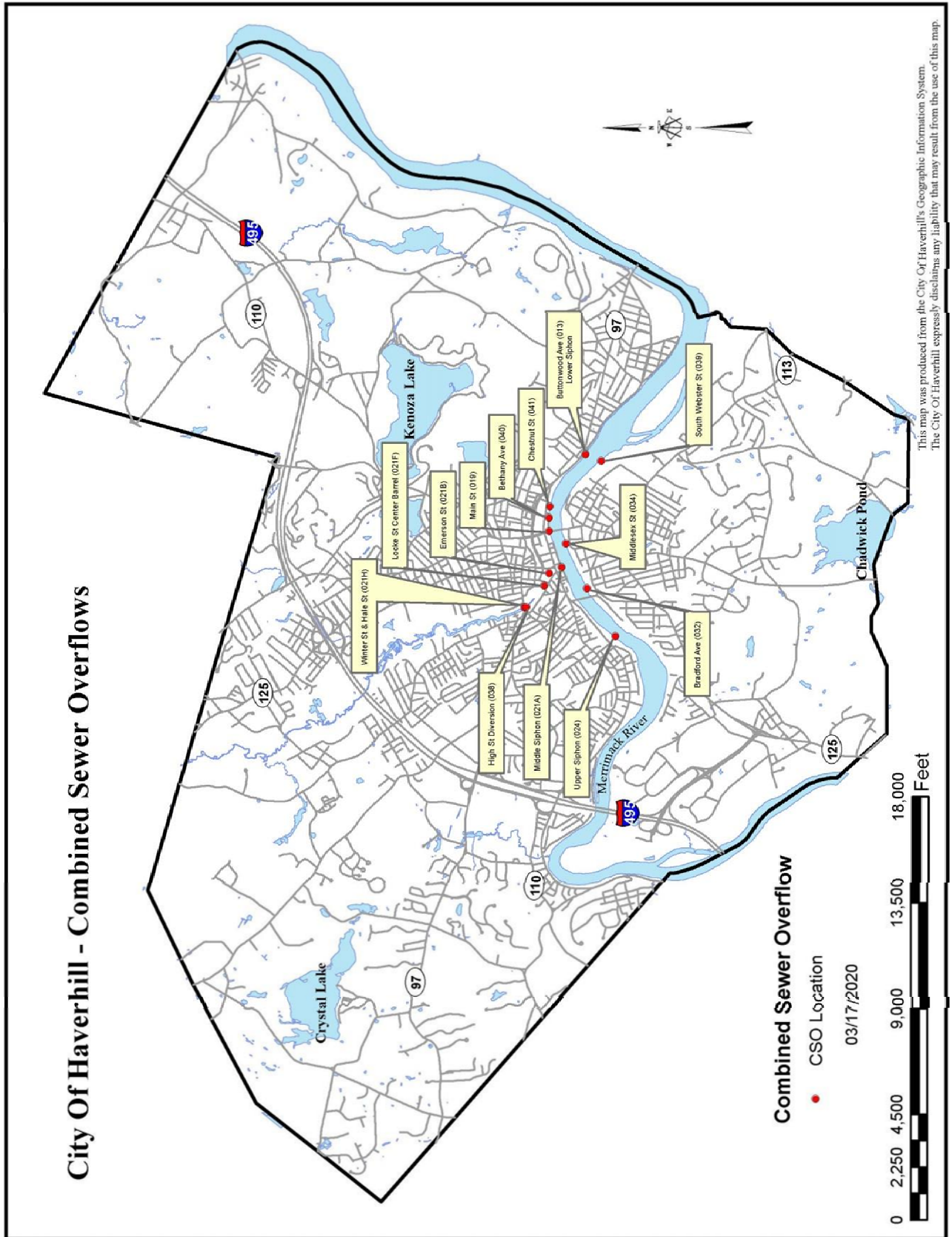
Outfalls 021H and 038 each have two regulator structures that discharge to them. Outfall 038 has regulator structures 037 and 038, and Outfall 021H has regulator structures 021H and 021G.

During periods of high levels in the Merrimack River and Little River, five CSO regulator structures function as flood diversion structures to protect downtown Haverhill. To provide flood protection and emergency relief to the collection system, sluice gates within the regulator structures close to divert flow from the collection system to the associated CSO outfall. Unless the city is under a river flood condition, these sluice gates remain fully open. Table 2 notes which outfall and regulators are part of the flood control system.

Table 1
CSO Outfalls and Regulators

NPDES Outfall ID	CSO Outfall Name	CSO Regulator Names (if more than 1)	Receiving Waters	Status
Upper Siphon System				
025	Beach Street		Merrimack River	Closed
024	Upper Siphon - Varnum Street		Merrimack River	Open
023	266 River Street		Merrimack River	Closed
022	Railroad Bridge		Merrimack River	Closed
Middle Siphon System				
021H	Winter Street and Hale Street	021H Winter Street at Hale Street 021G Winter Street	Little River	Open
038	High Street Diversion	037 Broadway 038 High Street	Little River	Open
021B	Emerson Street		Little River	Open
021E	Little River South (Locke Street South)		Little River	Closed
021M	Marginal Pump Station		Little River	Closed
021D	Little River North (Locke Street North)		Little River	Closed
021F	Center Barrel - Locke Street		Little River	Open
021A	Middle Siphon - Essex Street		Little River	Open
Lower Siphon System				
019	Main Street North		Merrimack River	Open
016	Fire Station		Merrimack River	Closed
040	Bethany Avenue		Merrimack River	Open
041	Chestnut Street		Merrimack River	Open
013	Lower Siphon - Buttonwoods Avenue		Merrimack River	Open
010	Boardman Street		Merrimack River	Closed
001	Bates Bridge		Merrimack River	Closed
Bradford System				
031	Front Street		Merrimack River	Closed
032	Bradford Avenue		Merrimack River	Open
033	South Prospect Street		Merrimack River	Closed
034	Middlesex Street		Merrimack River	Open
035	South Main Street		Merrimack River	Closed
036	Ferry Street		Merrimack River	Closed
039	South Webster St.	042 Colby Street/ Salem Street	Merrimack River	Open

Figure 1



CSO Discharge Monitoring

Since 2014, each of the City's CSO outfalls has been monitored by a depth measuring device at the weir and/or a depth/velocity meter in the CSO outfall pipe, as indicated in Table 2. All CSO regulators are monitored by a depth gauge located at the weir (some are ultrasonic meters, and some have both ultrasonic and transducer gauge). Most of the CSO regulators also have a depth/velocity gauge in the outfall to measure the flow through the outfall pipe.

Table 2
CSO Outfalls and Regulators

Outfall ID	CSO Outfall Name	CSO Regulator Names (if more than 1)	CSO Monitoring and Volume Measurement Method
Upper Siphon System			
024	Upper Siphon –Varnum Street		Depth/Sluice Gate Opening-Orifice Equation in SCADA
Middle Siphon System			
021A	Middle Siphon –Essex Street		Depth at Weir and Depth/Velocity in Outfall
021H	Winter Street and Hale Street	021H Winter Street / Hale Street (F)	Depth at Weir
		021G Winter Street (F)	Depth at Weir and Depth/Velocity in Outfall
038	High Street Diversion	037 Broadway (F) 038 High Street (F)	Depth at Weir Depth at Weir
021B	Emerson Street (F)		Depth at Weir
021F	Center Barrel –Locke Street		Depth at Weir and Depth/Velocity in Outfall
Lower Siphon System			
019	Main Street North		Depth at Weir and Depth/Velocity in Outfall
040	Bethany Avenue		Depth at Weir and Depth/Velocity in Outfall
041	Chestnut Street		Depth at Weir and Depth/Velocity in Outfall
013	Lower Siphon – Buttonwood Avenue		Depth/Sluice Gate Opening-Orifice Equation in SCADA
Bradford System			
032	Bradford Avenue		Depth at Weir and Depth/Velocity in Outfall
034	Middlesex Street		Depth at Weir
039	South Webster Street	042 Colby Street/ Salem Street	Depth at Weir and Depth/Velocity in Outfall

(F) Also functions as a flood diversion structure.

The flow monitoring equipment is maintained by a contractor, Flow Assessment Services (FAS), who also reports the CSO activations and volumes estimates on a website accessible to the city. Flow alert emails are sent to certain Haverhill wastewater staff when activations start and stop.

CSO flow computations at the CSO weir are determined using a depth of flow over a weir calculation. The depth/velocity gauges utilize an area-velocity equation to calculate flow in the outfall pipe. In some cases, the depth/velocity meters could not be installed on the outfall pipe because flow measurements were hydraulically affected by river backwater conditions and/or downstream backwater gates.

As previously mentioned, two CSO outfalls have two regulators that share the outfall. To accurately record CSO volumes, flow is measured at each regulator structure. CSOs for Outfall 038 are measured and reported under Broadway 037 and High Street 038. CSOs for Outfall 021H are measured and reported under the Winter Street/Hale Street 021H and Winter Street 021G regulators.

In early 2017, the City completed the construction of the Wet Weather Maximization and CSO Structure Modification project, which is discussed later in this report. Under this project, the weirs at Outfall 024 and 013 were removed and a set of two modulating sluice gates were installed on each CSO outfall opening. These improvements enable the City to store wet weather flow in the interceptor pipes upstream of each CSO regulator. Now Outfall 024 and 013 activate by automated or remote controls when the CSO discharge gates are opened.

CSO volumes at Outfalls 024 and 013 are now calculated by the City using an orifice equation that reflects the typically surcharged (but variable) CSO gate opening. Each regulator has radar units to record the depths in the influent sewer, downstream of the CSO gates (river conditions), and downstream of the flow inlet gate to the siphons (to evaluate the backwater condition of the Bradford Interceptor).

Working with CDM Smith, the City developed appropriate computations to calculate flow through the variable orifice sluice gate openings. The City uses these equations to calculate CSO volumes discharged from Outfalls 024 and 013. CDM Smith added these flow calculations into the City's SCADA system in 2019. The City can now view real-time flows during storm events. The CSO gate positions are connected to the City's SCADA system. The CSO flow calculations are stored in Hach WIMS™ Historian database that is queried to produce this annual report.

2020 CSO Outfall Activations

Activation frequency and flow characteristics are measured by the FAS meters, as discussed above. FAS provides monthly and yearly flow data, including volume, from their meters. FAS analyzes flow data on a monthly basis to assure that accurate flow data is being measured and reported. For Outfalls 024 and 013, the City uses the data downloaded from the City's SCADA system.

Table 3 summarizes the total CSO volume discharged and the number of activations for each outfall/regulator for 2020.

Table 3
2020 CSO Summary by Regulator

Outfall ID	CSO/ Regulator Name	Number of Activations	Total Volume (gallons)
013	Lower Siphon	2	60,600
019	Main Street North	0	-
021A	Middle Siphon	9	4,473,617
021B	Emerson Street	1	31,743
021F	Center Barrel Locke Street	28	3,208,669
021G	Winter Street	7	65,905
021H	Winter/ Hale Street	15	1,261,453
024	Upper Siphon	3	611,732
032	Bradford Avenue	4	208,107
034	Middlesex Street	13	4,298,250
037	Broadway	0	-
038	High Street	1	4,101
039	South Webster Street	14	180,513
040	Bethany Avenue	18	431,615
041	Chestnut Street	13	163,782
		Total	15,000,088

Appendix A shows the Date, rainfall, and CSO volumes for the days with CSO activations.

Appendix B provides information required by the City's NPDES permit, including monthly total flow, the monthly total duration of flow, and the number of discharges for the month.

Appendix C provides CSO activation information required by the Consent Decree, including start and stop times, the amount of precipitation, and the volume released.

2020 Precipitation

The City collects rain data using three rain gauges: a tipping bucket rain gauge at the WWTP ASPW building, a NOAA supplied rain gage at the WWTP ASPW building, and a tipping bucket rain gauge at the Marginal Pumping Station. The gauge at the Marginal Pumping Station is the closest gauge to most of Haverhill's combined sewer areas.

The data from the tipping bucket rain gauge at the WWTP ASPW building is connected to SCADA and Hach WIMS and is automatically pulled into a report created by the City. This report summarizes total daily rain in inches and 15-minute peak rain intensities.

The NOAA supplied rain gauge resembles a graduated cylinder that measures total rain in inches per day. A wastewater treatment operator reads this rain gauge at 7:00 am each day and records this total precipitation in Hach WIMS. The City reports these readings to NOAA. Due to this reporting time, this gage will be removed and replaced with Lawrence Municipal Airport for the next annual report.

The tipping bucket rain gauge at the Marginal Pumping Station is owned and maintained by FAS. Rain data from this gauge, such as daily totals and 15-minute peak intensities, is transmitted to the FAS website where wastewater staff can view it at any time.

For this report we are including rain data from the nearest National Weather Station, which is located at the Lawrence Municipal Airport. The current location is elevation 149 feet, Latitude 42.7172° W, Longitude -71.1239° W. This rain gage is approximately 4½ miles from the Marginal Pump Station rain gage and most of Haverhill's combined sewer areas.

The rainfall totals for 2020 for each gauge is shown in Table 4 along with the annual average rainfall from the City's rainfall records. The NOAA gage total is the 52nd highest annual rainfall since 1895. The 2020 monthly precipitation for February, April, October, and December was significantly higher than the average for those months.

Table 4
Annual Rainfall Totals

Rain Gauge Location	Total Annual Rainfall (inch)
Tipping bucket rain gauge at the WWTP	46.5
NOAA supplied rain gauge at the WWTP	44.1
Tipping bucket rain gauge at the Marginal Pumping Station	35.7
Lawrence Municipal Airport (From NOAA)	40.0
City Rainfall Records – 1895 to 2020 Average	43.0
City Rainfall Records - 5-Year Average	46.0

Appendix D shows total daily rainfall (in inches), peak intensity (highest 15-minute sample multiplied by four to convert to inches per hour), storm duration, and average intensity. It should be noted that some storm durations continue overnight and into another day.

Haverhill's CSO Abatement Program

The following is a summary of the City's progress on its CSO abatement program over the last 20 years.

- In August 2002, the City submitted its Phase I CSO Long Term Control Plan (LTCP) to the EPA and MassDEP. The recommended plan included improvements to increase treatment capacity at the WWTP, influent pump station upgrades to handle additional wet weather flow, and regulator modifications to the Bradford side CSOs on the south bank of the Merrimack River. These improvements were implemented by 2006 and cost \$22 million. The benefits of the Phase I CSO LTCP improvements included a modeled reduction of annual CSO volume from 70 million to 30 million gallons and an increase of the percent capture of wet weather flow from 92 to 97 percent.
- In July 2011, the City submitted its Phase II CSO LTCP to the EPA and MassDEP. Based on EPA and MassDEP comments, the City revised its Phase II CSO LTCP and sent it to the EPA and MassDEP in June 2013. The revised plan included the permanent closure of 13 CSOs, raising of weirs at three CSO regulators, and implementation of the Wet Weather System Maximization/CSO Structure Modifications project which included CSO regulator modifications, a new CSO sewer, and installation of a real-time automated flow system to further increase CSO discharge control. These system improvements were completed by early 2017. The upgrades were expected to reduce annual CSO

volume to approximately 20 million gallons, eliminate or reduce the frequency of CSOs from some outfalls, and increase the percent capture of wet weather flow to about 98 percent. The cost of the Phase II program was \$12 million.

As previously discussed in this report, the City monitors each CSO outfall and regulator structure so that we know when an overflow occurs, how long it lasts, and the volume of the overflow. The City started this program in 2014, which costs approximately \$50,000 per year to continue.

- In 2016, the City also modified the Outfall 032 and Outfall 021A) to improve the flow capacity into its interceptor system to maximize flow to the WWTP.
- In February 2017, the City completed and submitted to EPA and MassDEP an Integrated Final LTCP, an updated implementation program that encompassed Capacity Maintenance Operation Management (CMOM) for the collection system; a Wastewater Comprehensive Plant Evaluation (CPE); Infiltration Inflow Assessment (I/I); Green Infrastructure; and a Phase 3 CSO LTCP. The cost to prepare this plan was approximately \$2.8 million.
- In 2017, a Comprehensive Plant Evaluation (CPE) was completed that reviewed and assessed all the processes, equipment, and infrastructure needs at the plant to keep the facility running reliably and to maximize treatment levels of wet weather flow conveyed to the WWTP. These facility improvements were prioritized, and an implementation plan was established to complete these improvements. These recommendations are included in the capital improvements program.
- In 2018, the City submitted its response to comments from EPA and MassDEP on the City's Integrated Final LTCP. In the City's response, the City proposed a more aggressive schedule for the Phase 3 CSO program. The program includes system conveyance improvements, CSO structure dry weather connector pipe improvements, raising the Middle Siphon weir, post-construction monitoring and system optimization, a green infrastructure demonstration project, and improvements to the Locke Street sewer area. The preliminary estimated cost for the Phase 3 CSO program is \$25 million. In addition to the CSO program, the Integrated Final LTCP includes improvements to the wastewater treatment plant, sewer collection system, and stormwater program, all estimated to cost \$45 million.
- The City continued to fine-tune the Wet Weather System Maximization control setpoints. In November 2020, the City completed a redesign of the system's control program. The new control strategy starts with the dry weather gates at a low open setpoint which allows the dry weather flow. Once the level upstream of the dry weather gate reaches its maximum level, the dry weather gate opens and modulates to a predefined setpoint. When the upstream level reaches its maximum level, then the CSO gate opens until it reaches a predefined set point.

This change is dramatically different than the original control strategy. Now, when the CSO gates need to open, they are modulated to maintain a specified level. This modulation will reduce the volume of CSO discharges at Outfalls 024 and 013.

- In 2019, the City hired Wright-Pierce to perform the planning, study, and preliminary design for the Phase 3 CSO program. The Phase 3 CSO work is ongoing and includes cleaning the Middle Siphon Interceptor from Locke Street to the Bradford Interceptor and ending at the South Mill Street Pumping Station; modifying the connector pipes at four CSO regulators, raising the Middle Siphon weir, post-construction monitoring and system optimization, implementing a green infrastructure demonstration project, and Locke Street Interceptor area design and construction to reduce CSOs at 021F and 021H. The cost of this ongoing work is \$2.5 million.
- In September 2019, the City started the repair and replacement of various sewer pipes along Kenoza Street, Lawrence Street and several side streets between Main Street and Lawrence Street. The project cost is approximately \$1.4 million and is approximately 95% complete.
- In 2020, the City continued preliminary design of the Phase 3 CSO program. Wright-Pierce continued their analysis of the Locke Street CSO area. At the end of 2020 the analysis was 90% complete and Wright-Pierce was drafting a technical memo to summarize the results.
- The City continued moving forward with the Dry Weather Connector Pipe Improvements project by hiring Wright-Pierce for \$226,300 to provide bidding and construction services. The City received and reviewed the 90% design plans and provided comments. The City received construction bids and awarded the contract to N. Granese for 1.3 million.

Nine Minimum Controls

The following is a summary of activities during the calendar year 2020 relating to compliance with the Nine Minimum Controls (NMC).

1. Proper operation and regular maintenance programs for the sewer system and CSO outfalls.

The City continued to use its Computerized Maintenance Management System (CMMS) MaintStar to track and manage the maintenance of their combined sewer system, including inspection and cleaning of sewers, drains, pumping stations, CSO regulators, and CSO outfalls. Sewer segments with frequent problems are added to a list in CMMS to receive more frequent maintenance.

The City added cleaning and inspecting the Upper Siphon to Wright-Pierce's scope of service. The total project cost for 2019 and 2020 is \$922,092. This includes a condition assessment by Wright-Pierce.

The City continued to upgrade the monitoring and alarm systems at sewer pumping stations. Another seven Mission systems were installed last year by Weston & Sampson at the cost of \$45,500. There are now 23 pumping stations equipped with Mission alarm and monitoring systems.

The City continued to inspect its sewer pumping stations daily for stations with a flow greater than 100,000 gallons per day and weekly for all the other stations. The City completes preventive maintenance quarterly at each of the stations.

Collection system personnel perform monthly inspections of the CSO regulators and outfalls. In addition, CSO regulators are monitored by flow meters that notify wastewater staff when activations occur. If an activation notice is received during dry weather, collection system operators are immediately dispatched to investigate and correct the problem.

The City appropriated \$575,000 to purchase a new sewer line cleaning truck with a vacuum unit. The truck is scheduled for delivery in May 2021.

2. Maximize the use of the collection system for storage

Weirs at CSO regulators throughout the City have been raised periodically to reduce CSO discharges based on recommendations in the LTCPs. The City has closed 13 CSO outfalls, which effectively increases the use of the collection system for wet weather storage. No weirs were raised or CSOs sealed in 2020. The City expects to raise the Middle Siphon CSO weir in 2021 as part of the Phase III CSO Improvements. Raising weirs any higher and closing more CSO outfalls will likely cause building and street flooding problems.

The automated real-time control system (instrumentation, depth monitoring, and modulated flow control gates operated by automated programming) installed at the Upper and Lower Siphon CSO structures is designed to utilize the interceptor storage upstream of each regulator structure to allow more flow from the Middle CSO to be conveyed to the Bradford Interceptor, and ultimately to the WWTP, to maximize the use of interceptor storage for wet weather flows and to reduce CSO discharges. The City continued to fine-tune this real-time flow control system to optimize the use of the interceptor piping system for wet weather storage.

3. Review and modification of pretreatment program to assure CSO impacts are minimized

One of the goals of the Industrial Pretreatment Program (IPP) is to help minimize the impacts of discharges in the combined sewer system from non-domestic sources during wet weather events. The IPP Coordinator monitors significant industrial users (SIU) that discharge to the City's sewer system.

The City's sewer use regulations prohibit any discharge to the collection system that may be detrimental to the wastewater treatment process or the receiving water. These regulations establish limits for pollutant loads that can be discharged to the sewer system. All industrial discharges to the City's sewer system are required to adhere to the requirements of the City's IPP Program. Inspections of these dischargers are performed by City staff.

The WWTP influent fats, oil, and grease (FOG) has decreased significantly since the improvements to its IPP program. Since loadings have fallen, WWTP staff have been able to maintain low secondary blanket levels, which has allowed staff to avoid secondary bypassing since September of 2017.

The IPP Coordinator continues to maintain the FOG program via annual inspections. These inspections include checking pump out receipts of all grease traps and interceptors, inspecting and measuring FOG using a modified sludge judge in all the grease traps and interceptors, ensuring owners have the proper maintenance schedules, and ensuring proper waste grease disposal. The City hired a contractor to inspect all food service establishments using the procedures and protocols established by the IPP Coordinator. These inspections continued through 2020. To date, FOG has significantly decreased in both the collection system and in the influent flow to the WWTP.

In 2018, the City hired Hoyle and Tanner to review and revise the City's Local Limits. A sampling plan was submitted to EPA and approved by EPA. To date, all sampling for the Local Limits reevaluation has been completed and data is being analyzed. The City has been in contact with the EPA and kept them apprised of the progress of the Local Limit reevaluation. The completion of this study is expected in 2021.

In 2020, the City hired an employee for review and modification of the ERP, Sewer Use Ordinance and Slug Control Plan evaluations, as required by section E.6 of the NPDES Permit. Once the new Local Limits are approved, the City will submit the revised ordinance and ERP to EPA for approval.

The City implemented a new permitting software (ViewPoint) for all business occupancy permits, site plan applications, and wastewater discharge permits. Wastewater employees (currently the Collection System Supervisor and Pretreatment Coordinator) review applications and issue permits as applicable. This system allows the City to improve tracking of non-residential wastewater discharged to the City's collection system.

4. Maximization of flow to the publicly owned treatment works (POTW) for treatment.

The City continues to implement measures to maximize flow to the WWTP, including raising weirs and adding CSO control gates that will allow real-time control to reduce CSO discharges. WWTP staff prioritize the maintenance and repair of equipment at the plant and South Mill Street Pumping Station to maximize flow to the plant during wet weather. For example, staff monitor the influent pumps at South Mill Street Pumping Station, perform scheduled preventative maintenance, and perform any needed corrective maintenance on the pumps as a high priority.

As discussed in NMC #1, a contractor hired by the City cleaned and inspected the Middle Siphon Interceptor at Lock Street, the Middle Siphon, Upper Siphon, and the Bradford Interceptor and removed all debris and obstructions in the pipes.

WWTP staff operate and maintain the plant process to ensure the plant is capable of maximizing wet weather flow and treatment during wet weather. During 2020, for the third consecutive year, we were able to maximize wet weather flow through the plant without bypassing the secondary treatment process.

The City is working with a company to implement an artificial intelligence system to monitor and analyze some of the major equipment and processes which will help with maximizing flow to the plant.

5. *Prohibition of CSOs during dry weather overflows*

Dry weather overflows (DWOs) from the CSO discharge outfalls are prohibited under the NPDES permit. Wastewater staff inspect all the CSO outfalls/regulators monthly. As discussed previously in this report, CSO regulators are continuously monitored. If there is a CSO activation during dry weather, collection system operators are dispatched to investigate and resolve the issue as quickly as possible. In 2020 there were no known dry weather overflows.

Locke Street Siphon barrels both North and South are on a semi-annual flushing schedule.

Upper, Middle and Lower Siphons barrels are on a yearly flushing schedule to help prevent DWOs.

6. *Control of solid material and floatable materials in CSOs*

Under the Wet Weather System Maximization/CSO Structure Modifications project, the City is maximizing its capture of wet weather flow for eventual treatment at the WWTP, which maximizes floatables control. The City has also raised weirs to capture more wet weather flow, and floatables in the first flush, during storm events.

As part of the Integrated LTCP, CDM Smith evaluated other potential solids and floatables controls options that could be implemented at the CSO regulators. It was determined that there are no cost-effective approaches to capturing solids and floatables at the City's CSO regulators for a variety of reasons including the constrained space within the regulators to install new screens, trash racks, or baffles, the lack of available land (most of the outfalls are situated directly on the river with no reasonable room for inline screens along the outfall pipe), and river/flow conditions that would preclude outfall technologies (like booms or netting systems).

The City relies on regular cleaning of catch basins and street sweeping near CSO regulators as a preventive measure for the reduction of grit and floatables to its combined system and receiving waters. The City is increasing the frequency of catch basin cleaning and street sweeping, which will improve its floatables capture.

In 2020, the City continued placing out to bid catch basin cleaning. An outside contractor cleaned approximately 1100 catch basins, and about 100 catch basins were cleaned in-house. The City removed 431 tons of debris, some of which are floatables, at a cost of \$21,317. The City ordered a new Vac-truck which is scheduled for delivery in May 2021.

The City's wastewater department is in the process of implementing a new CMMS software to increase the efficiency of catch basin cleaning. It will include inspections of all catch basins to ensure that they are less than 50 percent full and will also be used to determine problem areas where catch basins fill up with grit quickly. Over time, the goal is to determine catch basin cleaning schedules for all catch basins.

7. Pollution prevention programs to reduce contaminants in CSOs

Haverhill has adopted City ordinances that prohibit litter and debris from being deposited on the street and within the watershed areas. The City also performs regular cleaning of catch basins and street sweeping as a preventive measure for the reduction of pollutants into the combined system. Additionally, the FOG program already discussed in this document helps minimize pollutants in the City's CSOs.

The City has created brochures, including stormwater pollution prevention for residents, FOG education for residents, FOG education for businesses, pet waste education, and education about flushable wipes for residents. These brochures are located on the City's website and available to the public at multiple City-owned buildings. Flyers are also distributed to problem areas.

The City also holds household hazardous waste collection days twice a year, waste oil drop-offs once a month, curbside leaf/grass pickups twice a year, and electronics recycling twice a year. In 2020, the spring hazardous waste event was canceled due to Covid-19 concerns. The City continued to operate its recycling and yard waste facility at the Highway garage.

8. Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts.

The City maintains a CSO webpage on the City's website to provide information about CSOs to the public. The web page also has links to prior years CSO reports.

Within 24 hours of a CSO occurrence, an email notification is sent to downstream communities, local Boards of Health, Harbor Masters, and local drinking water authorities. Appendix D is the current list of those notified within 24-hours of a CSO occurrence. Residents and businesses are added to the notification list upon request.

Each of the CSO regulators and outfalls has signage that identifies the CSO outfall in English and Spanish.

The City, as part of its NPDES Permit, is required to develop and implement a CSO Public Notification plan. This plan was sent to EPA and MassDEP and is included in Appendix F.

9. Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls.

In 2014, the City contracted with a flow metering company to install and maintain depth and depth/velocity meters at each of its CSO regulators. This program is discussed previously in this report. The flow monitoring program continued throughout 2020.

End of Report

Appendix A

Appendix A Summary of CSO Regulator Activations for 2020

							UPPER SIPHON SYSTEM			MIDDLE SIPHON SYSTEM							LOWER SIPHON SYSTEM				BRADFORD SYSTEM			
Activation by Storm Events (2020)									Upper Siphon	Middle Siphon	Emerson Street	Center Barrel Locke Street	Winter Street (Duncan Street)	Winter and Hale Street	Broadway Diversional	High Street Diversional	Lower Siphon	Main Street North	Bethany Avenue	Chestnut Street	Bradford Avenue	Middlesex Street	South Webster	
Date	Lawrence Airport Rain Gage		Marginal Pumping Station Rain Gage		ASPW Rain Gage		¹ ASPW Operator Observed NOAA Rain Gage																	
	Total Rainfall (in)	Peak Rainfall (in/hr)	Total Rainfall (in)	Peak Rainfall (in/hr)	Total Rainfall (in)	Peak Rainfall (in/hr)	Total Rainfall (in)	Max Flow WWTF (mgd)	24															
01/25/2020	3.00	0.69	0.12	0.75	0.18	0.95	0.91	60.49		260,748		186,167		378							208,840		656,133	
02/07/2020	0.17	0.40	0.03	0.45	0.19	0.55	0.08	55.04				9,094											9,094	
02/27/2020	4.58	0.98	0.14	0.93	0.18	1.10	0.16	63.51				214,447											214,447	
03/24/2020	0.58	0.30	0.06	1.24	0.16	0.53	0.14	58.10				8,084											8,084	
03/29/2020	1.17	0.74	0.03	0.78	0.17	0.92	0.84	61.16				97,690		71,520				7,958	6,975		51,285	9,076	244,504	
04/03/2020	5.75	1.38	0.06	1.24	0.13	1.65	0.09	64.80				68,691											68,691	
04/09/2020	0.08	1.13	0.10	0.96	0.17	1.21	0.13	64.59				139,619		2,507								1,480	150,124	
04/13/2020	9.50	0.81	0.05	0.52	0.13	1.03	0.09	61.88				23,735											23,735	
04/21/2020	0.67	0.34	0.09	0.25	0.17	0.29	0.26	54.46				20,100											20,100	
05/01/2020	0.08	0.08	0.04	0.09	0.53	0.12	0.24	65.00				103,080		3,176								121	106,377	
05/30/2020	0.08	0.08	0.04	0.09	0.53	0.12	0.24	40.60										687					687	
06/06/2020	0.25	0.59	0.15	0.39	0.78	0.78	0.72	61.71				4,288							2,041	792		184,037	9,155	200,312
06/11/2020	0.08	0.16	0.08	0.19	0.21	0.27	0.15	42.08											6,570					6,570
06/24/2020	0.42	0.69	0.23	0.41	0.82	0.75	0.80	63.58		109,316		70,881	7,507	112,626					29,425	17,086	24,451	214,984	15,094	601,370
06/28/2020	0.75	0.25	0.04	0.86	0.45	0.69	0.80	59.67	296,954	646,110	31,743	185,633	18,360	238,092		4,101	52,148		107,831	40,320	110,238	483,299	20,942	2,235,771
06/29/2020	0.25	0.61	0.09	0.42	0.19	0.69	0.41	60.10				11,030												11,030
07/14/2020	6.42	0.36	0.18	0.10	0.12	0.19	0.15	63.24				240,979	11,148	170,217					33,157	12,981				468,482
07/22/2020	0.58	0.80	0.16	0.06	0.12	0.64	0.94	64.57		140,465		224,462	1,632	79,575					66,938	16,621	6,710	222,509	18,281	777,193
07/23/2020	0.50	1.65	0.41	0.91	0.12	1.28	0.47	64.19	223,194	230,941		211,297		75,335					72,401	22,033	66,707	352,670	20,872	1,275,450
08/04/2020	0.25	0.28	0.14	0.19	0.33	0.35	0.26	64.82				67,599							5,566	1,642		33,482		108,289
08/23/2020	0.08	0.54	0.18	0.40	0.80	0.00	0.00	60.08		7,851		165,563	4,116	83,931					17,490	10,716		66,494	3,358	359,519
08/29/2020	0.08	0.54	0.05	0.55	0.17	0.58	0.50	45.26											2,654					2,654
09/10/2020	3.42	2.02	0.51	1.04	0.54	1.33	1.44	63.11		1,124,278		176,144	20,905	263,654					50,504	28,437		771,269	33,704	2,468,897
09/30/2020	0.08	0.37	0.11	9.00	0.04	0.30	0.28	40.80											2,048					2,048
10/13/2020	1.50	1.16	0.18	16.00	0.07	1.21	0.36	58.09				10,428												10,428
10/17/2020	5.42	1.34	0.25	10.00	0.13	1.32	0.48	61.63				129,121		4,362										133,483
11/15/2020	0.33	0.35	0.27	4.00	0.09	0.22	0.28	61.90				13,093		1,332					4,605			48,202	1,710	68,942
11/23/2020	7.17	1.97	0.52	8.00	0.25	2.03	0.92	55.64	91,584	1,935,396		512,542	2,237	149,868					13,049	4,905		1,627,579	41,254	4,378,415
11/30/2020	0.25	1.13	0.16	13.00	0.09	0.86	0.28					17,934												
12/01/2020	0.58	0.31	0.18	5.00	0.06	0.39	1.92	65.00				91,452		4,879					3,176	270		33,599	4,396	137,772
12/05/2020	1.75	1.94	0.19	18.00	0.11	2.21	2.30	60.74				29,802					8,452							
12/25/2020	0.42	1.58	0.20	16.00	0.10	1.26	1.42	64.05		18,511		175,713										1,070		
							Volume TOTALS	611,732		4,473,617	31,743	3,208,669	65,905	1,261,452	0	4,101	60,600	0	431,614	163,781	208,106	4,298,251	180,512	15,000,085

NOTE: 021D, 021E, and 021M

¹ASPW Operator Observed Rain Gage is measured and reported from 7:00 am to 7:00 am

August 21, 2020, Upper Siphon 3-barrels, (16", 18" and 30") were cleaned and inspected

November 2020 new CSO program initiated CSO gates now modulate reducing CSO volumes.

Appendix B

Appendix B 2020 Monthly CSO Summary

UPPER SIPHON SYSTEM			MIDDLE SIPHON SYSTEM							LOWER SIPHON SYSTEM				BRADFORD SYSTEM		
						Outfall 21H		Outfall 38								
Monthly Parameters	Outfall#	024	021A	021B	021F	021G	21 H	037	038	013	019	040	041	032	034	039
	CSO Outfall Name	Upper Siphon - Varnum Street	Middle Siphon	Emerson Street	Center Barrel Locke Street	Winter Street	Winter Street and Hale Street	Broadway Diversional	High Street Diversion	Lower Siphon Buttonwoods Avenue	Main Street North	Bethany Avenue	Chestnut Street	Bradford Avenue	Middlesex Street	South Webster
	Latitude	42.76683934	42.77306431	42.77456839	42.775144		42.7774519		42.77722968	42.77022981	42.77451679	42.77451183	42.7684245	42.77012127	42.77258144	42.7684245
	Longitude	71.09305991	71.07831599	71.08299865	71.084999		71.0883243		71.08832202	71.06418695	71.07634348	71.07424297	71.06525865	71.08543396	71.07832295	71.06525865
	Receiving Water	Merrimack River	Little River	Little River	Little River	Little River	Little River	Little River	Little River	Merrimack River	Merrimack River	Merrimack River	Merrimack River	Merrimack River	Merrimack River	Merrimack River
January 2020 Totals	Total Flows	ND	260,748	ND	186,167	ND	378	ND	ND	ND	ND	ND	ND	ND	208,840	ND
	Total Hrs		1.75		3.00		0.08									
	# Events		1		1		1									
February 2020 Totals	Total Flows	ND	ND	ND	223,541	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Total Hrs				4.75		ND									
	# Events				2		ND									
March 2020 Totals	Total Flows	ND	ND	ND	105,774	ND	71,520	ND	ND	ND	ND	7,958	6,975	ND	51,285	9,076
	Total Hrs				0.87		0.25					0.83	0.08		0.08	0.17
	# Events				2		1					1	1		1	1
April 2020 Totals	Total Flows	ND	ND	ND	252,145	ND	2,507	ND	ND	ND	ND	5,515	1,003	ND	ND	1,480
	Total Hrs				19		0.75					0.83	0.08			0.08
	# Events				4		1					1	1			1
May 2020 Totals	Total Flows	ND	ND	ND	103,080	ND	3,176	ND	ND	ND	ND	687	ND	ND	ND	121
	Total Hrs				2.42		0.08					0.08				0.08
	# Events				1		1					1				1
June 2020 Totals	Total Flows	296,954	755,426	31,743	271,832	25,867	350,718	ND	4,101	52,148	ND	145,867	58,198	134,689	882,320	45,191
	Total Hrs	0.18	1	0.08	1.42	0.17	0.83		0.08	0.07		0.58	0.5	0.25	0.92	0.92
	# Events	1	2	1	4	2	2		1	1		4	3	2	3	3
July 2020 Totals	Total Flows	ND	371,406	ND	676,738	12,780	325,127	ND	ND	ND	ND	172,496	51,635	73,417	575,179	39,153
	Total Hrs		1.25		1.42	0.17	0.83					6.92	0.58	0.33	0.83	0.83
	# Events		2		3	2	3					3	3	2	2	
August 2020 Totals	Total Flows	ND	7,851	ND	233,162	4,116	83,931	ND	ND	ND	ND	25,710	12,358	ND	99,976	3,358
	Total Hrs		0.08		0.67	0.08	0.25					0.24	0.16		0.16	0.08
	# Events		1		2	1	1					3	2		2	1
September 2020 Totals	Total Flows	ND	1,124,278	ND	176,144	20,905	263,654	ND	ND	ND	ND	52,552	28,437	ND	771,269	33,704
	Total Hrs		2.42		3.50	0.08	3.42					1.75	1.58		2.17	1.33
	# Events		1		1	1	1					2	1		1	1
October 2020 Totals	Total Flows	ND	ND	ND	139,548		4,362	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Total Hrs				6.92		0.17									
	# Events				2.00		1									
November 2020 Totals	Total Flows	260,660	1,935,396	ND	543,570	2,237	151,200	ND	ND	ND	ND	4,605	4,905	ND	1,675,782	42,964
	Total Hrs	4.07	3.42		7.75	0.50	2.83					0.08	1.17		3.83	2.67
	# Events	2.00	1.00		2.00	1.0	1					1	1		2	2
December 2020 Totals	Total Flows	ND	18,511	ND	296,968	ND	4,879	ND	ND	8452.379145	ND	3,176	270	ND	33,599	5,466
	Total Hrs		0.25		6.75		0.08					0.08	0.08		0.08	0.67
	# Events		1.00		2		1					1.00	1		1	2

ND (No Discharge)

Appendix C

Appendix C 2020 CSO Activation Report

Date	CSO Outfall Number	CSO Outfall Name	Overflow Start	Overflow End	Volume (gallons)	CSO Duration (hours)	Lawrence Airport NOAA Rain Gage				Marginal Pumping Station Rain Gage				ASPW Rain Gage¹				ASPW NOAA Rain Gage
							Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Avgerage Intensity (inches/hours)	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Avgerage Intensity (inches/hours)	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Avgerage Intensity (inches/hours)	Rain Total (inches)
1/25/2020	021F	Center Barrel - Locke St	1/25/20 19:35	1/25/20 22:35	186,167	3.00	0.69	0.24	6.00	0.12	0.75	0.28	4.08	0.18	0.95	0.40	5.25	0.18	0.91
1/25/2020	021A	Middle Siphon	1/25/20 21:10	1/25/20 22:55	260,748	1.75	0.69	0.24	6.00	0.12	0.75	0.28	4.08	0.18	0.95	0.40	5.25	0.18	0.91
1/25/2020	34	Middlesex Street	1/25/20 21:10	1/25/20 22:40	208,840	1.50	0.69	0.24	6.00	0.12	0.75	0.28	4.08	0.18	0.95	0.40	5.25	0.18	0.91
1/25/2020	021H	Winter and Hale	1/25/20 21:20	1/25/20 21:20	378	0.08	0.69	0.24	6.00	0.12	0.75	0.28	4.08	0.18	0.95	0.40	5.25	0.18	0.91
		STORM	TOTALS:		656,133														
2/7/2020	021F	Center Barrel - Locke St	2/7/20 14:45	2/7/20 14:55	9,094	0.17	0.40	0.07	14.00	0.03	0.45	0.36	2.42	0.19	0.55	0.28	7.00	0.08	0.37
		STORM	TOTALS:		9,094														
2/27/2020	021F	Center Barrel - Locke St	2/27/20 4:15	2/27/20 8:50	214,447	4.58	0.98	0.25	7.00	0.14	0.93	0.28	5.17	0.18	1.10	0.36	6.75	0.16	0.34
		STORM	TOTALS:		214,447														
3/24/2020	021F	Center Barrel - Locke St	3/24/20 0:30	3/24/20 1:05	8,084	0.58	0.30	0.12	5.00	0.06	1.24	0.32	7.92	0.16	0.53	0.28	3.75	0.14	1.73
		STORM	TOTALS:		8,084														
3/29/2020	021F	Center Barrel - Locke St	3/29/20 20:00	3/29/20 21:10	97,690	1.17	0.74	0.11	22.00	0.03	0.78	0.64	4.58	0.17	0.92	0.40	11.75	0.08	0.84
3/29/2020	40	Bethany Avenue	3/29/20 20:00	3/29/20 20:50	7,958	0.83	0.74	0.11	22.00	0.03	0.78	0.64	4.58	0.17	0.92	0.40	11.75	0.08	0.84
3/29/2020	021H	Winter and Hale	3/29/20 20:05	3/29/20 20:20	71,520	0.25	0.74	0.11	22.00	0.03	0.78	0.64	4.58	0.17	0.92	0.40	11.75	0.08	0.84
3/29/2020	34	Middlesex Street	3/29/20 20:05	3/29/20 20:05	51,285	0.08	0.74	0.11	22.00	0.03	0.78	0.64	4.58	0.17	0.92	0.40	11.75	0.08	0.84
3/29/2020	39	South Webster Street	3/29/20 20:05	3/29/20 20:15	9,076	0.17	0.74	0.11	22.00	0.03	0.78	0.64	4.58	0.17	0.92	0.40	11.75	0.08	0.84
3/29/2020	41	Chestnut Street	3/29/20 20:05	3/29/20 20:05	6,975	0.08	0.74	0.11	22.00	0.03	0.78	0.64	4.58	0.17	0.92	0.40	11.75	0.08	0.84
		STORM	TOTALS:		244,504														
4/3/2020	021F	Center Barrel - Locke St	4/3/20 5:35	4/3/20 11:20	68,691	5.75	1.38	0.16	24.00	0.06	1.24	0.20	9.25	0.13	1.65	0.20	19.25	0.09	0.60
		STORM	TOTALS:		68,691														
4/9/2020	021F	Center Barrel - Locke St	4/9/20 13:20	4/9/20 16:25	139,619	3.08	1.13	0.32	11.00	0.10	0.96	0.44	5.75	0.17	1.21	0.40	9.50	0.13	0.07
4/9/2020	40	Bethany Avenue	4/9/20 14:45	4/9/20 14:50	5,515	0.08	1.13	0.32	11.00	0.10	0.96	0.44	5.75	0.17	1.21	0.40	9.50	0.13	0.07
4/9/2020	41	Chestnut Street	4/9/20 14:45	4/9/20 14:45	1,003	0.08	1.13	0.32	11.00	0.10	0.96	0.44	5.75	0.17	1.21	0.40	9.50	0.13	0.07
4/9/2020	39	South Webster Street	4/9/20 14:50	4/9/20 14:55	1,480	0.08	1.13	0.32	11.00	0.10	0.96	0.44	5.75	0.17	1.21	0.40	9.50	0.13	0.07
4/9/2020	021H	Winter and Hale	4/9/20 14:55	4/9/20 15:40	2,507	0.75	1.13	0.32	11.00	0.10	0.96	0.44	5.75	0.17	1.21	0.40	9.50	0.13	0.07
		STORM	TOTALS:		150,124														
4/13/2020	021F	Center Barrel - Locke St	4/13/20 9:45	4/13/20 19:15	23,735	9.50	0.81	0.14	15.00	0.05	0.52	0.16	4.08	0.13	1.03	0.28	11.25	0.09	0.05
		STORM	TOTALS:		23,735														
4/21/2020	021F	Center Barrel - Locke St	4/21/20 16:25	4/21/20 17:05	20,100	0.67	0.34	0.25	4.00	0.09	0.25	0.32	1.50	0.17	0.29	0.28	2.50	0.12	0.26
		STORM	TOTALS:		20,100														
5/1/2020	021F	Center Barrel - Locke St	5/1/20 5:50	5/1/20 8:15	103,080	2.42	0.75	0.20	9.00	0.08	0.66	0.36	4.17	0.16	0.85	0.32	6.50	0.13	0.14
5/1/2020	021H	Winter and Hale	5/1/20 7:20	5/1/20 7:35	3,176	0.25	0.75	0.20	9.00	0.08	0.66	0.36	4.17	0.16	0.85	0.32	6.50	0.13	0.14
5/1/2020	39	South Webster Street	5/1/20 7:25	5/1/20 7:25	121	0.08	0.75	0.20	9.00	0.08	0.66	0.36	4.17	0.16	0.85	0.32	6.50	0.13	0.14
		STORM	TOTALS:		106,378														
5/30/2020	40	Bethany Avenue	5/30/20 3:00	5/30/20 3:00	687	0.08	0.08	0.07	2.00	0.04	0.09	0.36	0.17	0.53	0.12	0.36	0.50	0.24	0.09
		STORM	TOTALS:		687														
6/6/2020	34	Middlesex Street	6/6/20 13:55	6/6/20 14:10	184,037	0.25	0.59	0.50	4.00	0.15	0.39	1.04	0.50	0.78	0.78	1.52	1.75	0.45	0.72
6/6/2020	39	South Webster Street	6/6/20 14:00	6/6/20 14:15	9,155	0.25	0.59	0.50	4.00	0.15	0.39	1.04	0.50	0.78	0.78	1.52	1.75	0.45	0.72
6/6/2020	40	Bethany Avenue	6/6/20 14:05	6/6/20 14:10	2,041	0.08	0.59	0.50	4.00	0.15	0.39	1.04	0.50	0.78	0.78	1.52	1.75	0.45	0.72
6/6/2020	021F	Center Barrel - Locke St	6/6/20 14:10	6/6/20 14:20	4,288	0.17	0.59	0.50	4.00	0.15	0.39	1.04	0.50	0.78	0.78	1.52	1.75	0.45	0.72
6/6/2020	41	Chestnut Street	6/6/20 14:10	6/6/20 14:10	792	0.08	0.59	0.50	4.00	0.15	0.39	1.04	0.50	0.78	0.78	1.52	1.75	0.45	0.72
		STORM	TOTALS:		200,312														
6/11/2020	40	Bethany Avenue	6/11/20 12:35	6/11/20 12:35	6,570	0.08	0.16	0.15	2.00	0.08	0.19	0.20	0.92	0.21	0.27	0.76	1.75	0.15	0.03
		STORM	TOTALS:		6,570														
6/24/2020	021F	Center Barrel - Locke St	6/24/20 17:00	6/24/20 17:25	70,881	0.42	0.69	0.52	3.00	0.23	0.41	0.96	0.50	0.82	0.75	2.40	0.75	1.00	0.80
6/24/2020	021H	Winter and Hale	6/24/20 17:00	6/24/20 17:20	112,626	0.33	0.69	0.52	3.00	0.23	0.41	0.96	0.50	0.82	0.75	2.40	0.75	1.00	0.80
6/24/2020	34	Middlesex Street	6/24/20 17:10	6/24/20 17:10	214,984	0.17	0.69	0.52	3.00	0.23	0.41	0.96	0.50	0.82	0.75	2.40	0.75	1.00	0.80
6/24/2020	40	Bethany Avenue	6/24/20 17:00	6/24/20 17:10	29,425	0.17	0.69	0.52	3.00	0.23	0.41	0.96	0.50	0.82	0.75	2.40	0.75	1.00	0.80

Appendix C 2020 CSO Activation Report

Date	CSO Outfall Number	CSO Outfall Name	Overflow Start	Overflow End	Volume (gallons)	CSO Duration (hours)	Lawrence Airport NOAA Rain Gage				Marginal Pumping Station Rain Gage				ASPW Rain Gage¹				ASPW NOAA Rain Gage
							Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Avgerage Intensity (inches/hours)	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Avgerage Intensity (inches/hours)	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Avgerage Intensity (inches/hours)	Rain Total (inches)
6/24/2020	021G	Winter street	6/24/20 17:00	6/24/20 17:05	7,507	0.08	0.69	0.52	3.00	0.23	0.41	0.96	0.50	0.82	0.75	2.40	0.75	1.00	0.80
6/24/2020	021A	Middle Siphon	6/24/20 17:05	6/24/20 17:20	109,316	0.25	0.69	0.52	3.00	0.23	0.41	0.96	0.50	0.82	0.75	2.40	0.75	1.00	0.80
6/24/2020	39	South Webster Street	6/24/20 17:05	6/24/20 17:20	15,094	0.25	0.69	0.52	3.00	0.23	0.41	0.96	0.50	0.82	0.75	2.40	0.75	1.00	0.80
6/24/2020	41	Chestnut Street	6/24/20 17:05	6/24/20 17:10	17,086	0.08	0.69	0.52	3.00	0.23	0.41	0.96	0.50	0.82	0.75	2.40	0.75	1.00	0.80
6/24/2020	32	Bradford Avenue	6/24/20 17:05	6/24/20 17:10	24,451	0.08	0.69	0.52	3.00	0.23	0.41	0.96	0.50	0.82	0.75	2.40	0.75	1.00	0.80
		STORM	TOTALS:		601,370														
6/28/2020	021A	Middle Siphon	6/28/20 14:20	6/28/20 15:05	646,110	0.75	0.25	0.07	7.00	0.04	0.86	2.20	1.92	0.45	0.69	0.96	3.25	0.21	0.80
6/28/2020	021F	Center Barrel - Locke St	6/28/20 14:20	6/28/20 14:55	185,633	0.58	0.25	0.07	7.00	0.04	0.86	2.20	1.92	0.45	0.69	0.96	3.25	0.21	0.80
6/28/2020	021H	Winter and Hale	6/28/20 14:20	6/28/20 14:50	238,092	0.50	0.25	0.07	7.00	0.04	0.86	2.20	1.92	0.45	0.69	0.96	3.25	0.21	0.80
6/28/2020	34	Middlesex Street	6/28/20 14:20	6/28/20 14:50	483,299	0.50	0.25	0.07	7.00	0.04	0.86	2.20	1.92	0.45	0.69	0.96	3.25	0.21	0.80
6/28/2020	39	South Webster Street	6/28/20 14:20	6/28/20 14:45	20,942	0.42	0.25	0.07	7.00	0.04	0.86	2.20	1.92	0.45	0.69	0.96	3.25	0.21	0.80
6/28/2020	40	Bethany Avenue	6/28/20 14:20	6/28/20 14:35	107,831	0.25	0.25	0.07	7.00	0.04	0.86	2.20	1.92	0.45	0.69	0.96	3.25	0.21	0.80
6/28/2020	41	Chestnut Street	6/28/20 14:20	6/28/20 14:40	40,320	0.33	0.25	0.07	7.00	0.04	0.86	2.20	1.92	0.45	0.69	0.96	3.25	0.21	0.80
6/28/2020	021B	Emerson Street	6/28/20 14:25	6/28/20 14:25	31,743	0.08	0.25	0.07	7.00	0.04	0.86	2.20	1.92	0.45	0.69	0.96	3.25	0.21	0.80
6/28/2020	021G	Winter street	6/28/20 14:25	6/28/20 14:30	18,360	0.08	0.25	0.07	7.00	0.04	0.86	2.20	1.92	0.45	0.69	0.96	3.25	0.21	0.80
6/28/2020	32	Bradford Avenue	6/28/20 14:25	6/28/20 14:35	110,238	0.17	0.25	0.07	7.00	0.04	0.86	2.20	1.92	0.45	0.69	0.96	3.25	0.21	0.80
6/28/2020	38	High Street	6/28/20 14:25	6/28/20 14:25	4,101	0.08	0.25	0.07	7.00	0.04	0.86	2.20	1.92	0.45	0.69	0.96	3.25	0.21	0.80
6/28/2020	24	Upper siphon	6/28/20 15:32	6/28/20 15:42	296,954	0.18	0.25	0.07	7.00	0.04	0.86	2.20	1.92	0.45	0.69	0.96	3.25	0.21	0.80
6/28/2020	13	Lower Siphon	6/28/20 15:32	6/28/20 15:36	52,148	0.07	0.25	0.07	7.00	0.04	0.86	2.20	1.92	0.45	0.69	0.96	3.25	0.21	0.80
		STORM	TOTALS:		2,235,773														
6/29/2020	021F	Center Barrel - Locke St	6/29/20 18:45	6/29/20 19:00	11,030	0.25	0.61	0.27	7.00	0.09	0.42	0.28	2.17	0.19	0.47	0.28	4.00	0.12	0.80
		STORM	TOTALS:		11,030														
7/14/2020	40	Bethany Avenue	7/14/20 9:15	7/14/20 15:40	33,157	6.42	0.36	0.19	2.00	0.18	0.10	0.04	0.83	0.12	0.19	0.32	1.25	0.15	0.38
7/14/2020	021F	Center Barrel - Locke St	7/14/20 15:35	7/14/20 16:00	240,979	0.42	0.36	0.19	2.00	0.18	0.10	0.04	0.83	0.12	0.19	0.32	1.25	0.15	0.38
7/14/2020	021H	Winter and Hale	7/14/20 15:35	7/14/20 15:55	170,217	0.33	0.36	0.19	2.00	0.18	0.10	0.04	0.83	0.12	0.19	0.32	1.25	0.15	0.38
7/14/2020	41	Chestnut Street	7/14/20 15:35	7/14/20 15:45	12,981	0.17	0.36	0.19	2.00	0.18	0.10	0.04	0.83	0.12	0.19	0.32	1.25	0.15	0.38
7/14/2020	021G	Winter street	7/14/20 15:35	7/14/20 15:40	11,148	0.08	0.36	0.19	2.00	0.18	0.10	0.04	0.83	0.12	0.19	0.32	1.25	0.15	0.38
		STORM	TOTALS:		468,482														
7/22/2020	021F	Center Barrel - Locke St	7/22/20 22:45	7/22/20 23:20	224,462	0.58	0.80	0.66	5.00	0.16	0.06	0.08	0.50	0.12	0.64	0.88	3.00	0.21	0.94
7/22/2020	34	Middlesex Street	7/22/20 22:45	7/22/20 23:05	222,509	0.33	0.80	0.66	5.00	0.16	0.06	0.08	0.50	0.12	0.64	0.88	3.00	0.21	0.94
7/22/2020	39	South Webster Street	7/22/20 22:45	7/22/20 23:05	18,281	0.33	0.80	0.66	5.00	0.16	0.06	0.08	0.50	0.12	0.64	0.88	3.00	0.21	0.94
7/22/2020	40	Bethany Avenue	7/22/20 22:45	7/22/20 22:55	66,938	0.17	0.80	0.66	5.00	0.16	0.06	0.08	0.50	0.12	0.64	0.88	3.00	0.21	0.94
7/22/2020	41	Chestnut Street	7/22/20 22:45	7/22/20 22:55	16,621	0.17	0.80	0.66	5.00	0.16	0.06	0.08	0.50	0.12	0.64	0.88	3.00	0.21	0.94
7/22/2020	32	Bradford Avenue	7/22/20 22:45	7/22/20 22:50	6,710	0.08	0.80	0.66	5.00	0.16	0.06	0.08	0.50	0.12	0.64	0.88	3.00	0.21	0.94
7/22/2020	021A	Middle Siphon	7/22/20 22:50	7/22/20 23:30	140,465	0.67	0.80	0.66	5.00	0.16	0.06	0.08	0.50	0.12	0.64	0.88	3.00	0.21	0.94
7/22/2020	021H	Winter and Hale	7/22/20 22:50	7/22/20 23:05	79,575	0.25	0.80	0.66	5.00	0.16	0.06	0.08	0.50	0.12	0.64	0.88	3.00	0.21	0.94
7/22/2020	021G	Winter street	7/22/20 22:50	7/22/20 22:50	1,632	0.08	0.80	0.66	5.00	0.16	0.06	0.08	0.50	0.12	0.64	0.88	3.00	0.21	0.94
		STORM	TOTALS:		777,193														
7/23/2020	34	Middlesex Street	7/23/20 14:00	7/23/20 14:30	352,670	0.50	1.65	1.07	4.00	0.41	0.91	0.12	7.58	0.12	1.28	3.00	2.75	0.47	0.94
7/23/2020	39	South Webster Street	7/23/20 14:00	7/23/20 14:30	20,872	0.50	1.65	1.07	4.00	0.41	0.91	0.12	7.58	0.12	1.28	3.00	2.75	0.47	0.94
7/23/2020	40	Bethany Avenue	7/23/20 14:00	7/23/20 14:20	72,401	0.33	1.65	1.07	4.00	0.41	0.91	0.12	7.58	0.12	1.28	3.00	2.75	0.47	0.94
7/23/2020	41	Chestnut Street	7/23/20 14:00	7/23/20 14:15	22,033	0.25	1.65	1.07	4.00	0.41	0.91	0.12	7.58	0.12	1.28	3.00	2.75	0.47	0.94
7/23/2020	021F	Center Barrel - Locke St	7/23/20 14:05	7/23/20 14:30	211,297	0.42	1.65	1.07	4.00	0.41	0.91	0.12	7.58	0.12	1.28	3.00	2.75	0.47	0.94
7/23/2020	32	Bradford Avenue	7/23/20 14:05	7/23/20 14:20	66,707	0.25	1.65	1.07	4.00	0.41	0.91	0.12	7.58	0.12	1.28	3.00	2.75	0.47	0.94
7/23/2020	021A	Middle Siphon	7/23/20 14:10	7/23/20 14:45	230,941	0.58	1.65	1.07	4.00	0.41	0.91	0.12	7.58	0.12	1.28	3.00	2.75	0.47	0.94
7/23/2020	021H	Winter and Hale	7/23/20 14:10	7/23/20 14:25	75,335	0.25	1.65	1.07	4.00	0.41	0.91	0.12	7.58	0.12	1.28	3.00	2.75	0.47	0.94
7/23/2020	24	Upper siphon	7/23/20 15:10	7/23/20 15:22	223,194	0.19	1.65	1.07	4.00	0.41	0.91	0.12	7.58	0.12	1.28	3.00	2.75	0.47	0.94
		STORM	TOTALS:		1,275,451														
8/4/2020	021F	Center Barrel - Locke St	8/4/20 17:00	8/4/20 17:15	67,599	0.25	0.28	0.25	2.00	0.14	0.19	0.44	0.58	0.33	0.35	0.60	1.00	0.35	0.26

Appendix C 2020 CSO Activation Report

Date	CSO Outfall Number	CSO Outfall Name	Overflow Start	Overflow End	Volume (gallons)	CSO Duration (hours)	Lawrence Airport NOAA Rain Gage				Marginal Pumping Station Rain Gage				ASPW Rain Gage¹				ASPW NOAA Rain Gage
							Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Avgerage Intensity (inches/hours)	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Avgerage Intensity (inches/hours)	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Avgerage Intensity (inches/hours)	Rain Total (inches)
8/4/2020	34	Middlesex Street	8/4/20 17:00	8/4/20 17:00	33,482	0.08	0.28	0.25	2.00	0.14	0.19	0.44	0.58	0.33	0.35	0.60	1.00	0.35	0.26
8/4/2020	40	Bethany Avenue	8/4/20 17:00	8/4/20 17:00	5,566	0.08	0.28	0.25	2.00	0.14	0.19	0.44	0.58	0.33	0.35	0.60	1.00	0.35	0.26
8/4/2020	41	Chestnut Street	8/4/20 17:00	8/4/20 17:00	1,642	0.08	0.28	0.25	2.00	0.14	0.19	0.44	0.58	0.33	0.35	0.60	1.00	0.35	0.26
		STORM	TOTALS:		108,289														
8/23/2020	021G	Winter street	8/23/20 14:55	8/23/20 15:00	4,116	0.08	0.54	0.38	3.00	0.18	0.40	1.36	0.50	0.80	0.00	0.00	0.00	0.00	0.06
8/23/2020	021A	Middle Siphon	8/23/20 15:00	8/23/20 15:05	7,851	0.08	0.54	0.38	3.00	0.18	0.40	1.36	0.50	0.80	0.00	0.00	0.00	0.00	0.06
8/23/2020	021F	Center Barrel - Locke St	8/23/20 15:00	8/23/20 15:25	165,563	0.42	0.54	0.38	3.00	0.18	0.40	1.36	0.50	0.80	0.00	0.00	0.00	0.00	0.06
8/23/2020	021H	Winter and Hale	8/23/20 15:00	8/23/20 15:15	83,931	0.25	0.54	0.38	3.00	0.18	0.40	1.36	0.50	0.80	0.00	0.00	0.00	0.00	0.06
8/23/2020	34	Middlesex Street	8/23/20 15:00	8/23/20 15:05	66,494	0.08	0.54	0.38	3.00	0.18	0.40	1.36	0.50	0.80	0.00	0.00	0.00	0.00	0.06
8/23/2020	40	Bethany Avenue	8/23/20 15:00	8/23/20 15:05	17,490	0.08	0.54	0.38	3.00	0.18	0.40	1.36	0.50	0.80	0.00	0.00	0.00	0.00	0.06
8/23/2020	41	Chestnut Street	8/23/20 15:00	8/23/20 15:05	10,716	0.08	0.54	0.38	3.00	0.18	0.40	1.36	0.50	0.80	0.00	0.00	0.00	0.00	0.06
8/23/2020	39	South Webster Street	8/23/20 15:05	8/23/20 15:10	3,358	0.08	0.54	0.38	3.00	0.18	0.40	1.36	0.50	0.80	0.00	0.00	0.00	0.00	0.06
		STORM	TOTALS:		359,520														
8/29/2020	40	Bethany Avenue	8/29/20 10:50	8/29/20 10:50	2,654	0.08	0.54	0.18	10.00	0.05	0.55	0.32	3.17	0.17	0.58	0.28	6.00	0.10	0.50
		STORM	TOTALS:		2,654														
9/10/2020	021H	Winter and Hale	9/10/20 14:40	9/10/20 18:05	263,654	3.42	2.02	1.06	4.00	0.51	1.04	1.24	1.92	0.54	1.33	1.92	2.50	0.53	1.44
9/10/2020	021F	Center Barrel - Locke St	9/10/20 14:45	9/10/20 18:15	176,144	3.50	2.02	1.06	4.00	0.51	1.04	1.24	1.92	0.54	1.33	1.92	2.50	0.53	1.44
9/10/2020	021A	Middle Siphon	9/10/20 16:15	9/10/20 18:40	1,124,278	2.42	2.02	1.06	4.00	0.51	1.04	1.24	1.92	0.54	1.33	1.92	2.50	0.53	1.44
9/10/2020	34	Middlesex Street	9/10/20 16:15	9/10/20 18:25	771,269	2.17	2.02	1.06	4.00	0.51	1.04	1.24	1.92	0.54	1.33	1.92	2.50	0.53	1.44
9/10/2020	40	Bethany Avenue	9/10/20 16:15	9/10/20 17:55	50,504	1.67	2.02	1.06	4.00	0.51	1.04	1.24	1.92	0.54	1.33	1.92	2.50	0.53	1.44
9/10/2020	021G	Winter street	9/10/20 16:15	9/10/20 16:20	20,905	0.08	2.02	1.06	4.00	0.51	1.04	1.24	1.92	0.54	1.33	1.92	2.50	0.53	1.44
9/10/2020	39	South Webster Street	9/10/20 16:20	9/10/20 17:40	33,704	1.33	2.02	1.06	4.00	0.51	1.04	1.24	1.92	0.54	1.33	1.92	2.50	0.53	1.44
9/10/2020	41	Chestnut Street	9/10/20 16:20	9/10/20 17:55	28,437	1.58	2.02	1.06	4.00	0.51	1.04	1.24	1.92	0.54	1.33	1.92	2.50	0.53	1.44
		STORM	TOTALS:		2,468,897														
9/30/2020	40	Bethany Avenue	9/30/20 7:35	9/30/20 7:35	2,048	0.08	0.37	0.11	9.00	0.04	0.30	0.28	1.42	0.21	0.48	0.32	4.25	0.11	0.17
		STORM	TOTALS:		2,048														
10/13/2020	021F	Center Barrel - Locke St	10/13/20 14:25	10/13/20 15:55	10,428	1.50	1.16	0.18	16.00	0.07	1.21	0.36	7.25	0.17	1.62	0.44	12.25	0.13	0.36
		STORM	TOTALS:		10,428														
10/17/2020	021F	Center Barrel - Locke St	10/17/20 0:35	10/17/20 6:00	129,121	5.42	1.34	0.25	10.00	0.13	1.32	0.48	6.33	0.21	1.63	0.44	8.75	0.19	1.99
10/17/2020	021H	Winter and Hale	10/17/20 0:40	10/17/20 0:50	4,362	0.17	1.34	0.25	10.00	0.13	1.32	0.48	6.33	0.21	1.63	0.44	8.75	0.19	1.99
		STORM	TOTALS:		133,483														
11/15/2020	021F	Center Barrel - Locke St	11/15/20 23:20	11/15/20 23:40	13,093	0.33	0.35	0.27	4.00	0.09	0.22	0.28	0.83	0.27	0.27	0.88	3.00	0.09	0.83
11/15/2020	34	Middlesex Street	11/15/20 23:20	11/15/20 23:25	48,202	0.17	0.35	0.27	4.00	0.09	0.22	0.28	0.83	0.27	0.27	0.88	3.00	0.09	0.83
11/15/2020	39	South Webster Street	11/15/20 23:20	11/15/20 23:30	1,710	0.08	0.35	0.27	4.00	0.09	0.22	0.28	0.83	0.27	0.27	0.88	3.00	0.09	0.83
11/15/2020	40	Bethany Avenue	11/15/20 23:20	11/15/20 23:20	4,605	0.08	0.35	0.27	4.00	0.09	0.22	0.28	0.83	0.27	0.27	0.88	3.00	0.09	0.83
11/15/2020	021H	Winter and Hale	11/15/20 23:30	11/15/20 23:30	1,332	7.17	0.35	0.27	4.00	0.09	0.22	0.28	0.83	0.27	0.27	0.88	3.00	0.09	0.83
		STORM	TOTALS:		68,942														
11/23/2020	021F	Center Barrel - Locke St	11/23/20 5:10	11/23/20 12:20	512,542	7.17	1.97	0.52	8.00	0.25	2.03	0.92	5.67	0.36	1.98	0.60	6.50	0.30	0.39
11/23/2020	021H	Winter and Hale	11/23/20 8:30	11/23/20 11:15	149,868	2.75	1.97	0.52	8.00	0.25	2.03	0.92	5.67	0.36	1.98	0.60	6.50	0.30	0.39
11/23/2020	34	Middlesex Street	11/23/20 8:30	11/23/20 12:15	1,627,579	3.75	1.97	0.52	8.00	0.25	2.03	0.92	5.67	0.36	1.98	0.60	6.50	0.30	0.39
11/23/2020	40	Bethany Avenue	11/23/20 8:30	11/23/20 10:25	13,049	1.92	1.97	0.52	8.00	0.25	2.03	0.92	5.67	0.36	1.98	0.60	6.50	0.30	0.39
11/23/2020	021G	Winter street	11/23/20 8:30	11/23/20 9:00	2,237	0.50	1.97	0.52	8.00	0.25	2.03	0.92	5.67	0.36	1.98	0.60	6.50	0.30	0.39
11/23/2020	39	South Webster Street	11/23/20 8:55	11/23/20 11:25	41,254	2.50	1.97	0.52	8.00	0.25	2.03	0.92	5.67	0.36	1.98	0.60	6.50	0.30	0.39
11/23/2020	41	Chestnut Street	11/23/20 8:55	11/23/20 10:05	4,905	1.17	1.97	0.52	8.00	0.25	2.03	0.92	5.67	0.36	1.98	0.60	6.50	0.30	0.39
11/23/2020	021A	Middle Siphon	11/23/20 9:00	11/23/20 12:25	1,935,396	3.42	1.97	0.52	8.00	0.25	2.03	0.92	5.67	0.36	1.98	0.60	6.50	0.30	0.39
11/23/2020	24	Upper siphon	11/23/20 10:20	11/23/20 10:41	91,584	0.35	1.97	0.52	8.00	0.25	2.03	0.92	5.67	0.36	1.98	0.60	6.50	0.30	0.39
		STORM	TOTALS:		4,378,415														
11/30/2020	021F	Center Barrel - Locke St	11/30/20 18:45	11/30/20 19:00	17,934	0.25	1.13	0.16	13.00	0.09	0.86	0.28	5.83	0.15	1.26	0.32	10.25	0.12	0.00
		STORM	TOTALS:		17,934														

Appendix D

Appendix D 2020 Daily Rainflow

Lawrence Airport (US W00094723) NOAA Rain Gage					Marginal Pumping Station Rain Gage				ASPW Rain Gage				ASPW Operator Observed NOAA Rain Gage
Date	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Average Intensity (inches/hours)	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Average Intensity (inches/hours)	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Average Intensity (inches/hours)	Rain Total (in.)
02/17/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02/18/2020	0.49	0.11	10.00	0.05	0.48	0.16	3.92	0.12	0.65	0.20	7.25	0.09	0.00
02/19/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.55
02/20/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02/21/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02/22/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02/23/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02/24/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02/25/2020	0.03	0.02	2.00	0.02	0.00	0.00	0.00	0.00	0.01	0.04	0.25	0.04	0.00
02/26/2020	0.00	0.00	0.00	0.00	0.01	0.04	0.08	0.13	0.03	0.08	0.25	0.12	0.01
02/27/2020	0.98	0.25	7.00	0.14	0.93	0.28	5.17	0.18	1.10	0.36	6.75	0.16	0.34
02/28/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.05
02/29/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/01/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/02/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/03/2020	0.03	0.03	1.00	0.03	0.01	0.04	0.08	0.13	0.03	0.04	0.75	0.04	0.00
03/04/2020	0.02	0.01	2.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
03/05/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/06/2020	0.01	0.01	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/07/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/08/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/09/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/10/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/11/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/12/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/13/2020	0.37	0.10	10.00	0.04	0.29	0.16	2.25	0.13	0.44	0.16	5.50	0.08	0.21
03/14/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18
03/15/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/16/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/17/2020	0.01	0.01	1.00	0.01	0.01	0.04	0.08	0.13	0.01	0.00	0.00		0.00
03/18/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
03/19/2020	0.55	0.12	11.00	0.05	0.49	0.12	4.08	0.12	0.65	0.20	8.50	0.08	0.00
03/20/2020	0.04	0.02	3.00	0.01	0.09	0.08	0.75	0.12	0.08	0.08	1.50	0.05	0.58
03/21/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
03/22/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/23/2020	1.07	0.42	8.00	0.13	0.77	0.44	2.42	0.32	1.16	0.56	7.50	0.15	0.00
03/24/2020	0.30	0.12	5.00	0.06	1.24	0.32	7.92	0.16	0.53	0.28	3.75	0.14	1.73
03/25/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/26/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/27/2020	0.01	0.01	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
03/28/2020	0.01	0.01	1.00	0.01	0.01	0.04	0.08	0.13	0.00	0.00	0.00	0.00	0.00
03/29/2020	0.74	0.11	22.00	0.03	0.78	0.64	4.58	0.17	0.92	0.40	11.75	0.08	0.00
03/30/2020	0.09	0.03	7.00	0.01	0.11	0.04	0.92	0.12	0.09	0.08	2.00	0.05	0.84
03/31/2020	0.01	0.01	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15
04/01/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
04/02/2020	0.18	0.07	8.00	0.02	0.29	0.12	2.42	0.12	0.23	0.12	3.75	0.06	0.02
04/03/2020	1.38	0.16	24.00	0.06	1.24	0.20	9.25	0.13	1.65	0.20	19.25	0.09	0.60
04/04/2020	0.02	0.01	2.00	0.01	0.01	0.04	0.08	0.13	0.02	0.04	0.25	0.08	1.08

Appendix D 2020 Daily Rainflow

Lawrence Airport (US W00094723) NOAA Rain Gage					Marginal Pumping Station Rain Gage				ASPW Rain Gage				ASPW Operator Observed NOAA Rain Gage
Date	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Average Intensity (inches/hours)	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Average Intensity (inches/hours)	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Average Intensity (inches/hours)	Rain Total (in.)
05/23/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05/24/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05/25/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05/26/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05/27/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.08	0.25	0.08	0.00
05/28/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05/29/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.50	0.04	0.00
05/30/2020	0.08	0.07	2.00	0.04	0.09	0.36	0.17	0.53	0.12	0.36	0.50	0.24	0.09
05/31/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/01/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/02/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/03/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/04/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/05/2020	0.00	0.00	0.00	0.00	0.02	0.04	0.17	0.12	0.00	0.00	0.00	0.00	0.01
06/06/2020	0.59	0.50	4.00	0.15	0.39	1.04	0.50	0.78	0.78	1.52	1.75	0.45	0.00
06/07/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.08	0.25	0.08	0.72
06/08/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/09/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.44	0.50	0.26	0.00
06/10/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/11/2020	0.16	0.15	2.00	0.08	0.19	0.20	0.92	0.21	0.27	0.76	1.75	0.15	0.03
06/12/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17
06/13/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/14/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/15/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/16/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/17/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/18/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/19/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/20/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.25	0.04	0.00
06/21/2020	0.01	0.01	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/22/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/23/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/24/2020	0.69	0.52	3.00	0.23	0.41	0.96	0.50	0.82	0.75	2.40	0.75	1.00	0.00
06/25/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80
06/26/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/27/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
06/28/2020	0.25	0.07	7.00	0.04	0.86	2.20	1.92	0.45	0.69	0.96	3.25	0.21	0.00
06/29/2020	0.61	0.27	7.00	0.09	0.42	0.28	2.17	0.19	0.47	0.28	4.00	0.12	0.80
06/30/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.25	0.04	0.41
07/01/2020	0.04	0.02	3.00	0.01	0.06	0.04	0.50	0.12	0.10	0.16	1.50	0.07	0.04
07/02/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
07/03/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07/04/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07/05/2020	0.21	0.12	3.00	0.07	0.00	0.00	0.00	0.00	0.16	0.40	1.00	0.16	0.00
07/06/2020	0.00	0.00	0.00	0.00	0.04	0.08	0.33	0.12	0.00	0.00	0.00	0.00	0.15
07/07/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
07/08/2020	0.08	0.07	2.00	0.04	0.08	0.08	0.67	0.12	0.10	0.12	1.00	0.10	0.00
07/09/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09

Appendix D 2020 Daily Rainflow

Lawrence Airport (US W00094723) NOAA Rain Gage					Marginal Pumping Station Rain Gage				ASPW Rain Gage				ASPW Operator Observed NOAA Rain Gage
Date	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Average Intensity (inches/hours)	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Average Intensity (inches/hours)	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Average Intensity (inches/hours)	Rain Total (in.)
08/27/2020	0.14	0.08	4.00	0.04	0.16	0.12	1.33	0.12	0.23	0.12	3.00	0.08	0.00
08/28/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17
08/29/2020	0.54	0.18	10.00	0.05	0.55	0.32	3.17	0.17	0.58	0.28	6.00	0.10	0.00
08/30/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50
08/31/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/01/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/02/2020	0.11	0.04	4.00	0.03	0.06	0.08	0.50	0.12	0.16	0.16	1.75	0.09	0.00
09/03/2020	0.00	0.00	0.00	0.00	0.03	0.08	0.25	0.12	0.13	0.44	0.50	0.26	0.18
09/04/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
09/05/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/06/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/07/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/08/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/09/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/10/2020	2.02	1.06	4.00	0.51	1.04	1.24	1.92	0.54	1.33	1.92	2.50	0.53	0.00
09/11/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.25	0.04	1.44
09/12/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/13/2020	0.01	0.01	1.00	0.01	0.01	0.04	0.08	0.13	0.01	0.04	0.25	0.04	0.00
09/14/2020	0.01	0.01	1.00	0.01	0.00	0.00	0.00	0.00	0.04	0.08	0.50	0.08	0.04
09/15/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/16/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/17/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/18/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/19/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/20/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/21/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/22/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/23/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/24/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/25/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/26/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/27/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/28/2020	0.03	0.03	1.00	0.03	0.01	0.04	0.08	0.13	0.01	0.04	0.25	0.04	0.03
09/29/2020	0.01	0.01	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
09/30/2020	0.37	0.11	9.00	0.04	0.30	0.28	1.42	0.21	0.48	0.32	4.25	0.11	0.17
10/01/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25
10/02/2020	0.03	0.03	1.00	0.03	0.04	0.08	0.25	0.16	0.06	0.16	0.75	0.08	0.00
10/03/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
10/04/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10/05/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10/06/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10/07/2020	0.31	0.18	3.00	0.10	0.15	0.56	0.17	0.88	0.12	0.40	0.50	0.24	0.04
10/08/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
10/09/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10/10/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10/11/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10/12/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10/13/2020	1.16	0.18	16.00	0.07	1.21	0.36	7.25	0.17	1.62	0.44	12.25	0.13	0.00

Appendix D 2020 Daily Rainflow

Lawrence Airport (US W00094723) NOAA Rain Gage					Marginal Pumping Station Rain Gage				ASPW Rain Gage				ASPW Operator Observed NOAA Rain Gage
Date	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Average Intensity (inches/hours)	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Average Intensity (inches/hours)	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Average Intensity (inches/hours)	Rain Total (in.)
10/14/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.58
10/15/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10/16/2020	0.26	0.06	9.00	0.03	0.46	0.24	3.00	0.15	0.38	0.16	4.75	0.08	0.00
10/17/2020	1.34	0.25	10.00	0.13	1.32	0.48	6.33	0.21	1.63	0.44	8.75	0.19	1.99
10/18/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
10/19/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10/20/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10/21/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.25	0.04	0.02
10/22/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
10/23/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10/24/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10/25/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
10/26/2020	0.08	0.03	4.00	0.02	0.08	0.04	0.67	0.12	0.08	0.08	1.75	0.05	0.00
10/27/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.25	0.04	0.08
10/28/2020	0.29	0.05	13.00	0.02	0.30	0.08	2.50	0.12	0.47	0.12	7.50	0.06	0.01
10/29/2020	0.64	0.10	12.00	0.05	0.62	0.12	5.17	0.12	0.78	0.24	10.00	0.08	0.31
10/30/2020	0.26	0.04	12.00	0.02	0.10	0.08	0.83	0.12	0.46	0.24	6.00	0.08	0.78
10/31/2020	0.00	0.00	0.00	0.00	0.23	0.20	1.33	0.17	0.00	0.00	0.00	0.00	0.25
11/01/2020	0.40	0.10	8.00	0.05	0.37	0.12	3.08	0.12	0.53	0.20	5.75	0.09	0.00
11/02/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00		0.42
11/03/2020	0.00	0.00	0.00	0.00	0.01	0.04	0.08	0.13	0.00	0.00	0.00	0.00	0.00
11/04/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/05/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/06/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/07/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/08/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/09/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/10/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/11/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/12/2020	0.01	0.01	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/13/2020	0.10	0.04	7.00	0.01	0.07	0.04	0.58	0.12	0.16	0.12	2.75	0.06	0.01
11/14/2020	0.00	0.00	0.00	0.00	0.01	0.04	0.08	0.13	0.00	0.00	0.00	0.00	0.12
11/15/2020	0.35	0.27	4.00	0.09	0.22	0.28	0.83	0.27	0.27	0.88	3.00	0.09	0.00
11/16/2020	0.03	0.03	1.00	0.03	0.03	0.12	0.25	0.12	0.33	0.16	0.50	0.66	0.43
11/17/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/18/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/19/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/20/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/21/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/22/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/23/2020	1.97	0.52	8.00	0.25	2.03	0.92	5.67	0.36	1.98	0.60	6.50	0.30	0.39
11/24/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.68
11/25/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/26/2020	0.47	0.08	11.00	0.04	0.52	0.16	3.83	0.14	0.60	0.20	7.00	0.09	0.15
11/27/2020	0.00	0.00	0.00	0.00	0.01	0.04	0.08	0.13	0.00	0.00	0.00	0.00	0.38
11/28/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/29/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/30/2020	1.13	0.16	13.00	0.09	0.86	0.28	5.83	0.15	1.26	0.32	10.25	0.12	0.00

Appendix D 2020 Daily Rainflow

Lawrence Airport (US W00094723) NOAA Rain Gage					Marginal Pumping Station Rain Gage				ASPW Rain Gage				ASPW Operator Observed NOAA Rain Gage
Date	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Average Intensity (inches/hours)	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Average Intensity (inches/hours)	Rain Total (inches)	Peak hour intensity (inches/hours)	Storm Duration (hours)	Daily Average Intensity (inches/hours)	Rain Total (in.)
12/01/2020	0.31	0.18	5.00	0.06	0.39	0.48	1.92	0.20	0.74	0.60	2.75	0.27	1.92
12/02/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/03/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/04/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/05/2020	1.94	0.19	18.00	0.11	2.21	0.24	14.50	0.15	2.07	0.24	17.00	0.12	0.00
12/06/2020	0.00	0.00	0.00	0.00	0.05	0.04	0.42	0.12	0.04	0.04	0.25	0.16	2.30
12/07/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/08/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/09/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/10/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/11/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/12/2020	0.37	0.08	8.00	0.05	0.39	0.20	2.67	0.15	0.43	0.20	5.25	0.08	0.00
12/13/2020	0.00	0.00	0.00	0.00	0.01	0.04	0.08	0.13	0.00	0.00	0.00	0.00	0.41
12/14/2020	0.00	0.00	0.00	0.00	0.01	0.04	0.08	0.13	0.02	0.08	0.25	0.08	0.00
12/15/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/16/2020	0.01	0.01	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/17/2020	0.30	0.07	11.00	0.03	0.00	0.00	0.00	0.00	1.16	0.24	12.00	0.10	0.83
12/18/2020	0.00	0.00	0.00	0.00	0.06	0.12	0.50	0.12	0.00	0.00	0.00	0.00	0.26
12/19/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/20/2020	0.10	0.06	3.00	0.03	0.00	0.00	0.00	0.00	0.10	0.08	1.50	0.07	0.00
12/21/2020	0.00	0.00	0.00	0.00	0.11	0.16	0.83	0.13	0.00	0.00	0.00	0.00	0.11
12/22/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/23/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/24/2020	0.01	0.01	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/25/2020	1.58	0.20	16.00	0.10	1.26	0.24	8.42	0.15	1.62	0.36	13.75	0.12	0.18
12/26/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.42
12/27/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/28/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/29/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/30/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/31/2020	0.14	0.09	4.00	0.04	0.10	0.12	0.75	0.13	0.14	0.12	2.00	0.07	0.02
Total	39.98				35.70				46.53		201.00		44.05
Avg	0.04		1.84		0.05		0.30		0.05		0.55		0.05
Max	1.38	0.42	335.00	0.38	1.24	2.20	9.25	0.82	1.61	0.56	19.25	0.05	1.73

Appendix E

Appendix E Downstream Notification List

First Name	Last Name	Job Title	City/Company	E-mail
Allana	McOsker	Head Clerk	Haverhill	ajmcosker@haverhillwater.com
Andrea	Brochu		Salisbury	abrochu@salisburyma.gov
Ted	Angelakis	Water Superintendent	Newburyport	TAngelakis@cityofnewburyport.com
Berni	Angelo	Admin Asst Board of Health	Merrimac	BOH@townofmerrimac.com
Virginia	Bacon	Health Inspector	Newbury	boardofhealth@townofnewbury.org
Lori	Bentsen	Board of Health	Groveland	lbentsen@grovelandma.com
Beth	Buschini		Merrimack	BOH@townofmerrimac.com
Beth	Buschini			buschininbpt@comcast.net
	Bethaley			bethaley@bu.edu
Kevin	Brander	Muni Services/WW Section	MASSDEP	Kevin.Brander@state.ma.us
Mike	Buzzell	Wastewater Chief Operator	Merrimac	btmwwtf@comcast.net
Thomas	Connors			tmconnors@aol.com
James	Conte	Asset Management	Haverhill	jconte@Haverhillwater.com
Matthew	Corbin	Horizontal Infrastructure Assessment Group	Wright-Pierce	matthew.corbin@wright-pierce.com
Cheri	Cousens	GLSD Executive Director	Lawrence	ccousens@glsd.org
Greg	Coyle	Lowell WW Engineer	Lowell	gcoyle@lowellma.gov
Thomas	Cusick	Water Superintendent	Newburyport	TCusick@CityofNewburyport.com
John	D'Aoust	Water Facility Manager	Haverhill	jdaoust@haverhillwater.com
Lisa	DeMeo	Director of Public Works	Salisbury	ldemeo@salisburyma.gov
Megan	Desautels	Legislative Aide	Mass State House	Megan.Desautels@mahouse.gov
Robert	DesMarais	Director Public Works	Amesbury	rob@amesburyma.gov
Micah	Donahue			micahdonahue@gmail.com
Peter	Doyle			peter.doyle@edwardjones.com
Bonnie	Dufresne	Board of Health	Haverhill	bdufresne@cityofhaverhill.com
Dougan	Sherwood	CIC Health	Haverhill Chamber	dougan@haverhillchamber.com
Joe	Dugan	Wastewater Chief Operator	Newburyport	jdugan@CityofNewburyport.com
Keith	Eddings	Eagle Tribune Reporter	Haverhill	keddings@eagletribune.com
Gary	Field	DPW Technician	Amesbury	fieldg@amesburyma.gov
Frank	Giacalone	Director of Public Health	Newburyport	fgiacalone@cityofnewburyport.com
Alba	Gouldthrope		Newbury	boardofhealth@townofnewbury.org
J	Haggs			jhaggs100@gmail.com
Paul	Hogg	Harbor Master	Newburyport	phogg@cityofnewburyport.com
Donna	Holaday	Mayor	Newburyport	DHoladay@CityofNewburyport.com
Christopher	Hood	Sewer Superintendent	Newburyport	CHood@CityofNewburyport.com
Eileen	Hurley		Merrimack	boh@townofmerrimac.com
Jeff	Ingalls	WWTP Chief Operator	Salisbury	wwtp@sailsburyma.gov
Paul	Jessel	Collection System Supervisor	Haverhill	pjessel@haverhillwater.com
Jeff	Kennedy	North Shore Regional Supv	Gloucester	jeff.kennedy@state.ma.us
Deborah	Ketchen	Board of Health	Merrimac	Healthagent@townofmerrimac.com
Scott	Kinter	Avalon Communities	Peabody	Scott_kinter@avalonbay.com
Isaiah	Lewis	WW Facility Manager	Haverhill	ilewis@haverhillwater.com
John	Macone	MRWC	Lawrence	jmacone@merrimack.org
Sam	Marinez	WW Col Sr. Sys OP	Haverhill	smarinez@haverhillwater.com
Jeff	Mason	Water System Manager	Amesbury	masonj@amesburyma.gov
Kevin	McCarthy			kevinmccarthy1@gmail.com
Heather	McMann			heather@mcmann.net
Leonard	Mirra	State Representative Second Essex District	Mass State House	Leonard.mirra@mahouse.gov
Tom	Mitchell	Flow Assessment	Contractor	tmitchell@flowassessment.com
Marc	Moccio	Lead Project Engineer	Wright-Pierce	marc.moccio@wright-pierce.com
Nihar	Mohanty	DEP NERO	MASSDEP	nihar.mohanty@state.ma.us
Jack	Morris	Regional Health Director	Amesbury	morrisj@amesburyma.gov
John	Morris	Director of Public Health	Salisbury	jmorris@salisburyma.gov
Kevin	Olsen	Senior Project Engineer	Wright-Pierce	kevin.olson@wright-pierce.com
Solanch	Pastrana-DeValle	Enforcement/Compliance Assurance Div.	EPA, Region 1	pastrana-del-valle.solanch@epa.gov
Laurie	Perkins	Horizontal Infrastructure Assessment Group	Wright-Pierce	laurie.perkins@wright-pierce.com
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Appendix E Downstream Notification List

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