LOWELL REGIONAL WASTEWATER UTILITY

WASTEWATER COLLECTION AND TREATMENT

MARK A. YOUNG
EXECUTIVE DIRECTOR

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SUBJECT: 2017 Annual Report

DATE: April 30, 2018

Gentlemen:

In conformance with the reporting requirements of NPDES Permit No. MA0100633 and Administrative Order No. 010-026, the Lowell Regional Wastewater Utility (LRWWU) is submitting its 2017 Annual Report for review and comment.

LRWWU's annual report is now comprised of three distinct reports: the annual LTCP Progress Report; the annual CMOM Report; and the annual NPDES Report. The LTCP Progress Report describes initiatives that have been or will be completed to mitigate the discharge of CSOs into local waterways. The CMOM Report details the work done associated with the operation and maintenance of LRWWU's sewer collection system.

This year's annual report discusses several deficiencies that were identified in the CMOM Program Self-Assessment Checklist. LRWWU is pleased to report that many of the action items that were identified in the original checklist, submitted in 2011, have been addressed.

The NPDES report also includes the annual Infiltration/Inflow (I/I) Report and the annual Combined Sewer Overflow (CSO) Report. The I/I report describes I/I control actions taken in 2017 and the impact of these actions on I/I rates at LRWWU's Duck Island Clean Water Facility (CWF). The CSO report contains wet weather data summaries for 2017 (quarterly and annual summaries), certification statements related to CSO records and structure maintenance, and the annual Nine Minimum Controls (NMC) Report. This annual report also includes a summary of sewer rehabilitation projects completed in 2017. The rehabilitation work, which is now being planned and monitored through bi-weekly collection system meetings, is a prime example of LRWWU's commitment to its CMOM program.

The data provided in these reports indicate that significant progress has been made in reducing inflow and infiltration into the local sewer system and, as a result, CSO discharges have been substantially decreased. LRWWU is proud of the accomplishments of its LTCP Phase 1 Program: local sewer surcharging has been nearly eliminated; CSO discharges have been greatly reduced; many miles of new infrastructure have been installed; and infiltration and inflow into the sewer system have been significantly decreased.

One particular statistic demonstrates this progress: 2017 CSO annual discharges were 78% less than the annual average for the past thirteen years. Here are the actual numbers:

- The average annual CSO discharge volume in the past thirteen years is 487 MG; for 2017, the CSO discharge volume was 108 MG.

I hope that you agree that these numbers reflect the outstanding progress that LRWWU has made in recent years. That said, LRWWU recognizes the need for continued improvement with regards to I/I and CSO reduction. This is the primary objective of Lowell Water's Integrated Capital Improvement Plan (ICIP), which is currently being revised. Discussions are underway to establish the framework of this plan.

At this time, Lowell is proceeding with several components of its ongoing capital improvements program, including Duck Island improvements that will optimize peak wet-weather treatment, as well as an interceptor storage project at Read Station that will serve as the foundation of a future satellite CSO treatment facility at this location.

I look forward to partnering with you as we continue our efforts to improve the water quality in the Merrimack River watershed. If you require any additional information, or if you have any questions, please contact me or Mark Young, the Executive Director of the Lowell Regional Wastewater Utility.

Respectfully,

Michael Stuer
Engineering Manager
Lowell Water Utility
Copy / File

Mark Young, Executive Director
Aaron Fox, Maintenance Manager
Rick Toohey, Interim Operations Manager
Shannon Cohan, Collection System Supervisor
Evan Walsh, Engineering Supervisor
Greg Coyle, Staff Engineer

2017 NPDES ANNUAL REPORT

LOWELL WATER

NPDES Permit No. MA0100633

April 2018

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Introduction

In 2005, the United States Environmental Protection Agency (USEPA) re-issued authorization to discharge under the National Pollutant Discharge Elimination System (NPDES) to the Lowell Regional Wastewater Utility (Lowell Water).

NPDES Permit No. MA0100633 authorizes Lowell Water to discharge sanitary and industrial wastewater from its Duck Island Clean Water Facility and Combined Sewer Overflows (CSOs) from nine discharge locations, into the Merrimack River, the Concord River, and Beaver Brook. The permit became effective on November 1, 2005.

As part of the NPDES permit, Lowell Water is required to submit an annual report that summarizes CSO activity and precipitation, certifies adequate recording of CSOs and inspection of CSO facilities, and reports on Lowell Water's Nine Minimum Controls (NMC) program.

Lowell Water is also required to submit an annual report on infiltration and inflow (I/I) control activities in its sewer collection system, as well as Capacity, Management, Operation, and Maintenance (CMOM) corrective actions and other activities. The I/I Control and CMOM annual reports are also included in this document.

Wet-Weather Annual Report

2017 Annual Infiltration/Inflow Report

NPDES Permit Requirement: Part I.D.3
NPDES Permit No. MA0100633
Lowell, Massachusetts

The Lowell Regional Wastewater Utility (LRWWU) submitted an Infiltration/Inflow (I/I) Control Plan in May 2006 that documented I/I mitigation activities to-date and described a plan to continue mitigation work over the NPDES permit period. In accordance with NPDES Permit Requirement Part I.D.3, this document provides a summary of the I/I control actions implemented in 2016 and provides a projection of the activities that are planned for 2017.

2017 Infiltration Rates

Lowell operates a combined sewer system; therefore, the amount of inflow collected by the system is significant. The table below summarizes the estimated rain-related inflow and non-rain related I/I conveyed by the combined sewer system in Lowell in 2017.

The table summarizes the impact of infiltration and inflow (I/I) on flow rates at the Duck Island CWF, in Million Gallons per Day (MGD). The number of days with precipitation (*Wet Days*) and the number of days without precipitation (*Dry Days*) are given for each month. Also shown are the average daily flow rates through the CWF for *All / Wet / Dry Days*, for each month.

The *Average Rain-Related Inflow* rate (5.26 MGD) was calculated by subtracting the *CWF Average Daily Flow (Dry Days)* from the *CWF Average Daily Flow (Wet Days)*. The *Average Non-Rain Related Inflow / Infiltration (I/I)* was calculated by subtracting the average daily municipal water production rate for each month and the average town sewer flow contribution each month from the *CWF Average Daily Flow (Dry Days)*. The *Average Non-Rain Related I/I rate* for calendar year 2017 was 10.86 MGD. The month with the highest *Average Daily Non-Rain Related I/I* was April 2017 (23.02 MGD).

2017 Infiltration and Inflow Record

Month	Wet Days/Dry Days	Flow (MGD)				
		WWTF Avg Daily Flow (All Days)	WWTF Avg Daily Flow (Wet Days)	WWTF Avg Daily Flow (Dry Days)	Avg Rain-Related Inflow	Avg Non-Rain-Related I/I
January	14/17	30.09	32.92	27.76	5.16	12.11
February	10/18	28.49	29.01	28.21	0.81	13.02
March	14/17	28.68	30.66	27.04	3.62	12.05
April	12/18	43.29	46.72	41.00	5.72	23.02
May	14/17	30.21	33.49	27.51	5.98	11.85
June	12/18	30.16	35.07	26.88	8.18	9.96
July	12/19	24.97	27.77	23.19	4.58	7.77
August	7/24	24.20	26.49	23.53	2.96	7.91
September	9/21	23.66	28.28	21.68	6.60	6.77
October	8/23	24.56	33.44	21.48	11.96	6.80
November	8/22	26.25	28.71	25.36	3.35	11.06
December	9/22	24.00	27.00	22.78	4.22	7.98
Total/Average	129/236	28.21	31.63	26.37	5.26	10.86

2017 I/I Control Actions

In 2017, LRWWU invested about $1.4 million in I/I control actions related to in-house sewer inspection, sewer replacement and sewer rehabilitation programs.

Assessment and Rehabilitation Projects

LRWWU continued to invest in preventive maintenance and inspections throughout 2017, including such efforts as root removal and sewer line cleaning, sewer repairs and replacement, Cured-In-Place-Pipe (CIPP) Lining, CCTV inspections, and catch basin and manhole repairs and replacement. Notably, in the summer of 2017 several large root-balls were removed from the 36-inch Lower Tilden interceptor line (the largest blocking approximately 75% of the pipe diameter). Metrics of these activities are summarized in the table below, and are detailed in the accompanying CMOM Report, which can be found in the next section.

2017 Collection System Preventive Maintenance

Activity/Action	Summary of 2017 Actions
Root Removal and Sewer Line Cleaning	Approx. $5,103 spent on root removal; 60,187 LF cleaned
Sewer Repairs and Replacement	Repaired 1797 LF
CCTV Inspections	Inspected approx. 76,981 LF
CIPP Lining	Installed approx. 7,933 LF
Catch Basin and Manhole Repairs and Replacement	Replaced/repaired 176 catch basins and manholes; removed 485 tons of debris from catch basins

Projected 2018 I/I Control Actions

LRWWU will continue to inspect and rehabilitate cross-country sewers and other miscellaneous sewers that display excessive I/I or structural deficiencies. In particular, the interceptor manholes in low-lying areas near the river will be investigated by Lowell Water's engineering staff during the high-flow period of 2018 in efforts to identify potential sources of inflow suspected in this area contributing to high inflow observed in April.

No sewer separation projects are planned for 2018. A comparable investment to that of 2017, as discussed above and in the following CMOM Report, will be made in 2018.

Lowell Water

2017 Quarter 1 - High-Flow Operational Data

Lowell utilizes a Supervisory Control and Data Acquisition (SCADA) network to record levels and flows throughout its transport and treatment system. This data is subject to instrument and communication errors and requires validation by the Engineering Division prior to dissemination to downstream users and regulatory agencies. Data quality protocols prevent sharing of inaccurate or unreliable information. The data in this report has been reviewed and is the best representation of system flows available using standard engineering practices for hydraulic measurements.

Date	Clean Water Discharge			Precipitation				High-Flow Treatment			Barasford Street			Beaver Brook			Merrimack Street			Read Street			Tilden Street			Walker Street			Warren Street			West Street			All Diversions		
01/01/17 12/31/17	Flow (MG)	Peak Hour (MGD)	Event Peak (MGD)	Precip Days (No.)	Daily Total (Inches)	Peak Hour (Inches)	Event Peak hour (Inches)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)
1/1/2017	29.34	47.24		1	0.08	0.03	0.03	1	2.60	1.24																										
1/3/2017	43.97	91.63	91.63	1	0.59	0.14	0.14	1	6.50	11.51							1	0.58	0.89													1	0.53	0.59	1	0.58	1.48
1/4/2017	36.63	72.76	72.76	1	0.04	0.01	0.01	1	4.37	3.17																										
1/6/2017	27.72	30.68		1	0.03	0.02	0.02																													
1/10/2017	25.78	39.18		1	0.31	0.07	0.07																													
1/11/2017	39.17	78.11		1	0.15	0.07	0.07	1	9.60	6.39																										
1/12/2017	29.46	31.70		1	0.09	0.02	0.02																													
1/17/2017	28.18	48.65		1	0.17	0.10	0.10	1	3.28	1.49																										
1/18/2017	32.28	41.44		1	0.34	0.04	0.04																													
1/22/2017	27.69	33.77		1	0.08	0.02	0.02																													
1/23/2017	30.88	38.58		1	0.28	0.04	0.04	1	0.95	0.28																										
1/24/2017	38.13	48.66		1	0.60	0.06	0.06	1	15.88	7.30																										
1/25/2017	36.46	42.05		1	0.10	0.03	0.03	1	3.38	0.84																										
1/26/2017	35.21	39.17		1	0.02	0.02	0.02																													
2/1/2017	27.63	31.41		1	0.09	0.07	0.07																													
2/2/2017	28.51	30.75		1	0.09	0.00	0.00																													
2/8/2017	30.69	49.02		1	0.57	0.16	0.16	1	5.07	2.56																										
2/9/2017	26.32	30.90		1	0.57	0.00	0.00																													
2/14/2017	24.08	27.76		1	0.12	0.05	0.05																													
2/15/2017	25.55	32.61		1	0.43	0.07	0.07																													
2/16/2017	26.95	30.99		1	0.43	0.02	0.02																													
2/17/2017	24.78	27.79		1	0.05	0.00	0.00																													
2/25/2017	36.98	51.50	51.50	1	0.20	0.11	0.11	1	1.32	1.18																			1	1.60	0.76				1	1.60	0.76
2/26/2017	38.61	63.97	63.97	1	0.20	0.00	0.00	1	2.53	1.56																										
3/7/2017	26.94	32.28		1	0.02	0.01	0.01																													
3/8/2017	27.10	30.08		1	0.06	0.02	0.02																													
3/9/2017	26.80	29.55		1	0.06	0.00	0.00																													
3/10/2017	26.38	29.07		1	0.02	0.01	0.01																													
3/11/2017	25.99	30.10		1	0.02	0.00	0.00																													
3/14/2017	24.97	31.41		1	0.10	0.04	0.04																													
3/16/2017	23.91	28.21		1	0.17	0.05	0.05																													
3/17/2017	24.49	28.73		1	0.22	0.06	0.06																													
3/24/2017	25.33	29.06		1	0.04	0.03	0.03																													
3/25/2017	29.72	45.30		1	0.19	0.05	0.05	1	2.55	0.91																										
3/27/2017	44.64	96.15	96.15	1	0.51	0.18	0.18	1	14.57	14.39							1	0.42	0.42				1	1.05	0.18				1	1.47	0.72				1	1.47	1.32
3/28/2017	41.43	81.53		1	0.44	0.08	0.08	1	7.78	10.80																										
3/29/2017	43.07	80.48		1	0.06	0.02	0.02	1	14.00	9.60																										
3/31/2017	38.52	65.27		1	0.13	0.02	0.02	1	7.80	5.63																										

Date	Clean Water Discharge			Precipitation				High-Flow Treatment			Barasford Street			Beaver Brook			Merrimack Street			Read Street			Tilden Street			Walker Street			Warren Street			West Street			All Diversions		
No. Days 365	Flow (MG)	Peak Hour (MGD)	Event Peak (MGD)	Precip Days (No.)	Daily Total (Inches)	Peak Hour (Inches)	Event Peak hour (Inches)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)
Total/Max	**1,180.28**	**96.15**	**-**	**38**	**7.67**	**0.18**	**-**	**16**	**102.18**	**78.85**	**0**	**0.00**	**0.00**	**0**	**0.00**	**0.00**	**2**	**1.00**	**1.31**	**0**	**0.00**	**0.00**	**1**	**1.05**	**0.18**	**0**	**0.00**	**0.00**	**2**	**3.07**	**1.48**	**1**	**0.53**	**0.59**	**3**	**3.65**	**3.56**
Avg/Percent	**31.06**	**44.67**	**75.20**	**10%**	**0.20**	**0.05**	**0.05**	**42%**	**6.39**	**4.93**	**0%**	**0.00**	**0.00**	**0%**	**0.00**	**0.00**	**5%**	**0.50**	**0.66**	**0%**	**0.00**	**0.00**	**3%**	**1.05**	**0.18**	**0%**	**0.00**	**0.00**	**5%**	**1.53**	**0.74**	**3%**	**0.53**	**0.59**	**8%**	**1.22**	**1.19**

Lowell Water

2017 Quarter 2 - High-Flow Operational Data

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Date	Clean Water Discharge			Precipitation				High-Flow Treatment			Barasford Street			Beaver Brook			Merrimack Street			Read Street			Tilden Street			Walker Street			Warren Street			West Street			All Diversions		
01/01/17 12/31/17	Flow (MG)	Peak Hour (MGD)	Event Peak (MGD)	Precip Days (No.)	Daily Total (Inches)	Peak Hour (Inches)	Event Peak hour (Inches)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)
4/1/2017	60.58	80.95		1	0.83	0.11	0.11	1	23.75	28.34																											
4/2/2017	58.10	80.43		1	0.57	0.14	0.14	1	23.73	25.88																											
4/3/2017	49.12	54.37				0.00	0.00	1	24.00	16.78																											
4/4/2017	66.97	83.14		1	0.60	0.07	0.07	1	24.00	35.16																											
4/5/2017	54.69	80.25				0.00	0.00	1	23.73	22.03																											
4/6/2017	70.95	97.12	97.12	1	0.97	0.22	0.22	1	24.00	34.00	1	5.13	1.95	1	0.22	0.20	1	2.15	1.90				1	0.60	0.10				1	3.25	0.98	1	2.33	1.85	1	5.13	6.98
4/7/2017	63.82	89.97	89.97			0.01	0.01	1	23.75	28.49																											
4/8/2017	54.09	59.06				0.00	0.00	1	24.00	20.53																											
4/9/2017	49.51	54.38				0.00	0.00	1	24.00	17.14																											
4/10/2017	46.18	49.48				0.00	0.00	1	24.00	14.38																											
4/11/2017	42.58	45.90				0.00	0.00	1	24.00	11.72																											
4/12/2017	44.91	66.34		1	0.14	0.06	0.06	1	24.00	13.39																											
4/13/2017	39.14	44.75				0.01	0.01	1	10.67	3.65																											
4/19/2017	32.93	37.78		1	0.05	0.02	0.02																														
4/20/2017	31.68	34.83		1	0.02	0.01	0.01																														
4/21/2017	42.05	79.31	79.31	1	0.42	0.09	0.09	1	14.73	11.17																						1	0.13	0.11	1	0.13	0.11
4/22/2017	34.68	39.58		1	0.02	0.01	0.01	1	1.77	0.31																											
4/25/2017	39.27	72.92		1	0.40	0.08	0.08	1	7.35	9.59																											
4/26/2017	49.02	71.16		1	0.30	0.08	0.08	1	24.00	16.00																											
4/27/2017	33.30	40.25				0.01	0.01	1	1.27	0.13																											
4/30/2017	29.46	34.60		1	0.02	0.02	0.02																														
5/2/2017	30.72	36.00		1	0.13	0.07	0.07																														
5/5/2017	44.79	94.66	94.66	1	0.74	0.23	0.23	1	7.93	13.29	1	1.53	0.52	1	0.15	0.01	1	0.68	0.60				1	1.18	0.16				1	1.90	1.26	1	0.95	1.82	1	1.90	4.37
5/6/2017	34.26	42.44		1	0.09	0.02	0.02	1	2.22	0.61																											
5/13/2017	25.91	30.98		1	0.03	0.02	0.02																														
5/14/2017	45.30	79.38		1	0.52	0.10	0.10	1	17.38	13.72																											
5/15/2017	37.37	56.21		1	0.19	0.06	0.06	1	10.48	4.91																											
5/18/2017	27.31	31.44		1	0.07	0.07	0.07																														
5/19/2017	28.14	34.17		1	0.02	0.02	0.02																														
5/22/2017	27.57	39.40		1	0.16	0.03	0.03																														
5/25/2017	28.09	40.83		1	0.16	0.04	0.04	1	1.85	0.55																											
5/26/2017	49.15	86.25	86.25	1	0.85	0.38	0.38	1	13.85	15.47	1	3.08	1.19	1	0.77	0.16	1	2.70	4.23				1	2.93	0.93	1	0.45	0.09	1	1.92	2.38	1	3.27	6.29	1	3.27	15.27
5/27/2017	28.90	33.92	33.92	1	0.02	0.01	0.01																														
5/29/2017	28.61	34.14		1	0.02	0.01	0.01																														
5/31/2017	32.73	80.79	80.79	1	0.23	0.13	0.13	1	3.38	6.05													1	0.27	0.02				1	0.43	0.16				1	0.43	0.18
6/1/2017	28.94	50.74				0.00	0.00	1	1.75	1.20																											
6/4/2017	25.87	36.70		1	0.07	0.03	0.03																														
6/5/2017	39.96	73.36		1	0.57	0.14	0.14	1	8.43	8.61																											
6/6/2017	63.71	90.89		1	0.94	0.09	0.09	1	22.45	30.02																											
6/7/2017	46.01	87.17		1	0.13	0.07	0.07	1	13.60	12.62																											
6/16/2017	31.65	76.15	76.15	1	0.57	0.22	0.22	1	5.72	5.80							1	0.18	0.15				1	0.57	0.10				1	0.45	0.13	1	0.38	0.63	1	0.57	1.01
6/17/2017	40.01	76.54	76.54	1	0.19	0.11	0.11	1	6.57	10.65							1	0.47	0.36													1	0.02	0.01	1	0.47	0.37
6/19/2017	28.60	54.37		1	0.09	0.05	0.05	1	3.12	2.22																											
6/20/2017	25.91	30.73		1	0.03	0.01	0.01	1	0.18	0.01																											
6/24/2017	23.99	28.12		1	0.04	0.04	0.04																														
6/25/2017	24.45	51.04		1	0.12	0.06	0.06	1	1.37	1.36																											
6/26/2017	23.09	34.48				0.01	0.01	1	0.60	0.14																											
6/27/2017	38.32	90.05	90.05	1	0.57	0.30	0.30	1	7.18	11.98	1	2.75	0.52	1	0.77	0.68	1	2.30	1.92	1	0.18	0.06	1	1.13	1.32	1	0.75	1.71	1	1.37	1.82	1	1.35	1.67	1	2.75	9.70
6/28/2017	24.40	27.04	27.04			0.00	0.00																														
6/30/2017	32.34	79.49	79.49	1	0.54	0.17	0.17	1	4.10	7.34				1	0.70	0.46	1	0.50	0.33	1	0.07	0.01	1	0.72	0.73	1	0.27	0.06	1	0.48	0.37	1	0.82	1.23	1	0.82	3.19
Date	Clean Water Discharge			Precipitation				High-Flow Treatment			Barasford Street			Beaver Brook			Merrimack Street			Read Street			Tilden Street			Walker Street			Warren Street			West Street			All Diversions		
No. Days 365	Flow (MG)	Peak Hour (MGD)	Event Peak (MGD)	Precip Days (No.)	Daily Total (Inches)	Peak Hour (Inches)	Event Peak hour (Inches)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)
Total/Max	**1,959.12**	**97.12**	**-**	**38**	**11.43**	**0.38**	**-**	**37**	**478.92**	**455.24**	**4**	**12.50**	**4.18**	**5**	**2.60**	**1.51**	**7**	**8.98**	**9.49**	**2**	**0.25**	**0.07**	**7**	**7.40**	**3.36**	**3**	**1.47**	**1.86**	**7**	**9.80**	**7.10**	**8**	**9.25**	**13.61**	**9**	**15.47**	**41.18**
Avg/Percent	**39.18**	**58.08**	**75.94**	**10%**	**0.30**	**0.07**	**0.07**	**97%**	**12.94**	**12.30**	**11%**	**3.13**	**1.05**	**13%**	**0.52**	**0.30**	**18%**	**1.28**	**1.36**	**5%**	**0.13**	**0.04**	**18%**	**1.06**	**0.48**	**8%**	**0.49**	**0.62**	**18%**	**1.40**	**1.01**	**21%**	**1.16**	**1.70**	**24%**	**1.72**	**4.58**

Lowell Water

2017 Quarter 3 - High-Flow Operational Data

Lowell utilizes a Supervisory Control and Data Acquisition (SCADA) network to record levels and flows throughout its transport and treatment system. This data is subject to instrument and communication errors and requires validation by the Engineering Division prior to dissemination to downstream users and regulatory agencies. Data quality protocols prevent sharing of inaccurate or unreliable information. The data in this report has been reviewed and is the best representation of system flows available using standard engineering practices for hydraulic measurements.

Date	Clean Water Discharge			Precipitation				High-Flow Treatment			Barasford Street			Beaver Brook			Merrimack Street			Read Street			Tilden Street			Walker Street			Warren Street			West Street			All Diversions		
01/01/17 12/31/17	Flow (MG)	Peak Hour (MGD)	Event Peak (MGD)	Precip Days (No.)	Daily Total (Inches)	Peak Hour (Inches)	Event Peak hour (Inches)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)
7/1/2017	30.52	69.26				0.00	0.00	1	3.55	3.82																										
7/2/2017	23.26	28.18		1	0.02	0.01	0.01																													
7/7/2017	27.82	68.04		1	0.36	0.12	0.12	1	3.32	2.88																										
7/8/2017	25.55	52.76	52.76	1	0.21	0.19	0.19	1	3.43	2.66																			1	0.50	0.52				1	0.50	0.52
7/11/2017	25.31	44.94		1	0.16	0.07	0.07																													
7/12/2017	32.16	88.86	88.86	1	0.46	0.19	0.19	1	4.02	7.01													1	0.45	0.05				1	0.53	0.16				1	0.53	0.21
7/13/2017	25.53	42.40		1	0.03	0.01	0.01	1	1.33	0.48																										
7/14/2017	23.06	27.53		1	0.03	0.03	0.03																													
7/15/2017	23.94	32.90		1	0.07	0.06	0.06																													
7/18/2017	34.27	102.37	102.37	1	0.78	0.78	0.78	1	5.55	8.93	1	1.63	0.86	1	0.73	0.94	1	1.23	1.86	1	0.17	0.06	1	1.15	1.37	1	0.87	2.29	1	1.18	5.43	1	0.10	0.15	1	1.63	12.96
7/24/2017	43.11	99.97	99.97	1	1.15	0.26	0.26	1	9.62	15.09	1	2.82	0.56				1	2.62	2.63				1	2.05	0.20				1	1.12	0.18	1	0.18	0.28	1	2.82	3.85
7/25/2017	25.75	35.41		1	0.06	0.04	0.04			0.03																										
7/27/2017	23.55	27.12		1	0.03	0.02	0.02																													
8/2/2017	28.79	55.17		1	0.21	0.08	0.08	1	2.70	1.62																										
8/5/2017	27.68	46.37		1	0.20	0.12	0.12																													
8/12/2017	24.43	28.98		1	0.06	0.04	0.04																													
8/18/2017	26.43	56.34		1	0.17	0.09	0.09	1	1.30	0.64																										
8/19/2017	23.68	28.56		1	0.02	0.02	0.02																													
8/23/2017	32.48	93.84	93.84	1	0.24	0.19	0.19	1	2.95	4.53				1	0.03	0.02							1	0.57	0.11				1	0.65	0.27				1	0.65	0.40
8/30/2017	21.98	26.72		1	0.02	0.01	0.01																													
9/3/2017	33.29	75.66	75.66	1	0.52	0.21	0.21	1	6.48	6.24																			1	2.50	0.86				1	2.50	0.86
9/6/2017	42.09	101.89	101.89	1	0.91	0.42	0.42	1	7.43	12.24				1	0.82	0.82				1	0.05	0.01	1	1.27	0.49	1	0.40	0.14	1	2.72	3.78				1	2.72	5.24
9/7/2017	41.06	99.17	99.17	1	0.94	0.21	0.21	1	6.73	8.01													1	0.58	0.11				1	1.82	1.54				1	1.82	1.65
9/9/2017	23.63	28.09		1	0.03	0.03	0.03																													
9/14/2017	24.33	50.85		1	0.12	0.06	0.06	1	1.03	0.57																										
9/15/2017	24.10	36.96		1	0.02	0.01	0.01	1	0.38	0.06																										
9/19/2017	21.94	25.97		1	0.02	0.01	0.01																													
9/20/2017	21.63	26.16		1	0.05	0.02	0.02																													
9/30/2017	22.50	32.78		1	0.20	0.09	0.09																													

Date	Clean Water Discharge			Precipitation				High-Flow Treatment			Barasford Street			Beaver Brook			Merrimack Street			Read Street			Tilden Street			Walker Street			Warren Street			West Street			All Diversions		
No. Days 365	Flow (MG)	Peak Hour (MGD)	Event Peak (MGD)	Precip Days (No.)	Daily Total (Inches)	Peak Hour (Inches)	Event Peak hour (Inches)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)
Total/Max	**803.84**	**102.37**	**-**	**28**	**7.09**	**0.78**	**-**	**15**	**59.83**	**74.81**	**2**	**4.45**	**1.42**	**3**	**1.58**	**1.78**	**2**	**3.85**	**4.49**	**2**	**0.22**	**0.07**	**6**	**6.07**	**2.33**	**2**	**1.27**	**2.43**	**8**	**11.02**	**12.74**	**2**	**0.28**	**0.43**	**8**	**13.17**	**25.69**
Avg/Percent	**27.72**	**52.87**	**89.32**	**8%**	**0.25**	**0.12**	**0.12**	**54%**	**3.99**	**4.68**	**7%**	**2.23**	**0.71**	**11%**	**0.53**	**0.59**	**7%**	**1.93**	**2.25**	**7%**	**0.11**	**0.04**	**21%**	**1.01**	**0.39**	**7%**	**0.63**	**1.22**	**29%**	**1.38**	**1.59**	**7%**	**0.14**	**0.22**	**29%**	**1.65**	**3.21**

Lowell Water

2017 Quarter 4 - High-Flow Operational Data

Lowell utilizes a Supervisory Control and Data Acquisition (SCADA) network to record levels and flows throughout its transport and treatment system. This data is subject to instrument and communication errors and requires validation by the Engineering Division prior to dissemination to downstream users and regulatory agencies. Data quality protocols prevent sharing of inaccurate or unreliable information. The data in this report has been reviewed and is the best representation of system flows available using standard engineering practices for hydraulic measurements.

Date	Clean Water Discharge			Precipitation				High-Flow Treatment			Barasford Street			Beaver Brook			Merrimack Street			Read Street			Tilden Street			Walker Street			Warren Street			West Street			All Diversions		
01/01/17 12/31/17	Flow (MG)	Peak Hour (MGD)	Event Peak (MGD)	Precip Days (No.)	Daily Total (Inches)	Peak Hour (Inches)	Event Peak hour (Inches)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)
10/8/2017	22.07	40.67		1	0.09	0.08	0.08																													
10/9/2017	31.05	86.55	86.55	1	0.39	0.15	0.15	1	3.12	4.21													1	0.38	0.05				1	0.63	0.36				1	0.63	0.41
10/14/2017	20.46	24.75		1	0.02	0.01	0.01																													
10/24/2017	22.04	51.61		1	0.27	0.10	0.10	1	1.22	0.92																										
10/25/2017	36.47	75.13	75.13	1	0.49	0.12	0.12	1	8.20	7.08																			1	0.47	0.13				1	0.47	0.13
10/26/2017	43.60	91.01	91.01	1	0.47	0.11	0.11	1	11.32	8.61																			1	0.95	0.32				1	0.95	0.32
10/29/2017	31.05	103.64	103.64	1	0.69	0.20	0.20	1	2.70	4.62				1	0.18	0.01	1	0.87	1.14				1	1.22	0.13				1	1.77	1.08				1	1.77	2.36
10/30/2017	60.77	115.03	115.03	1	1.29	0.51	0.51	1	11.93	22.09	1	2.75	2.23	1	4.78	3.66	1	5.00	8.20				1	4.62	2.88	1	0.05	0.06	1	4.70	6.83	1	4.90	7.93	1	5.00	31.79
11/6/2017	26.15	33.67		1	0.05	0.03	0.03																													
11/7/2017	25.17	29.10		1	0.06	0.03	0.03																													
11/8/2017	24.56	28.83		1	0.02	0.02	0.02																													
11/13/2017	27.13	39.80		1	0.24	0.05	0.05																													
11/16/2017	31.74	50.56		1	0.34	0.09	0.09																													
11/18/2017	24.99	33.53		1	0.07	0.05	0.05																													
11/19/2017	31.71	49.38		1	0.27	0.10	0.10																													
11/22/2017	38.19	78.98		1	0.47	0.13	0.13	1	7.17	7.26																										
12/1/2017	24.27	27.71		1	0.04	0.02	0.02																													
12/5/2017	24.28	38.16	38.16	1	0.28	0.19	0.19	1	0.25	0.15																			1	0.42	0.13				1	0.42	0.13
12/6/2017	35.64	64.92	64.92	1	0.28	0.20	0.20	1	6.07	4.07							1	0.57	0.68										1	0.77	0.17	1	1.77	1.62	1	1.77	2.47
12/10/2017	24.50	32.41		1	0.40	0.13	0.13																													
12/11/2017	23.73	30.81		1	0.10	0.03	0.03																													
12/12/2017	28.84	47.89		1	0.27	0.06	0.06																													
12/19/2017	21.25	27.34		1	0.02	0.02	0.02																													

Date	Clean Water Discharge			Precipitation				High-Flow Treatment			Barasford Street			Beaver Brook			Merrimack Street			Read Street			Tilden Street			Walker Street			Warren Street			West Street			All Diversions		
No. Days 365	Flow (MG)	Peak Hour (MGD)	Event Peak (MGD)	Precip Days (No.)	Daily Total (Inches)	Peak Hour (Inches)	Event Peak hour (Inches)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)	Event (No.)	Duration (Hours)	Volume (MG)
Total/Max	**679.66**	**115.03**	**-**	**23**	**6.62**	**0.51**	**-**	**9**	**51.97**	**59.01**	**1**	**2.75**	**2.23**	**2**	**4.97**	**3.67**	**3**	**6.43**	**10.02**	**0**	**0.00**	**0.00**	**3**	**6.22**	**3.06**	**1**	**0.05**	**0.06**	**7**	**9.70**	**9.02**	**2**	**6.67**	**9.55**	**7**	**11.00**	**37.61**
Avg/Percent	**29.55**	**52.24**	**82.06**	**6%**	**0.29**	**0.11**	**0.11**	**39%**	**5.77**	**6.56**	**4%**	**2.75**	**2.23**	**9%**	**2.48**	**1.84**	**13%**	**2.14**	**3.34**	**0%**	**0.00**	**0.00**	**13%**	**2.07**	**1.02**	**4%**	**0.05**	**0.06**	**30%**	**1.39**	**1.29**	**9%**	**3.33**	**4.78**	**30%**	**1.57**	**5.37**

LOWELL REGIONAL WASTEWATER UTILITY

WASTEWATER COLLECTION AND TREATMENT

MARK A. YOUNG
EXECUTIVE DIRECTOR

SERVING LOWELL
CHELMSFORD
DRACUT
TEWKSBURY
TYNGSBORO

April 30, 2018

Water Technical Unit
U.S. Environmental Protection Agency
PO Box 8127 (SEW)
Boston MA 02114

Massachusetts Department of Environmental Protection
Northeast Regional Office
Bureau of Resource Protection
One Winter Street
Boston MA 02108

Subject: Annual Certification Statement of CSO Discharges for NPDES Permit No. MA0100633

To Whom It May Concern,

On behalf of the Lowell Regional Wastewater Utility (LRWWU), I hereby certify that all CSO discharges from LRWWU's permitted outfalls have been recorded for the 2017 reporting period. CSO discharge records are kept on file.

These records include dates and times of CSO events, CSO volumes and durations, precipitation amounts, and wet weather flows treated by the Utility.

Respectfully,

Greg Coyle

Staff Engineer

LRWWU

Copy / File

Mark Young, Executive Director
Mike Stuer, Engineering Manager
Aaron Fox, Maintenance Superintendent
Tom Kawa, Operations Superintendent

LOWELL REGIONAL WASTEWATER UTILITY

WASTEWATER COLLECTION AND TREATMENT

MARK A. YOUNG
EXECUTIVE DIRECTOR

SERVING LOWELL
CHELMSFORD
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April 30, 2018

Water Technical Unit
U.S. Environmental Protection Agency
PO Box 8127 (SEW)
Boston MA 02114

Massachusetts Department of Environmental Protection
Northeast Regional Office
Bureau of Resource Protection
One Winter Street
Boston MA 02108

Subject: Annual Certification Statement of CSO Structure Inspections for NPDES Permit No. MA0100633

To Whom It May Concern,

On behalf of the Lowell Regional Wastewater Utility (LRWWU), I hereby certify that all CSO structures have been routinely inspected during the 2017 reporting period. Inspection records are kept on file.

These inspections include the date, the time, the inspectors, the general conditions of the facility, and notes on the operating condition of the facility.

Respectfully,

Aaron Fox

Maintenance Superintendent

LRWWU

Copy / File

Mark Young, Executive Director

Mike Stuer, Engineering Manager

Tom Kawa, Operations Superintendent

Lowell, Massachusetts
NPDES No. MA0100633)

Summary of Nine Minimum Control Measures Program Modifications
2017 Annual Report

Permit Item Part I.F.3.d

The Lowell Regional Wastewater Utility (LRWWU) submitted a Nine Minimum Control Measures (NMC) Report in April 1998 that documented and evaluated existing NMCs in Lowell's combined sewer system and considered enhancements to those existing measures. The report was approved by the U.S. Environmental Protection Agency and the Massachusetts Department of Environmental Protection.

This document provides a summary of the current NMCs and modifications that were considered and implemented last year.

Minimum Control Measure	Current Practices / Modifications Implemented	Modifications Considered
Proper Operation and Maintenance Programs	LRWWU has a comprehensive, system-wide operation and maintenance program that is designed to prevent dry weather overflows and minimize CSO discharges. The program includes regular inspection of all critical CSO facilities and pumping stations; performance of routine/preventive maintenance; and provisions for immediate emergency response to avoid unnecessary diversion of sanitary or combined wastewater. In addition to inspection and maintenance programs, LRWWU utilizes a SCADA system to continuously monitor all CSO diversion stations. Numerous SCADA alarms have been set up for immediate awareness of equipment malfunction and process upsets. Recent modifications and a complete system upgrade have improved the reliability of this monitoring program, with all conditions electronically recorded on a continuous basis. Modifications to the Merrimack, Beaver Brook, Tilden Street, Warren, West Street, and Read Street CSO Diversion Stations have improved operations and reduced maintenance at these stations. LRWWU has also upgraded the Data Management and Reporting Software. This has allowed LRWWU to report and analyze process data more efficiently. **Achieved Minimum Control**	LRWWU continues to meet its commitment to its operational and maintenance programs and continues to make improvements to each of its CSO and pumping stations to improve the capture of wet weather flow and reduce untreated CSO discharges. While existing operations and maintenance practices are sufficient to monitor, maintain and operate the combined sewer system, LRWWU is upgrading to a more enhanced Computerized Maintenance Management System (CMMS). This CMMS will consist of a new and improved work order system, as well as an improvement in scheduling of preventive maintenance.

Minimum Control Measure	Current Practices / Modifications Implemented	Modifications Considered
Maximize Use of Collection System for Storage	In 2008, LRWWU upgraded its SCADA network to improve the reliability of remotely-controlled equipment. The Head Operator at the Clean Water Facility (CWF) utilizes the SCADA system to operate a network of programmable logic controllers (PLCs) to remotely control gates and pumps at eight diversion stations. Modifications to the CSO Stations' gates and equipment have caused an increase in upstream interceptor system pipeline storage and have significantly minimized CSO discharges. This has resulted in enhanced control and monitoring of wet weather flows in the combined sewer system. Improvements to gate operations at the West Street and Warren CSO Stations have led to the utilization of additional storage capacity in the North Bank Interceptor and the Concord River Interceptor, respectively. LRWWU routinely inspects the interceptor system, regulators, pumping facilities, and flap gates and have not identified any operational problems or blockages that are limiting storage maximization. LRWWU has completed a holistic evaluation of wet weather flow storage in its interceptor system. This evaluation, referred to as High Flow Management (HFM), is described in detail in a March 2010 report submitted to USEPA and MADEP. The results of LRWWU's HFM assessment are as follows: 1) optimum gate actuation set points have been enabled; 2) a standard protocol for wet weather operations is being implemented; 3) a substantial opportunity for additional interceptor storage has been identified and constructed at Read Station, which will be implemented in 2018. A PLC program is currently being utilized to automatically control gates at West and Merrimack stations. These gates control the flow of combined sewage to the Duck Island WWTF. The PLC program is designed to maximize flow to the WWTF while minimizing the discharge of CSOs by balancing storage in both the North Bank and South Bank interceptors. **Achieved Minimum Control**	LRWWU had installed real-time depth monitors in its interceptor system to evaluate the current use of in-line interceptor storage. LRWWU evaluated the data from wet weather events, and determined that a wet weather treatment facility would enhance the capture of CSOs and installing a gate along the interceptor would maximize storage. This interceptor storage project at Read Station was completed and put online in early 2018. Through this project, new flow control gates at Read Station now allow LRWWU to fully utilize the available pipe storage in the 96-inch diameter North Bank Interceptor, resulting in an additional one million gallons of in-line storage. LRWWU will continue to monitor and record CSO activations and the operating depth of the upstream interceptors. Monthly "High Flow Management" team meetings are conducted to review this data for recent high flow events and consider opportunities for improvement. Where practical, LRWWU will continue to modify operations to maximize the use of the collection system for CSO storage. In 2018, LRWWU is reviewing and recalibrating its collection system model and dedicating engineering staff to managing the model in support of further optimization of the collection system design and operation.

Minimum Control Measure	Current Practices / Modifications Implemented	Modifications Considered
Pollution Prevention Programs	There are a number of pollution prevention programs currently implemented by LRWWU that help to reduce the impact of extraneous pollution in CSO discharges. These include street sweeping, catch basin cleaning, catch basin labeling, hazardous waste collection, litter control programs, pet waste management, garbage collection, recycling, and city ordinances prohibiting dumping and requiring erosion control and stormwater retention at developments. LRWWU's GIS program has resulted in extensive mapping of Lowell's drain lines, catch basins, and outfalls. Improved mapping has helped to inform the catch-basin labeling program, which will continue until all catch basins are properly labeled. This program educates the public about the effects of illicit dumping and promotes ownership in the public drainage system. **Achieved Minimum Control**	As part of its NPDES Phase II Stormwater and CSO Programs, LRWWU will update the CWF's website and distribute brochures that help to increase public awareness of the stormwater and CSO pollution issues. As LRWWU continues its CSO control program, public outreach is utilized to inform local residents of pollution prevention issues.
Control of Solids and Floatable Materials in CSO Discharges	Non-structural solids and floatable control technologies such as street sweeping, catch basin cleaning, and sewer system maintenance are performed by LRWWU and the City of Lowell to remove solids and floatables before they enter the receiving water. LRWWU has reverted to in-house street sweeping operations in order to minimize the transport of solids into the combined sewer system. The City of Lowell's Department of Public Works has purchased new equipment and will once again be responsible for this control measure. LRWWU is working hard to ensure that catch basins are cleaned on a set schedule, thus decreasing solids-entry rates into the combined sewer system. Beaver Brook and Walker Stations screen their influent wastewater for solids and floatable materials using bar screens. These bar screens are maintained and cleaned, as needed, on a daily basis. It is not practical or cost-effective to implement additional solids and floatable control technologies at LRWWU's other CSO diversion structures. **Achieved Minimum Control**	LRWWU continues to maintain CSO screening equipment, and clean catch basins along with contracted help on a daily basis. New street cleaning and salting vehicles have greatly reduced the amount of solids and floatables in CSO discharges and in LRWWU's sewer system.

Minimum Control Measure	Current Practices / Modifications Implemented	Modifications Considered
Prohibiting CSO Discharges During Dry Weather	No Dry Weather Overflows have been observed during regular inspections of the CSO Diversion Structures and combined sewer system. LRWWU remotely monitors its CSO Diversion Stations. All conditions are continuously monitored at each of the stations and alarms alert the Head Operator at the CWF if any CSO discharges are about to occur or are currently discharging. Recent upgrades to the SCADA system have improved the reliability of the control and monitoring CSO diversion stations, thus reducing the possibility of a dry-weather CSO discharge. LRWWU has upgraded its Influent Pumping Station, which includes new screw pumps and new emergency generators. These improvements have resulted in more reliable wet weather operations at the CWF, which will reduce the possibility of a dry-weather CSO discharge. In addition, the School Street Pump Station, an unreliable pumping station, has been replaced. This upgrade further reduces the possibility of dry-weather discharges from Lowell's combined sewer system. LRWWU monitors the equipment at all CSO stations daily. Head Operators at the LRWWU continue to keep a close watch on all SCADA alarms and interceptor levels, to prevent any CSO discharges during dry weather. **Achieved Minimum Control**	LRWWU is satisfied with their preventive actions against CSO Discharges during Dry Weather. No new modifications are being considered during this time.
Review and Modification of the Industrial Pretreatment Program	The Industrial Pretreatment Program, including its compliance reporting, provides LRWWU with the mechanism to monitor and control metals and other pollutants generated from industrial wastewater dischargers that are served by the combined sewer system. **Achieved Minimum Control**	LRWWU continually updates this program and its sewer use permit discharge standards to meet updated state and federal regulations. LRWWU has implemented a hauled waste management program that controls the quality and of waste discharged at the treatment facility. Monitoring is performed to ensure compliance with local limits, which were updated in 2017..

Minimum Control Measure	Current Practices / Modifications Implemented	Modifications Considered
Maximizing Flows to the LRWWU Wastewater Treatment Facility	The CWF is operated at its full practical flow/treatment capacity during every storm event to maximize treatment of combined sewer flow that might otherwise be discharged as untreated CSOs. In order to fully realize its goal of maximizing flows to the CWF, LRWWU has upgraded its existing influent pumping station. All four screw pumps have been replaced. Since upgrading the screw pumps, LRWWU has had some problems pumping flows through the WWTF. All problems with the screw pumps have been fixed and have been working properly since 2015. All flows to the plant receive primary treatment. Wet weather flow greater than the secondary aeration system capacity is directed around the secondary system and blended with secondary effluent before disinfection and discharge to the Merrimack River. LRWWU has developed tools for the operators to help maximize flows to the plant without violating the NPDES permit. In order to prevent further Effluent TSS violations, LRWWU has installed three new TSS meters. One TSS meter is located in the Primary Effluent and the other two meters are located in the Secondary Effluent. Using data from the TSS meters and numerous flow meters, LRWWU has now been able to calculate an estimated Plant Effluent TSS concentration along with an estimated Daily Average TSS concentration. These tools have helped prevent any TSS violations before they occur. To further maximize flows to the CWF, LRWWU partnered with a consultant to analyze historical wet-weather data to determine the hydraulic capacity of the plant and ascertain the most efficient way to run the influent screw pumps. Consequently a more aggressive High-Flow Management (HFM) program has been established, and wet-weather flows are maximized to the extent possible without disturbing process stability or violating permit limits. One particular change implemented was the reconfiguration of the rate of closure on the flow-control gates at the two main diversion stations such that the gates open slowly and close rapidly, thus allowing the CWF to take on flow to meet full capacity and then rapidly decrease flow in order to prevent damage from a hydraulic surge. **Achieved Minimum Control**	LRWWU strives to maximize the use of in-line interceptor pipeline storage capacity, which will ultimately maximize the use of available treatment capacity at the CWF for wet weather flow to avoid untreated CSO discharges and maximize treatment of urban stormwater runoff that would otherwise degrade water quality. LRWWU is in the process of designing new mechanical equipment for the clarifiers. These new clarifiers will be more reliable and will allow the CWF to further increase flows to be treated. As described in a previous section, LRWWU has constructed and brought on-line a new flow control gate in the Read Interceptor in early 2018. It was determined during a hydraulic analysis that this flow control gate will allow LRWWU to maximize storage in the Read Interceptor thus allowing increased flows to the CWF.

Minimum Control Measure	Current Practices / Modifications Implemented	Modifications Considered
Public Notification	In 2006, the existing program was modified to include: • *Outfall signs visible from both water and land*. LRWWU installed signs that are visible from both sides of each outfall**.** • *Signs/Notices at recreational areas impacted by CSOs*. LRWWU prepared a notice that was placed on all existing bulletin boards or kiosks located at all public boat launches, swimming areas, or recreational access points to the river. This notice advises the public about the existence of CSO discharges and the potential health risks posed by use of the river during rainfall events because of CSO discharges. • *Quarterly posting of CSO discharges on website*. LRWWU created a website that posts quarterly information on CSO discharges from its combined sewer system. • *Annual notification of CSO abatement progress*. LRWWU's website will be updated annually to include information regarding the implementation of the LTCP and the progress achieved in reducing CSO discharges. • *Notice to downstream river users of CSO discharges*. LRWWU verbally notifies downstream river users within 24 hours of a CSO discharge. This program was expanded to include other interested downstream individuals or agencies such as the shellfish wardens and harbormasters. A detailed report of high-flow events, including CSO durations and volumes, is shared with all interested parties within ten days of the event. **Achieved Minimum Control**	The City of Lowell unveiled a new web-site management platform that has allowed LRWWU staff to directly control content, thus making public notifications and presentation of relevant information more efficient. LRWWU is in the progress of developing a website under this new platform that will help to inform the public about the Lowell Regional Wastewater Utility operations, its CSO program, and other activities conducted by LRWWU to improve water quality in the Merrimack and Concord Rivers. Over time, LRWWU expects to post information on the Internet regarding its LTCP and sewer separation programs and progress on CSO abatement. LRWWU has determined that the practice of calling downstream users is generally inefficient, particularly during high-flow events when operators' attentions are required elsewhere. Instead of phone calls, email may be a better method of first notification of the occurrence of CSO's. Emails sent at the start and finish of each CSO event will be shared with downstream parties and any other member of the public who wishes to sign up for the notification. LRWWU has begun sharing final notifications with the Merrimack River Watershed Council, which maintains a Facebook account and notifies its members of CSOs. LRWWU is also considering social media options for improving public notification. LRWWU's *Clean Stream Initiative*, summarized in the next section, will help to characterize the magnitude and duration of CSO events as well as impacts to water quality due to stormwater runoff in the absence of CSOs. As the program continues to develop, opportunities to improve public awareness of wet-weather discharges will be identified and, where feasible, implemented.

Minimum Control Measure	Current Practices / Modifications Implemented	Modifications Considered
Monitoring to Effectively Characterize CSO Impacts and the Efficacy of CSO Controls	LRWWU submitted a Long-Term Control Plan (August 2014) that fully characterized Lowell's combined sewer system, including its diversion structures, outfall discharges, pollutant loads, and receiving water impact. The Long-Term Control Plan (LTCP) also developed alternatives and a phased set of recommendations to reduce CSO discharges. LRWWU originally installed long-term gauges to monitor flows and CSO discharges during the implementation of the LTCP. The gauging program became increasingly expensive and ineffective. As a result, LRWWU utilized an alternative method of flow monitoring– direct measurement of CSO discharges using appropriate hydraulic principles of flow-measurement. LRWWU has installed a system-wide SCADA network to help monitor and control CSO discharges. Multiple level-monitoring devices have been installed at each CSO diversion structure to measure flow through the structure, control operations, and to estimate CSO discharges. Level measurements are used with appropriate open-channel flow measurement formulae to estimate flow discharged through various diversion-gate openings. CSO volumes through gate openings are modeled as flow through orifices or flow over weirs. These level measurements are transmitted to local PLCs for data storage and operational control. All of the collection system PLCs are connected by radio telemetry to the CWF, where operators monitor and record interceptor flows and CSO discharges. LRWWU recently completed a major initiative to verify the existing SCADA/communications networks for monitoring and gathering CSO flow information in the system. This endeavor has also resulted in the development and verification of automated, electronic reporting systems to facilitate the compilation of system data, especially with regard to wet weather operations. **Achieved Minimum Control**	LRWWU continues to work on verifying and enhancing the accuracy of CSO flow measurements. LRWWU has initiated a program to systematically monitor key CSO stations to verify flow formulae that are used by the data collection and reporting systems. LRWWU has verified CSO flow measurements in two of the four key CSO diversion stations and will continue to work on verifying the CSO flow measurements in the other diversion stations. A continual review of the flow monitoring system will be undertaken, as part of the ongoing HFM Program previously discussed, to identify potential opportunities for improvement in monitoring and estimation of flows as technology is updated. LRWWU is developing a water-quality monitoring and modeling program, the *Clean Stream Initiative*, with a goal to collect, organize and analyze water-quality information in the Merrimack and Concord Rivers in the Lowell area. This program will enable Lowell and other interested parties to better characterize the magnitude and duration of impacts to water quality due to LRWWU discharges. The program consists of two monthly sampling events: one during dry-weather conditions and one during wet-weather conditions. Wet-weather information will be organized into the Watershed Assessment Model developed on behalf of the Merrimack River Basin Community Coalition and the US Army Corps of Engineers. Dry-weather information during near-steady-state conditions will be organized into the more detailed Qual2K model developed for EPA. The models will be used to determine which potential CSO control scenarios may most effectively improve water quality. In addition, weekly bacteria samples will be collected on a regular schedule and analyzed to support a strong geometric mean during the recreational season.

CMOM Annual Report

2017 CMOM ANNUAL REPORT

LOWELL REGIONAL WASTEWATER UTILITY

April 2018

2017 CMOM ANNUAL REPORT SUMMARY

This CMOM Program Implementation Annual Report outlines the actions taken by Lowell Water for the 2017 calendar year, in compliance with the September 2010 Administrative Order. The items addressed in this report are as follows:

- A description of the Corrective Actions taken in 2017 and how successful these actions were in mitigating the CMOM deficiencies identified in the CMOM corrective action self-assessment checklist. A description of Lowell Water's plans for future corrective actions for outstanding deficiencies identified in the self-assessment checklist.
- A summary listing all unauthorized discharges. The City of Lowell had seven sewer surcharges reported in the 2017 calendar year. A Summary Table and Location Map of unauthorized discharges is included herein. The summary includes the location, date and time, source of notification, cause, discharge volume, ultimate fate of discharge, and mitigation measures to reduce or eliminate these discharges.
- A description of the City of Lowell's GIS system and how Lowell Water utilizes the system for location of assets and mapping the collection system.
- A description of Lowell Water's measures to reduce extraneous flows through sewer separation and other infiltration and inflow projects during the 2017 calendar year.
- A description of Lowell Water's collection system activities, including bi-weekly progress meetings to discuss all aspects of the collection system from maintenance to rehabilitation to capital projects.

2017 CMOM CORRECTIVE ACTIONS

In conformance with the September 2010 Administrative Order, Article IV.8, Lowell Water has developed a CMOM Corrective Action Plan and has identified deficiencies that are to be corrected. Lowell Water has addressed a number of these deficiencies in the past (including a system for notification and record of sewer system blockages, sewer surcharge notification, and a sewer cleaning schedule); this effort continued in 2017, as summarized below.

- **Sewer System Capacity Analysis** – The CMOM checklist identified the need for determining the capacity of the existing sewer system to accommodate new connections. Lowell Water has developed a robust field inspection program (see above) that is augmented by a review process that evaluates the capacity of a local sewer system to accommodate additional flow from new connections. All significant property development projects within the City of Lowell are reviewed during a multi-departmental process that considers, amongst other things, sewer capacity. Both the Sewer Collection Supervisor and the Engineering Manager review and approve new sewer connections before permits are issued by the City Engineer. This review process is supported with bi-weekly internal meetings that provide a forum for discussing the capacity of the collection system in specific locations, related to certain development projects or notable problem areas. In addition to ongoing localized reviews, Lowell Water has contracted with a consulting engineer (Hazen & Sawyer) to evaluate and modify an existing SWMM model that characterizes system-wide responses to both dry and wet-weather conditions. This deficiency has been corrected.

- **Emergency Response Plan** - The CMOM checklist identified the need for a written emergency response plan in the event of serious failure of the sewer collection system. Lowell Water is currently developing such a plan, which will include protocol for contacting appropriate department personnel and agencies to successfully resolve collection system failures and mitigate these emergencies if they occur. The basis of an emergency response plan has begun with training of Lowell Water staff to respond to the release of hazardous materials into the sewer collection system.

  In 2016, Lowell Water trained a response team that could be deployed to a hazardous materials spill. Altogether, more than a dozen employees were trained as HAZWOPER 24-hour spill response technicians. This training will serve as the foundation of future emergency response efforts. Lowell Water has completed a draft Emergency Response and Preparedness Manual which includes contact information and call lists for emergencies as well as detailed information regarding proper response procedures. This draft will be finalized in 2018 after incorporating a section of procedures for more general collection system emergencies.

- **Collection System Asset Evaluation** – The CMOM checklist identified the need for estimating collection system infrastructure value. Lowell Water is currently developing an integrated capital improvements plan (ICIP) for its entire POTW system, including sewerage and drainage collection systems. As part of the CIP, an estimated value of assets will be determined. Lowell Water has extended the target date for completing an asset evaluation; Lowell Water now anticipates this evaluation will be completed in 2020.

- **Collection System Work Order / Asset Management System** – The CMOM checklist identified the need for a program for managing and tracking scheduled and unscheduled collection system work orders. Lowell Water currently utilizes a work order system called MP2; it is a relatively old system with some limitations, but it does include a scheduler and a database that tracks historical activities.

  However, the current work order system does not track man-hours, equipment use, or inventory. Although the work order system is adequate, Lowell Water does intend to purchase a new system that has more robust capabilities. This purchase will be made as part of a new asset management system. Lowell Water, along with its consultant Hazen, has evaluated thirteen different products for suitability. This assessment has identified six products that are advantageous for Lowell Water's application. The timetable for obtaining a new work order / asset management system is anticipated in 2019.

  Upon obtaining the system, Lowell Water's engineering, operations and maintenance staff will work collaboratively to implement an asset characterization protocol that will include a rank-order system based on asset condition, criticality and value. This rank-order system will take several years to implement system-wide, but benefits will accrue throughout the term of the project.

CMOM OPPORTUNITIES FOR IMPROVEMENT NOT PREVIOUSLY IDENTIFIED

In addition to deficiencies identified in the 2011 CMOM Checklist, Lowell Water has identified several other opportunities for improvements associated with its sewer collection system. These initiatives include revisions to the City of Lowell's sewer and drain ordinances, development of a set of standards and specifications for all sewer work, a more robust FOG program with stronger enforcement capabilities, clarification of individual grinder pump ownership, revised betterment fees for sewer users, and a clearer definition of private and public ownership of sewer services.

In 2016, Lowell Water developed new local limits for Significant Industrial Users (SIUs). These updated pretreatment limits are a better reflection of current industry standards,

and therefore provide a more accurate assessment of the impact that SIUs have on the collection system and treatment facility.

Lowell Water is prioritizing the aforementioned improvements in order to establish a plan for development and implementation of these new initiatives. More information will be made available regarding these efforts in subsequent CMOM reports.

2017 COLLECTION SYSTEM ACTIVITIES

Lowell Water has made a strong commitment to improving the operation, maintenance, and management of its sewerage and drainage systems. More than $1M per year is allocated to sewer rehabilitation, which includes pipe repairs, catch basin and pipe replacement, and Cast-In-Place Pipe (CIPP) lining.

In-house video inspection is performed on a daily basis, along with catch basin cleaning, and sewer pipe cleaning. Root removal and heavy cleaning projects are frequently added to the maintenance program. Field survey captures system assets that are recorded in Lowell's Geographical Information (GIS) system, which can be accessed through iPads that are utilized by Lowell Water staffers who fulfill a role in Lowell Water's CMOM implementation program.

Ongoing efforts are made to better characterize collection system responses to wet-weather through flow metering and system modeling. Lowell Water has hired an engineering consultant (Hazen & Sawyer) to assist with these efforts. In 2016, flow metering along the North Bank Interceptor informed the operation of Lowell Water's High Flow Management plan. Also, a Lowell Water staffer received training from Hazen & Sawyer on their Storm Water Management Model (SWMM) for the collection system, and the model will be assessed more frequently against observed storms throughout the year as part of the High Flow Management Program.

All of these activities are reviewed and discussed at bi-weekly CMOM meetings with Lowell Water's collection system management team. These meetings have proven to be invaluable in coordinating CMOM activities and communicating priorities, objectives, and plans for improvements.

SUMMARY OF 2017 CMOM ACTIVITIES

In 2017, Lowell Water responded to and resolved 550 requests for catch basin, sewer back-up and street flooding requests. Additionally, Lowell Water installed 7,933 feet of CIPP lining; repaired 1,797 feet of existing sewer and drain lines; replaced/repaired 176 catch basins and manholes; cleaned 917 catch basins; spent $5,103 treating sewer

lines for root blockages; rodded and cleaned 60,187 feet of sewer and drain lines; and inspected 76,981 feet of sewer and drain lines. Catch basin debris totaling 485 tons were removed from Lowell Water's collection systems by vacuum trucks, and 697 tons were collected by street sweeping.

LOWELL WATER COLLECTION SYSTEM BACKGROUND

Approximately 60% of Lowell's sewer system is combined, resulting in substantial inflow from catch basins and other sources, including private inflow. Lowell Water has committed to reducing this inflow through a combination of in-house investigations and improvements, as well as a robust capital improvements program.

In 2003, Lowell Water obtained authorization for a $50 million sewer separation program. This program, designated as Phase I of Lowell Water's Long-Term Control Plan (LTCP) for CSO reduction, funded the installation of many miles of new drain lines in the City of Lowell. Six (6) new stormwater outfalls have been installed along streams that now convey millions of gallons of stormwater that previously flowed into Lowell's combined sewer system.

Since 2005, Lowell Water's sewer separation program has resulted in the installation of more than fifteen miles of new drainage, removing inflow and reducing extraneous flow from hundreds of acres. In addition, nearly nine miles of sewer lines were replaced or lined as part of the sewer separation program. Plans are being developed for another phase of sewer separation projects that will continue to remove additional inflow and rehabilitate the combined sewer system. A prioritization list of future rehabilitation projects is being developed and a dynamic plan is in place to address changing priorities.

In 2007, Lowell Water obtained approval for a bond authorization for a $5.5 million, 5-year sewer replacement/rehabilitation program. The $1.1 million annual program funding was used to pay for in-house television inspections, identification of sewer rehabilitation/replacement needs, and completion of the improvements. Existing sewers have been evaluated and rehabilitated with replacement sewers or cast-in-place pipe (CIPP) lining. These improvements have reduced infiltration into the existing sewer system by addressing the most serious rehabilitation needs that are identified. To date, more than eight (8) miles of sewer rehabilitation has been implemented through this program.

In 2010, Phase I of Lowell Water's LTCP was completed, with investments completed for more than $60M of sewer separation, inspection, and rehabilitation. Approximately 750 acres have been separated and about 300 private inflow sources have been disconnected from Lowell Water's sewer system. This removal of unnecessary inflow

has significantly reduced Lowell's Combined Sewer Overflows (CSOs). Implementation of remote gate control at all of Lowell Water's CSO diversion control gates has maximized Lowell Water interceptor storage and greatly reduced CSO volumes.

During the year 2012, a flow assessment program was implemented. This consisted of flow monitoring meters set up at 24 different locations and groundwater meters at three different locations all throughout the city of Lowell. This flow assessment was used to monitor wet weather flows and will help target the areas of Lowell where excessive I/I is present. As described earlier in the report, targeted metering projects and subsequent model revisions have been implemented in 2016. Plans have been developed for further metering and modeling projects as part of Lowell Water's ICIP program and are underway in 2018.

FUNDING, STAFF, & EQUIPMENT

The Lowell Regional Wastewater Utility Maintenance Division dedicates nine employees to Lowell Water's collection systems, at an annual labor cost of approximately $350K. Eighty five percent of this labor cost is actual work performed on the system, with approximately fifteen percent downtime associated with weather, collection equipment repairs, and utilization for wastewater treatment facility maintenance.

Lowell Water deploys two staffers to operate two vacuum trucks that perform daily catch basin cleaning and sewer/drain line rodding. Two Lowell Water staffers are assigned on a daily basis to perform inspections at all CSO diversion stations, pump stations, and metering stations. This includes routine maintenance, such as cleaning of manual bar racks, removing screenings, back-flushing pumps and making minor repairs as needed.

Another resource that is utilized daily is a full-time, state of the art, video truck that is manned by two Lowell Water staffers. The video truck enables Lowell Water to inspect an average of more than 80,000 feet of sewer and drain lines each year. A new truck was purchased in 2015, which has allowed Lowell Water to identify numerous system deficiencies. Identifying, and subsequently correcting these deficiencies, has allowed Lowell Water to be very proactive with its sewer rehabilitation program in critical locations, thus preventing much more problematic events from occurring.

The Head Collection Supervisor is on-call at all times; he answers all inquiries regarding the collection system and manages all aspects of the collection system maintenance program, including scheduling of the vacuum truck and television truck crews. Other maintenance activities include, but are not limited to, managing repair contractors, implementing a root treatment program, a catch basin cleaning program, a heavy pipe cleaning program, overseeing any litigation proceedings or damage claims, recording all work in a computer database, and obtaining street-opening permits required for contractors.

In addition to in-house maintenance activities, Lowell Water invests more than $1 million annually for contractors to clean, rehabilitate, and replace aging sewer and drain lines throughout the city. A contractor who is responsible to respond to Lowell Water's needs on a daily basis performs both planned and emergency repairs. Considering both in-house and contracted services, annual collection system maintenance costs total more than $1.5 million.

Street sweeping with Lowell Water-funded equipment cleans all 250 miles of roads within Lowell, which eliminates many tons of sediment that would otherwise end up in Lowell Water's catch basins and, ultimately, in the sewer and drain collection systems. Street sweeping is performed twice per year, in the spring and the fall seasons. In addition to in-house cleaning, a hired contractor performs large-scale catch basin cleaning, thus preventing debris captured in these catch basins from migrating into the combined sewer and drainage systems.

INVESTIGATION

Lowell Water's video truck continues its preventative maintenance program by inspecting sewers and drains throughout the city and repairing collection system defects before they become major problems, therefore reducing long-term maintenance and operational costs. Because sewer services are owned and maintained by private property owners, Lowell Water does not inspect these private sewers.

During video inspection of sewer/drain lines, camera operators get an up-close view of what is happening in our pipes. The two operators were trained and certified through the Pipeline Assessment Certification Program (PACP) for pipe rating standards specified by the National Association of Sewer Service Companies (NASSCO). Although Lowell Water does not utilize a PACP system, the training has proven valuable as Lowell Water video operators have matured into experienced specialists.

In Lowell Water's rating system, pipe conditions are characterized using a scale from 1 to 5, with 5 being a serious defect that requires immediate attention. The grading system has been developed by Lowell Water to correlate with NASSCO standards. Through inspection reports generated using software on the video truck, Lowell Water is able to identify all sewer/drain pipes that warrant rehabilitation. These pipes are then added to Lowell Water's priority list of pipes to be lined, repaired, or replaced.

Prioritization of pipes to be investigated is coordinated with the City Engineer's Office and their street paving list for the city. The city has a five-year moratorium after paving has occurred, so it is imperative Lowell Water investigates and makes the appropriate repairs to all its infrastructure within any street that is on the list to be paved.

CATCH BASIN CLEANING & STREET SWEEPING

Lowell Water uses a combination of in-house resources, outside contractors, and Lowell's Department of Public Works (DPW) to sweep the city streets and clean its catch basins. All of these activities are funded by Lowell Water in order to keep residuals from entering the collection systems, or to remove those residuals that migrate into the systems.

In 2014, the residual management operation was moved to a local landfill, where Lowell's DPW has equipment and personnel to assist with the storage, dewatering, and disposal of catch basin residuals. Use of this facility removes a source of odors and frees up space at Lowell Water's Duck Island CWF. Street sweeping is performed by Lowell's DPW twice per year (spring and fall) to reduce the amount of residuals that migrate into Lowell Water's collection systems.

ROOT REMOVAL & SEWER LINE CLEANING

Aging sewer lines are susceptible to root growth, which can lead to sewer surcharges and CSOs, creating public health concerns and water-quality exceedances. Problems such as I/I, decreased capacity, and increased maintenance costs are common effects of sewer lines with untreated root problems. The best course of action is preventive maintenance, ensuring that sewer pipes remain root-free.

Blockages and constrictions from other causes (besides roots) are typically removed using in-house vacuum trucks and personnel. Vacuum trucks are equipped with high-pressure water guns and mechanical rodding appurtenances. Lowell Water owns and operates two vacuum trucks that are used to clean sewer lines. Lowell Water contracts with a "heavy cleaning" vendor who operates specialized equipment for situations when debris cannot be removed using in-house equipment.

SEWER REPAIRS & REPLACEMENT

Lowell Water contracts with a vendor that specializes in sewer and drain line repairs and replacement. These repairs, accomplished through excavation and exposure of buried sewer/drain lines, vary from spot repairs to replacement of hundreds of feet of damaged piping. In addition, manholes and catch basins are continuously being replaced or repaired.

Investigate work performed by the video truck is planned based off of the city paving list. Depending on the severity of damage to the sewer line seen during inspection, the pipe is either repaired or replaced. After exposing the compromised piping, the scope of

repairs often changes, sometimes requiring additional repairs. Usually, this “dig and replace” method is chosen when it is impractical to rehabilitate sewer/drain lines using CIPP lining.

CURED IN PLACE PIPE (CIPP) LINING

Lowell Water uses CIPP lining extensively for sewer and drain line rehabilitation. Pipe lining is the preferred method for rehabilitating damaged pipes. In recent years, the cost of CIPP lining has decreased such that it is an attractive alternative to traditional dig and replace methods. Typically, Lowell Water targets damaged clay pipes that were installed 40-80 years ago. These pipes tend to experience cracking and other relatively minor defects that can be rehabilitated with CIPP lining.

In addition to restoring the structural integrity of rehabilitated piping, CIPP lining significantly reduces infiltration into the combined sewer system. Some of the worst infiltration occurs in cross-country lines, since they tend to be built in low-lying areas with high water table. Cross country lines comprise nearly half of the CIPP lining that Lowell Water undertakes.

Other candidates for CIPP lining are pipes that are located in the dense urban sections of Lowell where a dig and replace method would be more disruptive or more expensive. Targeted areas include pipes that run under buildings, cross country lines that run through wetlands, and public sewers that traverse private property.

MANHOLE & CATCH BASIN LOCATION PROGRAM

There are approximately 5,000 manholes in the City of Lowell’s drainage and sewerage systems. Lowell Water locates buried sewer and drain manholes as part of the sewer collection system maintenance plan on a continual basis. Each manhole is individually numbered and identified in the Lowell GIS system. Sewer manholes are prefixed in GIS with “SMH”, and drain manholes are prefixed as “DMH” followed by unique identification numbers for both types of structures to allow for straightforward differentiation between the structure types.

Manholes are typically located by Lowell Water’s video truck during the process of inspecting the infrastructure. The video crew identifies any buried manholes and marks them to be raised to grade. Additionally, as new construction projects are completed, Lowell Water locates as-built structures by GPS survey instrumentation. GIS is then systematically updated to incorporate the research information obtained by each of the methods of location employed.

As part of the manhole location program, Lowell Water conducts inspections of the collection system and periodically replaces manholes along with the associated

manhole frames and covers as determined to be necessary during inspection by the collection system personnel. Recently, Lowell Water has committed to locating all of its catch basins in order to map its drainage systems. This effort has been initiated to satisfy changing MS4 requirements related to mapping.

EXTRANEOUS FLOW REDUCTION PROGRAMS

The City of Lowell has almost 300 miles of sewer and drain pipes, nearly half of which are more than 100 years old. Numerous sewer lines are installed outside public ways, traversing wetlands or underneath buildings. In recent years, there is a growing concern that a line failure in a precarious location could be very disruptive, dangerous, and expensive.

In addition to compromised structural integrity, the aging sewers also leak, allowing significant amounts of infiltration into the sewer system. This infiltration leads to higher flows at the wastewater treatment facility.

Since 2006, Lowell Water's Non-Rain Related I/I has decreased significantly due to numerous sewer separation and sewer rehabilitation projects valued at more than $60 million. April 2017 was observed to have the highest dry-weather I/I rate, coinciding with high river levels, and investigations into the source of this inflow from low-lying manholes near the river are underway. See the enclosed Infiltration/Inflow report for more details regarding I/I initiatives.

CMOM MEETINGS

In order to supports its CMOM activities, Lowell Water has established bi-weekly meetings with key personnel involved in the operation and maintenance of the sewerage and drainage collection systems. Typically, meeting participants include Lowell Water's Collection System Supervisor, Maintenance Manager, Collection System Engineer, Engineering Manager, and Executive Director. Also participating are representatives from Lowell's drinking water utility, the gas utility (National Grid), the city engineers, and others that may be able to contribute to the planning of activities associated with the operation and maintenance of the collection systems.

At each meeting, coordination and communication amongst the participants leads to more effective management of CMOM activities. A list of action items is assigned to specific personnel who are responsible for follow-up. The meeting agenda includes the following:

- City Engineer Coordination: plans for the street paving projects are discussed. Lowell Water is tasked with inspecting all sewerage and drainage within the extents of planned paving projects, to identify any defects that need to be addressed. Inspection video is used to plan any rehabilitation improvements that need to be

completed before targeted streets are paved. This helps Lowell Water comply with the city's five-year moratorium on street openings subsequent to a new paving project.

- Water Utility Coordination: discuss any work that is either effected by, or will have an effect on, projects related to the Lowell Regional Water Utility (LRWU). The City of Lowell is assessing a merge of departments between Lowell Water and the LRWU, this section of the meeting allows both utilities to coordinate and organize their respective utility duties in order to complete work in an efficient manner.
- Planning and Development: discuss any concerns related to either Lowell Water's or LRWUs infrastructure that are within the project scope of any plans organized by the city's Department of Planning and Development (DPD).
- Inspections and Assessments: during this part of the meeting, participants discuss the activities of the video truck, as well as any other ongoing assessments, such as sewer system metering or level monitoring. These assessment initiatives are crucial to understanding problem areas associated with capacity and maintenance concerns. In this way, participants can target inspections in problems areas and make recommendations for certain reaches of the collection systems that should be investigated.
- Collection System Maintenance: meeting participants discuss activities related to collection system maintenance, including street sweeping, catch basin cleaning, root treatment, and rodding and cleaning of sewer lines.
- Sewer Rehabilitation: activities related to sewer rehabilitation – sewer and drain repairs utilizing dig and replace method as well as trenchless technology – are discussed in detail. Prioritization and implementation of sewer repairs, replacement, and CIPP lining projects are assessed at each meeting. Rehabilitation costs are tracked, contractors are monitored for performance, and project inspections are reviewed.
- Collection System Capital Projects: details of collection system capital projects are presented to the collection system management team. Lowell Water has been very active in planning and constructing new drainage systems throughout the city of Lowell during the past decade. Sewer rehabilitation is also an important part of these capital projects. By sharing plans and progress related to capital projects, the collection system team ensures that the lines of communication are open and all stakeholders are aware of system improvements.

LOWELL GIS OVERVIEW

Geographic Information Systems is a computer-based system for capture, storage, retrieval, analysis and display of spatially defined data. GIS is one of the basic building blocks of the City's technology offerings. The goal is to deploy GIS throughout the organization, improving the way services are delivered to residents and businesses. To

this end, GIS supports databases, develops applications, and provides technical assistance to a growing base of users. The Lowell GIS system was last updated on November 2014; the current version is ERSI software v 10.2.2.
The City of Lowell GIS is based on 2013 aerial photogrammetric mapping at a 1"=100' scale. These maps meet or exceed National Map Accuracy Standards (NMAS).

The standards ensure that other data, such as municipal parcel maps, compiled using similar specifications can be overlaid without major discrepancies, and that ground coordinates can be derived from the map to a stated accuracy. Lowell GIS data uses the North American Datum of 1983 (NAD83) Massachusetts State Plane Feet. Lowell GIS parcel and boundary lines are compliant to the MassGIS Level 2 Standard.

GIS has been integrated into many city applications such as Larimore Public Safety for 911, Crimeview (Crime Analysis), Vision Property Appraisal, MUNIS permit system, VHB Road Manager (Pavement Management). Lowell GIS layers include building locations, address information, parcel properties, street centerline network, railroads, waterway/wetlands areas, flood plains, paved roadways, schools, neighborhood boundaries, census data, election wards and districts, police and fire stations and sectors, historical landmarks, special needs locations, zoning, trash day schedule, sewer and water facility infrastructure. GIS uses within city departments include Planning and Development, Public Safety (Police and Fire), Engineering, Public Works, Health, Emergency Management, Inspectional Services and Special Events.

Lowell Water has implemented extensive GIS utilization, its projects include:

- **Sewer System O&M** – Lowell Water's collection system staff utilize GIS extensively for operation and maintenance (O&M) of the sewerage and drainage systems. The Collection System Supervisor has Lowell's GIS maps available on an iPad (2014 purchase) in his vehicle. This enables the supervisor to quickly familiarize himself with the local sewers and identify all relevant information about the system. Having this information available in the field allows for expeditious resolution of sewer back-ups and other O&M issues. Nine other Lowell Water personnel also have access to the sewer system maps and information via iPads (2014 purchase). The GIS tools facilitate the execution of utility mark-outs, system characterization, and trouble-shooting tasks, making all system O&M tasks more efficient. When discrepancies are identified in the field, a GIS mark-up tool enables a correction that is sent via email to in-house GIS editors.
- **Sewer Inspection** – Lowell Water owns and operates a sewer inspection vehicle that records video that is integrated in Lowell's GIS. In 2015, Lowell Water purchased a new video truck to replace its aging vehicle, which was seven years old and experiencing mechanical problems. Through its sewer inspection program,

Lowell Water has identified countless defects that have led to several miles of sewer rehabilitation and more than $15 million in sewer improvements in the past decade.

- **Drainage System Characterization** – Lowell Water is embarking on an ambitious effort to identify and characterize all drainage outfalls into local waterways within the extents of the City of Lowell. This program is mandated by EPA stormwater regulations and implemented through the Lowell's MS4 Stormwater Permit. Through this program, the locations of all drainage outfalls are captured and integrated into Lowell's GIS. Having these assets integrated into GIS will allow Lowell Water to better operate and maintain them. All drainage pipes are also integrated into GIS, including more than five miles of new drains that have been installed in Lowell Water's sewer separation program.
- **Project Design and Planning** – As part of Lowell Water's Long-Term Control Plan (LTCP) program to control combined sewer overflows (CSOs), more than $50 million has been invested to upgrade Lowell Water's drainage system and separate inflow/infiltration sources from the combined sewer system. Lowell's GIS has been utilized extensively to plan and design six sewer separation projects that have resulted in the installation of more than 20 miles of new drains, sewers, and water mains in the past ten years.
- **Property Development** – Lowell Water is able to assist property developers when they need information about local utilities. Lowell's GIS has information on water, sewer, drain, and gas utilities, allowing developers to effectively plan their projects.
- **Resident Support** – When residents inquire about local utilities, Lowell Water is able to provide relevant information immediately. Of particular value to home-owners are records of their sewer services. Although these records are not available through the Internet, they are provided upon request.
- **Spill Containment**– Using GIS, Lowell Water is able to provide quick access to information in determining what is affected downstream of the spill and where to set up spill containment.

GIS ON-LINE SERVICES

Developed as a means to provide access to Lowell GIS data through a website application and as a component for E-government services, Lowell's GIS online services incorporate an internal Intranet alongside an external Internet presence. Using GIS web services, a user can search by criteria such as parcel address or street name and the Lowell GIS site will return an interactive map of the location requested. This allows users to view GIS data, query databases linked to GIS, view related documents and print maps. A mark-up tool has been developed over the years, at significant expense, to aid in the correction of the GIS. This continuous editing of the GIS makes it as accurate as possible, using lines, points, polygons, and text on top of the base map

of the GIS. These corrections are then sent to the GIS editors and the base maps are revised.

WASTEWATER UTILITY INTERNAL SITE

This GIS Site displays the general GIS layers available as well as Wastewater Department specific layers. Examples of Wastewater Department GIS data layers are the city sanitary sewer and drain network including sewer and drain pipes and wastewater infrastructures as well as other relevant GIS layers. Lowell also has developed an ArcGIS server website for retrieval and display of sewer service records. This GIS Site designed for the general public through the city website (www.lowellma.gov). This site displays the general GIS data layers include base mapping (roadways, buildings, property and address locations, elevation model, neighborhood, and zoning boundaries, and assessor tax parcels and property data linked to the parcels).

FUTURE GIS WORK

Lowell Water is preparing to use Lowell's GIS to support an asset management program. This program will be implemented after the selection and start-up of a CMMS software program. Lowell Water will track its assets for condition, preventative maintenance, and life-cycle costs. Considering the substantial assets operated and maintained by Lowell Water, the CMMS should prove to be a valuable tool for managing the City of Lowell's assets.

In 2015, Lowell Water purchased a new truck, equipped with hardware and software that will seamlessly transition with the existing technology and have features that enable video editing in the field through real-time updating of GIS attribute tables. What makes this possible is a comprehensive data collection and management software offering flexibility, customization, and ease-of-use this state of the art of the pipeline inspection industry.

Built using contemporary Microsoft Visual Studio™ technologies and designed with an asset-based architecture, a user can navigate to a particular asset (e.g., pipe segment) and view all inspections. Because this is the database structure on which asset management and Geographic Information Systems (GIS) are built, data integration is seamless. Being able to see the pipes below the ground is valuable, but unless that information is shared and distributed, the knowledge gained has limited use. The new system will support video viewing through a hyperlink within the GIS.

SEWER SURCHARGE NOTIFICATION

Lowell Water has updated the protocol for gathering the information, investigating the cause of, and notification of the sewer surcharges within the timeframes set forth by MassDEP. The program, which utilizes collaboration between the Collection System Engineer and the Collection System Supervisor, allows a more effective work flow that features iPads.

The Collection System Supervisor notifies the Collection System Engineer via email when he is in the field investigating a suspected sewer surcharge. Photos are also shared using the new iPads (the pictures help with estimating volumes). Witnesses can also help with estimation of volume and add anecdotal information to better characterize a sewer surcharge. The engineer then notifies MassDEP and EPA through email and phone call before submitting a Notification Form to the agencies within five days of the event.

In 2017, Lowell Water reported seven sewer surcharges, which are described below. The program instituted to record and distribute information to internal and external stakeholders has created a knowledge base of areas that may need rehabilitation or maintenance, and therefore encourages further investigation of the system to improve infrastructure, as well as public health and safety**.**

In October of 2016, Lowell Water completed its Marginal Relief Sewer Project. This project added a 600-foot wet-weather relief pipe in a location that, historically, has been the site of many sewer surcharges. Out of the six sewer surcharges that Lowell Water reported in 2016, four of them occurred in this location before the pipe was installed. Since completion of the project, two more sewer surcharges have occurred in this area and consequently the conceptual plan of a Pevey Storage Facility to increase capacity in this catchment is now prioritized.

2017 Sewer Surcharges

Lowell Regional Wastewater Utility

Location	Date (Time)	Notification	Cause	Discharge Volume (Gallons)	Destination of Discharge	Mitigation Measures
Near 1371 Middlesex Street	June 26, 2017 (3PM – 3:30PM)	Resident	Rain event	5,000	Ground surface (no release to surface water)	Marginal Sewer Relief Pipe was installed in 2016, the Pevey Storage Facility is now prioritized.
13 Newhall Street	July 18, 2017 (5:30PM – 6:30PM)	Property Owner	Rain event coupled with bar-rack failure at downstream station	500	Backup into Property Basement	Assessing benefit of bar-rack at downstream station (Warren Street)
Near 35 Windward Street	July 18, 2017 (5:30PM – 6:30PM)	Resident	Rain event	5,000	Ground surface (no release to surface water)	Douglas Storage Facility plans are in development to alleviate surcharging in this area.
174 Boylston Street	July 18, 2017 (5:30PM – 6:30PM)	Property Owner	Rain event coupled with failed check valve located in private sewer service	600	Backup into Property Basement	Douglas Storage Facility plans are in development to alleviate surcharging in this area.
Chelmsford Street near Baltimore Street	July 18, 2017 (5:30PM – 6:30PM)	Lowell Police Department	Rain event	3,000	Ground surface (no release to surface water)	Greater pumping capacity at Chelmsford Street Pump Station will be installed in next upgrades.
Eagle Court	July 18, 2017 (5:30PM – 6:30PM)	Resident	Rain event	6,000	Ground surface (no release to surface water)	Pevey Storage Facility would alleviate this surcharge.
Marginal Street	July 18, 2017 (5:30PM – 6:30PM)	Resident	Rain event	6,000	Ground surface (no release to surface water)	Pevey Storage Facility would alleviate this surcharge.

2017 SEWER REPAIRS/REPLACEMENT

WORK DONE	DIA (in.)	LENGTH (ft.)	US MH	DS MH	STREET	REPAIR COST	MATERIAL	INSPECTION DATE	REPAIRED DATE
CB REPAIRS					88 11th STREET	$540	CONCRETE	11/29/2017	11/29/2017
CB REPAIRS					CAROLYN ST	$540	CONCRETE	11/29/2017	11/29/2017
CB REPAIRS					WENTWORTH AT NURSING HOME	$540	CONCRETE	11/29/2017	11/29/2017
CB REPAIRS					ROGERS AT PARKVIEW	$540	CONCRETE	11/29/2017	11/29/2017
CB REPAIRS					MANSUR AT NESMITH	$540	CONCRETE	11/29/2017	11/29/2017
CB REPAIRS					BACHMAN AT LAKEVIEW	$1,903	CONCRETE	11/28/2017	11/28/2017
CB REPAIRS					20 MARLBORO	$1,903	CONCRETE	11/28/2017	11/28/2017
CB REPAIRS					6 GORMAN ST	$2,131	CONCRETE	11/27/2017	11/27/2017
CB REPAIRS					WESTLAWN AVE	$2,131	CONCRETE	11/27/2017	11/27/2017
CB REPAIRS					24 LAMB ST	$1,077	CONCRETE	11/21/2017	11/21/2017
CB REPAIRS					630 MERRIMACK ST	$1,077	CONCRETE	11/21/2017	11/21/2017
CB REPAIRS					175 FORT HILL AVE	$1,077	CONCRETE	11/21/2017	11/21/2017
CB REPAIRS					ANDOVER ST	$896	CONCRETE	11/20/2017	11/20/2017
CB REPAIRS					47 ALBERT ST	$896	CONCRETE	11/20/2017	11/20/2017
CB REPAIRS					MIDDLESEX AT PEARL ST	$896	CONCRETE	11/20/2017	11/20/2017
SMH					CITY AVE	$1,967	CONCRETE	11/17/2017	11/17/2017
CB REPAIRS					WARREN STATION	$525	CONCRETE	11/16/2018	11/16/2018
CB REPAIRS					HIGH ST AND POTTER AVE	$525	CONCRETE	11/16/2018	11/16/2018
CB REPAIRS					MERRIMACK AND PALMER	$525	CONCRETE	11/16/2018	11/16/2018
CB REPAIRS					HOLLYROOD	$525	CONCRETE	11/16/2018	11/16/2018
CB REPAIRS					HIGH ST AT POTTER	$525	CONCRETE	11/16/2018	11/16/2018
SEWER REPAIRS	12	10	4639	4640	90 C STREET	$6,744	PVC	11/15/2017	11/15/2017
NEW SMH					85 C STREET	$4,076	CONCRETE	11/14/2017	11/14/2017
SEWER REPAIRS	12	12	4642	4641	C STREET AND NEW SPAULDING	$5,949	PVC	11/10/2017	11/10/2017
NEW SMH					52 MT WASHINGTON	$3,662	CONCRETE	11/13/2017	11/13/2017
NEW SMH					133 MT WASHINGTON	$3,262	CONCRETE	11/8/2017	11/8/2017
SEWER REPAIRS	12	10	3485	3484	251 MT VERNON	$7,241	PVC	11/7/2017	11/7/2017
SEWER REPAIRS	12	8	3485	3484	251 MT VERNON	$1,742.00	PVC CONCRETE	11/6/2017	11/6/2017
NEW CB					MARKET ST CENTRAL ST	$15,571	PVC CONCRETE	11/5/2017	11/5/2017
SEWER REPAIRS	12	10			MT VERNON AND BOWERS AVE	$8,108	PVC CONCRETE	11/3/2017	11/3/2017
SEWER REPAIRS	15	7			PAWTUCKET ST AND MT VERNON	$3,749	PVC	11/2/2017	11/2/2017
PAVING					HENRY AND BRIDGE	$4,800	ASPHALT MIX	9/21/2017	9/21/2017
NEW SMH					33 FRED ST	$3,140	CONCRETE	9/20/2017	9/20/2017
SEWER REPAIRS	10	300	2810	NEW	HENRY AVE	$141,694	PVC	9/11/2017	9/11/2017
SEWER REPAIRS	10	16			109 HIGHLAND AVE	$19,350	PVC	9/7/2017	9/7/2017
SEWER REPAIRS	6	40			109 HIGHLAND AVE		PVC	9/7/2017	9/7/2017
LEECHING BASIN					147 GLENWOOD ST	$5,911	CONCRETE	9/6/2017	9/6/2017
NEW CB					E MERRIMACK AND GLEN ROAD	$7,440	CONCRETE	9/5/2017	9/5/2017
NEW CB					STACKPOLE AND FAYETTE ST	$7,340	CONCRETE	9/4/2017	9/4/2017
NEW CB					POWELL AND D STREET	$7,440	CONCRETE	9/1/2017	9/1/2017
SEWER REPAIRS	6	16			ANDOVER ST	$6,040	PVC	8/28/2017	8/28/2017
SEWER REPAIRS	6	8			FULTON ST	$3,300	PVC	8/24/2017	8/24/2017
SEWER REPAIRS	12	40	1461	1380	WALKER ST	$40,914	PVC	8/3/17-8/10/17	8/3/17-8/10/17
RAISE SMH					WALKER ST	$7,692	CONCRETE	8/3/17-8/10/17	8/3/17-8/10/17
SEWER REPAIRS	18	190	7144	7143	BRIDGE ST	$81,995	PVC	7/20-7/31/2017	7/20-7/31/2017
CB LATERAL	6	15			BRIDGE AND W THIRD	$4,500	PVC	7/19/2017	7/19/2017
CB REPAIRS					75 CHESTNUT STREET	$800	BRICK	7/16/2017	7/16/2017
CB REPAIRS					172 QUEBEC STREET	$800	BRICK	7/15/2017	7/15/2017
CB REPAIRS					EDSON CEMETERY	$800	BRICK	7/15/2017	7/15/2017

2017 SEWER REPAIRS/REPLACEMENT

WORK DONE	DIA (in.)	LENGTH (ft.)	US MH	DS MH	STREET	REPAIR COST	MATERIAL	INSPECTION DATE	REPAIRED DATE
CB REPAIRS					FORT HILL PARK	$800	BRICK	7/15/2017	7/15/2017
CB REPAIRS					HUMPHEY ST	$800	BRICK	7/15/2017	7/15/2017
CB REPAIRS					FATHER MORRISSETTE	$800	BRICK	7/15/2017	7/15/2017
CB REPAIRS					WORBURN AND EASTON	$800	BRICK	7/15/2017	7/15/2017
DRAIN REPAIRS	12	180	5406	9002	CHRISTIAN AREA	$105,660	PVC /CONCRETE	6/28/17-7/14/17	6/28/17-7/14/17
NEW SMH					EAST MERRIMAC AT MCCCOLLEGE	$6,040	CONCRETE	6/9/2017	6/9/2017
SEWER REPAIRS	15	25			CRAWLEY PARKING LOT	$11,250	PVC	5/31/2017	5/31/2017
SEWER REPAIRS	8	28	7529	192	CALEB ST	$9,700	PVC	5/28/2017	5/28/2017
5 CBs					JFK PLAZA	$4,000	PVC /CONCRETE	5/18-22/17	5/18-22/17
DRAIN INSTALL	8	25			JAMES ST	$8,250	PVC	5/17/2017	5/17/2017
SEWER INSTALL	6	25			JAMES ST	$4,850	PVC	5/17/2017	5/17/2017
NEW CB					WARREN AT CENTRAL	$7,440	CONCRETE	5/11/2016	5/11/2016
NEW CB					LAKEVIEW	$7,440	CONCRETE	7/6/2017	5/8/2017
NEW CB					ANDOVER ST AT FORT HILL	$7,440	CONCRETE	5/8/2017	5/8/2017
SEWER REPAIRS	12	6			BILLERICA ST	$2,700	PVC	5/4/2017	5/4/2017
NEW CB LEACHING					172 GLENWOOD	$5,050	CONCRETE	4/28/2017	4/28/2017
SEWER REPAIRS	6	22			CLIFTON ST	$8,200	PVC	4/21/2017	4/21/2017
CB REPAIRS	6	6			6TH AT VARNUM	$3,550	BRICK	4/25/2017	4/25/2017
SEWER REPAIRS	8	6			CLIFTON ST	$4,950	PVC	4/21/2017	4/21/2017
SEWER REPAIRS	10	9			CLIFTON ST		PVC	4/21/2017	4/21/2017
SEWER REPAIRS	8	10	5955		36 DOUGLAS RD	$5,200	PVC	4/20/2017	4/20/2017
NEW CB					301 WILDER ST	$6,700	CONCRETE	7/10/2017	4/19/2017
NEW CB					34 D ST	$5,760	CONCRETE	7/6/2017	4/18/2017
NEW CB					MIDDLESEX AT MCINTYRE	$6,950	CONCRETE	7/10/2017	4/11/2017
CB REPAIRS					91 HAYES AVE	$825	BRICK	7/6/2017	4/11/2017
CB REPAIRS					771 BROADWAY	$825	BRICK	7/6/2017	4/11/2017
CB REPAIRS					206 WILDER ST	$850	BRICK	7/6/2017	4/11/2017
CB REPAIRS					142 JEWETT ST	$475	BRICK	7/6/2017	4/10/2017
CB REPAIRS					BENNINGTON AT VARNUM	$950	BRICK	7/10/2017	4/10/2017
CB REPAIRS					MIDDLE AT PALMER	$1,150	BRICK	7/10/2017	4/10/2017
CB REPAIRS					VARNUM AT BEDFORD	$850	BRICK	7/10/2017	4/10/2017
CB REPAIRS					88 6TH ST	$450	BRICK	7/10/2017	4/10/2017
CB REPAIRS					AIKEN ST	$400	BRICK	7/10/2017	3/20/2017
CB REPAIRS					HALE ST	$825	BRICK	7/10/2017	3/20/2017
CB REPAIRS					TERRY AVE	$825	BRICK	7/10/2017	3/20/2017
CB REPAIRS					STACKPOLE	$475	BRICK	7/10/2017	3/8/2017
CB REPAIRS					22 GARDEN ST	$825	BRICK	7/10/2017	3/8/2017
CB REPAIRS					BRANCH AT NICHOLS	$825	BRICK	7/6/2017	3/8/2017
CB REPAIRS					THORNDIKE ST AT LRTA	$825	BRICK	7/6/2017	3/8/2017
CB REPAIRS					CROSS ST AT SCHOOL ST	$850	BRICK	7/6/2017	3/6/2017
CB REPAIRS					SWAN AT INDUSTRIAL AVE	$850	BRICK	7/6/2017	3/6/2017
CB REPAIRS					MOODY ST	$850	BRICK	7/6/2017	3/6/2017
WYE REPAIR	6	22			244 HILDRETH ST	$12,240	PVC	7/10/2017	3/5/2017
NEW CB	8	6			172 GLENWOOD	$9,250	CONCRETE	7/6/2017	3/3/2017
NEW CB	10	9			172 GLENWOOD		CONCRETE	7/6/2017	3/3/2017
CB REPAIRS					JOHN ST AT BOURDING HOUSE PK	$850	BRICK	7/6/2017	3/3/2017
CB REPAIRS					COURT AT MANCHESTER	$475	BRICK	7/6/2017	3/3/2017
CB REPAIRS					208 FAIRMOUNT	$825	BRICK	7/6/2017	3/3/2017
CB REPAIRS					315 HIGH ST	$850	BRICK	7/10/2017	3/3/2017
CB REPAIRS					1115 WESTFORD ST	$850	BRICK	7/10/2017	3/2/2017

2017 SEWER REPAIRS/REPLACEMENT

WORK DONE	DIA (in.)	LENGTH (ft.)	US MH	DS MH	STREET	REPAIR COST	MATERIAL	INSPECTION DATE	REPAIRED DATE
CB REPAIRS					OLD FERRY RD AT VARHAM	$850	BRICK	7/10/2017	3/2/2017
CB REPAIRS					MT WASHINGTON AT PAWTUCKET	$850	BRICK	7/10/2017	3/2/2017
CB REPAIRS					ORLEANS ST AT OSGOOD	$475	BRICK	7/6/2017	1/26/2017
CB REPAIRS					236 MT HOPE	$825	BRICK	7/6/2017	1/26/2017
CB REPAIRS					BELMONT AT SUMMIT ST	$475	BRICK	7/6/2017	1/26/2017
CB REPAIRS					ARNOLD ST	$500	BRICK	7/10/2017	1/13/2017
NEW CB	6	8			LPW GARAGE MIDDLESEX ST	$7,950	CONCRETE	7/10/2017	1/12/2017
NEW SMH	12	13			CROSSPOINT TOWERS EASEMENT	$6,710	CONCRETE	1/10/2017	1/10/2017
CB REPAIRS					LWWU GARAGE	$3,200	PVC		1/6/2017
SEWER REPAIRS	12	35	6292	7141	BRIDGE AND 8TH	$21,890	PVC	1/4-5/17	1/4-5/17
TOTAL		1,117				$710,769			

2017 SEWER REPAIRS/REPLACEMENT

WORK DONE	DIA (in.)	LENGTH (ft.)	US MH	DS MH	STREET	REPAIR COST	MATERIAL	INSPECTION DATE	REPAIRED DATE

2017 Cast-in-Place Pipe (CIPP) Lining

Work Done	DIA (IN)	LENGTH (FT)	UP SMH	DOWN SMH	STREET	COST	REASON FOR REPAIR	PIPE MATERIAL	DATE
CIPP Lining	36"	220	NEW	NEW	MARGINAL RELIEF SEWER	NO COST	MULT. FRACTURES	CONCRETE	1/10/2017
CIPP Lining	10"	150	1621	1619	BEDFORD AVE	$4,800	POOR SHAPE	ACP	3/20/2017
CIPP Lining	8"	245	3387	3404	LEXINGTON AVE	$7,350	POOR SHAPE	ACP	3/20/2017
CIPP Lining	10"	90	NEW	NEW	ARCH ST -MIDDLESEX ST	$3,150	PREVENTIVE	CLAY	3/21/2017
CIPP Lining	12"	80	NEW	4713	ARLENE RD	$3,500	MULT. FRACTURES	ACP	3/21/2017
CIPP Lining	12"	275	7232	7233	AGAWAM ST	$9,625	MULT. FRACTURES	ACP	3/22/2017
CIPP Lining	12"	800	2734	2640	FARMLAND RD	$31,500	MULT. FRACTURES	ACP	3/22/2017
CIPP Lining	15"	450	4051	4054	GORHAM ST	$27,000	PREVENTIVE	CONCRETE	3/23/2017
CIPP Lining	12"	660	3936	4086	LUCY LARCOM PARK	$26,000	MULT. FRACTURES	ACP	3/27/2017
CIPP Lining	21" X 24"	360	7143	7141	BRIDGE STREET	$37,800	MULT. FRACTURES	BRICK	3/28/2017
CIPP Lining	15"	300	2762	3074	BY ST	$22,000	MULT. FRACTURES	CLAY	6/1/2017
CIPP Lining	10"	330	5291	5292	BILLERICA ST [DRAIN]	$13,500	MULT. FRACTURES	CONCRETE	6/1/2017
CIPP Lining	10"	450	194	7529	CALEB ST	$17,750	MULT. FRACTURES	CONCRETE	6/1/2017
CIPP Lining	10"	815	4946	4947	SEVENTEENTH	$32,000	ROOTS	CONCRETE	6/1/2017
CIPP Lining	15"	200	NEW	NEW	MT VERNON	$17,000	MULT. FRACTURES	CONCRETE	6/1/2017
CIPP Lining	10"	450	DMH4557	DMH7324	W ALBERT	$22,310	MULT. FRACTURES	CONCRETE	10/17/2017
CIPP Lining	8"	800	4556	7606	W ALBERT	$28,650	MULT. FRACTURES	CONCRETE	10/17/2017
CIPP Lining	15"	150	7633	7353	MIDLAND	$10,740	MULT. FRACTURES	CONCRETE	10/17/2017
CIPP Lining	15"	260	4411	4410	MT WASHINGTON	$20,595	MULT. FRACTURES	ACP	10/17/2017
CIPP Lining	10"	200	7331	7340	W JENNESS	$8,071	MULT. FRACTURES	CONCRETE	10/17/2017
CIPP Lining	8"	640	4544	4543	WELLESLEY AVE	$28,060	MULT. FRACTURES	CONCRETE	10/17/2017
CIPP Lining	15"	600	TBN	TBN	SWAN	$30,900	MULT. FRACTURES	CORRUGATED	10/17/2017
CIPP Lining	10"	260	5199	1531	PRINCETON	$17,056	MULT. FRACTURES	CONCRETE	8/30/2017
CIPP Lining	12"	1700	1531	1593	PRINCETON	$71,340	MULT. FRACTURES	CONCRETE	8/30/2017
TOTAL		10,265				$490,697			

CSO Control Plan Annual Progress Report

2017 CSO CONTROL PLAN

ANNUAL PROGRESS REPORT

LOWELL REGIONAL WASTEWATER UTILITY

April 2018

Overview of LTCP Activities during the Past Several Years:

In 2011, Lowell Water completed an eight-year, $50 M sewer separation program that was a critical element of its LTCP Phase 1 Program. As part of the Phase 1 sewer separation program, more than fifteen miles of new drainage pipes were installed in the City of Lowell. This new infrastructure allowed the removal of public and private inflow in several hundred acres of combined sewer basins. Another eight miles of sewer lines were rehabilitated to reduce Infiltration/Inflow (I/I) into Lowell's combined sewer system.

In addition to sewer separation, Lowell also invested nearly $40 M in capital improvements to its Duck Island CWF and several key diversion stations along the large-diameter interceptor system. Improvements enabled more effective storage and treatment of wet-weather flows that historically would have been diverted as CSOs into nearby streams.

In 2013, Lowell Water received funding authorization for another $40 M in capital improvements, $30M of which is earmarked for collection system and wet-weather improvements that will enhance storage and treatment capabilities. Those funds are being utilized to construct new drainage (sewer separation), create new wet-weather interceptor storage, improve peak-flow treatment reliability, upgrade satellite facilities, and rehabilitate existing sewer lines.

In August 2014, Lowell Water submitted a CSO control plan that proposed a $123M, two-phase plan that included substantial investment in sewer separation projects, as well as satellite storage and treatment facilities, siphon upsizing (conveyance of wet-weather flows), and other capital projects. Subsequently, EPA and MassDEP regulators responded with a request for a revised plan that adheres to certain guidelines for affordability, alternative analysis, and specified levels of CSO control.

Shortly after submission of the 2014 plan, Lowell proceeded with Phase 2 of its capital improvement program (CIP Phase 2) by selecting five engineers to design and oversee Phase 2 projects. Hazen & Sawyer was selected as program manager, leading the Phase 2 program along with CDM-Smith, Woodard & Curran, Tighe & Bond, and Stantec, who are acting as project engineers for various capital projects. It is Lowell's expectation that five Phase 2 capital improvement projects, valued at over $40M, will be completed by 2019.

During Phase 2, Hazen & Sawyer is assisting Lowell Water with the development of an Integrated Capital Improvement Plan (ICIP) that will evaluate a variety of capital needs associated with drinking water, stormwater, and wastewater infrastructure. These needs will be prioritized along with CSO control projects, in order to balance the water infrastructure needs of the community with optimal environmental benefits. Lowell Water is currently collaborating with MassDEP and EPA to create a comprehensive integrated capital improvement plan that judiciously invests Lowell's precious public funds with these objectives in mind.

Interim High Flow Management Plan:

In order to optimize the storage and treatment of wet-weather flows, Lowell Water invested in its capability to remotely control and monitor gates, valves, and pumps through its Supervisory Control and Data Acquisition (SCADA) network. In addition to equipment at Duck Island, remote monitoring and control was enabled at eight diversion stations along the interceptor system. Lowell Water has developed wet-weather protocols to control operations at these diversion stations and Duck Island.

These improvements and protocols are detailed in an Interim High Flow Management Plan (HFMP) that was submitted to the regulatory agencies in March 2011. The Interim HFMP describes the substantial efforts undertaken by Lowell Water to improve its wet-weather operations. The improvements and protocols focus on the premise that an aggressive approach to wet-weather storage and treatment could be enabled once the transport and treatment system's response to wet weather conditions was better understood.

A two-year initiative to characterize the system's wet-weather response yielded the understanding that allowed Lowell Water to implement a "safe-storage" strategy that features modulating gate control and maximum storage in the interceptor system. Interceptor gate control has been optimized by the implementation of automatic control at two key diversion stations – West and Merrimack – based on conditions at Duck Island. This automatic gate control balances flows at the treatment facility with storage in the interceptor system, so that maximum treatment capacity and interceptor storage are achieved.

The Interim HFMP also identified a significant opportunity to increase interceptor storage by installing in-line gate control at Read Station. The Read Station Storage Project will create almost one million gallons of additional in-line storage during wet-weather events. In 2016, construction began for an integrated interceptor storage project at Read Station and a flood pumping project at West Station. Once the additional wet-weather storage capacity become available in early 2018, the benefits of this improvement will be evaluated and reported.

The Read Station Storage Project represents the last substantial opportunity to improve utilization of existing infrastructure for wet-weather storage. Now active, Read Station is the primary control point for wet-weather flows emanating from the north bank of the Merrimack River. Interceptor storage is now fully utilized, and optimization of peak flow treatment at Duck Island is attainable through ongoing Phase 2 Improvements. With the improvements slated for completion in 2019, LRWWU now intends to develop a revised HFMP in 2020.

WWTF Wet-Weather Capacity:

Further evaluation of the Duck Island WWTF's capacity to treat wet-weather flows was necessary to maximize treatment during rain events. LRWWU and its consulting engineers have been studying the facility's primary and secondary treatment capabilities, both during high-flow and average-flow conditions. This evaluation has included a hydraulic grade line

(HGL) analysis, secondary clarifier stress testing, hydraulic and solids loading assessments, chlorination dosing rates, and flow-and mass-balancing calculations.

A preliminary evaluation was conducted in 2009-2010, with inconclusive findings. Previous target peak flow rates of 110 MGD and 50 MGD, respectively, for reliable primary and secondary treatment, were not confirmed. In 2015, LRWWU embarked on a second flow capacity study to determine its peak wet-weather flow rates. Results of this analysis are now available, with the conclusion that the peak flow rates of 110 MGD (primary) and 50 MGD (secondary) can be routinely achieved while still meeting permit effluent limits.

As part on the Phase 2 improvements, Duck Island's Sodium Hypochlorite disinfection system is being upgraded to support the addition of "pre-chlorination" of wet-weather treatment flow upstream of the Chlorine Contact Chambers. While increased peak flow treatment capacity is anticipated with this improvement, no quantitative measure of increased capacity has yet been identified.

Currently, Lowell Water is embarking on a chlorination study to determine the effectiveness of the pre-chlorination system during wet-weather conditions. As part of the next phase of plant upgrades (2018-2019), automatic dosing of wet-weather flows will be initiated. This will result in more contact time for chlorination of wet-weather flows and will ultimately support maximization of peak flow treatment at Duck Island.

In the meantime, Lowell Water has implemented real-time monitoring of its secondary treatment system. This monitoring has greatly improved our ability to monitor and control the TSS concentration in Duck Island's clean water discharge. Specific target flow rates (aeration flow-through rate plus RAS return rate) have been identified, depending upon operating conditions. In-line TSS meters are utilized to calculate TSS concentrations on a continuous basis. During peak flow conditions, this monitoring system allows operators to confidently balance maximization of peak flow treatment and compliance with permit limits.

Recent upgrades to the influent pumping system and the aeration system, intended to substantially improve the reliability of the treatment process during wet weather conditions, have yielded mixed results. The new pumping equipment experienced several failures, leaving Duck Island less capable of consistently treating high flows than previously anticipated. Meanwhile, several of the new ultra-efficient aeration blowers have experienced catastrophic failures. In recent years, these system failures have impacted Lowell Water's ability to consistently maximize wet-weather flow through the Duck Island treatment facility. In 2016, the influent pumping system was stabilized; however, the unreliability of aeration blowers continued to hinder wet-weather treatment capacity.

Lowell has been diligently working with its engineering consultants and equipment vendors to ensure that reliable treatment of wastewater, particularly during high flow conditions, is consistently provided by the Duck Island facility. Through these efforts, the influent screw pumps have been completely replaced and numerous repairs have been made to them. In 2018, re-grouting of the screw pump channels will solidify the reliability of the influent pumps

Meanwhile, Lowell continues to experience operational failures of its aeration blowers. Altogether, more than fifteen replacements/repairs of aeration blowers have been performed in the past eight years. In 2015, the aeration blowers at Duck Island were upgraded with a new "sequencer" designed as a master controller for the aeration blower units. Lowell Water has evaluated the long-term viability of the current aeration system and concluded that it is necessary to completely replace the aeration blowers in order to resolve this operational vulnerability. This work will be completed in the current phase of improvements.

Because of similar concerns with reliability, Lowell Water has also decided to replace all of its ten clarifier mechanisms (six primary and four secondary tanks). New mechanisms will be included in the plant improvement project that is currently in the bidding phase. The expectation is that new clarifiers will be installed in 2018-2019, significantly reducing "down time" associated with the existing clarifiers, which are original equipment (nearly 40 years old). Likewise, new aeration blowers will be installed during the upcoming plant upgrades. The end result will be much more reliable treatment of peak flows through Duck Island.

Interceptor System Plans and Assessments:

In order to support the evaluation of storage and treatment facilities, Lowell Water completed revised drawings of its entire interceptor system. Plan and profile drawings for almost 40,000 linear feet of large-diameter pipes – ranging from 48" to 120" – were crafted in 2013. These drawings update existing information and provide a useful resource for future projects along the interceptor system.

Another initiative involving the interceptor system was started in 2012: the assessment of all large-diameter pipes alongside the Merrimack River, the Concord River, and Beaver Brook. Through this project, inspection of the interceptor system was accomplished using video cameras and visual observation. Video inspection is intended to identify any defects that may compromise the structural integrity of this critical infrastructure. As importantly, the inspections also identify any defects that allow the inflow of stream water into the interceptor pipes, a scenario that has been suspected during high-level stream conditions in the past.

In-house inspections have been completed for several thousand feet of interceptor pipes. Although this inspection program has not identified any deficiencies, substantial inflow enters Lowell's interceptor system, particularly in the springtime when stream levels are elevated. In order to identify the source(s) of this inflow, a meter isolation project will be implemented in 2018. If inflow sources are identified, they will be prioritized according to severity and corrected as soon as practical.

Reducing CSO Discharge Volume & Frequency:

The combination of sewer separation, improvements to diversion stations and Duck Island, and an effective high flow management program has resulted in markedly lower CSO

discharge volumes in recent years. CSO discharge data indicate that this downward trend is continuing: in 2017, annual CSO discharge volume was approximately 108 MG.

The 2017 CSO annual amount is the lowest total recorded since Lowell Water began compiling annual CSO data in 2003. The volume of 108 MG is a fraction of the **average** annual CSO discharge volume during the past thirteen years (487 MG). Furthermore, the frequency of CSO diversions is the third-lowest during that time span, with diversions occurring only 21% of the total number of precipitation days. This compares quite favorably with the thirteen-year average of 29% occurrence.

CSO Control Plan:

In the past fifteen years, LRWWU has committed more than $1 million towards sewer system metering and modeling, with the intention of using a dynamic model to identify cost-effective solutions that would remedy flow capacity restrictions and identify opportunities for improvement in the collection and treatment systems. The solutions for mitigating these restrictions will likely be a combination of satellite treatment and storage, sewer separation, and treatment facility upgrades (peak flow treatment).

In 2012, LRWWU embarked on the development of a revised CSO control plan. As part of the system characterization effort, twenty-three sewer meters, three groundwater gauges, and one rain gauge were installed in Lowell's collection system service area. The sewer meters measured flows in Lowell's combined sewer system during varying flow conditions. Data from this project, collected on a weekly basis, were input into a sewer system model that predicts system responses to a variety of rainfall conditions. These predictions, their usefulness, and their limitations, were presented in a 2014 LTCP Phase 2 report.

The sewer system model, which informed Lowell's plan for CSO reduction, was originally developed by CDM Smith. In 2014, Lowell Water hired Hazen & Sawyer to oversee its CSO control program, as well as the modeling of its combined sewer system. Three years later, Lowell and Hazen & Sawyer are collaborating to develop another revision of the CSO control plan. This plan will be part of a comprehensive Integrated Capital Improvement Plan (ICIP) that is currently being developed.

The CSO control plan will prioritize solutions based upon costs and benefits. It is important to note that the planned solutions will be implemented in a phased approach. This way, Lowell Water will understand the incremental benefits of each improvement before embarking on the next phase of improvements. This approach will allow for ongoing calibration of the sewer system model, while ensuring a cost-effective program that strives for CSO elimination and optimizes the investment of precious local funding.

The planning associated with CSO control will be informed by modeling the sewer system and the primary receiving stream (Merrimack River) for Lowell's discharges. One interesting feature of Lowell's CSO control plan is the balancing of wet weather flows from both sides of the Merrimack River. Since Lowell is bisected by the river, flows are conveyed to the

treatment facility through a set of siphons and interceptors on each side of the river. Therefore, constructing new storage/treatment facilities on one side of the river would affect the transmission of flow from the other side of the river to the Duck Island.

Another important aspect of Lowell's CSO control plan will be identifying certain siphons where it makes sense to increase their capacity, thus allowing for more flow from the upstream basin to be transmitted downstream to satellite storage/treatment facilities or the Duck Island facility. This approach will need to balance flow conveyed to all storage and treatment facilities, including inline storage in Lowell Water's interceptor system. The benefits of interceptor storage have been mostly realized during the past fifteen years, with only the Read Interceptor Storage project to be completed in early 2018.

In addition to satellite storage (off-line and inline) and sewer separation projects, Lowell Water will continue to focus its efforts on maximizing peak flow treatment at Duck Island. Recent improvements to our "high flow management" approach include both operational changes (real-time effluent TSS monitoring) and capital improvements (screw pump and clarifier mechanism replacements). All of these changes will support Lowell's aggressive approach towards high flow management, resulting in lower CSO frequencies and volumes.

Lowell's CSO control plan will also feature strategic sewer separation projects that will relieve constrictions and reduce CSOs, while also addressing local sewer surcharging. Lowell Water intends to incorporate several stormwater infiltration components into these projects, including "green street" improvements. Indeed, the recently-completed Decatur West project features a green alley with a porous concrete walkway… more details are provided below.

CSO Control Projects:

In 2016, LRWWU completed a sewer separation project in the Tilden Basin – a project named Decatur West Stormwater Management. This collaborative project with UMass-Lowell created a green alley with recreational and cultural elements; the alley has been renamed "Decatur Way – Water, Art & You". The green alley includes a porous concrete walkway that enables stormwater infiltration and reduces wet-weather flow to Tilden Station.

A second project in this phase of improvements features a sewer relief pipe for the Marginal Street sewer, a critical sewer main that is overwhelmed with wet-weather flow and often experiences sewer surcharging (CSO surcharges). The Marginal Sewer Relief Pipe project, which was completed in 2016, is the first component of a two-phase project that will address chronic sewer surcharging in the Marginal-Pevey-Middlesex sewer line. In order to characterize the wet weather conditions in this sewer line, Lowell will continue to conduct level monitoring, so that "before" and "after" conditions in this sewer system are quantified. This effort will inform the design of a subsequent phase of improvements – likely a storage project in the Pevey Street area.

Meanwhile, Lowell Water is constructing an in-line storage project at Read Station. This project, part of a larger project that includes an upgrade to the Centralville flood protection system, is the final piece of a strategy to fully utilize existing infrastructure before building new treatment or storage facilities. Lowell began design for this project in 2015, and expects construction will be completed in early 2018. The project is the first phase of a two-phase project to construct a wet-weather treatment facility at Read Station. The expectation is that a screening and disinfection facility will be constructed at this location during a subsequent phase of Lowell's CSO control program.

All of the initiatives described above are part of Lowell Water's LTCP Phase 2 program. This program includes an interceptor storage project at Read Station, targeted sewer separation in the Tilden Basin, sewer relief projects associated with the Marginal-Pevey Sewer, strategic upgrades to the WWTF, and the completion of an Integrated Capital Improvement Plan (ICIP). While the next CSO control plan is being developed and reviewed, Lowell intends to proceed with several priority projects in Phase 3 of its CSO control program. Those projects will be identified and vetted through the ongoing long-term plan development, and described in future progress reports.