Hazen

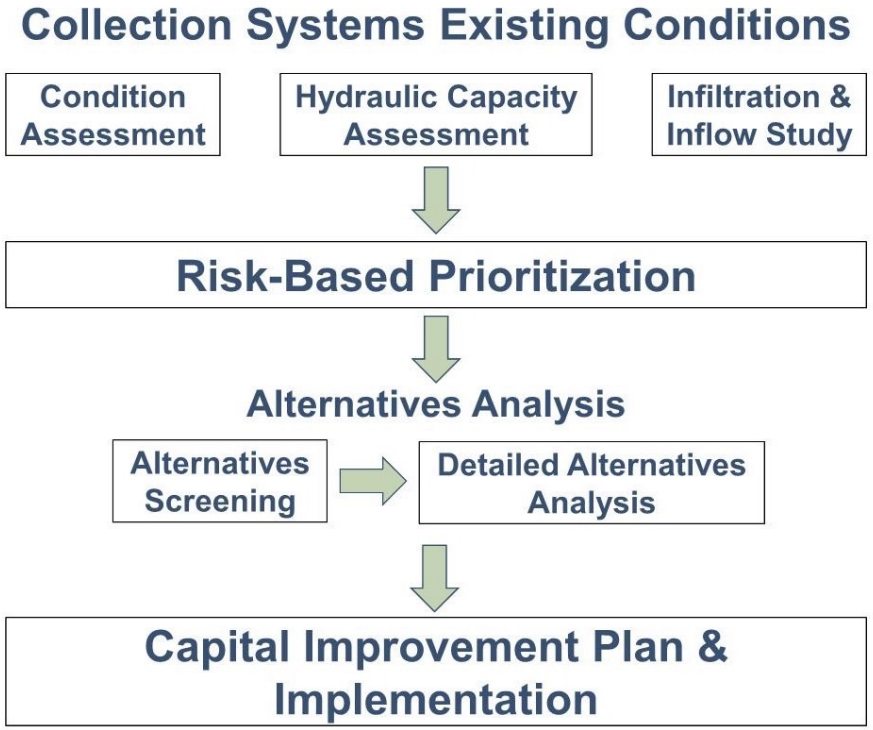
Managing Your Siphons: A Lesson in Maintaining and Rehabilitating Critical Infrastructure

City of Nashua, NH

- Nashua is the second-largest city in New Hampshire (population ~90,000).
- Nashua Wastewater Division:
  - Approximately 23,000 Service Connections
  - 497 miles of gravity sewer (combined and dedicated sanitary)
  - 4 miles of forcemains
  - 13 Pump Stations
  - 8 Inverted Siphons
  - 1 WWTF
- Nashua is a CSO community

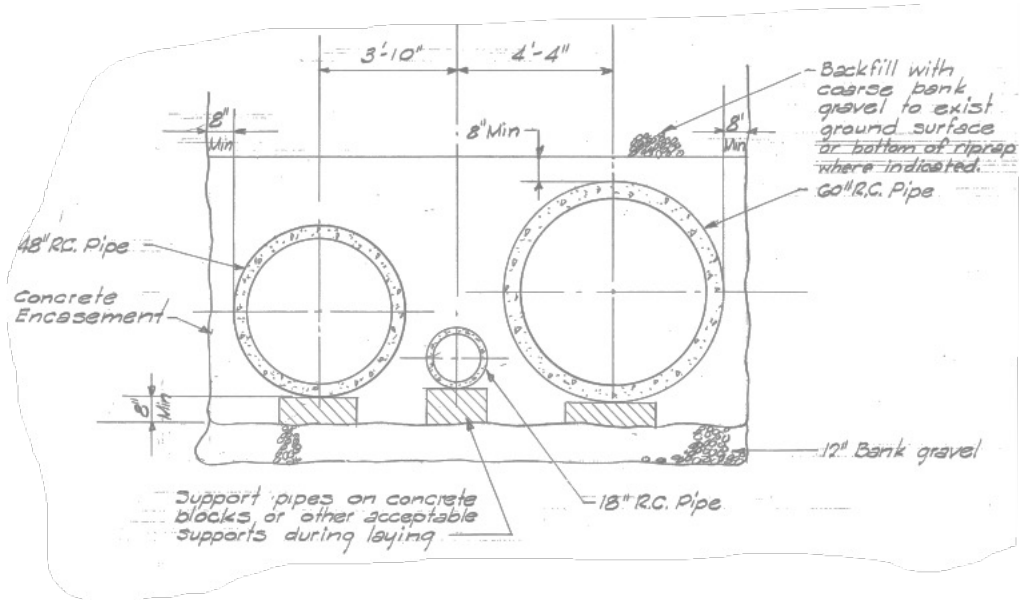
CMOM Program Overview

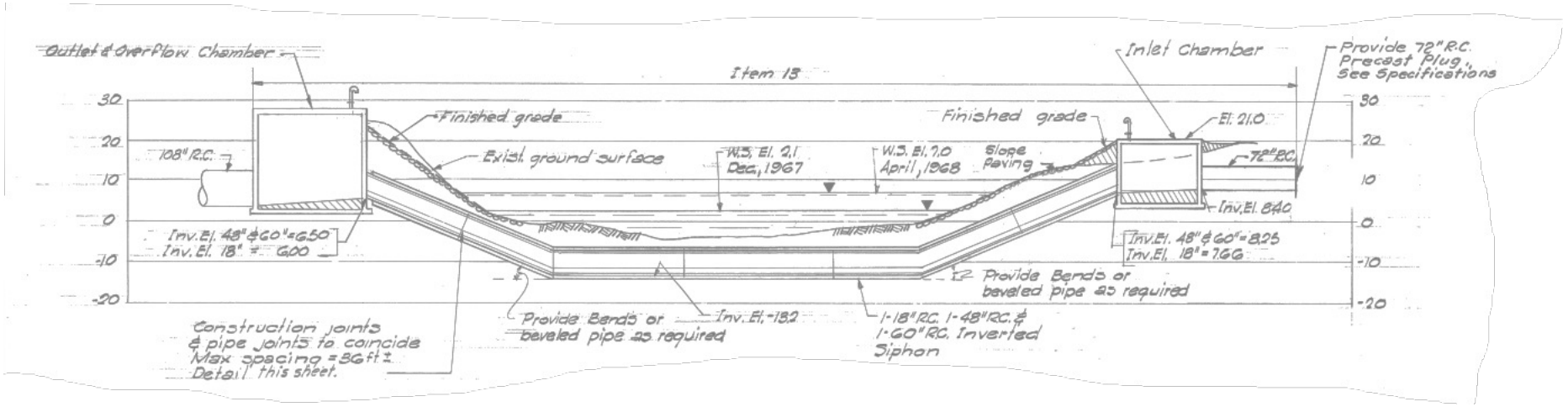
- Contracted with Hazen in 2019 to conduct CMOM Program as a condition of their NPDES permit
- CMOM (Capacity, Management, Operation, and Maintenance) Programs serve 2 main purposes:
    1. Understand and operate a collection system more efficiently
    2. Prevent Sanitary Sewer Overflows (SSOs)
- Core component of CMOM is condition assessment of assets
    - Gravity sewers and inverted siphons inspected via CCTV inspection
    - Recommendations for rehab or replacement follow



Inverted Siphon Overview

- Nashua's Inverted Siphons
  - Installed between 1968 and 1982, ranging in size from 6 to 60-inch barrels
  - Used at river crossing in lieu of pump stations
- Prone to Fats, Oils, and Grease (FOG) build up and debris impaction, particularly at pipe bends





Initial Inverted Siphon Cleaning

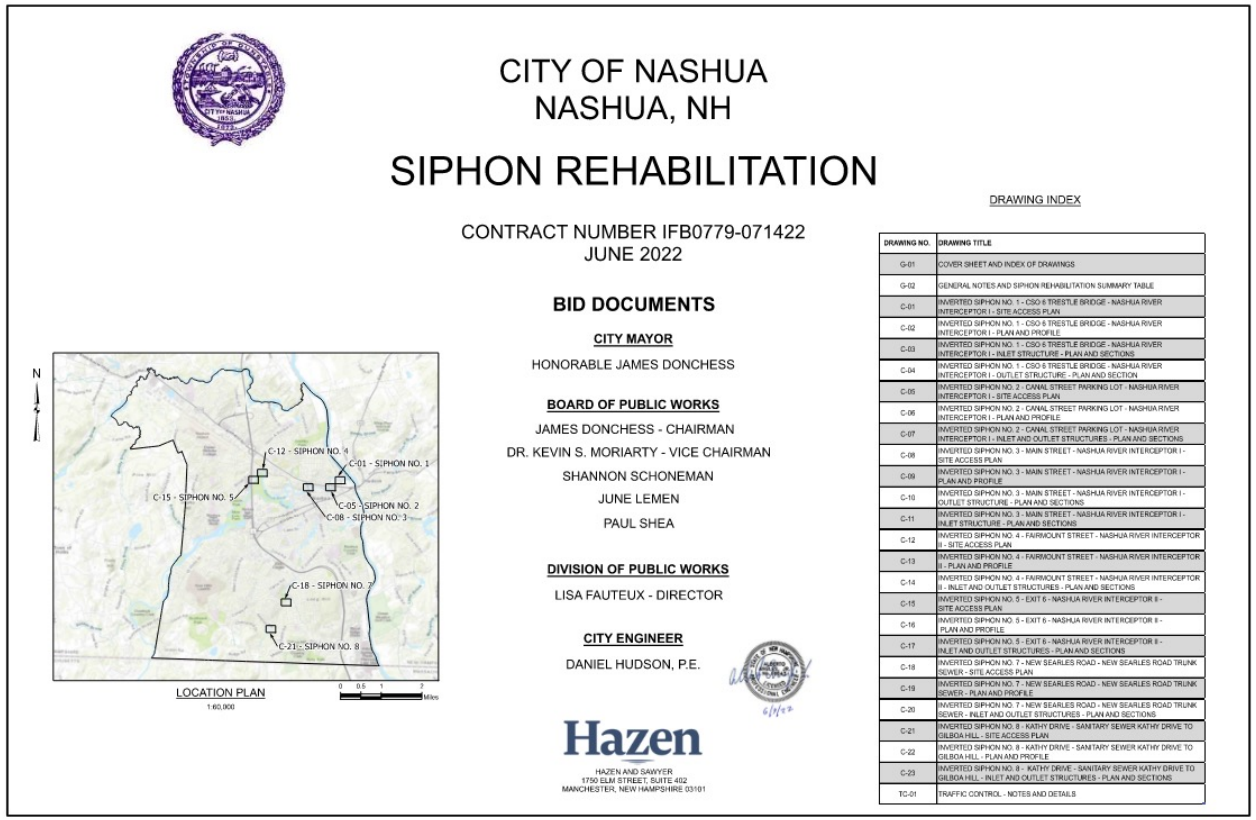
- All 8 inverted siphons were cleaned and inspected over a 2-year period
  - CUES Digital Universal Camera (DUC) used on first 4 siphons
  - Traditional high-resolution camera used on remaining 4
- Crews encountered various challenges when cleaning:
  - Depth of structures
  - Pipe sizes
  - Lack of prior maintenance
- Innovative approaches to cleaning:
  - Customized vacuum tubes, manned entry, uncommon cleaning equipment

Initial Inverted Siphon Cleaning

- Coordination with City of Nashua, private utilities, and residents was key to project success
- As anticipated, inspections found the barrels to be in various states of operability:
  - Heavy grease build up in most barrels
  - Several barrels completely occluded with debris
  - Many defects requiring repair

Inverted Siphon Rehabilitation Design and ESDC

- Hazen recommended rehab for 14 barrels across 7 siphons.
- Design team settled on cured-in-place-pipe (CIPP) lining, cured by hot water.
  - Water selected over steam:
    - Reliability
    - Curing in vertical bends in pipe
  - Added bonus – minimal styrene odor with water cure
- Insituform was awarded the contract, began work in March 2023.
  - Hazen performed ESDC and Resident Engineering
  - Completed work in July 2023.



CITY OF NASHUA
NASHUA, NH

SIPHON REHABILITATION

CONTRACT NUMBER IFB0779-071422
JUNE 2022

BID DOCUMENTS

CITY MAYOR

HONORABLE JAMES DONCHESS

BOARD OF PUBLIC WORKS

JAMES DONCHESS - CHAIRMAN
DR. KEVIN S. MORIARTY - VICE CHAIRMAN
SHANNON SCHONEMAN
JUNE LEMEN
PAUL SHEA

DIVISION OF PUBLIC WORKS

LISA FAUTEUX - DIRECTOR

CITY ENGINEER

DANIEL HUDSON, P.E.

Hazen

HAZEN AND SAWYER
1750 ELM STREET, SUITE 402
MANCHESTER, NEW HAMPSHIRE 03101

LOCATION PLAN
1:60,900

DRAWING INDEX

DRAWING NO.	DRAWING TITLE
G-01	COVER SHEET AND INDEX OF DRAWINGS
G-02	GENERAL NOTES AND SIPHON REHABILITATION SUMMARY TABLE
C-01	INVERTED SIPHON NO. 1 - CSO 6 TRESTLE BRIDGE - NASHUA RIVER INTERCEPTOR I - SITE ACCESS PLAN
C-02	INVERTED SIPHON NO. 1 - CSO 6 TRESTLE BRIDGE - NASHUA RIVER INTERCEPTOR I - PLAN AND PROFILE
C-03	INVERTED SIPHON NO. 1 - CSO 6 TRESTLE BRIDGE - NASHUA RIVER INTERCEPTOR I - INLET STRUCTURE - PLAN AND SECTIONS
C-04	INVERTED SIPHON NO. 1 - CSO 6 TRESTLE BRIDGE - NASHUA RIVER INTERCEPTOR I - OUTLET STRUCTURE - PLAN AND SECTION
C-05	INVERTED SIPHON NO. 2 - CANAL STREET PARKING LOT - NASHUA RIVER INTERCEPTOR I - SITE ACCESS PLAN
C-06	INVERTED SIPHON NO. 2 - CANAL STREET PARKING LOT - NASHUA RIVER INTERCEPTOR I - PLAN AND PROFILE
C-07	INVERTED SIPHON NO. 2 - CANAL STREET PARKING LOT - NASHUA RIVER INTERCEPTOR I - INLET AND OUTLET STRUCTURES - PLAN AND SECTIONS
C-08	INVERTED SIPHON NO. 3 - MAIN STREET - NASHUA RIVER INTERCEPTOR I - SITE ACCESS PLAN
C-09	INVERTED SIPHON NO. 3 - MAIN STREET - NASHUA RIVER INTERCEPTOR I - PLAN AND PROFILE
C-10	INVERTED SIPHON NO. 3 - MAIN STREET - NASHUA RIVER INTERCEPTOR I - OUTLET STRUCTURE - PLAN AND SECTIONS
C-11	INVERTED SIPHON NO. 3 - MAIN STREET - NASHUA RIVER INTERCEPTOR I - INLET STRUCTURE - PLAN AND SECTIONS
C-12	INVERTED SIPHON NO. 4 - FAIRMOUNT STREET - NASHUA RIVER INTERCEPTOR II - SITE ACCESS PLAN
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C-15	INVERTED SIPHON NO. 5 - EXIT 6 - NASHUA RIVER INTERCEPTOR II - SITE ACCESS PLAN
C-16	INVERTED SIPHON NO. 5 - EXIT 6 - NASHUA RIVER INTERCEPTOR II - PLAN AND PROFILE
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C-18	INVERTED SIPHON NO. 7 - NEW SEARLES ROAD - NEW SEARLES ROAD TRUNK SEWER - SITE ACCESS PLAN
C-19	INVERTED SIPHON NO. 7 - NEW SEARLES ROAD - NEW SEARLES ROAD TRUNK SEWER - PLAN AND PROFILE
C-20	INVERTED SIPHON NO. 7 - NEW SEARLES ROAD - NEW SEARLES ROAD TRUNK SEWER - INLET AND OUTLET STRUCTURES - PLAN AND SECTIONS
C-21	INVERTED SIPHON NO. 8 - KATHY DRIVE - SANITARY SEWER KATHY DRIVE TO GILBOA HILL - SITE ACCESS PLAN
C-22	INVERTED SIPHON NO. 8 - KATHY DRIVE - SANITARY SEWER KATHY DRIVE TO GILBOA HILL - PLAN AND PROFILE
C-23	INVERTED SIPHON NO. 8 - KATHY DRIVE - SANITARY SEWER KATHY DRIVE TO GILBOA HILL - INLET AND OUTLET STRUCTURES - PLAN AND SECTIONS
TC-01	TRAFFIC CONTROL - NOTES AND DETAILS

Inverted Siphon Pre-Lining Cleaning

- Prior to rehab, designated barrels were cleaned and inspected
    - In just 3-4 years, barrels exhibited heavy grease build up and large debris, including rocks, sand, ragging, and more
- Again, crew relied on less common equipment and techniques to clean siphons
    - Pneumatic rock hammers, pigging, specialized vacuum hoses, etc.

Inverted Siphon CIPP Process

- After cleaning and dewatering, heat tracing wires were fed through the invert of the siphon
  - Used to track temperature of water throughout cure to ensure proper curing of liner
  - Continuous-length heat trace provides more reassurance in cure
- Liner inverted using water from nearby hydrants or jet trucks
- Once liner was inverted, water was circulated through the liner and a boiler to maintain specified temperatures for the duration of the cure
- Water was allowed to cool down prior to release downstream to the treatment plant

Inverted Siphon Weko Seal – Siphon #2

- 36” RCP at Siphon #2 initially recommended for short liner installation for cracking near elbow
    - Because of bend in pipe, equipment could not navigate and install a short liner at this location
- After considering various products and solutions, project team selected to install a Weko Seal
    - This is a rubber gasket secured in place via steel rings
    - Installed via manned entry

Inverted Siphon CUES LOCK Installation – Siphon #3

- During inspection Siphon #3 was found to have a large hole in the 21” barrel allowing constant infiltration
- Hole was determined to be near the river’s waterline, contributing to inflow
- Design team initially proposed installation of a pre-liner, followed by a full-length CIP liner
    - After installation of the CIP liner, the crew was to drill a hole and grout the void that had been lined over
- Field conditions did not allow this
    - Higher water level → more infiltration → could not install liners or grout

Inverted Siphon CUES LOCK Installation – Siphon #3

- Solution – install CUES LOCK sleeves to occlude the hole in the crown, install CIP Liner, grout the void via injection through upstream siphon structure wall
  - CUES LOCK are steel sleeves that expand to a set diameter and lock into place, providing a structural repair
- Specialty equipment was flown in from CUES and a representative was on site for installation
- Four, 2-foot sleeves were installed to repair the defect
- Grout was installed via drills holes in the upstream structure's wall to seal the void externally

Lessons Learned

- Regular Cleaning/Inspection Program is crucial
  - Rule of thumb is 3 years, can be adjusted case-by-case after that
- Siphons can pose unique challenges for short liner installation
- Rising river water levels can create rehab challenges
- Continuous-length Temperature Monitoring
- Hot water curing is very time consuming
  - Larger diameter barrels required >24 hours for installation and curing

Thank You to Our Project Team!

- City of Nashua Engineering and Wastewater
- Vortex
- National Water Main Cleaning Company
- Insituform
- Hazen’s Team of Resident Engineers

Questions?