TATA & HOWARD

January 8, 2019

Mr. Charles J. Dam, P.E.
DPW Director
Town of Manchester-by-the-Sea
10 Central Street
Manchester by the Sea, MA 01944

Subject: Harbor Loop Preliminary Design

Dear Mr. Dam:

In accordance with our contract agreement, Tata & Howard, Inc. (T&H) is pleased to present this letter report as a follow up to the alternatives analysis previously submitted on March 29, 2018 for the repair of the Harbor Loop Sewer in the Manchester-by-the-Sea (MBTS) wastewater collection system. A more focused analysis was performed for the structural pipe lining and pump station alternatives including field investigations and updated cost estimates.

1.0 Introduction

The Harbor Loop Alternatives Analysis dated March 29, 2018 provided an overview of each alternative considered and the pros and cons associated with each. This report will provide additional information gathered regarding the structural lining and pump station alternatives, including an option of using a local shallow sewer to service the houses currently connected to the Harbor Loop sewer instead of grinder pumps. The report also provides a refined cost estimate associated with those alternatives.

2.0 Existing Conditions

Although there was a significant decrease in flow to the wastewater treatment plant after the emergency repair in the Harbor Loop sewer, there is still evidence of sea water at the plant. Salinity meters were installed in March 2018 as part of the continuing salt water intrusion investigations to assess conditions after various sewer improvements. Salinity meter results are included in Appendix E. Using depth of flow data provided by salinity meters installed in March of 2018, an average flow of 57 gallons per minute (gpm) and a peak flow of 140 gpm was calculated, which is significantly higher flows than expected, indicating that some tidal intrusion into the Harbor Loop sewer may still be occurring. The salinity meter results did show, however, that the emergency repair work to fix the broken section of pipe in the Harbor Loop sewer did significantly reduce flows in the sewer.

The average raw depth reported in manhole 119 during the March 2018 metering period was 3.28 inches while the maximum depth was 5.52 inches. This is significantly lower than the data provided from the March 2016 salinity metering which reported an average raw depth of 6.43 inches and a maximum depth of 35.74 inches.

Discussions with the wastewater treatment plant operator revealed that the treatment plant is still seeing an average of two or three very small shrimp when twenty-four-hour composite sampling is performed. Larger shrimp or minnows seen in the past have not been observed, however, a new grinder was recently installed at the influent channel.

The following tasks were performed to provide additional information to refine and supplement the earlier Harbor Loop Analysis study:

- A topographic survey of the project site.
- Homeowner's meeting
- Home inspections to identify service connection locations
- Additional discussions with lining companies
- Site visit to observe conditions
- Discussion with previous contractor for 2011 work
- Refine cost estimates of alternatives
- Preliminary pump station sizing

3.0 Additional Information and Investigations

3.1 Topographic Survey

A topographic survey was performed by WSP USA Corp. in August 2018. The survey provides the existing conditions and an accurate basis for future design. As part of the survey, inverts and rim elevations of all structures were obtained, as well as all pipe sizes. Existing conditions information was included as a basis for all preliminary design alternatives included in Appendix A.

3.2 Homeowner's Meeting

A homeowner's meeting was held on September 13, 2018 with both the Town and T&H present. All homes and businesses directly affected by the area of proposed improvements were invited to attend. At this meeting, details of the Harbor Loop sewer alternatives were presented to attendees and questions and concerns were discussed.

One of the main concerns expressed by the homeowners was regarding the pump station alternative which would potentially include the installation of individual grinder pumps at each home. If individual pumps were installed at the properties, responsibility of operation and maintenance would become an item of further discussion. An additional concern by homeowners was the proposed construction in their backyards and the effects on the property. The impact to the homeowners will vary widely depending on the final design.

As part of this meeting, appointments were scheduled with homeowners to perform inspection of their private service connections to the sewer. This was conducted to obtain more information on

the conditions around the service connection and the approximate location of the service and connection to the main line. A copy of the meeting notes and sign in sheet from the homeowners meeting is included in Appendix B.

3.3 Home Inspections

Following the homeowners meeting, home inspections were scheduled. T&H along with the Town performed home inspections to determine the location of services and possible obstacles that may be encountered on each property for the alternatives.

Home service inspections were performed on September 26, 2018 by T&H supplemented by Town inspections performed as additional homeowners were available.

During inspections, the main focus was to gather information of the service locations as well as the surroundings. This information will be needed during design to determine the extent of construction and restoration efforts necessary for each of the properties impacted by the proposed sewer improvements. It also allowed for better understanding of the feasibility of each option. Field notes, sketches, and photos of home inspections are included in Appendix C.

Notable Observations

Due to the elevation differential at each property it appears that installation of grinder pumps to connect each home to the sewer on Bridge Street is feasible but would present difficulties. Connection would likely be made by drilling though the 7 to 10 foot retaining walls on either the east or west of each home and excavating at the street side to connect to the sewer on Bridge Street. Depending on the property and piping needed, there could be significant added costs compared to installation of a typical grinder pump system. Additionally, from previous sewer rehabilitation construction experience in Town, it is possible that ledge will be encountered on Bridge Street when installing the grinder pump discharge piping from each home which will add to the difficulty of the work and further increase costs.

An alternative option to installing a grinder pumps for each of the homes currently serviced by the Harbor Loop sewer would be to install a shallow sewer along the back of the properties and direct flows from those homes back to the new pump station. Through observations of the site conditions and field survey, there will be several structures that will have to be removed and replaced during construction of the shallow sewer including retaining walls, fences, and stairs. A conceptual layout of the shallow sewer for this alternative is shown in Figure No. 1 (Appendix A).

During inspections for 12A and 12B Ashland Avenue, the owner reported that the sewer service for the building is submerged during high tide. Upon visual inspection, the service appeared to be in poor and brittle condition which was confirmed by the owner. This could be a potential source for salt water intrusion in the system and should be addressed. Additionally, the service at 12C Ashland Avenue is also submerged during high tide, however, this service has been replaced recently and has a protective barrier around it as shown in the 12C Ashland Avenue photo in Appendix C. The home inspections completed provide some information as to where the service lateral exited the home, however, the elevation of the service laterals could not be determined. All services located went directly into the ground to an unknown depth. From survey information provided, however, it is assumed at this time that the service laterals are located approximately 4

feet below ground level. If a shallow sewer is installed, test pits would need to be performed during the design phase to provide an accurate service lateral depth for connection to a new shallow sewer. A profile of the proposed shallow sewer option is included in Appendix A.

3.4 CIPP Lining Discussions

To gain more information on the feasibility and longevity of the CIPP lining, a lining contractor, Green Mountain Pipeline Services (GMPS), was contacted. Based on the project information, GMPS was asked to provide an opinion on the feasibility and logistics of lining this stretch of the Harbor Loop sewer. GMPS scheduled a site visit with the Town to assess the conditions and location restrictions of the Harbor Loop. The site visit and past experience with tidally influenced sewer concluded that this stretch of the Harbor Loop sewer can be lined with less difficulty than previously thought.

Even though the sewer line was recently replaced from manhole 126A to manhole 123, GMPS recommends lining the whole stretch of pipe from manhole 126A to manhole 119, approximately 1,200 linear feet. This would avoid the need for a barge to access the manholes in the central portion of the Harbor Loop sewer to perform the lining work. It would also provide a continuous liner through the Harbor Loop sewer providing better protection against infiltration and inflow into the pipe. GMPS noted that they have recently completed a similar continuous inversion of 1,400 linear feet of a 14-inch pipe located along a portion of the harbor in Gloucester. Of most concern to achieving a single continuous liner, is the sharp bend at manhole 123. If a lining company is unable to guide the lining through that manhole bend, the best option would then be to line the pipe in two segments. First, from manhole 119 to manhole 123 and then from manhole 126A to manhole 123.

Another concern with CIPP lining of the existing Harbor Loop sewer that needs to be considered is the condition of the existing pipe. The recent repair work completed on the sewer revealed that the pipe may too brittle in locations to withstand the heavy cleaning typically completed before installation of the CIPP lining. GMPS was provided CCTV of the existing sewer and based on a review of CCTV tapes, GMPS stated that they believe the pipe could be cleaned well enough to adequately install the liner.

GMPS recommends water inversion with a hot water cure as the preferred installation method to ensure the liner maintains the form of the pipe throughout the inversion and curing process as it is the most conservative way to perform the work. Though this is the safest way to cure the lining, it is not the most efficient. The process would start at high tide and would take an estimated 6-8 hours to invert and an additional 10-12 hours to fully cure. Further, the finished pipe lining will take the shape of the existing pipe, including imperfections left after any light cleaning that is able to be completed prior to lining installation. Further, the lined pipe would include any dips or sags of the existing pipe. We are aware of three sags along the length of pipe from manhole 126A to manhole 125. Additionally, the pipe between manhole 123 and manhole 122 exhibits settlement and the pitch appears to be reversed slightly toward the upstream manhole as observed during the emergency repair of the pipe.

Per reference of GMPS, T&H had further discussions with a lateral lining contractor, BLD, LLC. BLD indicated that they should be able to line the laterals. BLD has previous experience with tidally influenced projects and have smaller equipment that can be used when access is limited.

4.0 Findings

Using information gathered from field observations, homeowner meeting, service inspections, contractor opinion, and past data, the alternatives of CIPP Lining and Pump Station were further evaluated. A refined cost estimate was also developed for consideration in comparing alternatives.

4.1 Harbor Loop Flow Estimate

Harbor Loop flow estimates were calculated for evaluating the design alternatives. These flows were used to evaluate pipe capacity as well as to estimate required pump sizing.

Total contributing flow was calculated based on the properties connected to the system upstream as well as the Harbor Loop area using Title 5 flows of 110 gallons per day (gpd) per bedroom. The number of properties connected to the Harbor Loop Sewer upstream of manhole 119 was determined to be approximately 62. Of those properties, three were identified as commercial buildings.

Table No. 4-1 presents the estimated average and peak flows for the Harbor Loop Sewer. Peak flows were estimated using a peaking factor (PF) of 4.25 using peak flow curves based on population served. Estimated flows included flow from possible future sewer extensions in the collection area as identified in the Comprehensive Wastewater Management Plan (CWMP) was also included in the flow estimate. An infiltration component of 500 gpd/idm was also added.

Table No. 4-1
Harbor Loop Design Sewer Flow Calculations – Title 5

	No. of Dwellings	Bedrooms	Flow/ Bedroom or Avg Flow/Lot	gpd	gpm	Notes
Residential	59	3	110	19,470	13.5	
Commercial	3	-	1100	3,300	2.3	Assumed 3.5 gpd per Avg SF/100
CWMP Estimated Flow						
Sewer Extension	10	3	110	3,300	2.3	
Total Design Flow						
	Flow (gpd)		Flow (gpm)		Notes	
Flow for Design	26,070		18.1			
I/I Component	2,175		2		500 gpd/idm	
Total Flow for Design	**28,245**		**20**			
Peaking factor	4.25					
Peak Design Flow	**120,041**		**85**			

4.2 CIPP Lining

CIPP lining of the entire length of the Harbor Loop sewer could significantly improve the water tightness of the Harbor Loop Sewer against tidal intrusion with little disruption to homeowners. Lining of the service laterals to above the tidal height, if possible, should be performed in conjunction with the sewer CIPP lining. Additionally, all manholes located along the Harbor Loop should be lined and sealed with a water tight frame and cover installed. If a manhole is submerged during high tide periods, raising of the manhole should also be considered, manholes 123 and 125 are currently subject to tides above the rim elevations. A preliminary design of the lining alternative is shown in Figure No. 2 (Appendix A).

Although lining was deemed feasible during contractor discussion, collapse of the pipe during installation is a potential concern that should be addressed in the design should lining be chosen as a solution. The proposed use of a water inversion technique to install the liner is intended to address this concern.

Further, due to the restriction on heavy cleaning because of the fragility of the pipes, much of the internal build up is expected to remain after cleaning. This, along with the thickness of the added liner may restrict the carrying capacity of the existing sewer pipes.

Assuming a thickness of 0.15 inches for liner installation and a decrease in size for the corrosion factor, we can assume, as worst case, the rehabilitation of the pipe will provide a size closer to 6-inches in diameter in the cast iron section from manhole 123 to manhole 119. A pipe capacity analysis was performed on the Harbor Loop system assuming a diameter of 6” (Appendix D).

A reduction of 2-inches in pipe size reduces the capacity of flow the pipe can handle, however, the addition of a liner would reduce friction in the pipe which would compensate for some of this reduction. The existing pipe capacity was calculated to be between 170 to 260 gpm, while the lined pipe capacity was calculated to be 100 to 160 gpm. The analysis indicates that with this reduction in pipe size, all pipes would be under 30% full at average design flow and under 60% full at estimated peak flows. Further, at peak design flow, the depth of flow in the pipe increases minimally from 3.0 – 3.8 inches to 3.1 - 4.3 inches.

Adding a liner to the existing pipe that reduces the effective internal pipe diameter does not appear to be a concern, the lined pipe will result in a minor decrease in capacity. The liner and other proposed improvements to the Harbor Loop Sewer should reduce peak flows through the sewer by eliminating infiltration and inflow sources offsetting any capacity reduction. Further, evaluation of current conditions shows that there does not appear to be any issues with surcharging or back up in the area.

A refined cost estimate, detailing items expected during construction is provided in Table No. 4-2. Sewer lateral lining was assumed to extend the full length of service, for a total of 12 services. Pricing received for lateral lining included an initial fee of $3,500 for the first 5 feet of lining per service. After the initial fee, a cost per foot was applied to the remaining footage.

Table No. 4-2
Pipe Lining Cost Estimate

Item	Quantity	Unit	Cost/Unit	Cost Estimate
CIPP Lining	1,100	LF	$200.00	$220,000
Sewer Services Lining First 5'	12	LS	$3,500.00	$42,000
	610	LF	$100.00	$61,000
Manhole Rehab Lining	22	VF	$250.00	$5,500
Manhole Rehab Watertight Frame and Cover	3	EA	$1,500.00	$4,500
Subtotal				$333,000
Contingency (25%)				$83,250
Subtotal w/Contingency				$416,250
Engineering (25%)				$104,063
Total				**$520,313**

4.3 Pump Station

Construction of a submersible sewer pump station that bypasses flow from the existing Harbor Loop Sewer will eliminate future tidal intrusion into the wastewater collection system that may currently exist in the sewers in the Harbor Loop area. Given homeowner concerns with individual grinder pumps and the potential difficulties of installing service connection from each home to the Bridge Street sewer, a modified pump station option which includes installation of a shallow sewer to bring flows from the homes along the Harbor Loop Sewer to the pumps station was developed. The shallow sewer would be located at as high an elevation as possible above the high tide elevation while still being able to collect flows from all the existing services laterals of the homes currently serviced by the existing Harbor Loop Sewer. A preliminary design of the conceptual layout of the pump station and shallow sewer collection system is show in Figure No. 1 (Appendix A). Location of the sewers and pump station are conceptual and subject to modification. Land acquisition for siting the pump station and sewer easements will be required.

Construction of a new shallow sewer along the back of the Harbor Loop properties will cause significantly more disruption to private properties than CIPP lining of the existing sewer. Construction of a shallow sewer would damage homeowners' lawns, require removal and replacement of fencing, retaining walls, and other structures. The work required for restoration of homeowners' yards to pre-construction condition will add to the cost of the project.

Based on the preliminary flows estimated for the Harbor Loop sewer previously discussed in Section 4.1, the pump station would be required to handle an average design flow of approximately 28,000 gpd with a peak hour flow of approximately 5,200 gallons per hour (gph). Preliminary

costs for the pump station are based on a submersible pump station with dual 200 gpm pumps located in a 6 foot diameter pre-cast manhole wet well, a 8-foot diameter pre-cast manhole valve vault, above-ground controls, and a self-enclosed emergency generator would be used with controls located above ground.

A refined cost estimate, detailing items expected during construction is provided in Table No. 4-3. Pricing for the pump station was estimated from T&H pump station projects with similar sizing. Installing a pump station would be costly and may present obstacles, however, would help eliminate the threat of salt water intrusion into the system in the future.

Table No. 4-3
Pump Station and Shallow Sewer Cost Estimate

Item	Quantity	Unit	Cost/Unit	Cost Estimate
Pump Station	1	EA	$300,000.00	$300,000
4" D.I. Force Main	700	LF	$65.00	$45,500
Pavement	900	LF	$75.00	$67,500
6" PVC Sewer	1,330	LF	$50.00	$66,500
Installation new SMH	6	EA	$9,500.00	$57,000
Shallow Test Pits – Sewer Service	9	EA	$50.00	$450
Landscape/Restoration	615	SY	$20.00	$12,300
Wall, Stair Repair	Allowance		$30,000.00	$30,000
Lateral Relocations – 4" PVC Pipe	152	LF	$50.00	$7,600
				-
Subtotal Construction				$586,850
Contingency (25%)				$146,710
Construction w/Contingency				$733,560
Engineering (25%)				$183,390
Land Acquisition/ Easements				TBD
Total				**$916,950**

5.0 Recommendations

It is recommended that the Town install a CIPP liner to the Harbor Loop sewer system including lining or rehabilitation of laterals to a point above the mean high tide elevation. Discussion with the lining contractor indicates this method will be effective and provide minor disruption to homeowner property. It is recommended that light cleaning be performed to the pipe and that a

water inversion technique is used to minimize potential for damage to existing pipe during installation.

Following installation of the liner, the system should be cleaned, maintained and monitored regularly to ensure that the system is functioning properly and remains watertight. Further, it is advised that the flow in the system be periodically monitored to ensure that there are no additional issues in the future.

As part of the design, a plan should be developed in the event that there is a collapse of the pipe during installation. Additionally, special attention should be made for the lateral connections located in the tidal plain, specifically at 12A/12B Ashland Avenue. These laterals should be inspected to determine if full replacement will be necessary.

A pump station with a shallow sewer serving the homes along the Harbor Loop is a viable alternative to CIPP lining of the Harbor Loop Sewer should the Town desire a more long-term solution to addressing the Harbor Loop Sewer with an option that removes the sewer from its location along and within the tidal plain.

We appreciate the opportunity to assist on this important project. If you have any questions, please do not hesitate to contact our office.

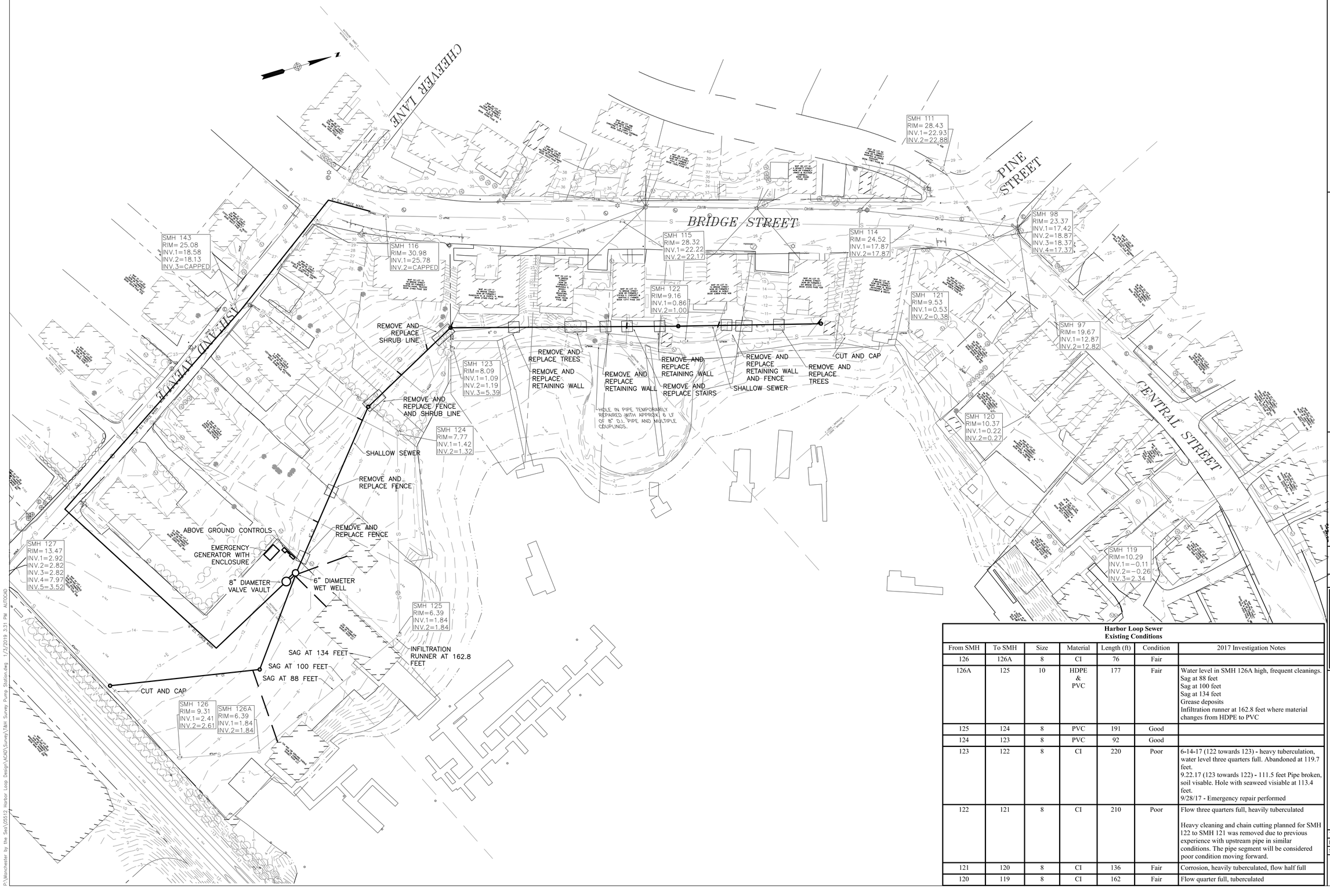
Sincerely,

TATA & HOWARD, INC.

Steven J. Landry, P.E.
Vice President

Appendix A

TATA & HOWARD



Harbor Loop Sewer
Existing Conditions

From SMH	To SMH	Size	Material	Length (ft)	Condition	2017 Investigation Notes
126	126A	8	CI	76	Fair	
126A	125	10	HDPE & PVC	177	Fair	Water level in SMH 126A high, frequent cleanings. Sag at 88 feet Sag at 100 feet Sag at 134 feet Grease deposits Infiltration runner at 162.8 feet where material changes from HDPE to PVC
125	124	8	PVC	191	Good	
124	123	8	PVC	92	Good	
123	122	8	CI	220	Poor	6-14-17 (122 towards 123) - heavy tuberculation, water level three quarters full. Abandoned at 119.7 feet. 9.22.17 (123 towards 122) - 111.5 feet Pipe broken, soil visable. Hole with seaweed visiable at 113.4 feet. 9/28/17 - Emergency repair performed
122	121	8	CI	210	Poor	Flow three quarters full, heavily tuberculated Heavy cleaning and chain cutting planned for SMH 122 to SMH 121 was removed due to previous experience with upstream pipe in similar conditions. The pipe segment will be considered poor condition moving forward.
121	120	8	CI	136	Fair	Corrosion, heavily tuberculated, flow half full
120	119	8	CI	162	Fair	Flow quarter full, tuberculated

MANCHESTER-BY-THE-SEA
MASSACHUSETTS

HARBOR LOOP PROJECT

SUBMERSIBLE SEWER PUMP STATION AND SHALLOW SEWER

Drawn By: | Designed By: | Checked By: | Approved By:

Rev.	Date	Description

90% DRAFT SUBMITTAL NOT FOR CONSTRUCTION

TATA & HOWARD

T&H NO.:
DATE:
SCALE: AS NOTED

01

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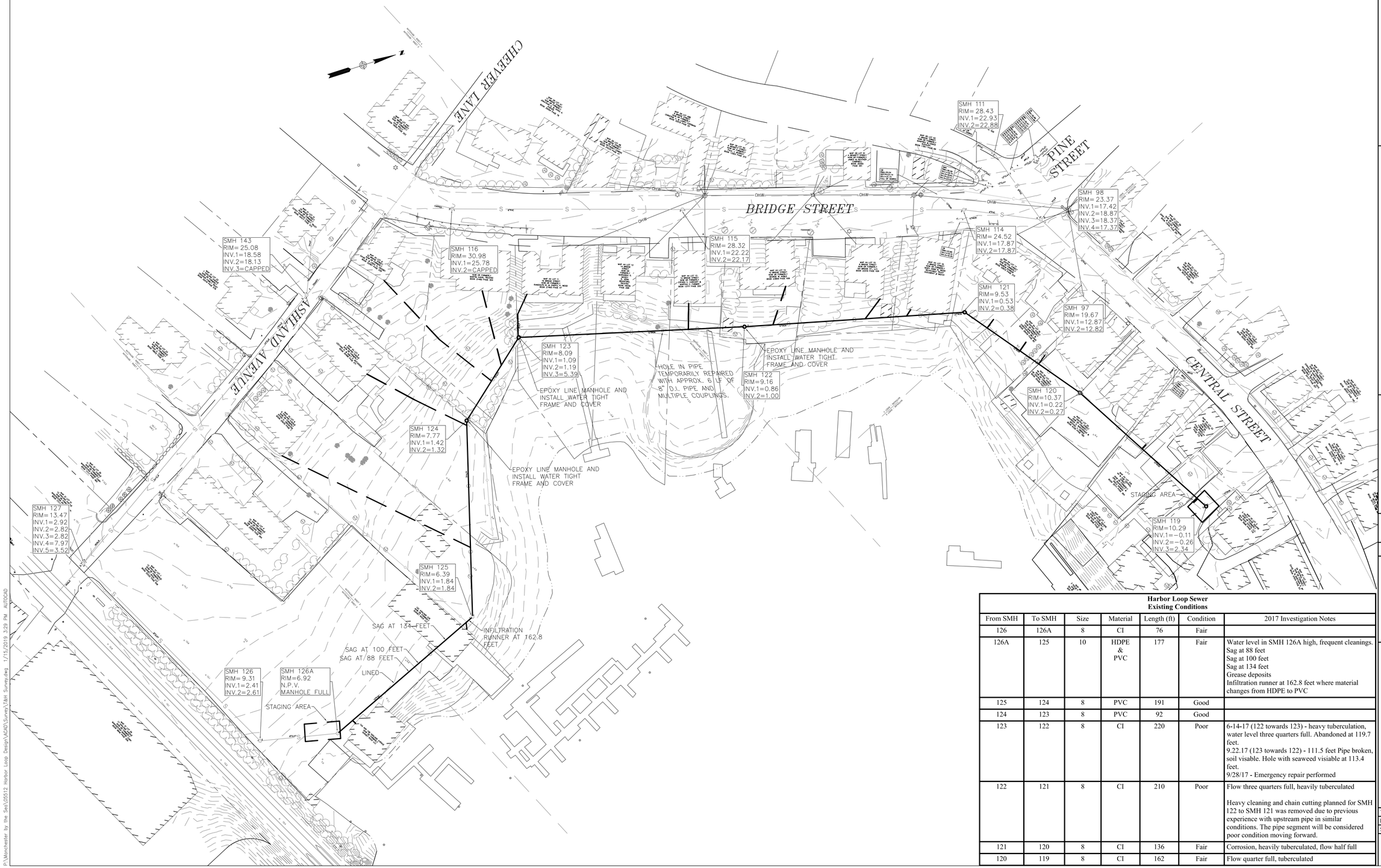

Harbor Loop Sewer
Existing Conditions

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120	119	8	CI	162	Fair	Flow quarter full, tuberculated

MANCHESTER-BY-THE-SEA
MASSACHUSETTS

HARBOR LOOP PROJECT

PIPE LINING

Drawn By: | Designed By: | Checked By: | Approved By:

Rev.	Date	Description

TATA & HOWARD

T&H NO.:
DATE:
SCALE: AS NOTED

02

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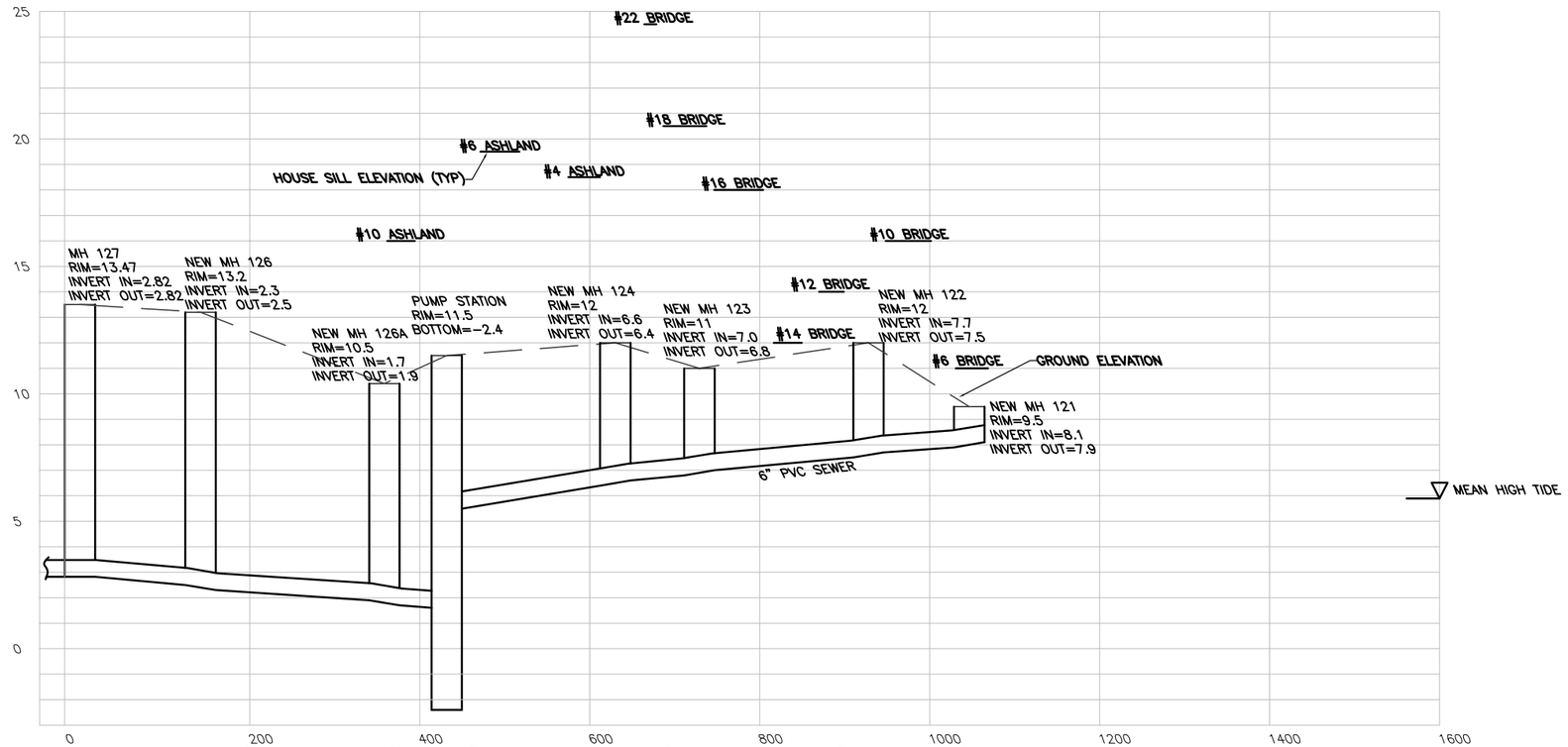
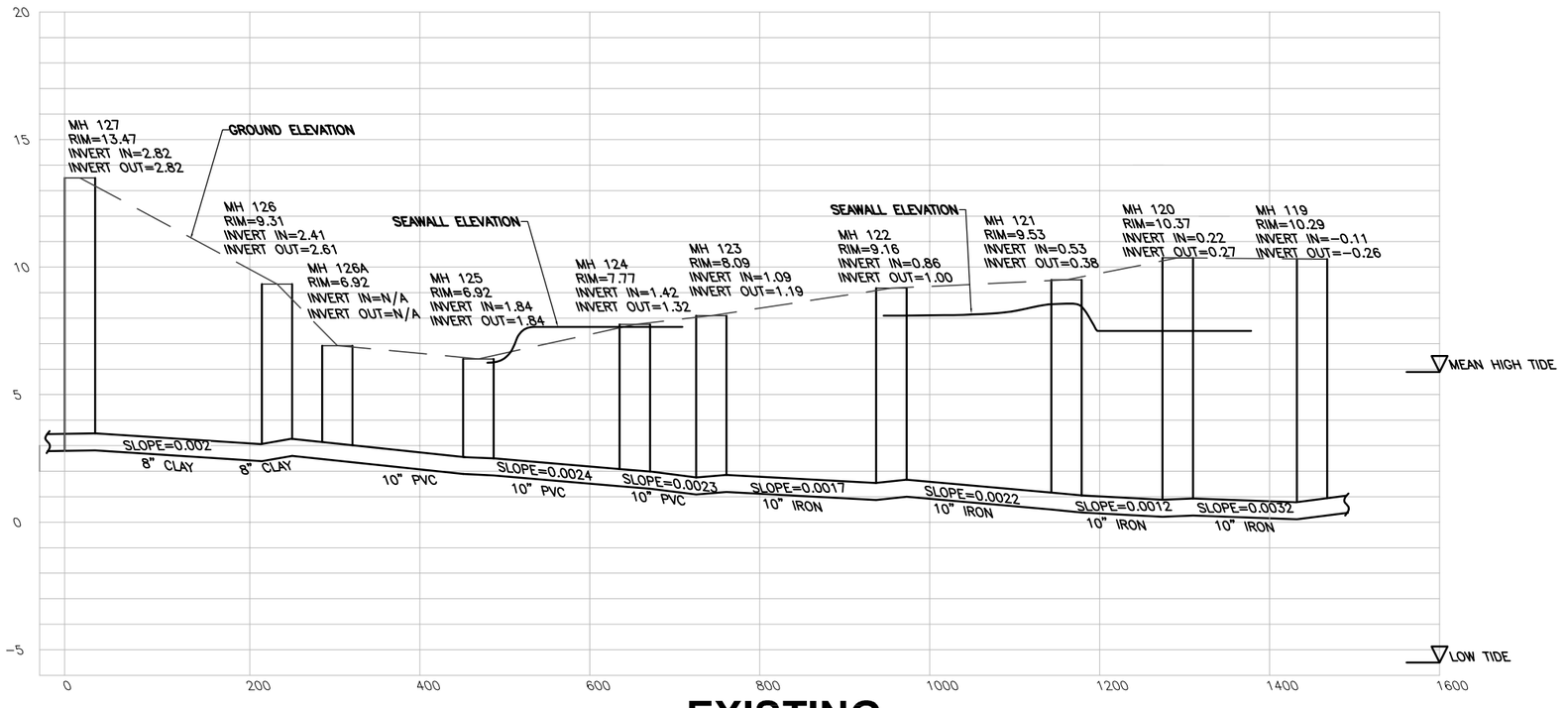


SHALLOW SEWER TO PUMP STATION ALTERNATIVE



EXISTING

Figure No. 3

SEWER PROFILE
HARBOR LOOP DESIGN
MANCHESTER-BY-THE-SEA, MASSACHUSETTS

TATA & HOWARD

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Appendix B

TATA & HOWARD

Meeting Agenda
Department of Public Works
Manchester by the Sea
September 13, 2018 @ 3:00 PM, 6:00 PM

Attendees:
Allison Shivers – Tata & Howard
Kasey Kenyon – Tata & Howard
Charles Dam – Department of Public Works

Harbor Loop Sewer Rehabilitation Project

- Information needed from homeowners
  - Sewer service lines – Sewer inspections basement
    - Contact information
    - Permission to inspect sewer service entry
    - Any information homeowner has regarding service line
      - Owner info/pictures if available
      - Description of location

- Sewer Rehab Recommendations
  - What are the possible alternatives being considered for repair?
    - Repair in place
      - Lining of Sewer length
    - Sewer line relocation
      - shallow sewer to new Pump station
    - Ejector Pump Stations – EOne

- Construction Time Concerns – Spring 2019
  - Expected to be designed by end of year
  - Construction should take 2-3 months
  - Possible to hold off until following Fall for construction if construction is undesired through summer

- Questions

Meeting Agenda
Department of Public Works
Manchester by the Sea
September 13, 2018 @ 3:00 PM, 6:00 PM

Notes:

Attendees:
Allison Shivers- Tata & Howard
Kasey Kenyon- Tata & Howard
Charles Dam- MBTS Department of Public Works
Nate Desrosiers- MBTS Department of Public Works

3PM Meeting

No homeowners showed up, conversation with Chuck and Nate

- Will there be salinity issues on the grinder pumps (E-One)
  - Winter conditions
    - Installation
  - Metal protections
- Pump station versus pipe lining
  - Would overall O&M of cleaning pipe after lining be less than the cost to run pump station (gas, electric, etc.)
- Pipe Lining
  - Line the laterals to the houses as well
    - Will be more linear footage but will prevent any problems in the future
  - Push Camera?
    - Insert into cleanouts
    - Give a better picture of house service lines
- BOH will have records for services to houses

6PM Meeting

Questions from homeowners;

- Who is paying for E-One?
  - MBTS
- I have never experienced any problems, never had a backup, why is this a problem now?
  - Since the emergency break there has been a large influx of salinity to WWTP
- Where does the sewer run?
  - Show plans, in their backyard
- I heard that they might be planning on moving the WWTP since it's in the flood zone
  - Very costly, not a priority right now
- When do you expect to start?
  - Look at basements, cleanouts, etc. in the next few weeks
  - Early as this fall for lining
  - Spring for pump station
- Why did they stop the pipe burst when they did it?
  - No records of why
- I am putting in a fence in my backyard, should I wait until this job is complete?
  - We would recommend holding off, just incase it would be in the way of construction, it would have to be replaced again

Meeting Agenda
Department of Public Works
Manchester by the Sea
September 13, 2018 @ 3:00 PM, 6:00 PM

- Randy Wood
    - Could most likely tell where they stopped for the pipe bursting a few years ago if we don't have exact location

Home Owner Info Sheet
Harbor Loop Sewer Repair Inspections
Manchester-by-the-Sea, Massachusetts
September 13, 2018

Name	Address	Phone #	E-mail Address	Availability
Chuck Dam	MBTS			
Karen J Hatch	6 Bridge ST		karenjhatch@gmail.com	
Erik Stevenson	10-12 Ashland Ave	978-815-299X	ESTEVENSON@BROXINDUSTTIES.COM	
MARY ANNE WOOD	2 Bridge St.	978-526-4082		- Back Thursday
George Noble	10 Bridge St	978 526-7416	—	
Martha Farmer Steve Carhart	12 Bridge St. "	978-526-7806 508-527-1832 (c) 978-407-8454 (c)	marthafarm@gmail.com	

Home Owner Info Sheet
Harbor Loop Sewer Repair Inspections
Manchester-by-the-Sea, Massachusetts
September 13, 2018

Name	Address	Phone #	E-mail Address	Availability
Nate Desrosiers	MBTS			
Randy Wood	16 Bridge ST	C. 978.239.1560		

Appendix C

TATA & HOWARD

Field Notes
September 26, 2018
Harbor Loop Sewer Preliminary Design
Manchester-by-the-Sea, MA

2 Bridge Street

- Service lateral is located in crawl space under house at ground level. Approximately 4' from edge of building as shown on sketch.
- Unable to see elevation of pipe as it goes directly into ground at its furthest point visible.
- On east side of home there is a fence that leads up to a 7' wall to Bridge Street.
- On the west side of the house there is very little space as it borders the shoreline.

6 Bridge Street

- Lateral can be seen in walkout basement. Located back about 14' from the back of the home where it enters straight into the ground. Approximately 3" from the inside east wall.
- The east side of the home contains a shed. Ground elevation slopes up toward street with steps along the way.
- West side of the home has a 9' wall and stair case to Bridge Street.

12 Bridge Street (10am)

- Unable to locate lateral in home. Basement finished and walk-out.
- Could last see plumbing behind washer in basement. Measured location to where is entered ground behind washer.
- Homeowners have plans to replace fence in the yard but will hold off in case any work is to be done.

10 Bridge Street

- Small hatch in back of home contained visible sewer lateral. Appears to come straight out of home.
- Right outside of area where lateral exits home is a patio/deck and 10" tree. On east side of home walkway with stairs and 9' wall.

16 Bridge Street

- Located cleanout for sewer outside of home 2' from building corner.
- On east side of home 7'-4" wall to Bridge Street.
- Yard is separated into two sections by 3'-9" stone wall.
- MH123 is located in the south east corner.

4 Ashland Street

- Lateral enters ground at 15'2" from inside wall in home.
- Yard appears to have several features including a retaining wall, patio, steps etc.

10 Ashland Ave

- Inspection and tie card information indicated that this service is connected to sewer on Ashland Ave.

12C Ashland Street

- Workshop, newer build. Building extends over the water.Plumbing is located under building encased.
- Plumbing is submerged at high tide, located on north side of building. Plumbing then connects into MH 125 line.

12B + 12A Ashland Street

- Service lateral located in apartment under hatch in closet. Located about halfway mark of building.
- Runs out to line to MH 126A.
- Noted that service cleanout/pipe is in poor condition and should be replaced soon.
- Service was reported to be underwater during high tide.

6 Ashland Street

- Cleanout located outside of main house 6" from building corner as shown on sketch.
- Cleanout located on studio building located in backyard, approx. 15' from far building corner (sketch). It is likely that lines combine to pipe at MH125.

18 Bridge Street – by Town on 10/5/18

- Unable to locate service. Fully finished basement including full bathroom. Drainlines all encased in chases.
- Bathroom is located approx. in middle of house. Lateral likely runs through middle of house.

22 Ashland Street – by Town on 10/10/18

- Unable to locate where the waste line exits the house. After visual inspection of bathrooms/sinks the best guess would be that the service exits the right rear corner (looking from the street) of their house.

TATA & HOWARD

JOB MBB HARBOR LOAD

SHEET NO. _____ OF _____

CALCULATED BY _____ DATE 9/26/18

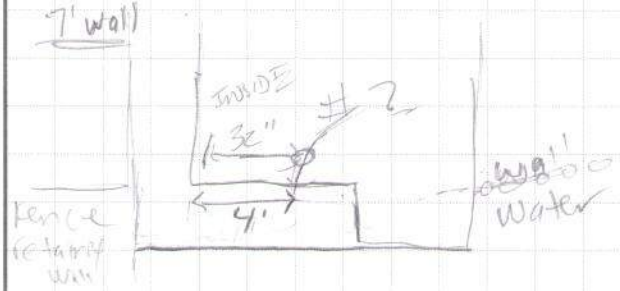
CHECKED BY _____ DATE _____

SCALE _____

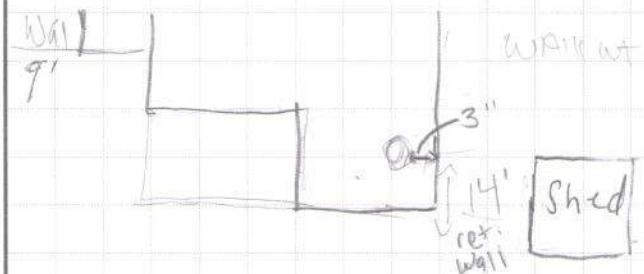
2 BRIDGE STREET

TRAP DOOR UNDER HOUSE CRAWL SPACE WALL OUT

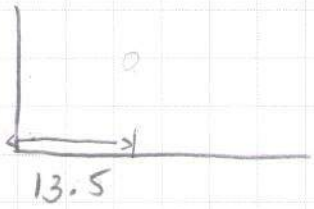
32" from Wall.



6 BRIDGE STREET



12 BRIDGE STREET 10 am Cartwright const. - redid all Plumbing/foundation



Could not see pipe at of house or cleanout location measured where we could see Pipe enter ground in house behind washer

TATA & HOWARD

JOB _____

SHEET NO. _____ OF _____

CALCULATED BY _____ DATE _____

CHECKED BY _____ DATE _____

SCALE _____

10 BRIDGE

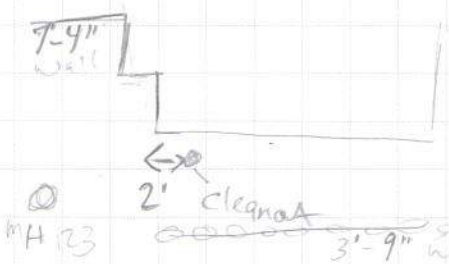
in BASEMENT WALL

same wall as 6 Bridge on Side of house 9'

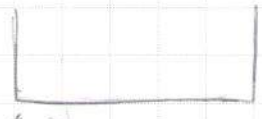
retaining wall/trees, Patio

Appeared to be coming through at of house

16 Bridge



4 Ashland



15'-2" inside wall

patio

steps

retaining wall

15 steps

3 OF 3

TATA & HOWARD

JOB

SHEET NO. OF

CALCULATED BY DATE

CHECKED BY DATE

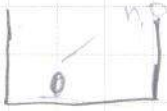
SCALE

12C - work shop 1 Bathroom

BLDG on WATER

under BLDG at high tide
PICTURE IN FILE

12B + 12A

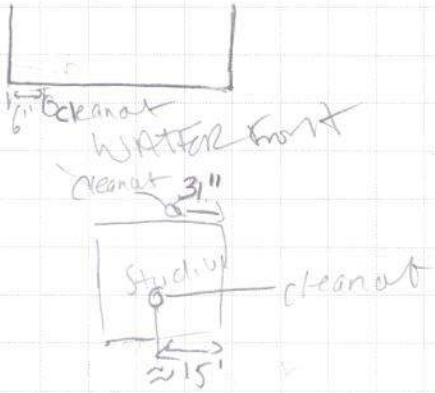


But left side unit located about halfway

Parking lot

NOTE: SERVICE CLEANOUT PIPE IN POOR CONDITION AND UNDERWATER DURING HIGH TIDE

6 Ashland



Michael Alesse
EAST COAST EXCAVATING
(978) 521-0775
(508) 328-7267 CELL

CHUCK SAID HE WOULD CALL AFTER ERIC (BROX) GAVE INFO
HE IS CONTRACTOR WITH PERMANENT
PIPE BURST IN 2011

Field Visit Photos 9/26/18

2 Bridge Street

6 Bridge Street

10 Bridge Street

16 Bridge Street

10 Ashland Avenue

12A/12B Ashland Avenue

12C Ashland Avenue

Appendix D

TATA & HOWARD

Pipe Capacity Analysis

													Full			Half full			Q/Qfull (Avg Design Flow -Title 5)	d/D (Avg Design Flow - Title 5)	Q/Qfull (Design Peak Flow -Title 5)	d/D (Design Peak Flow - Title 5)	
Pipe Segment	Upstream MH	Upstream MH invert	Downstream MH	Downstream MH Invert	Length of Pipe Segment (ft)	Pipe Diameter (in)	Slope	Pipe Material	manning's n	Area	R (full)	R(half)	Q, flow (cfs)	Q (gpm)	Q (gpd)	Q, flow (cfs)	Q (gpm)	Q (gpd)	%	%	%	%	Depth of flow at peak design flow (in)
MH126A to MH125	MH 126A	-	MH 125	1.84	177	10		HDPE/PVC	0.01	0.545138889	0.208333333	0.20822772	-	-	-	-	-	-	-	-	-	-	-
MH125 to MH124	MH 125	1.84	MH124	1.42	191	8	0.002198953	PVC	0.01	0.348888889	0.166666667	0.16658217	0.738267701	331.3566921	477153.6366	0.36900908	165.6223	238496.2	6%	16%	26%	34%	3.40
MH124 to MH123	MH124	1.32	MH123	1.19	92	8	0.001413043	PVC	0.01	0.348888889	0.166666667	0.16658217	0.591811867	265.6229202	382497.0051	0.29580592	132.7666	191183.9	8%	17%	32%	38%	3.04
MH123 to MH122	MH123	1.09	MH122	0.86	220	8	0.001045455	CI	0.013	0.348888889	0.166666667	0.16658217	0.391575158	175.7506783	253080.9767	0.1957214	87.84564	126497.7	11%	22%	48%	48%	3.84
MH122 to MH121	MH122	1	MH121	0.53	210	8	0.002238095	CI	0.013	0.348888889	0.166666667	0.16658217	0.57293036	257.1483333	370293.5999	0.28636835	128.5307	185084.2	8%	18%	33%	40%	3.20
MH121 to MH120	MH121	0.38	MH120	0.22	136	8	0.001176471	CI	0.013	0.348888889	0.166666667	0.16658217	0.415387183	186.4382292	268471.05	0.20762339	93.18761	134190.2	11%	22%	46%	47%	3.76
MH120 to MH119	MH120	0.27	MH119	-0.11	162	8	0.002345679	CI	0.013	0.348888889	0.166666667	0.16658217	0.586538934	263.2562697	379089.0284	0.29317034	131.5836	189480.4	8%	17%	32%	38%	3.04

***Reducing pipe size by 2" in heavily corroded pipes**

													Full			Half full			Q/Qfull (Avg Design Flow -Title 5)	d/D (Avg Design Flow - Title 5)	Q/Qfull (Design Peak Flow -Title 5)	d/D (Design Peak Flow - Title 5)	
Pipe Segment	upstream M	Upstream MH	Downstream M	Downstream	Length of Pipe	Pipe Diameter (in)	Slope	Pipe Material	manning's n	Area	R (full)	R(half)	Q, flow (cfs)	Q (gpm)	Q (gpd)	Q, flow (cfs)	Q (gpm)	Q (gpd)	%	%	%	%	Depth of flow at peak design flow (in)
MH126A to MH125	MH 126A	-	MH 125	1.84	177	8		HDPE/PVC - CIPP	0.01	0.348888889	0.166666667	0.16658217	-	-	-	-	-	-	-	-	-	-	-
MH125 to MH124	MH 125	1.84	MH124	1.42	191	6	0.002198953	PVC- CIPP	0.01	0.19625	0.125	0.12493663	0.34280244	153.860019	221558.4274	0.17134329	76.90401	110741.8	13%	24%	55%	54%	4.32
MH124 to MH123	MH124	1.32	MH123	1.19	92	6	0.001413043	PVC - CIPP	0.01	0.19625	0.125	0.12493663	0.274798087	123.3376254	177606.1805	0.1373526	61.64797	88773.07	16%	25%	69%	58%	3.48
MH123 to MH122	MH123	1.09	MH122	0.86	220	6	0.001045455	CI - CIPP	0.01	0.19625	0.125	0.12493663	0.236367913	106.0890103	152768.1748	0.11814401	53.02658	76358.27	19%	28%	80%	64%	3.84
MH122 to MH121	MH122	1	MH121	0.53	210	6	0.002238095	CI - CIPP	0.01	0.19625	0.125	0.12493663	0.345840001	155.2233678	223521.6496	0.17286155	77.58545	111723	13%	24%	55%	54%	3.24
MH121 to MH120	MH121	0.38	MH120	0.22	136	6	0.001176471	CI - CIPP	0.01	0.19625	0.125	0.12493663	0.25074165	112.5403748	162058.1398	0.12532845	56.25117	81001.68	18%	28%	76%	64%	3.84
MH120 to MH119	MH120	0.27	MH119	-0.11	162	6	0.002345679	CI - CIPP	0.01	0.19625	0.125	0.12493663	0.354054594	158.9103233	228830.8655	0.17696746	79.42831	114376.8	12%	24%	53%	53%	3.18

Appendix E

TATA & HOWARD

Tata & Howard
222 St. John Street, Suite 1G
Portland, ME 04102
Attn: Collin Stuart

April 11, 2018

Re: Manchester-by-the-Sea, MA
Conductivity/Salinity Monitoring
March – April 2018

Dear Mr. Stuart,

On March 23, 2018, a field crew from Flow Assessment Services LLC, installed two In-Situ recording conductivity meters at two locations in Manchester-by-the-Sea, MA.

These sites are identified as Site 151, within the Beach Street R.O.W., and Site 119, within the Peele House Square parking lot. Site sketches are available in this report under **Appendix 2** and as an electronic file on the disk which accompanies it.

Data was downloaded from the conductivity meters on March 26th and again April 9th when both recorders were removed from their respective locations. The 15 minute recorded interval data is included in an excel format on the disk that accompanies this letter. We have also included predicted and preliminary tide data from NOAA COOPS Station 8443970 located in Boston, MA. Please note that the NOAA COOPS Station 8443970 was not operational from 4/3/18 at 14:42 to 4/4/18 at 06:06; no preliminary tide data exists for this time period.

In this report, under **Appendix 1,** you will find graphs displaying salinity, temperature, raw depth, and COOPS Station 8443970 preliminary tide data for each of the sites. Please note that the data on these graphs are compressed hourly to better display trends. A PDF copy of the graphs can also be located on the report disk.

If you have any questions or require anything additional, please feel free to call.

Sincerely,

Lucas Chapman
Data Analyst / Project Manager

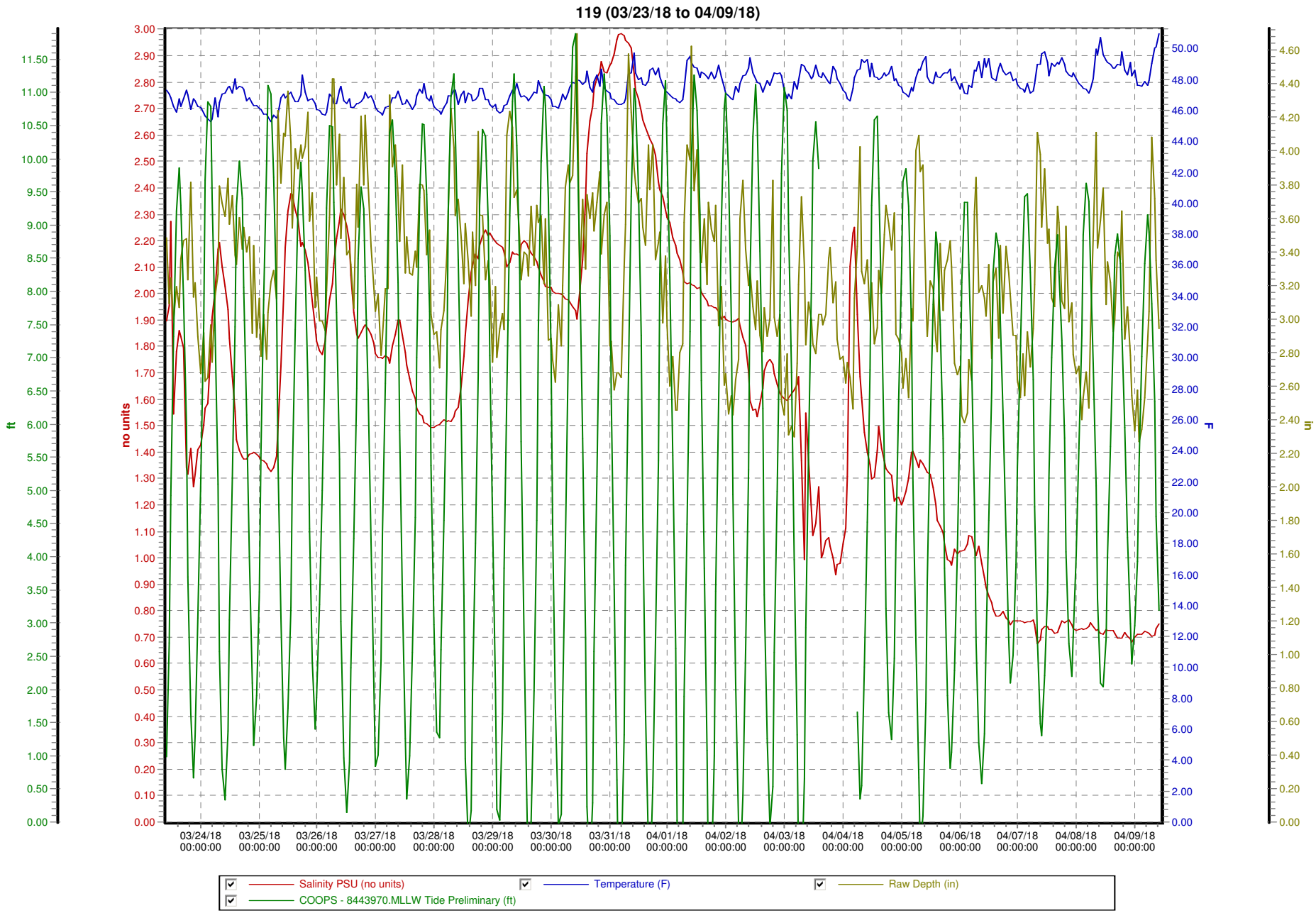
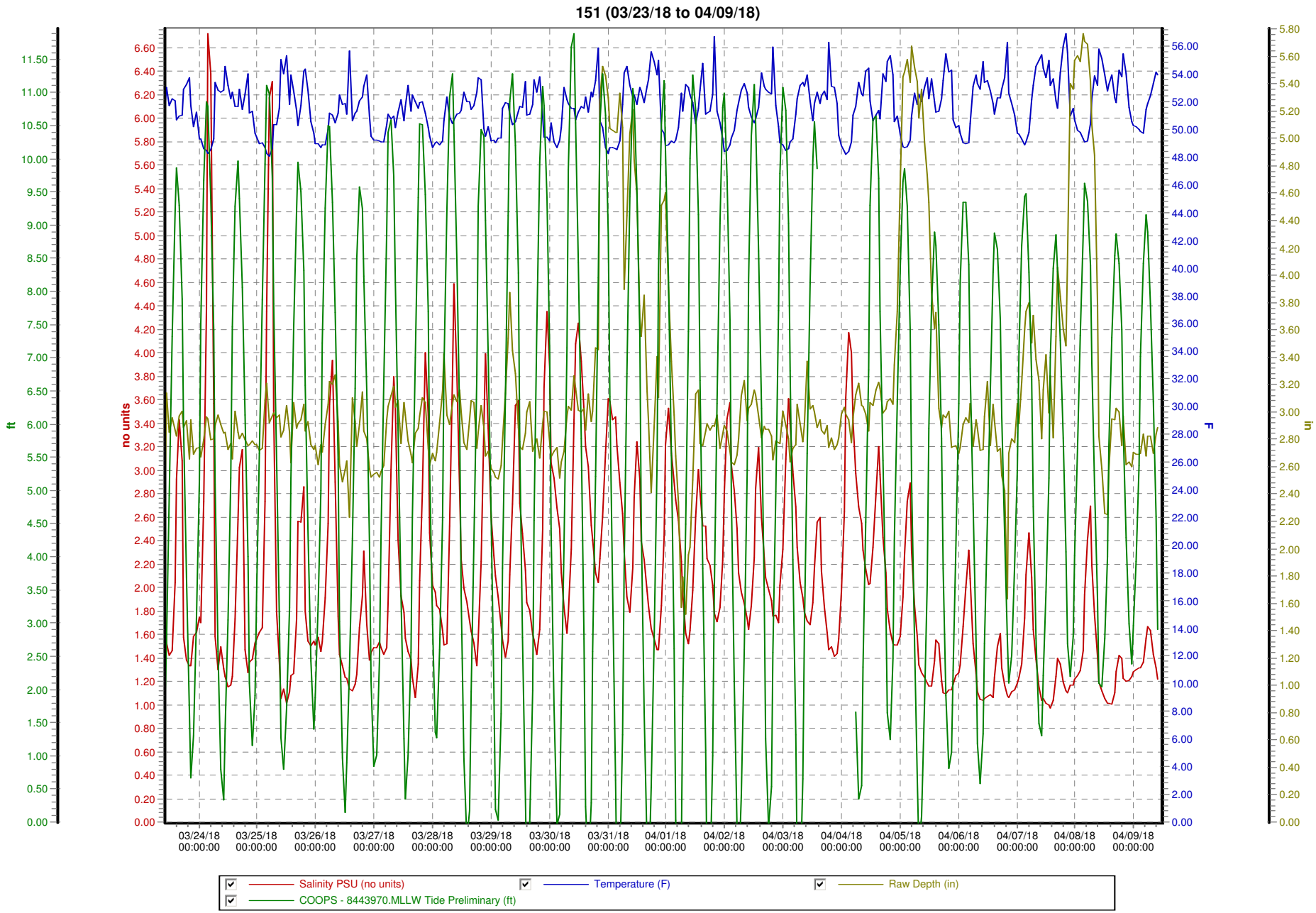

119 (03/23/18 to 04/09/18)
ft
no units
F
in
Salinity PSU (no units)
Temperature (F)
Raw Depth (in)
COOPS - 8443970.MLLW Tide Preliminary (ft)

Figure 1


151 (03/23/18 to 04/09/18)
ft
no units
F
in
03/24/18 00:00:00
03/25/18 00:00:00
03/26/18 00:00:00
03/27/18 00:00:00
03/28/18 00:00:00
03/29/18 00:00:00
03/30/18 00:00:00
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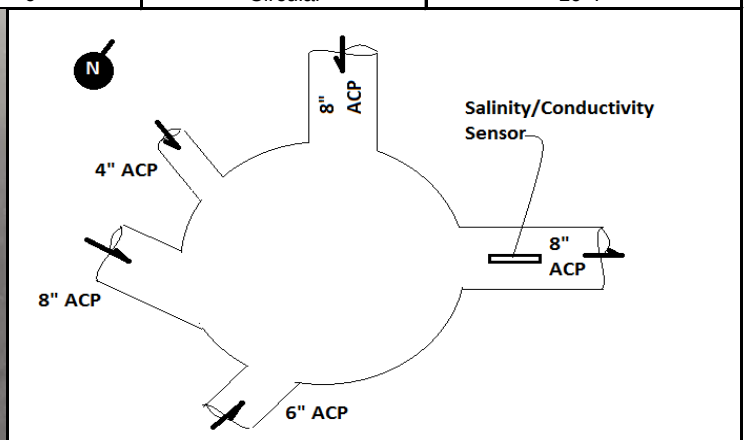
04/02/18 00:00:00
04/03/18 00:00:00
04/04/18 00:00:00
04/05/18 00:00:00
04/06/18 00:00:00
04/07/18 00:00:00
04/08/18 00:00:00
04/09/18 00:00:00
Salinity PSU (no units)
Temperature (F)
Raw Depth (in)
COOPS - 8443970.MLLW Tide Preliminary (ft)

Figure 2

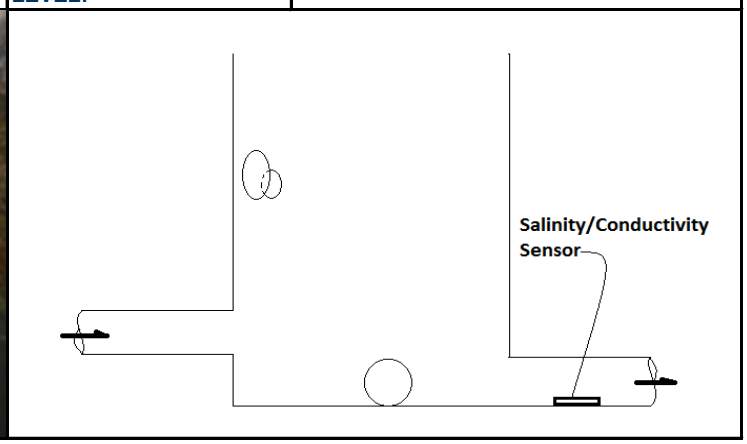
METER SITE INFORMATION FIELD LOG

PROJECT: Manchester By the Sea, MA	**DATE:** March 23, 2018	**JOB#:** 18039
LOCATION: Peele House Square	**MH#:** 119	**METER SITE:** 119
GPS/COMMENTS: 42.574982, -70.773506		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	8	ACP	3.3	0	Circular	10' 6"
Incoming	6	ACP	0.2	0.5	Circular	9' 7"
Incoming	8	ACP	0.4	0	Circular	4' 7"
Outgoing	8	ACP	3.3	0	Circular	10' 7"



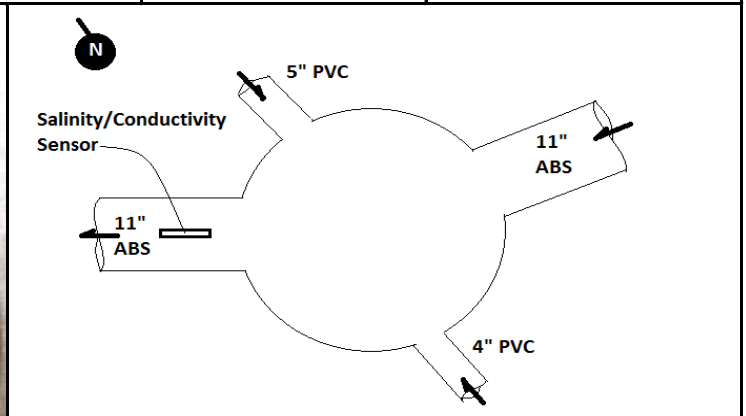
SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT:	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO: 8'	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**	



METER SITE INFORMATION FIELD LOG

PROJECT: Manchester By the Sea, MA	**DATE:** March 23,2018	**JOB#:** 18039
LOCATION: 35 Beach Street	**MH#:** 151	**METER SITE:** 151
GPS/COMMENTS: 42.573750, -70.770922		

	Size (")	Material	Flow Depth (")	Debris	Shape	MH Depth
Incoming	11	ABS	2	0	Circular	13' 1"
Incoming	4	PVC	0	0	Circular	4' 2"
Incoming	5	PVC	0	0	Circular	4' 5"
Outgoing	11	ABS	2	0	Circular	13' 2"



SURCHARGE INFORMATION	WEIR INFORMATION	
SURCHARGE NONE EVIDENT: X	**LENGTH:**	**HEIGHT ABOVE WEIR:**
SURCHARGED MARKS TO:	**BREADTH:**	**OVERFLOW OCCURS AT:**
SURCHARGE CURRENTLY TO:	**LEVEL:**