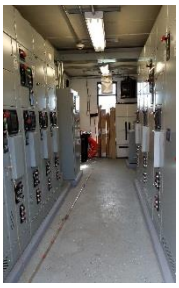
Dewberry



FY 18 EEA Municipality Vulnerability Preparedness (MVP) Program Action Grant - Wastewater Treatment Plant Climate Change Resilience

Task 1 – Technical Memorandum

City of Newburyport, Massachusetts

October 31, 2018

SUBMITTED BY:

Dewberry Engineers Inc.
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Boston, MA 02210

SUBMITTED TO:

City of Newburyport
Department of Public Services
16A Perry Way
Newburyport, MA 01950

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CD – GIS Geodatabase (Under separate cover)

1 PROJECT SCOPE AND DESCRIPTION

1.1 Introduction

The City of Newburyport owns, operates and maintains a wastewater treatment facility (WWTP) located adjacent to Water Street along the bank of the Merrimack River. The WWTP provides secondary treatment to domestic and commercial wastewater flow generated within the City. The treated waste is pumped via an underground pipe and outfall to the Merrimack River as it becomes an estuary at Newburyport inner harbor.

In recent years, the City has observed storm events of increasing intensity, in some cases coupled with high tides and/or storm surge that have created flood conditions that have threatened the WWTP facility. The City has concerns that future storm intensity is likely to increase and that sea level rise is also likely to impact the region. It is prudent to consider the vulnerability of the WWTP in light of these anticipated risks, so that informed strategic investment decisions can be made to protect the City's ability to provide sanitary service and to minimize risk to the environment.

The WWTP consists of various assets such as primary and secondary clarifiers, aeration basins, effluent pumps, administrative buildings and others that are built at various finished floor elevations within the WWTP. The purpose of this technical memorandum is to inventory these assets through the creation of a GIS geodatabase and identify points of entry for water intrusion based on the available topographic survey data and other available data of the entire WWTP.

2 WASTEWATER TREATMENT PLANT OPERATIONS

2.1 Wastewater Flow Paths

The Newburyport WWTP treats roughly 3.5 million gallons per day (MGD) of raw sewage. Wastewater first enters the headworks structure of the WWTP where it is screened, flows through a grit collector, and then flows to the influent wet well. The influent is then pumped to the primary clarifiers, where solids are separated from the influent. The effluent flows to the aeration tanks and then to the secondary clarifiers. From the secondary clarifiers, the effluent flows to the chlorine contact tank and is then pumped either into the plant as reclaimed plant water or to the outfall diffuser in the Merrimack River.

Any grit from the grit collector located in the headworks is pumped to the grit classifier, further separating the solids which are disposed off-site. The sludge from the clarifiers is pumped to the gravity thickeners, where it is then ground, dewatered, and disposed off-site. Liquid overflow from the gravity thickeners flows back to the primary clarifier flow settler, while liquids from dewatering flow back to the influent wet well. The scum from the secondary clarifiers is pumped to the aerobic digesters and any overflow returns to the influent wet well.

A flow diagram of the solid and liquid streams within the WWTP is shown in Figure 2-1 on the following page. Every point in the process can be considered critical to the operation of the plant, however there is redundancy built into the system.

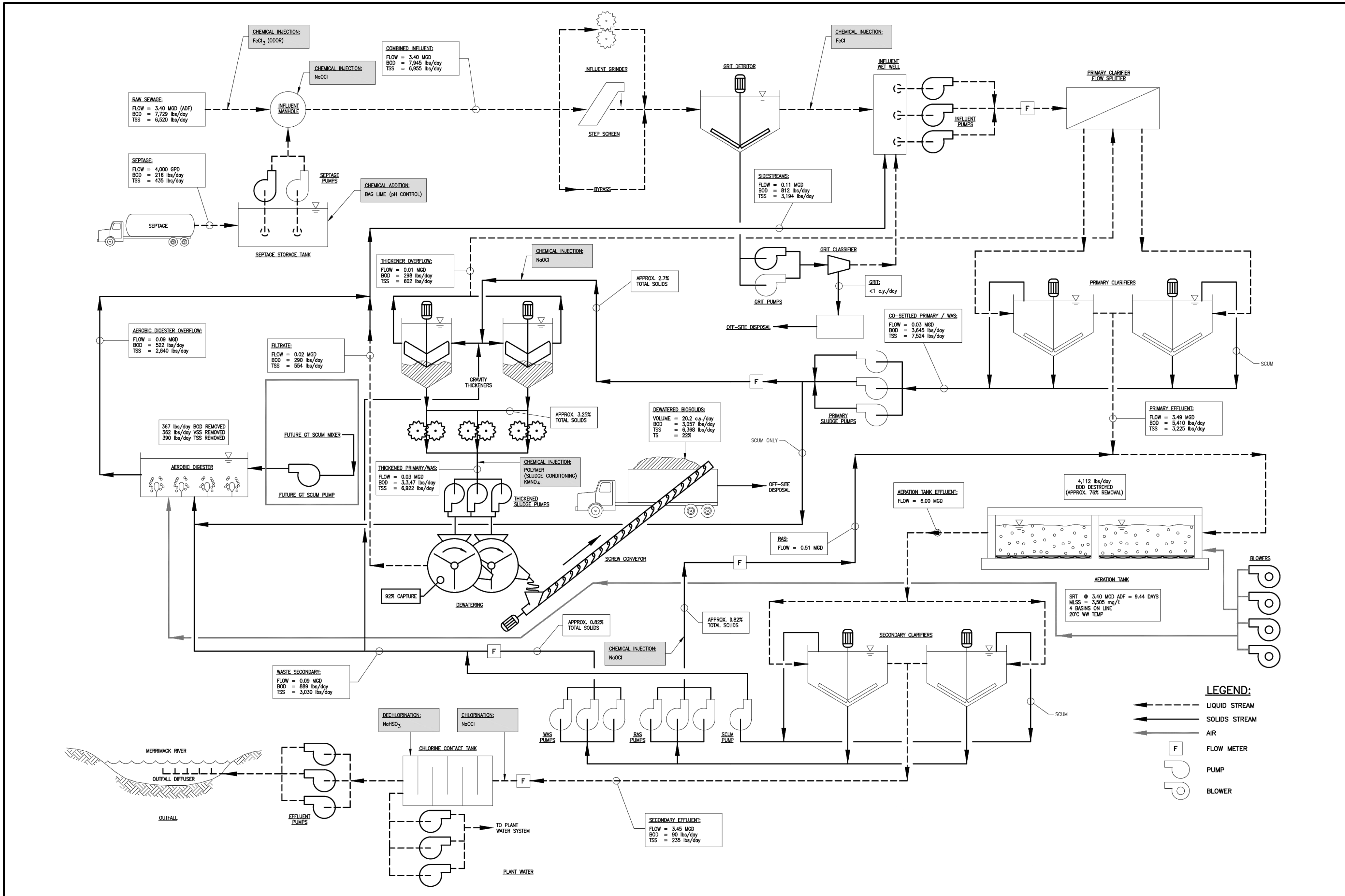


FIGURE 2-1

TITLE
PROCESS FLOW SCHEMATIC

DATE
OCT, 2018

SCALE
NTS

Dewberry®
280 SUMMER ST.,
10TH FLOOR
BOSTON, MA 02210
(617) 695-3400
(617) 695-3310

3 EXISTING SITE CONDITIONS (ASSETS)

3.1 Buildings, Tanks and Basins

Figure 3-1 on the following page shows the layout of the Newburyport WWTP. It consists of 14 numbered buildings and 13 tanks including clarifiers and wastewater structures. Part of the facility is paved with porous pavement, while the rest of the property is grass or asphalt. The following Tables 3.1 and 3.2 highlight critical elevations of each asset as well as the age of the systems within the asset. Elevations presented in the task are based on the NAVD 88 datum.

Table 3.1 – Critical Building Elevation Information (NAVD88 Datum)

Building #	Description	Year of Construction	Ground Elevation (ft.)	Sill Elevation (ft.)	First Floor Elevation (ft.)	Basement 1 Elevation (ft.)	Basement 2 Elevation (ft.)
1	Operations and Lab	2009	11.53	12.30	12.50		
2	Switchgear	2009	11.15	12.05	12.05		
3	Generator	2009	11.15	12.50	12.00		
4	Aeration Blower	2009	11.30	12.00	12.00		
5	Disinfection	2009	9.35	12.59	12.59	4.50	-3.10
6	Effluent Pumping	2009	10.42	12.35	12.35	5.92	-6.00
7	Secondary Sludge Pumping	1979	10.27	10.39	10.39	-7.75	
8	Operations	2011	11.50	12.00	12.30	-1.75	-6.67
9	Headworks	2011	11.20	12.20	12.20	6.50	1.84
10	Gravity Thickener	2011	10.69	12.50	12.50	2.50	
11	Primary Sludge Pumping	1979	12.90	13.67	14.20	0.70	
12	Odor Control	2011	11.58	12.50	12.50		
13	Ferric Chloride	2011	11.76	12.28	12.28		
14	Yard Storage Building		10.70	N/A	N/A		

Table 3.2 – Critical Tank and Basin Elevation Information (NAVD88 Datum)

Description	Ground Elevation	Top Elevation (ft.)	Bottom Elevation (ft.)	Weir Elevation (ft.)
Influent wetwell	10.50	2.00	-6.30	
Secondary Clarifier 1	10.22	12.14	-1.90	8.30
Secondary Clarifier 2	10.02	11.95	-1.90	8.30
Chlorine Contact Tanks	9.89	11.60	-6.00	5.75
Gravity Thickener 1	10.70		6.00	
Gravity Thickener 2	10.70		6.00	
Primary Clarifier 2	12.90	16.50	5.90	15.00
Primary Clarifier 1	13.00	16.40	5.90	15.00
Aerobic Digesters	9.91	17.33	4.19	
Biofilters	11.58	15.68		
Aeration Basins	12.80	17.01	0.80	12.30
Generator Fuel Tank	11.00	12.04		
Headworks	11.50	6.50	1.80	1.10
Aeration Basin Flow Splitter	13.40	15.01	-1.57	10.75

BLDG	DESCRIPTION
1	OPERATIONS, CONTROL, & LABORATORY
2	SWITCHGEAR
3	EMERGENCY GENERATOR
4	AERATION BLOWER BUILDING
5	DISINFECTION BUILDING
6	EFFLUENT PUMP BUILDING
7	SECONDARY SLUDGE PUMP BUILDING
8	INFLUENT PUMPING & OPERATIONS BUILDING
9	HEADWORKS
10	GRAVITY THICKENER BUILDING
11	PRIMARY SLUDGE BUILDING
12	BIO-FILTER CONTROL SYSTEM
13	FERRIC CHLORIDE CONTAINMENT BUILDING
14	YARD STORAGE BUILDING

MERRIMACK RIVER

APPROX. LOCATION OF 100-YEAR FLOOD ZONE ELEV. = 9 FEET

CONCRETE JERSEY BARRIERS

GENERATOR TRANSFORMER

ABOVE GROUND GENERATOR FUEL TANK

TANK

AERATION BASIN NO. 3

AERATION BASIN NO. 4

AERATION BASIN NO. 1

AERATION BASIN NO. 2

BIO-FILTER

AEROBIC DIGESTER NO. 2

AEROBIC DIGESTER NO. 1

SHED

BUILDING CHLORINATION

CHLORINE CONTACT TANKS

EFFLUENT PUMPING

SECONDARY SLUDGE PUMPING

CHAINLINK FENCE

OPERATIONS, CONTROL, AND LABORATORY BUILDING

PERMEABLE PAVERS

PRIMARY CLARIFIER NO. 1

PRIMARY SLUDGE PUMPING

PRIMARY CLARIFIER NO. 2

GRAVITY THICKENER NO. 2

GRAVITY THICKENER NO. 1

SHED

BIT. CONC.

DIRT/GRAVEL ROAD

SLUDGE TRUCK BAY

GRIT WASH ROOM

CHEMICAL FEED ROOMS

SLUDGE PRESS ROOM

BUILDING OPERATIONS

RAW SEWAGE PUMP ROOM

WET WELL

HEAD WORKS

FERRIC CHLORIDE SHED

INFLUENT SEWER MANHOLE

SECONDARY CLARIFIER NO. 1

SECONDARY CLARIFIER NO. 2

FIGURE 3-1

TITLE EXISTING CONDITIONS SITE PLAN

DATE OCT, 2018

SCALE 1"=60'

Dewberry
280 SUMMER ST.,
10TH FLOOR
BOSTON, MA 02210
(617) 695-3400
(617) 695-3310

3.2 Asset Inventory

The city's WWTP assets are situated in the various buildings on the property as outlined below.

Building 1 – Operations, Control & Laboratory (OCL)

Building 1 is a one story building with a concrete slab on grade foundation which contains office space for the operations and laboratory staff. This includes spaces for the Chief Operator, Assistant Chief Operator, Control Room, and Laboratory Staff. The Control Room includes a Programmable Logic Controller (PLC) and an Uninterrupted Power Supply (UPS) system. The control room is considered part of the essential equipment for the plant.

Buildings 2&3 – Switchgear and Emergency Generator

Adjacent to Building 1 are two pad-mounted enclosures and an above-ground fuel oil tank. Building 2 is the enclosure that contains the switchgear for the facility, and Building 3 is the enclosure that contains the Emergency Generator for the facility. The transformers that feed the switchgear are located just outside the facility perimeter fence which is approximately 15 feet from the switchgear enclosure. To the north of the enclosure is a 3,000 gallon above-ground fuel oil tank that supplies fuel to the Emergency Generator. Both the Switchgear and Emergency Generator are critical equipment for the operation of the facility during storm events.

Building 4 – Aeration Blower Building

This building contains four (4) large positive displacement blowers that supply air to four (4) aeration basins located adjacent to the Aeration Blower Building. The blowers provide oxygen and mixing for the aerobic treatment in the aeration basins. These blowers also provide air flow to the digester tanks. The end of the Aeration Blower Building is located within the current FEMA Limit of moderate wave action. Coupled with a point of entry at 12 feet, this building could be very susceptible. Although the blowers are not essential to run during an inundation event, they are necessary for the quick recovery of operations and treatment after a storm.

Building 5 – Disinfection Building

The first floor of the Disinfection Building contains chemical storage and an electrical room that houses Motor Control Center (MCC) 2A and MCC-2B. These MCCs control the effluent pumps, secondary sludge pumping, the plant's water system pumps, chlorine transfer pump, chlorine tank mixers, septic waste pump, secondary sludge pumping and secondary clarifiers. The basement level of this building has sump pumps, septic waste pumps and the plant water pumps. Adjacent to this structure are two chlorine contact tanks. Although not essential, this building is in close proximity to the wave action zones with a high probability of damage.

Building 6 – Effluent Pump Building

This building has a first floor level for the effluent pump room with the effluent flow in a lower level. There are three (3) effluent pumps at this structure that provide the primary force of moving the effluent flow stream of the wastewater treatment plant. The pumps are necessary for vacating water from the plant

during high tides. The building is in close proximity to the wave action zones with a high probability of damage. The hydraulics of these pumps may also be impacted by an inundation event. Further analysis on the operations of these pumps during such an event will need to be completed to determine if modifications to these pumps will be necessary.

Building 7 – Secondary Sludge Pump Building

The Secondary Sludge Pump Building contains a storage room and an electrical room that houses MCC 4A and MCC-4B. These MCCs control the secondary waste sludge pumps, secondary return sludge pumps, secondary scum pumps, and HVAC exhaust fan. In addition, the basement level of this building includes the secondary waste sludge pumps and the secondary return sludge pumps. Although not essential during an inundation, these systems are necessary for a quick recovery of the treatment system to achieve treatment goals.

Building 8 – Influent Pumping and Operations Building

The Influent Pumping and Operations Buildings is a multi-level structure that contains the following:

First Floor - Maintenance area, boiler room, storage rooms, locker rooms, grit washer room, $KmNO_4$ Room, polymer chemical room, dewatering equipment room with two (2) dewatering rotary presses, tandem sludge truck drive through garage, and an electrical room that houses MCC 1A and MCC 1B. These MCCs control the influent pumps, gravity thickeners, odor control blowers, sludge mixers, inline sludge grinders and aerobic digesters.

Basement Levels – Sludge pump room with three (3) in line sludge grinder pumps and three (3) press feed pumps; compressor room with two (2) dewatering air compressors; two (2) press wash water booster pumps, three (3) influent sewage pumps and grit pump.

The Influent Pumping System including the electrical equipment is the heart of the plant which will be essential to keep in operation during an inundation to prevent the upstream sewer system from backing up into customers' buildings. This is viewed as the most critical system to keep operating during inundation and after for recovery.

Building 9 – Headworks

The Headworks is a one story structure with sub levels to accommodate step screen, launder channel and washpress equipment.

Though normally not considered an essential piece of equipment, the configuration of the headworks with a low point of entry, makes the headworks susceptible to taking in flood waters which could inundate the Influent Wet Well. Special consideration should be given to this area in preparation for a storm event.

Building 10 – Gravity Thickener Building

This building has two (2) gravity thickeners that both have an upper level and lower level with a connector structure that joins the two thickeners. The connector structure contains a sludge scum pump as well as a sump pump.

Building 11 – Primary Sludge Pumping

Building 11 has a basement level and a first floor level. The basement has three (3) sludge pumps that move slurry from the primary clarifier to the gravity thickeners in Building 10. The first floor has a storage area and an electrical room that houses MCC 3A and 3B which control the aeration blowers, HVAC exhaust fan, primary scum mixer, primary sludge pumps and primary clarifiers.

Although not essential during an inundation, these systems are necessary for a quick recovery of the treatment system to achieve treatment goals. All of the systems impacted in this area are necessary for a return to normal treatment operations.

Building 12 - Bio filter Control System

This building contains the control system for the Bio Filter which is the primary part of the odor control that removes organics from air that is collected from various processes of the WWTP. This system is not necessary for recovery. The building is in close proximity to the wave action zones with a high probability of damage.

Building 13 – Ferric Chloride Containment Building

Adjacent to the Headworks Building is the Ferric Chloride ($FeCl_3$) Containment building which contains the storage tank and day tank for this chemical as well as the pump and control equipment for injecting the chemical into the flow stream.

Building 14 – Yard Storage Building

Building 14 was formerly called the Odor Control Blower Building. The equipment has been removed and it is currently utilized as a storage building with minimal power for lighting and miscellaneous use. Therefore this structure was not considered as a critical part of the operation of the WWTP.

4 ENTRY POINTS

4.1 Data Collection

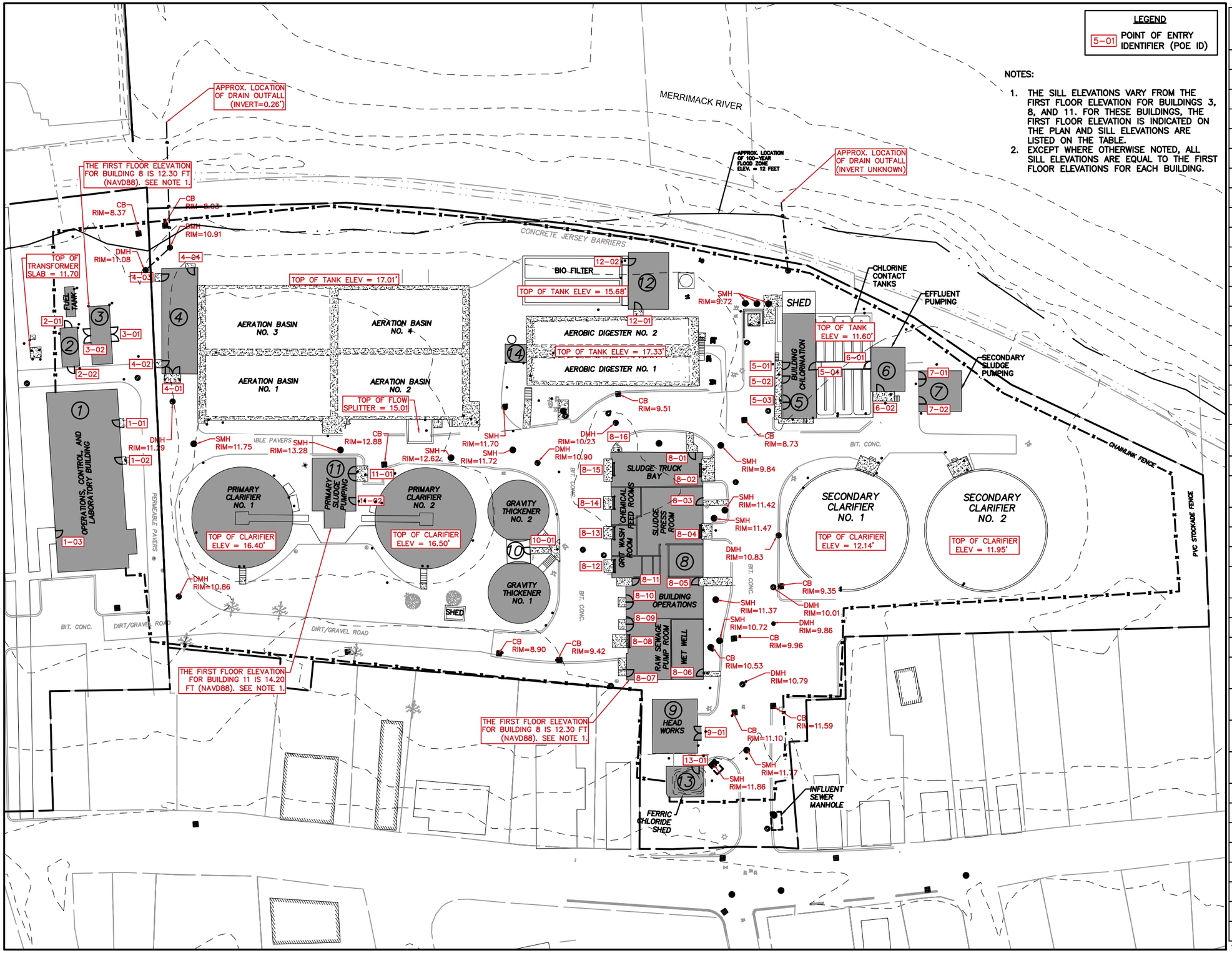
The existing conditions base maps shown in this technical memorandum (Figures 3-1 and 4-1) were compiled by the City's Engineering Department into AutoCAD drawing format, and is based on the following documents:

1. Wastewater Treatment Facility Improvements Project, Contract 2, Record Drawing Site Plan by Weston and Sampson, dated January 2014,
2. Odor Control Improvements Contract 2, Site Work - Proposed Site Work Layout , Record Drawing, by Environmental Partners Group's dated March 2017, and
3. MassDOT Highway Division Clipper City Rail Trail-Phase 2 Existing Conditions, dated June 28, 2013
4. Parcels and miscellaneous data beyond the WWTP facility provided by City of Newburyport's GIS as of October 15, 2018.

In addition, Dewberry performed field survey on October 17, 2018, using handheld GPS data recorders to obtain current, as-built elevations throughout the WWTP and to provide consistency amongst the record plans noted above. These existing conditions (the documents noted above as well as the GPS elevations obtained by Dewberry) are suitable for the purposes of this Technical Memorandum but do not provide the accuracy needed for construction-related projects. The base maps produced for this Technical Memorandum are intended and only suitable for planning purposes only.

Dewberry also performed site visits to the WWTP and noted locations of potential entry points for water intrusion that would result in failures to the operation of the facility. Data collected on these visits was added to the GIS Geodatabase that was compiled from the existing conditions AutoCAD files, as-built records and GIS files. Figure 4-1 identifies the critical elevations for points of entry for each asset including buildings, tanks and basins that have been the subject of this Technical Memorandum.

In addition to the noted assets, Figure 4-1 includes the respective rim elevations of all catch basins, drain manholes and sewer manholes, where known. There are two drainage outfalls that run underneath the WWTP property to the Merrimack River, but the invert for one of these outfalls is unknown and would require further investigation beyond the scope of this task. Per discussions with the client, there are no tide gates on these outfalls and could be a source of flooding during a storm surge event.



POE ID	POE TYPE	SILL ELEV. (NAVD88 FT)
1-01	DOOR	12.30
1-02*	DOOR	12.30
1-03	DOOR	12.30
2-01*	DOOR	12.05
2-02	DOOR	12.05
3-01	DOOR	12.50
3-02*	DOOR	12.50
4-01*	DOOR	12.00
4-02	DOOR	12.00
4-03	DOOR	12.00
5-01	DOOR	12.59
5-02*	DOOR	12.59
5-03	DOOR	12.59
5-04	DOOR	12.59
6-01*	DOOR	12.35
6-02	DOOR	12.35
7-01*	DOOR	10.39
7-02*	DOOR	10.39
8-01	DOOR	12.00
8-02*	OVERHEAD DOOR	12.05
8-03	DOOR	12.05
8-04*	OVERHEAD DOOR	12.45
8-05	DOOR	12.05
8-06*	DOOR	12.05
8-07	DOOR	12.30
8-08	OVERHEAD DOOR	12.30
8-09	DOOR	12.30
8-10	DOOR	12.30
8-11	DOOR	12.30
8-12	OVERHEAD DOOR	12.30
8-13	OVERHEAD DOOR	12.30
8-14	OVERHEAD DOOR	12.30
8-15	OVERHEAD DOOR	12.00
8-16	DOOR	12.00
9-01*	DOOR	12.20
10-01	DOOR	12.50
11-01*	DOOR	13.79
11-02*	DOOR	13.67
12-01	DOOR	12.50
12-02*	DOOR	12.50
13-01*	DOOR	12.28

*INDICATES GPS MEASUREMENT IN FIELD.

FIGURE 4-1

POINTS OF ENTRY (POE)

TITLE

DATE OCT, 2018

SCALE 1" = 60'

Dewberry
280 SUMMER ST.,
10TH FLOOR
BOSTON, MA 02210
(617) 695-3400
(617) 695-3310

5 CRITICALITY OF ASSETS

5.1 Assessment

Dewberry reviewed each of the assets in regard to their vulnerability to flooding and importance to the operation of the WWTP. There are several measures of what can make a component critical. The following table was put together as a simplified summary of the results of that evaluation for each asset/operation. For example, there are components critical to keep the plant functioning during an inundation event and components that will be necessary for the recovery after an event to achieve environmental compliance. We have assigned the highest Tier of Criticality to equipment which will need to be protected and kept running as long as possible during an inundation event to prevent the sewer system from causing damage to private properties upstream of the WWTP. We have assigned a number of 1, 2 or 3, which respectively represent criticality of High, Moderate or Low. Table 5.1 identifies how we rated the assets based on qualitative judgement considering both vulnerability and consequences.

Table 5.1 – Criticality of Assets (NAVD88 Datum)

Assest No.	Description	Critical Operation	P.O.E. El. (ft.)	Criticality of Assets		
				High - 1	Mod. - 2	Low - 3
1	Secondary Clarifier 1	There is Redundancy but Vulnerable due to Low Elev	12.14	✓		
2	Secondary Clarifier 2	There is Redundancy but Vulnerable due to Low Elev	11.95	✓		
3	Chlorine Contact Tanks	There is Redundancy but Vulnerable due to Low Elev	11.60	✓		
4	Primary Clarifier 1	Essential but there is Redundancy	16.40		✓	
5	Primary Clarifier 2	Essential but there is Redundancy	16.50		✓	
6	Aerobic Digesters	Not Essential and there is Redundancy	17.33			✓
7	Bio Filters	Not Essential	15.68			✓
8	Aeration Basins	There is Redundancy	17.01		✓	
10	Aeration Basin Flow Splitter	Essential and no Redundancy	15.01	✓		
11	Bldg.#1 - Operations, Control and Laboratory	Essential Controls	12.30	✓		

Assest No.	Description	Critical Operation	P.O.E. El. (ft.)	Criticality of Assets		
				High - 1	Mod. - 2	Low - 3
12	Bldg.#2 – Switchgear	Essential Main Power	12.05	✓		
13	Bldg.#3 - Emergency Generator	Essential Back Up Main Power	12.50	✓		
14	Bldg.#4 - Aeration Blower Building	Necessary for Quick Recovery	12.00	✓		
15	Bldg.#5 - Disinfection Building	MCC 2	12.59		✓	
16	Bldg.#6 - Effluent Pump Building	Effluent pumps Necessary for High Tide Operation	12.92	✓		
17	Bldg.#7- Secondary Sludge Building	MCC 4 – Secondary Systems	10.39	✓		
18	Bldg.#8 - Influent Pumping and Operations Building	Essential MCC 1 Influent Pumps and Controls	12.00	✓		
19	Bldg.#9 - Headworks	Due to Low Elev if Headworks Floods then the Influent Wet Well Floods	12.20	✓		
20	Bldg.#10 - Gravity Thickener Building		12.50			✓
21	Bldg.#11 - Primary Sludge Pumping Building	MCC 3	13.67		✓	
22	Bldg.#12 - Bio Filter Building		12.50			✓
23	Bldg.#13 - Ferric Chloride Containment Building		12.28			✓