CITY OF
PORTSMOUTH, NEW HAMPSHIRE

PEASE WASTEWATER TREATMENT FACILITY EVALUATION

JANUARY 2014
(DRAFT)

Underwood Engineers, Inc.
Portsmouth, New Hampshire
FILE NO. 1775

EXECUTIVE SUMMARY

This executive summary presents the objectives of the Pease Wastewater Treatment Facility Evaluation, provides a brief overview of existing conditions, summarizes the engineering investigations and analysis, and provides a brief outline of conclusions and recommendations.

1. The City of Portsmouth owns and operates the Pease Wastewater Treatment Facility. Therefore, the City is interested in updating their capital improvements plan (CIP) for the wastewater treatment facility comprised of short-term, and long-term planning projects.

2. The primary objectives of this study were to:

    - Complete a detailed review of the existing structures, equipment, processes and systems
    - Perform an engineering analysis of the existing structures, equipment, processes, and systems regarding their condition, efficiency, energy use, sustainability, and capacity to meet current and proposed treatment conditions
    - Perform flow and load scenarios based on build out projections, flow shedding scenarios, and client requests for capacity
    - Develop a long term capital improvement plan for the Pease WWTF
    - Provide the City with a comprehensive planning document to use for its capital planning needs

3. The original wastewater treatment facility (WWTF) began operation in 1954 under the supervision of the Pease Air Force Base and is located on Corporate Drive as shown on Figure 1. The original facility consisted of a primary treatment facility with disinfection and anaerobic sludge digestion. Several improvements to the wastewater treatment facility have been added since it was began operation in 1954. Major construction activity is summarized below

    - 1971 – 55' trickling filter
    - 1974/1975 – 75' trickling filter
    - 1986 – headworks
    - 1997 – Major WWTF Upgrade including the following:
        - Enclose Headworks facility/improvements
        - Raw sewage pumps replacement
        - Activated sludge system (Sequencing Batch Reactors) to replace trickling filters
        - New Blower/Sludge Dewatering (Operations) building (chemicals, blowers and sludge dewatering)
        - Improvements to the Intermediate pumping station

  - Improvements to one of the sludge storage tank
  - Disinfection system improvements
  - Odor control system
  - Laboratory/Administration Building
- 2002 –Septage facility

- 2013 – SBR Emergency Maintenance
  - During routine maintenance, the City discovered that both the decanter support assembly and the aeration piping support assemblies at SBR No.1 were in need of repair. The City is currently undertaking the following improvements:
  - Replacement of the existing decanter support assembly and aeration support assemblies in SBR 1
  - Replacement of influent motorized plug valves
  - Addition of influent isolation valves at the motorized plug valves

4. In the 1990's, the City of Portsmouth took over operations of the wastewater treatment facility in an intermunicipal agreement with the Pease Tradeport. The wastewater treatment facility is an activated sludge facility serving local domestic, commercial and industrial sewer users with the Craft Brewer Alliance (Redhook) and Lonza Biologics contributing almost 50% of the flow and 60 % of the load to the WWTF.

5. A process schematic of the WWTF is shown on Figure 2. The existing flow and loads for the wastewater treatment facility are provided below.

Historical Flow and Loads				
Criteria	**Year**			
	2010	**2011**	**2012**	**Design**
Flow (MGD)				
Average Day	0.639	0.638	0.495	1.2
Max Day	1.803	1.600	0.790	3.345
Max Week	1.245	0.992	0.695	
Max Month	0.934	0.845	0.631	
BOD (lbs/d)				
Average Day	2,474	1,503	1,527	2,907
Max Day	6,684	3,176	2,943	5,467
Max Week	6,217	2,997	2,767	

Historical Flow and Loads				
Criteria	Year			
	2010	2011	2012	Design
Max Month	4,371	2,376	2,118	
TKN (lbs/d)				
Average Day				364
Max Day				829
Max Week				
Max Month				
TSS (lbs/d)				
Average Day	1,502	2,200	2,296	2,907
Max Day	3,499	6,995	7,270	5,467
Max Week	2,749	6,512	6,095	
Max Month	2,247	3,609	3,947	

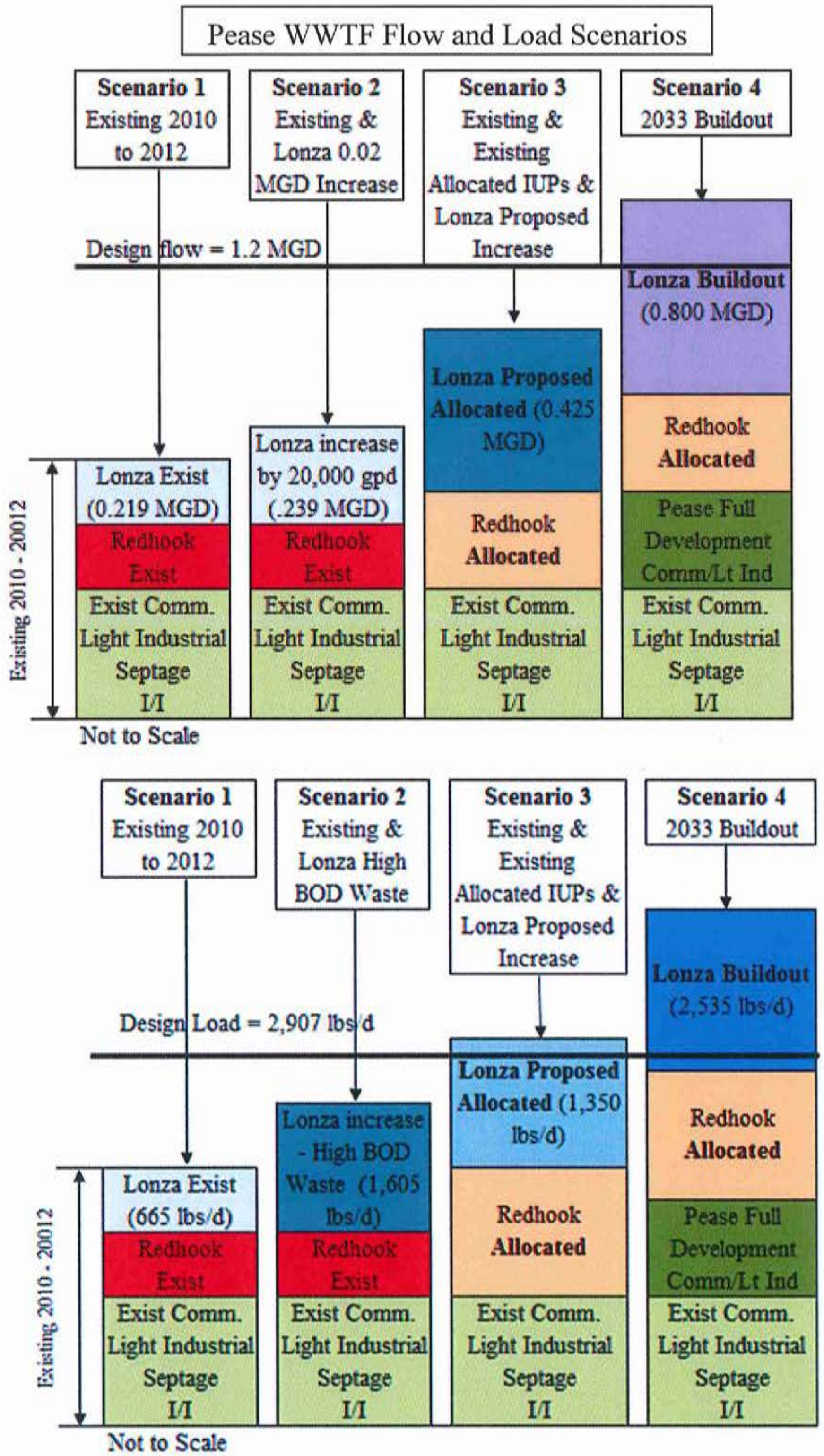
The WWTF has seen an average flow of 0.59 MGD over the past three years. The average BOD_5 and TSS loads for the past three years are, 1,840 lbs/d and 2,000 lbs/d, respectively. Lonza's flows comprised approximately 46% of the WWTF total flow and 42% of the WWTF total BOD_5 load in 2012.

6. Underwood Engineers developed four (4) projected flow scenarios for the Pease WWTF. They are shown on the next page. All proposed improvements are sized to accommodate the 20 year flow scenario (scenario 4) and to estimate total nitrogen of effluent. The SBR's cannot achieve an 8 mg/L TN with existing recalcitrant nitrogen levels of incoming flows in the 7 to 13 mg/L range.

7. Underwood Engineers prepared a condition assessment project list to utilize in a meeting with the City's staff to gather ideas for projects to be further evaluated at the WWTF. A data collection sheet organized by unit process/building was distributed to the staff and project team so that each individual had the opportunity to review the facility and offer suggestions for modifications/replacements or improvements to the WWTF.

8. The ideas that were developed during the condition assessment evaluation were tabulated for discussion in a project team meeting. The project list was utilized to determine which projects the City wanted to pursue and in what time frame. The ideas were then tabulated and listed in order of priority and time frame to be completed. The City also eliminated

ideas that would be taken care of as part of normal maintenance at the WWTF. The ideas were then further evaluated and project costs were developed. A complete list of the ideas is provided in Appendix A.



9. An HVAC report assessing the condition of the existing HVAC systems was prepared. Proposed improvements and costs have been incorporated into this report. A copy of the report is provided in Appendix C.
10. An odor control report assessing the condition of the existing odor control system was prepared. Proposed improvements and costs have been incorporated into this report. A copy of the report is provided in Appendix D.
11. A structural report assessing the condition of existing buildings and structural components was prepared. Proposed improvements and costs have been incorporated into this report. A copy of the report is provided in Appendix E.

Recommendations

1. Conceptual opinions of probable construction costs were developed for each of the ideas warranting further evaluation and are included in Appendix A. This was used to further define which projects the City would move forward with as discussed under Section 8 Recommended Improvements. Ideas that the City was not interested in pursuing at this time are shown as shaded and no further costs were developed.
2. Based on Underwood's review of the project list with the City's conceptual opinion of probable costs, a list of recommended projects was developed. Underwood prepared a conceptual opinion of probable costs for the recommended projects and placed them into either the short-term or long-term planning project categories. The projects are described below.
3. The Pease WWTF cannot achieve low effluent nitrogen values given the high level of recalcitrant nitrogen in the wastewater (7 to 13 mg/L N). Future permit limits will require this recalcitrant nitrogen be identified and reduced.

Short-Term Planning Projects:

Short-term planning projects are projects directly associated with immediate needs at the wastewater treatment facility within the next 5 year period. The recommended short-term planning projects are listed in detail in Table 9.1 of this report. A summary of the short-term planning project costs are presented below.

SHORT – TERM PLANNING PROJECTS	
SYSTEM ID	**OPINION OF PROJECT COST**
Preliminary Treatment (New Headworks Building, Screening, Grit Removal, Raw Wastewater Pumping; Septage Receiving improvements, key card additional storage, ramp on side of building/relocate inlet)	$4,473,000
Intermediate Pumping Station	$85,200
SBR's/Blower/Dewatering Building	$1,842,100
Equalization	$329,000
Sludge Storage and Chlorine Analyzer	$596,800
Odor Control (Separate for New Headworks Building and Septage Building)	$996,000
Laboratory/Administration Building	$296,300
Operation and Maintenance	$50,000
Facilities and Structures	$162,500
Other	$200,000
TOTAL (ENR October 2013)	$9,030,900

Long-Term Planning Projects:

Long-term planning projects are associated with future improvements and are within the 10 to 20 year time frame. The recommended long-term planning projects are listed in detail in Table 9.1 of this report. A summary of the long-term planning project costs are presented below.

LONG – TERM PLANNING PROJECTS	
SYSTEM ID	**OPINION OF PROJECT COST**
Preliminary Treatment	$34,000
Primary Treatment	$772,000
SBR's/Blower/Dewatering Building	$5,055,400
Equalization	$241,000

LONG – TERM PLANNING PROJECTS	
SYSTEM ID	**OPINION OF PROJECT COST**
Primary and Waste Activated Sludge	$149,000
Sludge Storage and Chlorine Analyzer	$73,000
Sludge Dewatering and Disposal	$1,926,000
TOTAL (ENR October 2013)	$8,250,400

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Common Abbreviations

fps	Feet Per Second
ft.	Feet
gal.	Gallons
gpd	Gallons Per Day
gpm	Gallons Per Minute
mg/L	milligrams per liter
HP	Horsepower
in.	Inches
kva	Kilovolt-ampere
kw	Kilowatt
lb.	Pound
max.	Maximum
MGD	Million Gallons Per Day
Min.	Minimum
ppm	Parts Per Million
%	Percent
psi	Pounds Per Square Inch
psig	Pounds Per Square Inch Gage
rpm	Revolutions Per Minute
s.f.	Square Foot
s.y.	Square Yard
TDH	Total Dynamic Head

1. INTRODUCTION

Project Background and Objectives

The City of Portsmouth is responsible for operating and maintaining the wastewater treatment facility and the wastewater collection system and pumping stations located within the Pease International Tradeport (Tradeport) in the City of Portsmouth. The Pease Development Authority (PDA) controls development within the Tradeport, a former Air Force base converted to use for military and civilian purposes. The Tradeport is a 1,207 $^{+/-}$ acre area in the Southwest corner of Portsmouth. The Tradeport consists of mixed use office spaces, industries, an airport, golf course, and military facilities.

The wastewater treatment facility began operating in 1954. The wastewater treatment facility receives wastewater from domestic, commercial and industrial sources. The major industrial contributors are Craft Brewer Alliance (Redhook) and Lonza Biologics. Together they contribute almost 50% of the flow and 60 % of the load to the WWTF.

Several improvements to the wastewater treatment facility have been added since it began operation in 1954. The major improvements include the following:

- 1971 – 55' trickling filter
- 1974/1975 – 75' trickling filter
- 1986 – headworks building
- 1997 – Major WWTF Upgrade including the following:
  - Enclose Headworks facility/improvements
  - Raw sewage pumps replacement
  - Upgrade primary clarifiers
  - Activated sludge system (Sequencing Batch Reactors) to replace trickling filters
  - Convert secondary clarifiers into equalization basins
  - New Blower/Sludge Dewatering (Operations) building (chemicals, blowers and sludge dewatering)
  - Sludge dewatering equipment
  - Improvements to the Intermediate pumping station
  - Convert one anerobic digester to aerated sludge storage
  - Disinfection system improvements
  - Odor control system
  - Laboratory/Administration Building
- 2002 –Septage facility

While most of the major components of the original WWTF have been upgraded, there remain a number of original systems and components that are in need of repair or replacement. In addition, some systems and equipment upgraded in 1997 have exceeded their useful lifespan and are in need of repair or replacement.

As mentioned above, the bulk of flow to the WWTF consists of two main industrial users, Lonza Biologics, Inc. (46%) and Redhook Ale Brewery (15%). Both Lonza and Redhook are among existing clients requesting to have an increased flow and load discharge capacity.

Accordingly, the Pease WWTF Evaluation has been prepared to accomplish the following objectives:

- *Complete a detailed review of the existing structures, equipment, processes and systems*
- *Perform an engineering analysis of the existing structures, equipment, processes, and systems regarding their condition, efficiency, energy use, sustainability, and capacity to meet current and proposed treatment conditions*
- *Perform flow and load scenarios based on build out projections, flow shedding scenarios, and client requests for capacity*
- *Develop a long term capital improvement plan for the Pease WWTF*
- *Provide the City with a comprehensive planning document to use for its capital planning needs*

Scope of Work

To accomplish the objectives of this study, the following tasks were completed:

- *Task 1 - Data Gathering and Review*
- *Task 2 - Engineering Analyses*
- *Task 3 - Report Development*
- *Task 4 - Project Meetings*

Summary of Prior Reports, Studies, and Plans

During the preparation of this update, the following information was reviewed by Underwood Engineers, Inc.

<u>Plans</u>

a. <u>Wastewater Treatment Plant Improvement Program</u>, November 20, 1997 prepared by Underwood Engineers, Inc.

b. <u>Portsmouth Airforce Base Sewage Treatment Plant</u>, January 1954 prepared by Whitman and Howard

Reports/Memos

a. Lonza biologics, Inc. Discharge Permit Request, dated November 21, 2007 prepared by Underwood Engineers.

b. 1995 WWTP Baseline Evaluation Report, dated October 5, 1995 prepared by Underwood Engineers.

c. Resources listed on the City of Portsmouth website: portsmouthwastewater.com.

2. EXISTING CONDITIONS

Existing Wastewater Treatment Facility

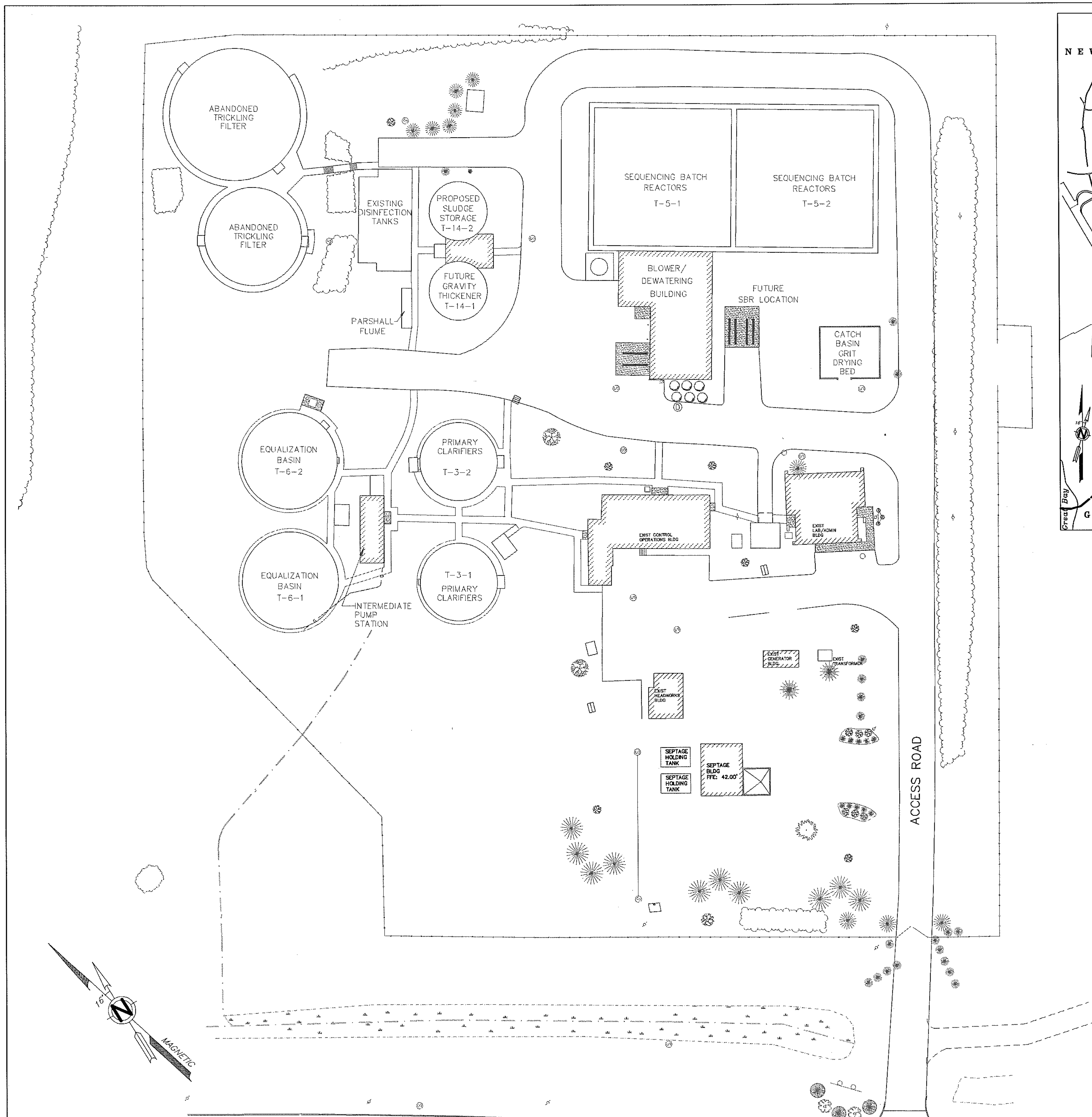
The original wastewater treatment facility (WWTF) began operation in 1954 and is located on Corporate Drive as shown on Figure 1. Several upgrades to the facility have been constructed since that time and were discussed in Section 1 of this report. The wastewater treatment facility is an activated sludge facility serving local domestic, commercial and industrial sewer users. A process schematic of the WWTF is shown on Figure 2.

The existing wastewater treatment facility consists of the following major components:

- Septage Receiving Facility
- Headworks Facility
- Raw Sewage Pumping
- Primary Clarifiers
- Intermediate Pumping Station
- Sequencing Batch Reactors (Biological Tanks)
- Equalization Tanks
- Chlorine Contact Tanks
- Sludge Handling System
- Odor Control System
- Blower/Sludge Dewatering (Operations) building (chemicals, blowers and sludge dewatering)
- Lab/Administration Building
- Control Building

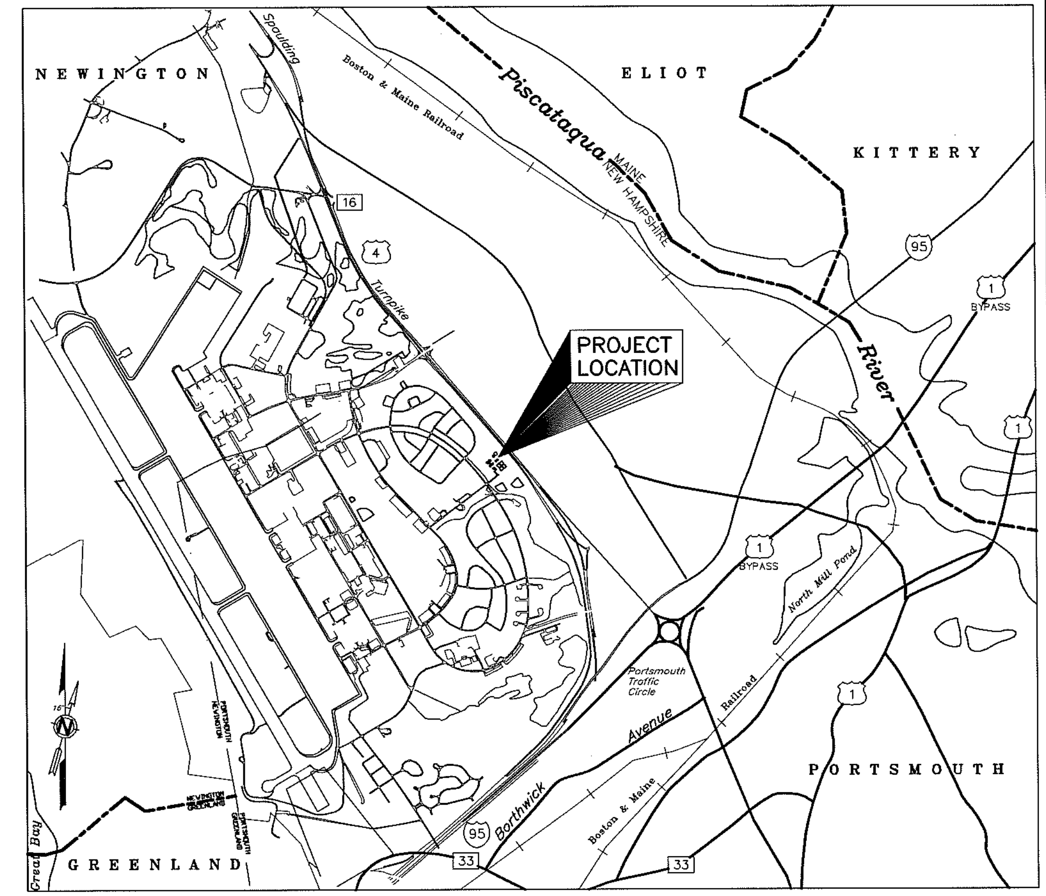
2.1.1 Current Permit Conditions

The WWTF's most recently issued National Pollutant Discharge Elimination System (NPDES) permit (No. NH009000) is dated August 9, 2000 (Effective Date August 8, 2000). The permit expired in 2005. The permit requirements are summarized in Table 2.1 NPDES Permit Discharge Limitations. We note that the whole effluent toxicity requirements are not shown (sampling required 1/year).



PLAN VIEW

SCALE: 1 INCH = 30 FT.



VICINITY MAP

SCALE: 1 INCH = 2000 FT.

ISSUE FOR APPROVAL Date By
CONSTRUCTION Date By
RECORD DRAWING Date By

NO.	REVISIONS	APP'D

Drawn/Chk. RMG
Designed
Checked
Approved
Date 9/3/2013
Book No.
Project No. 1775
Dwg. ID
Scale AS SHOWN

UNDERWOOD engineers
25 Vaughan Mall, Portsmouth, N.H. 03801
Tel. 603-436-6192 Fax. 603-431-4733

FIGURE 1 – SITE PLAN

PEASE WWTF

PEASE
PORTSMOUTH, NH

DWG NO

SHEET OF 178

H:\Real Numbers\Portsmouth\1775 Pease Evaulation\Work Plans\1775 FIGURE 1.dwg, Layout1, 12/31/2013 4:03:19 PM, tjb

Table 2.1 – NPDES Permit Discharge Limitations

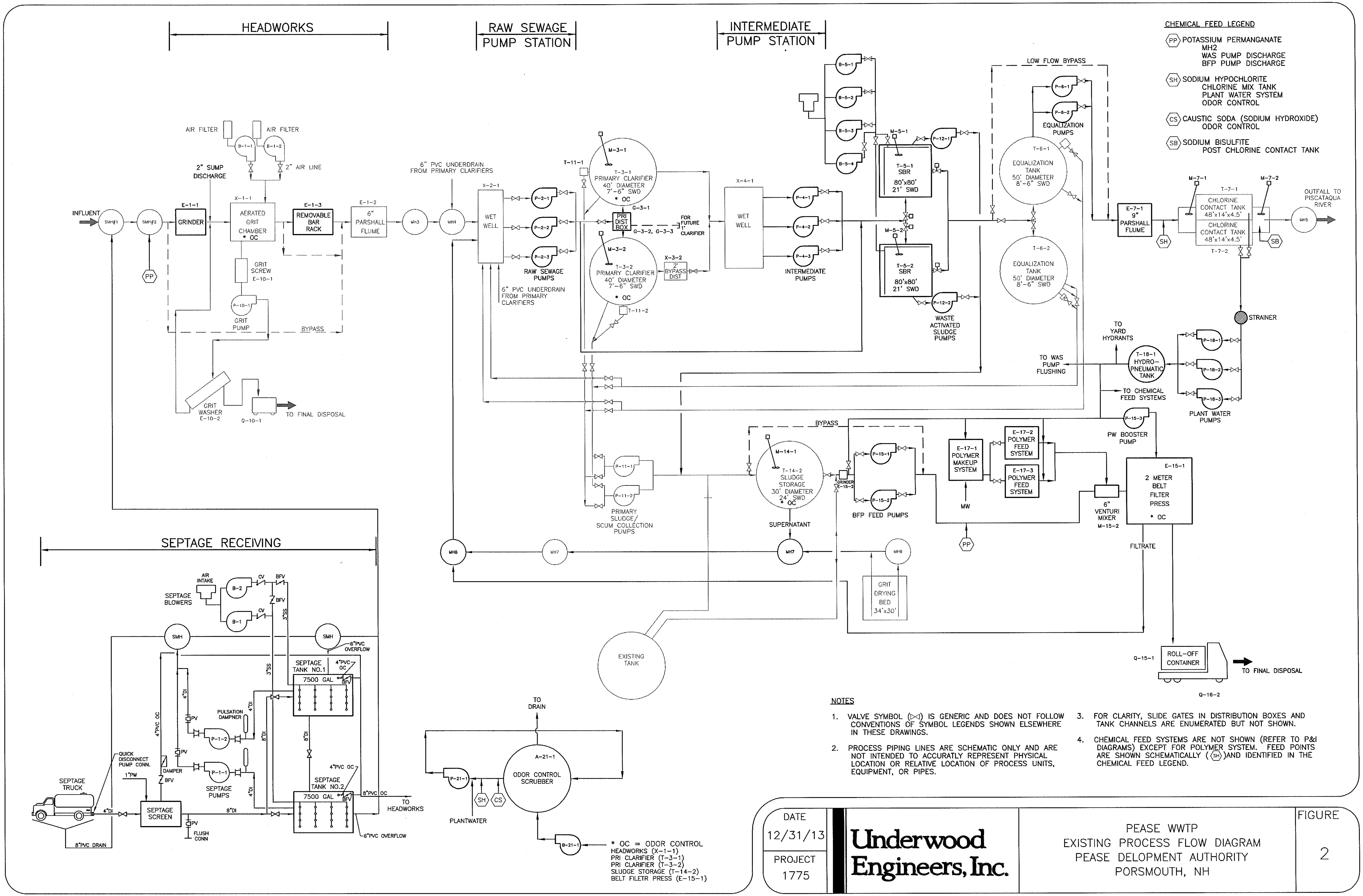
Effluent Characteristic	Discharge Limitations		
	Average Month	Average Week	Max Day
Flow, MGD	Report	Report	Report
BOD_5, ppd (mg/l)	300 ppd, (30 mg/l)	450 ppd (45 mg/l)	500 ppd, (50 mg/l)
TSS, ppd (mg/l)	300 ppd, (30 mg/l)	450 ppd (45 mg/l)	500 ppd, (50 mg/l)
Fecal Coliform, colonies/100 ml	14/100 ml	14/100 ml	14/100 ml**
Total Residual Chlorine	0.75 mg/l		1.0 mg/l
pH	6.0 – 8.0 Standard Units		

- pounds per day = ppd
- milligrams per liter = mg/l

** Permit limit more stringent than other NPDES permits in the region

2.1.2 Process Schematic

After reviewing all previous record drawings, a detailed process schematic was prepared to present the configuration of the facility in graphical form. Figure 2 shows the process schematic along with the major design criteria for each unit process and the location of all sidestream flows in the proper location that they discharge to the system.



NOTES

1. VALVE SYMBOL (⋈) IS GENERIC AND DOES NOT FOLLOW CONVENTIONS OF SYMBOL LEGENDS SHOWN ELSEWHERE IN THESE DRAWINGS.
2. PROCESS PIPING LINES ARE SCHEMATIC ONLY AND ARE NOT INTENDED TO ACCURATELY REPRESENT PHYSICAL LOCATION OR RELATIVE LOCATION OF PROCESS UNITS, EQUIPMENT, OR PIPES.
3. FOR CLARITY, SLIDE GATES IN DISTRIBUTION BOXES AND TANK CHANNELS ARE ENUMERATED BUT NOT SHOWN.
4. CHEMICAL FEED SYSTEMS ARE NOT SHOWN (REFER TO P&I DIAGRAMS) EXCEPT FOR POLYMER SYSTEM. FEED POINTS ARE SHOWN SCHEMATICALLY (SH) AND IDENTIFIED IN THE CHEMICAL FEED LEGEND.

DATE			FIGURE
12/31/13	Underwood Engineers, Inc.	PEASE WWTP EXISTING PROCESS FLOW DIAGRAM PEASE DELOPMENT AUTHORITY PORSMOUTH, NH	2
PROJECT 1775			

2.1.3 Existing Wastewater Flows and Loads

Historical records were reviewed to establish the flow and loads to the facility over a three year period. The period of records reviewed was from January 2010 to December 2012.

Table 2.2 Pease WWTF Flows and Loads identifies existing flows and loadings for the wastewater treatment facility base on data obtained during January 2010 to December 2012.

Table 2.2 - Pease WWTF Historical Flows and Loads

Criteria	Year			
	2010	**2011**	**2012**	**Design**
Flow (MGD)				
Average Day	0.639	0.638	0.495	1.2
Max Day	1.803	1.600	0.790	3.345
Max Week	1.245	0.992	0.695	
Max Month	0.934	0.845	0.631	
BOD (lbs/d)				
Average Day	2,474	1,503	1,527	2,907
Max Day	6,684	3,176	2,943	5,467
Max Week	6,217	2,997	2,767	
Max Month	4,371	2,376	2,118	
TKN (lbs/d)				
Average Day				364
Max Day				829
Max Week				
Max Month				
TSS (lbs/d)				
Average Day	1,502	2,200	2,296	2,907
Max Day	3,499	6,995	7,270	5,467
Max Week	2,749	6,512	6,095	
Max Month	2,247	3,609	3,947	

The WWTF has seen an average flow of 0.59 MGD over the past three years. The average BOD_5 and TSS loads for the past three years are, 1,840 lbs/d and 2,000 lbs/d, respectively. Lonza's flows comprised approximately 46% of the WWTF total flow and 42% of the WWTF total BOD_5 load in 2012.

2.1.3.1 Water Demand

UEI estimated water demand for all four scenarios by compiling existing and potential water consumers for the buildable areas of the entire Tradeport. A potential water consumer was defined as a business expansion or a new business in a developable area of the Tradeport. Developable land is significantly limited by wetlands, protected open space, and other buffer zones (i.e. airport, wells, etc.).

UEI compiled a database of existing and potential water consumers, categorized by business type and zone, and estimated the existing water demand based on number of employees, square footage, or an estimated demand rate. Existing tenant records provided by the PDA included business names, and addresses, built square footage, and number of existing and future employees. Zone and business category were determined by UEI based on address and business type. Water consumption for existing tenants was estimated by applying a per capita consumption rate per employee.

Table 2.3 provides a summary of water demand scenarios.

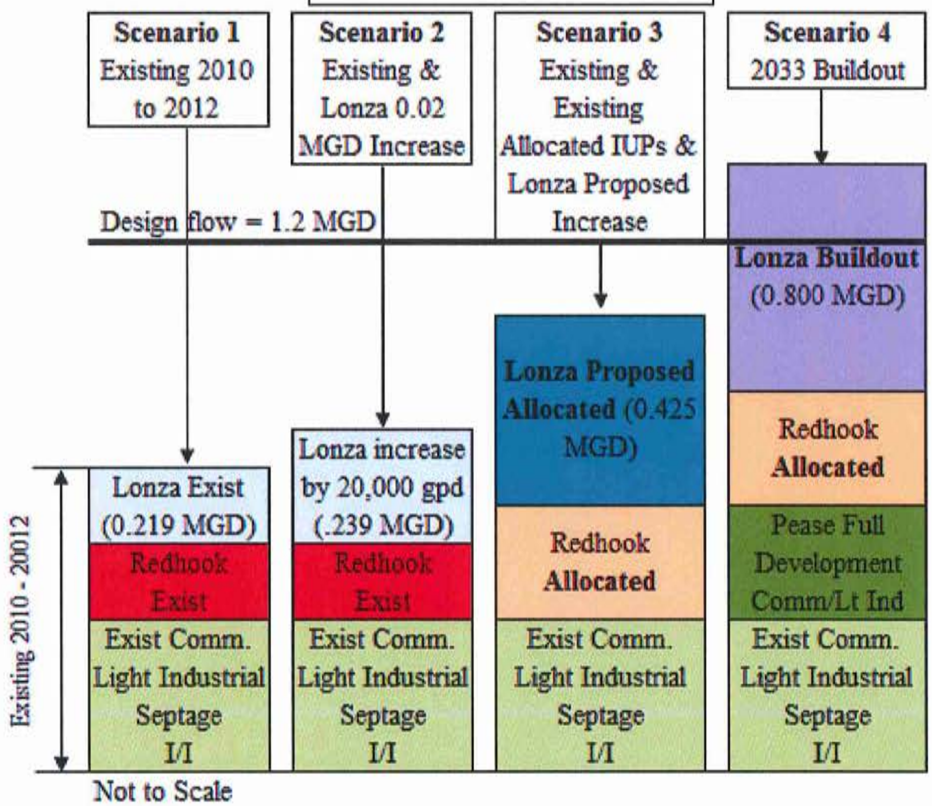
Table 2.3- Summary of Water Demand Scenarios

Scenario	*Description*	*Water Demand (gpd)*
1	Existing	491,000
2	5 year projection	511,000
3	10 year projection	856,000
4	2033 Buildout of Pease	1,578,000

2.1.3.2 Flow and Load Projections

Based on WWTF data and existing and proposed industrial user permits (IUP) conditions, four flow and load projections scenarios were developed. These scenarios best evaluate the WWTFs capability to provide treatment of proposed conditions. Figure 3 summarizes the selected flow scenarios. The flow to the WWTF based on the buildout scenarios is shown in Table 2.4.

Figure 3 –Flow Scenarios



Lonza Biologics, Inc. is the largest industrial discharger to the Pease WWTF. Lonza's flows comprised approximately 46% of the WWTF total flow and 42% of the WWTF total BOD_5 load in 2012.

Table 2.4 - Water Demand Flow Projections

Zone	Type	2013 Existing Occupied Building Space: Area (sq ft)	Employees	Flow (gpcd)	Demand (gpd)	Notes	Existing and Existing Allocated IUPs: Area (sq ft)	Employees	Flow (gpcd)	Demand (gpd)	Notes
A	Office/R&D	22,000	13	15	195		22,000	13	15	195	
	Transportation Services	1,200	7	15	105		1,200	7	15	105	
	Transportation Support	52,000	25	15	375		52,000	25	15	375	
AI	Air Cargo	61,184	13	15	195		61,184	13	15	195	
	Aircraft Manufacturing	3,309				1	3,309				
	Golf	14,400					14,400				
	Employees		8	12	96			8	12	96	
	Players		300	15	4,500			300	15	4,500	
	Irrigation				82,000					82,000	
	Hangar	0	9	15	135		0	9	15	135	
	Light Industrial	43,650	9	15	135		43,650	9	15	135	
	Office/R&D	80,280	329	15	4,935		80,280	329	15	4,935	
	Restaurant	2,500	6	15	90		2,500	6	15	90	
	Transportation Services	117,500	284	15	4,260		117,500	284	15	4,260	
B/C	Biotech Industry	659,890	650		228,000		659,890	650		**300,000**	
	Brewery	129,124	55		57,310		129,124	55		**160,000**	
	Childcare	34,898	43	15	645		34,898	43	15	645	
	Gym	5,230				1	5,230				
	Hotel/Conference Center	86,000					86,000				
	Employees		25	10	250			25	10	250	
	Guests		150	50	7,500			150	50	7,500	
	Light Industrial	54,071	108	15	1,620		54,071	108	15	1,620	
	Medical	73,225					73,225				
	Employees		49	10	490			49	10	490	
	Patients		190	15	2,850			190	15	2,850	
	Office/R&D	1,220,576	3,908	15	58,620		1,220,576	3,908	15	58,620	
	Restaurant	15,402					15,402				
	Employees		51	10	510			51	10	510	
	Patrons		75	9	675			75	9	675	
	Retail	924	4	10	40		924	4	10	40	
	School	165,290					165,290				
	Employees		90	15	1,350			90	15	1,350	
	Students		200	15	3,000			200	15	3,000	
I	Biotech Industry	23,583	20		**Incl Above**		23,583	20		**Incl Above**	
	Light Industrial	74,946	135	15	2,025		74,946	135	15	2,025	
	Medical	30,500					30,500				
	Employees		9	10	90			9	10	90	
	Patients		18	15	270			18	15	270	
	Office/R&D	480,246	1,491	15	22,365		480,246	1,491	15	22,365	
	Transportation Support	30,502	17	15	255		30,502	17	15	255	
	Warehouse	147,000	0	15	0		147,000	0	15	0	
NHANG	Light Industrial	N/A	12	15	180		N/A	12	15	180	
	Office/R&D	N/A	401	15	6,015		N/A	401	15	6,015	
	Aircraft Manufacturing										
	Total	**3,629,430**	**8,704**		**491,081**		**3,629,430**	**8,704**		**665,771**	

Zone	Type	Existing and Lonza Proposed Allocated Increase: Area (sq ft)	Employees	Flow (gpcd)	Demand (gpd)	Notes	Existing and Existing Allocated IUPs & Lonza Proposed Allocated Increase: Area (sq ft)	Employees	Flow (gpcd)	Demand (gpd)	Notes
A	Office/R&D	22,000	13	15	195		22,000	13	15	195	
	Transportation Services	1,200	7	15	105		1,200	7	15	105	
	Transportation Support	52,000	25	15	375		52,000	25	15	375	
AI	Air Cargo	61,184	13	15	195		61,184	13	15	195	
	Aircraft Manufacturing	3,309					3,309			0	
	Golf	14,400					14,400			0	
	Employees		8	12	96			8	12	96	
	Players		300	15	4,500			300	15	4,500	
	Irrigation				82,000					82,000	
	Hangar	0	9	15	135		0	9	15	135	
	Light Industrial	43,650	9	15	135		43,650	9	15	135	
	Office/R&D	80,280	329	15	4,935		80,280	329	15	4,935	
	Restaurant	2,500	6	15	90		2,500	6	15	90	
	Transportation Services	117,500	284	15	4,260		117,500	284	15	4,260	
B/C	Biotech Industry	659,890	650		**490,000**		659,890	650		**490,000**	
	Brewery	129,124	55		**57,310**		129,124	55		**160,000**	
	Childcare	34,898	43	15	645		34,898	43	15	645	
	Gym	5,230					5,230				
	Hotel/Conference Center	86,000					86,000				
	Employees		25	10	250			25	10	250	
	Guests		150	50	7,500			150	50	7,500	
	Light Industrial	54,071	108	15	1,620		54,071	108	15	1,620	
	Medical	73,225					73,225			0	
	Employees		49	10	490			49	10	490	
	Patients		190	15	2,850			190	15	2,850	
	Office/R&D	1,220,576	3,908	15	58,620		1,220,576	3,908	15	58,620	
	Restaurant	15,402					15,402			0	
	Employees		51	10	510			51	10	510	
	Patrons		75	9	675			75	9	675	
	Retail	924	4	10	40		924	4	10	40	
	School	165,290					165,290			0	
	Employees		90	15	1,350			90	15	1,350	
	Students		200	15	3,000			200	15	3,000	
I	Biotech Industry	23,583	20		**Incl Above**		23,583	20		**Incl Above**	
	Light Industrial	74,946	135	15	2,025		74,946	135	15	2,025	
	Medical	30,500					30,500				
	Employees		9	10	90			9	10	90	
	Patients		18	15	270			18	15	270	
	Office/R&D	480,246	1,491	15	22,365		480,246	1,491	15	22,365	
	Transportation Support	30,502	17	15	255		30,502	17	15	255	
	Warehouse	147,000	0	15	0		147,000	0	15	0	
NHANG	Light Industrial	N/A	12	15	180		N/A	12	15	180	
	Office/R&D	N/A	401	15	6,015		N/A	401	15	6,015	
	Aircraft Manufacturing										
	Total	**3,629,430**	**8,704**		**753,081**		**3,629,430**	**8,704**		**855,771**	

Zone	Type	2033 Buildout (includes occupation of all buildings): Area (sq ft)	Employees	Flow (gpcd)	Demand (gpd)	Notes
A	Office/R&D	22,000	13	15	195	
	Transportation Services	1,200	7	15	105	
	Transportation Support	52,000	25	15	375	
AI	Air Cargo	61,184	13	15	195	
	Aircraft Manufacturing	3,309	N/A	N/A	**2,647**	
	Golf	14,400			0	
	Employees		8	12	96	
	Players		300	15	4,500	
	Irrigation				82,000	
	Hangar	0	9	15	135	
	Light Industrial	43,650	9	15	135	
	Office/R&D	80,280	**330**	15	**4,950**	
	Restaurant	2,500	**10**	15	**150**	
	Transportation Services	117,500	284	15	4,260	
B/C	Biotech Industry	659,890	**775**		**800,000**	
	Brewery	129,124	55		**160,000**	
	Childcare	34,898	**46**	15	**690**	
	Gym	5,230				
	Hotel/Conference Center	86,000				
	Employees		25	10	250	
	Guests		150	50	7,500	
	Light Industrial	**69,071**	**208**	15	**3,120**	
	Medical	**77,725**			0	
	Employees		**69**	10	**690**	
	Patients		190	15	2,850	
	Office/R&D	**1,394,265**	**4,489**	15	**67,335**	
	Restaurant	15,402			0	
	Employees		51	10	510	
	Patrons		75	9	675	
	Retail	924	4	10	40	
	School	165,290			0	
	Employees		90	15	1,350	
	Students		200	15	3,000	
I	Biotech Industry	23,583	20		**Incl Above**	
	Light Industrial	74,946	135	15	2,025	
	Medical	30,500				
	Employees		9	10	90	
	Patients		18	15	270	
	Office/R&D	**654,246**	**2,512**	15	**37,680**	
	Transportation Support	30,502	17	15	255	
	Warehouse	147,000	0	15	0	
NHANG	Light Industrial	N/A	12	15	180	
	Office/R&D	**N/A + 100,000**	**651**	15	9,765	
	Aircraft Manufacturing					
	Total	**3,996,619**	**10,809**		**1,198,018**	

Notes: 1. facilities with acerage but no demand do not have any employees on record

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2.1.4 Description of Existing Wastewater Treatment Facility

A brief description of the wastewater treatment facility is provided in the following sections. We note that concerns with the existing systems are identified in the condition assessment project list in Appendix A.

2.1.4.1 Septage Acceptance System

The septage receiving facility was added 2002 and consists of a septage screening unit, two (2) precast concrete 7,000 gallon aerated septage storage tanks and two (2) septage transfer pumps. The Septage Acceptance System (SAS) unit is a Lakeside Model 31 SAP located in the Septage Screen room in the Septage Receiving Station building. The unit consists of a 3-plane cylindrical bar screen complete with screen basket, rotating rake, cleaning comb, screenings screw conveyor, dewatering screw and screenings press with drive unit, tank spray wash system, quick coupling inlet connection, motorized inlet valve, outlet connection, liquid level sensing system, and screenings bagger. A pre-engineered housing with hinged and gasketed cover encloses the entire processing unit for odor control. The system includes a unit main control panel, local control station, and remote hauler control panel.

Two (2) Watson-Marlow/Bredel hose pumps convey aerated septage transfer from the aerated septage holding tanks to the influent municipal wastewater ahead of the Headworks building.

The septage transfer pumps are located in the Pump and Blower room in the Septage Receiving Station building. Each peristaltic hose pump has a capacity of 50 gpm and 15 ft TDH. Each constant speed pump is driven by a 7.5 hp, 3 phase 460 volt, 60 Hz squirrel-cage induction motor that is coupled to the pump through a two-stage gear drive unit. The pumps are controlled by SCADA or manually at the pump

2.1.4.2 Headworks Facility

The headworks facility consists of a channel grinder, bar rack/bypass channel, influent flow monitoring, aerated grit chamber, two (2) blowers, grit classifier and a grit pump. Improvements to the headworks facility were made during the 1997 upgrade and included enclosing the aerated grit chamber, relocating the grinder and adding aluminum checkered plates over the channels.

The Disposable Waste Systems, Inc grinder (Muffin Monster) is located in the influent channel of the Headworks Building. The 40 inch cutting chamber, single rotating drum model is driven through a 29:1 planetary gear reducer by a 3 horsepower motor that operates at 3 phase, 230/460 volt, 60 Hz current.

The aerated grit removal system includes the grit chamber, effluent baffle, air diffusion system, blowers, grit pump and grit washer.

The grit chamber is a 10'x10'x8' concrete tank with a volume of 80 cubic feet. The tank has a treatment capacity of 5,964 gallons. At peak hour it provides a detention time of 3 minutes.

The aeration diffusion system consists of a one swing arm coarse bubble type air diffuser assembly with air main, manifold connectors, feeder manifold and swing arm assembly and individual diffusers on a single header.

Two rotary positive displacement air blowers provide air to the diffusion system. Each blower is equipped with an inlet silencer and discharge silencer, inlet filter, expansion joints, temperature gauge and pressure gauge. Each blower is driven through a V-belt drive by a 2 horsepower motor operating off of 3 phase, 460 volt, 60 Hz current.

The centrifugal, nonclog grit pump is rated at 100 gpm at 18' TDH at 875 rpm. The pump is driven through a variable speed handwheel set, motion control V-belt drive over a range of 700 to 1000 rpm by a 5 horsepower motor operating at 1800 rpm off of 3 phase, 460 volt, 60 Hz current.

The influent flow metering equipment consists of a 6" Parshall flume, an ultrasonic open channel flow transponder with microprocessor based control module, a flow recorder, and an indicating totalizer. The flume has a range of .0009 - 3.980 mgd.

2.1.4.3 Raw Sewage Pumping

The Raw Sewage Pumps convey wastewater from the station wetwell to the Primary Clarifier Distribution Box under normal operations. However, the primary clarifiers can be bypassed and the raw sewage pumps can pump directly to the Sequencing Batch Reactors (SBRs). The Raw Sewage Pump room and wetwell are located at the northwestern end of the Operations Building. The installation includes a wet well and three variable speed, vertical, dry pit, bottom suction, heavy duty, nonclog, centrifugal pumps. Each pump has a maximum capacity of 1,100gpm. Each variable speed pump is driven by a 15 hp, 3 phase, 460 volt, 60 Hz squirrel cage induction motor that is directly connected to a variable speed coupling which in turn is connected to the pump through intermediate shafting. The pumps are furnished with a local control panel, a variable frequency control panel and a dual air pump bubbler control system to control the operation of the pumps through a variable speed drive controller. The 115 volt, 60 Hz diaphragm oscillatory air pumps deliver 5.0 SCFH air flow at 7 psi.

2.1.4.4 Primary Clarifiers

There are two (2) center feed circular primary clarifiers at the wastewater treatment facility. The primary clarifier removes settleable solids and floating materials (and the BOD associated with these materials) from the influent flow. The center feed 40' diameter x 7'10" SWD clarifiers each have a holding capacity of 73,562 gallons and provide a detention time of 2.9 hours at the design flow of 1.2 mgd.

The collector mechanism includes a center drive unit, drive control with overload protection, stationary influent column, feedwell, center cage, sludge scraper collection arms, scum skimmer and scum box.

Each drive system consists of a ¾ horsepower gear motor that operates at 1,800 rpm off of 3 phase, 460 volt, 60 Hz current. The drive system is connected by a chain-sprocket to a worm gear speed reducer and a final speed reduction pinion to drive the collector mechanism.

Wastewater is pumped by the Raw Sewage Pumps to the Primary Clarifier Distribution Box. Equally divided wastewater flows by gravity to each primary clarifier. Wastewater flows from each clarifier to the Intermediate Pump Station. Primary sludge and scum is pumped by the Primary Sludge Pumps to the Sludge Storage Tank.

2.1.4.5 Intermdiate Pumping Station

The intermediate pumps receive wastewater from the primary clarifiers and discharge primary effluent to the sequencing batch reactors. The intermediate pump station houses three horizontal, Gorman-Rupp self-priming, centrifugal non-clog sewage pumps that are each rated at 1,300 gpm at 27' TDH. Each pump is driven by a 20 horsepower motor operating at 1,780 rpm through a V-belt drive to achieve an output speed of 850 to 1,050 rpm. The pumps operate off of 3 phase, 460 volt, 60 Hz current. The system is furnished with a dual air pump bubbler control system to control the operation of the pumps from setpoints that are set and adjusted from the front of the controller.

2.1.4.6 Sequencing Batch Reactors

The biological system was upgraded in 1997 to an activated sludge system comprising of two sequencing batch reactors (SBR's). Two sequencing batch reactors include the following:

Capacity	: 1,010,099 gallons each at 21.1' SWD, 670,200 gallons at 14' LWL
Dimensions	: 80' x 80' x 21.1' SWD each to 14' at LWL
Process	: Activated Sludge
Detention Time	: At 1.22 mgd, the detention time is 26.4 hours. At 3.4 mgd, the detention time is 14.2 hours.

Each SBR is equipped with an influent control valve, a mixer, blower fed diffusion equipment, air control valve, one effluent decanter, a decant control valve, and a waste sludge pump.

Each SBR receives wastewater from the intermediate pump station. Clarified supernatant is decanted from each SBR and flows to the equalization basins. Air is supplied to each SBR by the blowers in the Blower/Dewatering Building. Mixed liquor is circulated during the anoxic (unaerated) treatment stage in each reactor by the associated mixer. Waste activated sludge is pumped to the sludge storage tank. The biological process is discussed more in depth in Section 2.2 of this report.

The two sequencing batch reactors are provided with a mixing/aeration system consisting of DDM floating mixers, rotary lobe positive displacement blower located in the Blower/Dewatering Building and retrievable fine bubble air diffusion banks. One of the four blowers provided serves as a standby unit. More specifically, the following equipment is provided to achieve the necessary SBR mixing and aeration:

Two (2): Mechanical floating downward pumping mixers (one per reactor), each rated to pump 16,500 gpm. The mixer is driven by a 30 horsepower, 880 rpm totally enclosed fan cooled motor designed to operate on 460 volt, 3 phase, 60 Hertz power. Each motor is controlled from the SBR control panel.

Four (4): Rotary lobe positive displacement air blowers each rated to deliver 993 ICFM @ 10.7 psig including filters, flexible connectors, unloading valve, discharge check valve, pressure relief valve and controls. Each blower is driven through a V-belt drive by a 1,780 rpm, 75 Hp, 460 volt, 3 phase TEFC motor. Each blower is controlled from the SBR control panel.

Eighteen (18): Diffuser racks consisting of (50) fine bubble tube diffusers each. These racks are designed to diffuse the air from the blowers into the water column.

In May of 2013 of the year, the City discovered that aeration piping at SBR No.1 was disconnected and swinging freely. Therefore, the City is currently undertaking the following improvements on their own:

- Replacement of the existing decanter assembly in SRB No.1
- Replacement of the existing nine (9) fine bubble diffuser assemblies
- Replacement of influent motorized plug valves
- Addition of influent isolation knife gate valves at the motorized plug valves

2.1.4.7 Equalization Tanks

The Equalization Basins store processed wastewater that is discharged from the SBR's at a high flow rate and is pumped to the chlorine contact tank at a lower, more constant flow rate. Concrete basins (former secondary clarifiers) were converted to Equalization Basins. Each 50' diameter by 8.5' SWD basin has a storage volume of 16,689 cubic feet for 124,775 gallons of water. Total storage volume for the two tanks is 249,550 gallons. The maximum decant volume from each SBR is 340,000 gallons.

One basin is equipped with two centrifugal, submersible raw sewage pumps. Each pump has a maximum capacity of 2,150 gpm at 12.5' TDH. Each variable speed pump is driven by a 14 Hp, 3 phase, 460 volt, 60 Hz squirrel cage induction motor that is directly connected to a variable speed coupling which in turn is connected to the pump through intermediate shafting. The pumps are provided with a local control panel, a variable frequency control panel, and an ultrasonic level control system. The pumps are provided with guide rails and lifting chains.

2.1.4.8 Disinfection System

The disinfection system consists of a chlorine contact tank and hypochlorite and sodium bisulfite chemical feed systems. The chlorination system is comprised of the following components:

- Two (2) Chlorine contact tanks. Each tank is 48 ft. long by 15.5 wide and is operated at a SWD of 4.5 ft. The tanks has a treatment capacity of 25,245 gallons each and provides a detention time of 22 minutes at average design flow.
- One (1) Sodium hypochlorite diffuser
- One (1) Top mounted, foil impeller mixer. The mixer is driven through a single reduction helical gear reducer and variable frequency drive by a 1 horsepower motor that operates at 1800 rpm off of 3 phase, 460 volt, 60 Hz power. The 14" diameter impeller rotates nominally at 350 rpm.
- Three (3) Simplex electromagnetic diaphragm pumps. Each pump is rated at 0 - 9 gph pumping 15% solution of sodium hypochlorite (NaOCl) with a discharge pressure of 30 psi. Each pump is provided with a four-way anti-siphon valve and flow indicator.
- One (1) Pump controller to pace the chemical feed system off of the 4-20 mA signal from the main PLC controller. The effluent flow and chlorine residual signals are transmitted to the main PLC controller which transmits a 4-20 mA signal to the pump controller.
- One (1) Black, XLPE NaOCl storage tank with a capacity of 6200 gallons.
- One (1) Residual-chlorine analyzer and recorder.

The dechlorination system is located in the blower/dewatering building and is comprised of the following equipment:

- Three (3) simplex, electromagnetic, diaphragm pumps. Each pump is rated at 0 -

4.6 gph capable of pumping 38% sodium bisulfite solution at a maximum rate of 5.0 gph with a discharge pressure of 30 psi.

- One (1) sodium bisulfite diffuser.
- One (1) top mounted, foil impeller mixer. The mixer is driven through a single reduction helical gear reducer and variable speed drive by a 1 horsepower motor that operates at 1800 rpm off of 3 phase, 230/460 volt, 60 Hz current. The 14" diameter impeller rotates at a nominal speed of 350 rpm.
- Three (3) anti-siphon valves, one on each pump's discharge line.
- One (1) microprocessor based compound loop pump controller and stroke length actuator. The pump controller paces the operation of the dechlorination pumps off of a 4-20 mA signal from the main PLC controller. The main controller integrates separate 4-20 mA signals from the effluent flow meter and from the chlorine residual analyzer and transmits a single 4-20 mA signal to the pump controller to control pump operations.
- One (1) 1500 gallon, XLPE storage tank with float type level indicator.

Sodium bisulfite from the storage tank in the Blower/Dewatering Building is pumped to the tail end of the chlorine contact tank where it is diffused into and mixed with the chlorinated wastewater in the structures discharge channel.

An ammonia system was added in 2005 to allow for chlorine to combine with the ammonia to form chloramines, which proved to be adequate to disinfect the wastewater to meet a 14 per 100 ml fecal coliform limit. Subsequent to the ammonia addition, violations occurred due to interference with the disinfection process. It is thought that organic nitrogen is causing the interference. This City built a shelter for the equipment to protect it from the weather.

2.1.4.9 Plant Water System

The skid mounted plant water system is comprised of three (3) pumps, one hydropneumatic tank and one control panel located in the sludge storage building. The system provides service water throughout the plant for washdown, spray wash systems, process water, dilution water, etc.

The three pumps are horizontal mounted close-coupled end suction centrifugal pumps. Lead pump P-18-1 is rated at 60 gpm at 220 ft. TDH. The pump is driven by a 10 horsepower motor operating at 3500 rpm off of 3 phase, 460 volt, 60 Hz power. Lag pumps P-18-2 and P-18-3 are each rated at 120 gpm at 220 ft. TDH. The pumps are driven by 15 horsepower motors operating at 3500 rpm off of 3 phase, 460 volt, 60 Hz power.

The 30" diameter by 79" tall vertical hydropneumatic tank is fitted with a storage bladder that holds 170 gallons. The system is designed to provide 300 gpm at 90 psig.

2.1.4.10 Sludge Handling System

The sludge handling system consists of primary sludge pumps, sludge storage, waste activated sludge pumps, sludge feed pumps, and belt filter press. Each of these components is described below.

Primary Sludge Pumps

The primary sludge/scum pumping system consists of two existing pumps that are located in the Operations Building. Each pump has a capacity of 75 gpm and is driven by a 5 horsepower motor that operates at 750 rpm off of 3 phase, 460 volt, 60 Hz power. Sludge is drawn from the primary clarifiers and scum from each scum pit by the primary sludge pumps. The primary sludge pumps convey sludge/scum to the sludge storage tank.

Sludge Storage

An original anaerobic sludge digester was converted to a sludge storage tank during the 1997 upgrade. The tank is 30 ft. in diameter and is operated at a side water depth of 24 feet. At that side water depth, the tank has a storage volume of 16,964 cubic feet or 126,895 gallons. At an average daily sludge flow of 27,841 gallons to the storage tank, the tank provides a storage or detention time of 4.55 days prior to decanting. Decanting will extend the storage time.

The tank is equipped with a floating decanting weir and a guide rail mounted, centrifugal, submersible mixer. The mixer is driven by a 7.5 horsepower motor that operates at 580 rpm off of 3 phase, 460 volt, 60 Hz power.

Waste Activated Sludge

Two positive displacement disc pumps are installed in the Blower/Dewatering Building. Each pump has a capacity of 135 gpm @ 25 ft. TDH. Each pump is driven through a V-belt drive by a 7.5 horsepower motor that operates at 1750 rpm off of 3 phase, 230/460 volt, 60 Hz current. The waste sludge pumps are located in the Blower/Dewatering Building, one for each SBR. The pumps convey waste sludge from the SBR's to the sludge storage tank.

Sludge Grinder

A grinder (Muffin Monster) by Disposable Waste Systems, Inc is installed in the sludge line to the filter press in the Sludge Building. The 12 inch cutting chamber, single rotating drum model is driven through a 29:1 planetary gear reducer by a 5 horsepower motor that operates at 3 phase, 230/460 volt, 60 Hz current.

Sludge Feed Pumps

There are two (2) Sludge Feed Pumps located in the basement of the Sludge Storage Building. They draw sludge from the Sludge Storage Tank and pump it to the Belt Filter Press. The sludge feed pumps are Penn Valley positive displacement disc pumps. Each pump has a capacity of 210 gpm at 24 ft. TDH. Each pump is driven through a variable frequency drive by a 10 horsepower motor. Each motor operates off of 3 phase, 460 volt, 60 Hz current. One of the sludge feed pumps was having vibration issues and was replaced in September 2013.

Polymer Feed System

The polymer system consists of storage hopper, screw feeder, blower, dry polymer wetting device, dispenser, mix tank, transfer valve, storage feed tank, liquid level control probes, control panel and solution metering pumps/post dilution assemblies. The polymer feed system provides polymer solution to the primary/WAS slurry from the Sludge Storage Tank prior to dewatering at the Belt Filter Press. The polymer feed systems is located in the Blower/Dewatering Building.

The system is provided with three in-line venturi type sludge/polymer static mixers for the mixing and flocculation of feed sludge conditioned with polymer. Each static mixer is provided with four injection ports between the injection ring and manifold.

Sludge Dewatering

The belt filter press and its support systems are located in the Blower/Dewatering Building. The press is preceded by an in-line static mixer for the addition of polymer which conditions sludge. The sludge press consists of a gravity drainage section, pressure/shear dewatering section, filtrate drainage system, two belts, belt tracking/tensioning system, doctor blades, belt wash stations, and roller assemblies.

The 2.0 meter belt filter press is designed to handle 1,600 pounds of dry sludge per hour or dewater 70 to 150 gpm of conditioned liquid sludge that exhibits a dry solids concentration of two to four percent. The press discharges a sludge cake that exhibits a minimum solids concentration of 20% when the press receives sludge conditioned with a maximum of 10 pounds of polymer per ton of dry solids. The press is equipped with two endless belts (top and bottom) forming the gravity, wedge, and high pressure dewatering zones.

The filter press is provided with one belt drive assembly. The drive assembly consists of a 5 horsepower TEFC motor rated to operate at 1,800 rpm on 460 volt, 3 phase, 60 Hz power through a right angle shaft mounted helical bevel gear reducer. The reducer exhibits a 150:1 reduction ratio to produce an output speed of 12 rpm. The drive assembly is connected to a variable frequency drive controller for belt speed adjustment.

A compressor is provided to power the pneumatically controlled belt tracking and belt tensioning systems. The compressor is provided with a 30 gallon receiver refrigerated air dryer and a 2 horsepower motor that operates at 1,725 rpm off of 3 phase, 460 volt, 60 Hz current.

A belt wash system is provided for the filter press. Potable water supplied at 90 gpm at 60 psi is boosted by the spray wash pump to 120 psi to wash both filter belts. The washwater pump is of the end suction type. The pump has a capacity of 90 gpm at 277 ft. TDH (120 PSI). The pump is directly coupled to a 7.5 horsepower motor that operates at 3,500 rpm off of 3 phase, 460 volt, 60 Hz current.

The system is provided with one sludge hopper to direct the sludge cake discharged from the press to the roll off container in the garage below the belt filter press room.

2.1.4.11 Odor Control

The odor control system was installed during the 1997 upgrade to remove hydrogen sulfide and associated odors from air ventilated from the septage receiving station, aerated grit tank in the Headworks, the Primary Clarifier Distribution Box, effluent launder of each Primary Clarifier, the Sludge Storage Tank and the Belt Filter Press room.

The odor control system is comprised of a packed tower, recirculation pump, exhaust fan, sodium hydroxide (NaOH) metering pumps, sodium hypochlorite (NaOCl) metering pumps and collection/discharge ductwork.

The wet scrubber tower is a 5 ft. diameter 19.33 ft. filament wound fiberglass bottom entry/top discharge packed bed reactor with an integral recirculation sump that uses counter current air flow. The reactor is packed with polypropylene media to a minimum depth of 10 feet. A demister or entrainment separator is provided at the scrubber discharge to remove water droplets.

A scrubber recirculation pump is installed to recirculate scrubbing liquid and makeup water from the recirculation sump to the scrubber's distribution header with enough pressure to ensure that the solution is distributed over the entire packing surface. The pump is rated for 105 gallons per minute at 55' TDH. The pump is driven by a 3 horsepower motor that operates off of 3 phase, 460 volt, 60 Hz power.

The NaOCl feed system is comprised of a storage tank and two metering pumps. The storage tank has a capacity of 6,200 gallons and is also used to store hypochlorite for the chlorination system. The NaOCl feed system is serviced by two positive displacement diaphragm metering pumps. The pumps are suitable for pumping 15% NaOCl solution. Each pump is rated at 15 gallons per hour at 88 strokes per minute against a maximum back-pressure of 300 psig. Each pump is driven by a 1/6 horsepower motor that operates at 1,750 rpm off of single phase, 115/230 volt, 60 Hz power.

The sodium hydroxide feed system is comprised of a 550 gallon storage tank and two metering pumps. The storage tank is able to store 50% sodium hydroxide (NaOH) solution. Each NaOH feed pump is capable of pumping 50% NaOH solution at 5 gallons per hour at 88 strokes per minute against a maximum back pressure of 175 psi. Each pump is driven by a 1/6 horsepower motor that operates at 1,750 rpm off of single phase, 115/230 volt, 60 Hz power.

One centrifugal fan is provided to draw odorous air from the structures and processes previously mentioned and force it through the packed tower. The two speed fan is capable of moving 7,000 cfm of gas and air at 8 inches of maximum static pressure through the system. The fan is driven by a two speed 15 horsepower motor that operates off of 3 phase, 460 volt, 60 Hz power. Low speed will move approximately 3,500 cfm of air.

2.1.4.12 Laboratory/Administration Building

The Laboratory/Administration Building is a single story brick building that houses the laboratory, public access area and staff offices. The building provides a controlled atmosphere for laboratory testing purposes. Staff locker rooms provide areas for the staff of three people to change into work clothes and clean up at the end of the work day.

2.1.4.13 Blower/Sludge Dewatering Building (Operations Building)

The Blower/Dewatering Building is a two story brick and block structure that provides separate areas for sludge dewatering, chemical system storage/feed and control and SBR system control valves, aeration blowers and control panels.

The first floor contains the odor control system and chemical feed systems. In the same area are disinfection system storage and feed systems, a permanganate system for odor control and a water softener system.

The second floor contains a blower room, SBR control panel room and a belt filter press for sludge dewatering.

2.1.4.14 Control Building

The control building is a repurposed 1954 two level building. This multipurpose building contains the following unit processes:

- Raw sewage wetwell
- Raw sewage pumping system
- Primary sludge pumping system
- Influent grit dewatering system
- Main Electrical control panels and SCADA control computer
- Maintenance storage and workroom

Existing Biological Process

2.2.1 Biological Process Evaluation

The existing SBR biological process was studied in depth in order to prepare a whole-plant simulator model (BioWin 4.0) that could be used for predicting effluent quality for various plant modifications and influent loading conditions. Main and sidestream wastewater flows and concentrations were estimated for total and soluble fractions of COD, nitrogen and phosphorus in order to input these parameters into the wastewater model. Key to this estimate was the level of soluble organic nitrogen in the influent that passes through the WWTF into the effluent. Levels tested in January 2012 measured 7 to 13 mg/L of this type of nitrogen.

Kinetic and stoichiometric parameters, including the fraction of unbiodegradable soluble nitrogen, were estimated based on available information. It is recommended that an intense testing and calibration process be performed during preliminary design in order to confirm the assumptions utilized in the BioWin model.

Evaluations were performed under four scenarios conditions – existing, five year, ten year and twenty year. Primary Clarifier removal rates for the future scenarios were 30% BOD, 100% TKN and 60% TSS.

Aeration evaluations were also performed in order to determine if the aeration system is adequate for the existing and future design capacity needs.

Finally, the model was then utilized to estimate effluent quality based on modifications to the biological process under various flow and loads, focusing on meeting the NPDES permit and future nitrogen limits.

3. FUTURE CONDITIONS

Future Permit Limits

Lonza Biologics is the only entity that has expressed interest in increasing its Industrial User Permit. The future conditions assume that Lonza will increase its allowable discharge from 0.271 mgd to 0.425 mgd within a 10 – year time frame.

Water quality concerns in the Great Bay Watershed have driven new NPDES permit limits for nitrogen for those WWTF within the watershed. Limits as low as 3 mg/L total nitrogen are included in the permits for Dover, Newmarket and Exeter. Potential limits range from 3 mg/L to 8 mg/L N are being discussed for other facilities.

US EPA Washington has been discussing a national change in policy, indicating that future NPDES permits may include standard requirements for nitrogen and phosphorus limits. EPA is suggesting nutrient removal be added to the definition of secondary treatment and limits be set in the range of 1 mg/L total phosphorus and 8 mg/L total nitrogen as a starting point and could go lower.

Projected Wastewater Flows and Loadings

3.2.1 Major Influent Streams

Historical wastewater flows and loads were compiled with available data provided by the City including:

- Pease WWTF operating records 2010-2012
- Industrial User Permits
- Redhook and Lonza wastewater records 2010-2012

Sewer contributions were divided into four major categories based on the type of wastewater discharge and included the following:

- Commercial/Light Industrial
- Heavy Industrial
    - Lonza
    - Redhook
    - Other Permitted Industrial Users
- Septage
- Infiltration and Inflow

There two major influent streams to the Pease WWTF are Lonza Biologics and Redhook Brewery. Combined, the two industries make up 60% and 50% of flow and load to the treatment facility each day. The remaining flow is made up of minor industrial users, septage, and commercial users in the Pease International Tradeport. Inflow and Infiltration can make up to over 50% of the flow at peak flow wet weather events.

3.2.2 Influent Flow and Loads

The WWTF 2010 through 2012 operating data was the basis for current conditions and scenario 1 flows. Scenario 2 flows includes an increase of flow from Lonza to 0.239 mgd, within their current permit. This 20,000 gpd flow increase is based on a unique product line from Lonza. The impacts of this product line were assessed by an onsite pilot performed by Blueleaf, Inc. Scenario 3 assumes Redhook will fully meet its 0.160 mgd permit, and Lonza increases their permit to 0.425 mgd. Scenario 4 is the 20 year buildout and assumes both Redhook and Lonza will achieve full buildout to 0.800 mgd, and the Pease Tradeport will also achieve full buildout. Wastewater flows for buildout of the Tradeport were based on the water demand estimates.

Average daily flow rates for scenarios 1 through 3 were taken directly from City provided data. Maximum day flow rates were taken from available data were possible. Maximum day flow rates for Scenario 4 and peak hour flow rates for Scenarios 1 through 4 were based on a peaking factor from the Merrimack Curve.

Table 3.1 – Project Wastewater Flows

Flow (MGD)	Scenario				Design (1997)
	1	2	3	4	
	Existing	5 Year Projection	10 Year Projection	2033 Buildout of Pease	
Average Day (Max Month)	0.5904	0.6104	0.8891	**1.3518**	1.20
Maximum Day	1.8030	1.8291	2.0683	2.3558	3.345
Peak Hour	2.4502	2.5026	3.3786	**4.8394**	4.00

Note: Values **bold** exceed design criteria

The flow scenarios are shown in Figure 4 on the following page.

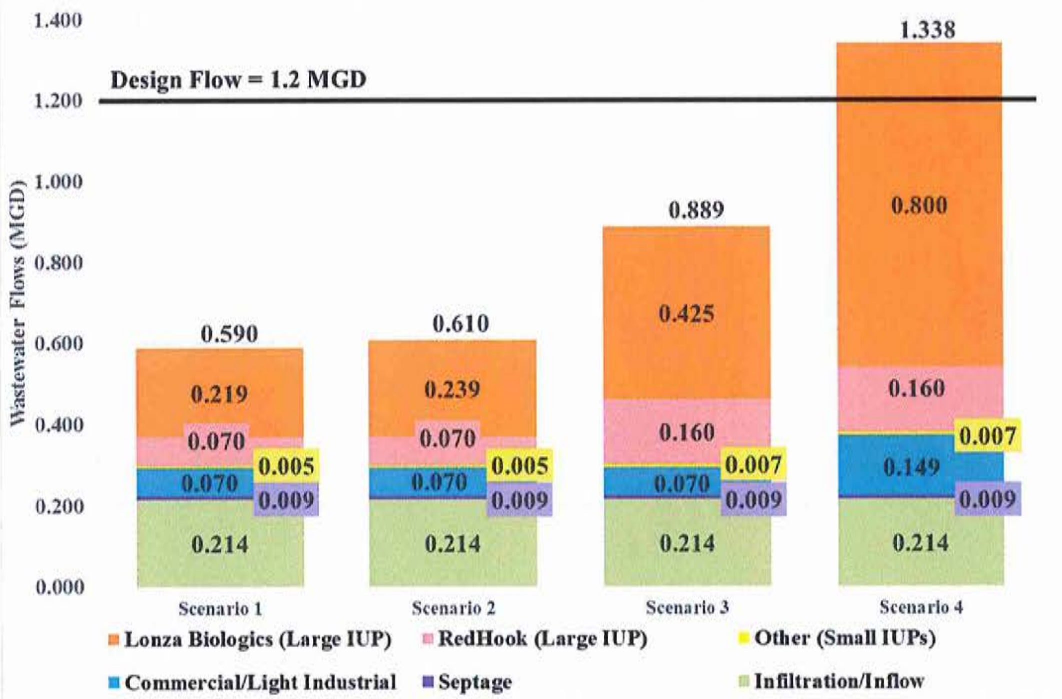
3.2.3 WWTF Evaluation

Based on flow and load projections, a comprehensive evaluation of the WWTF was conducted including preparation and review of a mass balance, unit process evaluation, and treatment system modeling.

3.2.3.1 Mass Balance

A mass balance of the treatment facility was calculated for all four Scenarios. The mass balance was used to evaluate the plant's ability to handle different loading scenarios. The mass balance is included in Appendix B.

Figure 4 – Projected Flow Scenarios



3.2.3.2 Unit Process Evaluation

The unit process evaluation identified hydraulic or load limiting unit processes. Each unit process was evaluated against the following criteria:

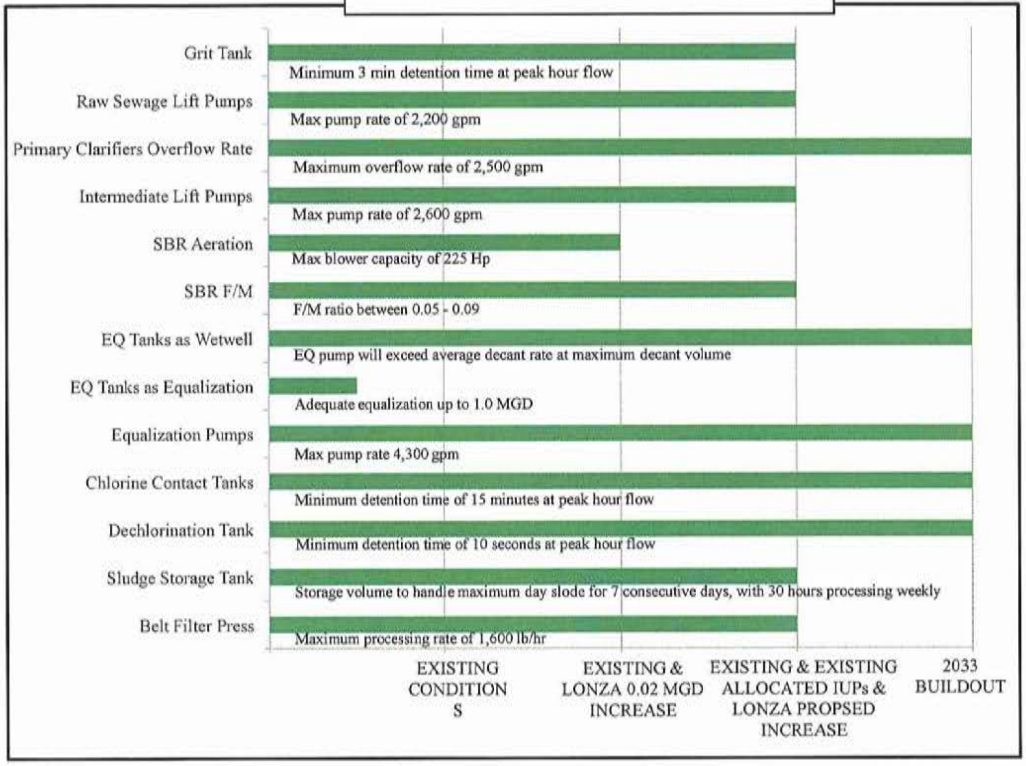
Table 3.2 - Unit Process Evaluation Criteria

Unit Process	*No. of Units*	*Average Day Flow*	*Max Day Flow*	*Peak Hour Flow*	*Criteria*	*Value*
Grit Tank	1			X	Minimum Detention Time	3 minutes
Raw Sewage Lift Pumps (2 duty, 1 standby)	3			X	Pump Rate	2,200 gpm
Primary Clarifiers	2			X	Overflow Rate	Avg 1,000 gpd/sf
Intermediate Lift Pumps (2 duty, 1 standby)	2			X	Pump Rate	2,600 gpm
SBR F/M	2	X			F/M Ratio	Max 0.09
SBR Aeration	3		X		HP	225
Equalization Tanks as Wetwells	2		X		Tank Volume	122,4000 gals
Equalization Tanks as Equalization	2		X		Tank Volume	122,4000 gals
Equalization Pumps (2 pumps)	2		X	X	Pump Rate	4,300 gpm
Chlorine Contact Tanks	2			X*	Min Detention Time	15 minutes
Dechlorination Tank	1			X*	Min Detention Time	10 seconds
Sludge Storage Tank	1		X		Tank Volume	126,800 gals
Belt Filter Press	1		X		Capacity	1,600 lbs/hr

* Flow to CCT and dechlorination tank is dependent upon the EQ pumps discharge rate

Based on the criteria, UEI calculated each unit process capacity to handle flows and loads for the selected scenarios. The following figure shows limiting unit processes for each scenario based on the above design criteria:

Figure 5 – Unit Process Evaluation



In the WWTF's current state, it can only handle flows and loads projected up to the 5-year scenario. This scenario includes existing conditions and Lonza increasing their current flow by 200,000 gpd (this is within their current IUP). At the 10-year projection scenario, the ability of the SBR blowers to handle any max daily load is inadequate. This scenario includes existing conditions, allocated IUPs, and a Lonza proposed increase from 0.271 MGD to 0.425 MGD (Scenario 3).

Unit process deficiencies include the existing EQ tanks. The EQ tanks are adequate when operated as a wetwell. This was determined based on design data of the EQ pump capacity verses average decant rates calculated at peak decant volume. The City has the ability to control decant rate using a valve on the decant piping. Additional storage volume would be required to operate the tanks as true flow equalization.

Ability to meet varying levels of Nitrogen

An evaluation was performed to assess the capability of the SBR system to achieve low Total Nitrogen (TN) limits of 8, 5 or 3 mg/L.

Recalcitrant nitrogen is organic nitrogen in the soluble phase that passes through the WWTF without being effected by the treatment process. Batch tests performed on three separate occasions in January 2012 estimated this type of nitrogen to be in the 7 to 13 mg/L.

Due to the presence of this recalcitrant nitrogen, the WWTF cannot achieve nitrogen levels less than these levels of 7 to 13 mg/L.

A wastewater simulator (BioWin 4.0) was used to model the performance of the SBR system under the various flow and load scenarios. The results are presented in the summary table below.

Table 3.3 – Modeling Results for Various Flow and Load Scenarios

Scenario	1	2	3	4	
Parameter	**Existing**	**5 Year**	**10 Year**	**20 Year**	**Design**
Influent Flow, MGD	0.6	0.62	0.9	1.36	1.2
BOD_5	311	486	436	413	290
TSS	269	348	484	409	290
TKN	40	39	54	55	36
Effluent, mg/L					
BOD_5	4	6	7	12	30
TSS	15	18	24	45	30
TKN	10	10	11	9	5
NH3-N	0.1	0.2	0.4	0.8	1
NO3-N	7	2	5	8	-
Total N	17	12	16	17	-
Key Parameters					
MLSS, mg/L	1,300	2,200	3,250	4,200	4,000
Average Air, ICFM	2,000	2,800	3,700	5,000	3,060
% recalcitrant N	20 %	20 %	14 %	9 %	2 %
Temp °C Range	18-28	18-28	18-28	18-28	18-28

The SBR system can remove nitrogen to low levels up through the 10 year conditions if the recalcitrant nitrogen was within typical range of 2 % as shown in Table 3.4.

Table 3.4 – Modeling Results for Recalcitrant N @2%

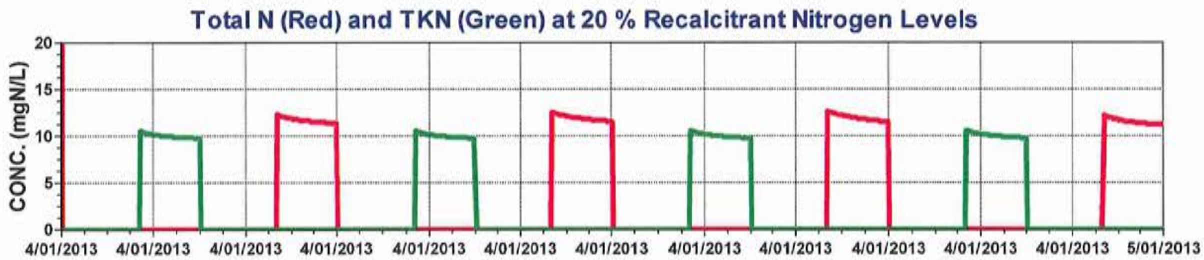
Scenario Parameter	1 Existing	2 5 Year	3 10 Year	4 20 Year	Design
Influent Flow, MGD	0.6	0.62	0.9	1.36	1.2
BOD_5	311	486	436	413	290
TSS	269	348	484	409	290
TKN	40	39	54	55	36
Effluent, mg/L					
BOD_5	5	6	7	12	30
TSS	15	18	24	46	30
TKN	3	3	4	5	5
NH3-N	0.2	0.2	0.5	0.8	1
NO3-N	0	3	8	9	-
Total N	14	6	11	15	-
Key Parameters					
MLSS, mg/L	1,000	2,350	3,300	4,300	4,000
Average Air, ICFM	2,100	2,800	3,800	5,300	3,060
% recalcitrant N	2 %	2 %	2 %	2 %	2 %
Temp °C	18	18	18	18	18

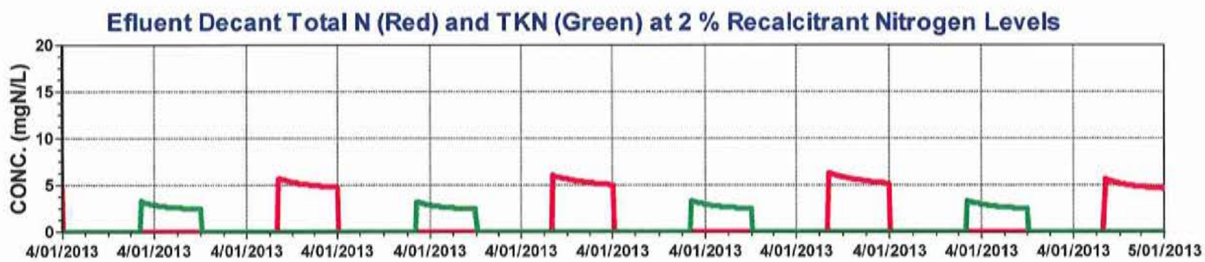
The aeration system should be replaced within the next ten years due to limitations in meeting the aeration demand. A third SBR is required to meet the 20 year capacity needs.

Figure 4 demonstrates the level of total nitrogen exiting the SBR from a recalcitrant nitrogen level of 20% and 2%.

At 20% recalcitrant nitrogen, as much as 8 mg/L of nitrogen passes through the facility under Scenario 2 and is not treated. At a 2% level of recalcitrant nitrogen, which is considered typical, total nitrogen of the effluent below 10 mg/L is predicted based on current modeling assumptions.

Figure 4 - Estimate of Effluent TN and TKN from Scenario 2 (5 Year)





4. CONDITION ASSESSMENT

Project List

Underwood Engineers prepared a condition assessment project list to utilize in a meeting with the City's staff to gather ideas for projects to be further evaluated at the WWTF. A data collection sheet organized by unit process/building was distributed to the staff and project team so that each individual had the opportunity to review the facility and offer suggestions for modifications/replacements or improvements to the WWTF.

Project List Ranking and Evaluation

The ideas that were developed during the condition assessment evaluation were tabulated for discussion in a project team meeting. The project list was utilized to determine which projects the City wanted to pursue and in what time frame. The ideas were then tabulated and listed in order of priority and time frame to be completed. The City also eliminated ideas that would be taken care of as part of normal maintenance at the WWTF. The ideas were then further evaluated and project costs were developed. A complete list of the ideas are provided in Appendix B.

Conceptual Opinion of Probable Construction Costs

Conceptual opinions of probable construction costs were developed for each of the ideas warranting further evaluation and are included in Appendix A. This was used to further define which projects the City would move forward with as discussed under Section 8 Recommended Improvements. Ideas that the City was not interested in pursuing at this time are shown as shaded and no further costs were developed.

5. ODOR CONTROL EVALUATION

An evaluation of the existing odor control system and future improvements was prepared and is provided as Appendix C. It is noted that the odor control improvement costs are included in the costs provided in Section 8.

Summary of Findings

The existing chemical scrubber odor control system serving the Pease WWTP is approximately 15 years old and is in need of significant rehabilitation. Further, the uncovered settling zone of the primary clarifiers was identified as a major odor source in a 2007 study by Bowker & Associates. Loadings of odorous compounds to the plant are high due to the contributions from a brewery and a manufacturer of pharmaceutical chemicals. Corrosion associated with presence of hydrogen sulfide is widespread at the plant.

Two options were evaluated: 1. Rehabilitation of the 7,000 cfm chemical scrubber, with construction of a 2,500 cfm biofilter, and 2. construction of a new 12,500 cfm central biofilter. The chemical scrubber will continue to have a high operating cost due to the chemical usage and high operation and maintenance requirements. However it may be possible to construct the biofilter in stages as odor sources are addressed and/or the chemical scrubber is replaced.

The high loadings of sulfide to the plant are due to industrial contributions that are causing odor and corrosion problems. The City should consider modifying industrial pretreatment requirements to include a limitation on sulfide. The high odor emissions measured in 2007 may require a more conservatively-designed and costly odor control system unless influent sulfide loadings can be controlled.

6. HVAC EVALUATION

The Heating and Ventilation (HVAC) report was prepared and is provided as Appendix D. It is noted that the HVAC costs are included in the costs provided in Section 8.

Summary of Findings

A complete upgrade to HVAC (heating, ventilation, air conditioning) and plumbing systems is recommended for the Laboratory & General Facilities Building and Operations & Maintenance Building, while partial upgrades to HVAC and plumbing systems are recommended for the other buildings. In many cases, the existing systems are in poor condition with several components and systems no longer in service. Recommended goals for replacement equipment, systems and materials is that they be simple, meet current code, provide safe work conditions, are energy efficient, durable, economical, and serviceable.

Ventilation systems need to meet code required exchange rates and should be configured to make it unlikely that their operation is abandoned over time – a common problem in these types of applications. Therefore we recommend that exhaust fans be outfitted with variable speed drives to allow for the operator to have some flexibility in the operation of the ventilation systems – more than simply on-off control.

The new Headworks Building should be classified as Class 1 Division 1, such that continuous ventilation is not required. The recommended ventilation system operates at 30 ACH for a purge cycle then either 12 ACH (high speed) or 3 ACH (low speed) when occupied and purge cycle is complete. The approach includes gas detection systems interlocked to ventilation systems.

If the existing headworks remains in use, the ventilation system should upgraded the same as described above for the new headworks building.

7. STRUCTURAL EVALUATION

The structural report was prepared and is provided as Appendix E. It is noted that the structural costs are included in the costs provided in Section 8.

Summary of Findings

The Laboratory/Administration building requires reconstruction of all the brick wall projections outside the exterior wall line of the building. The parapet wall metal flashing downslope terminations at the brick need sealant with back rod and the folded seams should be brazed shut to prevent opening of those seams. Brick at these same locations should be replaced or saw cut to provide a straight edge to form the sealant joint. Roof insulation and vapor barrier integrity inside the building must be restored to prevent heat and moisture loss into the attic space, or an alternative insulation method must be used for the building.

Masonry wall repairs are required at the control building grit room, intermediate pump station and walls between the sludge storage tanks. Roof membrane repairs are necessary at the intermediate pump station to prolong the life span of the membrane and prevent roof leakage that may damage the underlying structure.

Two new brick veneer control joints should be constructed at the blower building.

8. RECOMMENDED IMPROVEMENTS

.Recommended Improvements

Based on our review of the proposed planning projects with the City, a list of recommended projects was developed and placed into short term and long term planning categories. There were planning projects identified that the City determined would not be pursued or they would take care of as part of regular operation and maintenance. Those projects are not included here. The projects are described below.

8.1.1 Short-Term Planning Projects

Short-term planning projects are projects directly associated with immediate needs at the wastewater treatment facility within the next 5 year period. The recommended short-term planning projects are listed below. A work plan showing the short-term planning improvements is provided as Figure 5.

Preliminary Treatment

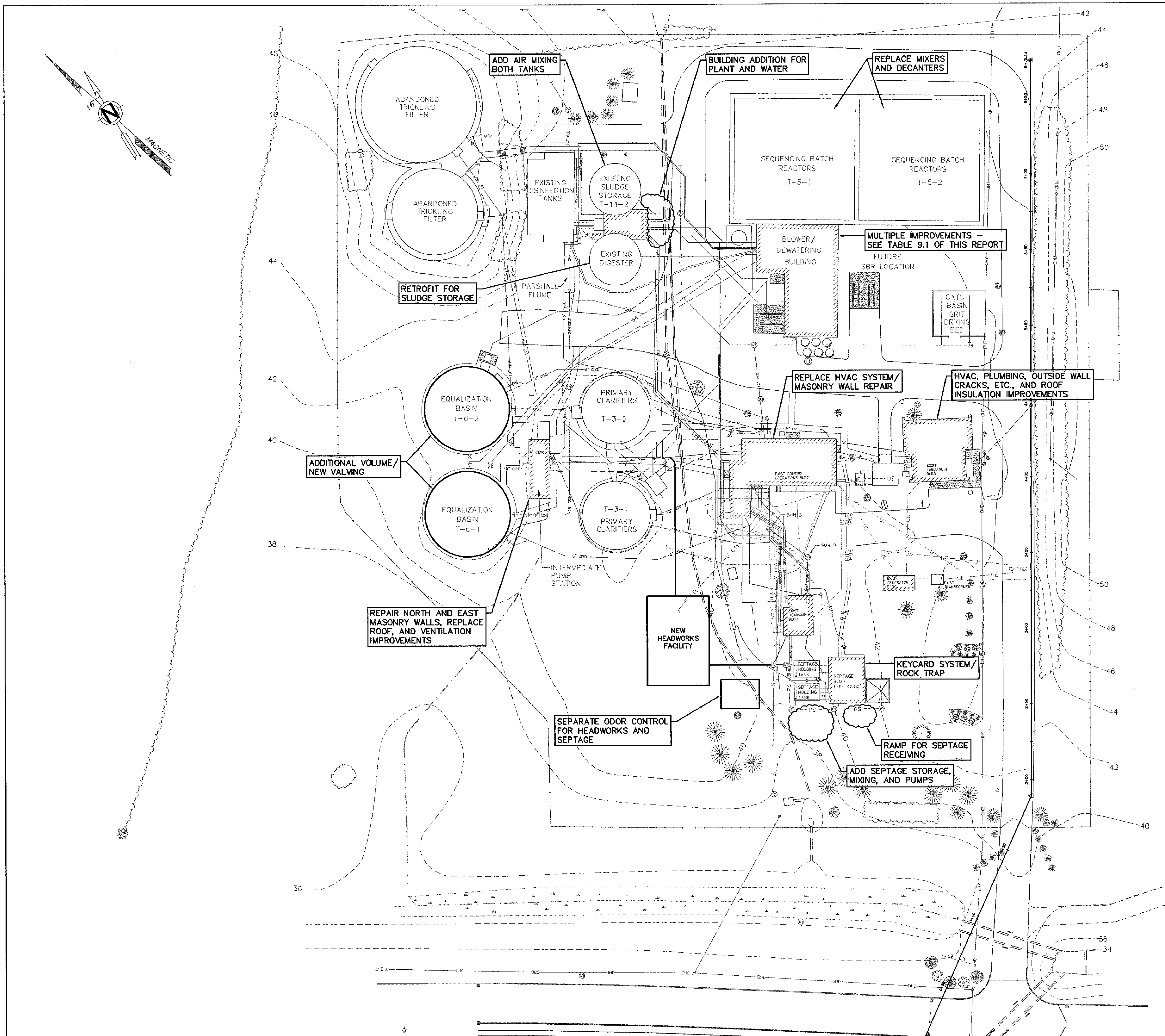
- New Headworks – Screen, Grit system, Raw sewage Pumps (Note: Odor Control discussed separately and not included here.)
- Key card for Septage Facility
- Add rock trap on Septage Acceptance Unit
- Additional septage storage or an additional septage pump
- Separate odor control for Septage from existing headworks building
- New ramp on side of septage building

Intermediate Pumping Station:

- Re-point exterior of north and east masonry walls. Apply sealer to outside surface of all masonry walls.
- Perform selective CMU block replacement at the southeast corner of the building, where block is cracked and spalling.
- Replace roof membrane, install tapered insulation and 2 drain scuppers on the north edge of the roof to move water drip line off of wall surface.
- Provide Heat Relief Ventilation (intake louver/damper assembly, ductwork, and exhaust fan w/ line voltage T-stat control)

SBR's/First Floor Process Building:

- Replace inoperable inline fan in chemical storage room
- Replace corroded ductwork with FRP ductwork



NOTE:

SEE TABLE 9.1 IN SECTION 9 OF THIS REPORT FOR MORE DETAIL. THIS DRAWING IS NOT INTENDED TO SHOW ALL SHORT TERM IMPROVEMENTS.

PLAN VIEW

30 0 30 60

SCALE: 1 INCH = 30 FT.

ISSUE FOR		
APPROVAL	Date	By
CONSTRUCTION	Date	By
RECORD DRAWING	Date	By

NO.	REVISIONS	APP'D

Drawn/Chk. RMG
Designed
Checked
Approved
Date 01/10/2014
Book No.
Project No. 1775
Dwg. ID 1775workplan
Scale AS SHOWN

UNDERWOOD engineers

25 Vaughan Mall, Portsmouth, N.H. 03801
Tel. 603-436-6192 Fax. 603-431-4733

FIGURE 5 – WORK PLAN SHORT TERM IMPROVEMENTS

PEASE WWTF

PEASE PORTSMOUTH, NH

DWG NO

SHEET OF

H:\Real Numbers\Portsmouth\1775 Pease Evaluation\Work Plans\1775 work plan.dwg, Layout1, 1/10/2014 3:33:39 PM, tjb

SBR's/Second Floor Process Building:

- Add VFD on #4 blower (better air control to SBRs)
- Complete Aeration Replacement (Blower, pipes)
- Replace original mixer and decanter (spare motors)
- Replace corroded ductwork with FRP ductwork
- Replace HVAC equipment in Dewatering Room with explosion proof unit heater in the space or roof-top Equipment
- Replace boiler with high efficiency condensing boiler and combustion & flue exhaust systems
- Improve ventilation in Blower Room to eliminate surface corrosion on SS pipes
- Insulate air piping to eliminate condensation and prevent additional surface corrosion
- Saw cut new control joints in the brick veneer at the south end of the east wall and the east end of the north wall, at locations of cracks. Replace brick if needed and place backer rod and sealant in new joints.
- Reset east door onto SBR tank walkway in sealant beneath metal sill.

Equalization:

- Construct additional equalization volume (build up walls or new tank)
- Add new valves and piping to isolate EQ tanks
- Replace check valve and discharge valves in Pit

Sludge Storage and Chlorine Analyzer Room:

- Retrofit second anaerobic digester to sludge storage
- Add air mixing to both sludge storage
- Building addition for plant water
- Replace corroded ductwork with FRP ductwork
- Update exhaust fan and damper control to be more "user friendly"

Sludge Dewatering and Disposal:

- Additional Sludge Storage

Odor Control:

- Repair existing odor control system
- Separate odor control for septage and headworks

Laboratory/Administration Building:

- Provide new thermal, vapor and air barrier at ceiling/roof level to eliminate air infiltration into the space and freezing of pipes in the winter months – consider eliminating "cold attic" by insulating at the underside of roof.
- Provide insulation on all piping located above and/or near the ceiling plane
- Replace HVAC equipment & plumbing

- Replace backflow preventer and associated piping
- Provide heat in mechanical room
- Repair leaks in lab from ceiling
- Remove and replace cracked brick veneer at walls outside of building wall envelope. Braze termination fold at bottom of wall flashing at roof edge to prevent snow/ice from opening fold. At low end of wall flashing to vertical brick joint, saw cut brick edge to straight line. Place backer rod and sealant between the brick edge and wall flashing termination fold to eliminate water entry behind brick.
- Replace and /or re-support soffit trim on east side of the building where it is dropping out.
- Adjust or add insulation at roof truss bottom chord level to eliminate holes and heat loss. Check insulation above exterior stud walls and adjust to reduce ice dams. Replace vapor barrier with new barrier with taped joints.
- At Lab/Admin building, add heater tape on roof overhangs above entry doors where ice dams have formed.

Operation and Maintenance:

- Develop Asset Management program
- Establish maintenance schedule
- Consider volumetric wasting
- Complete an Energy Study
- Perform Wastewater Characterization Testing

Facilities and Structures:

- Control building needs new doors and windows
- At north wall of newer addition to control building, saw cut cracked mortar joints and repoint.
- At control building, repoint chimney above roof.
- Repair east wall joint of north addition to original control building, removing mortar fill, placing backer rod and flexible sealant. Perform similar repair where the east end of the south wall of newer north addition joins the original building.
- At north masonry wall of sludge storage building between two round above ground tanks, repoint cracked and deteriorated mortar joints.
- HVAC and plumbing improvements if control building is repurposed

Other:

- New Generator to Meet NPDES Permit

8.1.2 Long Term Planning Projects.

Preliminary Treatment

- Convey septage directly to storage or dewatering

Primary Treatment:

- Replace centerwell, drive, flights, etc

Intermediate Pumping Station:

- Wet well configuration - inside building

SBR's/First Floor Process Building:

- Isolate hypo and bisulfite chemical systems
- Replace polymer system
- New pump to pump from SBR tank 1 to tank 2
- Coat floor due to chemical concerns
- Replace truckbay unit heater with larger capacity unit heater
- Provide truckbay exhaust fan and make-up air damper/louver in truckbay for background ventilation when overhead door is closed.
- Provide DX, mini-split A/C unit to serve Polymer Feed Room to eliminate clumping of powder

SBR's/Second Floor Process Building:

- Trolley with electric winch to lift items to 2nd floor
- Roof – New skirting, original roof
- Additional SBR for future flows

Equalization:

- Hard pipe hypo line to EQ or inject into SBR Effluent
- Replace splitter box with a manhole/demo
- Additional pumps – small jockey pump or pumps in 2nd tank

Disinfection:

- New chemical process areas
- Remove from chemical building and move closer to SBR's
- Move Hypo near ammonia tank
- Move bisulfite over by old building near drying beds

Primary and Waste Activated Sludge Pumping:

- New pump to pump from SBR tank 1 to tank 2

- New primary sludge pumps, piping and valves, include scum withdrawal

Sludge Storage and Chlorine Analyzer Room:

- Demo Chlorine analyzer room

Sludge Dewatering and Disposal:

- New dewatering system

Odor Control:

- New biofilter odor control system to replace existing systems

Facilities and Structures:

- Control building needs new doors and windows

9. PROJECT COSTS

The project costs for the Wastewater Treatment Facility projects are presented in Table 9.1 Engineers Probable Opinion of Conceptual Costs.

Table 9.1
Engineer's Opinion of Probable Project Costs
Recommended Projects

Location/Number	Project	Short-Term Planning Projects (Includes Engineering and Contingency)	Long-term Planning Projects (Includes Engineering and Contingency)
A. PRELIMINARY TREATMENT			
A-1	New Headworks Facility	$4,125,000	
A-3	Key Card for Septage Building	$109,000	
A-4	Add Rock Trap for Septage Building	$31,000	
A-5	Additional Septage Storage	$143,000	
A-6	New Ramp on side of septage building	$65,000	
A-7	Separate odor control for Septage	see J. Odor Control	
A-8	Piping mods to convey septage directly to sludge storage for dewatering		$34,000
	TOTAL A. PRELIMINARY TREATMENT	**$4,473,000**	**$34,000**
B. PRIMARY TREATMENT			
B-1	Replace centerwell, drive, flights, etc.		$459,000
B-2	New scum pit with valves and pumps		$50,000
B-8	cover entire tank for odor control		$263,000
	TOTAL B. PRIMARY TREATMENT	**$0**	**$772,000**
C. INTERMEDIATE PUMPING STATION			
C-4	Pump orientation makes maintenace difficult	NA	
C-6	Repoint exterior of north and east masonry walls	$43,900	
C-7	Perform selective CMU block replacement at the southeast corner	incl. in C-6	
C-8	Replace roof membrane	$26,300	
C-9	Provide Heat Relief Ventilation	$15,000	
	TOTAL C. INTERMEDIATE PUMPING STATION	**$85,200**	**$0**
D1. SBRS/BLOWER/SLUDGE DEWATERING BUILDING			
D1-1	Isolate hypo and bisulfite chemical systems		$128,000
D1-2	replace polymer system		$68,000
D1-5	new pump and piping to pump fm one SBR to the other		$115,000
D1-6	coat floor due to chemical concerns		$5,000
D1-7	replace truckbay unit heater with larger capacity heater		$4,900
D1-8	provide exhaust fan and makeup air damper/louver		$4,400
D1-9	provde DX, mini split A/C unit to serve Polymer feed room		$3,800
D1-11	replace inoperable inline fan in chemical storage room	$27,500	
D1-12	replace corroded ductwork with FRP ductwork	incl. in D-11	
D1-13	separate/isolate odor control equipment fm chemical storage		SEE D1-1
D1-14	remove odor control system from building - new system		SEE J-1

Table 9.1
Engineer's Opinion of Probable Project Costs
Recommended Projects

Location/Number	Project	Short-Term Planning Projects (Includes Engineering and Contingency)	Long-term Planning Projects (Includes Engineering and Contingency)
D1-15	modify suction to each SBR to provide uniform withdrawal of sludge during dewatering		$35,000
D1-16	Additional SBR to handle future flows		$4,553,000
D2-1	Trolley with electric winch to lift items to 2nd floor		$31,000
D2-2	VFD on #4 blower (better air control to SBRs?)	$44,000	
D2-3	New Aeration Blowers(Turbo) and Piping	$974,000	
D2-4	Replace Original Mixer and Decanter	$660,000	
D2-5	Replace corroded ductwork with FRP ductwork	incl. in D2-5	
D2-6	Replace HV equipment in De-watering Room with explosion proof unit heater in the space or roof-top Equipment	$114,000	
D2-7	Replace boiler with high efficiency condensing boiler (existing propane or natural gas available?) and combustion & flue exhaust systems	incl. in D2-5	
D2-8	Improve ventilation in Blower Room to eliminate surface corrosion on SS pipes	incl. in D2-5	
D2-9	Insulate air piping to eliminate condensation and prevent additional surface corrosion	$8,000	
D2-10	Roof – New skirting, original roof		$107,300
D2-11	Saw cut new control joints in the brick veneer at the south end of the east wall and the east end of the north wall, at locations of cracks. Replace brick if needed and place backer rod and sealant in new joints.	$13,000	
D2-12	Remove miscellaneous metal debris from roof to prevent membrane puncture.	CITY	
D2-13	Reset east door onto SBR tank walkway in sealant beneath metal sill.	$1,600	
	TOTAL D. SBRS/BLOWER-DEWATERING BUILDING	**$1,842,100**	**$5,055,400**
E. EQUALIZATION TANKS			
E-1A	Additional equalization volume (build up walls or new tank)	$263,000	
E-5	New valves and piping to isolate EQ tanks	$35,000	
E-6	Hard pipe hypo line to EQ or inject into SBR Effluent		$24,000
E-7	Replace splitter box with a manhole/demo?		$19,000
E-8	Replace check valve and discharge valves in Pit	$31,000	
E-9	Additional pumps small jockey pump or pumps in 2nd tank		$198,000
	TOTAL E. EQUALIZATION TANKS	**$329,000**	**$241,000**

Table 9.1
Engineer's Opinion of Probable Project Costs
Recommended Projects

Location/Number	Project	Short-Term Planning Projects (Includes Engineering and Contingency)	Long-term Planning Projects (Includes Engineering and Contingency)
F. DISINFECTION			
F- 1	New chemical process areas		NA - Move odor control
F - 2	Remove from chemical building and move closer to SBR's		NA - Move odor control
F - 3	Move Hypo near ammonia tank		NA - Move odor control
F - 4	Move bisulfite over by old building near drying beds		NA - Move odor control
F - 5	New UV system to replace chemical disinfection and ammonia addition. Include UV Pilot testing.		Piloting to confirm design
	TOTAL F. DISINFECTION	**$0**	**$0**
G. PRIMARY AND WASTE ACTIVATED SLUDGE SYSTEMS			
G-3	New primary sludge pumps, piping and valves, include scum withdrawal		$149,000
G-4	New dewatering equipment to replace BFP in future. May reduce odor control needs		SEE 1-3
	TOTAL G. PRIMARY AND WASTE ACTIVATED SLUDGE SYSTEMS	**$0**	**$149,000**
H. SLUDGE STORAGE AND CHLORINE ROOM			
H-1	Demo Chlorine analyzer room		$73,000
H-2	Retrofit second anaerobic digester to sludge storage	$224,000	
H-5	Building addition for plant water	$361,000	
H-6	Replace corroded ductwork with FRP ductwork	$11,800	
H-7	Update exhaust fan and damper control to be more "user friendly"	Incl. H-6	
	TOTAL H. SLUDGE STORAGE AND CHLORINE ROOM	**$596,800**	**$73,000**
I. SLUDGE DEWATERING AND DISPOSAL			
I-1	Additional Sludge Storage	SEE H-2	
I-3	New dewatering system		$1,926,000
	TOTAL I. SLUDGE DEWATERING AND DISPOSAL	**$0**	**$1,926,000**
J. ODOR CONTROL			
J - 2	Repair existing odor control system	$161,000	
J - 3	Exhaust fans at each location to centralized system		incl. in J-1
J - 4	Separate Odor control for Septage and Headworks	$835,000	
J - 5	Eliminate/Repurpose primary clarifiers		
	TOTAL J. ODOR CONTROL	**$996,000**	**$0**

Table 9.1
Engineer's Opinion of Probable Project Costs
Recommended Projects

Location/Number	Project	Short-Term Planning Projects (Includes Engineering and Contingency)	Long-term Planning Projects (Includes Engineering and Contingency)
K. LAB/ADMINSTRATION BUILDING			
K - 2	Provide new thermal, vapor and air barrier at ceiling/roof level to eliminate air infiltration into the space and freezing of pipes in the winter months - consider eliminating cold attic by insulating at the underside of roof.	$130,000	
K - 3	Provide insulation on all piping located above and/or near the ceiling plane.	incl. in K-2	
K-4	Replace HVAC equipment and plumbing.	incl. in K-3	
K-5	Replace backflow preventer and associated piping.	incl. in K-4	
K-6	Provide heat in mechanical room.	incl. in K-5	
K-7	Issue with leaks in lab from ceiling.	incl. in K-8	
K-8	Remove and rebuild ends of gable end walls; cut brick cleanly; repair metal wall flashing at lower ends; construct waterproof joints at lower ends of wall flashing to brick; repair soffit trim; remove existing ceiling insulation and vapor barrier; place new spray foam insulation at the underside of roof sheathing and in gable end walls above ceiling level.	$162,500	
K-9	Replace and/or re-support soffit trim on east side of the building where it is dropping out.	incl. in K-8	
K-10	Adjust or add insulation at roof truss bottom chord level to eliminate holes and heat loss. Check insulation above exterior stud walls and adjust to reduce ice dams. Replace vapor barrier with new barrier with taped joints.	incl. in K-9	
K-11	Repair cracks of Lab/Admin building	incl. in K-10	
K-12	Add heater tape on roof overhangs above entry doors where ice dams have formed.	$3,800	
	TOTAL K. LAB/ADMINISTRATION BUILDING	**$296,300**	**$0**

Table 9.1
Engineer's Opinion of Probable Project Costs
Recommended Projects

Location/Number	Project	Short-Term Planning Projects (Includes Engineering and Contingency)	Long-term Planning Projects (Includes Engineering and Contingency)
I. OPERATION AND MAINTENANCE			
1	Develop Asset Management Program	CITY	
2	Establish Maintenance Schedule	CITY	
3	Consider Volumetric Wasting	CITY	
4	Complete Energy Study	$20,000	
5	Wastewater Characterization	$30,000	
	TOTAL L. OPERATION AND MAINTENANCE	**$50,000**	**$0**
M. FACILITIES AND STRUCTURES			
M-1	Control Building needs new doors and windows	City	
M-2	At grit room north and east walls, clean masonry block, repoint, and apply paint or sealer. Repair both vertical construction joints at original building.	$14,600	
M-3	At control building, repoint chimney above roof	incl. in M-2	
M-4	Repair east wall joint north addition to original control building, removing mortar fill, placing backer rod and flexible sealant. Perform similar repair where the east end of the south wall of newer north addition joins the original building.	incl. in M-3	
M-5	Sludge storage building - clean masonry block, repoint and apply paint or sealer.	$17,900	
M-6	Replace HVAC system in Control Building	$130,000	
	TOTAL M. FACILITIES AND STRUCTURES	**$162,500**	
N. OTHER			
N-1	New Generator to meet NPDES Permit Requirements	$200,000	
	TOTAL N. OTHER	**$200,000**	
	TOTAL COSTS (ENR OCTOBER 2013)	**$9,030,900**	**$8,250,400**

APPENDIX A

CONDITION ASSESSMENT PROJECT LIST

Location/Number	Project	Short-Term Planning Projects (Includes Engineering and Contingency)	Long-term Planning Projects (Includes Engineering and Contingency)	Do Not Pursue
A. PRELIMINARY TREATMENT				
A-1	New Headworks Facility	$4,125,000		
A-2	Move primary sludge/scum pumps			X
A-3	Key Card for Septage Building	$109,000		
A-4	Add Rock Trap for Septage Building	$31,000		
A-5	Additional Septage Storage	$143,000		
A-6	New Ramp on side of septage building	$65,000		
A-7	Separate odor control for Septage	see J. Odor Control		
A-8	Piping mods to convey septage directly to sludge storage for dewatering		$34,000	
B. PRIMARY TREATMENT				
B-1	Replace centerwell, drive, flights, etc.		$459,000	
B-2	New scum pit with valves and pumps		$50,000	
B-3	groundwater leakage in tank 2		$0	
B-4	recoat tanks			X
B-5	New primary sludge pumps, piping and valves		$149,000	
B-6	third primary clarifier for future flow			X
B-7	flow equalization of primary effluent		$380,000	
B-8	cover entire tank for odor control		$263,000	
C. INTERMEDIATE PUMPING STATION				
C-1	Discharge piping issues	$9,800		
C-2	Power issues - loss of VFD's			X
C-3	Wet Well configuration - inside building		$71,200	
C-4	Pump orientation makes maintenace difficult			
C-5	Replace existing unit heaters throughout and provide heat relief/ventilation			X
C-6	Repoint exterior of north and east masonry walls	$43,900		
C-7	Perform selective CMU block replacement at the southeast corner	incl. in C-6		
C-8	Replace roof membrane	$26,300		
C-9	Provide Heat Relief Ventilation	$15,000		
C-10	Demo tankage behind pumping station		$45,000	
C-11	New Intermediate Pumping Station		$1,246,000	

Location/Number	Project	Short-Term Planning Projects (Includes Engineering and Contingency)	Long-term Planning Projects (Includes Engineering and Contingency)	Do Not Pursue
D1. SBRS/PROCESS BUILDING FIRST FLOOR				
D1-1	Isolate hypo and bisulfite chemical systems		$128,000	
D1-2	replace polymer system		$68,000	
D1-3	replace permanganate system			by City
D1-4	new influent isolation valves			by City
D1-5	new pump and piping to pump fm one SBR to the other		$115,000	
D1-6	coat floor due to chemical concerns		$5,000	
D1-7	replace truckbay unit heater with larger capacity heater		$4,900	
D1-8	provide exhaust fan and makeup air damper/louver		$4,400	
D1-9	provde DX, mini split A/C unit to serve Polymer feed room		$3,800	
D1-10	replace drinking fountain			X
D1-11	replace inoperable inline fan in chemical storage room	$27,500		
D1-12	replace corroded ductwork with FRP ductwork	incl. in D-11		
D1-13	separate/isolate odor control equipment fm chemical		SEE D1-1	
D1-14	remove odor control system from building - new system		SEE J-1	
D1-15	modify suction to each SBR to provide uniform withdrawal of sludge during dewatering		$35,000	
D1-16	Additional SBR to handle future flows		$4,553,000	
D2. SBRS/PROCESS BUILDING SECOND FLOOR				
D2-1	Trolley with electric winch to lift items to 2nd floor		$31,000	
D2-2	VFD on #4 blower (better air control to SBRs?)	$44,000		
D2-3	New Aeration Blowers(Turbo) and Piping	$974,000		
D2-4	Replace Original Mixer and Decanter	$660,000		
D2-5	Replace corroded ductwork with FRP ductwork	$0		
D2-6	Replace HV equipment in De-watering Room with explosion proof unit heater in the space or roof-top	incl. in D2-5		
D2-7	Replace boiler with high efficiency condensing boiler (existing propane or natural gas available?) and combustion & flue exhaust systems	incl. in D2-5		
D2-8	Improve ventilation in Blower Room to eliminate surface corrosion on SS pipes	incl. in D2-6		
D2-9	Insulate air piping to eliminate condensation and prevent additional surface corrosion	$8,000		
D2-10	Roof – New skirting, original roof		$107,300	

Location/Number	Project	Short-Term Planning Projects (Includes Engineering and Contingency)	Long-term Planning Projects (Includes Engineering and Contingency)	Do Not Pursue
D2-11	Saw cut new control joints in the brick veneer at the south end of the east wall and the east end of the north wall, at locations of cracks. Replace brick if needed and place backer rod and sealant in new joints.	$13,000		
D2-12	Remove miscellaneous metal debris from roof to prevent membrane puncture.	CITY		
D2-13	Reset east door onto SBR tank walkway in sealant beneath metal sill.	$1,600		
D2-14	New dewatering equipment to replace BFP in future. May reduce odor control needs		SEE I - 3	
D2-15	New WAS thickening system and TWAS storage adjacent to SBR building in front of Lab		SEE G -5	
D2-16A	Use storage tank for primary sludge storage and use inclined screw to dewater straight primary plus MLSS 24/7. Need WAS storage and WAS pumps.		SEE G - 5	
D2-16B	Also need new WAS sludge feed pumps to dewatering. 500 gpm pumps for volumetric wasting		SEE G - 5	
D2-16C	And 120 gpm WAS feed pumps to dewatering.		SEE I - 3	
E. EQUALIZATION TANKS				
E-1A	Additional equalization volume (build up walls or new tank	$263,000		
E-1B	Additional equalization volume - new tank	$705,000		
E-2	Coat inside of EQ tank			X
E-3	Cover tanks – eliminate algae		$383,000	
E-4	Mixer/aeration in EQ		$963,000	
E-5	New valves and piping to isolate EQ tanks	$35,000		
E-6	Hard pipe hypo line to EQ or inject into SBR Effluent		$24,000	
E-7	Replace splitter box with a manhole/demo?		$19,000	
E-8	Replace check valve and discharge valves in Pit –original?	$31,000		
E-9	Additional pumps – small jockey pump or pumps in 2nd tank		$198,000	

Location/Number	Project	Short-Term Planning Projects (Includes Engineering and Contingency)	Long-term Planning Projects (Includes Engineering and Contingency)	Do Not Pursue
F. DISINFECTION				
1	New chemical process areas		NA - Move odor control	
2	Remove from chemical building and move closer to SBR's		NA - Move odor control	
3	Move Hypo near ammonia tank		NA - Move odor control	
4	Move bisulfite over by old building near drying beds		NA - Move odor control	
5	New UV system to replace chemical disinfection and ammonia addition. Include UV Pilot testing.		Piloting to confirm design	
G. PRIMARY AND WASTE ACTIVATED SLUDGE SYSTEMS				
G-1	New pump and piping to pump from one SBR to the other to drain tank for maintenance (See D.5)	$115,000		
G-2	Keep Primary Sludge pumps where they, are if raw sewage pumps move		NA	
G-3	New primary sludge pumps, piping and valves, include scum withdrawal		$149,000	
G-4	New dewatering equipment to replace BFP in future. May reduce odor control needs		SEE 1-3	
G-5	New WAS thickening system and TWAS storage adjacent to SBR building in front of Lab		SEE I-4	
G-6	Use storage tank for primary sludge storage and use inclined screw to dewater straight primary plus MLSS 24/7. Need WAS storage and WAS pumps.		SEE I-4	
G-7	500 gpm pumps for volumetric wasting		SEE I-3 & I-4	
G-8	And 120 gpm WAS feed pumps to dewatering.		SEE I-3	
H. SLUDGE STORAGE AND CHLORINE ROOM				
H-1	Demo Chlorine analyzer room		$73,000	
H-2	Retro 2nd anaerobic digester to sludge storage	$224,000		
H-3	Add air mixing to both sludge storage tanks	$1,365,000		
H-4	Plant water, penn valley pumps, sludge grinder. No room to work on equipment, relocate something.		NA	
H-5	Building addition for plant water	$361,000		
H-6	Replace corroded ductwork with FRP ductwork	$11,750		
H-7	Update exhaust fan and damper control to be more "user friendly"	Incl. H-6		
H-8	See previous ideas on sludge handling			
I. SLUDGE DEWATERING AND DISPOSAL				

Location/Number	Project	Short-Term Planning Projects (Includes Engineering and Contingency)	Long-term Planning Projects (Includes Engineering and Contingency)	Do Not Pursue
I-1	Additional Sludge Storage	SEE H-2		
I-2	Cover BFP – reduce volume for odor control			X
I-3	New dewatering system		$1,926,000	
I-4	New waste activated sludge thickening system (includes new building) and storage		$3,151,000	
J. ODOR CONTROL				
1	New biofilter odor control system to replace existing systems		$2,260,000	
2	Repair existing odor control system	$161,000		
3	Exhaust fans at each location to centralized system		incl. in J-1	
4	Separate Odor control for Septage and Headworks	$835,000		
5	Eliminate/Repurpose primary clarifiers			
K. LAB/ADMINSTRATION BUILDING				
1	Update lab equipment			X
2	Provide new thermal, vapor and air barrier at ceiling/roof level to eliminate air infiltration into the space and freezing of pipes in the winter months - consider eliminating cold attic by insulating at the underside of roof.	$130,000		
3	Provide insulation on all piping located above and/or near the ceiling plane.	incl. in K-2		
4	Replace HVAC equipment and plumbing.	incl. in K-3		
5	Replace backflow preventer and associated piping.	incl. in K-4		
6	Provide heat in mechanical room.	incl. in K-5		
7	Issue with leaks in lab from ceiling.	incl. in K-8		
8	Remove and replace cracked brick veneer at walls outside of building wall envelope. Braze termination fold at bottom of wall flashing at roof edge to prevent snow/ice from opening fold. At low end of wall flashing to vertical brick joint, saw cut brick edge to straight line. Place backer rod and sealant between the brick edge and wall flashing termination fold to eliminate water entry behind brick.	$162,500		
9	Replace and/or re-support soffit trim on east side of the building where it is dropping out.	incl. in K-8		
10	Adjust or add insulation at roof truss bottom chord level to eliminate holes and heat loss. Check insulation above exterior stud walls and adjust to reduce ice dams. Replace vapor barrier with new barrier with taped joints.	incl. in K-9		

Location/Number	Project	Short-Term Planning Projects (Includes Engineering and Contingency)	Long-term Planning Projects (Includes Engineering and Contingency)	Do Not Pursue
11	Repair cracks of Lab/Admin building	incl. in K-10		
12	Add heater tape on roof overhangs above entry doors where ice dams have formed.	$3,800		
I. OPERATION AND MAINTENANCE				
1	Develop Asset Management Program	CITY		
2	Establish Maintenance Schedule	CITY		
3	Consider Volumetric Wasting	CITY		
4	Complete Energy Study	$20,000		
5	Wastewater Characterization	$30,000		
M. FACILITIES AND STRUCTURES				
M-1	Control Building needs new doors and windows	City		
M-2	At north wall of newer addition to control building, saw cut cracked morter joints and repoint	$14,600		
M-3	At control building, repoint chimney above roof	incl. in M-2		
M-4	Repair east wall joint north addition to original control building, removing mortar fill, placing backer rod and flexible sealant. Perform similar repair where the east end of the south wall of newer north addition joins the original	incl. in M-3		
M-5	At north masonry wall between two round above ground tanks, repoint cracked and deteriorated mortar joints.	$17,900		
M-6	Replace HVAC system in Control Building	$130,000		
M-7	Heat recovery from effluent to heat/cool buildings		Should be evaluated during energy audit	
M-8	Solar energy alternatives - hot water heating		Dependent on location to be utilized.	
M-9	LEED design			X
N. OTHER				
N-1	New Generator to meet NPDES Permit Requirements			

Note: Total cost for Short and Long-Term project ideas shown will be dependent upon which projects are selected to be constructed, in which combination and construction year. Costs provided are in 2013 dollars. All costs should be escalated to the midpoint of construction when those dates are identified.

Table 9.1
Engineer's Opinion of Probable Project Costs
Recommended Projects

Location/Number	Project	Short-Term Planning Projects (Includes Engineering and Contingency)	Long-term Planning Projects (Includes Engineering and Contingency)
A. PRELIMINARY TREATMENT			
A-1	New Headworks Facility	$4,125,000	
A-3	Key Card for Septage Building	$109,000	
A-4	Add Rock Trap for Septage Building	$31,000	
A-5	Additional Septage Storage	$143,000	
A-6	New Ramp on side of septage building	$65,000	
A-7	Separate odor control for Septage	see J. Odor Control	
A-8	Piping mods to convey septage directly to sludge storage for dewatering		$34,000
	TOTAL A. PRELIMINARY TREATMENT	**$4,473,000**	**$34,000**
B. PRIMARY TREATMENT			
B-1	Replace centerwell, drive, flights, etc.		$459,000
B-2	New scum pit with valves and pumps		$50,000
B-8	cover entire tank for odor control		$263,000
	TOTAL B. PRIMARY TREATMENT	**$0**	**$772,000**
C. INTERMEDIATE PUMPING STATION			
C-4	Pump orientation makes maintenace difficult	NA	
C-6	Repoint exterior of north and east masonry walls	$43,900	
C-7	Perform selective CMU block replacement at the southeast corner	incl. in C-6	
C-8	Replace roof membrane	$26,300	
C-9	Provide Heat Relief Ventilation	$15,000	
	TOTAL C. INTERMEDIATE PUMPING STATION	**$85,200**	**$0**
D1. SBRS/BLOWER/SLUDGE DEWATERING BUILDING			
D1-1	Isolate hypo and bisulfite chemical systems		$128,000
D1-2	replace polymer system		$68,000
D1-5	new pump and piping to pump fm one SBR to the other		$115,000
D1-6	coat floor due to chemical concerns		$5,000
D1-7	replace truckbay unit heater with larger capacity heater		$4,900
D1-8	provide exhaust fan and makeup air damper/louver		$4,400
D1-9	provde DX, mini split A/C unit to serve Polymer feed room		$3,800
D1-11	replace inoperable inline fan in chemical storage room	$27,500	
D1-12	replace corroded ductwork with FRP ductwork	incl. in D-11	
D1-13	separate/isolate odor control equipment fm chemical storage		SEE D1-1
D1-14	remove odor control system from building - new system		SEE J-1

APPENDIX B

MASS BALANCE

Mass Balance: AVERAGE and MAX DAY FLOW & LOAD

Calc. by: JVF
Reviewed by: wsc

File name: "1775. Mass Balance"
Latest Revision: 10/15/2013

	Existing 2010-2012		Scenario 2 5-year Buildout		Scenario 3 10-year Buildout		2033 PDA Buildout		DESIGN*	
	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX
TOTAL INFLUENT FLOW, MGD	**0.5904**	**1.8030**	0.6104	1.8291	0.8891	2.0683	**1.3384**	2.3369	1.2000	3.345
Commercial/Light Industrial	0.0744	0.3187	0.0744	0.3187	0.0744	0.3187	0.1487	0.3123		
Heavy Industrial	0.2936	0.4475	0.3136	0.4736	0.5923	0.7128	0.9673	0.9878		
RedHook (Large IUP)	**0.0699**	**0.1543**	**0.0699**	**0.1543**	**0.1600**	**0.1800**	**0.1600**	**0.1800**		
Lonza Biologics (Large IUP)	**0.2191**	**0.2854**	**0.2391**	**0.3115**	**0.4250**	**0.5250**	**0.8000**	**0.8000**		
Other (Small IUPs)	**0.0046**	**0.0078**	**0.0046**	**0.0078**	**0.0073**	**0.0078**	**0.0073**	**0.0078**		
Septage	**0.0089**	**0.0365**	**0.0089**	**0.0365**	**0.0089**	**0.0365**	**0.0089**	**0.0365**		
Infiltration/Inflow	**0.2135**	**1.0003**	**0.2135**	**1.0003**	**0.2135**	**1.0003**	**0.2135**	**1.0003**		
Max Day PF (Merrimack Curve)		From Data		From Data		From Data	2.10	2.10		
ORGANIC LOAD, BOD5										
AVERAGE DAILY BOD5, mg/l	311	384	486	332	436	353	413	459	290	546
Commercial/Light Industrial	**300**	140	**300**	140	**300**	140	**300**	286		
Heavy Industrial	353	916	690	689	520	630	465	755		
RedHook (Large IUP)	**322**	1,166	322	1,200	900	800	900	800		
Lonza Biologics (Large IUP)	**364**	798	805	462	380	577	**380**	**750**		
Other (Small IUPs)	**300**	**300**	**300**	**300**	**300**	**300**	**300**	**300**		
Septage	**6,500**	**6,500**	**6,500**	**6,500**	**6,500**	**6,500**	**6,500**	**6,500**		
AVERAGE DAILY BOD5, lb/day	1,531	5,771	2,472	5,071	3,235	6,097	4,607	8,946	2,907	5467
Commercial/Light Industrial	186	**372**	186	372	186	**372**	372	**744**		
Heavy Industrial	864	3,420	1,805	2,720	2,568	3,746	3,754	6,224		
RedHook (Large IUP)	188	**1,500**	**188**	**1,500**	**1,200**	**1,200**	**1,200**	**1,200**		
Lonza Biologics (Large IUP)	665	**1,900**	**1,605**	**1,200**	**1,350**	**2,526**	2,535	5,004		
Other (Small IUPs)	12	20	12	20	18	20	18	20		
Septage	481	1,979	481	1,979	481	1,979	481	1,979		
TOTAL NITROGEN - N										
TOTAL NITROGEN - N, mg/l	40	47	39	46	54	54	55	60	36	30
Commercial/Light Industrial	**30**	14	**30**	14	**30**	14	**30**	29		
Heavy Industrial	52	123	49	116	67	115	65	108		
RedHook (Large IUP)	**84**	**190**	**84**	**190**	**84**	**190**	**84**	**190**		
Lonza Biologics (Large IUP)	**43**	**90**	40	82	62	91	**62**	**90**		
Other (Small IUPs)	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**		

	Existing 2010-2012		Scenario 2 5-year Buildout		Scenario 3 10-year Buildout		2033 PDA Buildout		DESIGN*	
	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX
Septage	**700**	**700**	**700**	**700**	**700**	**700**	**700**	**700**		
TOTAL NITROGEN - N, lb/day	198	709	198	709	402	936	615	1,173	364	829
Commercial/Light Industrial	19	**37**	19	37	19	**37**	37	**74**		
Heavy Industrial	128	459	128	459	332	685	526	886		
RedHook (Large IUP)	49	245	49	245	112	285	112	285		
Lonza Biologics (Large IUP)	79	214	**79**	**214**	**220**	**400**	414	600		
Other (Small IUPs)	1	2	1	2	2	2	2	2		
Septage	52	213	52	213	52	213	52	213		
SOLIDS LOAD, TSS										
SOLIDS LOAD, TSS, mg/l	269	457	348	511	484	427	409	445	290	196
Commercial/Light Industrial	**225**	105	**225**	443	**225**	836	**225**	1,394		
Heavy Industrial	129	949	104	904	292	352	244	242		
RedHook (Large IUP)	**575**	**2,500**	**575**	**2,500**	**900**	**800**	**900**	**430**		
Lonza Biologics (Large IUP)	**55**	**130**	**36**	**130**	**120**	**200**	**120**	**200**		
Other (Small IUPs)	**225**	**225**	**225**	**225**	**225**	**225**	**225**	**225**		
Septage	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**	**10,000**		
SOLIDS LOAD, TSS, lb/day	1,324	6,865	1,773	7,791	3,591	7,358	4,570	8,669	2,907	5467
Commercial/Light Industrial	140	**279**	588	**1,177**	1,111	**2,223**	1,815	**3,630**		
Heavy Industrial	444	3,541	445	3,569	1,740	2,091	2,015	1,995		
RedHook (Large IUP)	335	3,217	335	3,217	1,201	1,201	1,201	646		
Lonza Biologics (Large IUP)	101	309	101	338	525	876	801	1,334		
Other (Small IUPs)	9	15	9	15	14	15	14	15		
Septage	740	3,044	740	3,044	740	3,044	740	3,044		
FSS, %	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**		
VSS, %	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**		
TOTAL INFLUENT LOAD										
BOD, lbs/day	1,531	5,771	2,472	5,071	3,235	6,097	4,607	8,946	2,907	5,467
TKN, lbs/day	198	709	198	709	402	936	615	1,173	364	829
TSS, lbs/day	1,324	6,865	1,773	7,791	3,591	7,358	4,570	8,669	2,907	5,467
FSS, lbs/day	265	1,373	355	1,558	718	1,472	914	1,734		
VSS, lbs/day	1,059	5,492	1,418	6,232	2,873	5,887	3,656	6,935		
BOD, mg/L	311	384	486	332	436	353	413	459	290	196
TKN, mg/L	40	47	39	46	54	54	55	60	36	30
TSS, mg/L	269	457	348	511	484	427	409	445	290	196
FSS, mg/L	54	91	70	102	97	85	82	89		
VSS, mg/L	215	365	279	409	387	341	328	356		

	Existing 2010-2012		Scenario 2 5-year Buildout		Scenario 3 10-year Buildout		2033 PDA Buildout		DESIGN*	
	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX
PRIMARY CLARIFIERS										
TOTAL RECIRCULATION LOAD, LBS/D										
BOD	79	373	115.79	374.01	194.63	385.35	259.09	498.20	80.00	144.00
TKN	25	118	37	119	62	122	82	158	0	0
TSS	153	738	221	760	385	768	508	975	156	282
FSS	27	146	37	166	77	156	97	184	0	0
VSS	126	592	184	594	309	612	411	791	0	0
FLOW, MGD	0.008	0.038	0.015	0.042	0.023	0.045	0.031	0.060	0.008	0.015
FLOW, gpd	8,495	38,120	14,729	41,701	23,057	44,811	31,235	60,498	8,083	14,574
PRIMARY INFLUENT LOAD W/RECIRCULATION, LBS/D										
BOD	1,611	6,143	2,588	5,445	3,430	6,482	4,866	9,444	3259	6121
TKN	223	827	235	828	464	1,058	697	1,331		
TSS	1,477	7,602	1,994	8,551	3,977	8,126	5,078	9,644	3615	6743
FSS	292	1,519	392	1,724	795	1,628	1,011	1,918		
VSS	1,185	6,083	1,602	6,826	3,182	6,498	4,067	7,726		
Flow, MGD	0.59889	1.841	0.625	1.871	0.912	2.113	1.370	2.397	1.226	3.391
TOTAL BOD, mg/L	322	400	496	349	451	368	426	472		
TKN, mg/L	45	54	45	53	61	60	61	67		
TSS, mg/L	296	495	382	548	523	461	445	482		
% PRIMARY REMOVALS										
BOD	**42**	**42**	**30**	**30**	**30**	**30**	**30**	**30**		
TKN	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**		
TSS	**69**	**69**	**60**	**60**	**60**	**60**	**60**	**60**		
FSS	**69**	**69**	**60**	**60**	**60**	**60**	**60**	**60**		
VSS	**69**	**69**	**60**	**60**	**60**	**60**	**60**	**60**		
PRIMARY EFFLUENT LOAD, LBS/D										
BOD	934	3,563	1,811	3,811	2,401	4,537	3,406	6,611	2629	4771
TKN	201	745	212	745	418	952	627	1,198		
TSS	458	2,357	798	3,420	1,591	3,250	2,031	3,857	1808	3372
FSS	91	471	157	690	318	651	404	767		
VSS	367	1,886	641	2,730	1,273	2,599	1,627	3,090		
Flow, MGD	0.596	1.825	0.621	1.855	0.905	2.098	1.360	2.379	1.211	3.381
PRIMARY EFFLUENT LOAD, mg/L										
BOD	188.026	234	349.521	246	318.238	259	300.285	333		
TKN	40.410	49	40.837	48	55.385	54	55.306	60		
TSS	92.137	155	153.901	221	210.839	186	179.083	194		
FSS	18	31	30	45	42	37	36	39		
VSS	74	124	124	177	169	149	143	156		

	Existing 2010-2012		Scenario 2 5-year Buildout		Scenario 3 10-year Buildout		2033 PDA Buildout		DESIGN*	
	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX
PRIMARY SLUDGE, LBS/D										
BOD	676	2,580	776	1,633	1,029	1,945	1,460	2,833	635	1350
TKN	22	83	24	83	46	106	70	133		
TSS	1,019	5,246	1,196	5,130	2,386	4,875	3,047	5,786	1808	3372
FSS	201	1,048	235	1,035	477	977	606	1,151		
VSS	817	4,198	961	4,096	1,909	3,899	2,440	4,636		
% TS	**3.80**	**3.80**	**3.80**	**3.80**	**3.80**	**3.80**	**3.80**	**3.80**		
GPD	3,215	16,552	3,775	16,188	7,529	15,384	9,614	18,258	5419	10107
ACTIVATED SLUDGE										
EFFLUENT CONCENTRATIONS										
BOD, mg/L	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**		
TKN, mg/L	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**		
TSS, mg/L	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**		
EFFLUENT LOAD, LBS/D										
BOD	98	301	102	305	148	345	223	390	250	697
TKN	98	301	102	305	148	345	223	390		
TSS	98	301	102	305	148	345	223	390	150	418
FSS	20	60	20	61	30	69	45	78		
VSS	79	241	81	244	119	276	179	312		
Flow, MGD	0.590	1.799	0.609	1.825	0.887	2.064	1.336	2.332	1.198	3.342
SLUDGE PRODUCTION										
FSS Removed, lbs/day	71	411	136	629	288	582	360	689		
BOD Removed, lbs/day	836	3,262	1,709	3,506	2,253	4,192	3,183	6,221		
LBS VSS/LBS BOD Removed	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**	**0.50**		
VSS Produced, lbs/day	418	1,631	855	1,753	1,126	2,096	1,591	3,111		
TKN Removed, lbs/day	102	444	110	440	270	607	404	808		
LBS VSS/LBS TKN Removed	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**	**0.20**		
VSS Produced, lbs/day	20	89	22	88	54	121	81	162		
TOTAL BIO. SLUDGE, lbs/day	509	2,131	1,013	2,470	1,468	2,800	2,032	3,962		
% TS	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**		
FLOW RATE, GPD	6,104	25,548	12,146	29,614	17,608	33,569	24,362	47,500		
% BOD in Waste	**63**	**63**	**63**	**63**	**63**	**63**	**63**	**63**		
BOD in Waste, lbs/day	321	1,342	638	1,556	925	1,764	1,280	2,496		
% TKN in Waste	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**		
TKN in Waste, lbs/day	102	426	203	494	294	560	406	792		

	Existing 2010-2012		Scenario 2 5-year Buildout		Scenario 3 10-year Buildout		2033 PDA Buildout		DESIGN*	
	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX
<u>SLUDGE STORAGE</u>										
PRIMARY SLUDGE LOAD, LBS/D										
BOD	676	2,580	776	1,633	1,029	1,945	1,460	2,833	635	1350
TKN	22	83	24	83	46	106	70	133	1808	3372
TSS	1,019	5,246	1,196	5,130	2,386	4,875	3,047	5,786		
FSS	201	1,048	235	1,035	477	977	606	1,151		
VSS	817	4,198	961	4,096	1,909	3,899	2,440	4,636		
Flow, MGD	0.003	0.017	0.004	0.016	0.008	0.015	0.010	0.018		
Flow,gpd	3,215	16,552	3,775	16,188	7,529	15,384	9,614	18,258	5419	10107
WAS, LBS/D										
BOD	321	1,342	638	1,556	925	1,764	1,280	2,496	11178	2053
TKN	102	426	203	494	294	560	406	792		
TSS	509	2,131	1,013	2,470	1,468	2,800	2,032	3,962	1870	3259
FSS	71	411	136	629	288	582	360	689		
VSS	438	1,720	877	1,841	1,180	2,218	1,672	3,272		
Flow, MGD	0.006	0.026	0.012	0.030	0.018	0.034	0.024	0.048		
Flow,gpd	6,104	25,548	12,146	29,614	17,608	33,569	24,362	47,500	22422	39076
MIXED LOAD, LBS/D										
BOD	997	3,923	1,414	3,189	1,954	3,708	2,740	5,329	1541	2893
TKN	124	509	226	577	340	666	476	925		
TSS	1,528	7,376	2,209	7,600	3,855	7,675	5,079	9,748	3126	5636
FSS	272	1,459	371	1,663	765	1,559	966	1,840		
VSS	1,256	5,918	1,838	5,937	3,089	6,117	4,113	7,908		
Flow, MGD	0.009	0.042	0.016	0.046	0.025	0.049	0.034	0.066		
Flow,gpd	9,319	42,100	15,921	45,802	25,137	48,953	33,976	65,758	9864	17784
<u>BELT FILTER PRESS</u>										
FEED SOLIDS, LBS/D										
TSS	1,528	7,376	2,209	7,600	3,855	7,675	5,079	9,748		
FSS	272	1,459	371	1,663	765	1,559	966	1,840		
Flow, GPD	9,319	42,100	15,921	45,802	25,137	48,953	33,976	65,758		
% CAPTURE	**90**	**90**	**90**	**90**	**90**	**90**	**90**	**90**		
DEWATERED SLUDGE, LBS/D										
TSS	1,375	6,639	1,988	6,840	3,469	6,908	4,571	8,773		
% TS	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**		
Flow, GPD	824	3,980	1,192	4,101	2,080	4,141	2,740	5,260		
Dry Tons per Week	4.8	23.2	7.0	23.9	12.1	24.2	16.0	30.7	10.4	18.7
Wet Tons per Week	24.1	116.2	34.8	119.7	60.7	120.9	80.0	153.5		
Total Volume, CY/d	4	20	6	20	10	20	14	26	8.81	15.89
RECIRCULATION LOAD, LBS/D										
% BOD OF VSS	**63**	**63**	**63**	**63**	**63**	**63**	**63**	**63**		

	Existing 2010-2012		Scenario 2 5-year Buildout		Scenario 3 10-year Buildout		2033 PDA Buildout		DESIGN*	
	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX	AVG	MAX
BOD	79	373	116	374	195	385	259	498	80	144
% TKN OF VSS	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**		
TKN	25	118	37	119	62	122	82	158		
TSS	153	738	221	760	385	768	508	975	156	282
FSS	27	146	37	166	77	156	97	184		
VSS	126	592	184	594	309	612	411	791		
Flow, GPD	8,495	38,120	14,729	41,701	23,057	44,811	31,235	60,498	8083	14574
RECIRCULATION FLOW, MGD	0.008	0.038	0.015	0.042	0.023	0.045	0.031	0.060		

*DESIGN INCLUDED GRAVITY THICKENER RECIRCLUATION FLOW NOT INCLUDED IN THIS MASS BALANCE

Fine Bubble Aeration
Pease SBRs
Taken from File name: "fine bubble aeration -- master.xls"
Latest Revision:
04-Nov-13
07:32 AM

Calc. by: wsc
Reviewed by: ____________

	Condition			Condition		
	1	2	3	4	2a	4a
Flow, Q, MGD	**0.596**	**0.621**	**0.905**	**1.360**	**1.242**	**2.720**
Temperature, T, oC	**18**	**18**	**18**	**18**	**18**	**18**
Temperature, T, Kelvin	291.15	291.15	291.15	291.15	291.15	291.15
Oxygen Requirements						
BOD, lb O2/lb BOD5	1.00	1.00	1.00	1.00	1.00	1.00
TKN, lb O2/lb TKN	4.57	4.57	4.57	4.57	4.57	4.57
Oxygen Transfer Coefficients						
Beta	0.95	0.95	0.95	0.95	0.95	0.95
C*(s)(T), mg/L	9.45	9.45	9.45	9.45	9.45	9.45
C*(s)(20), mg/L	9.09	9.09	9.09	9.09	9.09	9.09
tau, unitless	1.040	1.040	1.040	1.040	1.040	1.040
C(L), mg/L	2.0	2.0	2.0	2.0	2.0	2.0
P(b), PSI	14.7	14.7	14.7	14.7	14.7	14.7
P(s), PSI	14.7	14.7	14.7	14.7	14.7	14.7
Omega, unitless	1	1	1	1	1	1
P(vt), PSI	0.2968	0.2968	0.2968	0.2968	0.2968	0.2968
P(v20), PSI	0.3362	0.3362	0.3362	0.3362	0.3362	0.3362
Base Tank Liquid Depth, ft.	14	14	14	14	14	14
Effect. depth, %	32	32	32	32	32	32
d(e), Effect. Depth, Inches	53.8	53.8	53.8	53.8	53.8	53.8
gamma(w20), Lbs/Cu. In.	0.0361	0.0361	0.0361	0.0361	0.0361	0.0361
C*(infinite)(20), mg/L	10.317	10.317	10.317	10.317	10.317	10.317
theta, unitless	1.024	1.024	1.024	1.024	1.024	1.024
theta ^ (T-20), unitless	0.954	0.954	0.954	0.954	0.954	0.954
a (alpha), unitless	0.8	0.8	0.8	0.8	0.8	0.8
F (%), unitless	60	60	60	60	60	60
a*F, unitless	0.48	0.48	0.48	0.48	0.48	0.48
SOTR/OTR	2.7521	2.7521	2.7521	2.7521	2.7521	2.7521

DESIGN	Existing Year			Design Year		
	1	2	3	4	2a	4a
Secondary Loadings						
BOD5, mg/L	188	350	318	300	341	341
TKN, mg/L	40	41	55	55	40	40
BOD, lbs /day	934	1813	2400	3403	3532	7736
TKN, lbs/day	199	212	415	624	414	907
Oxygen Requirements						
BOD, lbs O2/day	934	1813	2400	3403	3532	7736
TKN, lbs O2/day	909	970	1897	2851	1893	4147
Nitrification credit for BOD oxidation	0	0	0	0	0	1597
TOTAL Oxygen Req'd, lbs/day	1843	2783	4297	6254	5426	10285
TOTAL Oxygen Req'd, lbs/hr	77	116	179	261	226	429
SOTR/OTR from above	2.7521	2.7521	2.7521	2.7521	2.7521	2.7521
SOTR, lbs/day	5072	7659	11827	17211	14932	28306
SOTE, %	23.3	23.3	23.3	23.3	23.3	23.3
Air Required, scfm	866	1308	2020	2939	2550	4834
Convert To ICFM						
Standard Pressure, PSIA	14.7	14.7	14.7	14.7	14.7	14.7
Site Elevation	50	50	50	50	50	50
Site Temperature, deg F	80	80	80	80	80	80
Site Atmospheric Pressure, PSIA	14.65	14.65	14.65	14.65	14.65	14.65
Actual Pressure At Inlet, PSIA, assume 0.5	14.15	14.15	14.15	14.15	14.15	14.15
Relative Humidity, fraction	0.3	0.8	0.8	0.8	0.8	0.8
Blower Inlet Actual Temp., deg C	26.7	26.7	26.7	26.7	26.7	26.7
Blower Inlet Actual Temp., Kelvin	299.8	299.8	299.8	299.8	299.8	299.8
Sat. Vapor Press. at Standard, PSI	0.3391	0.3391	0.3391	0.3391	0.3391	0.3391
Sat. Vapor Press. at Actual Temp, PSI	0.30	0.30	0.30	0.30	0.30	0.30
Standard Temp., R	528	528	528	528	528	528
Actual Temp., R	540	540	540	540	540	540
Air Required, icfm	918	1401	2163	3148	2732	5178
Press. At diffuser	7.4	7.4	7.4	7.4	7.4	7.4
Total Pressure	22.05058824	22.05058824	22.05058824	22.05058824	22.05058824	22.05058824
Inlet Temp. oF	90	90	90	90	90	90
Blower Effic.	70	70	70	70	70	70
Approx. Horsepower Needed, Bhp	38	58	89	130	113	214
Number of Blowers	1	2	2	2	3	3
Air per Blower, ICFM	918	701	1082	1574	911	1726
Approx. Horsepower Per Blower, Bhp	38	29	45	65	38	71

Fine Bubble Aeration
Pease SBRs
Taken from File name: "fine bubble aeration -- master.xls"
Latest Revision:
04-Nov-13
07:33 AM

Calc. by: wsc
Reviewed by: ___________

	Condition			Condition		
	1	2	3	4	2a	4a
Flow, Q, MGD	**0.596**	**0.621**	**0.905**	**1.360**	**1.242**	**2.720**
Temperature, T, oC	**28**	**28**	**28**	**28**	**28**	**28**
Temperature, T, Kelvin	301.15	301.15	301.15	301.15	301.15	301.15
Oxygen Requirements						
BOD, lb O2/lb BOD5	1.00	1.00	1.00	1.00	1.00	1.00
TKN, lb O2/lb TKN	4.57	4.57	4.57	4.57	4.57	4.57
Oxygen Transfer Coefficients						
Beta	0.95	0.95	0.95	0.95	0.95	0.95
C*(s)(T), mg/L	8.74	8.74	8.74	8.74	8.74	8.74
C*(s)(20), mg/L	9.09	9.09	9.09	9.09	9.09	9.09
tau, unitless	0.961	0.961	0.961	0.961	0.961	0.961
C(L), mg/L	2.0	2.0	2.0	2.0	2.0	2.0
P(b), PSI	14.7	14.7	14.7	14.7	14.7	14.7
P(s), PSI	14.7	14.7	14.7	14.7	14.7	14.7
Omega, unitless	1	1	1	1	1	1
P(vt), PSI	0.5436	0.5436	0.5436	0.5436	0.5436	0.5436
P(v20), PSI	0.3362	0.3362	0.3362	0.3362	0.3362	0.3362
Base Tank Liquid Depth, ft.	14	14	14	14	14	14
Effect. depth, %	32	32	32	32	32	32
d(e), Effect. Depth, Inches	53.8	53.8	53.8	53.8	53.8	53.8
gamma(w20), Lbs/Cu. In.	0.0361	0.0361	0.0361	0.0361	0.0361	0.0361
C*(infinite)(20), mg/L	10.317	10.317	10.317	10.317	10.317	10.317
theta, unitless	1.024	1.024	1.024	1.024	1.024	1.024
theta ^ (T-20), unitless	1.209	1.209	1.209	1.209	1.209	1.209
a (alpha), unitless	0.8	0.8	0.8	0.8	0.8	0.8
F (%), unitless	60	60	60	60	60	60
a*F, unitless	0.48	0.48	0.48	0.48	0.48	0.48
SOTR/OTR	2.3949	2.3949	2.3949	2.3949	2.3949	2.3949

	Existing Year			Design Year		
DESIGN	1	2	3	4	2a	4a
Secondary Loadings						
BOD5, mg/L	188	350	318	300	341	341
TKN, mg/L	40	41	55	55	40	40
BOD, lbs /day	934	1813	2400	3403	3532	7736
TKN, lbs/day.	199	212	415	624	414	907
Oxygen Requirements						
BOD, lbs O2/day	934	1813	2400	3403	3532	7736
TKN, lbs O2/day	909	970	1897	2851	1893	4147
Nitrification credit for BOD oxidation	0	0	0	0	0	1597
TOTAL Oxygen Req'd, lbs/day	1843	2783	4297	6254	5426	10285
TOTAL Oxygen Req'd, lbs/hr	77	116	179	261	226	429
SOTR/OTR from above	2.3949	2.3949	2.3949	2.3949	2.3949	2.3949
SOTR, lbs/day	4414	6665	10292	14977	12994	24632
SOTE, %	23.3	23.3	23.3	23.3	23.3	23.3
Air Required, scfm	754	1138	1758	2558	2219	4207
Convert To ICFM						
Standard Pressure, PSIA	14.7	14.7	14.7	14.7	14.7	14.7
Site Elevation	50	50	50	50	50	50
Site Temperature, deg F	80	80	80	80	80	80
Site Atmospheric Pressure, PSIA	14.65	14.65	14.65	14.65	14.65	14.65
Actual Pressure At Inlet, PSIA, assume 0.5	14.15	14.15	14.15	14.15	14.15	14.15
Relative Humidity, fraction	0.3	0.8	0.8	0.8	0.8	0.8
Blower Inlet Actual Temp., deg C	26.7	26.7	26.7	26.7	26.7	26.7
Blower Inlet Actual Temp., Kelvin	299.8	299.8	299.8	299.8	299.8	299.8
Sat. Vapor Press. at Standard, PSI	0.3391	0.3391	0.3391	0.3391	0.3391	0.3391
Sat. Vapor Press. at Actual Temp, PSI	0.54	0.54	0.54	0.54	0.54	0.54
Standard Temp., R	528	528	528	528	528	528
Actual Temp., R	540	540	540	540	540	540
Air Required, icfm	803	1237	1910	2779	2411	4571
Press. At diffuser	7.4	7.4	7.4	7.4	7.4	7.4
Total Pressure	22.05058824	22.05058824	22.05058824	22.05058824	22.05058824	22.05058824
Inlet Temp. oF	90	90	90	90	90	90
Blower Effic.	70	70	70	70	70	70
Approx. Horsepower Needed, Bhp	33	51	79	115	99	189
Number of Blowers	1	2	2	2	3	4
Air per Blower, ICFM	803	618	955	1390	804	1143
Approx. Horsepower Per Blower, Bhp	33	26	39	57	33	47

APPENDIX C

ODOR CONTROL EVALUATION REPORT

ASSESSMENT OF FUTURE ODOR CONTROL NEEDS AT THE PEASE WWTF

Prepared for:

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January, 2014

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1. INTRODUCTION

The Pease Development Authority Wastewater Treatment Facility (Pease WWTF) treats wastewater from a variety of commercial and industrial enterprises at the Pease International Tradeport. Much of the existing plant was constructed as part of a major upgrade in 1997. Beginning in 2007, the facility was the subject of odor complaints from residential and commercial areas north of the Spaulding Turnpike. Prior to that, odor complaints were rare. However, due to increasing flows and loadings from new and existing tenants at the Tradeport, the City must now consider expanding the facility. As part of that expansion, new odor control facilities will be required to ensure that any off-site odor impacts are minimized.

This report represents an assessment of the existing odor control systems at the Pease WWTF, and what modifications will be necessary to ensure odors are controlled from future wastewater and sludge handling processes.

2. DESCRIPTION OF FACILITIES

The Pease WWTF as currently configured began operation in 1997 with a design flow of 1.2 mgd. Current wastewater flows to the plant are approximately 0.8 mgd. The plant was designed to serve the Pease International Tradeport, which currently includes several large industries (a brewery and a biotech industry) as well as offices, restaurants, and a hotel.

The Pease WWTF consists of the following unit processes:

- comminutors
- aerated grit chambers
- primary clarifiers
- sequencing batch reactors
- effluent holding
- chlorination/dechlorination
- sludge thickening and holding
- belt press dewatering

- septage receiving/holding

Odor control facilities consist of a single packed-tower chemical scrubber designed to treat 7,000 cfm of odorous air from the aerated grit chambers and channels, primary clarifier distribution box, primary clarifier effluent launders, sludge holding tank, and belt press room. The scrubber is designed to use sodium hydroxide (caustic) and sodium hypochlorite (bleach) to absorb and oxidize the odorous compounds in the air stream.

The plant uses an existing sand drying bed for dewatering of storm drain debris and plant grit. It was identified as a minor odor source during an assessment of odor emissions in 2007.

The Redhook Brewery wastewater is pretreated using an upflow, anaerobic sludge blanket (UASB) reactor. Effluent BOD typically ranges from 300 to 600 mg/L, although excursions of over 1,500 mg/L have been reported. Average flow during the work week is 50,000 to 100,000 gpd. There have been multiple incidents of process upset in which the anaerobic sludge blanket is discharged to the sewer system. Monthly grab samples are analyzed for sulfate, sulfide, and sulfite. Reported sulfide levels range from <1.0 mg/L to 7 mg/L. Sulfite levels have been reported up to 25 mg/L. Sulfite is a precursor to sulfide. Temperature of the discharge is approximately 35°C.

Lonza Biologics, Inc. discharges approximately 200,000 gpd of pretreated wastewater having a BOD of about 415 mg/L and a TSS of 70 mg/L (2006 average data). The industry is currently undergoing a major expansion at the site. Temperature of the discharge ranges from 30 to 40°C.

The remaining wastewater contributions are principally from light industrial/commercial sources and office buildings.

The existing odor control system is over 15 years old, and although it has provided good service, increasing hydrogen sulfide loadings makes the technology very costly to operate due to its reliance on chemicals to remove the H_2S. Further, the system does not have adequate capacity to handle additional odor sources such as the primary clarifiers that are contributing to off-site odors.

3. SUMMARY OF PREVIOUS DATA

An odor study of the Pease WWTF conducted by Bowker & Associates in November, 2007 included sampling of the influent wastewater as well as the air emissions from the primary clarifier and odor control system. In addition, H_2S concentrations were continuously monitored in the headspace of the covered, aerated grit chamber. Table 1 shows the results of the wastewater testing. Table 2 shows the results of the odorous air analysis. Figure 1 shows the continuous measurement of H_2S in the grit chamber headspace.

Conclusions from the 2007 sampling were as follows:

1. The plant is experiencing high levels of sulfide in the influent wastewater that have caused corrosion of the headworks as well as high odor emissions from the primary clarifier due to release of hydrogen sulfide gas.
2. At the aerated grit chamber, hydrogen sulfide levels were as high as 350 ppm, and over 80 ppm at the quiescent surface of the primary clarifier.
3. An anaerobic pretreatment system serving a nearby brewery has experienced upsets that have likely caused high sulfide loadings to the plant.
4. At the time of the testing, the major sources of odor from the Pease WWTF were the open quiescent surface of the primary clarifier and the wet scrubber odor control system.
5. At the time of the testing, the odor control system was not using sodium hypochlorite or caustic soda, resulting in the discharge of untreated odorous air.
6. Odor emissions from the primary clarifier were very high on November 14, 2007 due to the high levels of sulfide in solution (5 mg/L). Such high sulfide levels are unusual for a plant with a limited geographical service area, and could be attributable to the anaerobic pretreatment system serving the brewery.

TABLE 1

SUMMARY OF LIQUID STREAM SAMPLING DATA
PEASE WWTF
November 14, 2007

Location	Time	pH, s.u.	ORP, mV	Temp., °C	Total Sulfide, mg/L
Influent	8:40 AM	7.2	-140	20.3	3
Primary effluent before weir	8:50 AM	7.0	-180	21.5	5
Influent	10:05 AM	7.2	-140	21.5	2.5
Primary effluent before weir	10:10 AM	7.1	-180	21.7	3.5
Influent	12:35 PM	7.3	-160	23.5	3
Primary effluent before weir	12:40 PM	7.1	-110	22.7	1.5

TABLE 2

SUMMARY OF ODOR PANEL AND REDUCED SULFUR DATA
PEASE WWTF
November 14, 2007

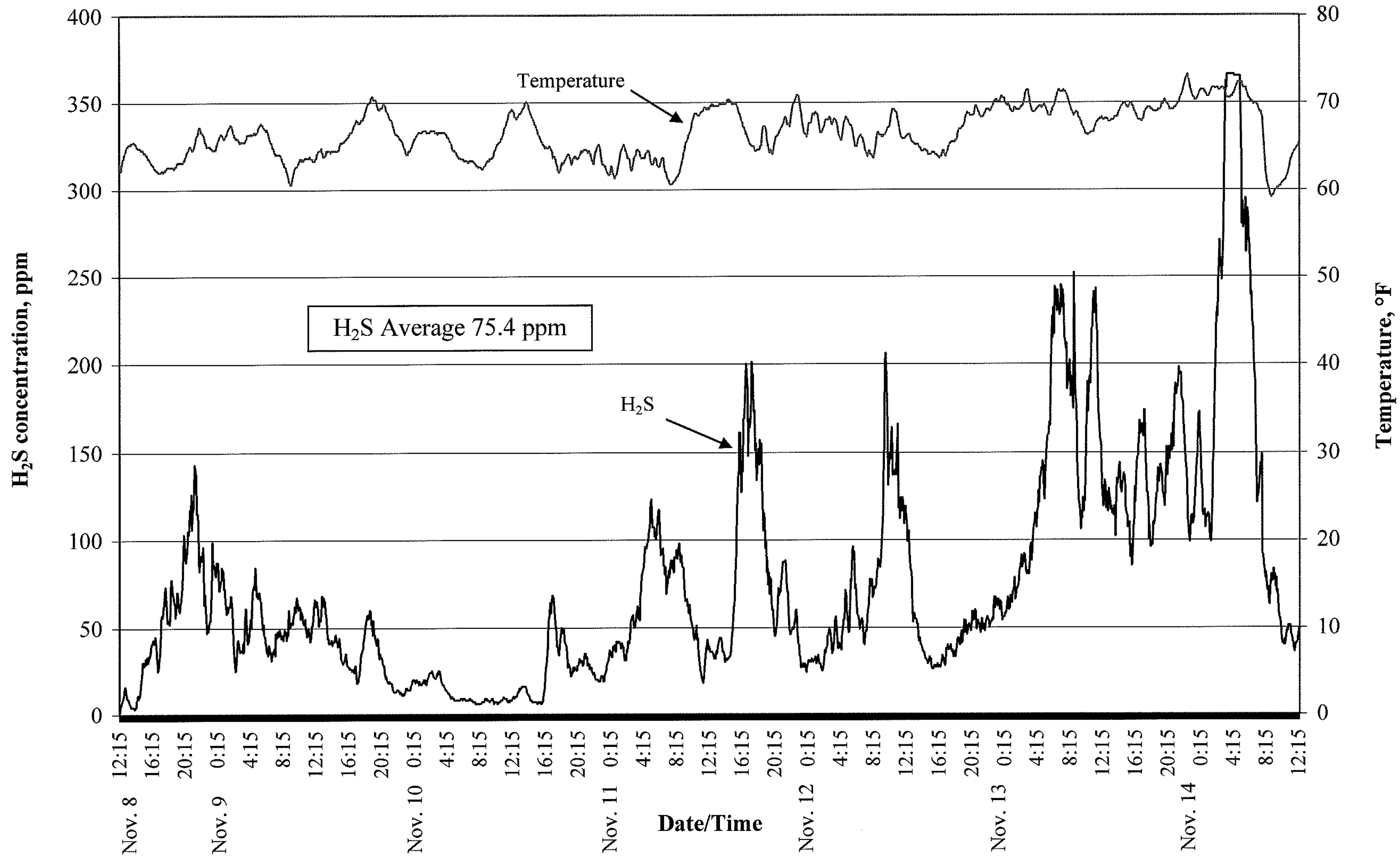
Sample No.	Time	Location	Odor Conc'n D/T	Reduced Sulfur Compounds,[1] ppb (except where noted)								
				H_2S, ppm (field)	H_2S (lab)	COS	MM	DMS	CS_2	MTE	DMDS	DMTS
1	9:40 AM	Primary clarifier quiescent surface	240,000	84	65,979	66	884	368	935	0.1	37	65
2	11:20 AM	Scrubber outlet[3]	20,000[2]	15.5	12,506	26	30	67	171	<0.1	0.5	<0.1
3	11:50 AM	Scrubber inlet	26,000	16.5	16,013	27	154	46	178	0.2	4.6	<0.1

1 H_2S hydrogen sulfide; COS carbonyl sulfide; MM methyl mercaptan; DMS dimethyl sulfide; MTE (methyl thio) ethane; DMDS dimethyl disulfide; DMTS dimethyl trisulfide

2 Sample destroyed in transit. Odor concentration estimated based on H_2S.

3 Scrubber operating conditions:
pH = 6.25
ORP = 270 mV

FIGURE 1
H_2S CONCENTRATION IN GRIT CHAMBER HEAD SPACE
PEASE WWTP
November 8-14, 2007



4. EVALUATION OF ODOR CONTROL ALTERNATIVES

4.1 Sources Requiring Control

Based on evaluation of 2007 data on odor and H_2S emissions from the existing processes, as well as an understanding of potential new sources that are likely to be included in an upgrade of the plant, the following sources will require odor control:

1. Headworks

Due to the high levels of hydrogen sulfide expected, this is an obvious source of odors that will require control. Two approaches are possible: 1) treatment of the full volume of room air in the headworks area, or 2) isolation of odor sources (such as channels and processing equipment) and extraction of air from the source. The former would result in air flow rates of approximately 6,000 cfm; the latter would result in an air flow of about 1,000 cfm if sources were isolated and treated.

In addition, it is proposed that the wet well of the influent pump station be covered, with evacuated air conveyed to odor control.

2. Septage pretreatment/holding

Air would be extracted directly from the septage pre-treatment unit and the septage holding tanks. Total air flow from one machine and three holding tanks is estimated to be 900 cfm.

3. Primary clarifiers

Due to the high measured odor emissions, full covers are recommended for the two existing primary clarifiers and a third future clarifier. Assuming 40-ft diameter tanks, the estimated air flowrate is 1,000 cfm per clarifier, for a total of 3,000 cfm.

4. Sludge holding tanks

Two, 35-ft diameter sludge holding tanks are assumed. These tanks are currently under odor control, with one tank operated as a thickener. Assuming both tanks are used for aerated sludge holding, the estimated air flow rate is 800 cfm per tank, or 1,600 cfm.

5. Sludge dewatering

The existing belt press room is ventilated at 12 air changes per hour to the odor control system. It is assumed that the belt press will be retained, and the ventilation strategy unchanged. It should be noted that many new dewatering technologies such as screw presses are fully enclosed, with fittings for ductwork connections. For two screw presses and a covered conveyor, the air flow requirement would be less than 1,000 cfm, compared to 5,500 cfm for the full volume of room air exchanged at 12 air changes per hour.

4.2 Air Flow Estimates

Table 3 shows estimated air flow rates for each process that would be slated for odor control. The total air flow of 12,500 cfm encompasses the headworks channels, screens, and wet well, the septage pretreatment unit and holding tanks, three fully-covered primary clarifiers, two sludge holding tanks, and the sludge dewatering room.

4.3 Odor Treatment Options

Table 4 summarizes the available technologies for treatment of the odorous air. With the anticipated H_2S loadings and the presence of other odorous constituents the following technologies are considered appropriate for this application.

1. Packed tower chemical scrubber
2. Biofilter
3. Bioscrubber

TABLE 3

ESTIMATED AIR FLOWS TO NEW ODOR CONTROL SYSTEM
Upgraded Pease WWTP

Location	Basis of Calculation	Estimated Air Flow, cfm
1. Headworks	covered channels @ 1 cfm/sq ft enclosed screens @ 200 cfm each covered wet well: 20 x 30' @ 1 cfm/sq ft	600 400 600 1,600
2. Septage pretreatment/ holding	Tanks: 3 @ 7' x 7' @ 1 cfm/sq ft + aeration Machine: per unit	600 200 800
3. Primary clarifiers (full coverage)	3 @ 40' diam; 0.75 cfm/sq ft	3,000
4. Sludge holding	2 @ 35 ft diam; .75 cfm/sq ft + aeration rate	1,600
5. Sludge dewatering	Existing; 12 AC/hr	5,500
	TOTAL	12,500 cfm

TABLE 4

SUMMARY OF ODOROUS AIR TREATMENT ALTERNATIVES
Bowker & Associates, Inc.

Technique	Frequency of Use	Cost Factors	Advantages	Disadvantages
Packed tower wet scrubbers	High	Moderate capital, high O&M cost	Effective and reliable; long track record; small footprint	High chemical consumption, high O&M
Activated carbon adsorbers	High	Cost-effectiveness depends on carbon replacement frequency	Simple; few moving parts; effective; several media options	Applicable to relatively dilute air streams in order to ensure long carbon life
In-ground biofilters	High	Low to moderate capital; low O&M costs	Simple; low O&M; effective; no chemicals	Large footprint; design criteria varies; some failures due to short-circuiting, overloading
Pre-engineered biofilters	Medium	Moderate to high capital; low O&M	Low O&M, no chemicals; longer media life and smaller footprint than in-ground systems	Higher capital costs than in-ground biofilters
Bioscrubbers, Biotrickling filters	Medium	Moderate capital; low O&M	Smaller footprint than biofilters, high H_2S loadings possible; little or no chemicals	Reduced performance at low temperatures; not as effective for non-H_2S odors
Thermal oxidizers	Low	Very high capital and O&M (energy) costs	Effective for wide spectrum of odors and VOCs	Only economical for high-strength, difficult to treat air streams
Diffusion into activated sludge basins	Low	Economical if use existing blowers or diffusers	Simple; low O&M; effective, reliable	Potential for corrosion of blower inlet components; add'l air filtration required
Odor counteractants	High	Operating cost dependent on chemical usage	Low capital cost	Limited odor removal efficiency (<40%); only applicable for dilute air streams

These are discussed briefly below:

Packed tower scrubbers

This technology has been the workhorse of the odor control industry for over 50 years. Unfortunately, chemical usage is proportional to the odorant loading, so high H_2S levels will mean high chemical consumption and operating costs. Further, O & M requirements are high to the need to regularly clean and calibrate probes, acid-wash the packing, and maintain the chemical feed system. Operators must handle sodium hypochlorite and sodium hydroxide, both hazardous chemicals. In the experience of Bowker & Associates, the high levels of hydrogen sulfide at the Pease WWTF make this technology much less desirable than biological treatment options due to the high chemical demand and associated costs.

Biofilters

Traditional, engineer-designed "wood chip" biofilters have been in use in the U.S. for over 30 years. A conservatively designed biofilter with an empty bed retention time of 60 seconds will provide a high level of odor treatment, and maintenance is usually limited to irrigating the bed to maintain the right moisture content and replacing the media every 3 to 4 years. Vendor-supplied biofilters are another option, in which the vendor provides the components and media, and the system is built in place. Self-contained modular units would be too small for this application. If a vendor supplied biofilter is considered, it is important that the EBRT be long enough to allow removal of odorous sulfur compounds other than H_2S.

Bioscrubber or biotrickling filter

This technology has been available in the U.S. for the past 15 years or so. These systems treat the air biologically in a tower, which is packed with a proprietary media that retains the microorganisms but allows air and water to pass. They are extremely effective for H_2S, removing 99 percent of the H_2S at EBRT's of less than 10 seconds. However, if other reduced sulfur compounds are present in significant quantities, longer detention times are required.

Bioscrubbers or biotrickling filters can be irrigated with secondary effluent or potable water. In the latter case, nutrients must be added to the irrigation water to satisfy the microorganisms.

4.4 Odor Control Strategies

It is recognized that the availability of funds for an upgrade of the Pease WWTP may dictate that a phased approach be employed to address odors. One alternative is to rehabilitate the existing odor control system to treat the existing odor sources, and to construct a second odor control systems for the new odor sources. This approach, along with the strategy of a single, central odor control system, is discussed below.

4.4.1 Rehabilitate chemical scrubber and construct biofilter for new sources

This strategy would involve rehabilitation of the existing 7,000 cfm chemical scrubber, and adding a 2,500 cfm biofilter to treat the air from the new headworks and septage pretreatment/holding. The existing scrubber would continue to serve the sludge dewatering room, sludge holding tanks, and primary clarifier launders. The primary clarifiers would be fitted with full covers and an odor control system at a future date. Note that the belt press room accounts for the majority of air treated by the existing scrubber. It is assumed that the belt press will remain in service. Enclosing the press to reduce air volume is not recommended due to concerns for machine corrosion.

Table 5 provides a breakdown of costs to rehabilitate the chemical scrubber to treat the odors from the belt press room and sludge holding tanks. Table 6 shows the costs to construct a 2,500 cfm biofilter system for the new headworks and existing septage handling facilities (with an additional storage tank). To effectively treat the high loadings of H_2S and other sulfur compounds, a hybrid biotrickling filter/biofilter system is recommended. Should the City be able to reduce the sulfide loadings to the plant through an enhanced industrial pretreatment program, it is likely that a simpler and less costly odor control system could be implemented.

TABLE 5

PEASE WASTEWATER TREATMENT FACILITY

PORTSMOUTH, NH

COST SHEET - REHAB EXISTING ODOR CONTROL; 7,000 cfm

ITEM	QUANTITY	UNIT	UNIT PRICE	PROBABLE COST
General Requirements	1	LS	$ 10,235.00	$10,200
Conduct detailed inspection	1	LS	$5,000	$5,000
Replace media	1	LS	$10,000	$10,000
Replace recirc. & metering pumps	1	LS	$30,000	$30,000
Update controls	1	LS	$20,000	$20,000
Repair leaking joints	1	LS	$15,000	$15,000
Electrical	1	LS	$ 9,000.00	$9,000
SUBTOTAL				***$99,000***
Contractor OH&P - 15%				$15,000
Contingency - 15%				$15,000
TOTAL PROBABLE CONSTRUCTION COST				**$129,000**
Admin, Engineering and Construction Services				$32,000
TOTAL PROJECT COSTS YEAR 2013				***$161,000***

TABLE 6

PEASE WASTEWATER TREATMENT FACILITY

PORTSMOUTH, NH

COST SHEET - SEPTAGE AND HEADWORKS ODOR CONTROL; 2,500 cfm

ITEM	QUANTITY	UNIT	UNIT PRICE	PROBABLE COST
General Requirements	1	LS	$ 53,015.00	$53,000
Site work and mobilization	1	LS	$10,000	$10,000
Equipment	1	LS	$250,000	$250,000
Installation	1	LS	$87,500	$88,000
Ductwork	1	LS	$30,000	$30,000
Plumbing (allowance)	1	LS	$15,000	$15,000
Electrical	1	LS	$45,000	$45,000
Instrumentation	1	LS	$ 22,500.00	$23,000
SUBTOTAL				***$514,000***
Contractor OH&P - 15%				$77,000
Contingency - 15%				$77,000
TOTAL PROBABLE CONSTRUCTION COST				**$668,000**
Admin, Engineering and Construction Services				$167,000
TOTAL PROJECT COSTS YEAR 2013				***$835,000***

Table 7 shows the estimated capital cost to install full covers over three primary clarifiers (two existing and one new), and to construct a 3,000 cfm biofilter to treat the air from the three tanks. It is assumed that this project would be done separately from the new headworks at a future time. Again, a two-stage biotrickling filter/biofilter will likely be required to effectively treat the high odorant loadings anticipated from the primary clarifiers.

4.4.2 Construct central biofilter

The existing chemical scrubber is costly to operate and maintain, and it requires the handling of hazardous chemicals. Ideally, the scrubber would be abandoned and a new central biofilter system constructed to treat all the odorous air from the plant.

Table 8 shows the estimated cost of a vendor-supplied 12,500 cfm biofilter having a conservative detention time of 54 seconds. The design utilized two layers of media – an inorganic layer for removal of H_2S, and a wood-based layer for removal of non-H_2S sulfur compounds. A concrete shell is cast-in-place to house the underdrain, air distribution piping, media, and irrigation piping. Covers are provided to better control the temperature and moisture content of the media, and to allow discharge of the exhaust via stack to improve dispersion of the residual odor. The conservative empty bed retention time of 54 seconds, with two distinct media layers, would ensure a high degree of odor reduction. The footprint of a vendor-supplied biofilter with dual media beds is approximately 40 ft x 50 ft.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

1. The Pease WWTF receives high loadings of dissolved sulfide that causes corrosion and elevated odor emissions at the plant.
2. The primary clarifiers have partial covers, but odor emissions from the uncovered zones are sufficiently high to warrant full covers.

TABLE 7

PEASE WASTEWATER TREATMENT FACILITY

PORTSMOUTH, NH

COST SHEET – PRIMARY CLARIFIERS ODOR CONTROL; 3,000 cfm

ITEM	QUANTITY	UNIT	UNIT PRICE	PROBABLE COST
General requirements	1	LS	$69,000	$69,000
Site work and mobilization	1	LS	$ 10,000	$10,000
Covers for primary clarifiers	1	LS	$171,000	$171,000
Equipment -odor treatment system	1	LS	$280,000	$280,000
Equipment installation	1	LS	$60,000	$60,000
Ductwork	1	LS	$30,000	$30,000
Electrical	1	LS	$20,000	$20,000
Instrumentation	1	LS	$20,000	$20,000
Yard piping allowance	1	LS	$10,000	$10,000
SUBTOTAL				***$870,000***
Contractor OH&P - 15%				$101,000
Contingency - 15%				$101,000
TOTAL PROBABLE CONSTRUCTION COST				**$872,000**
Admin, Engineering and Construction Services				$218,000
TOTAL PROJECT COSTS YEAR 2013				***$1,090,000***

TABLE 8

PEASE WASTEWATER TREATMENT FACILITY

PORTSMOUTH, NH

COST SHEET - NEW CENTRAL ODOR CONTROL; 12,500 cfm

ITEM	QUANTITY	UNIT	UNIT PRICE	PROBABLE COST
General requirements	1	LS	$ 143,405.00	$143,400
Site work and mobilization	1	LS	$ 20,000.00	$20,000
Concrete	1	LS	$108,000	$108,000
Equipment	1	LS	$450,000	$450,000
Fan	1	LS	$30,000	$30,000
Equipment Installation	1	LS	$168,000	$168,000
Primary clarifier covers	1	LS	$171,000	$171,000
Ductwork	1	LS	$100,000	$100,000
Electrical	1	LS	$120,000	$120,000
Instrumentation	1	LS	$60,000	$60,000
Yard piping allowance	1	LS	$20,000	$20,000
SUBTOTAL				***$1,390,000***
Contractor OH&P - 15%				$209,000
Contingency - 15%				$209,000
TOTAL PROBABLE CONSTRUCTION COST				**$1,808,000**
Admin, Engineering and Construction Services				$452,000
TOTAL PROJECT COSTS YEAR 2013				***$2,260,000***

3. Due to the high levels of hydrogen sulfide, the existing chemical scrubber is costly to operate, and maintenance requirements are high. The technology requires the use of hazardous chemicals to remove the odorous compounds.
4. The existing chemical scrubber is 15 years old and is nearing the end of its useful life. Although it would be possible to rehabilitate the unit and continue its service, the operating cost is much higher than biological systems such as biofilters and bioscrubbers.

5.2 Recommendations

1. The City should impose and enforce a discharge limit of 0.1 mg/L of sulfide for any industry discharging into the municipal sewer system.
2. As part of the future upgrade, the recommended odor control strategy is to abandon the existing chemical scrubber odor control system and install a central biofilter system.
3. A central biofilter would serve the headworks, septage pretreatment, primary clarifiers, sludge holding tanks, and sludge dewatering room. Estimated capital cost is $2.3M, including new primary clarifier covers and ductwork.
4. If funds are not available to replace the existing odor control system with a central biofilter, the City should consider rehabilitating the existing chemical scrubber and constructing a 2,500 cfm biofilter for the new headworks and septage handling processes.
5. The cost of rehabilitating the existing chemical scrubber is estimated to be $161,000, including engineering and contingencies. A new 2,500 biological odor control system is estimated to cost $835,000. This estimate is based on a conservative 2-stage design to handle the high loadings of hydrogen sulfide. A simpler and less costly alternative may be feasible if the influent odorant loading can be controlled through an enhanced industrial pretreatment program.
6. If influent sulfide loadings to the plant remain uncontrolled, full covers over the primary clarifiers will be necessary, with the air exhausted to a bioscrubber or biofilter. The capital cost of such a system is estimated to be $1.1M .

APPENDIX D

HVAC EVALUATION REPORT

Petersen Engineering

Pease WWTF
Facility Analysis – HVAC & Plumbing Systems

1/9/2014

Prepared by Petersen Engineering

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Table of Contents

I. Summary

A complete upgrade to HVAC and Plumbing systems is recommended for the Laboratory & General Facilities Building and Operations & Maintenance Building, while partial upgrades to HVAC and Plumbing systems are recommended for the other buildings. In many cases, the existing systems are in poor condition with several components and systems no longer in service. Recommended goals for replacement equipment, systems and materials is that they be simple, meet current code, provide safe work conditions, are energy efficient, durable, economical, and serviceable.

Ventilation systems need to meet code required exchange rates and should be configured to make it unlikely that their operation is abandoned over time – a common problem in these types of applications. Therefore we recommend that exhaust fans be outfitted with variable speed drives to allow for the operator to have some flexibility in the operation of the ventilation systems – more than simply on-off control.

The existing or new Headworks Building should be classified as Class 1 Division 1, such that continuous ventilation is not required. The recommended ventilation system operates at 30 ACH for a purge cycle then either 12 ACH (high speed) or 3 ACH (low speed) when occupied and purge cycle is complete. The approach includes gas detection systems interlocked to ventilation systems.

II. Background Information

Petersen Engineering has reviewed available record drawings and surveyed the mechanical (HVAC and Plumbing) systems serving the Pease Wastewater Treatment Facility (WWTF) in Portsmouth, NH. Surveys were conducted in November 2012 and August 2013. The scope of this evaluation is as follows:

1. Review of HVAC systems in the Intermediate Pump Station, Blower/Dewatering Building, Sludge Storage/Chlorine Building, Lab/General Facilities Building, Operations/Maintenance Building and Headworks Building.
2. Recommend system upgrades to existing facilities and provide recommendations for new HVAC systems approaches for new Headworks Building.
3. Provide budget estimates for recommended system upgrades and for new systems to serve a new Headworks.

III. Existing Conditions

A. Intermediate Pumping Station

The heating systems are in poor condition and are beyond their statistical useful life. We also understand that current heat relief provisions are not adequate.

- Heat relief ventilation– Skylight with integral louvers that are covered in the winter months.
- Heat – Qty-2 electric unit heaters. The unit heaters are in poor condition and appear very aged.
- Air-Conditioning – Qty-1 DX split system serving the control room. Unit is approximately five years old and performance is adequate.

B. Blower/De-Watering Building - SBRS/Activated Sludge (1st Floor)

The heating and ventilation systems are original to the 1996 building and generally in reasonable working condition. Due to the interconnection of spaces with different functions (i.e. odor control system located within the Chemical Storage Room which freely communicates with the Blower Room above), there is moderate to severe corrosion on exposed ductwork, piping and equipment.

- Chemical Storage/Pump Room Ventilation – Qty-1 inline exhaust fan, currently not operational, located on the east wall and connected to ductwork that is intended to draw exhaust air from that space. Make-up air is intended to be provided by qty-1 30"x24" louver located on opposite side of the room on the west wall. The associated ductwork was extremely corroded during our November 2012 visit but has since been replaced with coated galvanized sheet metal.
- Polymer Feed Ventilation – Qty-1 inline exhaust fan, located on the east wall and connected to ductwork that is intended to draw exhaust air from that space. Due to the infrequency of the fan operation, make-up air is not provided.
- Toilet Ventilation – Qty-1 ceiling exhaust fan.
- Odor Control – Odor control equipment is located within the Chemical Storage/Pump Room and freely communicates with spaces above. There have been leaks at the gaskets but have not been easily fixed.
- Heat – Qty-4 hot water unit heaters located throughout per original construction documents.
- Potable water – Potable water and an electric hot water heater was observed to serve bathroom fixtures, hose bibs, and emergency eyewash/shower stations.

C. Blower/De-Water Building – SBRS/Activated Sludge (2nd Floor)

The heating and ventilation systems are original to the 1996 building and are in reasonable working condition. Due to the interconnection of spaces with different functions (i.e. odor control system located within the Chemical Storage Room which freely communicates with the Pump/Blower Room above), there is moderate to severe corrosion on exposed ductwork, piping and equipment.

- Blower Room Ventilation – Qty-1 sidewall, propeller exhaust fan located on the north wall that is intended to draw exhaust air from that space. Make-up air is intended to be provided by qty-1 48"x72" louver located low on the west wall. The fan was operational but not providing adequate ventilation.
- Control Room Ventilation – Qty-1 inline exhaust fan, located on the east wall that is intended to draw exhaust air from that space. Make-up air is intended to be provided via qty-1 transfer air grille into the Blower Room.
- De-Watering Room Ventilation – Qty-1 inline exhaust fan, located on the east wall that is intended to draw exhaust air from that space. The fan is functioning but was not on during our visit. Make-up air is intended to be provided by qty-1 Make-up Air Unit (MUA) located within the space with a louver on the west wall. The MUA is the only source of heat in the space which is no longer operational. The associated ductwork appears to have been partially replaced with a coated galvanized sheet metal.
- Odor Control – Odor control ductwork located within the De-Watering Room was extremely corroded during our November 2012 visit but has since been replaced with coated galvanized sheet metal.
- Heat
  - Qty-1 dedicated propane tank serves this building
  - Qty-1 450 MBH cast iron hot water boiler that has had a gas valve replaced in the recent past. There is some leakage and corrosion on the boiler as well as extreme corrosion on the boiler venting. Combustion air is provided by a high and low louver/damper assembly which is covered and disabled in the winter months.
  - Qty-3 hot water unit heaters located throughout per original construction documents.
- Miscellaneous – Blower stainless steel pipes have moderate surface corrosion due to inadequate ventilation in the space and open communication with chemical spaces below.

D. Sludge Storage & Chlorine Building

The ventilation system appears to be in good working condition but utilizes an outdated timeclock control.

- Ventilation – Qty-1 inline exhaust fan, located on the east wall and connected to ductwork that is intended to draw exhaust air from the Sludge Storage Building. Make-up air is intended to be provided via qty-1 24"x16" louver located on the east wall. The associated ductwork is completely corroded and in very poor condition.

E. Laboratory & General Facilities Building

The heating, air-conditioning, and ventilation systems are in poor condition and are beyond their statistical useful life. The building is served by a buried propane gas tank.

- HVAC – Qty-1 gas-fired furnace with cooling coil and on-grade condensing unit. The exterior refrigerant piping insulation is in poor condition. Return grille in corridor is slightly corroded and supply diffusers are aged but ductwork appears to be in good working condition.
- Lab Ventilation

    - Qty-1 inline exhaust fan serving the canopy hood.
    - Qty-1 uplast roof-mounted exhaust fan serving the fume hood. Make-up air is intended to be provided via an inline supply fan, duct heater, and ductwork.
- Toilet Ventilation - Qty-2 ceiling exhaust fans.
- Plumbing
    - Qty-1 electric water heater in fair condition.
    - Plumbing fixtures are aged and in poor condition (i.e. toilets, shower, sinks, emergency fixtures, etc.)
    - Backflow preventer and associated piping is corroded and in poor condition.
- Miscellaneous
    - Domestic cold water pipes located in ceiling space of the mechanical room freeze in the winter.
    - The thermal and vapor barrier located directly above the ceiling plane is damaged throughout, causing cold air leakage into the plenum space where piping, ductwork and equipment are located.

F. Control Building

The heating, air-conditioning, and ventilation systems are in poor condition and are beyond their statistical useful life.

- Grit Collection Ventilation – Qty-1 inline exhaust fan located on the west wall that is intended to draw exhaust air from within this space. Make-up air is not provided.
- Maintenance Area Ventilation – Qty-1 inline exhaust fan located on the north wall and connected to ductwork that is intended to draw exhaust air from the basement area. Make-up air is intended to be provided by transfer grilles located on both the north and south exterior walls. The associated ductwork and grilles are corroded and in poor condition
- Toilet Ventilation – Qty-1 ceiling exhaust fan.
- Air-Conditioning – Qty-1 DX split system serving the control room in fair/poor condition
- Heat
    - Qty-1 450 MBH cast iron hot water boiler. Three-way valve on hot water return line to boiler has been removed and may have adverse affects on system life and boiler operation. The circulator pump has been replaced a couple times in the last 15 years.
    - Qty-4 hot water unit heaters. Unit heaters located in Sludge Pump Room and Grit Collection are corroded and in poor condition. Low capacity issues in the Sludge Pump Room.
- Plumbing
    - Qty-1 electric water heater installed in 2012 and in good condition.
    - Plumbing fixtures are aged

- Backflow preventer & water meter located in Maintenance Area are completely corroded
- Sump pump located in basement of Maintenance Area.

G. Headworks

The ventilation systems are exposed to a very corrosive environment and are in poor condition. The odor control system that serves this building passes through from Septage Receiving in a "series" style piping layout, which appears to be ineffective.

IV. Recommendations

A. Intermediate Pumping Station

The suggested HVAC itemized upgrades are as follows:

- Demo existing unit heaters throughout
- Demo sidewall louvers within skylight
- Install new electric unit heaters throughout with corrosion resistant coating (Qty-3 5kW heaters)
- Install new intake louver/motor actuated damper on exterior wall (Qty-1 42"x18" louver & motorized damper)
- Install exhaust fan with line voltage thermostat control (Qty-1 1,000 cfm exhaust fan & qty-1 24"x24" louver)

B. Blower/De-Watering Building - SBRS/Activated Sludge (1st Floor)

The suggested HVAC and plumbing itemized upgrades are as follows:

- Demo corroded ductwork in the Chemical Storage/Pump Room
- Demo inoperable inline exhaust fan located in the Chemical Storage/Pump Room
- Demo unit heater in Truckbay
- Install new hot water unit heater in Truckbay (Qty-1 200 MBH hot water unit heater)
- Install FRP exhaust ductwork (18"Ø & 14"Ø)
- Install new inline exhaust fans with aluminum cabinet and corrosion resistant coating located in the Chemical Storage Areas & Pump Room (Qty-3 1,000 cfm exhaust fan)
- Install new exterior louver/damper assemblies (Chemical Storage & Truckbay)
- Install new inline exhaust fan with aluminum cabinet and corrosion resistant coating located in the Truckbay (Qty-1 1,000 cfm exhaust fan)
- Install DX, mini split A/C unit located in Polymer Room (Qty-1 2-ton DX A/C unit)

C. Blower/De-Water Building – SBRS/Activated Sludge (2nd Floor)

The suggested HVAC and plumbing itemized upgrades are as follows:

- Demo corroded odor control ductwork in De-Watering Room
- Demo inline exhaust fan, inoperable make-up air unit (MUA), associated ductwork and accessories in the De-Watering Room
- Demo propeller exhaust fan in Blower Room
- Demo intake louver in Blower Room
- Demo cast iron boiler, venting, combustion air louvers, and accessories
- Install FRP odor control ductwork in De-Watering Room (20" Ø, 18"Ø & 14"Ø)
- Install new roof-mounted exhaust fan with aluminum cabinet and corrosion resistant coating & associated intake louver/motor actuated damper on exterior wall, sized for 3 air changes per hour (Qty-1 1,000 cfm exhaust fan & qty-1 42"x18" louver and motorized damper)
- Install a new recirculation roof-top unit (RTU) to provide heat to the space with limited distribution ductwork (Qty-1 3,000 cfm, 200 MBH RTU & 18"Ø FRP ductwork)

- Install a new propeller exhaust fan with aluminum cabinet and corrosion resistant coating in Blower Room (Qty-1 10,000 cfm exhaust fan)
- Install new intake louver sized at 500 fpm with distribution ductwork (Qty-1 96"x60" louver & motorized damper, 36"Ø, 28"Ø & 20"Ø FRP ductwork)
- Install a new high efficiency condensing boiler (propane gas) with combustion air through the sidewall & flue exhaust through the roof (Qty-1 450 MBH condensing boiler, 8"Ø CPVC combustion air pipe, and 8"Ø polypropelene flue exhaust)
- Insulate blower air piping in Blower Room to eliminate condensation and prevent additional surface corrosion.

D. Sludge Storage & Chlorine Building

The suggested HVAC itemized upgrades are as follows:

- Demo corroded exhaust ductwork
- Demo exhaust fan/damper timeclock control
- Install FRP exhaust ductwork (16x10)
- Install a wall-mounted controller or switch to control exhaust fan and associated intake damper/louver assembly.

E. Laboratory & General Facilities Building

The suggested HVAC and plumbing itemized upgrades are as follows:

- Demo plumbing fixtures throughout
- Demo backflow preventer and associated piping in mechanical room
- Demo air terminals throughout
- Demo gas-fired furnace, cooling coil, condensing unit, and refrigerant piping.
- Demo duct heater
- Demo electric water heater
- Demo toilet exhaust fans
- Demo lab canopy hood and fume hood exhaust fans
- Demo fume hood make-up air fan
- Install new thermal, vapor and air barrier at the ceiling/roof level to eliminate air infiltration into the space and freezing of pipes in the winter months. Likely solution includes spray foam insulation to the underside of the roof and gable end walls.
- Install new high efficiency, low-flow plumbing fixtures throughout (Qty-2 water closets, qty-2 showers, qty-2 lavatories, qty-1 kitchen sink, qty-2 emergency fixtures)
- Install new backflow preventer and associated piping in the mechanical room (Qty-1 reduced pressure zone backflow preventer with strainer and shut-offs & 1" copper tubing and insulation)
- Install new air terminals throughout in same locations shown on existing plans (Qty-7 24"x24" ceiling diffusers, qty-1 30"x24" return grille, qty-4 10"x6" exhaust grilles, qty-1 12"x10" supply grille, qty-2 24"x12" ceiling transfer grilles, & qty-1 12"x8" ceiling transfer grille)
- Install new high efficiency gas-fired furnace, cooling coil & on grade condensing unit with associated refrigerant piping (Qty-1 100 MBH gas furnace, qty-1 60 MBH cooling coil & condensing unit, and 1-1/8" RS & 3/8" RL piping with insulation)
- Install new electric duct heater serving make-up air in the lab (Qty-1 13kW duct heater)

- Install new electric water heater in mechanical room (Qty-1 50 gallon water heater with 4500 watt upper & lower elements)
- Install new ceiling exhaust fans in the toilet rooms with wall switch (Qty-2 100 cfm exhaust fans)
- Install new canopy hood inline exhaust fan with variable speed drive & wall switch (Qty-1 600 cfm exhaust fan)
- Install new roof-mounted explosion-proof upblast fume hood exhaust fan interlocked to fume hood controls (Qty-1 770 cfm exhaust fan)
- Install new fume hood inline make-up air fan (Qty-1 540 supply fan)
- Install insulation on all pipes located above and/or near the ceiling plane.

F. Control Building

The suggested HVAC and plumbing itemized upgrades are based on the building functions remaining the same and are as follows:

- Demo hot water unit heaters throughout
- Demo corroded ductwork & air terminals
- Demo inline exhaust fan in Grit Collection
- Demo inline exhaust fan in Maintenance Area
- Demo ceiling exhaust fan in Toilet room
- Demo DX split system in Control Room
- Demo cast iron boiler, circulator pump, venting, combustion air louvers, and accessories
- Demo backflow preventer and water meter in Maintenance Area
- Demo plumbing fixtures throughout (water closet, laundry sink and sump pump)
- Install new hot water unit heaters throughout and with galvanized steel and corrosion resistant coating in Sludge Pump Room & Grit Collection (Qty-1 175 MBH, qty-2 25 MBH and qty-1 113 MBH unit heaters)
- Install FRP exhaust ductwork in Maintenance Area (24"x12") and exhaust grille (Qty-1 22"x26")
- Install new inline exhaust fan with aluminum cabinet and corrosion resistant coating in Grit Collection (Qty-1 1,500 cfm exhaust fan) and provide adequate make-up air.
- Install new inline exhaust fan with aluminum cabinet and corrosion resistant coating in Maintenance Area (Qty-1 1,500 cfm exhaust fan) and provide adequate make-up air.
- Install new ceiling exhaust fan in Toilet Room (Qty-1 75 cfm exhaust fan)
- Install new DX split A/C system in Control Room (Qty-1 2-ton ductless unit & condensing unit on grade)
- Install a new high efficiency condensing boiler (propane gas), circulator pump, combustion air through the sidewall & flue exhaust through the roof (Qty-1 450 MBH condensing boiler, 30 gpm pump, 8"Ø CPVC combustion air pipe, and 8"Ø polypropelene flue exhaust)
- Install new 3-way valve on hot water return to the boiler in mechanical room to optimize boiler operation and system efficiency
- Install new backflow preventer and water meter in Maintenance Area (Qty-1 reduced pressure zone backflow preventer with strainer and shut-offs and water meter)
- Install new high efficiency, low-flow plumbing fixtures (qty-1 water closet, qty-1 laundry sink, qty-1 sump pump)

G. New Headworks

The suggested HVAC and plumbing systems assume Class 1, Division 1 classification and are as follows:

Odor Control

- Install FRP odor control ductwork to connect to Headworks and Grit Chamber channels as well as the wet well area.

Headworks/Grit Chamber (1st floor)

- Install a high efficiency condensing boiler (propane gas) plant with glycol, including circulator pump, venting systems and ancillary equipment in a separate mechanical room.
- Install a roof-top gravity ventilator and roof-mounted FRP explosion-proof exhaust fan to provide a manual or gas detected purge cycle set at 30 ACH for maximum of 30 minutes (Qty-1 102"x60" gravity ventilator and qty-1 18,000 cfm exhaust fan).
- Install a roof-mounted FRP explosion-proof exhaust fan with VFD to provide an intermittent 3 ACH (low speed) or 12 ACH (high speed) when occupied and purge cycle is complete (Qty-1 7,200 cfm exhaust fan with VFD).
- Install FRP exhaust ductwork with high and low openings (60"x30" ductwork)
- Install explosion-proof, corrosion-resistant hydronic unit heaters

Wetwell/Dry Pit (below grade)

- Install a roof-top gravity ventilator with ductwork and roof-mounted FRP explosion-proof exhaust fan to provide a manual or gas detected purge cycle set at 30 ACH for maximum of 30 minutes (Qty-1 72"x48" gravity ventilator and qty-1 9,600 cfm exhaust fan).
- Install a roof-mounted FRP explosion-proof exhaust fan with VFD to provide an intermittent 3 ACH (low speed) or 12 ACH (high speed) when occupied and purge cycle is complete (Qty-1 4,000 cfm exhaust fan with VFD).
- Install FRP exhaust ductwork with high and low openings (46"x24" ductwork)
- Install plumbing fixtures as required (floor drains, sump pump, etc)
- Install explosion-proof, corrosion-resistant hydronic unit heaters

H. Existing Headworks

Odor Control

- Disconnect existing odor control ductwork from Septage Receiving and install FRP odor control ductwork dedicated to serve the existing Headworks.

Headworks

- Heating Options:
    1. Install a high efficiency condensing boiler (propane gas) plant with glycol, including circulator pump, venting systems, terminal units and ancillary equipment in a separate shed attached to the existing building.
    2. Install explosion-proof, corrosion resistant electric unit heaters
- Install a louver/damper assembly and sidewall mounted FRP explosion-proof exhaust fan to provide a manual or gas detected purge cycle set at 30 ACH for maximum of 30 minutes (Qty-1 102"x60" louver/damper and qty-1 15,000 cfm exhaust fan).

- Install a sidewall-mounted FRP explosion-proof exhaust fan with VFD to provide an intermittent 3 ACH (low speed) or 12 ACH (high speed) when occupied and purge cycle is complete (Qty-1 6,000 cfm exhaust fan with VFD).

V. Budget Estimates

Building	Recommendation	Budget*
Intermediate Pumping Station	Provide heat relief ventilation (intake louver/damper assembly, ductwork, and exhaust fan with line voltage thermostat. Replace existing electric unit heaters.	$20,000
Blower/De-Watering Building – 1st floor	Replace inoperable inline exhaust fan in Chemical Storage and replace corroded ductwork with FRP ductwork. (Truckbay UH - $3,000, Truckbay ventilation - $3,500, DX mini split - $3,000, Chem Storage/Pump EFs - $7,500, FRP ductwork - $6,000)	$25,000
Blower/De-Watering Building – 2nd floor	Replace corroded ductwork with FRP ductwork and insulate blower air piping. Improve ventilation in Blower Room and replace HV equipment in De-Watering Room with roof-top unit. Replace boiler with high efficiency condensing boiler and combustion & flue exhaust systems.	$100,000
Sludge Storage & Chlorine Building	Replace corroded ductwork with FRP ductwork and updated exhaust fan control to be more "user friendly".	$7,500
Laboratory & General Facilities Building	Replace HVAC equipment & plumbing throughout. Provide insulation on all piping in ceiling plane and replace backflow preventer. Provide new thermal, vapor and air barrier at underside of roof & gable end walls (see structural budget costs for insulation work).	$80,000
Control Building	Replace boiler with high efficiency condensing boiler and combustions & flue exhaust systems. Replace exhaust fans, hot water unit heaters, backflow preventer and water meter. Replace corroded ductwork with FRP ductwork.	$75,000
New Headworks Building	Provide odor control ductwork to serve entire building. Provide H&V systems (roof-mounted exhaust fans with gravity intake ventilations and electric unit heaters) and high efficiency boiler plant.	$120,000
Existing Headworks Building	Provide dedicated odor control ductwork. Provide ventilation systems with exhaust fans and intake/damper assembly. Provide either electric unit heaters or separate high efficiency boiler plant.	$60,000 (elec. UH's) $85,000 (boiler plant)

*Budget costs do not include O&P, contingency or engineering design fees.

APPENDIX E

STRUCTURAL EVALUATION REPORT

TIREY & ASSOCIATES, P.C.
CONSULTING STRUCTURAL ENGINEERS

January 6, 2014

Mr. W. Steve Clifton, PE
Underwood Engineers, Inc.
25 Vaughan Mall, Suite 1
Portsmouth, NH 03801

RE: Pease WWTP General Structural Evaluation, Portsmouth, NH

Dear Steve:

At your request, we performed a general visual structural condition evaluation at the Pease WWTP facility in Portsmouth, NH, on August 15, 2013. For ease of directional reference in this report, the sides of buildings which are parallel to Corporate Dr. will be called the west sides. The report will be broken down by individual building, with a couple of the buildings excluded from the evaluation at your direction.

Laboratory & Administration Building

While there are no structural issues with the building and it appears to be in good condition, there are some architectural issues which are contributing to degradation of portions of the building.

- The original copper standing seam metal roof is in good condition with two exceptions at specific locations on the roof. The gable end walls of the building rise above the roof plane, with vertical flashing extending from the roof to the top of the gable end walls. Where the vertical flashing meets the brick veneer of the walls at the bottom vertical edge of the flashing, the brick and flashing are not properly joined with a waterproof detail, resulting in a gap between the two materials that can vary from 1/8" to as much as 3/4". In some cases, the metal flashing is pushed back from the face of the brick, creating a surface facing up slope on the roof which can grab snow and ice and re-direct it into the wall (moisture entry) or apply a force onto the brick which it was never intended to experience. These open joints permit water infiltration into the brick veneer cavity, which is in turn causing degradation of the brick veneer. The water entry into the brick veneer cavity is causing cracking of the brick from freeze-thaw action. The wall extensions beyond the corners of the building envelope are experiencing efflorescence on the outside brick surface and vertical cracking of the brick due to freeze-thaw action of water inside the wall. This condition is evident at all corners and wall extensions of this building. The brick that returns to the metal flashing, was not saw cut when originally installed, leaving a jagged vertical line which is difficult to seal. The bottom end of the vertical flashing also has a folded seam to terminate the flashing. However, the seam is folded towards the main field of the roof, thereby permitting snow and ice sliding down the roof to grab the exposed edge of the seam and pry it open, allowing water to enter and exacerbating the aforementioned water infiltration problem.

- The soffit materials on the east eave line of the roof are not well supported or fastened to the eave soffit framing. The soffit materials are dropping down or falling out completely.

- The northwest corner of the building roof is experiencing significant ice dam formations at the portion of the roof over the outside covered entry. The ice dam formation results from snow above the heated portion of the building melting, running down the roof and freezing on the cold roof surface which is outside the building envelope line (walls). The constriction of the roof drainage, with two orthogonal sloping roof planes joined by a valley line, also exacerbates the ice dam formation by limiting the ability of snow to slide off the roof at this area.

- The vapor barrier and fiberglass batt insulation at the bottom chord of the roof trusses is not fully intact. One accessible location above the ceiling at the women's bathroom has an opening in the insulation and the plastic vapor barrier is hanging down from the truss. This condition lets warm air and moisture escape into the attic space of the trusses and contributes to the ice dam formation by causing more snow melt.

- It is noted that the brick veneer on the building, at locations where the backup wall is part of the heated structure, is in good condition.

Control Building with Grit Room

This single story building is older and has masonry block exterior walls, steel beam framing for the roof supporting a precast plank system that appears to be either a concrete or gypsum plank. There is an additionof similar construction on the north end of the building that houses the grit room.

- The concrete exterior masonry walls of the north addition are in poor condition. Where the addition joins the original structure, the joints have cracked and opened up, particularly at the northeast re-entrant corner. The joints appear to have no connectors, such as Z-straps, joining the newer to older walls. The joint is also a mortar joint, which has cracked with mortar fallen out of the joint. Moisture from the grit room is migrating through the masonry wall, leading to extensive freeze-thaw cracking in the mortar joints on the north wall of this addition. Moss is also growing on some of these mortar joints, a further indication of the amount of moisture passing through the wall.

- The masonry block chimney above the roof surface is cracked at mortar joints and is in need of repointing.

- The roof membrane on this building is a non-ballasted EPDM membrane which is in good condition, with an expected life span of no less than 5 years, and more likely about 10 years with regular maintenance.

- Tree branches which overhang the east side of the building roof should be trimmed back so as not to sit directly on the roof.

Intermediate Pump Station

The intermediate pump station is a single story building with one end containing a pit area for entering piping. The building is a masonry block wall supporting a precast concrete plank roof deck. The roof membrane is a non-ballasted EPDM membrane.

- The roof is sloped down from south to north, with water shedding off the north roof edge and running down the north masonry wall face. The masonry block on the north side of the building is degrading as a result of water infiltration and absorption from the roof drainage. Cracking of the mortar joints is occurring due to freeze-thaw action. Moss is growing in some of the mortar joints. Paint is flaking and peeling off the masonry surfaces due to the high moisture content of the block.

- The roof membrane is in fair to good condition. Some of the lap seams have separated and will permit moisture entry. Some roofing plate fasteners are working up from the structural substrate, creating small membrane "tents" where the fastener is pushing the membrane upwards. These locations may eventually create holes in the membrane. The membrane needs repair of lap joints in 0 - 1 years, with likely replacement of the entire membrane in no more than 10 years.

- Miscellaneous nails and screws have been left on the roof membrane and should be removed to avoid possible membrane punctures.

- The southeast wall corner of the building is cracked, with spalling of the block face shells starting to occur. These deteriorated blocks should be removed and be replaced.

- We noted that the northwest corner of the building was recently rebuilt, based on the non-painted block at this corner. Since this corner is part of an addition to the original building, we surmise that the building corner may have been hit by something, causing sufficient damage to require replacement.

- The paint on the outside of the building walls is deteriorated and failing. The exterior surface of the walls should be cleaned and sealed to prevent water intrusion into the block that would cause freeze-thaw damage.

Chlorine Contact Tank

- The chlorine contact tank is in good condition.

Sludge Storage Tanks and Chlorine Building

- The masonry block walls of the chlorine building between the two round sludge storage tanks are in fair condition. The brown paint is failing and peeling off the walls. Some of the mortar joints on the north side of this building are deteriorated and in need of cleaning and re-pointing.

- The tank walls appear to be in good condition.

Blower Building

- At the southeast corner of the building, on the east face of exterior brick veneer, there is a vertical crack about 4" from the outside corner resulting from an insufficient number of control joints in the east wall face of the brick veneer and a change of overall height of the brick as it turns the corner from the south face to the east face of the building. A new control joint should be constructed in the brick veneer on the east face of the wall at 4" north from the outside corner. Some brick may need to be replaced where cracking is more than 4" from the corner. The control joint should have a foam backer rod placed in the joint behind a flexible sealant suitable for weather exposure and movement.

- At the northeast corner of the building where it joins the SBR tanks, a vertical crack is starting to occur in the north face of the brick veneer, 4" west of the corner. This is a location where the brick height also changes significantly. There is currently no control joint in the brick veneer at this location, but there should be one. A new control joint should be saw cut in the north wall of the brick veneer, located 4" west of the corner. The control joint should have a foam backer rod placed in the joint behind a flexible sealant suitable for weather exposure and movement.

- The operators have reported that wind driven rain is being blown under the threshold and the bottom of the door frame at the east second floor door that exits onto the walkways on top of the SBR tank walls. The interior slab elevation is the same as the exterior walkway slab elevation. The door frame and door sill should be reset with an appropriate flexible sealant and possibly a hydrophyllic waterstop to prevent the migration of water from outside to inside the building via the door sill and door frame.

- The roof membrane is a ballasted EPDM membrane with newer flashing over the parapet walls around the edge of the roof. There are scuppers through the south parapet wall for water overflow relief, should the roof drains become clogged. The membrane appears to be in good condition with an expected life span of the membrane being in the range of 7 - 10 years.

- The balance of the building structure appears to be in good condition.

SBR Tanks

- The SBR tanks are generally in good condition. There are some minor shrinkage cracks with effloresecing occurring at the west wall of the south tank. These conditions do not appear to have changed over the last 5 years and are not believed to present a need for repair.

Budget Estimates		
Building or Structure	Recommended Work	Budget
Laboratory & Administration	Remove and rebuild ends of gable end walls; cut brick cleanly; repair metal wall flashing at lower ends; construct waterproof joints at lower ends of wall flashing to brick; repair soffit trim; remove existing ceiling insulation and vapor barrier; place new spray foam insulation at the underside of roof sheathing and in gable end walls above ceiling level. Add heater tape on roof above entry doors.	$100,000. $3,000.
Control Building & Grit Room	At grit room north and east walls, clean masonry block, repoint, and apply paint or sealer. Repair both vertical construction joints at original building.	$9,000.
Intermediate Pump Station	Clean masonry block, repoint, and apply paint or sealer. Remove and reconstruct SE wall corner. Replace roof membrane, including installing tapered insulation and adding 2 scuppers with extended drip lines.	$27,000. $16,170.
Sludge Storage & Chlorine Building	Clean masonry block, repoint, and apply paint or sealer.	$11,000.
Blower Building	Sawcut and construct two new control joints in brick veneer. Replace original roof membrane Repair 2nd floor east door sill sealant	$8,000. $66,000. $1,000.
SBR Tanks	None	$0
Chlorine Contact Tank	None	$0

Please call if you have any questions or we can be of further assistance.

Truly Yours,

STATE OF NEW HAMPSHIRE
JEFFREY L. TIREY
No. 5503
LICENSED
PROFESSIONAL ENGINEER

Jeffrey L. Tirey, P.E., SECB

jlt

Enclosure

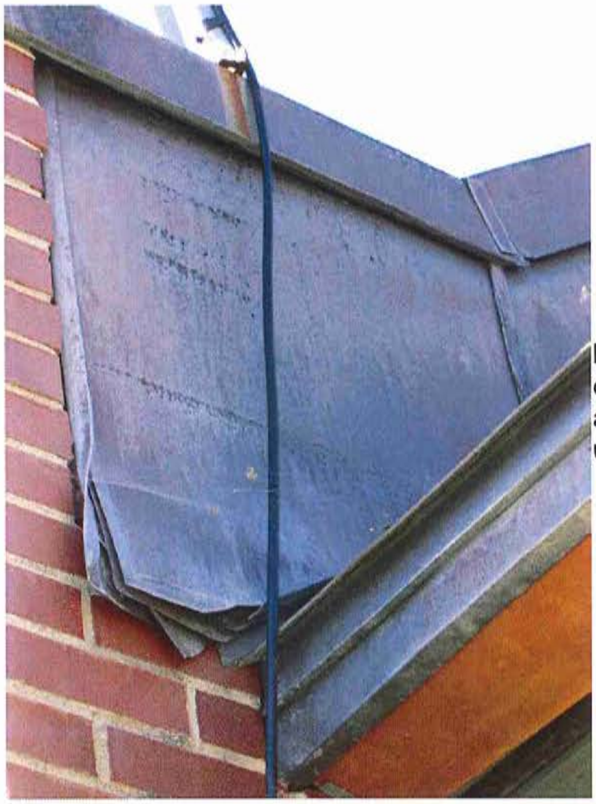

Photo 11: Lab/Admin - SE corner showing flashing at wall at bottom edge seam being unfolded by sliding snow and ice.

Photo 17: Lab/Admin - SE corner showing flashing termination seam being unfolded and lack of any sealant between metal flashing and brick veneer. Note jagged ends of brick in alternate courses, because bricks were not saw cut.

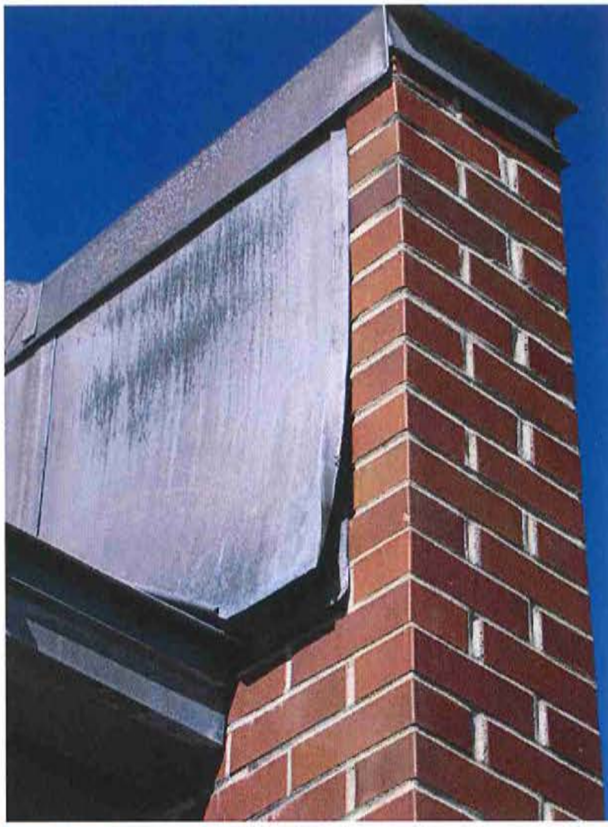

Photo 21: Lab/Admin - NE corner showing metal flashing bottom seam unfolded and flashing warping out and away from brick veneer, permitting water entry.

Photo 38: Lab/Admin - General view near NW corner of building at the main entry into building. Note the valley line at re-entrant roof eave corner and outside ceiling above the entry, which can produce a cold roof above to promote ice dam formation.

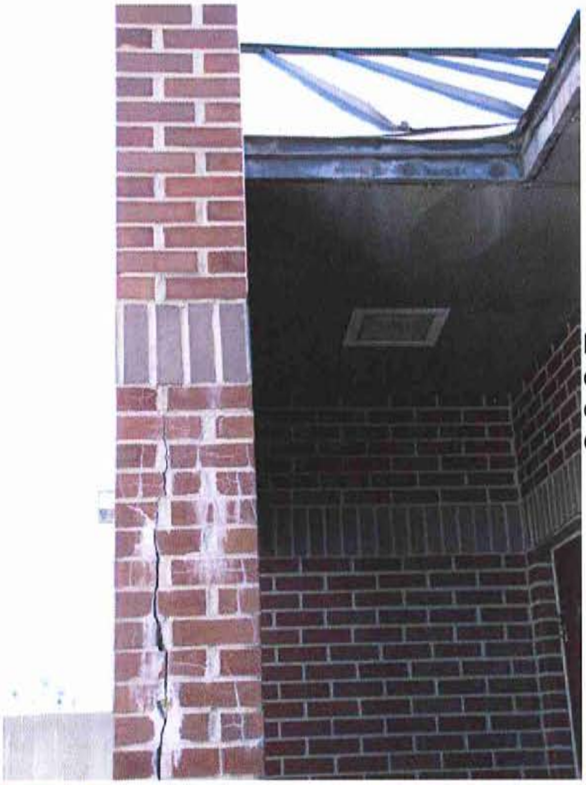

Photo 29: Lab/Admin - Closeup of NW corner of roof above main entry into building. Note severe crack in brick pilaster end.

Photo 35: Lab/Admin - Roof to wall flashing conditions at the south face of the wall end shown in photo 29. Note water can enter brick veneer cavity where the ice pick is stuck down into brick wall. Note ragged edge of brick ends and no sealant at vertical joint with wall flashing. Open joints between flashing and brick permit water entry into the wall.

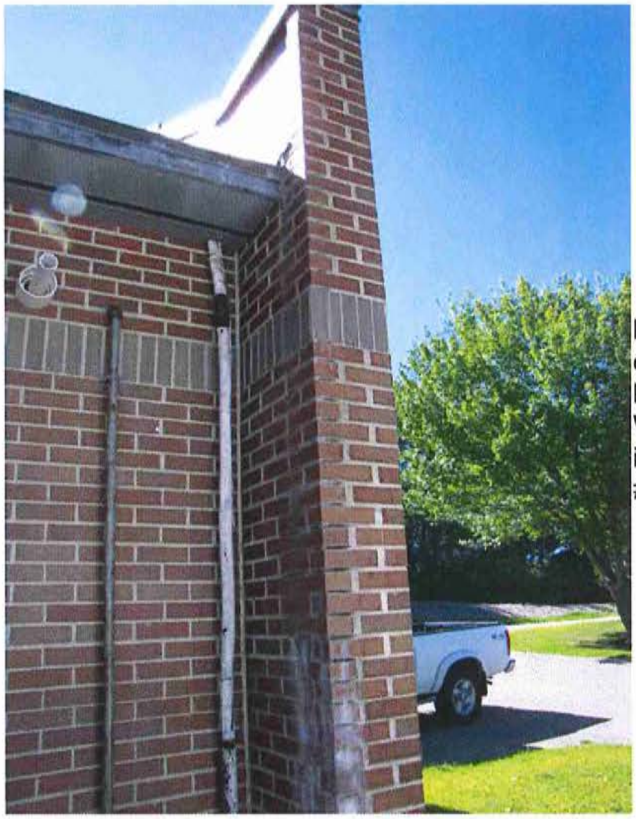

Photo 40: Lab/Admin - North end of west wall. Note shadow below parapet wall cap flashing. Wall flashing has pushed inwards. See close up photo #41.

Photo 41: Lab/Admin - Close up of metal flashing conditions from photo 40. There is insufficient backup material behind wall flashing to hold it in its proper location. Brick ends are ragged, preventing sealing to the folded flashing seam. There is no backer rod or sealant at the flashing to brick joint to prevent water infiltration. Sliding snow can easily get into this joint.

Photo 43: Lab/Admin - Vapor barrier and insulation conditions above women's room, permitting heat and moisture to escape into the attic space.

Photo 44: Control Building - General view of east side of building.

Photo 49: Control Building - View of west side of building, with north grit room addition on left end.

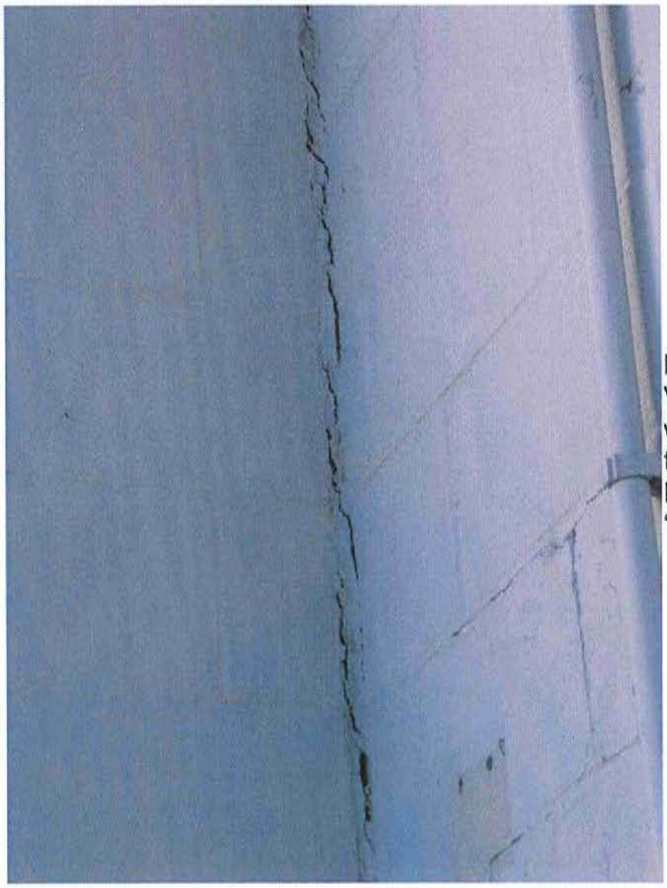

Photo 56: Control Building - View of vertical joint where south wall of grit room addition joins the west wall of the control building. Note separation of the "hard" (mortar) joint.

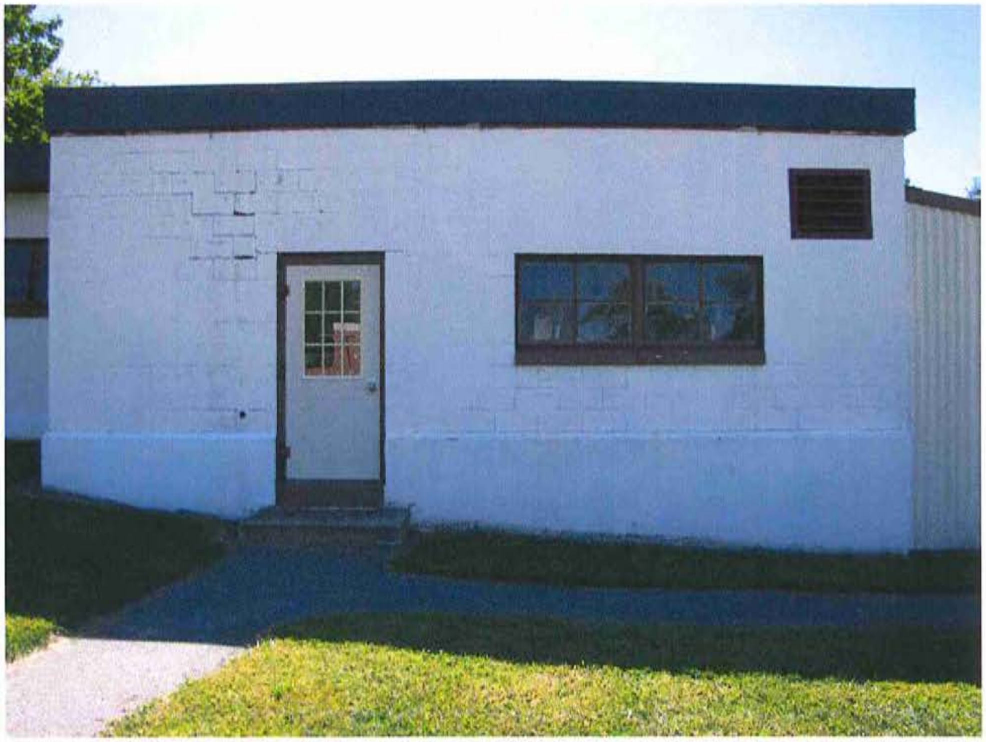

Photo 57: Control Building - North wall of grit room addition showing cracked masonry below the large window and above the door.

Photo 58: Control Building - Close up of the cracked masonry block mortar joints in photo 57, some with moss growing out of the joints.

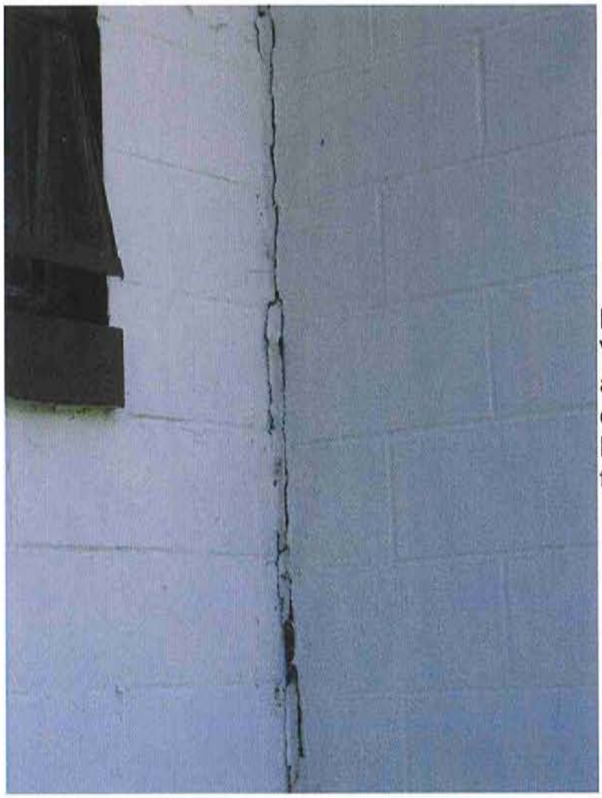

Photo 60: Control Building - View of east wall of grit room addition where it joins the original north wall of the control building, showing deterioration of the "hard" (mortar) joint.

Photo 62: Control Building - View of roof membrane looking north. Trees should be pruned back to prevent branches from sitting on membrane. Masonry block chimney needs re-pointing. Roof membrane is in good condition.

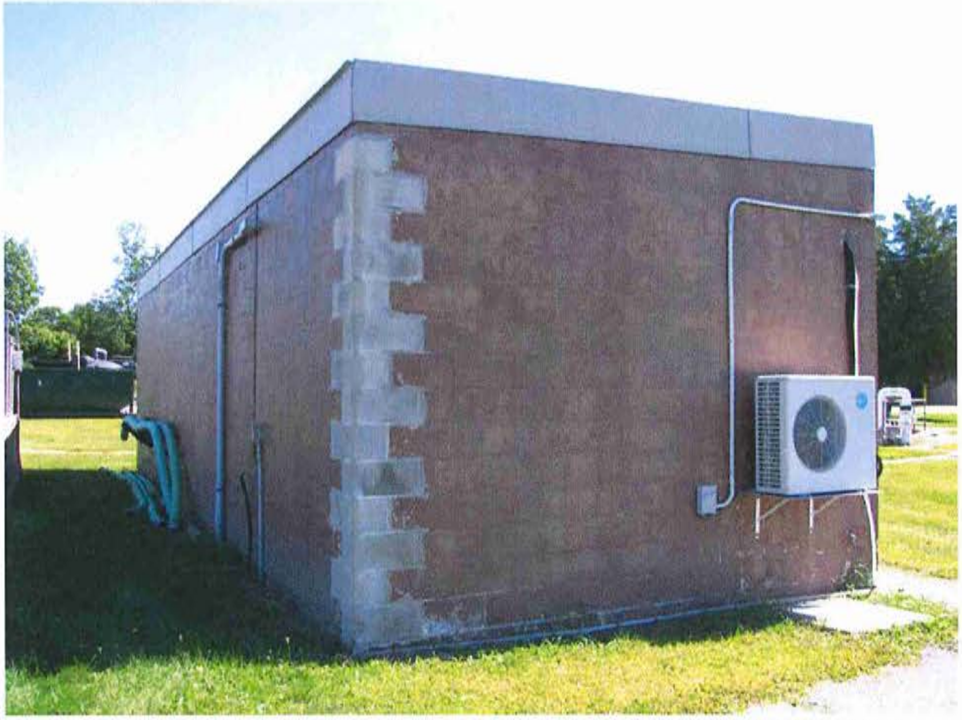

Photo 68: Intermediate Pump Station - View of repaired NW corner. Roof slopes down from right to left, permitting water to run down the face of the north (left) CMU wall.

Photo 69: Intermediate Pump Station - Cracked mortar joints in the north wall visible based on moss growing in the joints.

Photo 73: Intermediate Pump Station - View of north wall looking west, showing paint degradation and more moss growing in the mortar joints and on the wall face.

Photo 70: Intermediate Pump Station - View of south wall, with some paint degradation visible. Front right wall corner is cracked and in need of replacement and repair.

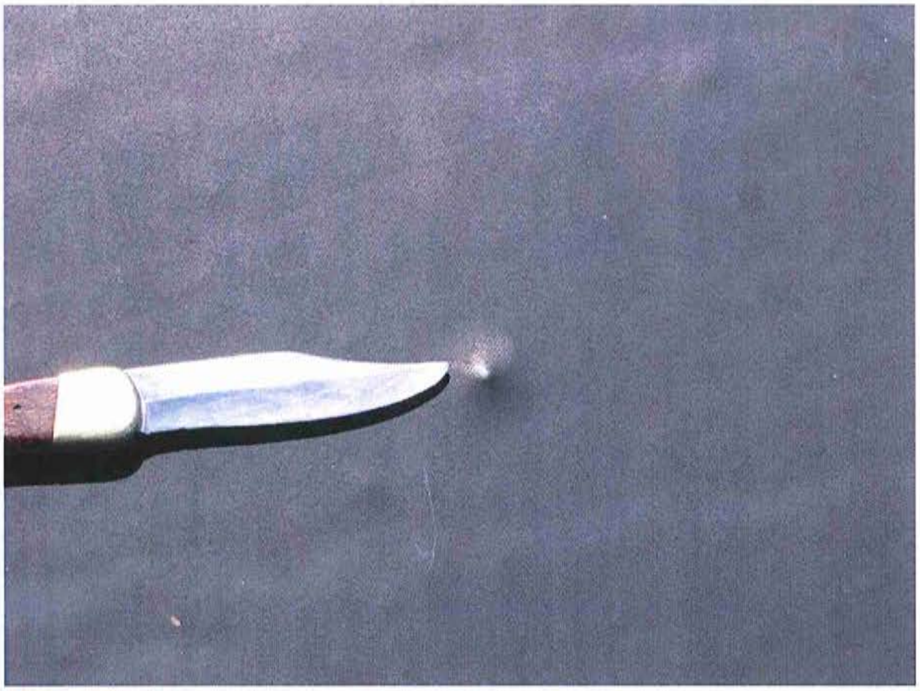

Photo 81: Intermediate Pump Station - Roof membrane with fastener below backing out and up into membrane. This will lead to a hole in the membrane.

Photo 83: Intermediate Pump Station - Roof membrane lap splice deterioration at knife location. Screws and nails should be removed from the membrane.

Photo 89: Sludge Storage Tanks - View of north connector wall with failed paint on masonry block.

Photo 92: Sludge Storage Tanks - Close up of photo 89, to the right side of small room with shed roof, showing mortar joint cracking and deterioration.

Photo 99: Blower Building - SE corner above 2nd floor, with brick cracked to the right side of the corner. See photo 100 for close up.

Photo 100: Blower Building - Close up of photo 99 showing cracked brick veneer. A control joint is needed at this location.

Photo 102: Blower Building - View of north wall at NE corner of building. See photo 103 for close up of brick cracking.

Photo 103: Blower Building - Close up of NE corner of building at 2nd floor level, showing crack extending up 9 brick courses above walkway of SBR tank. A control joint should be cut in place at this location.