PRELIMINARY DESIGN REPORT
for the
TOWN OF EXETER, NH
WWTF & MAIN PUMP STATION UPGRADE

October 2015

WRIGHT-PIERCE
Engineering a Better Environment

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE
PRELIMINARY DESIGN REPORT

OCTOBER 2015

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10.15.2015

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TOWN OF EXETER, NH – WWTF AND MAIN PUMP STATION UPGRADE PRELIMINARY DESIGN REPORT

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SECTION 1
INTRODUCTION & EXECUTIVE SUMMARY

1.1 PURPOSE OF THIS REPORT

The purpose of this Preliminary Design Report is: to document the basis of design for the components of the project for use in final design; to develop preliminary layout plans for the proposed improvements; to document alternatives analyses used in the selection of equipment or approaches; to refine the estimated project costs; to allow for value engineering; and to obtain Town and NHDES comments on the proposed project prior to proceeding with final design.

1.2 REPORT ORGANIZATION

This Preliminary Design Report is divided into the following sections:

1. Introduction
2. Design Considerations
3. Project Implementation
4. Preliminary Cost Estimate

Select information regarding equipment systems, technical memoranda and preliminary drawings can be found in the appendices to this report.

1.3 BACKGROUND

The Town of Exeter owns and operates a wastewater collection, treatment and disposal system which serves the Town of Exeter as well as small portions of the Towns of Stratham and Hampton. The collection system includes 9 pumping stations and approximately 51 miles of sewers. There are approximately 3,600 wastewater accounts.

The wastewater treatment facility (WWTF) is an aerated lagoon facility with disinfection that was constructed in 1964 and comprehensively upgraded in 1988. The WWTF discharges effluent into a tidally-influence segment of the Squamscott River (Class B), upstream of the

Great Bay. The WWTF outfall has a dilution factor of 25:1. The effluent must meet standards set forth in state and federal water quality legislation, including the Clean Water Act. The WWTF effluent quality requirements are contained in a National Pollutant Discharge Elimination System (NPDES) permit which is issued by the US Environmental Protection Agency (EPA).

EPA issued a new NPDES permit to the Town in December 2012, which included requirements that the existing WWTF is not able to accomplish. EPA then issued an Administrative Order on Consent (AOC) to the Town in June 2013. The AOC provides a framework and schedule for the Town to achieve compliance with the NPDES permit requirements.

This preliminary design report (PDR) builds upon the analysis, conclusions and recommendations outlined in the *Wastewater Facilities Plan* (Wright-Pierce, March 2015) for the physical upgrades proposed for the WWTF and the Main Pump Station.

The Town has been working diligently on the preliminary design since early April 2015, when the Board of Selectmen authorized the Wright-Pierce design contract. The preliminary design has included numerous workshops with the Town to obtain valuable input on this project. The Town DPW, Town Manager, Water and Sewer Advisory Committee and the Board of Selectmen have taken a keen interest in the preliminary design due to the magnitude of the dollars involved. The Town has never undertaken a project this large.

The Town directed Wright-Pierce to work on a "dual-track" to complete the preliminary design of a regional treatment approach at the Exeter WWTF site. Exeter is considering expanding its current regional role by incorporating increased flows from Stratham and potentially Newfields.

The Town closely followed and seriously considered a regional treatment approach in collaboration with the City of Portsmouth and the Town of Stratham. This was discussed at the meeting hosted in Exeter on February 24, 2015 which was attended by EPA, NHDES and representatives from numerous municipalities. As was discussed and agreed by all parties at the February 2015 meeting, a regional approach at the Pease WWTF location was worth taking some additional time to evaluate. After several months of study, the City of Portsmouth decided it would not move forward in this direction at a City Council meeting on May 18, 2015. The Town of Exeter reached the same conclusion at a Board of Selectmen meeting in July 2015.

To this end, there have been 4 workshops and meetings regarding process selection and phased construction of capacity. The Town is extremely focused on the affordability and sustainability of its wastewater infrastructure. These workshops culminated in a meeting on August 10, 2015 where the Water & Sewer Advisory Committee and Board of Selectmen indicated their desire to proceed in a phased manner as long as their permitted capacity could be retained. The Town directed Wright-Pierce to submit a letter to NHDES regarding whether phased construction would impact its permitted capacity. The request letter was submitted on August 12, 2015. Response letters were received from both EPA (dated August 20, 2015) and NHDES (dated August 21, 2015). These responses were very favorable but indicated that formal approval is subject to the full NPDES permit renewal process at some point in the future.

On August 25, 2015, the Water & Sewer Advisory Committee recommended that the Board of Selectmen vote to proceed with the project in a phased manner. This recommendation was based, in part, on correspondence from EPA (dated August 20, 2015) and NHDES (dated August 21, 2015) on the topic of maintaining the NPDES permit capacity of 3.0-mgd. One of the Selectmen was not present, so the Board of Selectmen did not formally vote and a follow-up meeting was scheduled to discuss. A combined Board of Selectmen/Water & Sewer Advisory Committee meeting was held on September 8, 2015. At that meeting, the Town elected to proceed with the project in phased manner (i.e., phased construction of capacity) and working with EPA and NHDES to maintain the NPDES permit capacity.

This Preliminary Design Report documents the recommended facility upgrades required for a 3.0-mgd design annual average capacity but proposed to construct the upgrades required for a 2.65-mgd design annual average capacity initial construction project (2.65-mgd via MLE process and 2.2-mgd via Bardenpho process). It is important to note that the 2.65-mgd constructed capacity is equal to the Town's projected flow needs in the planning period, as identified in the Wastewater Facilities Plan (Table 2-12). The Town is committed to designing and constructing a

WWTF which will achieve substantially better nitrogen removal than the minimum required by the AOC.

1.4 STATUS WITH REGARD TO THE REQUIREMENTS OF THE AOC

A summary of the AOC requirements, as well as the Town's current status/progress with regard to the requirements of the AOC (*indicated in italics*) is presented below.

- **June 30, 2016 [A.1]:** Initiate construction of the WWTF upgrade. *Based on the factors described above, the Town is currently behind schedule on this requirement. Refer to Section 3 of the PDR where the schedule is presented as well as potential approaches to reduce the amount of time needed to initiate construction are identified.*

- **June 30, 2018 [A.2]:** Achieve substantial completion of the WWTF upgrade. *See item above.*

- **September 30, 2018 [D.4]:** Submit a "Nitrogen Control Plan" for implementing specific control measures for non-point source and stormwater nitrogen loadings. *The Town-funded Wastewater Facilities Plan (Section 4) and the NERRS-funded (National Estuarine Research Reserve System) WISE Project Report represent significant progress towards the Nitrogen Control Plan. Additional work is planned in order to fulfill this requirement of the AOC.*

- **June 30, 2019 [B.2]:** Meet the interim effluent limit of 8 mg/l effluent TN. *See items above; however, it is expected that the upgraded facility will be discharging less than 8 mg/l effluent TN by this date (i.e. as a typical value vs a seasonal rolling average including the preceding six months).*

- **December 31, 2023 [E.2]:** Submit an engineering evaluation with recommendations to achieve the NPDES effluent TN discharge requirement of 3 mg/l or a justification for leaving the interim limit of 8 mg/l. *Work on this will begin after completion of the WWTF Upgrade and the Nitrogen Control Plan.*

- **Nitrogen Tracking [D.1]:** Begin tracking all activities that the Town should reasonably be aware of that affect the total nitrogen load to Great Bay Estuary. *The Town has been conducting nitrogen tracking since the submittal of the January 2014 annual report required by the AOC and will continue to do so.*

- **Coordination with NHDES and other Great Bay Communities [D.2,D.3]**: Begin coordination with the NHDES, other Great Bay communities, and watershed organizations in NHDES's efforts to develop and utilize a comprehensive subwatershed-based tracking/accounting system for quantifying the total nitrogen loading changes associated with all activities within the Town that affect the total nitrogen load to the Great Bay Estuary [D.2] and to develop a subwatershed community-based total nitrogen allocation." [D.3] *Town staff has been actively involved in the on-going NHDES PTAPP project. Town staff/elected officials/citizens have been actively involved in the recently completed WISE project. The Town will continue to coordinate with NHDES and the other Great Bay communities through PTAPP.*

1.5 DESIGN CAPACITY AND PHASED CONSTRUCTION

The August 2015 letters from EPA and NHDES indicated that the project must comply with the requirements of the NHDES design regulations (Env-Wq 700). Specifically, the NHDES letter provided a few specific citations. These citations, as well as how the Town has addressed them (*indicated in italics*), are summarized below.

- **Env-Wq 708.05(a)** – WWTP design and layout must include locations of forseeable future facilities on construction drawings. *The drawings indicate the location of the current proposed and future proposed facilities for the full 3.0-mgd design flow as well as potential future primary and tertiary treatment.*

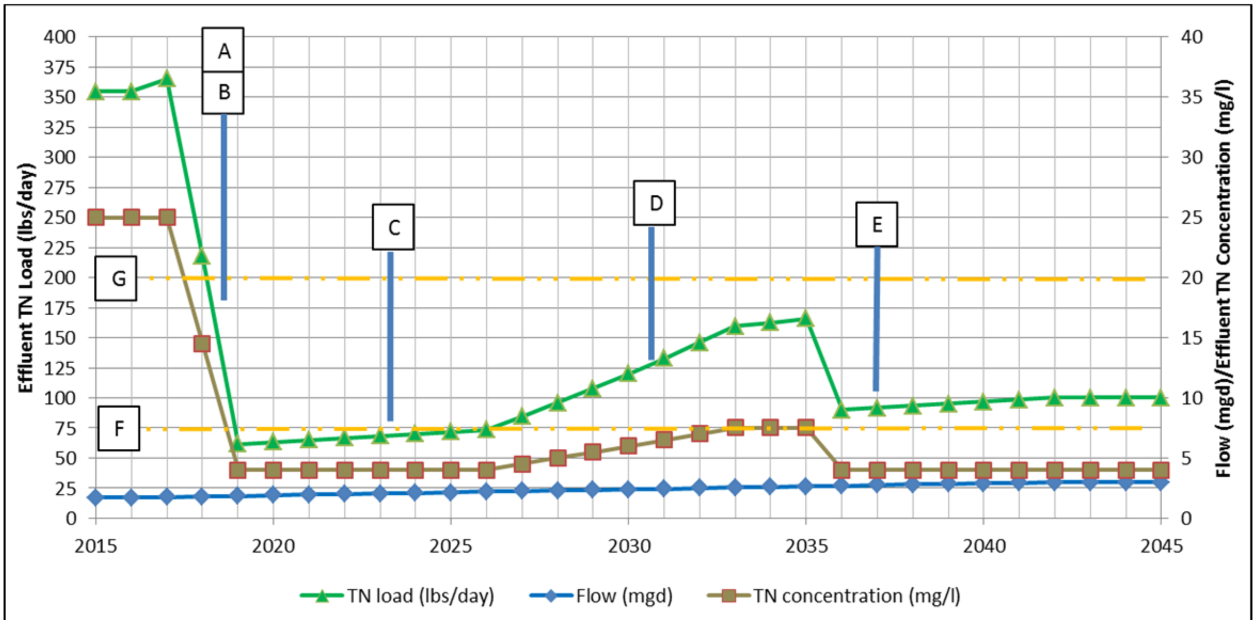
- **Env-Wq 708.05(b)** – WWTP hydraulics, sizing of conduits connecting unit processes, and flow distribution shall provide for future expansion. *The drawings indicate the hydraulic elevations and conduit sizes for the current proposed and future facilities for the full 3.0-mgd design flow.*

- **Exeter must meet the 80 percent design flow capacity or design loading capacity permit requirement for all permit conditions.** *The design flow for the future facility is 3.0-mgd (Bardenpho process). The design flow for the current proposed facility is 2.2-mgd (Bardenpho process, TN<5-mg/l) and 2.65-mgd (Modified Ludzack-Ettinger process, TN<8-mg/l). The proposed trigger flow is a 3-month average of 2.4-mgd; which is 80 percent of the design flow capacity for the 3.0-mgd facility.*

- **Exeter must consider the time to design, bid and construct additional facilities required to meet varying flow and loading conditions while maintaining compliance with the AOC.** *The AOC allows for an effluent total nitrogen concentration of 8-mg/l between April 1 and October 31 (seasonal rolling average). Based on our Biowin modeling, the MLE process will achieve this objective. The timeline to complete the funding, final design, bidding and construction of the additional facilities identified herein is approximately 30 to 36 months. Given the flow allowance between the MLE capacity (2.65-mgd) and the trigger capacity (2.4-mgd), sufficient time is available to complete those tasks.*

A graphical depiction of the conceptual wastewater flow (mgd), effluent TN concentration (mg/l) and effluent TN load (lbs/day) based on the phased construction of the design capacity is shown in **Figure 1-1** below.

FIGURE 1-1
CONCEPTUAL WASTEWATER FLOW, EFFLUENT TN CONCENTRATION AND EFFLUENT TN LOADS OVER TIME



A - Complete Initial WWTF Upgrade (2018)
B - Complete Nitrogen Control Plan (2018)
C - Complete Engineering Evaluation (2023)
D - Hit "Trigger Flow", beginning planning for Phase 2 Upgrade (2030)
E - Complete Phase 2 Upgrade (2036)
F - NPDES Permit Limit (75 lbs/day) based on 3.0-mgd at 3-mg/l effluent TN. Superseded by AOC (8-mg/l, no mass limit).
G - AOC Limit (~200 lbs/day) based on 3.0-mgd at 8-mg/l effluent TN.

If, based on the content of this PDR, EPA and NHDES agree that the design capacity is sufficiently addressed, then the following permitting approach could be considered:

- 2016 and 2017 – Complete design/bidding of WWTF Upgrade, initiate construction
- 2017 – Complete NPDES permit renewal application (on or before June 12, 2017, which is 6 months prior to permit expiration)
- 2018 and 2019 – Complete WWTF Upgrade construction and the Nitrogen Control Plan
- 2019 to 2023 – Implement Nitrogen Control Plan projects & develop Engineering Evaluation
- 2023 to 2024 – Evaluate progress with EPA/NHDES and act on 2017 NPDES renewal.

This potential permitting approach should be discussed among the Town, EPA and NHDES.

1.6 SCHEDULE

The AOC, which was issued in June 2013, calls for construction to be initiated by June 30, 2016 and to be substantially completed by June 30, 2018. A WWTF project of this size would typically take between 24 to 36 months from notice to proceed to substantial completion. This specific site includes numerous unique aspects, several of which were identified during the preliminary design efforts, which will extend the total construction duration longer than the 24 months originally envisioned in the AOC. Based on the nature of the work, we are currently anticipating 3 to 4 construction contracts. A detailed project schedule is included in Section 3 and indicates key design, permitting and construction phase assumptions and milestones. In short, based on the information contained in Section 3:

- Initiating AOC related construction will be approximately 6 months late.
- Completing AOC related construction will be approximately 6 months late.
- Completing construction overall will extend beyond AOC related construction.

The Town has asked that we identify specific approaches which could be taken in order reduce or eliminate the need to request an AOC schedule extension. Some approaches will shorten the design/permitting duration, some approaches will shorten the overall construction duration and some approaches will increase the overall construction duration but reduce the time required for just the AOC-related components. The potential measures are listed in Section 3. These measures will impact the cost of the design and/or construction efforts; however, the magnitude (i.e., amount, positive/negative) has not been developed at this time.

1.7 COST ESTIMATE

The Project Cost Estimate and the Construction Cost Estimates for the project are presented as **Tables 4-1** and **4-2**, respectively. The Project Cost Estimate for the full scope of construction (i.e., Contracts 1/2/3/4) described herein is \$56.7M to \$59.8M (based on Option 2 and Option 3 for lagoon decommissioning and wetlands restoration and creation, respectively). This is greater than the amount originally allocated to the project based on the Wastewater Facilities Study (\$51.87M). This differential is due to a number of modifications to the project approach from that identified in the Wastewater Facilities Plan as well as to an improved understanding of the site subsurface conditions and project needs during the preliminary design process. We have prepared a list of the factors associated with the cost increase in Section 4.1**.**

Given the AOC requirements, the preliminary design phase followed an aggressive schedule for a project of this size. Significant process and site layout work needed to be completed earlier than desired (i.e., before geotechnical work was completed). Ideally more time would have been available in order to fine tune the site layout based on the geotechnical information and the significant earthwork cuts/fills required. We have already initiated some these fine-tuning efforts in anticipation of the Value Engineering process and have identified approximately \$16M in potential cost savings or deferrals. A tabular summary of these items is included as **Figure 1-2** at the end of this section.

When working through potential cost savings items, it is critical to understand the inter-dependency of the various items, as a decision on one item may have a significant impact on a separate item. **Table 1-1** provides a listing of the major project components and identifies whether each is required for AOC compliance (or for a different reason) and how it is inter-related to the overall project.

FIGURE 2-1: PRELIMINARY COST AND TIME SAVING OPPORTUNITIES

	Preliminary Cost (C##) & Time (T##) Saving Opportunities	Savings Project Cost ($M)	Input/Preference					Decision	Savings ($M)	Cumulative ($M)
			WP	VE	DPW	WSAC	BOS			
C1	Eliminate future tertiary system from hydraulic profile.	$0.5								
C2	Eliminate Main Pump Station influent channels, channel grinder and odor control system.	$0.8								
C3	Reduce Headworks peak flow from 12.5-mgd to 6.6-mgd.	$0.7								
C4	Eliminate Septage Receiving and odor control system.	$0.9								
C5	Eliminate Headworks odor control system.	$0.1								
C6	Use diesel generators in lieu of natural gas generators at WWTF and Main Pump Station.	$0.6								
C7	Defer IEQ basin upgrade but construct IEQ pump station.	$0.5								
C8	Seek NHDES waiver on Disinfection Building enclosure for UV System.	$0.2								
C9	Seek NHDES waiver to reduce Sludge Storage Tank volume from 5 days at design maximum month (300kgal) to 5 days at design annual average (200kgal).	$0.4								
C10	Reconfigure the site plan to minimize costs associated with subsurface conditions.	$0.5								
C11	Reconfigure the Solids Handling Building and Sludge Storage Tanks to raise the dewatering operation to a higher elevation. Eliminate the Yard Pump station.	$0.5								
C12	Reconfigure the Headworks Building to incorporate Supplemental Alkalinity. Eliminate Supplemental Chemical Building and construct stand-alone Supplemental Carbon tank.	$0.4								
C13	Eliminate UV System, retain CCT and construct an addition to the Plant Water Building for Sodium Hypochlorite and Sodium Bisulfite storage and feed systems.	$0.4								
C14	Defer sludge removal and disposal from Aerated Lagoon Nos. 1, 2 & 3.	$3.8								
C15	Defer embankment removal and wetlands restoration of Aerated Lagoon Nos. 2 & 3.	$6.3								
T1	Postpone design of Contracts 2/3/4 and focus efforts only on design of Contract 1.	Not Est.								
T2	Prepare Lagoon Closure Plan and obtain Sludge Quality Certificates prior to bidding Contract No. 1; or issue an early site work contract to prepare the Sludge Storage Lagoon site in advance of bidding Contract No. 1.	Not Est.								
T3	Advance the design of Contract No. 1 concurrent with the 60% value engineering review as well as Town/DES/EPA reviews.	Not Est.								
	Preliminary Total Cost Savings	**$16.6**								

TABLE 1-1
INTER-DEPENDENCY OF PROJECT COMPONENTS

Project Component	Required for AOC	Required or Desired for Other Reasons	Inter-Dependency
Main Pump Station		X	Hydraulic profile
Main Pump Station forcemain		X	Hydraulic profile
Watermain extension	X		Fire protection for WWTF
Control Building Renovations	X		Staff, SCADA, Disinfection
Septage Building		X	None
Headworks Building		X	Hydraulic profile
Influent Equalization		X	Hydraulic profile
Primary Treatment (*Future*)		X	Hydraulic profile
Nutrient Removal Activated Sludge	X		Hydraulic profile
Tertiary Treatment (*Future*)			Hydraulic profile
Disinfection	X		Control Building
Solids Handling Building	X		Process
Sludge Storage Tanks	X		Process
Standby Generator	X		Process
Yard Pump Station	X		Process, hydraulic profile
Supplemental Chemical Building	X		Process
Plant Water Building	X		Process
Stormwater Treatment Basin	X		Site development
Maintenance Building		X	Displacing current space
Materials Storage Bins		X	Displacing current space
Decommission Sludge Storage Lagoon	X		Needed for new WWTF
Decommission Lagoon 1, 2, 3		NR	Not require until lagoons are out-of-service
Wetlands Restoration		NR	Preferred end-use when lagoons are out-of-service

1.8 NEXT STEPS

There are numerous critical and high priority tasks that need to be completed before final design can commence. These tasks, as well as the lead responsible parties, are identified below. ***Note: the project schedule presented in Section 3 of this PDR assumes that all of the following activities can be completed in 40 working days (60 calendar days).*** *It will take a concerted effort by all parties to complete these tasks in the allotted time. It is not unusual for these tasks to take longer than this and, if they do, the schedule will need to be extended.*

- Obtain Town, NHDES and EPA technical and permitting comments on the PDR.
- Obtain Town, NHDES and EPA direction on which time-saving items identified in Section 3 and on which cost-saving items identified in Section 4 are desired.
- Complete the Value Engineering process, including Engineer response and Town response.
- Obtain Town and NHDOT comments and approval on the proposed scope and traffic management concept for work in Route 85 (Newfields Road).
- Obtain Town and Unitil comments/agreement on the WWTF gas service request and WWTF access drive location based on the existing Unitil easements over Town land.
- Obtain input/concurrence from Town (legal counsel) on whether land acquisition or easements are required for any of the work items in the project.

Concurrent with the above tasks, initiate work on the following tasks:

- Conduct grant agency outreach
- Discuss preliminary approaches to cost-recovery from regional customers/partners
- Discuss initial strategies for Town Meeting warrant article
- Discuss additional data needs for final design, as identified in Section 3

1.9 ACKNOWLEDGEMENTS

The Preliminary Design Report is the culmination of many months of work. During this time, Town Public Works staff, Town volunteers (from the Water & Sewer Advisory Committee), elected officials (the Board of Selectmen), and NHDES staff generously provided their time and input to help guide the process.

Section 2

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SECTION 2
DESIGN CONSIDERATIONS

2.1 GENERAL

This section of the WWTP Preliminary Design Report provides an overview of the existing and new unit processes affected by the proposed upgrade. Basis of Design memoranda for process systems are included in APPENDIX A. Specific design considerations related to the Architectural, Structural, HVAC/Plumbing, Instrumentation/SCADA and Electrical disciplines are included in APPENDIX B. It is important to note that some of the design memoranda were prepared over the course of the preliminary design effort and, as such, there may be some information in Appendices which is not fully consistent with the content of this Section of the report. In those cases, this section of the report governs.

2.2 DESIGN FLOWS AND LOADS

The existing and design flows and loads for the project are presented in **Table 2-1, 2-2** and **2-3** are based on refined information from the Wastewater Facilities Study, including refined population growth projections. Additional information is presented in Appendix A.

2.3 EFFLUENT DISCHARGE LIMITATIONS

The Town's effluent discharge limitations are identified in its NPDES permit (Permit No. NH0100871, issued December 2012). The NPDES permit limits for the WWTF effluent (Outfall #001 to the Squamscott River) are summarized in **Table 2-4** (Facilities Plan Table 2-14). The mass limits for the WWTF are based on a design flow of 3.0-mgd. The NPDES permit limits for the permitted CSO (Outfall #003 to Clemson Pond) are summarized in **Table 2-5** (Facilities Plan Table 2-15). In addition the Town has a Groundwater Discharge Permit for the existing WWTF lagoons. The existing WWTF lagoons do not have impermeable liners. The NHDES recently issued the Town a Groundwater Discharge Permit to monitor the groundwater quality proximate to the lagoons (Permit No. GWP-198401079-E-001, issued January 2012). The sampling and monitoring requirements contained in the permit are summarized in **Table 2-6** (Facilities Plan Table 2-16). The effluent objectives for each of the processes are identified below in **Table 2-7**.

TABLE 2-1
EXISTING FLOWS AND LOADS SUMMARY

	Flow	BOD		TSS		TKN		TP	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Annual Average	1.71	150	2,138	178	2,544	21	306	3.2	45
Maximum Month	2.88	145	3,484	151	3,632	13	320	2.4	57
Maximum Day	3.75	135	4,210	140	4,376	15	480	2.5	77
Instantaneous Peak	5.65	-	-	-	-	-	-	-	-

TABLE 2-2
DESIGN FLOWS AND LOADS SUMMARY – FULL FACILITY

	Flow	BOD		TSS		TKN		TP	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Annual Average	3.0	200	5,000	236	5,900	33	815	4.8	120
Maximum Month	4.5	176	6,600	205	7,700	28	1,060	4.0	150
Maximum Day	6.6	183	10,100	196	10,800	27	1,470	3.6	200
Instantaneous Peak*	6.6	-	-	-	-	-	-	-	-

*Peak instantaneous flow managed via influent equalization.

TABLE 2-3
DESIGN FLOWS AND LOADS SUMMARY – PHASE 1

	Flow	BOD		TSS		TKN		TP	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Annual Average	2.6	197	4,000	231	4,600	30	655	4.2	90
Maximum Month	4.0	166	5,540	195	6,500	25	850	3.6	120
Maximum Day	5.5	184	8,460	198	9,060	26	1,180	3.6	166
Instantaneous Peak*	6.0	-	-	-	-	-	-	-	-

*Peak instantaneous flow managed via influent equalization.

TABLE 2-4
NPDES EFFLUENT LIMITS FOR WWTF

Parameter	Monthly Average	Weekly Average	Daily Maximum
Flow, mgd	Report	—	Report
BOD_5, mg/l	30	45	50
TSS, mg/l	30	45	50
pH, Std. Units	6.0-9.0	6.0-9.0	6.0-9.0
Fecal Coliform, #/100 mL	14	—	Report
Fecal Coliform, %	—	—	Report
Enterococci, #/100Ml	Report	—	Report
Total Residual Chorine, mg/L	0.19	—	0.33
Total Nitrogen, mg/l November 1 to March 31	Report	—	—
Total Nitrogen, mg/l (lb/d) April 1 to October 31, seasonal rolling average	3.0 (75)[1]	—	—
Whole Effluent Toxicity - LC50; % effluent	—	—	100
Total Recoverable Metals, mg/L Aluminum, Cadmium, Chromium, Copper Nickel, Lead, Zinc	Report	Report	Report
Ammonia Nitrogen as N, mg/L	Report	Report	Report

Note:
1) The AOC requirement is for 8.0 mg/l effluent total nitrogen, from April 1 to October 31, seasonal rolling average.
2) The AOC states that supplemental carbon is not required at any time during the year.

TABLE 2-5
NPDES EFFLUENT LIMITS FOR CSO #003

Parameter	Each CSO Event
Volume	Report
Escherichia Coli, #/100 mL	1,000
Duration	Report
1-hr and 24-hr rain gauge data (in.)	Report

TABLE 2-6
GROUNDWATER DISCHARGE PERMIT MONITORING REQUIREMENTS

Parameter	Sampling/Monitoring Frequency
WWTF Effluent Flow, mgd	Weekly
pH, Std. Units	May and November, each year
Escherichia Coli, #/100 mL	May and November, each year
Arsenic, Boron, Chloride, Nitrate, Total Kjeldahl Nitrogen, Total Phosphorus	May and November, each year
Static Water Level (ft)	May and November, each year
Water Temperature	May and November, each year
Drinking Water Metals and VOCs by EPA 8260B (including 1,4-Dioxane)	November 2014, May 2017

TABLE 2-7
TREATMENT REQUIREMENTS AND OBJECTIVES

	NPDES Limit	AOC Limit	Objective Bardenpho	Objective MLE
BOD	30 mg/l	n/a	10 mg/l	10 mg/l
TSS	30 mg/l	n/a	10 mg/l	10 mg/l
TN **	3 mg/l*	8 mg/l*	4± mg/l*	8 mg/l*

*Seasonal rolling average
**A separate stage process, installed in a future project, will be need to achieve the NPDES permit limit.

The existing WWTF was not designed to remove nitrogen from wastewater and, therefore, cannot meet the NPDES permit requirements. Accordingly, EPA issued Administrative Order on Consent (AOC) Docket No. 13-010. The AOC provides the Town with an interim effluent Total Nitrogen limit of 8.0 mg/l and provides a compliance schedule to achieve numerous specific tasks, as summarized below:

- June 30, 2016: Initiate construction of the WWTF upgrade.
- June 30, 2018: Achieve substantial completion of the WWTF upgrade.
- June 30, 2019: Meet the interim WWTF effluent limit of 8 mg/l Total Nitrogen.
- September 30, 2018: Submit a “Nitrogen Control Plan” for implementing specific control measures for non-point source (NPS) and stormwater nitrogen loadings to the Great Bay

Estuary (including Squamscott River) within the Town. The plan shall include a 5 year schedule for implementing the control measures.

- December 31, 2023: Submit an engineering evaluation with recommendations to achieve the NPDES TN discharge requirement of 3 mg/l or a justification for leaving the interim limit of 8 mg/l.
- Annually (beginning January 2014): Submit Total Nitrogen Control Plan Progress Reports to EPA and NHDES. The reports must include the following descriptions with sufficient information such that changes to Nitrogen loads within the watershed can be associated with individual sources of nitrogen.
- On-going: Take action to reduce NPS and stormwater sources of total nitrogen to the Great Bay, including: track all activities within the Town that affect TN including new/modified septic systems, decentralized WWTFs, changes to impervious cover, and any new or modified BMPs; coordinate with NHDES to develop and utilize a comprehensive subwatershed-based tracking/accounting system for quantifying the TN loading changes associated with Town activities; and coordinate with NHDES to develop a subwatershed community-based TN allocation.

2.4 PLANT HYDRAULICS

Plant hydraulic calculations are developed to estimate the hydraulic gradeline under a variety of flow scenarios and pipe conditions. The range of design flows for this project is summarized as follows:

Initial Minimum Day Flow:	1.00-mgd
Initial Minimum Month Flow:	1.20-mgd
Initial Average Flow:	1.71-mgd
Design Average Flow:	3.00-mgd
Design Maximum Month Flow:	4.50-mgd
Design Maximum Day Flow:	6.60-mgd
Design Peak Flow:	12.50-mgd (thru Headworks)
	6.60-mgd/ 6.0-mgd (downstream)

The preliminary design hydraulic analysis was based on information shown on the Sewerage Facilities, Contract Number 1 (J&B, 1979), Wastewater Treatment Facility Contract 10 (HTA, 1988) and WWTP Outfall Improvements (UEI, 2002) Record Drawings as well as the preliminary drawings provided herein. The hydraulic analysis assumes that no significant deterioration or restrictions, other than the normal pipe aging process, are present at the existing outfall or the existing-to-remain site piping. Additional calibration of the model will be conducted in final design. A summary of the key modifications to the WWTF hydraulics is:

- A new influent structure with forcemain connections for Exeter as well as Stratham and Newfields, if desired by the Town;
- A new Headworks Building with screening and grit removal equipment;
- Offline influent equalization basins within a portion of Lagoon 1 and a new Parshall Flume structure to monitor flow rate through the WWTF;
- A total of 3-feet of hydraulic head will be provided for future primary treatment;
- A two-train biological nutrient removal system with space for future expansion;
- Three new secondary clarifiers;
- A total of 6-feet of hydraulic head will be provided for future tertiary treatment;
- Modification to the CCT to include a new UV disinfection system;
- Retain the existing Parshall flume and replace the FRP flume insert;
- Retain the existing outfall without modifications at this time; and

The Town participated in the Climate Adaptation Plan for Exeter (CAPE) project with the purpose of considering 100-yr flood and storm surge for year 2070. In August 2014, CAPE team members provided preliminary model output to Wright-Pierce which indicated that flood elevations in the vicinity of the WWTF could increase to as high as EL 11 to 13 in the year 2070 due to the combined influence of sea level rise, storm surge and continued development within the watershed. The CAPE projected future flood elevation is below the existing grades at the Aerated Lagoon berms and the Disinfection Tank but is above the lowest hydraulic control point at the WWTF (i.e., the site would not be impacted but the hydraulic profile would be). The CAPE projected future flood elevation is at or above existing grade and the first floor of the Main Pump Station (i.e., the site and structure would be impacted).

The WWTF hydraulics would be significantly impacted by the projected CAPE flood elevation; however, it is cost prohibitive and premature to raise the hydraulic profile of the entire WWTF to accommodate the CAPE projected future flood elevation at this time. In the future, a combination of options will need to be evaluated, including: outfall modifications to reduce headloss, an effluent pump station and/or potentially an emergency outfall relief port set at an elevation which would only activate under an extreme flooding event.

The FEMA Flood Insurance Rate Map (FIRM Mapping revised April 2014) indicates the current 100-year flood elevation in the river in the vicinity of the WWTF and the Main Pump Station to be Elevation 8.0 (NGVD 1929). Accordingly, this project will utilize the following flood protection criteria: 1) provide for uninterrupted operation of all units under the current 25-year flood (estimated at EL 6.0); 2) protect WWTF structures and equipment from damage under the projected CAPE flood elevation (equivalent to the current base flood elevation plus 3 to 5 feet); and 3) match the existing level of protection at the Main Pump Station (equivalent to the current base flood elevation plus 3 feet).

2.5 UNIT PROCESS DESCRIPTIONS

The following sections present a summary of the existing-to-remain and proposed unit processes for the Main Pump Station and WWTF Upgrades.

2.5.1 Main Pump Station

Based on a review of WWTF flow and CSO flow data from 2011 to 2015, the peak flow to the Main Pump Station (MPS) is predicted to be 9 mgd several times per years and as high as 10 mgd very infrequently. The Main Pump Station receives flow from four separate sewer drainage areas which makes for dynamic influent sewer flow conditions. Since portions of the collection are quite old and are/were combined sewers, the influence of infiltration/inflow (I/I) on peak flows can vary significantly from each sewer drainage area. A preliminary SewerCAD model was developed of the sewers in the immediate area of the Main Pump Station. This SewerCAD model indicates that some parts of the gravity sewers to the MPS are undersized; however, it indicates that the peak influent sewer capacity to the station appears to be approximately 9.2 MGD to 9.7 MGD. The sewers to the Main Pump Station will be the limiting condition under certain storm events (i.e., those that produce more flow to the Spring Street

Diversion Structure). Since the Town is actively assessing and removing direct inflow sources in these sewer drainage areas, continued monitoring is recommended in conjunction with the pump station upgrade. See Appendix A for additional information.

The Main Pump Station upgrade will include the following key items:

- The new influent channel will have a new grinder (rated for 11.0-mgd) and a bypass channel. After the grinder the channel will split into two separate channels, which will have a cross-connection separated by a gate.
- The wet well will be separated into two wet wells to improve maintenance access. Each wet well will have an influent slide gate. Existing grout fill located within the wet well will be removed and new fillets installed.
- A ductile iron pipe with quick disconnects will be provided inside the wet well for connection to a vac-truck outside of the wet well to aid in grit removal and draining the wet well.
- The three existing pumps will be upgraded to four dry-pit submersible pumps sized to convey the full range of flows to the WWTF (1 MGD to 9 MGD, via lead/lag1/lag 2/standby). The pumps will be sized to decrease the frequency of combined sewer overflows (CSOs) caused by periodic high levels of infiltration/inflow. The stand-by pump will provide additional pumping capacity under peak influent flow conditions (approximately additional 1.0 MGD). Pumps will be provided with variable frequency drives (VFDs) for variable speed pumping.
- Miscellaneous process upgrades including new suction/discharge piping and valves, new core drilled holes for suction and discharge piping, and pressure injection of wetwell/drywell wall cracks will be provided.
- New PLC-based control panels with new instrumentation, including wetwell level sensing, combustible gas detection and wastewater flow.
- The electrical service, lighting, emergency lighting, fire alarm system, main power distribution and automatic transfer switch will be comprehensively upgraded. Refer to Electrical section for description of generator sizing. Process equipment will have local disconnects and ESTOPS.

- The building and building systems will be comprehensively upgraded, including: repairing the damaged base plates at the wall panels; replacing exterior doors; increasing ventilation rates to declassify the pump room, replacing the damaged stair nosings at the exterior stairs; replacing the roofing system; repainting the interior spaces; and upgrading the heating, ventilating and plumbing systems.
- A larger access hatch, monorail systems and lifting points will be provided to facilitate removal and installation the pumps.

2.5.2 Main Pump Station Forcemain/DPW Watermain

- One new 16-inch diameter ductile iron wrapped forcemain from the Pump Station to the WWTF (approximately 6,350 feet). The existing 16-inch diameter cast iron forcemain will be extended to the Headworks Building. The existing forcemain will continue to utilize the existing flow meter vault. A new isolation valve will be installed at the Main Pump Station.
- The new motor-operated gate valve will provide control over the existing forcemain. During periods of normal flow, only one forcemain will be required.
- New bypass connections will be installed on each forcemain. Suction for bypass pumping will be from a manhole upstream of the new influent channel.
- A new 12-inch diameter ductile iron wrapped water main from Water Street to the Public Works Complex will be constructed to provide potable water and fire protection flows (approximately 4,300 feet) for the Public Works Complex and WWTF.
- Contaminated soil and groundwater are anticipated to be encountered along Swazey Parkway and portions of Newfields Road from historic uses of the site. We have included costs for pre-treatment/testing of groundwater flows and for disposal of soils as Contaminated Waste. It is our understanding that the Town and Wright-Pierce will coordinate with historic site owners during the final design phase to coordinate plans for disposition and payment for contaminated soil and groundwater handling.

- For the preliminary design cost estimate, we have made the following key assumptions:
  - Based on Town direction, the watermain and forcemain will be less than 10 feet apart along Newfields Road. This is to allow for construction to occur in the south bound travel lane. The traffic control plan is to have alternating traffic in the area of construction along Newfields Road. This will be coordinated with the Town and NHDOT to allow for this to happen.
  - Trench patch pavement will match the existing thickness and be provided to a minimum of 5-inch thickness and a maximum of 8-inch thickness.
  - Final pavement overlay will be provided in the south-bound travel lane to a maximum 1.5-inch thickness and the impacted roads will be re-striped.
  - The anticipated work duration is 7.5 months of work (one full construction season).

2.5.3 Influent Flow Measurement and Sampling

- Both forcemains will be equipped with a magnetic flow meter.
- The existing influent sampler will be relocated from the Grit Building to the new Headworks Building.
- If "customer communities" are connected to the Exeter WWTF, they will measure and sample flows separate from Exeter's influent.

2.5.4 Septage Receiving

- A mechanical septage receiving unit (SRU) to provide for fine screening (1/4") and screenings washing/compaction will be provided. The septage receiving unit will include a flow meter to measure the volume of septage received from each hauling truck. The unit will be located in the existing Grit Building which will be repurposed as the Septage Building. Drains will be provided under the truck off-loading connection, rock trap, and SRU.

- A bypass channel will be provided with a manual bar rack for screening (1/2”) if the SRU is offline.
- The existing Grit Tank will be converted to a Septage Tank and will be upgraded including pressure injecting concrete cracks and adding instrumentation for level measurement. Volume within the tank will be increased by walling off the effluent and bypass channels (approximately 21,000 gallons effective volume).
- The Septage Building will be modified to include a new electrical room and a concrete cover above the septage tank with access hatches.
- The aeration system will be upgraded including one blower, coarse bubble diffusers, and aeration piping.
- A new septage chopper type pump will be constructed within the existing grit tank sump.

2.5.5 Screening and Grit Removal

- The existing Grit Building will be repurposed as a Septage Building.
- A new Headworks Building will be constructed with a cast-in-place concrete foundation and split-face concrete block walls.
- Grit removal will be completed by one vortex unitto separate grit from the influent wastewater using centrifugal forces. Vortex units are capable of maintaining grit removal rates across a moderate range of flows (10:1 turndown ratio). The vortex grit system has the advantage of not contributing unwanted dissolved oxygen to the secondary treatment influent. Requirements for the vortex grit system include a concrete grit structure and a paddle drive assembly.
- Collected grit will be pumped to a grit washer via two recessed impeller centrifugal pumps (lead / stand-by). The grit washer consists of a conical separator to wash organics from the grit which are drained back to the influent flow for treatment. Grit is then dewatered and conveyed to a roll-off cart via a dewatering screw.

- A multi-rake mechanical bar screen (1/4" spacing) with screenings wash press and by-pass manual bar rack will be constructed within the new Headworks Building. Collected solids are cleaned by multiple rake bars allowing for high screenings removal rates. Screenings will be deposited into a wash press for washing, compaction, and dewatering of influent screenings.
- Instrumentation, controls and SCADA connectivity will be provided for the Screening and Grit Removal systems.

2.5.6 Influent Equalization Basin

- Two off-line Influent Equalization (IEQ) Basins will be constructed within a portion of former Aerated Lagoon No. 1. The basins will be sized to limit the peak instantaneous flow rate and duration to the secondary treatment process. Influent flow will pass through the Headworks prior to being diverted to the equalization basins.
- A motor actuated weir gate will be constructed to act as an overflow weir and divert excess influent flow to the IEQ basins. The forward flow limit will be 6.0-mgd (operator adjustable) based on the phased construction of capacity (so-called "Option 6"). When the WWTF is upgraded in the future the forward flow limit will be raised to 6.6-mgd. The IEQ basins will be 2.0MG each. Flow will be directed to the IEQ basins during a portion of the day approximately 100 days per year under Phase 1 conditions and approximately 300 days per year under Phase 2 conditions.
- The weir gate will maintain the operator adjustable peak forward flow rate through the secondary process by adjusting the height of the weir gate based on the flow measured at the downstream Parshall flume. Structure 105, 102, and 101 (including existing piping and gates) will be reused to connect the Headworks Building to the IEQ Basins. A level element will be provided in each IEQ Basin to monitor water surface elevations.
- A triplex IEQ Pump Station with instrumentation (level, flow), controls, effluent flow metering, and SCADA connectivity will be constructed in order to pump

the IEQ basin contents back to the Headworks Building during lower flow periods. The pumps will be sized to convey 500-gpm to 1500-gpm.

- An overflow pipe will be provided in each IEQ basin above the maximum water level to allow overflow to supplemental equalization located in the remainder of Aerated Lagoon No. 1. An underflow pipe with gate valve in each basin will be provided to drain supplemental equalization back to the IEQ Basins and IEQ Pump Station. The dividing wall between the IEQ Basins will also have an overflow port set below the maximum water level.
- Tentatively eight existing floating aerators will be utilized to provide mixing and limited aeration within the IEQ basins. The total number of aerators needed, as well as which existing aerators are suitable for continued use, will be refined during Final Design. A minimum water depth of 2 to 3 feet will need to be maintained in the IEQ Basins for the aerators. Under low water surface elevations the aerators will be operated on repeat cycle timer. The aerators may need to be removed during the winter months.

2.5.7 Primary Treatment (Future)

- Space will be allocated on the site for a possible future primary treatment system, including an influent splitter structure, two primary clarifiers, primary sludge pumps, one gravity thickener, and piping. Three feet of hydraulic head will be built into the hydraulic gradeline to allow the potential future installation of primary treatment without additional pumping.

2.5.8 Advanced Secondary Treatment/ Nitrogen Removal

As phased approach to secondary treatment will be implemented (so-called “Option 6”). The phased approach is summarized as follows:

- Full Design: Three trains of Four-Stage Bardenpho (rated for 3.0-mgd with a total aeration tank volume of 2.7-milgal) and three secondary clarifiers.

- Phase 1: Two trains of Four-Stage Bardenpho (rated for 2.2-mgd) with a total aeration tank volume of 1.8-milgal. Operators will have the capability to easily change the process to MLE (rated for 2.65-mgd).

- Future Phase: Add the third aeration tank to increase Bardenpho capacity to 3.0-mgd.

Process Configuration

- The aeration tanks will include submersible internal recycle pumps, fine bubble air diffusers, and hyperboloid mixers in the anoxic and swing zones.
- The circular secondary clarifiers will be constructed with rapid sludge removal withdrawal mechanisms (center feed, peripheral weir).
- A new secondary scum pump station with one submersible chopper pump will be constructed and discharge to the sludge storage tanks.
- Four solids handling centrifugal return sludge pumps will be provided in the Solids Handling Building (one for each clarifier, plus standby).
- Two solids handling centrifugal waste sludge pumps will be provided in the Solids Handling Building (one duty, one standby).
- Three screw-hybrid positive displacement aeration blowers will be provided in the Solids Handling Building (two duty, one standby).
- A supplemental alkalinity system (magnesium hydroxide slurry) to maintain pH for process control (nitrification/denitrification) and effluent pH compliance will be constructed in Phase 1. This system will have a bulk liquid storage tank, two chemical feed pumps, and housed in the Supplemental Chemical Building near the aeration tanks along with the supplemental carbon system.
- A supplemental carbon storage and feed system will be constructed to achieve 3.5 to 5 mg/l effluent TN in Phase 1. This system will have a bulk liquid storage tank and three chemical feed pumps suitable for use with MicroC® or similar **non-combustible** products. The system will be housed in the Supplemental Chemical Building near the aeration tanks along with the supplemental alkalinity system.

2.5.9 Tertiary Treatment (Future)

- Space will be allocated on the site for a possible future tertiary facility, which would likely consist of a two or three train traditional filtration system (sand), including appurtenant pumping, chemical, instrumentation and control systems. Six feet of hydraulic head will be built into the hydraulic gradeline to allow for the potential future installation of tertiary treatment without additional pumping.

2.5.10 Disinfection

- The existing chlorination and dechlorination systems will be removed from the Control Building and from the Chlorination Building which will be renamed the Plant Water Building.
- A low pressure, high output UV disinfection system will be constructed in half of the existing Chlorine Contact Tank which will be renamed the "Disinfection Tank". Cracks and concrete deterioration will be repaired in the Disinfection Tank. Note, this work will reduce the effective contact time during construction, which will need to be compensated for with a higher hypochlorite dose.
- The UV disinfection system will be designed around a single manufacturer which will be selected by a competitive preselection process during Final Design.
- A ventilated building will be constructed around the UV disinfection system for year-round operation (Disinfection Building). The existing Disinfection Tank scum pump station will be upgraded and the discharge redirected to Junction Structure 3.
- The UV system will be connected to the WWTP's standby power source and the control panel will be equipped with an uninterruptible power supply.
- Instrumentation (level, flow, turbidity), controls and SCADA connectivity for the UV disinfection system will be provided. The UV System manufacturer will provide an integrated control panel with PLC dose pacing and local controls.

2.5.11 Effluent Flow Measurement and Sampling

- The existing Parshall flume insert will be upgraded and new ultrasonic instrumentation provided.
- The existing effluent sampler will be retained for continued use and upgraded to include flow-pacing capability based on effluent flow rate.

2.5.12 Outfall

- No modifications to the outfall or diffusers are anticipated within the planning period. See additional comments in Section 2.4.

2.5.13 Sludge Processing Systems

- A new Solids Handling Building with a sludge truck container bay will be constructed to house dewatering equipment, solids handling pumps, and blowers.
- Two new Sludge Storage Tanks will be constructed including fill and draw piping (waste sludge, scum, dewatering suction), overflow port, underflow port with sluice gate, fine bubble mixing/aeration system, decanting system and instrumentation (level elements, float switches. Sludge decanting will be provided by either manual telescoping valves system or by a manual slide rail pumping systems.
- The Sludge Storage Tanks volume is 300,000 gallons based on the NHDES regulation requirement to provide for 5 days of storage at design maximum month conditions. We believe that this requirement may not be intended facilities equipped with redundant mechanical dewatering capabilities; however, NHDES did not provide concurrence with this understanding. We would typically size sludge storage tanks for 3 days of storage under design maximum month conditions or 5 days of storage under design annual average conditions; which would reduce the tank size down to approximately 200,000 gallons. This cost-saving measure should be further evaluated with NHDES.

- The aeration system will consist of two variable speed, positive displacement blowers and fine bubble diffused aeration grids (sized for 30 to 40 scfm per thousand cubic feet).
- Dewatering of sludge will be by two centrifuges. Centrifuges provide high cake solids production and can adapt to varying sludge feed characteristics. For the Exeter WWTF, the centrifuge technology was found to have the lowest life cycle cost compared to other technologies. Each centrifuge will discharge to a covered shaftless screw conveyor connected to a common conveyor. The shared conveyor which will discharge to a reversing sludge bay conveyor with multiple discharge chutes to evenly fill the sludge dumpster / trailer.
- Two sludge feed pumps will feed sludge to the centrifuges. The feed pumps will be rotary lobe positive displacement type. The sludge feed pumps will be preceded by in-line sludge grinders (one on each feed pump suction line) to protect the pumps.
- Two polymer make-down systems will be provided. The systems will be liquid emulsion polymer type with space retained for a future dry polymer system, if desired by the Town in the future. Emulsion polymer systems are comprised of a neat polymer pump, in-line mechanical mixing device, ageing tank, and dilute polymer pumps. Polymer make-down units will have the ability to use either process water or plant water for dilution. The ageing tank and dilute polymer pumps provide additional polymer activation time and can decrease overall polymer consumption. The neat and dilute polymer pumps will be progressing cavity pumps to limit polymer feed pulsation.
- Space will be provided for two future potassium permanganate systems if additional odor suppression is desired or if primary treatment is added. The footprint will be based on two saturator type systems (one for each centrifuge) consisting of a storage tanks, automatic plant water addition and feed pumps. The saturator system requires addition of dry potassium permanganate which is mixed with water via a level controlled upflow system located at the bottom of the storage drum.

- Instrumentation, controls, and SCADA connectivity for the sludge processing systems will be provided.

2.5.14 Support Systems

- A new plant water system will be provided in the Plant Water Building (former Chlorination Building). Three vertical multi-stage centrifugal pumps will be provided with a suction duplex basket strainer, flow meter, discharge pressure element, and PLC-based control panel with SCADA connectivity. A hydropneumatic tank will be utilized. One pump will be a jockey pump sized to meet demand for systems which require a continuous or frequent flow. The remaining two pumps will be sized to accommodate peak water demands (washdown water, foam spray). The system has been sized to accommodate new and existing plant water flows at the WWTF including: process wash water (e.g., screenings wash press, centrifuge); chemical dilution/carrier water (e.g., supplemental alkalinity); pump seal water (e.g., return sludge, waste sludge, grit pumps); Aeration Tank foam spray water; and yard hydrants (two at once) and hose bibs.
- Backflow prevention devices will be provided at the water service entrance (town water vs on-site water) and where town water and process water (on-site non-potable water) connections exist.
- Space will be provided for an intermittent duty sodium hypochlorite system in the Solids Handling Building Lower Level. The space will have one chemical metering pump and space for two totes of sodium hypochlorite. The chlorination system will provide for miscellaneous process/filament control. A containment sump will be constructed to provide secondary containment for two 300-gallon totes.
- Four new Odor Control systems will be provided for the Main Pump Station, sludge processing areas, Septage Building, and Headworks Building. The systems will be activated carbon skid mounted systems with grease/mist eliminators located on a concrete pad outside of each treated location. Each skid

will have a local control station with SCADA connectivity. The odor control systems will manage air from the following sources:

  - OCS-1/Dewatering – From the centrifuge vents, screw conveyor vents and Sludge Truck Bay; on during dewatering operations and as desired. This system is strongly recommended and will be beneficial to the operators as well as minimize off-site odor propagation.
  - OCS-2/Headworks – From the channels and equipment; on/off based on operator preference. This system is discretionary.
  - OCS-3/Septage – From the Septage Tank and Septage Receiving Unit; on/off based on operator preference. This system is discretionary.
  - OCS-4/Main Pump Station – From the wetwell; on/off based on light switch and/or repeat cycle timer. There is no odor control at the pump station currently. This system appears warranted based on operator description of existing conditions and close proximity of neighbors. The odor control system will be located in the Wet Well Access Room to dampen any sound from the fan.

- A new Yard Waste Pump Station will be constructed to convey wastewater generated at the DPW complex buildings as well as the WWTF (i.e., sanitary, floor drain, washwater, centrate and decant flows). The system will be a skid-mounted triplex pump station with self-priming centrifugal pumps and will convey 500-gpm to 800-gpm. The pump station will discharge to Junction Structure No. 2 (prior to the Aeration Tanks). The size of the pump system is primarily driven by the centrate flow. A new concrete wet well will be constructed and the skid system placed over it with a manufacturer provided fiberglass enclosure. Controls will be by a PLC based control panel with SCADA connectivity. *Note: the Yard Pump Station could be significantly downsized if the centrifuges were elevated high enough to flow by gravity to Junction Structure No. 2.*

2.5.15 Sludge Storage Lagoon/Aerated Lagoon 1 Decommissioning

- Develop a Lagoon Closure Plan for NHDES review and approval, including Sludge Quality Certificate, for the Sludge Storage Lagoon and Aerated Lagoon.
- Remove accumulated sludge from the Sludge Storage Lagoon via mechanical removal. Segregate sludges for off-site disposal. Remove accumulated sludge from Aerated Lagoon 1 via hydraulic dredging, dewatering and off-site disposal. The sludge storage lagoon has not received sludge inputs in many years; ideally, this material could be excavated, stabilized and land applied.
- Construct the new WWTF in the footprint of the Sludge Storage Lagoon. Construct the Influent Equalization Basin and Pump Station in a portion of Aerated Lagoon 1.
- The cost estimate assumes that the accumulated sludge can be disposed of as an "unclassified waste" by a contractor. These costs are included in Contract 1 (WWTF Upgrade).

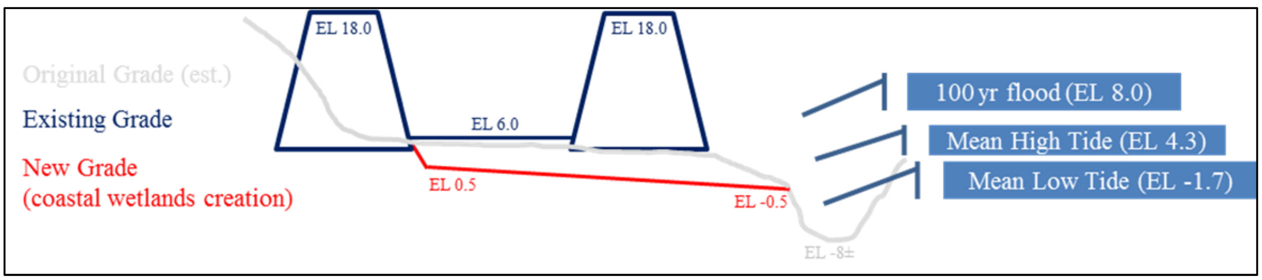
2.5.16 Aerated Lagoons 2 and 3 Decommissioning

- Retain Aerated Lagoons 2 and 3 for influent and/or effluent storage until such time as they can be removed from service.
- Develop a Lagoon Closure Plan for NHDES review and approval, including Sludge Quality Certificate, for Aerated Lagoons 2 and 3.Remove accumulated sludge from the lagoons via hydraulic dredging, dewatering and off-site disposal.
- The cost estimate assumes that the accumulated sludge can be disposed of as an "unclassified waste" by a contractor. These costs are included in Contract 4 (Lagoon Upgrades).
- Evaluate and select one of three approaches to the disposition of Lagoons 2/3 considering the cost, environmental benefit and potential grants available to implement the approaches. Also consider whether the lagoons can be utilized in an alternative discharge strategy (e.g., diurnal discharge, outgoing tidal discharge, seasonal spray irrigation, etc.). See **Table 2-8** and **Figure 2-1**.

TABLE 2-8
SUMMARY OF LAGOON OPTIONS

	Description	Environmental Benefits/ Challenges	Construction Cost	Grant Opportunity
1	No change. Utilize lagoons for influent/effluent storage.	No change in benefits or challenges.	$0M	None.
2	Remove lagoon embankments and re-establish original grade to restore upland wetlands. *Match "Original Grade".*	Restore flood plain; re-establish upland wetlands/ meadow. May be difficult to control phragmytes without a diligent management plan.	$2M	Lower dollar, lower likelihood
3	Remove lagoon embankments and construct new grades to create coastal wetlands. *Match "New Grade".*	Restore flood plain and create coastal wetlands habitat. Will naturally control phragmytes due to salinity and daily flooding.	$6M	Higher dollar, higher likelihood

FIGURE 2-1
SKETCH OF LAGOON OPTIONS



- Option 3 is the highest cost approach accrues the greatest environmental benefits and creates coastal wetlands habitat. Implementing this approach has regional benefits; accordingly, the Town of Exeter should only implement this approach if significant grant funds can be secured from outside entities.
- Option 1 is the lowest cost approach results in no change with regard to the flood plain or wetlands.
- ***Given the Town's obligations related to the AOC and the significant cost associated with site restoration, it is appropriate for this work to be a separate construction contract (i.e., Contract 4) and for the work to begin after 2019 (when Contracts 1/2/3 are complete). Costs for Contract 4 are presented as a range and do not include contributions from grant funding agencies.***

2.5.17 Civil-Site Improvements

- A new access drive from Route 85 to the new facilities will be constructed to address significant temporary construction traffic and permanent WWTF traffic on the existing Public Works facilities. Permanent WWTF related traffic will increase primarily due to biosolids hauling, chemical deliveries and septage deliveries (if septage is included).
- The existing site will be modified to address parking and access for vehicles, maintenance activities, chemical deliveries, septage deliveries and biosolids hauling.
- Stormwater management will be addressed for new and existing impervious areas, including stormwater harvesting for general purpose irrigation use and/or stormwater detention ponds or rain gardens. Stormwater will be discharged to the Squamscott River. The requirements of the draft MS4 permits and the Town's in-progress non-point source nitrogen management measures will be considered in final design.
- New and/or upgraded site piping systems for raw sewage, equalization flows, activated sludge, return/waste sludge, scum and chemicals will be constructed.
- The site will also reserve space for a modified snow dump (approximately 30,000 CY). Snow dump drainage will be routed through the stormwater treatment systems.
- Note that there is significant earthwork associated with this project; an estimated 75,000 CY of cut/fill are required for the WWTF work and an estimated 380,000 CY of cut/fill are required for the wetlands restoration work.

2.5.18 Architectural Improvements

- A new Headworks Building, Solids Handling Building, Disinfection Building (over the UV equipment), Supplemental Chemical Building, and Maintenance Garage will be constructed as described above.
- The existing Grit Building and Chlorination Building will be renovated and repurposed as described above (i.e., converted to the Septage Building and Plant

Water Building, respectively). The existing Control Building systems will be renovated to include space for the new staff needed at the facility.

- Renovations to the existing buildings will include: repairing the minor cracks in the exterior masonry walls; cleaning the moss and organic growth at the base of the walls; installing new sealants at the control joints and around the perimeter of all wall penetrations; replacing the shingle roofing and eave flashing; replacing vinyl siding at gable ends; replacing existing windows and doors; repainting the interior surfaces; and upgrading the heating, ventilating and plumbing systems. In addition, create new spaces in the Control Building to facilitate operations including converting the existing chemical rooms to occupied functions such as meeting/break room, locker rooms, control room, storage and a workshop and making the spaces ADA-accessible.

2.5.19 Structural and Geotechnical

- New concrete tanks and flow splitting structures will be constructed on-site for the treatment process.
- Existing concrete tanks will be repaired to maximize the life of the structures.
- Structures will be designed for snow/wind loadings, lateral earth pressures, hydrostatic lateral pressures, hydrostatic uplift pressures (buoyancy) and seismic forces (as applicable).
- The project structural engineer will closely coordinate with the project geotechnical engineer (Haley & Aldrich).
- The project geotechnical engineer completed site investigations in June 2015 along the Main Pump Station forcemain alignment and at the WWTF site. The data collected as a part of those investigations are detailed in the *Geotechnical Data Report* (August 2015), which is included as Appendix B.

2.5.20 Mechanical/Plumbing

- Mechanical and plumbing systems in renovated buildings will be upgraded including the Main Pump Station, Septage Building, Control Building, and Plant Water Building.
- Potable water will be extended to several new buildings.
- Gas services will be extended to several new buildings.
- A new gas service (approximately 4-inch diameter) from the gas main on Newfields Road is anticipated for the new loads at the WWTF. The existing gas service will be maintained. The new service needs to be coordinated with Unitil.

2.5.21 Instrumentation Improvements

- The existing SCADA system will be upgraded to incorporate the WWTF upgrade instrumentation, monitoring, control and alarming systems.
- The upgraded SCADA system will include four workstations – three in the Control Building and one in the Solids Process Building. New portable tablet systems will be provided for on-site and field use with one dedicated for use at the Main Pump Station.
- The existing radio telemetry system will be integrated in the new SCADA system.
- The alarming and report generation features will be upgraded.

2.5.22 Electrical Improvements - WWTF and Main Pump Station

- The utility service and main power distribution will be upgraded. The preliminary sizing of the new service entrance is 2500 ampere. The service entrance will be located in the new Solids Handling Building and all new and existing-to-remain buildings will be powered from this location.
- New standby generators and automatic transfer switches housed in a sound-attenuated, walk-in enclosure will be provided.

- The preliminary generator size for the WWTF is 725-kW. Sizing will be confirmed during final design. The unit will be gas-fired as long as the utility can provide the needed gas volume/pressure (10,000 cf/hr, up to 20 inches-water).
  - The preliminary generator size for the Main Pump Station is 350-kW. Sizing will be confirmed during final design. The unit will be gas-fired as long as the utility can provide the needed gas volume/pressure (4,600 cf/hr, up to 20 inches-water).
  - Coordination with the Unitil is on-going.
- The site duct bank system will be upgraded for power/signal/control distribution to existing and new buildings and tanks.
- Exterior site lighting for new driveways, tankage and buildings will be provided. Interior systems will include new energy efficient lighting, emergency lighting/exit signs, receptacles and addressable fire alarm system.
- Local disconnects and ESTOPS at process equipment will be provided.

2.5.23 Sustainable Utility Management Practices

The following types of sustainable utility management practices will be incorporated into the project:

- Plant water system will reuse treated effluent for numerous on-site water uses including washwater, flushing water, seal water, polymer makedown and chemical carrier water.
- Pumps and blowers will be sized for energy efficient operation at full duty range.
- NEMA premium efficiency motors will be used on all motors greater than 5 HP.
- Heat recovery systems will be used in the HVAC systems, where ever feasible.
- On-site stormwater will be managed for a net neutral or decrease in peak flow to the river and nearby wetlands.

- Solids handling systems will be designed to allow for off-site disposal of dewatered cake via truck as the primary method with off-site disposal of liquid sludge via truck as the backup method.
- Other measures which will be evaluated include: natural lighting; high efficiency lighting (with motion sensors in some locations); solar walls; effluent heat exchanger; air-to-air heat exchangers; energy recovery ventilators; minimization of impervious surfaces; and light-colored roofing for reduced solar gain.

Section 3

SECTION 3
PROJECT IMPLEMENTATION

3.1 PROJECT FUNDING

The Town will require both interim and a long-term financing for this project. Interim financing will be addressed by the Town independently. Long-term financing is expected to be via a loan from the NHDES CWSRF program. This project is ranked number 3 on the NHDES Draft 2015 SRF Project Priority List, including $2.5M in principal forgiveness. Project funding will be finalized during Final Design. CWSRF funding will include requirements for: Davis-Bacon wage rates; American Iron and Steel requirements; and Disadvantaged Business Enterprise (DBE) procurement goals.

3.2 STAFFING ANALYSIS

Currently, three personnel operate and maintain the existing WWTF including one Grade III operator, one Grade II operator and one full-time equivalent maintenance mechanics (two mechanics, part-time, shared with Public Works). The existing WWTF is a Grade II plant. Using the criteria established by NHDES in ENV-WS 901.18 ("Classification and Reclassification of Wastewater Treatment Plants"), the upgraded WWTF would become a Grade III facility after the Phase 1 upgrade and a Grade IV facility after the Phase 2 upgrade. Using the criteria established by EPA Publication MO-1 ("Estimated Staffing for Municipal Wastewater Treatment Facilities"), the upgraded WWTF is estimated to require five personnel.

3.3 INVASIVE SPECIES MANAGEMENT

The site contains a relatively large amount of invasive species, most notably the common reed (Phragmites) as well as lesser amounts of Purple Loosestrife, Japanese Knotweed, Oriental Bittersweet, Autumn Olive, Glossy Buckthorn, Multiflora Rose and Bush Honeysuckle. Given the level of site disturbance anticipated as a part of this project, invasive species management is necessary so as to not propagate these species further. An Invasive Species Management Plan

(Gove Environmental, September 2015) was prepared for the project and is included in Appendix B.

3.4 PERMITTING

The project involves renovation of existing facilities and construction of significant new facilities. In addition, the decommissioning of the lagoons creates a unique opportunity to restore coastal wetlands. Based on our understanding of the current project scope, expected permits are summarized below. Contact with the various permitting agencies, including pre-application meetings, will begin early in final design.

3.4.1 Federal Permits and Approval

1. NPDES Construction General Permit: Construction sites of greater than one acre are subject to a National Pollutant Discharge Elimination System (NPDES) Stormwater Permit for construction. The disturbed area for this project is anticipated to be greater than one acre; therefore, it will likely be necessary to apply for an NPDES Construction General Permit. This permit is applied for by the General Contractor as part of construction and will be covered in the Construction Costs.
2. NPDES General Permit for Dewatering: Construction dewatering activities in New Hampshire are subject to a General Permit for Dewatering. The depth of excavation will require a Dewatering Permit. This permit is applied for by the General Contractor as part of construction and will be covered in the Construction Costs.
3. Army Corps of Engineers (ACOE): The ACOE has regulatory jurisdiction over any navigable waterway. Removal of the berms along the lagoons as part of the decommissioning will alter the tidal patterns of the Squamscott River, and restore coastal wetlands. A Programmatic General Permit from the ACOE may not be needed for a non-controversial project approved by NHDES.
4. Federal Emergency Management Association (FEMA): Decommissioning of the lagoons will potentially alter the 100-year flood plain boundary for the

Squamscott River. As a result, a Letter of Map Revision or Amendment may need to be filed with the agency to reflect conditions after the decommissioning is complete. No disturbance is proposed within a 100-year flood plain (per FIRM number 33015C0402F).

3.4.2 State Permits and Approvals

1. Shoreland Zone Permit: The majority of the work at the WWTF and the Main Pump Station will occur within the protected shoreland zone as defined by NHDES. Work within this zone will likely require a Shoreland Water Quality Protection Act (SWQPA) permit. The Town of Exeter also has Shoreland requirements for work taking place within 300-feet of river, stream or wetland which is discussed under the local permit section (see below for additional information).
2. Alteration of Terrain (AOT) Permit: Construction sites with greater than 100,000 SF of contiguous disturbance or 50,000 SF if any portion is within a protected Shoreland, shall obtain approval from the NHDES AOT Bureau. The approximate contiguous area of disturbance associated with the proposed Exeter WWTF Upgrade is expected to be greater than 100,000 SF. An AOT permit will likely be required.
3. Wetlands: At this point in the design, the work at the Main Pump Station is greater than 100-feet away from the nearest wetland and therefore does not require a Wetlands Permit. Portions of the WWTF may be located within 100-feet or closer to wetlands and will require a Wetlands Permit. The decommissioning of the lagoons will disturb wetland areas adjacent to the river in order to restore the tidal flow within the former lagoon areas. It is likely this activity will require regulatory approval from NHDES and possibly ACOE.
4. New Hampshire Department of Historic Resources: It is not anticipated that this project will encounter or disturb any historic resources. However, a review of the project by the New Hampshire Department of Historic Resources (NHDHR) is required. This effort will be completed during Final Design. If additional

investigation efforts are required, they will be conducted following NHDHR's review.

5. Environmental Review: The NHDES Wastewater Engineering Bureau will conduct an Environmental Review for the project in support of the Town's request for funding under the State Revolving Fund. The project should be eligible for a categorical exclusion or "finding of no significant impact "(FONSI).
6. Design Review: The NHDES Wastewater Engineering Bureau will also conduct a Design Review of the PDR, 60% Review Submittal and 95% Regulatory Review Submittal for review and comment. The 100% Contract Set will be provided to the State for final approval to advertise and for their records.
7. NHDOT Design Review/Permit: A NHDOT permit will be required for the forcemain and watermain in Swasey Parkway and Newfields Road.
8. Lagoon Closure Plan/ Sludge Quality Certificate: A Lagoon Closure Plan is required for the overall site and a Sludge Quality Certificate for each lagoon.
9. Pesticide Application Permit: A permit will be required from the NH Department of Agriculture (Division of Pesticide Control) and a certified applicator will be needed for the invasive species management activities.

3.4.3 Local Permits and Approvals

1. Site Plan Review: Site Plan Review is generally required for all major projects in Exeter. The review is completed by the Town's Planning Board and includes a public hearing, letter of explanation, applicable fees, and waiver forms (where applicable). The Rockingham County Conservation District must also review the site plan. The Town is reviewing whether or not this project will be required to undergo a full Site Plan Review.
2. Shoreland Zone: A Conditional Use permit will be required due the work being within the Shoreland Protection District and potential small wetlands disturbances.
3. Wetlands Conservation Overlay District: A Conditional Use Permit will be required for work taking place within the buffers of wetlands present adjacent to

the project. Buffers vary from 25-feet for Inland Streams to 100-feet for Prime Wetlands.

4. Historic District Commission Review: Historic District Commission approval is not anticipated for this project because the project is not within the Historic District.
5. Building, Mechanical, Plumbing, and Electrical Permits: A building permit and inspection is required for the construction of new structures. These permits are available at the Town office and must be completed by the contractor completing the work. The Code Enforcement Office reviews each permit to ensure it meets applicable codes and regulations. These permits will be obtained by the Contractor. The Town is reviewing whether these permit fees will be waived.
6. Excavation Permits: An excavation permit will be required for the forcemain and watermain in Swasey Parkway and Newfields Road, including traffic/detour plan.
7. Value Engineering: The Town has stated that, given the size of the project, it intends to conduct formal value engineering at the 30% and 60% design milestones.
8. Coordination Regarding Contaminated Soil/Groundwater: Coordination regarding legacy pollutants and contaminated soil/groundwater will need to occur.
9. Burn Permit: A permit may be required from the Town for burning of harvested invasive species, if contractor proposes to utilize this method.

3.5 CONSTRUCTION SEQUENCING

The construction activities must be sequenced in order to maintain treatment performance and the contractor must ensure that permit limits and requirements are met for the duration of the project. The contractor must consider the following general constraints:

- Grit removal must be kept on-line at all times.

- Existing Lagoons 1, 2 and 3 will be kept on-line until the new treatment processes are completed, ready for operation, and pass performance requirements.
- Disinfection permit limits are in effect year-round. The new disinfection system must be installed and tested prior to removing the sodium hypochlorite and sodium hypochlorite chemical storage/pumping equipment (Control Building) and piping systems (site).
- Plant water must remain on-line at all times, except during the replacement of the system (Chlorination/Plant Water Building). The contractor shall be responsible for the cost of plant water during this change over.
- All mechanical/heating system work must be completed during the non-heating season (i.e., May 1 to September 30) and shall be fully functional during the heating season.
- Blasting shall be completed under "controlled blasting conditions" due to the proximity of sensitive utilities on the site (additional definition will be provided in final design).

There are many possible ways a contractor could sequence the project. The preliminary project constraints and preliminary sequence of construction are outlined below. A dedicated bypass pumping system is anticipated for the Main Pump Station work (by-pass pumping using the new bypass pump connection will be required at the Main Pump Station to terminate the existing forcemain piping and to connect the new forcemains to the new MPS pumps). Other bypass pumping or piping may be needed but is not anticipated to be significant.

Step 1 (<u>required</u> for AOC compliance)

- Obtain Sludge Quality Certification for Sludge Storage Lagoon.
- Address invasive species within the Sludge Storage Lagoon and along access road alignment.
- Remove and dispose of sludge from Sludge Storage Lagoon. Stabilize site and reach subgrade elevations.
- Continue wastewater treatment through Grit Building and Lagoons Nos. 1, 2 and 3.
- Construct the new access road
- Construct all elements of the new WWTF within the footprint of the former Sludge Storage Lagoon, including Headworks Building, Aeration Tanks, Secondary Clarifiers, Solids Handling Building, Sludge Storage Tanks, Supplemental Alkalinity and Carbon

systems, Odor Control Systems, Yard Pump Station, Scum Pump Station, including site structures and site piping.

- Connect piping from new Headworks Building/Diversion Structure to existing Structure 105 (which allows for peak flows to be directed to Aerated Lagoon No. 1 and/or 2 via existing Structures 102, 101 and 401).
- Construct new electrical service and standby generator
- Construct new UV disinfection system.
- Renovate the Control Building and Chemical Building (after UV disinfection is on-line).
- Install New SCADA System
- Start-up Step 1 facilities [***align completion date with completion of Step 2***]

Step 2 (<u>not</u> required for AOC compliance, but needed due to WWTF upgrades)

- Set up temporary pumping system
- Renovate the Main Pump Station
- Install the new forcemain from the Main Pump Station to the WWTF (new Headworks Building). Extend the existing forcemain from the DPW Complex to the WWTF (new Headworks Building). Bypass pumping will be required.
- Route all flow to Grit Building until Step 1 is complete. ***Note: Hydraulic gradeline is approximately 4 to 5 feet higher at new WWTF.***
- Install new water main to the DPW Complex and WWTF
- Start-up Step 2 facilities [***align completion date with completion of Step 1***]

Step 3 (<u>not</u> required for AOC compliance)

- Plug 24” pipe from Grit Building to existing Structure 105.
- Renovate Grit Building (to Septage Building)
- Obtain Sludge Quality Certification for Aerated Lagoon 1
- Address invasive species within Aerated Lagoon 1.
- Remove and dispose of sludge. Stabilize site and reach subgrade elevations.
- Construct Influent Equalization Basin walls/berms and IEQ Pump Station
- Start-up Step 3 facilities

Future Contract 4 (<u>not</u> required for AOC compliance)

- Obtain Sludge Quality Certification for Aerated Lagoon 2 and 3.
- Address invasive species within Aerated Lagoon 2 and 3.
- Remove and dispose of sludge. Stabilize site and reach subgrade elevations.
- Complete site restoration of Aerated Lagoon 2 and 3.

3.6 PROJECT SCHEDULE

The Town is under Administrative Order on Consent (AOC) to complete the WWTF portion of this project. The AOC, which was issued in June 2013, calls for construction to be initiated by June 30, 2016 and to be substantially completed by June 30, 2018. A WWTF project of this size would typically take between 24 to 36 months from notice to proceed to substantial completion. This site includes numerous unique aspects, several of which were identified during the preliminary design efforts, which will extend the construction duration longer than the 24 months originally envisioned in the AOC.

Based on the nature of the work, we are currently anticipating 2 or 4 construction contracts:

- Contract 1 - WWTF Upgrade (includes Steps 1 and 3 above)
- Contract 2 – Main Pump Station Upgrade (part of Step 2)
- Contract 3 (potential) – Forcemains and Watermain (part of Step 2)
- Contract 4 (future) – Lagoon Upgrades

A detailed project schedule is included at the end of this section and indicates key design, permitting and construction phase milestones.

3.6.1 Approaches to Improve Likelihood of Achieving AOC Dates

The Town has asked that we identify specific approaches which could be taken in order reduce or eliminate the need to request an AOC schedule extension. Some approaches will shorten the design/permitting duration, some approaches will shorten the overall construction duration and some approaches will increase the overall construction duration but reduce the time required for just the AOC-related components. Potential approaches are identified below:

- Prepare Lagoon Closure Plan and obtain Sludge Quality Certificate prior to bidding of Contract 1 or issue an early site work contract to prepare the Sludge Storage Lagoon site in advance of Contract 1.
- Advance the design concurrent with Town/DES/EPA reviews at the 60% and 90% submittal milestones; however, re-work resulting from significant comments will result in delays and potentially additional engineering fees.

These measures will impact the cost of the design and construction efforts; however, the magnitude (i.e., amount, positive/negative) has not been developed at this time.

3.6.2 Additional Considerations During Final Design

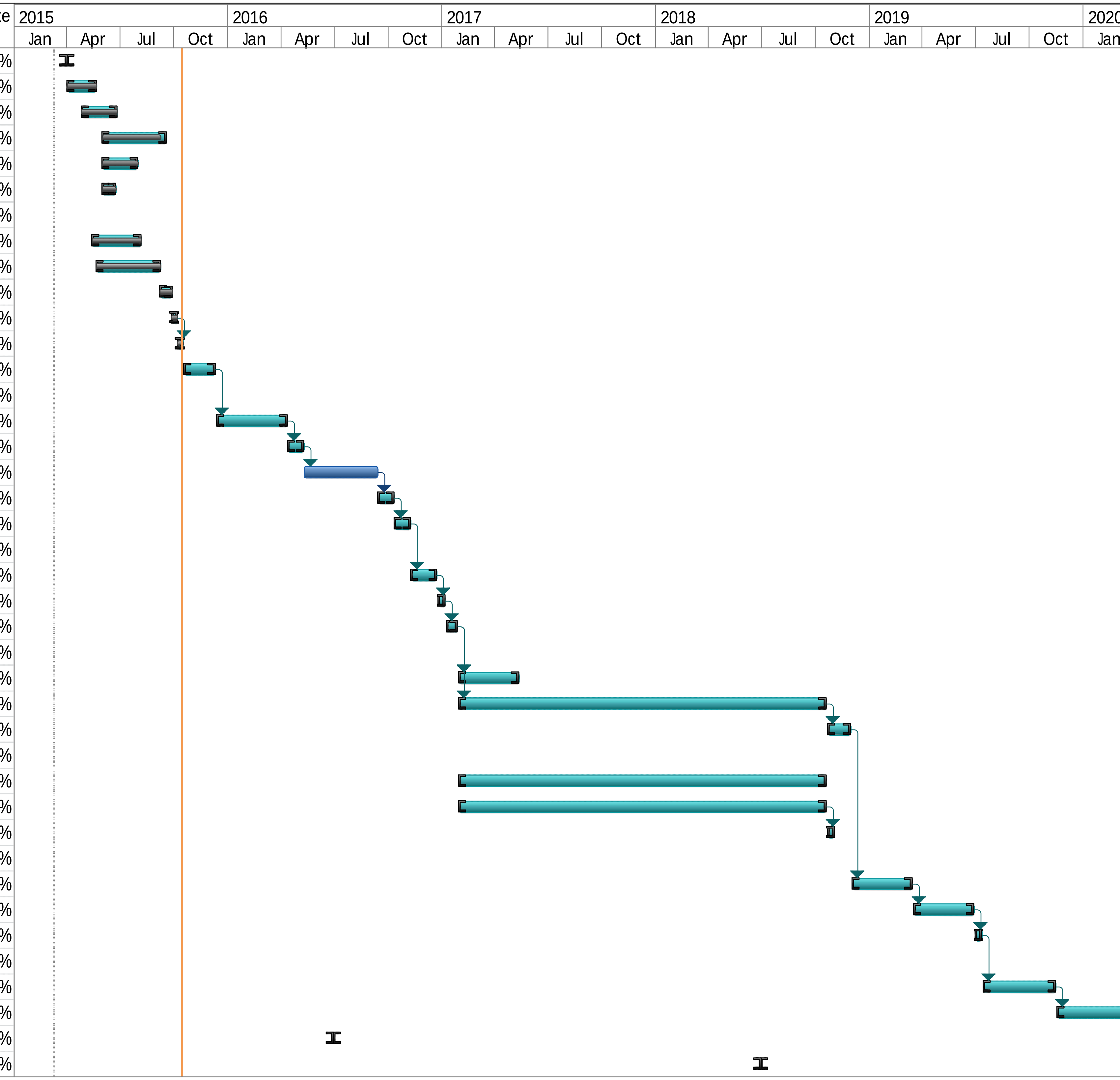
The following additional data will need to be collected during the Final Design:

- Additional 4 to 6 soil borings and/or ledge probes within the Sludge Storage Lagoon to refine structure location/depth and cost estimates related to subsurface conditions.
- Additional field work to quantify sludge in the Sludge Storage Lagoons to allow for better definition of site preparation requirements/costs and sludge disposal requirements/costs.
- Additional flow metering data is recommended within the collection system between the Water Street and Spring Street CSO structures, the CSO siphon structure and the Main Pump Station wetwell in order to refine the SewerCAD model.
- Acoustical testing of the existing Main Pump Station forcemain to determine if there are leaks. This would be accomplished with a SmartBall® via specialty contractor. This technique can identify relatively small leaks and can be inserted into the forcemain with only a brief interruption in service.
- It is recommended that the contractor perform invasive species management activities for 2 years following construction. Since this work will extend beyond the typical contract

duration and warranty periods, this item will need to be given consideration during the development of the Division 0 of the specifications.

- During construction, the Town may need to identify and utilize an alternative primary snow storage location. At a minimum, close coordination will be required with the Contractor so as not to interfere with construction activities.
- The Main Pump Station and Swasey Parkway sites are very sensitive in terms of public. Design layout and construction activities must minimize the loss of trees or tree canopy as a part of the finished project.

ID		Task Mode	Task Name	Duration	Start	Predecessors	Finish	% Complete
1	✓		Authorization to Proceed	1 day	Thu 4/2/15		Thu 4/2/15	100%
2	✓		Conceptual Design	37 days	Thu 4/2/15		Fri 5/22/15	100%
3	✓		Topo/Wetlands Surveys	45 days	Mon 4/27/15		Fri 6/26/15	100%
4			Geotechnical	80 days	Mon 6/1/15		Fri 9/18/15	90%
5	✓		Inv. Species Mgmt Plan	45 days	Mon 6/1/15		Fri 7/31/15	100%
6	✓		HazMat	18 days	Mon 6/1/15		Wed 6/24/15	100%
7			Preliminary Design					0%
8	✓		Calculations, Layouts	60 days	Fri 5/15/15		Thu 8/6/15	100%
9	✓		Phasing Decisions (Town)	78 days	Fri 5/22/15		Tue 9/8/15	100%
10	✓		Submittal to DPW	15 days	Tue 9/8/15		Mon 9/28/15	100%
11	✓		DPW Review Period	8 days	Mon 9/28/15		Wed 10/7/15	100%
12	✓		Submittal to Town/EPA/DES/VE	7 days	Thu 10/8/15	11	Fri 10/16/15	100%
13			Review Period (incl WSAC/BOS)	40 days	Mon 10/19/15		Fri 12/11/15	0%
14			Final Design					0%
15			60% Submittal	87 days	Mon 12/14/15	13	Tue 4/12/16	0%
16			Review Period	20 days	Wed 4/13/16	15	Tue 5/10/16	0%
17			90% Submittal	90 days	Wed 5/11/16	16	Tue 9/13/16	0%
18			Review Period	20 days	Wed 9/14/16	17	Tue 10/11/16	0%
19			100% Submittal	20 days	Wed 10/12/16	18	Tue 11/8/16	0%
20			Bidding					0%
21			Bidding/BOS Mtg	33 days	Wed 11/9/16	19	Fri 12/23/16	0%
22			Bid Evaluation	10 days	Mon 12/26/16	21	Fri 1/6/17	0%
23			Award/Notice to Proceed	15 days	Mon 1/9/17	22	Fri 1/27/17	0%
24			Construction - Step 1 (AOC)					0%
25			Prepare Sludge Lagoon Site	75 days	Mon 1/30/17	23	Fri 5/12/17	0%
26			WWTF Construction (450 wd)	450 days	Mon 1/30/17	23	Fri 10/19/18	0%
27			Startup Step 1 & Seed	30 days	Mon 10/22/18	26	Fri 11/30/18	0%
28			Construction - Step 2 (AOC)					0%
29			Main PS Upgrade (200 wd)	450 days	Mon 1/30/17		Fri 10/19/18	0%
30			Forcemain/Watermain (160 wd)	450 days	Mon 1/30/17		Fri 10/19/18	0%
31			Startup Step 2	10 days	Mon 10/22/18	30	Fri 11/2/18	0%
32			Construction - Step 3 (Not AOC)					0%
33			Decomission Lagoon 1	75 days	Mon 12/3/18	27	Fri 3/15/19	0%
34			Construct IEQ Basin & PS	75 days	Mon 3/18/19	33	Fri 6/28/19	0%
35			Startup Step 3	10 days	Mon 7/1/19	34	Fri 7/12/19	0%
36			Construction - Step 4 (Not AOC)					0%
37			Decommission Lagoon 2 and 3	90 days	Mon 7/15/19	35	Fri 11/15/19	0%
38			Complete wetland restoration	90 days	Mon 11/18/19	37	Fri 3/20/20	0%
39			AOC - Initiate Construction	1 day	Thu 6/30/16		Thu 6/30/16	0%
40			AOC - Complete Construction	1 day	Sat 6/30/18		Sat 6/30/18	0%



Project: Exeter WWTF Design and
Date: Thu 10/15/15

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline			
Split	External Tasks	Inactive Summary	Manual Summary	Progress			
Milestone	External Milestone	Manual Task	Start-only				
Summary	Inactive Task	Duration-only	Finish-only				

Section 4

WRIGHT-PIERCE
Engineering a Better Environment™

SECTION 4
PRELIMINARY COST ESTIMATE

4.1 COST ESTIMATE

A preliminary design cost estimate has been developed for the work described in this report. The estimated cost to construct or modify each of the affected unit processes was developed using standard cost estimating procedures utilizing preliminary design layouts, equipment quotations and unit cost information. Where appropriate, information derived from recent construction cost data was incorporated. This estimate incorporates construction cost estimates from civil, architectural, structural, HVAC/plumbing, instrumentation and electrical departments.

- Design contingency of 15% (for undeveloped items) of the construction cost estimate.
- Estimated construction inflation to mid-point of construction of 5%, based on the mid-point occurring in October 2017.
- Construction contingency of 5% of the construction cost estimate.
- Interim financing costs of 0.5% of the total project cost (i.e., 1% interest on 50% of the project cost)
- Allowances for hazardous materials removal (e.g., lead paint, asbestos, etc.) as well as for contaminated soil and groundwater disposal.
- Cost estimate is based on ENR Construction Cost Index 10037 (August 2015).

The Project Cost Estimate and the Construction Cost Estimates for the project are presented as **Tables 4-1** and **4-2**, respectively, at the end of this section. The Project Cost Estimate for the full scope of construction (i.e., Contracts 1/2/3/4) described herein is $56.7M to $59.8M (based on Option 2 and Option 3 for lagoon decommissioning and wetlands restoration and creation, respectively). This is greater than the amount originally allocated to the project based on the Wastewater Facilities Study ($51.87M). This differential is due to a number of modifications to the project approach from that identified in the Wastewater Facilities Plan as well as to an improved understanding of the site subsurface conditions and project needs during the preliminary design process.

This differential is due to modifications to the project approach from that identified in the Wastewater Facilities Study, "shifting of costs between construction contracts" in the estimate, and/or improved understanding of the site conditions and project needs during the preliminary design process. Some major examples include:

- Approximately $0.7M in added cost associated with additional ledge removal.
- Approximately $0.5M in added cost associated with invasive species management.
- Approximately $4.2M in added cost associate with additional excavation and disposal related to making the wetlands creation project.
- Approximately $0.6M in added costs associated with constructing a building around the UV system and increasing the Sludge Storage Tank size based on NHDES regulations.
- Approximately $1.0M in added cost associated with WWTF site improvements requested by the Town as part of the preliminary design (e.g., Maintenance Building, natural gas generator, roof over parshall flume, snow dump provisions, etc.).
- Approximately $1.1M in added cost associated with the Main Pump Station site improvements requested by the Town as part of the preliminary design (e.g., new influent channel, new grinder, odor control, natural gas generator, etc.). No costs have been included for implementing sewer system improvements. As described in Section 2, there are several existing conditions which limit peak influent sewer capacity which were identified as a part of the preliminary design phase. These additional costs are necessary to increase peak sewer capacity to the pump station from ~7.9 mgd to ~9.7 mgd.
- Approximately $0.1M in added cost associated with a one-lane overlay on Newfields Road.
- Approximately $4M in savings associated with selecting a phased construction approach.

Given the AOC requirements, the preliminary design phase followed an aggressive schedule for a project of this size. Significant process and site layout work needed to be completed earlier than desired. Ideally more time would have been available in order to fine tune the site layout based on the geotechnical information and the significant earthwork cuts/fills required. We have already initiated some fine-tuning efforts in anticipation of the Value Engineering process.

4.2 COST SAVING OPPORTUNITIES

It is not unreasonable to assume that a competitive bidding market with better-than-expected construction bids could result in a construction cost less than the estimate presented herein. Conversely, the risk exists for the actual cost to be higher. There are several approaches to addressing this budget issue, including: eliminating items from the project; modifying the scope of the project; and/or modifying the funding source(s). A list of potential items that could be considered, along with a preliminary estimate of *project cost reduction* for each item (i.e. compare to the costs indicated on **Table 4-1**), is identified below. This list is not prioritized and the projected cost savings are approximate.

1. Eliminate the future tertiary treatment system from the hydraulic profile and assume that, if required in the future, it would have an intermediate pumping station associated with it. Lowering the hydraulic gradeline of the aeration tanks and secondary clarifiers will results in additional ledge removal but less earthwork and will allow for the Yard Pump Station to be eliminated. (save $0.5M, plus annual O&M savings)
2. Eliminate new influent channels, channel grinders and odor control system at the Main Pump Station. (save $0.8M, however, this reduces CSO mitigation benefits)
3. Reduce design peak flow through the new Headworks from 12.5-mgd to 6.6-mgd by pumping directly from the Main Pump Station to the Influent Equalization Basin via the *existing* forcemain under peak wet weather conditions only (no screening and no grit removal) or by constructing the flow diversion upstream of the Headworks Building. This reduces flexibility but downsizes the Headworks Building. This may introduce more cleaning requirements in the IEQ Basins as flows increase in the future. Downsizing the Headworks will require a NHDES waiver. (saves $0.7M)
4. Eliminate Septage Receiving and associated odor control. (save $0.9M)
5. Eliminate Headworks Building odor control system. (save $0.1M)
6. Implement diesel generator in lieu of natural gas generators at the WWTF and Main Pump Station. (save $0.6M)
7. Defer IEQ basin upgrades (i.e., retain Aerated Lagoon 1 as is) but construct the IEQ pump station. (defer $0.5M, could have a minor impact on TN removal under cold weather conditions)

8. Seek NHDES waiver on Disinfection Building enclosure for UV System. (save $0.2M)
9. Seek NHDES waiver to reduce Sludge Storage Tank volume from 5 days at design maximum month (300,000 gallons) to 5 days at design annual average (200,000 gallons). (save $0.4M)
10. Reconfigure the site plan to minimize costs associated with subsurface conditions. A conceptual site plan is included as **Figure 4-1** at the end of this section. (save $0.5M)
11. Reconfigure the Solids Handling Building and Sludge Storage Tanks to raise the dewatering operation to a higher elevation such that the Yard Pump Station can be eliminated. This would result in a Process Building (for blowers , pumps and electrical gear) and a Dewatering Building (for dewatering, truck bay and sludge storage). Conceptual building plans are included as **Figures 4-2, 4-3, 4-4** and **4-5** at the end of this section. (save $0.5M)
12. Reconfigure the Headworks Building to incorporate Supplemental Alkalinity. Construct stand-alone, outdoor Supplemental Carbon System. Eliminate Supplemental Chemical Building. (save $0.4M)
13. Eliminate UV System, retain CCT and construct an addition to the Plant Water Building for Sodium Hypochlorite and Sodium Bisulfite storage and feed systems. (save $0.4M)
14. Defer sludge removal and disposal from Aerated Lagoon 1 (partial), 2 and 3. (defer $3.8M)
15. Defer embankment removal and wetlands restoration at Aerated Lagoon 2 and 3 until grant funding agencies can be secured to offset additional costs. (defer $6.3M)

Given the rate payer affordability concerns, the Town will undoubtedly want to take advantage of some of the above referenced cost saving opportunities as well as opportunities identified in the value engineering process. Any combination of these items could be implemented as cost-savings measures. Ultimately, the Town will to make the cost saving decisions considering both the capital cost savings and the associated operational trade-offs. Any and all cost-saving measures, phasing and/or Bid Alternates decisions will need to be selected prior to the commencement of Final Design.

TOWN OF EXETER, NEW HAMPSHIRE
WWTF PRELIMINARY DESIGN
W-P PROJECT NO. 12883B
ENR INDEX 10037 (September 2015)

TABLE 4-1
ESTIMATED CAPITAL COSTS FOR CONTRACTS 1, 2, 3 AND 4
BEFORE VALUE ENGINEERING

Project Component		**CONTRACT 1** WWTF TN 4 mg/l	**CONTRACT 2/3** Main Pump Station FM & WM	**CONTRACT 4** Lagoon Decommissioning	**Notes**
Construction		$34,400,000	$5,050,000	$8,720,000	1
Construction Contingency	5%	$1,720,000	$250,000	$440,000	2
Technical Services		$6,880,000	$1,010,000	$870,000	3
Value Engineering		$60,000	$0	$0	4
Materials Testing	0.25%	$90,000	$10,000	$20,000	5
Asbestos and Lead Paint Abatement		$0	$10,000	$0	6
Activated Sludge Seeding		$10,000	$0	$0	
Direct Equipment Purchase		$0	$0	$0	7
Land Acquisition/Easements		$0	$0	$0	7
Legal/Administrative		$10,000	$10,000	$10,000	8
Interim Financing	0.5%	$220,000	$30,000	$50,000	9
ENGINEER'S ESTIMATE		$43,390,000	$6,370,000	$10,110,000	10,11
EngEst Amounts from Facilities Plan		*$39,830,000*	*$5,070,000*	*$6,970,000*	
Differential from Facilities Plan		*$3,560,000*	*$1,300,000*	*$3,140,000*	
% differential from Facilities Plan		*9%*	*26%*	*45%*	
TOTAL - CONTRACTS 1 TO 4		$59,870,000	<< Note 12		
Total from Facilities Plan		*$51,870,000*			
Differential from Facilities Plan		*$8,000,000*			
% differential from Facilities Plan		*15%*			
TOTAL - CONTRACTS 1/2/3		$49,760,000	<< For Town Meeting 2016		

Notes
1.) Construction cost estimate details provided in Appendices. Costs based on ENR CCI 10037.
2.) Construction contingency is an allowance at 5% of construction cost.
3.) Technical services is an allowance at 20% of construction cost for Contracts 1/2/3 and 10% for Contract 4.
4.) Value engineering is an allowance assuming two sessions.
5.) Materials testing is an allowance based on similar sized projects.
6.) Asbestos and lead paint is not anticipated at the WWTF site, but should be evaluated at the Main Pump Station site.
7.) None anticipated
8.) Legal/administrative costs are for bond counsel and project advertisements.
9.) Financing is an allowance based on assumed interim financing costs at 0.5%.
10.) DES estimate for 5 mg/l effluent TN for Exeter was $44M ("Analysis of Nitrogen Loading Reductions for WWTF and NPS in the Great Bay Estuary Watershed", Dec 2010, ENR 8660).
11.) Contract 4 represents the cost for Option 3 "coastal wetlands creation" (Section 2.5.16), which is more than identified in the Wastewater Facilities Plan. The total cost for Option 2 "upland wetlands restoration" (Section 2.5.16) is $6.9M, which is the same as was identified in the Wastewater Facilities Plan. Under either scenario, approximately $3.8M is related to sludge removal and disposal.
12.) Total cost of $59.8M includes Contract 4/Option 3 ("coastal wetlands creation").
Total cost is $56.7M with Contract 4/Option 2 ("upland wetlands restoration").
Total costs is $53.5 with Contract 4/Option 1 ("keep lagoons for storage").

TOWN OF EXETER, NEW HAMPSHIRE
WWTF PRELIMINARY DESIGN
W-P PROJECT NO. 12883B
ENR INDEX 10037 (September 2015)

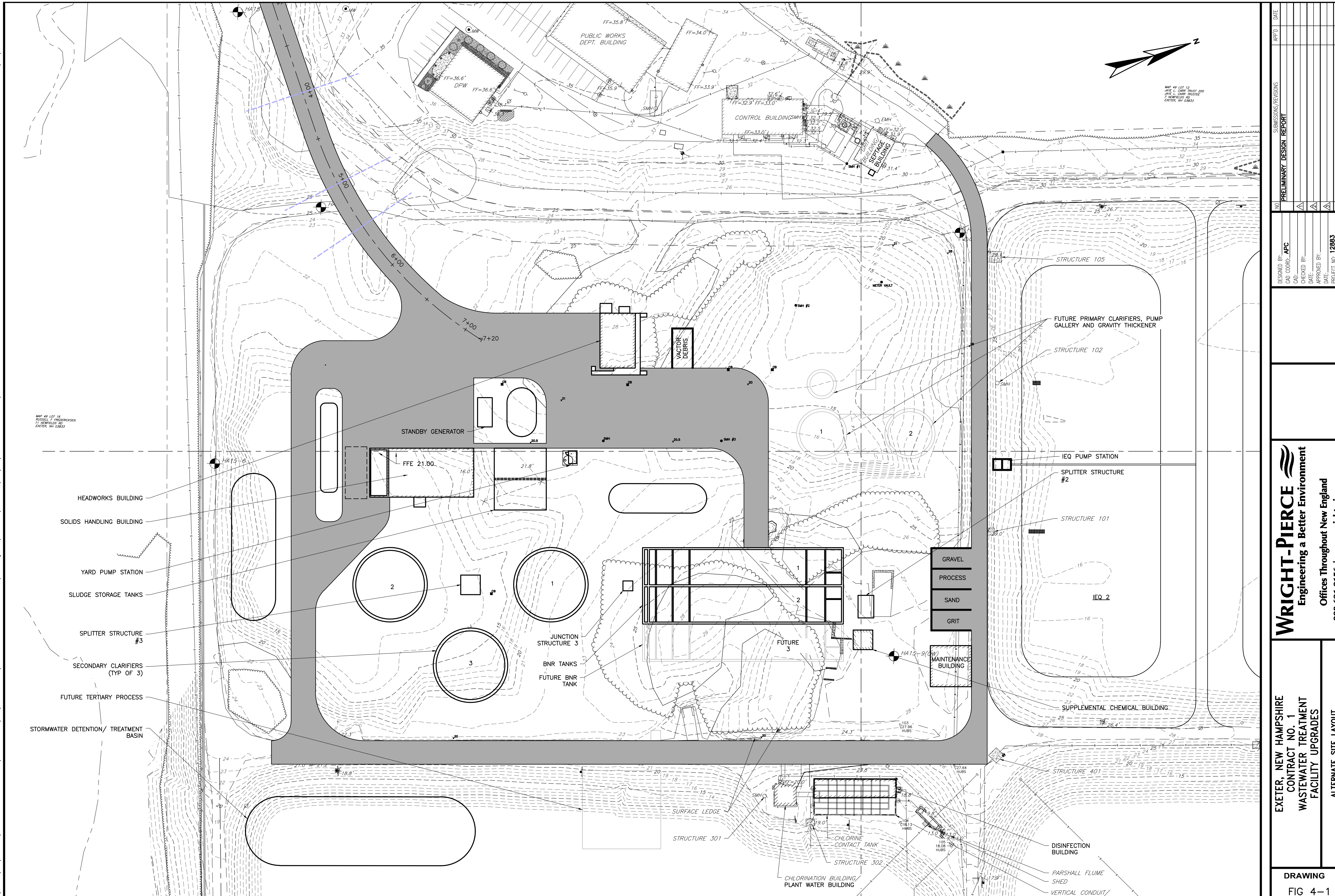
TABLE 4-2
CONSTRUCTION COST ESTIMATE FOR CONTRACTS 1, 2, 3, AND 4
BEFORE VALUE ENGINEERING

DESCRIPTION	CONTRACT 1 WWTF TN 4 mg/l	CONTRACT 2/3 Main Pump Station FM & WM	CONTRACT 4 Lagoon Decommissioning
CIVIL			
MPS FORCEMAIN & WATERMAIN		$1,650,000	
MPS SITE PIPING AND SITE WORK		$100,000	
WWTF DEMOLITION	$225,000		
WWTF SITE WORK	$1,150,000		
WWTF SITE DRAINAGE	$264,000		
WWTF INVASIVE SPECIES MANAGEMENT	$450,000		
WWTF ELECTRICAL DUCTBANKS AND PADS	$125,000		
WWTF SITE PIPING	$1,540,000		
ARCHITECTURAL			
MAIN PUMP STATION MODIFICATIONS		$92,000	
CONTROL BUILDING MODIFICATIONS	$302,000		
GRIT BUILDING MODIFICATIONS (SEPTAGE RECEIVING)	$78,000		
HEADWORKS BUILDING (NEW)	$416,000		
CHEMICAL BUILDING MODIFICATIONS (PW BLDG)	$62,000		
DISINFECTION BUILDING (NEW)	$78,000		
SOLIDS HANDLING BUILDING (NEW)	$921,000		
SUPPLEMENTAL CHEMICAL BUILDING (NEW)	$187,000		
MAINTENANCE GARAGE (NEW)	$149,000		
PROCESS EQUIPMENT & PIPING FINISHES	$100,000		
STRUCTURAL			
MAIN PUMP STATION CHANNELS & VAULT		$150,000	
CONTROL BUILDING MODIFICATIONS	$19,000		
GRIT BUILDING MODIFICATIONS (SEPTAGE RECEIVING)	$43,000		
HEADWORKS BUILDING (NEW)	$442,000		
CHEMICAL BUILDING MODIFICATIONS (PW BLDG)	$10,000		
DISINFECTION MODIFICATIONS	$110,000		
INFLUENT EQUALIZATION	$50,000		
AERATION TANKS / BNR (NEW)	$2,500,000		
SECONDARY CLARIFICATION & SCUM SYSTEM (NEW)	$1,900,000		
SOLIDS HANDLING BUILDING (NEW)	$875,000		
SUPPLEMENTAL CHEMICAL BUILDING (NEW)	$55,000		
MAINTENANCE GARAGE (NEW)	$84,000		
YARD WASTE PUMP STATION	$50,000		
PARSHALL FLUME	$20,000		
SLUDGE STORAGE TANKS (NEW)	$780,000		
JUNCTION STRUCTURES (NEW)	$200,000		
CONCRETE CRACK/SPALL REPAIR	$55,000		
PROCESS			
MAIN PUMP STATION UPGRADE		$525,000	
WWTF PROCESS DEMOLITION	$39,000		
SEPTAGE RECEIVING	$212,000		
SCREENINGS AND GRIT REMOVAL	$658,000		
INFLUENT EQUALIZATION BASINS	$164,000		
PRIMARY TREATMENT	Future phase		
AERATION TANKS / BNR	$1,124,000		
SECONDARY CLARIFICATION	$870,000		
SUPPLEMENTAL ALKALINITY SYSTEM	$97,000		
SUPPLEMENTAL CARBON SYSTEM	$74,000		
TERTIARY TREATMENT (including excavation, piping, building)	Future phase		
UV DISINFECTION	$629,000		
OUTFALL	$0		
SLUDGE STORAGE TANKS	$189,000		
SOLIDS PROCESSING SYSTEMS	$1,236,000		
POLYMER SYSTEM	$107,000		
PERMANGANATE SYSTEM	$0		
PLANT WATER SYSTEM	$227,000		
YARD WASTE PUMP STATION	$220,000		
ODOR CONTROL SYSTEMS	$263,000		
JUNCTION STRUCTURES/GATES	$0		
HVAC/PLUMBING		$71,000	
CONTROL BUILDING	$170,000		
GRIT BUILDING MODIFICATIONS (SEPTAGE RECEIVING)	$40,000		

TOWN OF EXETER, NEW HAMPSHIRE
WWTF PRELIMINARY DESIGN
W-P PROJECT NO. 12883B
ENR INDEX 10037 (September 2015)

TABLE 4-2
CONSTRUCTION COST ESTIMATE FOR CONTRACTS 1, 2, 3, AND 4
BEFORE VALUE ENGINEERING

DESCRIPTION		CONTRACT 1 WWTF TN 4 mg/l	CONTRACT 2/3 Main Pump Station FM & WM	CONTRACT 4 Lagoon Decommissioning
CHEMICAL BUILDING MODIFICATIONS (PW BLDG)		$10,000		
SUPPLEMENTAL CHEMICAL BUILDING (NEW)		$15,000		
HEADWORKS BUILDING (NEW)		$75,000		
SOLIDS HANDLING BUILDING (NEW)		$150,000		
MAINTENANCE GARAGE (NEW)		$60,000		
INSTRUMENTATION				
INSTRUMENTS		$260,000	$15,000	
CONTROL PANELS AND NETWORK		$270,000	$20,000	
SCADA SYSTEM HARDWARE, SOFTWARE & PROGRAMMING		$253,400	$17,000	
ELECTRICAL				
MAIN PUMP STATION (w/NG Genset)			$650,000	
WWTF STANDBY POWER (NG Genset)		$550,000		
WWTF ELECTRICAL DISTRIBUTION		$2,200,000		
WWTF ELECTRICAL SITE LIGHTING/MANHOLES		$170,000		
WWTF FIRE SYSTEM		$80,000		
WWTF PAGING SYSTEM		$0		
WWTF SECURITY SYSTEM		$0		
WWTF ELECTRICAL DEMOLITION		$100,000		
SPECIALS				
MOBILIZATION/DEMOBILIZATION		$100,000	$50,000	$50,000
SHEETING		$0	$0	
PILES		$0	$0	
BYPASS PUMPING		$0	$155,000	
GROUNDWATER DEWATERING		$100,000	$50,000	
CONTAMINATED SOILS & GROUNDWATER		none	$50,000	none
LAGOON - SLUDGE REMOVAL & DISPOSAL		$200,000	none	$2,500,000
LAGOON - EMBANKMENT REMOVAL/ WETLAND CREATION		none	none	$4,300,000
SUBTOTAL, CONSTRUCTION		$19,749,000	$2,822,000	$6,850,000
GENERAL CONTRACTOR OH&P, GENERAL CONDITIONS	15.0%	$2,962,000	$423,000	$0
SUBTOTAL, SUBCONTRACTORS		$4,403,400	$848,000	$0
GENERAL CONTRACTOR MARKUP	5.0%	$220,000	$42,000	$342,500
ELECTRICAL/ TELEPHONE/ GAS ALLOWANCES		$90,000	$20,000	$0
BONDS AND INSURANCE	1.5%	$360,000	$60,000	$100,000
UNIT PRICE ITEMS		$974,000	$0	$0
SUBTOTAL, CONSTRUCTION COSTS		$28,760,000	$4,220,000	$7,290,000
PROJECT MULTIPLIER, DESIGN CONTINGENCY	1.15			
PROJECT MULTIPLIER, INFLATION TO MIDPT CONST.	1.04			
ENGINEERS ESTIMATE OF CONSTRUCTION COST		**$34,400,000**	**$5,050,000**	**$8,720,000**


PUBLIC WORKS DEPT. BUILDING
DPW
CONTROL BUILDING
SEPTAGE BUILDING
VACTOR DEBRIS
STANDBY GENERATOR
FFE 21.00
HEADWORKS BUILDING
SOLIDS HANDLING BUILDING
YARD PUMP STATION
SLUDGE STORAGE TANKS
SPLITTER STRUCTURE #3
SECONDARY CLARIFIERS (TYP OF 3)
FUTURE TERTIARY PROCESS
STORMWATER DETENTION/ TREATMENT BASIN
JUNCTION STRUCTURE 3
BNR TANKS
FUTURE BNR TANK
FUTURE 3
GRAVEL
PROCESS
SAND
GRIT
MAINTENANCE BUILDING
SUPPLEMENTAL CHEMICAL BUILDING
FUTURE PRIMARY CLARIFIERS, PUMP GALLERY AND GRAVITY THICKENER
STRUCTURE 105
STRUCTURE 102
IEQ PUMP STATION
SPLITTER STRUCTURE #2
STRUCTURE 101
IEQ 2
STRUCTURE 401
SURFACE LEDGE
STRUCTURE 301
CHLORINE CONTACT TANK
STRUCTURE 302
CHLORINATION BUILDING/ PLANT WATER BUILDING
DISINFECTION BUILDING
PARSHALL FLUME
SHED
VERTICAL CONDUIT/ PIPE (TYP.)
NO. SUBMISSIONS/REVISIONS APP'D DATE
PRELIMINARY DESIGN REPORT
DESIGNED BY:
CAD COORD.: APC
CAD:
CHECKED BY:
DATE:
APPROVED BY:
DATE:
PROJECT NO.: 12883
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Offices Throughout New England
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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES
ALTERNATE SITE LAYOUT
DRAWING
FIG 4-1

LAST SAVED BY: ADAM.COUTURE 10/15/2015 7:24 AM

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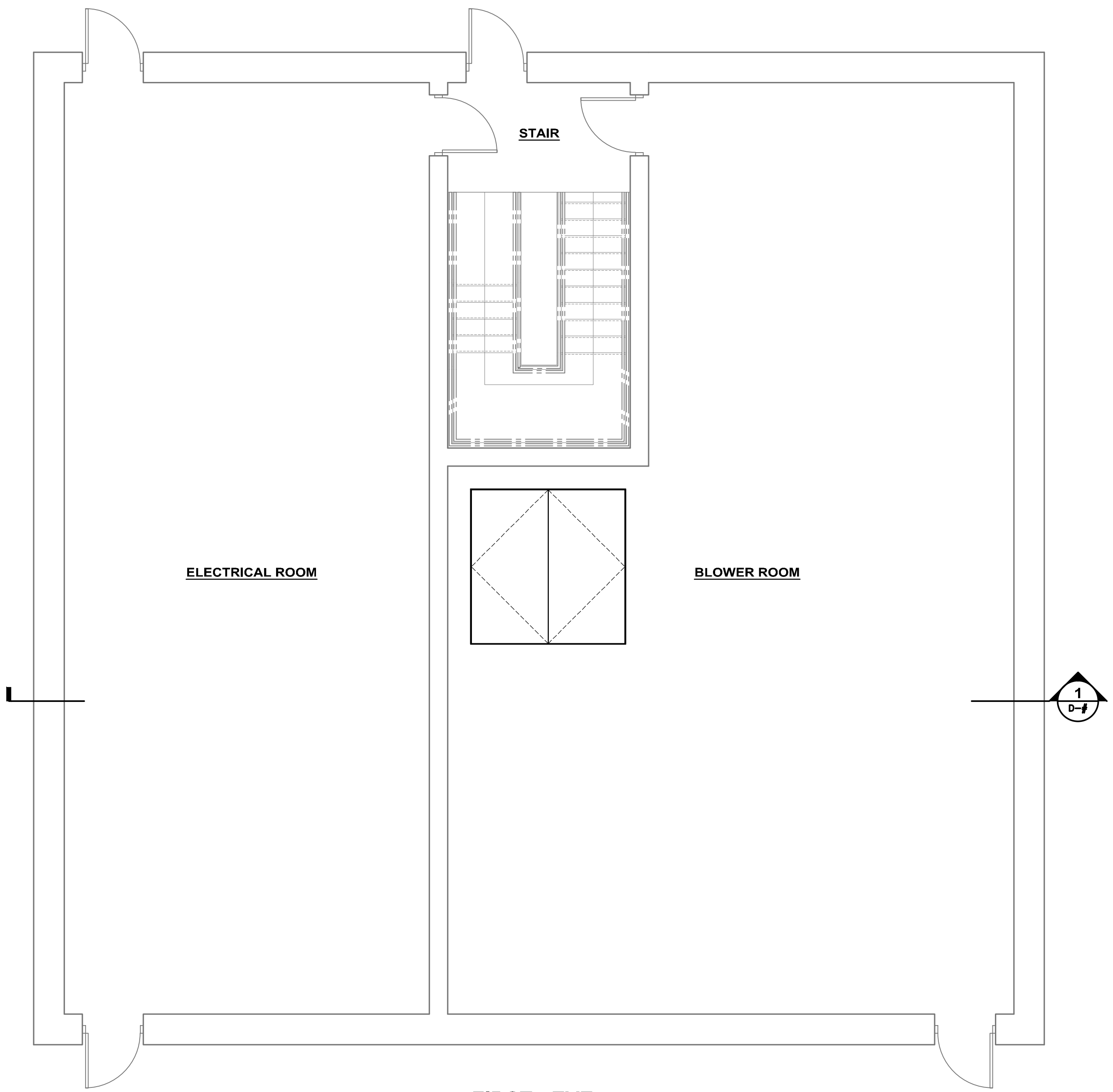
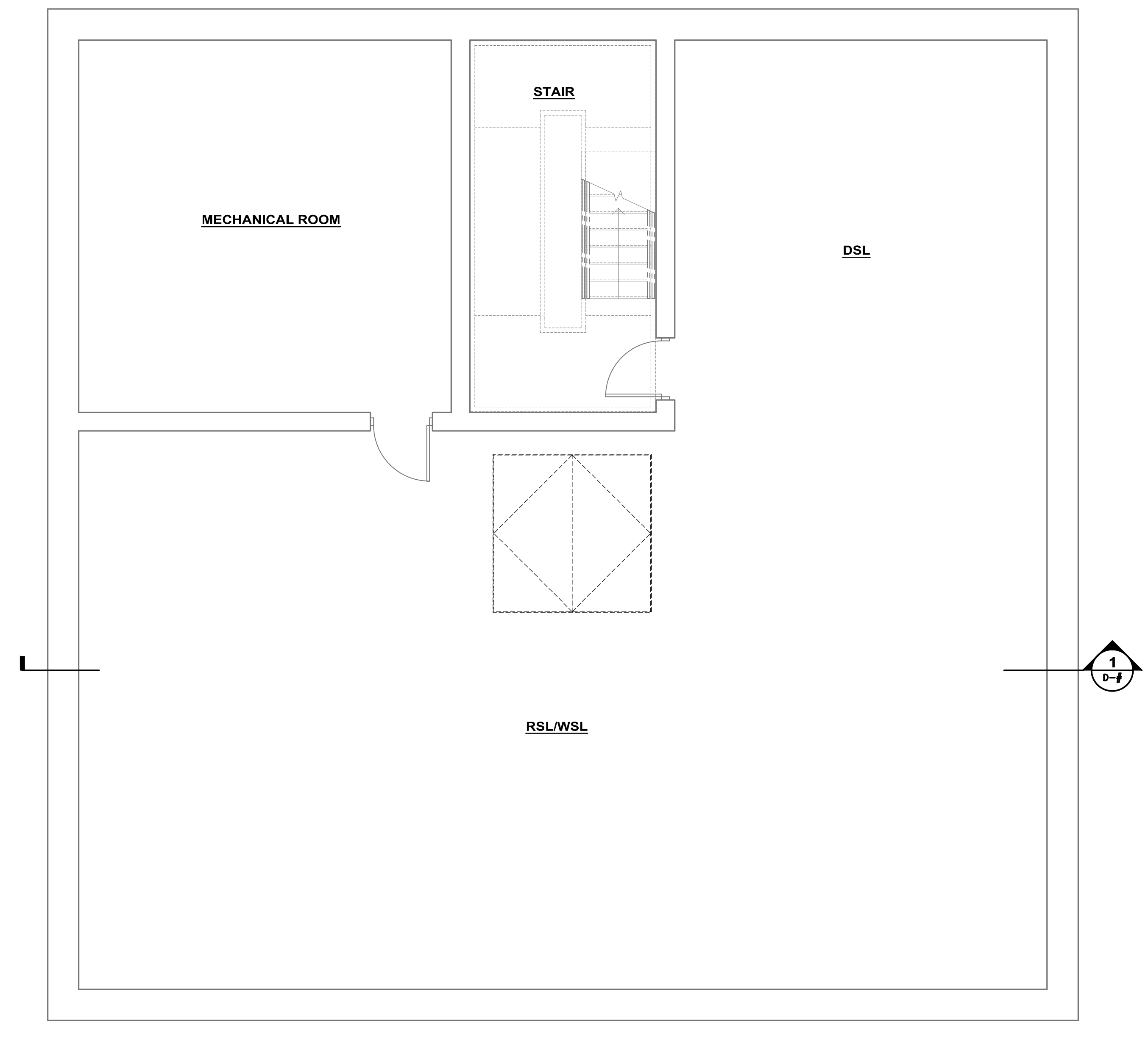


FIRST LEVEL
SCALE: 1/4"=1'-0"



LOWER LEVEL
SCALE: 1/4"=1'-0"

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY:
CAD COORD.: APC
CAD:
CHECKED BY:
DATE:
APPROVED BY:
DATE:
PROJECT NO: 12883

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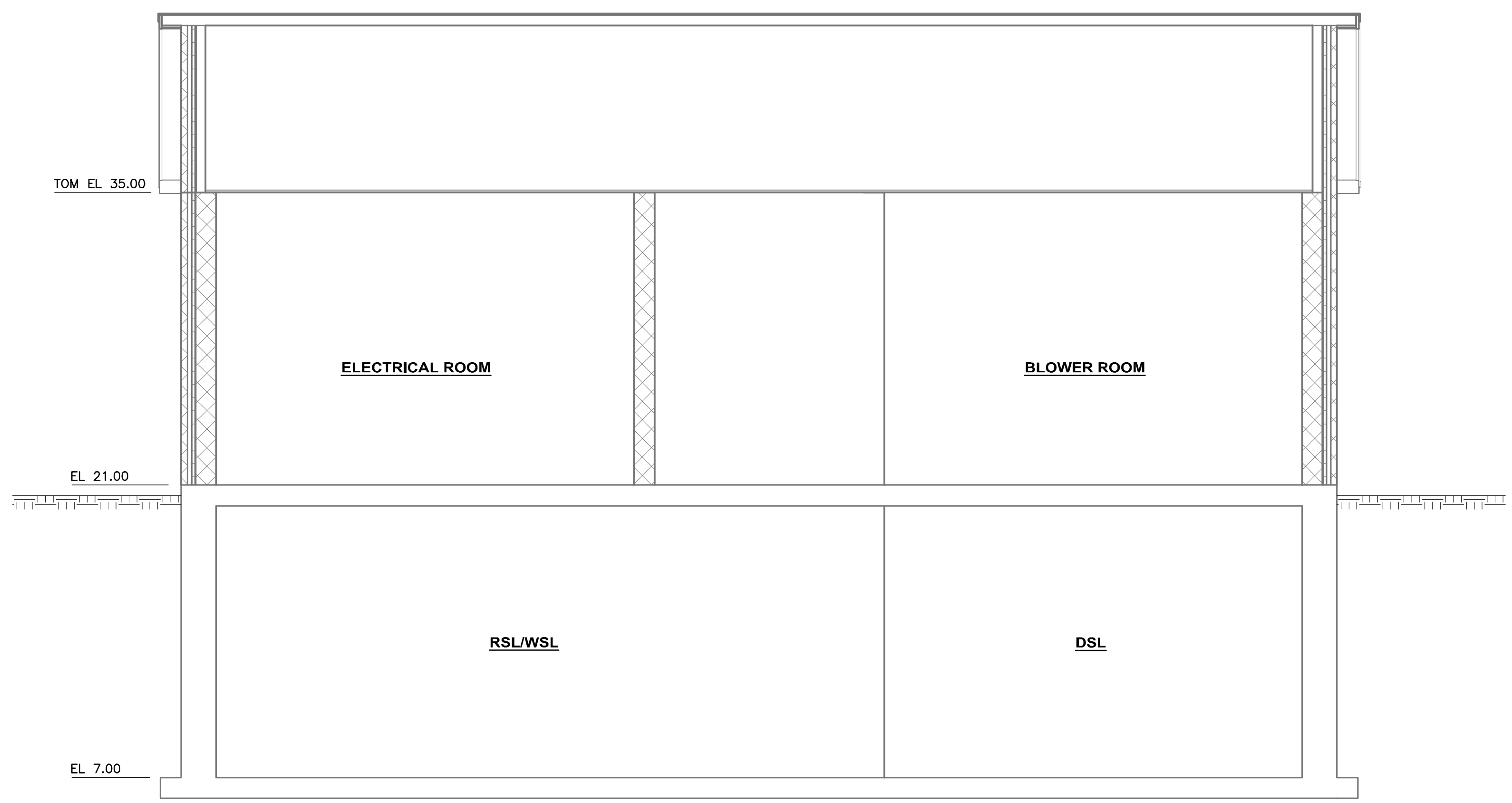
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

ALTERNATE "PROCESS BUILDING" PLANS

DRAWING
FIG 4-2



SECTION 1 / D-#
SCALE: 1/4"=1'-0"

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY:
CAD COORD.: APC
CAD:
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DATE:
APPROVED BY:
DATE:
PROJECT NO: 12883

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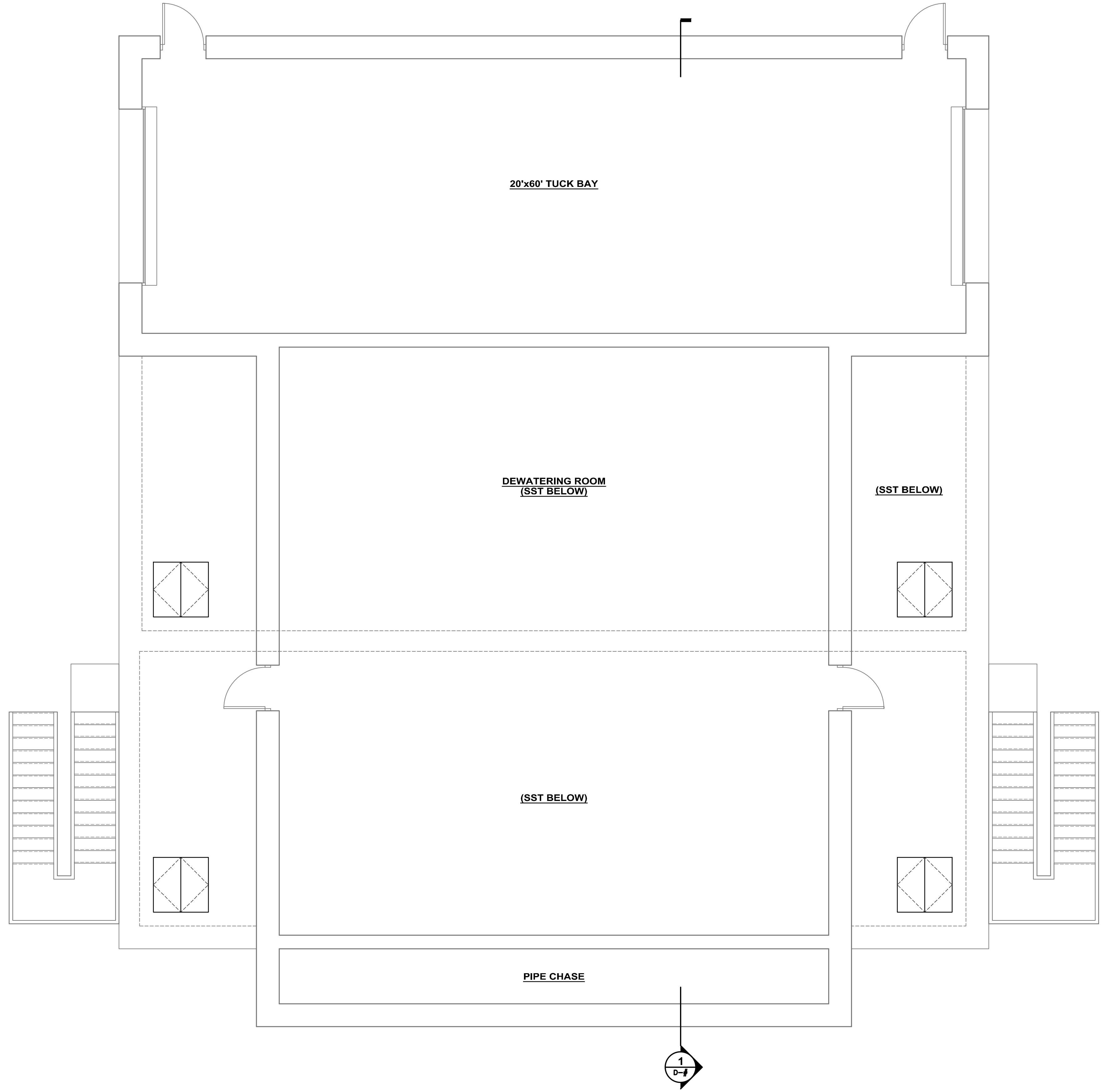
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

ALTERNATE "PROCESS BUILDING" SECTION

DRAWING
FIG 4–3



UPPER LEVEL
SCALE: 1/4"=1'-0"

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY:
CAD COORD.: APC
CAD:
CHECKED BY:
DATE:
APPROVED BY:
DATE:
PROJECT NO.: 12883

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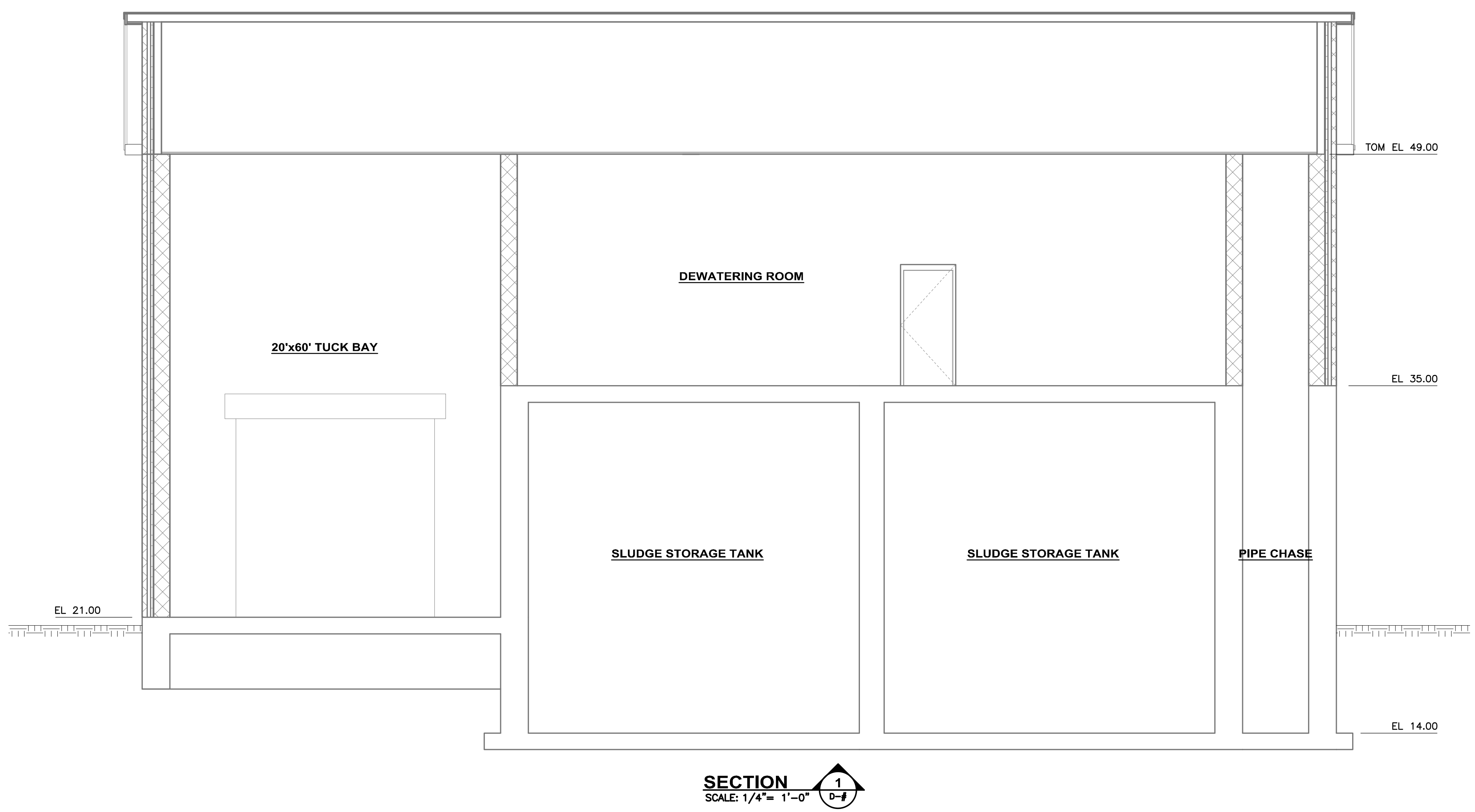
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

ALTERNATE "DEWATERING BUILDING" PLANS

DRAWING
FIG 4-4



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NO | SUBMISSIONS/REVISIONS | APP'D | DATE

PRELIMINARY DESIGN REPORT

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CAD COORD.: APC
CAD:
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DATE:
APPROVED BY:
DATE:
PROJECT NO.: 12883

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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

ALTERNATE "DEWATERING BUILDING" SECTION

DRAWING
FIG 4-5

Appendix A

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APPENDIX A

BASIC DESIGN CRITERIA

A-1: Proposed Equipment Lists

A-2: Main Pump Station Capacity & Influent Sewer Flows Memos

A-3: Main Pump Station Basis of Design

A-4: Preliminary Treatment System Basis of Design

A-5: Influent Equalization Basis of Design

A-6: Primary Treatment (Future) Basis of Design

A-7: Activated Sludge System Alternatives Analysis

A-8: Activated Sludge System Basis of Design

A-9: Tertiary Treatment (Future) Basis of Design

A-10: Disinfection System Basis of Design

A-11: Septage Receiving Basis of Design

A-12: Solids Handling System Basis of Design

A-13: Yard Pump Station Basis of Design

A-14: Plant Water Basis of Design

A-15: Supplemental Alkalinity & Carbon Basis of Design

A-16: Hypochlorite for Return Sludge Basis of Design

A-17: Lagoon Decommissioning Basis of Design

A-18: Odor Control Approach

A-19: Proposed Gate and Weir List

A-20: Watermain Sizing

PROJECT NAME: EXETER - WWTF & MAIN PUMP STATION UPGRADE
PHASE: PRELIMINARY DESEIGN - M AIN PUMP STATION
PROJECT NO: 12883B

VFD, RVSS, FVNR (constant speed/non-reversing), FVR (constant speed/reversing)

MCC, OEMCP, VFD/SA (stand-alone), VFD/MCC (mcc-mounted)

MASTER EQUIPMENT LIST (Process Equipment Electrical Motors List)

DESIGNER TO VERIFY THAT EQUIPMENT TERMINOLOGY & TAG DESIGNATIONS MATCHES THE PROJECT NOMENCLATURE MEMO

ITALICS ARE EQUIPMENT TO REMAIN, BLUE TEXT IS FOR DATA ENTRY, BLACK CELLS ARE CALCULATED

EQUIPMENT NAME	EQUIPMENT TAG	NO. OF UNITS				LOCATION	SIZE		ELECTRICAL INFORMATION								TYPICAL MANUF	SPEED CONTROL	COMMENTS
									TOTAL HP										
		NO. TOTAL	NO. OPERATING	NO. FUTURE (if any)	NO. ON STANDBY POWER	(BLDG NAME) (SITE)	PARAMETER	UNITS	EACH	OPER.	FUTURE	ON STANDBY POWER	POWER (VOLTAGE)	EXP. PROOF MOTORS	STARTER TYPE	POWER FROM			
PROCESS ITEMS																			
Sewage Pumps	INFP-1,2,3,4	4	3	0	3	Pump Room	9	MGD	70	210	0	210	460, 3Ø 60 Hz	N	VFD	VFD/SA	Flygt, Fairbanks	Constant Level	
Sewage Grinder No. 1	INFG-1	1	1	0	1	Influent Channel	11	MGD	6	6	0	6	460, 3Ø 60 Hz	Y	FVR	OEM LCP	Muffin Monster	NONE	5 HP Grinder Motor, 1 HP Drum Motor
Odor Control System 4 - Main Pump Station	OCF-4	1	1	0	0	Wet Well Access	1100	cfm	5	5	0	0	460, 3Ø 60 Hz	Y	FVNR	MCC	ECS	MANUAL	
PROCESS TOTALS										221	0	216							

Note: the list above does not include HVAC equipment

PROJECT NAME: EXETER - WWTF & MAIN PUMP STATION UPGRADE
PHASE: PRELIMINARY DESEIGN - WWTF
PROJECT NO: 12883B

MASTER EQUIPMENT LIST (Process Equipment Electrical Motors List)

BLUE TEXT IS FOR DATA ENTRY, BLACK CELLS ARE CALCULATED

VFD, RVSS, FVNR (constant speed/non-reversing), FVR (constant speed/reversing)

MCC, OEMCP, VFD/SA (stand-alone), VFD/MCC (mcc-mounted)

EQUIPMENT NAME	EQUIPMENT TAG	NO. OF UNITS				LOCATION	SIZE		ELECTRICAL INFORMATION								TYPICAL MANUF	SPEED CONTROL	COMMENTS
									TOTAL HP										
		NO. TOTAL	NO. OPERATING	NO. FUTURE (if any)	NO. ON STANDBY POWER	(BLDG NAME) (SITE)	PARAMETER	UNITS	EACH	OPER.	FUTURE	ON STANDBY POWER	POWER (VOLTAGE)	EXP. PROOF MOTORS	STARTER TYPE	POWER FROM			
PROCESS ITEMS																			
Mechanical Screen	SCR-1	1	1	0	1	Hdwks - Upper	12.5	mgd	2	2	0	2	460, 3Ø 60 Hz	Y	FVNR	OEMCP		NONE	LEVEL/TIMER
Screening Wash Press	WP-1	1	1	0	1	Hdwks - Upper	99	cf/hr	5	5	0	5	460, 3Ø 60 Hz	Y	FVR	OEMCP		NONE	BY SCREEN
Grit Removal System	GMX-1	1	1	0	1	Hdwks - Upper	12.5	mgd	2	2	0	2	460, 3Ø 60 Hz	Y	FVNR	MCC		NONE	
Grit Washer	GW-1B	1	1	0	1	Hdwks - Upper	250	gpm	1.5	1.5	0	1.5	460, 3Ø 60 Hz	Y	FVNR	MCC		NONE	BY PUMP
Grit Screw Conveyer	GW-1A	1	1	0	1	Hdwks - Upper	10	in-dia.	0.75	0.75	0	0.75	460, 3Ø 60 Hz	Y	FVNR	MCC		NONE	BY PUMP
Grit Pump	GTP-1,2	2	1	0	1	Hdwks - Lower	250	gpm	5	5	0	5	460, 3Ø 60 Hz	N	VFD	MCC		NONE	RPT CYCLE TIMER
Influent Equalization Pumps	IEQP-1,2,3	3	2	0	1	Exterior (subm)	700	gpm	20	40	0	20	460, 3Ø 60 Hz	Y	FVNR	MCC		MANUAL	
Influent Equalization Aerators	IEQA-1,2,3,4,5,6,7,8	8	8	0	0	Exterior (IEQ-floating)	-	-	7.5	60	0	0	460, 3Ø 60 Hz	Y	FVNR	MCC	<<Control Bldg??	MANUAL	EXISTING
Primary Clarifier	Future	0	0	2	2	Exterior	45	ft-dia	1	0	2	2	460, 3Ø 60 Hz	Y	FVNR	MCC		NONE	
Primary Scum Pump	Future	0	0	1	1	Primary Gallery	100	gpm	5	0	5	5	460, 3Ø 60 Hz	N	FVNR	MCC		NONE	RPT CYCLE TIMER
Primary Sludge Pumps	Future	0	0	2	1	Primary Gallery	100	gpm	15	0	30	15	460, 3Ø 60 Hz	N	FVNR	MCC		NONE	RPT CYCLE TIMER
Primary Sludge Grinder	Future	0	0	2	1	Primary Gallery	100	gpm	5	0	10	5	460, 3Ø 60 Hz	N	FVR	OEM LCP		NONE	RPT CYCLE TIMER
Supplemental Carbon Pumps	SPC-1,2,3	3	2	0	2	SuppChemBldg	5	gph	0.75	1.5	0	1.5	230/460, 3Ø 60 Hz	N	SCR	120		FLOW PACE	
Pre-Anoxic Zone Mixers	ANMX-1A,1B,1C,2A,2B,2C	6	6	3	3	Exterior	-	-	0.75/1/2	7.5	3.75	3	460, 3Ø 60 Hz	N	FVNR	MCC		NONE	
Swing Zone Mixers+A31	ANMX-1D,2D	2	2	1	2	Exterior	-	-	2	4	2	4	460, 3Ø 60 Hz	N	FVNR	MCC		NONE	
Post-Anoxic Zone Mixers	ANMX-1F,2F	2	2	1	2	Exterior	-	-	3	6	3	6	460, 3Ø 60 Hz	N	FVNR	MCC		NONE	
Internal Recycle Pumps	IRP-1,2,3	2	2	1	2	Exterior	4,160	gpm	10	20	10	20	460, 3Ø 60 Hz	N	VFD	VFD/MCC		MANUAL	
Secondary Clarifier	SCL-1,2,3	3	3	0	3	Exterior	70	ft-dia.	0.5	1.5	0	1.5	460, 3Ø 60 Hz	Y	FVNR	MCC		NONE	
Secondary Scum Pump	SCP-1	1	1	0	1	Scum Pit (subm)	250	gpm	10.0	10	0	10	460, 3Ø 60 Hz	N	FVNR	MCC		NONE	RPT CYCLE TIMER
Aeration Blowers	ATB-1,2,3	3	2	1	2	Solids Bldg - Lower	2200	acfm	150	300	150	300	460, 3Ø 60 Hz	N	VFD	VFD/SA		DO/PRESSURE	
Return Activated Sludge Pumps	RSP-1,2,3,4	4	3	1	2	Solids Bldg - Lower	925	gpm	10	30	10	20	460, 3Ø 60 Hz	N	VFD	VFD/SA		FLOW PACE	
Waste Activated Sludge Pumps	WSP-1,2	2	1	0	1	Solids Bldg - Lower	225	gpm	3	3	0	3	460, 3Ø 60 Hz	N	FVNR	MCC		NONE	RPT CYCLE TIMER
Rapid Mix Tank Mixers	Future	0	0	1	1	Tertiary (Future)	-	-	10	0	10	10	460, 3Ø 60 Hz	N	VFD	VFD/MCC		MANUAL	
Floc Tank Mixers	Future	0	0	2	2	Tertiary (Future)	-	-	2	0	4	4	460, 3Ø 60 Hz	N	VFD	VFD/MCC		MANUAL	
Filter - Drives	Future	0	0	2	1	Tertiary (Future)	-	-	2	0	4	2	460, 3Ø 60 Hz	N	FVNR	MCC		NONE	
Filters - Backwash Pumps	Future	0	0	6	2	Tertiary (Future)	-	-	5	0	30	10	460, 3Ø 60 Hz	N	FVNR	MCC		NONE	
UV Disinfection	UV-1A,1B, 1C	3	2	1	2	Disinfection	6.6	mgd	-	33	0	61	460, 3Ø 60 Hz	N		OEMCP		FLOW PACE	**[Ozonia 33 kW installed]**
Final Scum Pump	SCP-2	1	1	0	1	Disinfection	150	gpm	10	10	0	10	460, 3Ø 60 Hz	N	FVNR	MCC		NONE	
Sludge Storage Tank Blowers	STB-1,2	2	2	0	1	Solids Bldg - Lower	800	scfm	60	120	0	60	460, 3Ø 60 Hz	N	VFD	VFD/SA		NONE	
Sludge Grinders	DSG-1,2,3	2	2	0	1	Solids Bldg - Lower	200	gpm	2	4	0	2	460, 3Ø 60 Hz	N	FVR	MCC		MAN/ BY DEWATR	
Dewatering Feed Pumps	DSLP-1,2,3	2	2	1	1	Solids Bldg - Lower	200	gpm	10	20	10	10	460, 3Ø 60 Hz	N	VFD	VFD/MCC		MAN/ BY DEWATR	
Polymer Blending System	PBU-1,2	2	2	0	1	Solids Bldg - Upper	7	gph	1.0	2	0	1	460, 3Ø 60 Hz	N	VFD	OEM CP		MAN/ BY DEWATR	
Polymer Ageing Tanks	DPOLT-1, 2	1	1	0	1	Solids Bldg - Upper	800	gal	-	-	-	-	-	-	-	OEM CP		MAN/ BY DEWATR	
Dilute Polymer Pump	DPOL-1,2	2	2	0	1	Solids Bldg - Upper	2,500	gph	3.0	6	0	3	460, 3Ø 60 Hz	N	VFD	OEM CP		AUTO/ BY DEWATR.	
Centrifuge - Main Drive		2	2	0	0	Solids Bldg - Upper	950	lb/hr	-	-	-	-	-	-	-	OEM CP		AUTO/ BY DEWATR.	
Centrifuge - Main Drive	CEN 1	2	2	0	0	Solids Bldg - Upper	-	-	60	120	0	0	460, 3Ø 60 Hz	N	VFD	OEM CP		AUTO/ BY DEWATR.	
Centrifuge - Back Drive	CEN 2	2	2	0	0	Solids Bldg - Upper	-	-	40	80	0	0	460, 3Ø 60 Hz	N	VFD	OEM CP		AUTO/ BY DEWATR.	
Potassium Permanganate System (FUTURE)	PERM-1,2	0	0	2	1	Solids Bldg - Upper	23	gph	0.5	0	1	0.5	120, 1Ø 60 Hz	N	VFD	OEM CP		AUTO/ BY DEWATR.	
Sludge Screw Conveyors (from machine)	SSC-1,2	2	2	0	1	Solids Bldg - Upper	1,015	lb/hr	1.5	3	0	1.5	460, 3Ø 60 Hz	N	FVR	MCC		NONE	
Sludge Screw Conveyors (to truck bay)	SSC-3	1	1	0	1	Solids Bldg - Upper	2,030	lb/hr	7.5	7.5	0	7.5	460, 3Ø 60 Hz	N	FVNR	MCC		NONE	
Sludge Screw Conveyors (truck bay)	SSC-4	1	1	0	1	Solids Bldg - Upper	2,030	lb/hr	5	5	0	5	460, 3Ø 60 Hz	N	FVR	MCC		NONE	
Septage Receiving Unit	SRU-1	1	1	0	0	Grit Bldg	400	gpm	2	2	0	0	460, 3Ø 60 Hz	Y	VFD	OEM CP			
Septage Storage Blower	SEPB-1	1	1	0	0	Grit Bldg	100	scfm	3	3	0	0	460, 3Ø 60 Hz	N	FVNR	MCC		NONE	RPT CYCLE TIMER
Septage Pump	SEPP-1	1	1	0	0	Septage Tank (subm)	100	gpm	5	5	0	0	460, 3Ø 60 Hz	N	FVNR	MCC		NONE	RPT CYCLE TIMER
Alkalinity System Mixer	ALKM-1	1	1	0	1	SuppChemBldg	-	-	7.5	7.5	0	7.5	460, 3Ø 60 Hz	N	FVNR	MCC		NONE	RPT CYCLE TIMER
Alkalinity Feed Pumps	ALK-1,2	2	1	0	1	SuppChemBldg	5	gph	0.75	0.75	0	0.75	230/460, 3Ø 60 Hz	N	SCR	120		FLOW PACE	
Hypochlorite Feed Pumps (for RSL)	HYP-1,2	2	1	0	1	Solids Bldg - Lower	20	gph		0	0	0	120, 1Ø 60 Hz	N	SCR	120		FLOW PACE	
Plant Water Pumps (Duty)	PWP-1,2	2	2	1	2	Solids Bldg - Lower	450	gpm	25	50	25	50	460, 3Ø 60 Hz	N	VFD	OEM CP		PRESSURE P&ID	
Plant Water Pumps (Jockey)	PWP-3	1	1	0	1	Solids Bldg - Lower	5	gpm	3	3	0	3	460, 3Ø 60 Hz	N	VFD	OEM CP		PRESSURE P&ID	
Sump Pump (Plant Water Building)	SP-X	1	1	0	1	Solids Bldg - Lower	10	gpm	5	5	0	5	460, 3Ø 60 Hz	N		OEM CP		LEVEL	
Air Compressors	CA-1,2,3	3	2	0	2	Miscellaneous	-	cfm	3	6	0	6	460, 3Ø 60 Hz	N	FVNR	MCC		NONE	
Yard Pump Station	YPS-1,2,3	3	3	0	1	Exterior	320	gpm	10	30	0	10	460, 3Ø 60 Hz	N	FVNR	MCC		LEVEL	
Autosamplers	AS-1,2	2	2	1	3	Exterior	-	-		0	0	0	120, 1Ø 60 Hz	N	SCR	120		FLOW PACE	
Odor Control System 1 - Dewatering	OCF-1	1	1	0	0	Exterior	1840	cfm	10	10	0	0	460, 3Ø 60 Hz	Y	FVNR	MCC		MANUAL	
Odor Control System 2 - Headworks	OCF-2	1	1	0	0	Exterior	400	cfm	3	3	0	0	460, 3Ø 60 Hz	Y	FVNR	MCC		MANUAL	
Odor Control System 3 - Septage	OCF-3	1	1	0	0	Exterior	150	cfm	2	2	0	0	460, 3Ø 60 Hz	Y	FVNR	MCC		MANUAL	
PROCESS TOTALS										1037.5	309.75	702							

WRIGHT-PIERCE
Engineering a Better Environment

MEMORANDUM

TO:	File	DATE:	August 26, 2015
FROM:	A. Morrill, J. Mercer	PROJECT NO.:	12883B
SUBJECT:	Exeter, NH– Main Pump Station Design Flow Analysis		

This memo summarizes the analysis of flow data to determine the Main Pump Station (MPS) design flow rates. Compiled data from Exeter WWTF Monthly Operation Reports (MOR), Exeter Flow Assessment data account, and the WP pump test on May 7, 2014 were used to determine the design flow rates for the MPS.

Background

The MPS was originally constructed in 1964 and upgraded in 1995 to include three dry-pit submersible pumps with variable frequency drives and clamp-on Doppler type flow meters. The MPS discharges to a 16-inch diameter, cement-lined cast iron forcemain approximately 4,900 linear feet long. Due to the age of the pumps and poor condition of the forcemain an upgrade at the MPS is warranted. To reduce or eliminate CSO events, the MPS capacity will need to be increased.

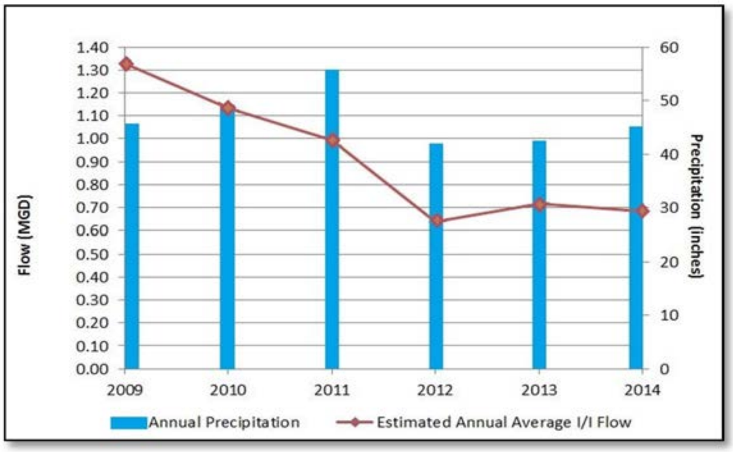
The Town has approximately 51 miles of separated gravity sewer lines, portions of which were originally constructed as combined sewers. The system contains two diversion structures on Water Street and Spring Street, which discharge to CSO Outfall No. 003 at Clemson Pond which has a tide gate discharge to Squamscott River (Outfall No. 002).

Data Analysis

Infiltration and Inflow

The Town continues to make improvements to further reduce I/I flows through regular O&M and sewer replacement projects, yet still experiences CSO events during storms. To limit the frequency of CSO events, the MPS capacity will need to be increased to accommodate normal wastewater flows and peak wet weather flows. **Figure 1** shows that the Town has significantly reduced the estimated annual average I/I flow over the past five years.

Figure 1: Infiltration and Inflow Trends



Exeter WWTF Monthly Operating Reports (MOR)

A review of current CSO and influent WWTF flows was conducted by analyzing data from MORs starting in 2007 through 2014. Influent WWTF flows were recorded by an area-velocity insert flow meter from 2007 through August 2010, and then by a magnetic flow meter on the influent force main from August 2010 to present. CSO flows were recorded by a level indicator over the weir structure in the Water Street and Spring Street diversion structures. The CSO and influent WWTF flows are totalized volumes for each day. To evaluate the combined CSO and influent WWTF peak flow condition, the "Patriot's Day Storm" from April 15, 2007 through April 20, 2007 was analyzed. **Table 1** summarizes the CSO and influent WWTF volumes during the April 2007 storm and CSO event.

Table 1: CSO Event – April 2007

Date	Total CSO (MG)	Influent WWTF (MG)	Combined Flow (MG)
4/15/2007	0.35	3.60	3.95
4/16/2007	1.87	4.30	6.17
4/17/2007	8.34	4.40	12.74
4/18/2007	6.51	4.40	10.91
4/19/2007	0.04	4.00	4.04
4/20/2007	0.01	3.60	3.61

The "Patriot's Day Storm" was a 100+ Year Storm and will not be used to determine the MPS design flows. Note: Town has made a number of sewer system improvements since 2007, so even with another comparable storm it is expected that flows would be less.

Main Pump Station Flow Data

Flow Assessment Services has collected and stored MPS and CSO flow rate data for the Town from 2011 to present. The MPS flow rate data is recorded every five minutes from the clamp-on Doppler flow meters on each pumps' discharge piping. The CSO flow rate data is recorded every five minutes from an ultrasonic level indicator, measuring the height of flow over the weirs in the Water Street and Spring Street diversion structures.

The Exeter WWTF Operators indicated that the clamp-on Doppler flow meters are inaccurate. Clamp-on Doppler flow meters are known to be inaccurate for measuring wastewater flows, due to the ductile iron pipe interfering with the Doppler signals. Also, during rain events the wastewater becomes diluted with stormwater from I/I and the Doppler signals have less solid objects to reflect off and obtain accurate readings.

The Exeter WWTF recently started storing flow data from the influent WWTF mag meter installed in 2011. Mag meters are widely used for wastewater flow measurement and do not experience a decrease in accuracy during rain events when wastewater becomes diluted from I/I.

Strap-on Doppler Meter Data vs. WWTF Influent Mag Meter Data

To identify a correlation between the strap-on Doppler meter data and the WWTF influent mag meter data, a pump test was performed on June 4, 2015. The pump test was conducted with all three pumps running at 60 Hz while data from the strap-on Doppler meters and the WWTF influent mag meter was recorded.

Flow data from the pump test and a storm event from April 20, 2015 through April 21, 2015 were compared by dividing the mag meter data by the Doppler meter data and expressed as a percentage. The mag meter versus Doppler meter results were averaged as shown in **Table 2**.

Table 2: MPS Flow Rate Comparison

Date	Mag Meter	Doppler Meter	Mag / Doppler Comparison
	MGD	MGD	%
04/20/2015	4.49	5.41	83.00
04/21/2015	4.62	5.67	81.52
06/04/2015	5.12	6.55	78.17
		Average	80.90

The average comparison was 80.90%; however, to be conservative the Doppler data was corrected to 85% of the original values. To evaluate the total CSO and influent WWTF peak flow conditions nine storms were analyzed and are summarized in **Table 3**. For each storm, the following data was analyzed:

- Peak flow from MPS during storm
- Peak flow from Water Street CSO during storm

- Peak flow from Spring Street CSO during storm

The most conservative combination is to combine the peak flows for each location during the CSO event. The highest combined value is 9.99 MGD which occurred on March 30th, 2014.

Table 3: MPS Peak Flow Analysis

Date | Conditions	100% Doppler	85% Doppler	CSO Water	CSO Spring	CSO Total	Total to Capture Storm 85% Doppler
3/7/2011						
Flows at Max PS Flow	7.05	6.00	0.92	1.42	2.34	8.34
Flows at Max Water St Flow	6.97	5.92	1.55	1.56	3.11	9.03
Flows at Max Spring St Flow	6.79	5.78	0.95	1.99	2.94	8.71
Max Values for Each	7.05	6.00	1.55	1.99	3.54	9.54
3/11/2011						
Flows at Max PS Flow	7.08	6.02	0.00	0.57	0.57	6.59
Flows at Max Water St Flow	7.00	5.95	0.85	0.67	1.52	7.47
Flows at Max Spring St Flow	6.99	5.94	0.33	1.16	1.49	7.43
Max Values for Each	7.08	6.02	0.85	1.16	2.02	8.03
8/19/2011						
Flows at Max PS Flow	7.20	6.12	0.00	1.42	1.42	7.54
Flows at Max Water St Flow	0.00	0.00	0.00	0.00	0.00	0.00
Flows at Max Spring St Flow	7.00	5.95	0.00	2.98	2.98	8.93
Max Values for Each	7.20	6.12	0.00	2.98	2.98	9.10
12/27/2012						
Flows at Max PS Flow	7.18	6.10	0.00	0.00	0.00	6.10
Flows at Max Water St Flow	0.00	0.00	0.00	0.00	0.00	0.00
Flows at Max Spring St Flow	7.08	6.02	0.00	0.05	0.05	6.07
Max Values for Each	7.18	6.10	0.00	0.05	0.05	6.15
3/30/2014						
Flows at Max PS Flow	7.03	5.97	0.00	0.00	0.00	5.97
Flows at Max Water St Flow	6.92	5.88	1.44	2.17	3.60	9.49
Flows at Max Spring St Flow	6.93	5.89	1.24	2.58	3.82	9.70
Max Values for Each	7.03	5.97	1.44	2.58	4.01	9.99
3/31/2014						
Flows at Max PS Flow	6.97	5.92	0.00	0.00	0.00	5.92
Flows at Max Water St Flow	6.78	5.77	0.67	1.44	2.11	7.88
Flows at Max Spring St Flow	6.95	5.91	0.47	1.78	2.26	8.16
Max Values for Each	6.97	5.92	0.67	1.78	2.45	8.38
12/9/2014						
Flows at Max PS Flow	6.40	5.44	0.57	1.66	2.23	7.67
Flows at Max Water St Flow	6.25	5.31	0.97	1.89	2.86	8.17
Flows at Max Spring St Flow	6.29	5.35	0.83	2.07	2.90	8.24
Max Values for Each	6.40	5.44	0.97	2.07	3.04	8.48
4/20/2015						
Flows at Max PS Flow	5.41	4.60	0.00	0.07	0.07	4.67
Flows at Max Water St Flow	0.00	0.00	0.00	0.00	0.00	0.00
Flows at Max Spring St Flow	5.29	4.50	0.00	0.68	0.68	5.18
Max Values for Each	5.41	4.60	0.00	0.68	0.68	5.28
4/21/2015						
Flows at Max PS Flow	5.67	4.82	0.00	0.00	0.00	4.82
Flows at Max Water St Flow	5.52	4.69	0.40	1.25	1.65	6.34
Flows at Max Spring St Flow	5.52	4.69	0.40	1.25	1.65	6.34
Max Values for Each	5.67	4.82	0.40	1.25	1.65	6.47

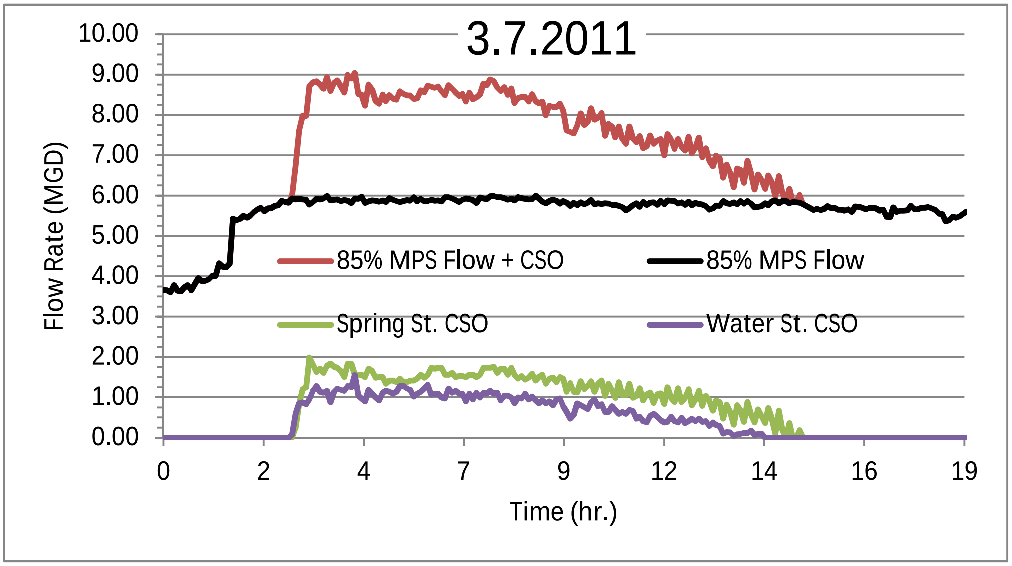
Main Pump Station Upgrade Recommendations

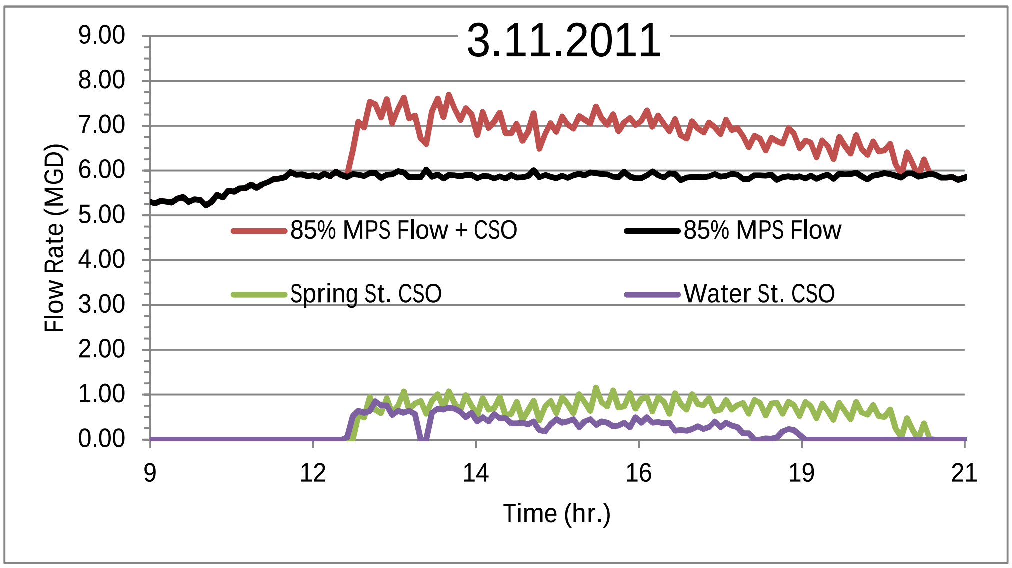
The Town continues to seek out and remove I/I from the collection system; accordingly, the peak flow rate is expected to be reduced over time as it has for the past 5 to 10 years. In order to not oversize the MPS, we recommend upgrading it to convey a minimum month flow rate of 1.09 MGD (760 gpm), a peak flow rate of 9.0 MGD (6,250 gpm) with three pumps running and the stand-by pump will provide additional pumping capacity under peak influent flow conditions (approximately additional 1.0 MGD). At these design flowrates, CSO events should be dramatically reduced or eliminated.

Peak Flow Potential Based on Existing Wetwell Sizing

The Main Pump Station design capacity is 7.9 mgd (5500 gpm), according to Table 3-1 in the Phase I Infiltration/Inflow Study (CDM, October 1997). The existing wetwell has approximately 4,800 gallons of effective volume between the inlet sewer invert and the pump off elevations. At the existing design flow, the existing wetwell allows for a pump cycle time of approximately 2.5 minutes. These pump cycle time are relatively low and strategies should be considered to increase wetwell volume.

FIGURE 2 - MAIN PUMP STATION AND CSO FLOW RATES FOR VARIOUS STORMS





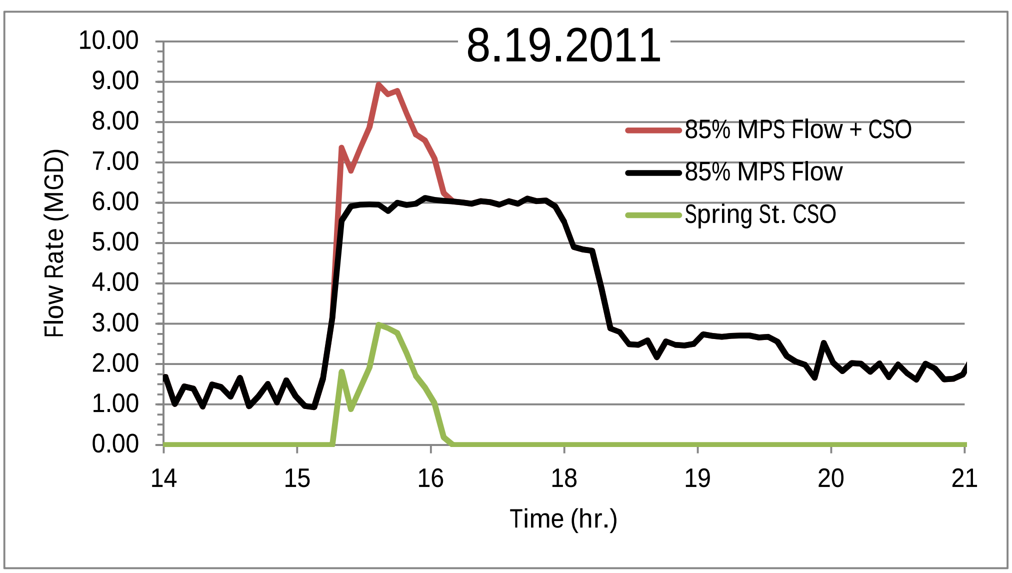
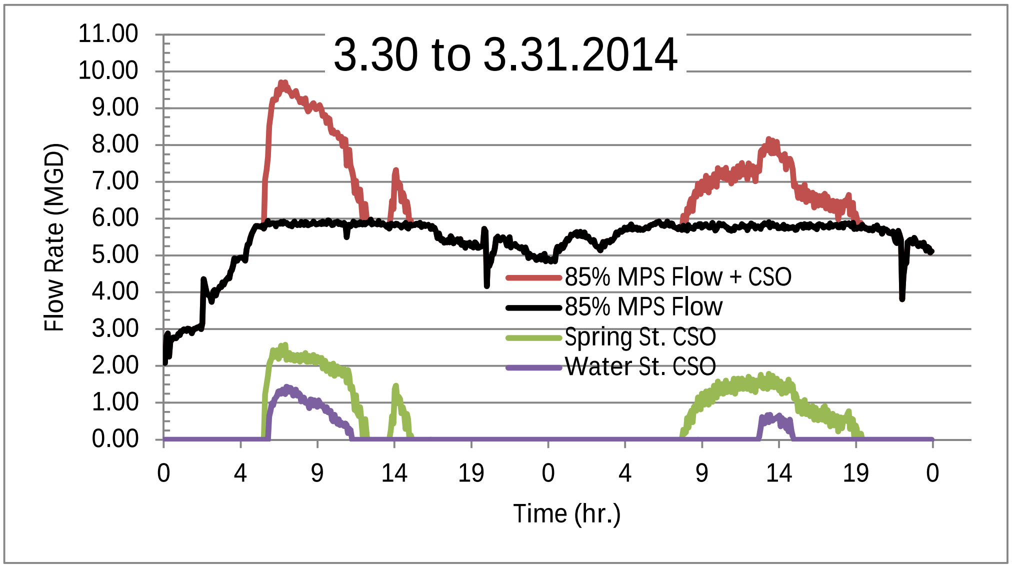
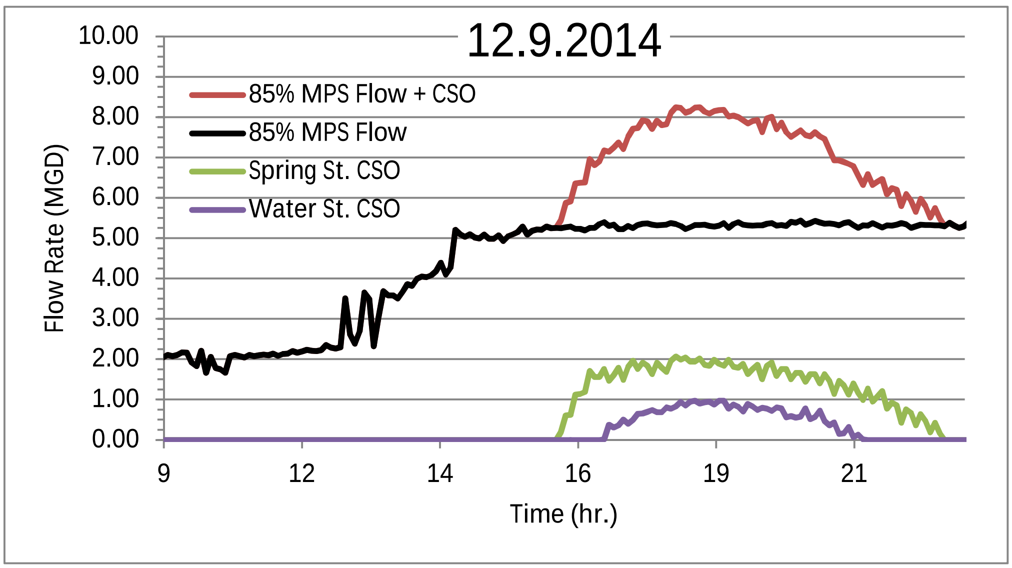
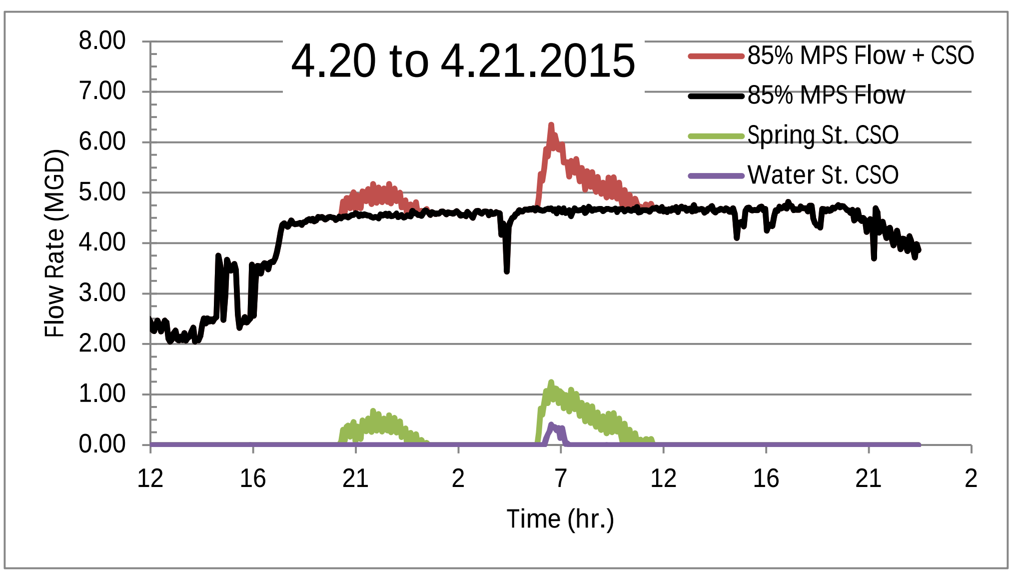


FIGURE 2 - MAIN PUMP STATION AND CSO FLOW RATES FOR VARIOUS STORMS







WRIGHT-PIERCE
Engineering a Better Environment

MEMORANDUM

TO:	File	DATE:	September 21, 2015
FROM:	A. Morrill, J. Mercer	PROJECT NO.:	12883B
SUBJECT:	Exeter, NH– WWTF & Main Pump Station Upgrade Main Pump Station Influent Sewer Capacity Analysis		

This memo summarizes the analysis of flow capacity within the collection system upstream of the Main Pump Station (MPS). Data from the following sources was used in this effort:

- Phase I Infiltration/Inflow Study, (CDM, 1997)
- Phase II Infiltration/Inflow Study, (CDM, 1998)
- Phase III Infiltration/Inflow Evaluation, (Underwood Engineers, 2013)
- Water Street Sewer Interceptor Improvements (Under Wood Engineers, 2013)
- Survey data was collected from Doucet Survey, Inc. (2009 and 2015)

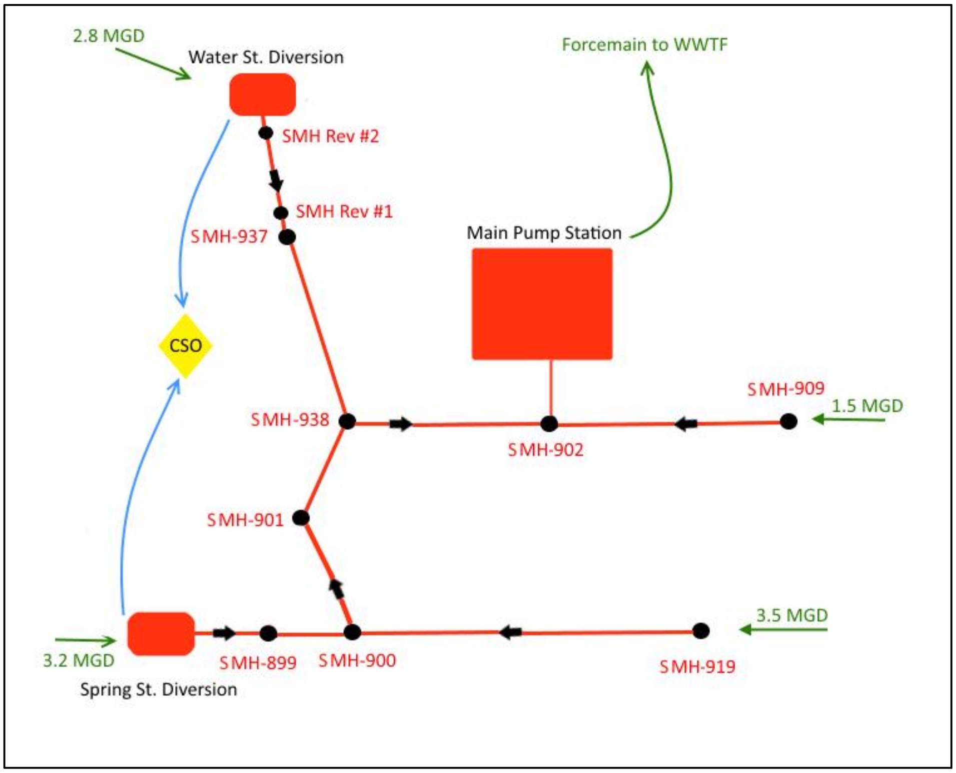
Background

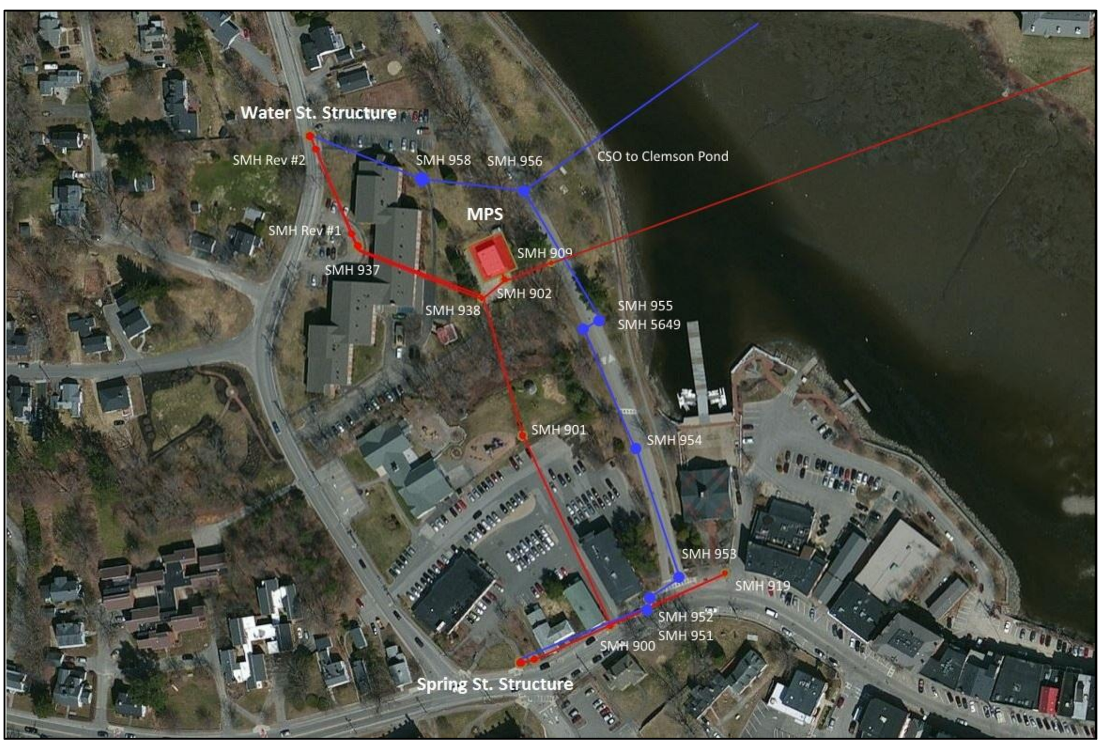
The Town has approximately 51 miles of separated gravity sewer lines, portions of which were originally constructed as combined sewers. The system still contains two diversion structures on Water Street and Spring Street with diversion structures at elevation 5.4-ft and 5.8-ft (NGVD 1929) respectively. The diversion structures discharge to the CSO Outfall No. 003, located at Clemson Pond and controlled by CSO Outfall No. 002, the Clemson Pond tide gate that discharges to the Squamscott River.

The Town continues to make improvements to further reduce I/I flows through regular O&M and sewer replacement projects, yet still experiences CSO events during storm events. To limit the frequency of CSO events, the MPS capacity will be increased to accommodate the normal wastewater flows and the storm flows from I/I. The purpose of this analysis was to determine the capacity of the surrounding influent sewers to determine if the full design flow can be conveyed to the MPS which was originally designed to convey approximately 5,000 gpm with two pumps running.

A SewerCAD (Version 8i) model was developed to assess the dynamic relationship between influent flows, pipe capacity, wet well level, and backwater conditions at the MPS and in the collection system. The model was used to determine the effects of various wet well levels at set influent flows. The influent flows were estimated based on field observations recorded by Underwood Engineers (UEI, 2013) and the three-phase I/I study (CDM, 1997; CDM, 1998; & UEI, 2013). **Figure 1** portrays the area evaluated.

FIGURE 1: SEWERCAD MODEL





Data Input

The Phase 1 I/I study (CDM, 1997), included a sewer system evaluation which was updated in the Phase 3 I/I study (UEI, 2013) based on sewer work completed by the Town between 1997 and 2013 and based on field measurements. The Wright-Pierce memo titled "Main Pump Station Design Flow Analysis" (August, 2015) determined that peak flows from 9.5 to 10.0 MGD at the MPS is likely based on MPS and CSO flow data from 2011 through 2014. This flow range is based on the assumption that the recordings are 15% to 20% high (when compared to the influent mag meter). However, flows in excess of 11.0 MGD upstream of the MPS have been recorded (Patriot's Day Storm) and are the basis for this analysis. To reach a total influent flow rate of 11.0 MGD for model input, the estimated flow rates from the Phase 3 I/I Study (UEI, 2013) were scaled. **Table 1** below summarizes the flows applied to the model. The model assumes the MPS is able to maintain a maximum wet well water level of 0-ft (NGVD 1929) based on increased pumping capacity. The influent channel grinders are assumed to both be operating with headloss based on influent flow and downstream water depth.

Note that SMH-909 and SMH-919 do not flow through either diversion structure. The SewerCAD model determines the hydraulic grade line through each pipe section using a combination of Manning's equation for non-pressurized flow and Hazen-William's equation for pressurized flow. The model then performs a backwater analysis to determine the impacts of surcharging pipes. Given the elevation of the overflow weirs at each CSO diversion structure, the model indicates whether a CSO is likely to occur at the given wet well level and influent flow rates. The SewerCAD Model is calibrated to existing conditions and field results from past reports.

Results

The I/I Study concluded that pipe sections from SMH-900 to SMH-938 and from the Water Street Diversion Structure to SMH-937 were flowing full and therefore undersized for gravity flow. In 2013, the piping between the Water Street Diversion Structure and SMH-937 was replaced with 24-inch piping with sufficient capacity for the design flows. The SewerCAD analysis indicated that the sections from SMH-900 to SMH-938 were flowing full for the flows applied to each section; therefore, confirming the conclusions from the I/I study. The hydraulic grade lines for each Diversion Structure are attached to this memo.

The backwater from SMH-937 to the Water Street Diversion Structure was not enough to raise the HGL above the overflow weir unless the wet well level exceeded an approximate elevation of 3.1-ft. Based on these results, it appears that overflows at the Water Street Diversion Structure are the result of insufficient pumping capacity.

At the Spring Street Diversion Structure, the backwater from the surcharging pipes, independent of backwater from the wet well, results in the HGL exceeding the overflow weir. At the design wet well level of 0-feet and peak influent flow rates (as shown in **Table 1**), the Spring Street Diversion Structure has an influent flow capacity of approximately 1.4 MGD caused by limited capacity from SMH-900 to SMH-938. Flow entering the Spring Street Diversion Structure exceeding 1.4 MGD, under the given conditions, would likely result in a CSO, even if the capacity at the MPS is increased. Raising the wet well level from 0-ft at the MPS causes additional flows to be diverted at the Spring Street Diversion Structure.

TABLE 1: SEWERCAD INPUT FLOW RATES TO MPS

Structure	**Phase 3 I/I Study Flow Rate (MGD)[1]**	**Peak Model Input Flow Rate (MGD)[2]**
Water St. Structure	2.6	2.8
SMH-909	1.4	1.5
SMH-919	3.2	3.5
Spring St. Structure	2.9	3.2
Total to MPS (MGD)	**9.1**	**9.2**
CSO (MGD)	**1**	**1.8**
Total	**10.1**	**11.0**

Notes: 1. Based on field measurements by UE during a CSO event on March 30, 2010
2. Assumes that the MPS maintains a wet well level of 0.0-ft

Conclusions

Based on this preliminary analysis, the collection system is able to convey a maximum of 8.7 to 9.2 out of the total 11.0 MGD peak flow to the Main Pump Station under existing conditions. Under the proposed conditions, including a new grinder and influent channel, the collection system is presumed to convey 9.2 to 9.7 MGD and up to 11.0 MGD with collection system improvements. This conclusion is based on the assumed SewerCAD model inputs indicated in **Table 1** which were used to calibrate the model. Furthermore, since the applied flow rates are based on a single storm, it is relatively unknown how the collection system reacts to differences between storms including rainfall intensity, groundwater level, time of day, etc. To develop a better understanding of the flows going to the MPS, we recommend the following next steps to be conducted during the final design phase:

- Install Flow Meters at SMH-901, 909, 919, and 937 to measure flows to the MPS from each sewer section
- Continue to collect CSO flow data at each Diversion Structure
- Update the SewerCAD model and calibrate
- Develop SewerCAD models for each sewer capacity option described below

Following these initial steps, there are three options moving forward:

Option 1: Continue to evaluate the conditions at the Diversion Structures and MPS before and after the MPS upgrade considering the Town continues to search for and eliminate sources of I/I to the collection system.

Option 2: Increase sewer capacity by installing a new pipe from SMH-956 back to the MPS to intercept CSO flow prior to going to Clemson Pond. This could be included as part of the MPS Upgrade or completed later. This would include about 130-ft of new pipe; however, impacts to the MPS hydraulics would need to be evaluated.

Option 3: Increase sewer capacity by upsizing the pipe sections from the Spring Street Diversion Structure to SMH-938. This could be included as part of the MPS Upgrade or completed later. This would include installation of about 680-ft of new pipe via open-trench or pipe-bursting. Impacts to downtown traffic would need to be evaluated.

BY DAM DATE 9-17-2015 **WRIGHT-PIERCE** Engineering a Better Environment SHEET NO. 1 OF 2

CHCKD. BY ________ DATE ________ PROJECT NO. 12883B

PROJECT EXETER MPS PDR BOOK NO. ________

MPS GRINDER HYDRAULIC PROFILE SUMMARY

EXISTING GRINDERS CHANNEL INVERT -1.75 FT

WIDTH 2 FT GRINDER HEIGHT 3 FT (EL 1.25 FT)

CHANNEL MONSTER HEIGHT 3.67 FT (1.92 FT)

SCENARIO 9MGD TO MPS

HGL @ GRINDER IS EL 1.18 FT

FREEBOARD - GRINDER FIELD 0.07 FT = 0.84 INCH

FREEBOARD - CHANNEL MONSTER 0.74 FT = 8.88 INCHES

SCENARIO 11MGD TO MPS

HGL @ GRINDER IS EL 1.625 FT

OVERTOP GRINDER FIELD 0.375 FT = 4.5 INCHES

FREEBOARD - CHANNEL MONSTER 0.295 FT = 3.54 INCHES

BY DAM DATE 9-17-2015 **WRIGHT-PIERCE** SHEET NO. 2 OF 2

Engineering a Better Environment

CHCKD. BY ________ DATE ________ PROJECT NO. 12883 B

PROJECT EXETER MPS PDR BOOK NO. ________

PROPOSED GRINDER CHANNEL INVERT -1.75FT

WIDTH 4.5FT GRINDER HEIGHT 3FT (EL. 1.25FT)

CHANNEL MONSTER HEIGHT 3.67FT (EL 1.92FT)

SCENARIO 9MGD TO MPS

HGL @ GRINDER IS EL 0.29FT

FREEBOARD - GRINDER FIELD 0.96FT = 11.52 INCHES

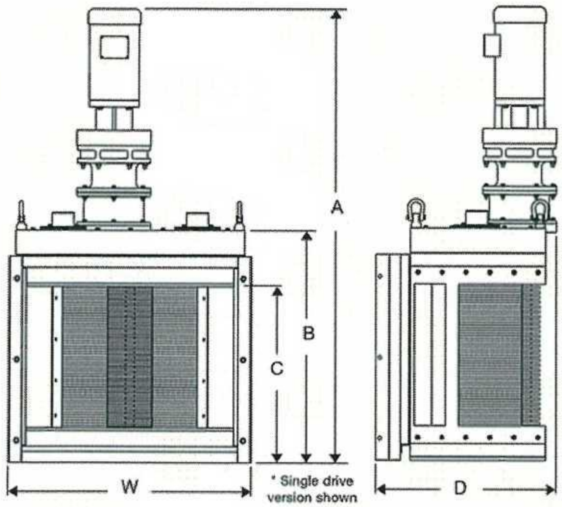
FREEBOARD - CHANNEL MONSTER 1.63FT = 19.56 INCHES

SCENARIO 11 MGD TO MPS

HGL @ GRINDER IS EL. 0.39FT

FREEBOARD - GRINDER FIELD 0.86FT = 10.32 INCHES

FREEBOARD - CHANNEL MONSTER 1.53FT = 18.36 INCHES

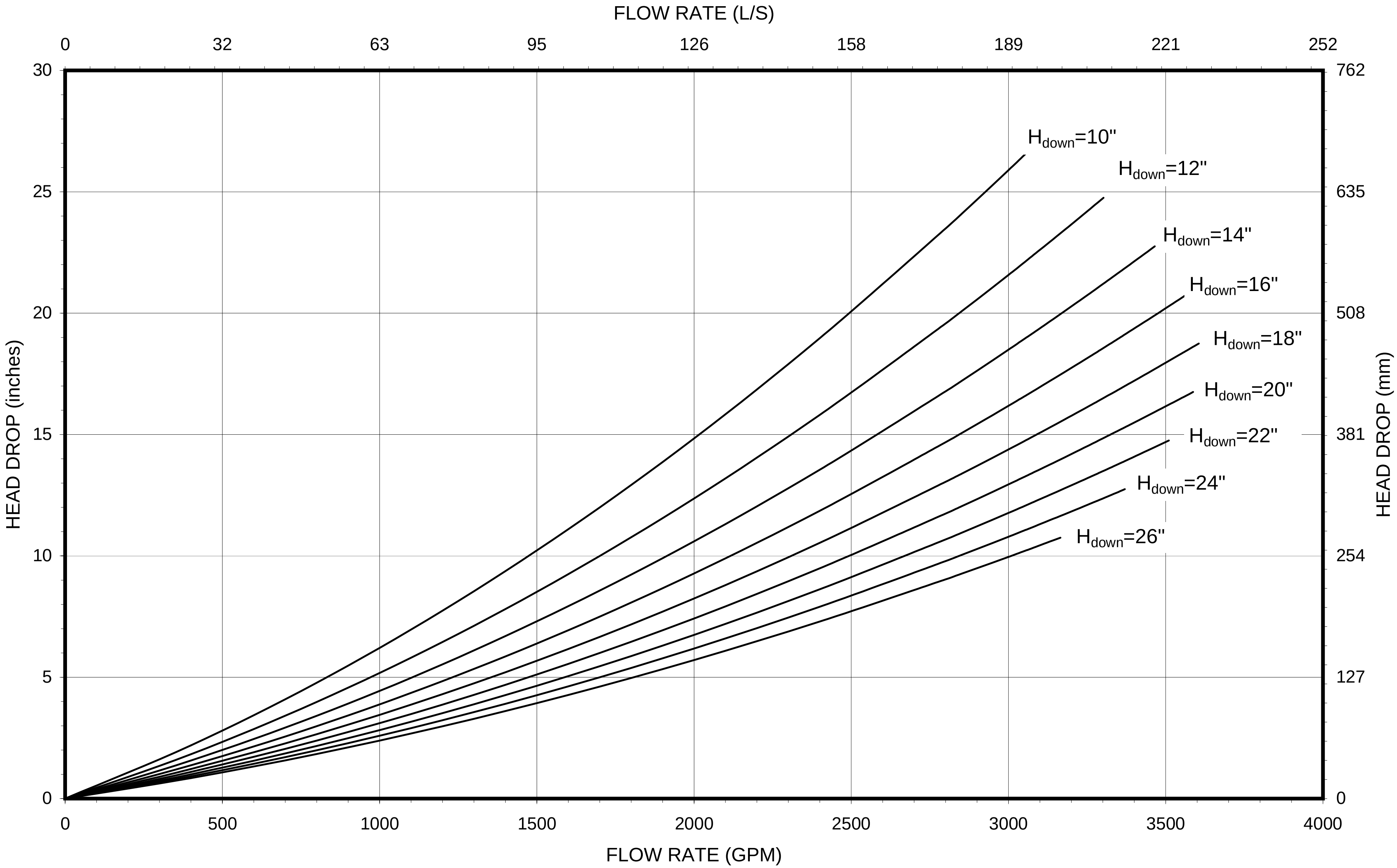


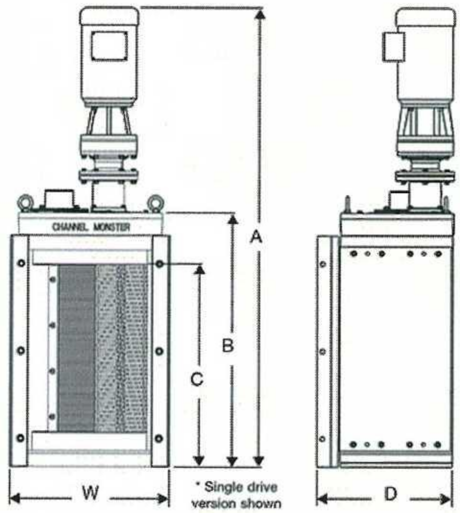
Model	A** inches (mm)	B inches (mm)	C inches (mm)	D – Min. inches (mm)	W – Min. Channel Width* inches (mm)	Max Flow Coil Drum MGD (m³/h)	Max Flow Perf Drum MGD (m³/h)	Weight lbs. (kg)
CDD1810-XD2.0	60-5/16 (1538)	30-1/2 (775)	23-1/8 (578)	21-3/4 (552)	30 (762)	3.7 (591)	3.3 (524)	1480 (671)
CDD2410-XD2.0	66-3/16 (1681)	36-1/8 (918)	28-7/8 (733)	21-3/4 (552)	30 (762)	5.4 (852)	4.8 (760)	1570 (712)
CDD3210-XD2.0	74-1/16 (1881)	44 (1118)	36-3/4 (933)	21-3/4 (552)	30 (762)	7.9 (1243)	7.1 (1113)	1645 (746)
CDD4010-XD2.0	81-15/16 (2081)	51-7/8 (1318)	44-1/2 (1130)	21-3/4 (532)	30 (762)	10.5 (1650)	9.4 (1481)	1720 (780)
CDD4010-XD2.5	96-3/16 (2443)	57 (1449)	46 (1168)	22-3/4(578)	30 (762)	10.5 (1650)	9.4 (1481)	4000 (1814)
CDD5010-XD2.5	105-15/16 (2691)	66-3/4 (1695)	55-3/4 (1416)	22-3/4(578)	30 (762)	13.9 (2195)	12.5 (1978)	4200 (1905)
CDD6010-XD2.5	116-9/16 (2961)	77-3/8 (1965)	66-3/8 (1686)	22-3/4(578)	30 (762)	17.6 (2775)	15.9 (2510)	4450 (2018)
CDD2416-XD2.0	66-3/16 (1681)	36-1/8 (918)	28-7/8 (733)	26 (660)	42 (1067)	7.1 (1126)	5.9 (935)	2070 (939)
CDD3216-XD2.0	74-1/16 (1881)	44 (1118)	36-3/4 (933)	26 (660)	42 (1067)	10.6 (1670)	8.9 (1403)	2295 (1041)
CDD4016-XD2.0	81-15/16 (2081)	51-7/8 (1318)	44-1/2 (1130)	26 (660)	42 (1067)	14.2 (2246)	12.1 (1907)	2395 (1086)
CDD4016-XD2.5	96-3/16 (2443)	57 (1449)	46 (1168)	32-3/4 (832)	42 (1067)	14.2 (2246)	12.1 (1907)	4750 (2155)
CDD5016-XD2.5	105-15/16 (2691)	66-3/4 (1695)	55-3/4 (1416)	32-3/4 (832)	42 (1067)	19.2 (3030)	16.5 (2600)	5000 (2268)
CDD6016-XD2.5	116-9/16 (2961)	77-3/8 (1965)	66-3/8 (1686)	32-3/4 (832)	42 (1067)	24.6 (3875)	21.1 (3345)	5300 (2404)
CDD3220-XD2.0	74-1/16 (1881)	44 (1118)	36-3/4 (933)	27-3/4 (705)	54 (1372)	16.6 (2612)	13.1 (2603)	2320 (1052)
CDD4020-XD2.0	81-15/16 (2081)	51-7/8 (1318)	44-1/2 (1130)	27-3/4 (7051)	54 (1372)	21.8 (3442)	17.8 (2803)	2395 (1086)
CDD4020-XD2.5	96-3/16 (2443)	57 (1449)	46 (1168)	33-1/2 (851)	54 (1372)	21.8 (3442)	17.8 (2803)	5400 (2449)
CDD5020-XD2.5	105-15/16 (2691)	66-3/4 (1695)	55-3/4 (1416)	33-1/2 (851)	54 (1372)	28.9 (4551)	24.2 (3815)	5675 (2574)
CDD6020-XD2.5	116-9/16 (2961)	77-3/8 (1965)	66-3/8 (1686)	33-1/2 (851)	54 (1372)	36.3 (5730)	31.2 (4920)	6000 (2722)
CDD9020-XD3.0	156-3/8 (3972)	113-3/16 (2875)	97-7/8 (2486)	42 (1066)	54 (1372)	59 (9306)	n/a	10,300 (4600)

** For ideal channel construction width please add 2" (50mm). ** Based on use of TEFC motor*

HEAD DROP
MODEL CMD3210
STAINLESS STEEL COIL DRUM

2-14-06





Model	A** inches (mm)	B inches (mm)	C inches (mm)	D – Min. inches (mm)	W – Min. Channel Width* inches (mm)	Max Flow Coil Drum MGD (m^3/h)	Max Flow Perf Drum MGD (m^3/h)	Weight lbs. (kg)
CMD1205-AD 2.0	52-3/8 (1330)	24-1/2 (622)	17-1/16 (433)	17-5/8 (448)	14 (356)	1 (160)	.9 (142)	655 (297)
CMD1810-XD2.0	60-5/16 (1538)	30-1/2 (775)	23-1/8 (578)	21-3/4 (552)	21 (533)	2.7 (420)	2.4 (376)	1270 (576)
CMD2410-XD2.0	66-3/16 (1681)	36-1/8 (918)	28-7/8 (733)	21-3/4 (552)	21 (533)	3.7 (584)	3.3 (528)	1395 (633)
CMD3210-XD2.0	74-1/16 (1881)	44 (1118)	36-3/4 (933)	21-3/4 (552)	21 (533)	5.2 (820)	4.7 (749)	1445 (655)
CMD4010-XD2.0	81-15/16 (2081)	51-7/8 (1318)	44-1/2 (1130)	21-3/4 (552)	21 (533)	6.7 (1057)	6.2 (975)	1570 (712)

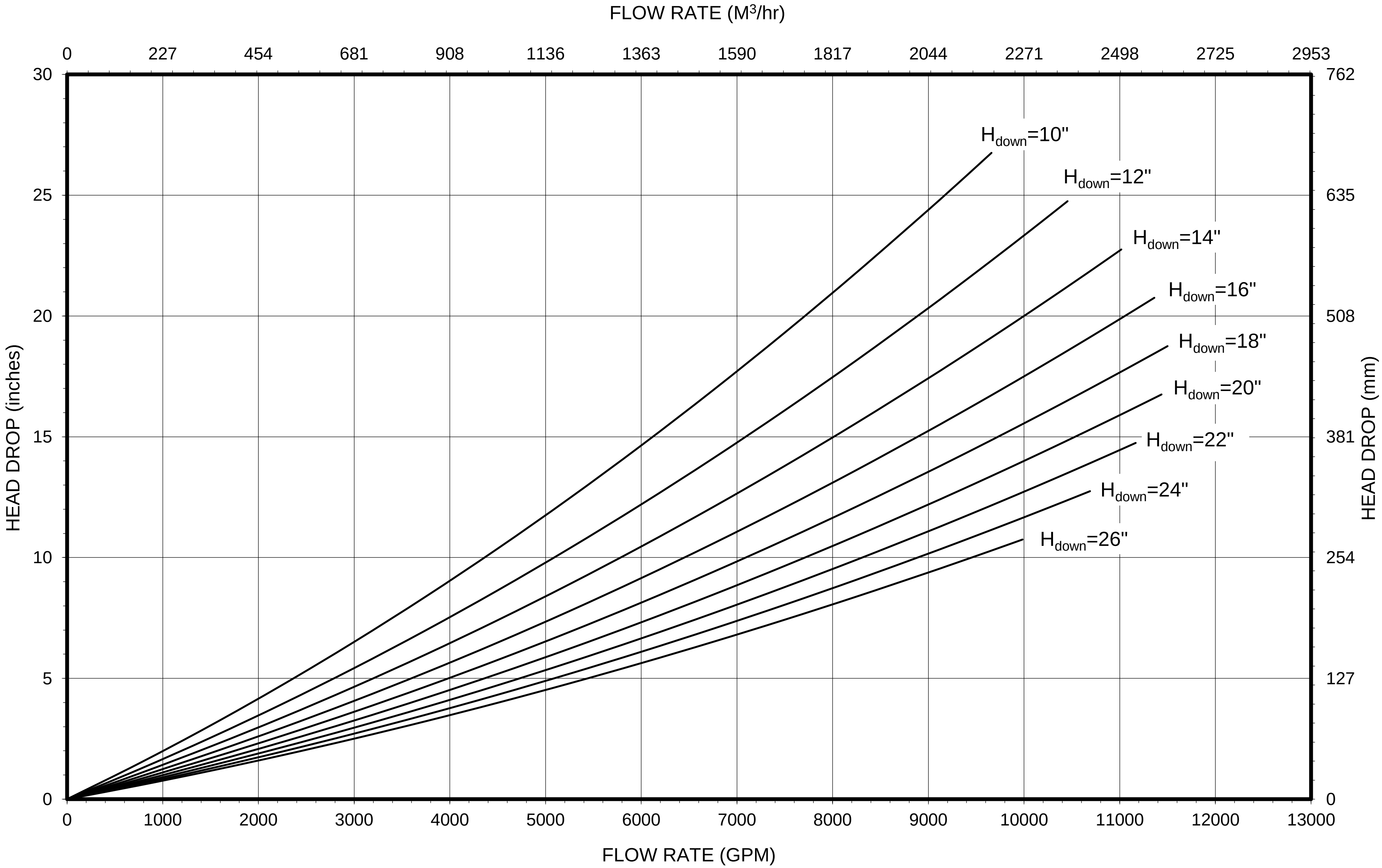
** For ideal channel construction width please add 2" (50mm). **Based on use of TEFC motor*

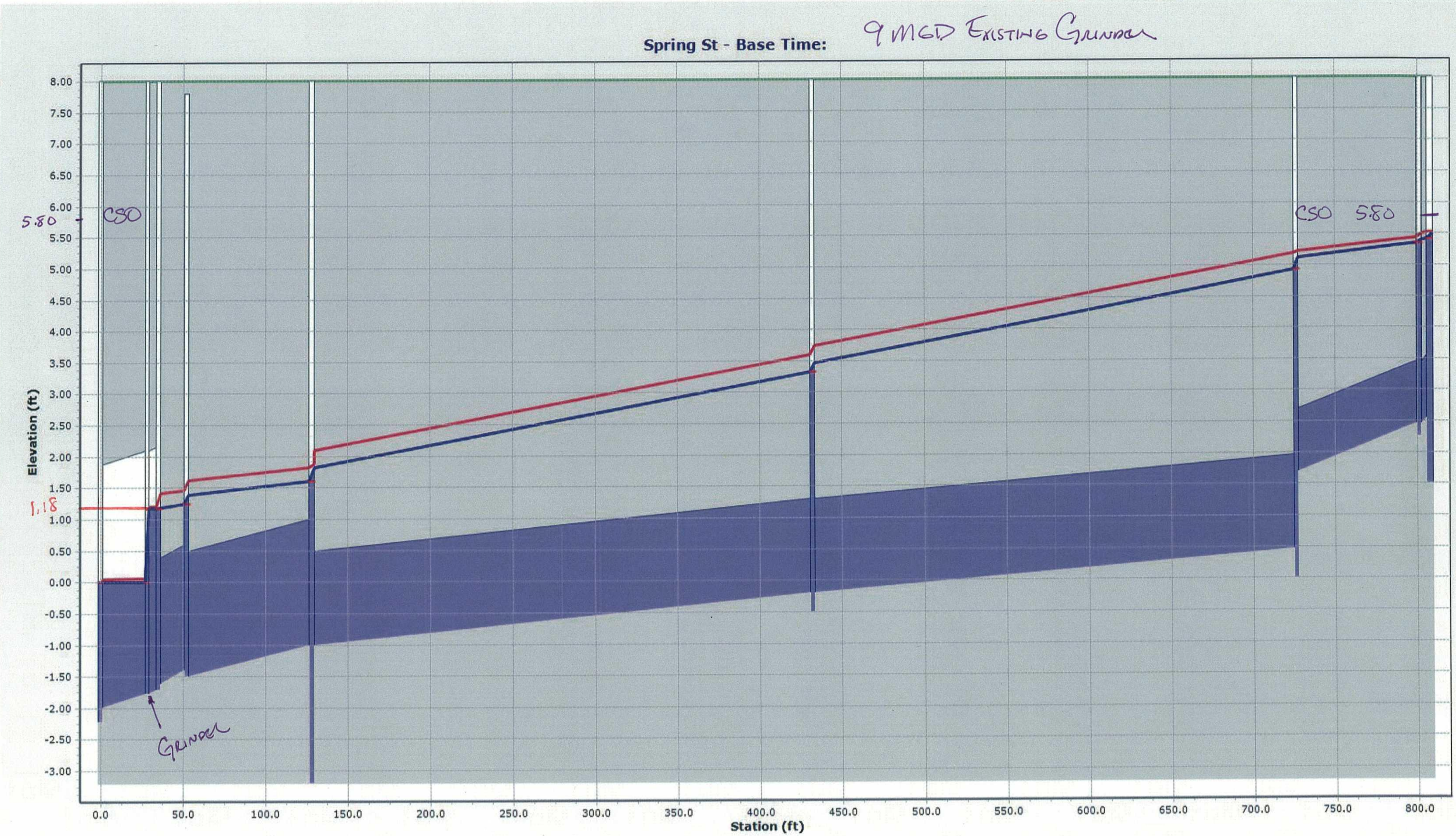
HEAD DROP

MODEL CDD3220-XD2.0

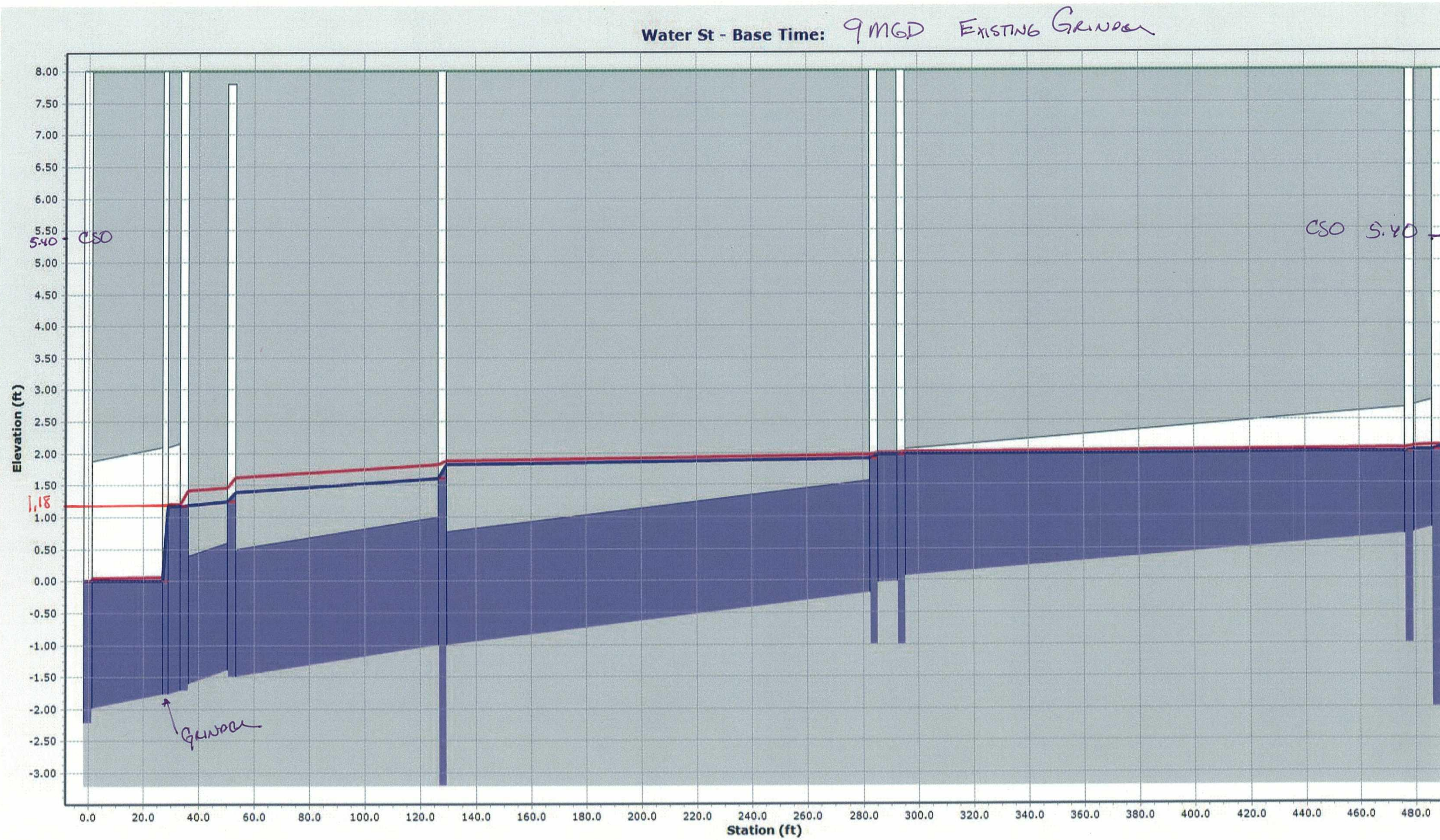
Ø1/2" PERFORATED STAINLESS STEEL DRUM

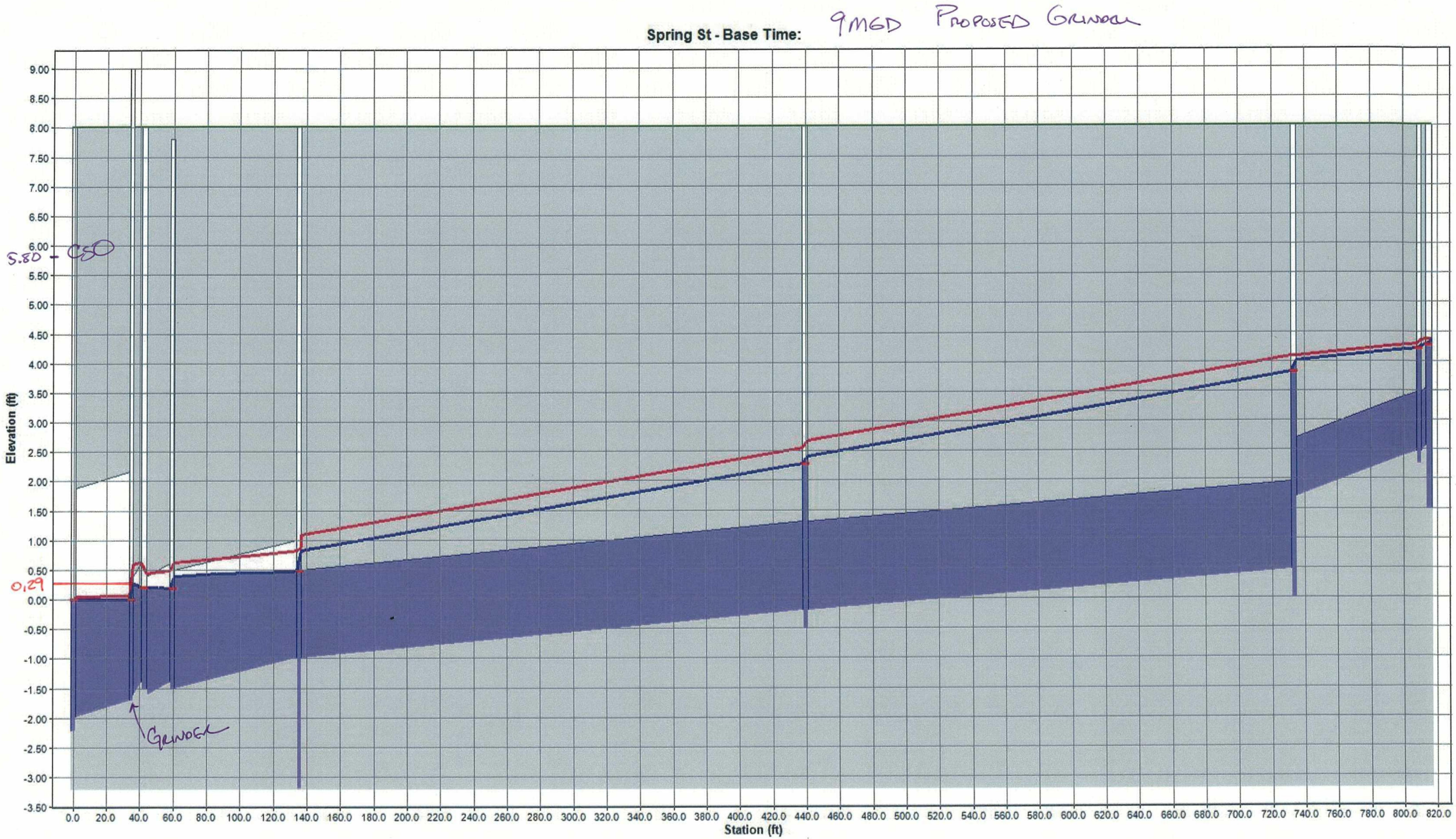
3-13-15



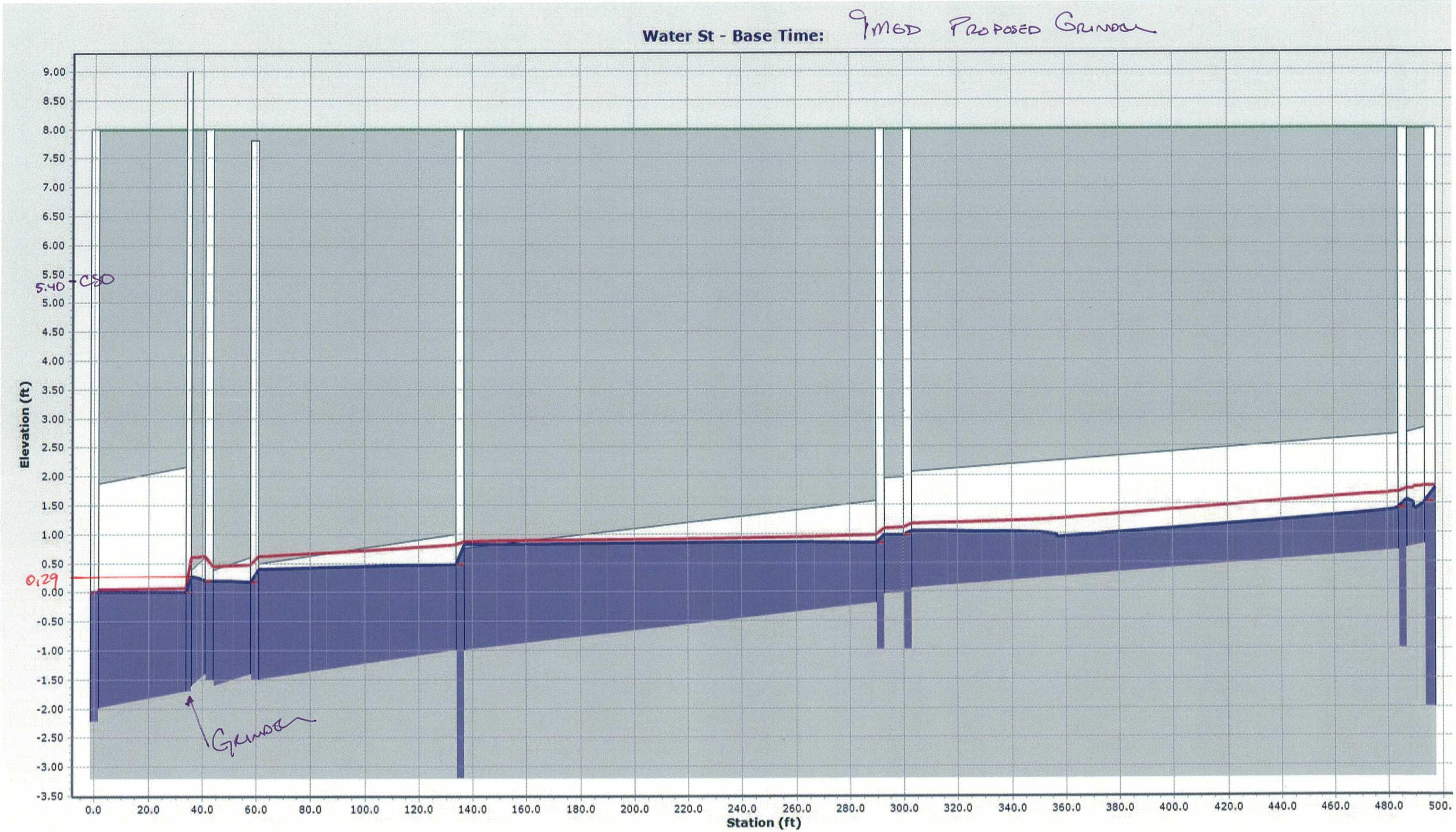


Spring St - Base Time:
9 MGD Existing Grinder
Elevation (ft)
Station (ft)
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
0.0
50.0
100.0
150.0
200.0
250.0
300.0
350.0
400.0
450.0
500.0
550.0
600.0
650.0
700.0
750.0
800.0
5.80
CSO
CSO
5.80
1.18
Grinder

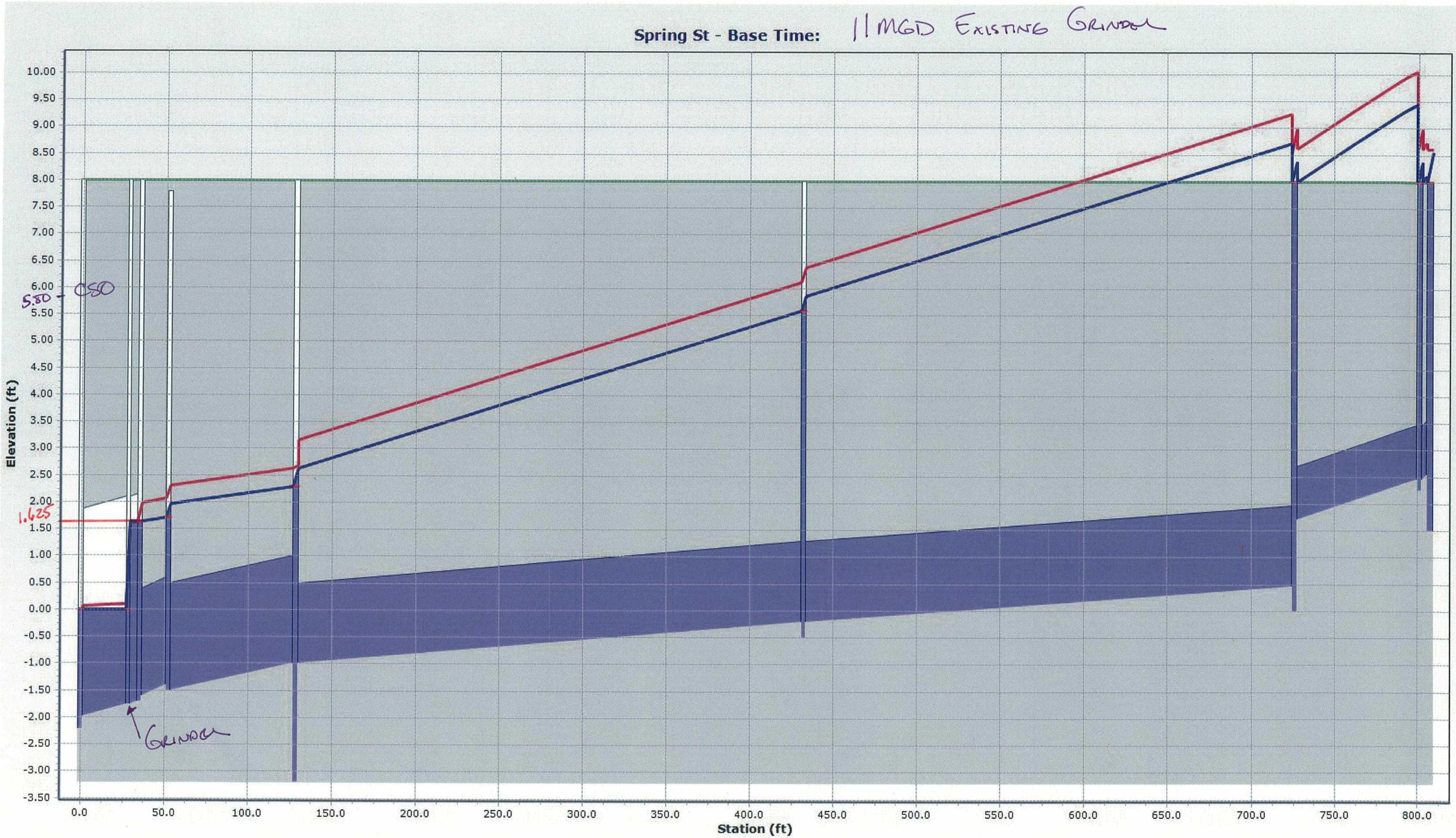

Water St - Base Time: 9MGD Existing Grinder
Elevation (ft)
8.00
7.50
7.00
6.50
6.00
5.50
5.40 CSO
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.18
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
CSO 5.40
Grinder
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0
220.0
240.0
260.0
280.0
300.0
320.0
340.0
360.0
380.0
400.0
420.0
440.0
460.0
480.0
Station (ft)



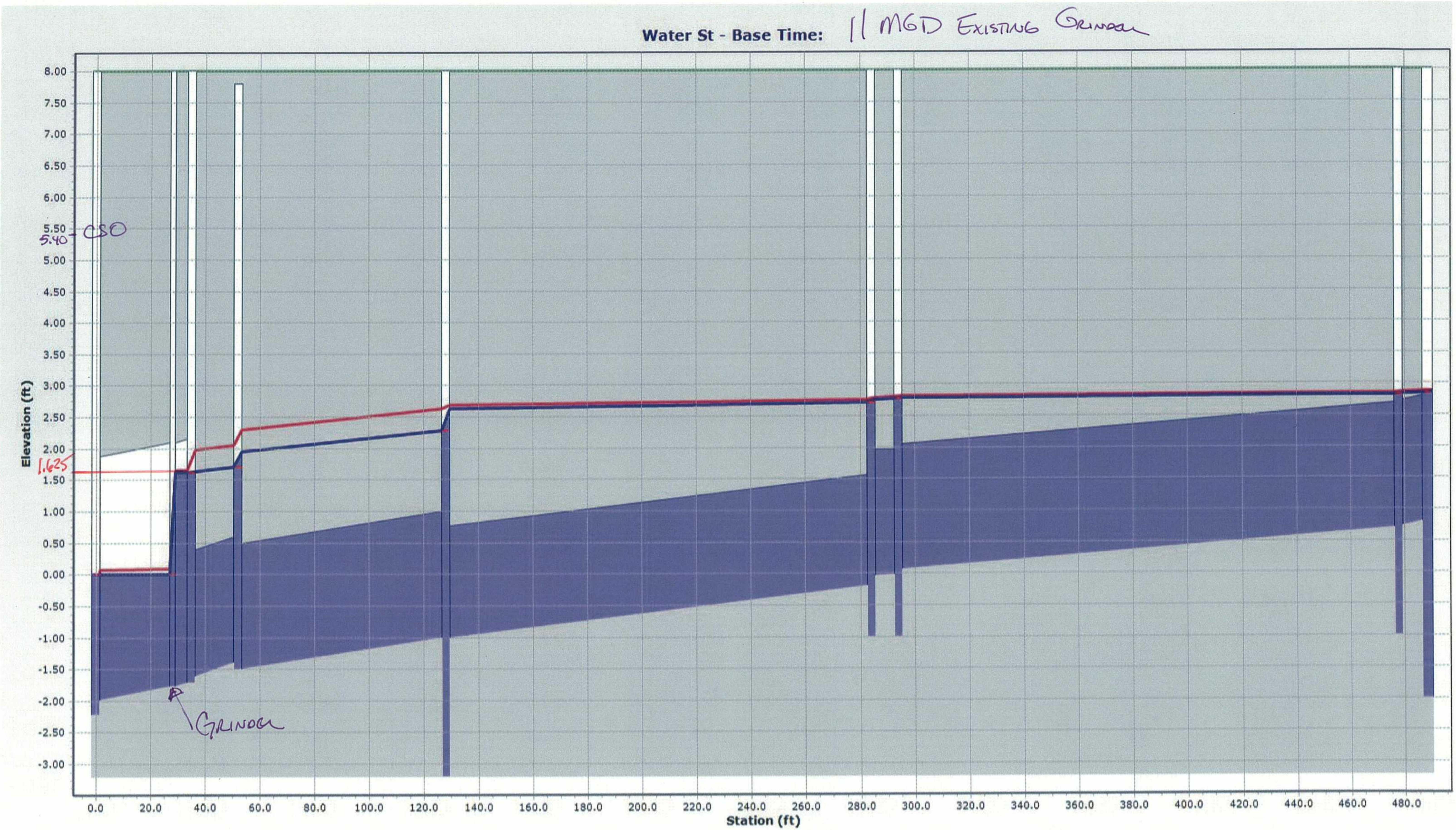
9MGD Proposed Grinder
Spring St - Base Time:
5.80 - CSO
0.29
Grinder
Elevation (ft)
Station (ft)
9.00
8.50
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
-3.50
0.0 20.0 40.0 60.0 80.0 100.0 120.0 140.0 160.0 180.0 200.0 220.0 240.0 260.0 280.0 300.0 320.0 340.0 360.0 380.0 400.0 420.0 440.0 460.0 480.0 500.0 520.0 540.0 560.0 580.0 600.0 620.0 640.0 660.0 680.0 700.0 720.0 740.0 760.0 780.0 800.0 820.0



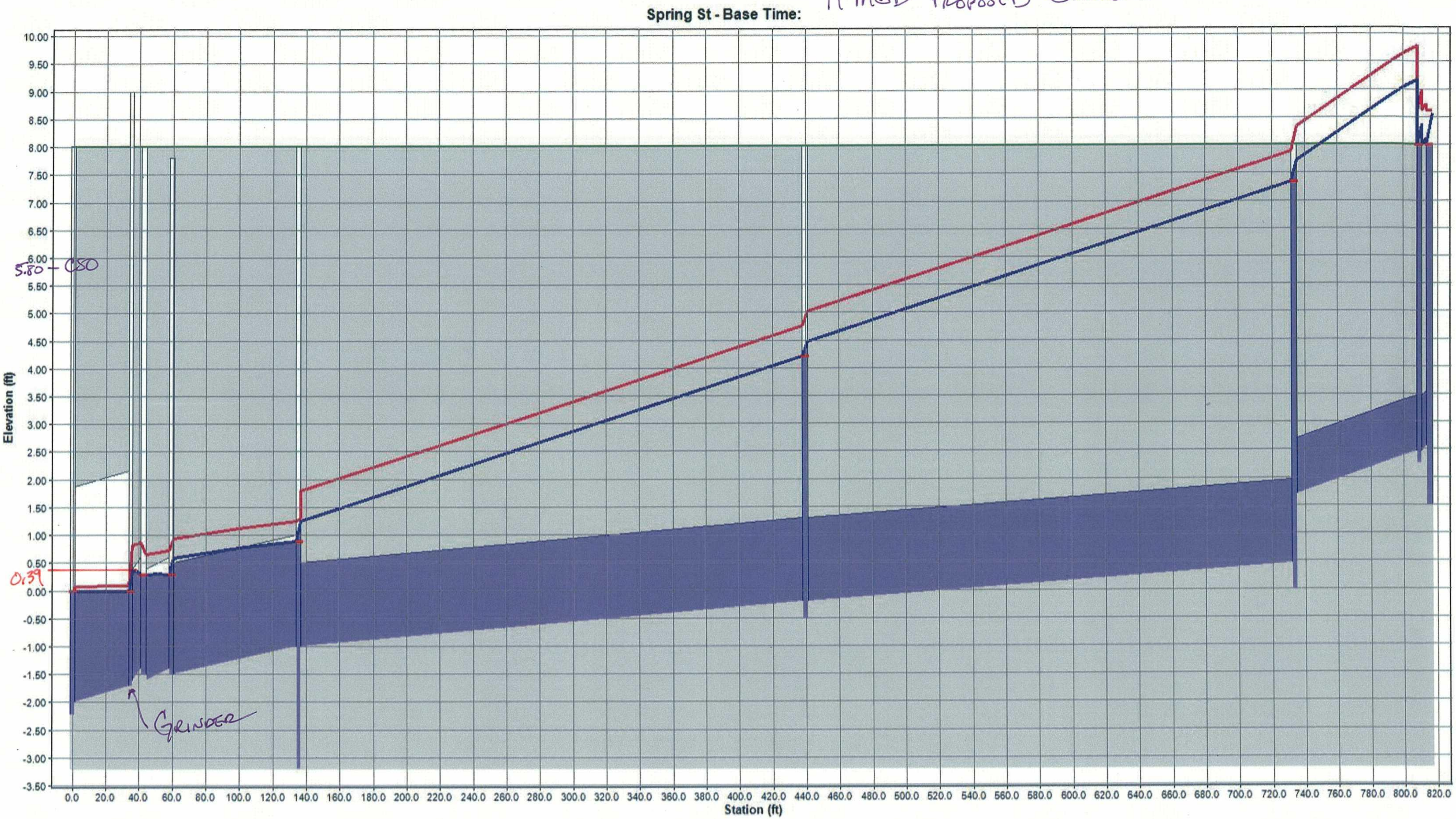
Water St - Base Time:
9MGD Proposed Grinder
Elevation (ft)
9.00
8.50
8.00
7.50
7.00
6.50
6.00
5.50
5.40 - CSO
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.29
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
-3.50
Grinder
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0
220.0
240.0
260.0
280.0
300.0
320.0
340.0
360.0
380.0
400.0
420.0
440.0
460.0
480.0
500.
Station (ft)



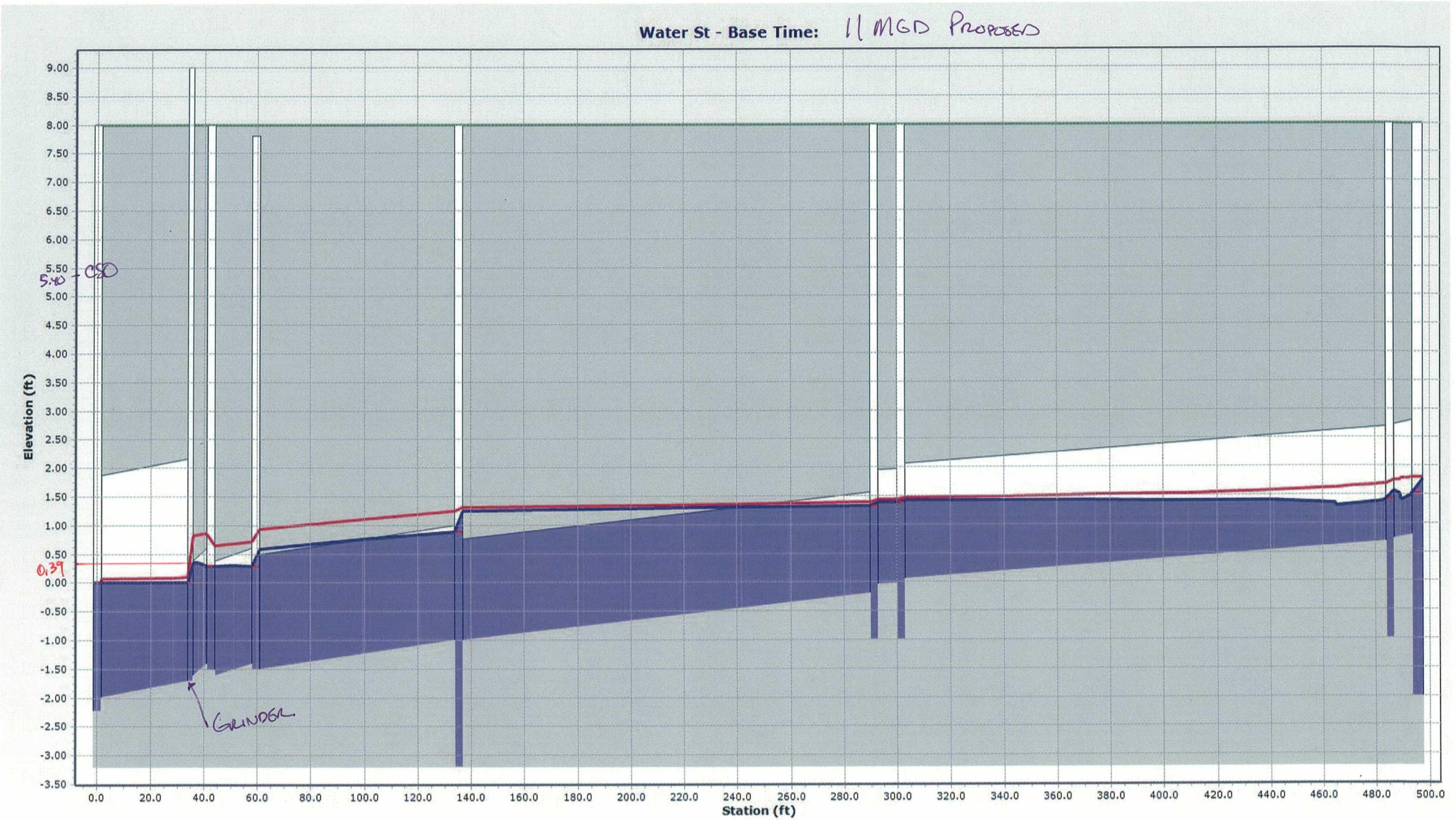
Note: To get 11 MGD to MPS CSO not allowed to activate at Spring St.


Water St - Base Time: 11 MGD Existing Grinder
Elevation (ft)
Station (ft)
5.40 - CSO
1.625
Grinder
8.00
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0
220.0
240.0
260.0
280.0
300.0
320.0
340.0
360.0
380.0
400.0
420.0
440.0
460.0
480.0

11 MGD Proposed Grinder



Note: To get 11 MGD to MPS CSO not allowed to actuate at Spring St.



Water St - Base Time: 11 MGD Proposed
Elevation (ft)
9.00
8.50
8.00
7.50
7.00
6.50
6.00
5.50
5.40 - CSO
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.39
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
-3.50
Grinder
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0
220.0
240.0
260.0
280.0
300.0
320.0
340.0
360.0
380.0
400.0
420.0
440.0
460.0
480.0
500.0
Station (ft)

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE

PROJECT NO.: 12883B

MAIN PUMP STATION DESIGN PACKAGE

System/Subject:	MAIN PUMP STATION		
Calculations By:	JEFF MERCER	Date:	7/10/15
Checked By:	ANDY MORRILL	Date:	7/17/15
Revised By:	JEFF MERCER	Date:	7/27/15
Checked By:	ED LEONARD	Date:	7/29/15

Checklist (to be completed by Design Engineer prior to calculation checking):

x Brief Process Description

x Graphs/Sketches of System Attached (Plans & Schematics)

x Design Calculations Attached

x Design Guidelines/Standards Noted

x Equations Noted and Referenced

x Electrical Loads Developed and Identified

x Process Control Description Developed

x Preliminary Basis of Design (Support Divisions) Attached

x Construction Sequence Developed

x Product Information Attached

\- Manufacturer's Review of Specs and Drawings (If Applicable)

x Electronic File Location Noted

\- Program(s) Used (Version) Noted

x Coordinated with Hydraulic Profile (If Applicable)

DESCRIPTION OF EXISTING FACILITIES

The Main Pump Station (MPS) was originally constructed in 1964 as a drywell/wetwell configuration with three 40 HP vertical, close coupled sewage pumps. The MPS was originally constructed with a sewage grinder (comminuter) and grit removal system (which consisted of a grit collection sump, grit pump and classifier); however, due to regular clogging the grit system was removed in the mid-1980s. The Main Pump Station was upgraded in 1995 to include three 75 HP vertical, close coupled sewage pumps (each with variable frequency drives). The design capacity of the pump station is 5,500 gpm at 72 feet total dynamic head. The pumps are operated in a lead-lag-standby configuration and each pump is alternated on a weekly basis. The pump station still has sewage grinding (two channel grinders) but no grit removal system. Grit is manually removed from the grit sump on a monthly basis. Wetwell level is monitored and controlled by an ultrasonic level sensor with a backup float system. Each pump discharge has a strap-on type doppler flow meter. A 200-kilowatt emergency generator installed in March 1999 serves the MPS and is located outside.

The mechanical, instrumentation and electrical components in the Main Pump Station have reached the end of their useful life and should be overhauled with any future upgrades to the facility. The pump station currently has reduced peak capacity due to pump wear and an upgrade is warranted in the near-term. The Main Pump Station pumping capacity should be comprehensively upgraded to convey peak flows and reduce the frequency of CSO events.

FACILITY PLAN RECOMMENDATIONS

The Facility Plan recommended the following improvements at the MPS:

- New influent sluice gate to wetwell (existing gate is non-functional).
- Continue grinding influent flow to the MPS.
- Upgrade the existing three pumps to dry-pit submersible pumps sized to convey peak flows to the WWTF in order to limit future combined sewer overflows (CSOs). Pumps will be provided with variable frequency drives (VFDs) for variable speed pumping.
- Provide miscellaneous process upgrades including new suction/discharge piping, new link-type seals on wet-to-dry well wall penetrations and pressure injection of wetwell/drywell wall cracks.

- Provide new PLC-based control panel with new instrumentation, including wetwell level, combustible gas, wastewater flow and CSO flow. Upgrade connectivity to the WWTF SCADA system.
- Comprehensively upgrade the electrical service, main power distribution and automatic transfer switch. Retain the existing standby generator for continued use. Provide local disconnects and ESTOPS at process equipment. Upgrade the remainder of the electrical systems to include energy efficient lighting (interior and exterior), emergency lighting/exit signs, receptacles and fire alarm system (if required by the Fire Chief).
- Comprehensively upgrade the building and building systems, including: repairing the damaged base plates at the wall panels; replacing exterior doors; creating separation between the "classified" Pump Room and the "unclassified" upper level; replacing the damaged stair nosings at the exterior stairs; replacing the roofing system; repainting the interior spaces; and upgrading the heating, ventilating and plumbing systems.

CLIENT PREFERENCES

The client has stated the following preferences:

- Each forcemain shall have a separate flow meter located in an underground valve box adjacent to the MPS building
- Continue grinding influent flow to MPS via two in-line grinders
- Separate wet well into two separate wet wells for ease of maintenance
- Construct a hose with quick disconnects inside the wet well for connection of a vac truck outside of the wet well for grit removal
- Construct a bypass connection for the forcemain (bypass pump suction shall be upstream of the wet well)
- Provide access hatch and monorails to remove and install the pumps for maintenance
- Provide an updated bathroom with shower
- Provide odor control for wetwell ventilation system

DESIGN GUIDELINES

The NHDES WQ-700 design standards include a section on Pump Station Design (Section 705). TR-16 contains similar suggestions in Chapter 3. The following is a summary of the requirements/suggestions:

- Stations with flows over 200 gpm shall have wet well division walls
- A bypass connection shall be provided at each station for pump maintenance
- A minimum of two pumps designed to handle peak hour flows shall be provided
- Stations with flows over 250 gpm shall have a form of flow measurement and recording
- Sufficient access shall be provided for pump maintenance and removal
- NFPA requirements shall be followed
- Provide automatic heating and dehumidification

REVIEW OF DESIGN CONSIDERATION & ALTERNATIVES

Two options were identified for upgrading the MPS:

- Option No. 1 - Replace pumps with dry-pit, submersible non-clog centrifugal pumps
- Option No. 2 - Replace pumps with suction-lift pumps

Option No. 2 was eliminated from consideration since the available net positive suction head was lower than the required net positive suction head for the suction-lift pumps.

The first option requires minimal pump station layout changes as described below:

<u>Influent Sewer</u>

Influent sewer will flow from existing SMH 902 and SMH 909 to a new SMH which will flow to a new influent channel structure which will be located outside of the building adjacent to the wet wells. A new inline channel grinder will be installed in the influent channel (rated for 11.0-mgd) and will have an influent and effluent slide gate for isolation. A bypass channel will be installed with an adjustable weir for flow control. The influent channel will split into to two channels following the grinder where flow will enter Wet Well No. 1 or Wet Well No. 2 respectively. Each wet well will have an influent slide gate and a cross connection channel will be provided with a slide gate.

Wet Well Modifications

The existing wet well contains a large volume of fill and two division walls with gates which creates multiple areas for grit to collect and is very difficult to maintain. As part of the upgrade, the existing fill will be removed, a new dividing wall constructed, and corner fillets installed. The dividing wall will have a face-mounted slide gate to hydraulically connect or separate the two wet wells.

Presently when the fan is turned on in the wet well access room the neighbors complain about orders. Therefore, a wet well odor control system will be installed in the wet well access room at elevation 11.0-feet.

Dry Well Modifications

The dry well will remain relatively unmodified. Pipe penetrations not reused will be patched and concrete surface repairs will be completed. New penetrations will be cored and provided with new wall sleeves.

Pumping Systems

The proposed upgrade will include four dry-pit submersible non-clog centrifugal pumps in a lead / lag 1 / standby configuration. The fourth pump will provide additional pumping capacity during peak flow events to limit CSOs.

New suction piping will be constructed with a bell-mouth to reduce inlet velocities and prevent vortices. New discharge piping will be constructed with each pump discharge connected to a common header. The common header will be connected to the existing cast iron force main to the north of the station and to a new ductile iron force main to the south of the station. A motor-operated gate valve will be installed prior to the existing cast iron force main and each force main will have a bypass connection installed. The existing cast iron force main will continue to use the existing magnetic flow meter located at the DPW Campus and a new magnetic flow meter will be installed on the new ductile iron force main at the WWTF site.

Discharge Forcemain

A wide range of dry and wet weather flowrates are anticipated at the MPS. Variation in flowrates results in unfavorable discharge velocities in a single forcemain (e.g. low velocities can result in solids settling and high velocities result in excessive pressure loss and premature pipe wear). As a result, a dual forcemain layout is recommended. During low flows, a single forcemain would be used; during high flows both forcemains would be used. Three options for providing dual forcemains were identified:

1. Option No. 1 - Retain existing 16-inch forcemain (no modifications) and install a new second forcemain.

2. Option No. 2 - Slipline existing 16-inch forcemain and install a new second forcemain.

3. Option No. 3 - Install two new forcemains in a shared open-cut trench.

Three options were compared based on cost and functionality, using various pipe diameters (14-inch, 16-inch, and 18-inch). A preliminary cost estimate found that Option No. 1 had the lowest cost; while Option Nos. 2 and 3 both had the highest costs.

The existing forcemain was evaluated by Town Staff and Wright-Pierce in August 2010. The forcemain showed deterioration to its cement lining affecting long-term reliability; however, it may have many years of useful life if it is only used during peak flow periods.   If problems develop in the future, it could be readily repaired or relined.

Sliplining the existing forcemain allows re-use of existing piping; however, it yields a smaller inside-diameter (between 12 and 13-inches). Furthermore, it requires excavation at pull locations to install the new piping (approximately 12-15 open-cut locations for the existing forcemain).

Two new parallel forcemains of the same diameter provide the Town with new piping of the same type, size, and age; but installation requires a wider open-cut trench.

Based on this analysis, Option No. 1 is recommended. Sizing of the forcemain is based on a minimum pump flow rate of 730 gpm and maximum of 1,910 gpm. The existing 16-inch forcemain yields a discharge velocity less than the recommended minimum of 2 fps at the minimum flow; however, the Town hasn't expressed any concerns with settling within the forcemain. During peak flow, two 16-inch forcemains result in a discharge velocity less than the recommended maximum of 7 fps; however, 14-inch piping results in velocities greater than 9 fps. Therefore, it is recommended that one new 16-inch ductile iron forcemain be constructed for primary use, with the existing 16-inch diameter cast iron force main maintained for use during high flow events.

The new forcemain will follow the same general route as the existing forcemain and will be constructed of ductile iron (DI) and be wrapped for corrosion resistance. HDPE was also considered and typically lasts longer, however it is not as resistant to crushing and requires a larger outside diameter than DI. The forcemain will discharge to the Headworks' Influent Structure. There is also the option of directing the second forcemain to the Influent Equalization Tank. This option would limit flexibility; however, it is a more simplistic and less costly alternative that would work well with either Option 1 or 2 above.

WET WELL	
Number/Type	2 / Concrete
Location	Main Pump Station
TOC Elev.	2.0-ft (existing)
Max Water Surface Elev.	-1.7-ft
Bottom Elev.	-8.0-ft (existing)
Freeboard	3.7-ft
Sidewater Depth	6.3-ft
Effective Depth	1.7-ft
Dimensions, LxW, each	8-ft by 15-ft
Effective Volume, each	1,525 gallons

MPS PUMPS	
Application	Pump unscreened raw sewage to WWTF
Number/Type	4 / Dry-pit submersible, non-clog centrifugal
Design Condition	6,675 gpm @ 90.0 ft TDH
Minimum Flow	700 gpm @ 41.0 ft TDH
Discharge Diameter	10-inch
Motor	70 HP, 480V/3ph/60 Hz
Other	16-inch Flow Meter, VFD
Acceptable Manufacturer(s)	Flygt, Fairbanks Morse, KSB

BUILDING / STRUCTURE DESCRIPTION

Architectural and Structural Considerations include the following:

Demolition of:

- Wet well fill

Construction of/Modifications to:

- Concrete repairs to the wet well and dry-well
- New concrete wall and fill within the existing wet well footprint
- Channel modifications to provide separate influent channels to each wet well
- Core new wet well penetrations for pump suction lines
- Core new wall penetration for discharge header
- New odor control system for wetwell ventilation system

Structural information:

Pumps	
Weight (approx.)	3,000 lb

PROCESS CONTROL DESCRIPTION

The pumping station wet well is classified as a Class 1/ Division 1 space (NFPA 820, Table 4.2.16). The dry well will be an unclassified space via ventilation (NFPA 820, Table 4.2.17).

Pump operation will be based on variations of liquid level in the wet well. Monitoring of the station controls, environmental, and alarm functions shall be accomplished through a microprocessor based digital control system. The controller shall interface with the wet well level transducer for each wet well, backup float switches, panel display unit, motor starters, environmental system, accessories and alarm functions through optically isolated digital and analog input and output ports as required. Other functions include:

- Motor operated plug valves with remote access to control the active forcemain(s)
- Transient voltage protection for all control inputs
- A controller display unit mounted through the front of the panel to provide operator input to and visual output from the microprocessor controller
- Hand-Off-Auto mode of operation
- Manual or automatic pump alternation and select alternation time interval

Display Functions

- Pump running and alarm indication
- Hand-Off-Auto indication for each pump
- Lead Pump indication
- Alarm Reset and silencing
- Wet well level
- Elapsed run time for each pump
- Level control settings
- Alarm level settings

The following instruments, control stations, and control panels are anticipated:

Item	Location	NEMA	By Division	Range
Flow Meter (16-inch)(1)	Vault	Class 1/Div 2	11-OEM	700 to 8,400 gpm
Motor Operated Valves (1)	Dry Well	Class 1/Div 2	13	open/close
Level Elements (2)	Wetwell	Class 1/Div 1	13	0 to 10-ft
Float Switches (4)	Wetwell	Class 1/Div 1	13	-
Pump LCS (4)	Drywell	4X	16	-
MPS Control Panel	First Floor	12	13	-

Electrical information:

	Pumps
Number	4
Power	70 HP
Speed	VFD
Enclosure	Submersible
Volts, Phase/ Hz	460/ 3/ 60

x Coordinated with NFPA Memo

x Coordinated with Equipment List

CONSTRUCTION SEQUENCING

Flow from the MPS must be maintained for the duration of the project. This will be accomplished through use of the existing forcemain during construction of the new forcemain. Flow will need to be bypassed when the new pumps and piping are being installed and the wet wells are being modified. Bypass pumping will be accomplished via a rented bypass pumping system and the new bypass connection on the existing forcemain.

FUTURE EXPANSION CONSIDERATIONS

The MPS will be designed for future flows and loads. Future expansion is not anticipated.

FILE LOCATION

12883B-WW Design\Technical\Process\Design Memos

ATTACHMENTS

- A Cut Sheets

Wright-Pierce

Project: Exeter, NH
Main Pump Station Wet Well Design
Project No. 12883B

Wet Well Design - Maximum Wet Well Elevation at the influent sewer invert (Existing Conditions)

Maximum Wet Well Elevation	-1.55	ft	Elevation of the influent sewer invert (High Water Alarm)
Minimum Wet Well Elevation	-4.50	ft	Elevation above pump volute (Pump Off)
Effective Wet Well Volume (V)	4606	gal	

V = (Øq)/4 pumps

Minimum Pump Cycle Time (Ø)

Peak Flowrate (q)	5000	gpm
	7.2	MGD
Minimum Flowrate	757	gpm
	1.1	MGD

Ø = (V4)/q   Pump Cycle Time

Ø	3.68	min
No. Pumps	2	
Pump Cycle Time per pump	7.37	min

Wright-Pierce

Project: Exeter, NH
Main Pump Station Wet Well Design
Project No. 12883B

Wet Well Design - Maximum Wet Well Elevation at the influent sewer crown (Existing Conditions)

Maximum Wet Well Elevation	0.45	ft	Elevation of the influent sewer crown (High Water Alarm)
Minimum Wet Well Elevation	-4.50	ft	Elevation above pump volute (Pump Off)
Effective Wet Well Volume (V)	6910	gal	

V = (Øq)/4

Minimum Pump Cycle Time (Ø)

Peak Flowrate (q)	5000	gpm
	7.2	MGD
Minimum Flowrate	757	gpm
	1.1	MGD

Ø = (V4)/q Pump Cycle Time

Ø	5.53	min
No. Pumps	2	
Pump Cycle Time per pump	11.06	min

BY DAM DATE 09-16-2015 **WRIGHT-PIERCE** SHEET NO. 1 OF 1

Engineering a Better Environment

CHCKD. BY ________ DATE ________ PROJECT NO. 12883B

PROJECT EXETER MPS PDR BOOK NO. ________

EXISTING WET WELL VOLUMES

ELEVATION (FEET)

+ 0.45	CROWN OF INFLUENT SEWER
- 1.55	INVERT OF INFLUENT SEWER
- 4.50	MIN WATER LEVEL

VOLUME OF WET WELL TO INVERT OF INFLUENT SEWER

(13.33 FT * 2.95 FT) + (5.25 FT * 2.95 FT) + (4.75 FT * 2 FT) + (6.33 FT * 2 FT)

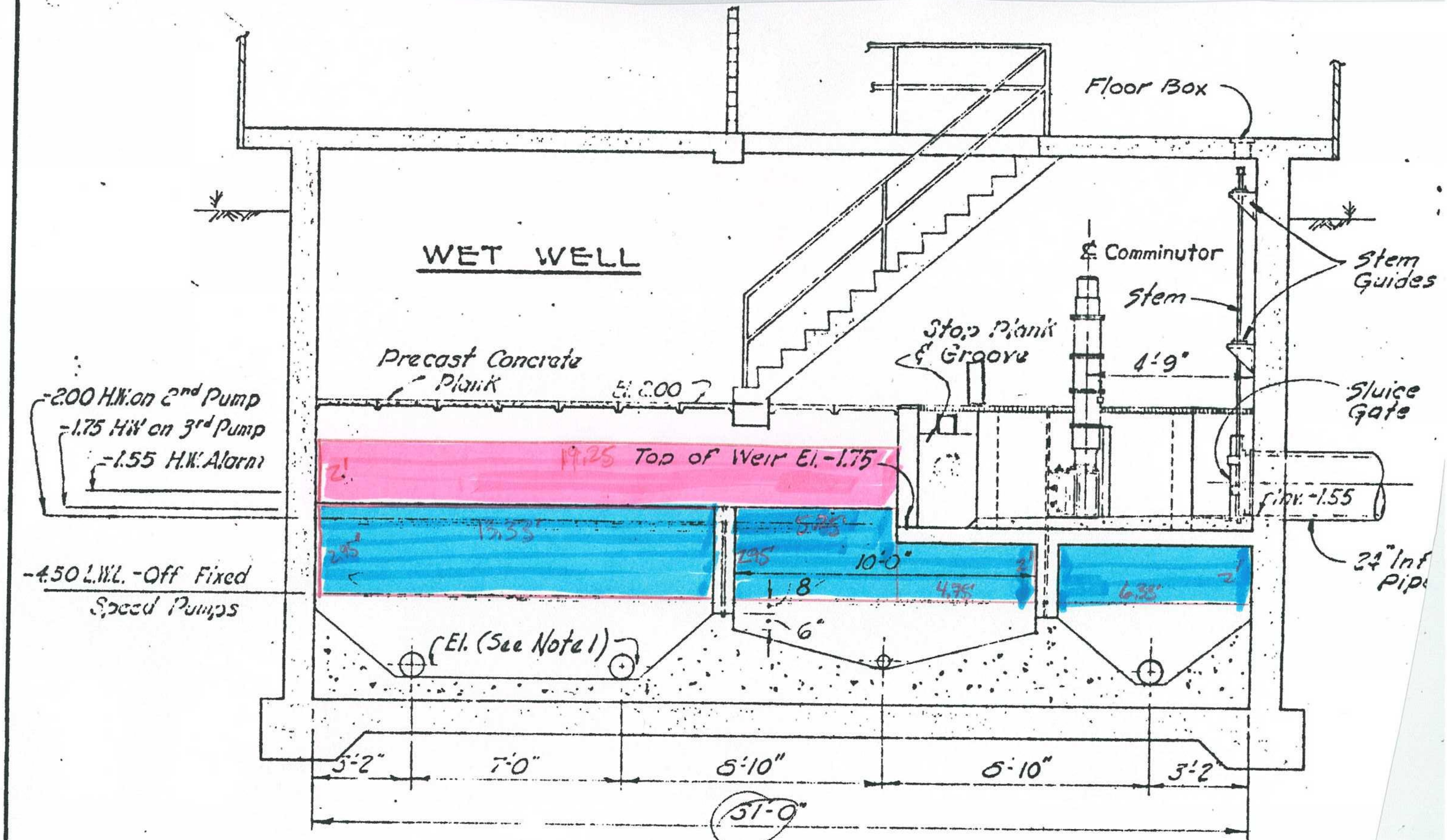
39.32 FT² + 15.49 FT² + 9.5 FT² 12.66 FT²

76.97 FT² * 8 FT = 615.76 FT³ = 4,605.89 GAL

VOLUME OF WET WELL TO CROWN OF INFLUENT SEWER

(19.25 FT * 2 FT * 8 FT) + 615.76 FT³ = 923.76 FT³

6,909.73 GAL



SECTION B-B

Scale: 1/4"=1'-0"

Wright-Pierce

Project: Exeter, NH
Main Pump Station Wet Well Design
Project No. 12883B

Wet Well Design - Maximum Wet Well Elevation at the influent sewer invert (Proposed Conditions)

Maximum Wet Well Elevation	-1.74	ft	Elevation of the influent sewer invert (High Water Alarm)
Minimum Wet Well Elevation	-3.40	ft	Elevation at top of pump volute (Pump Off)
Effective Wet Well Volume (V)	3018	gal	

V = (Øq)/4 pumps

Minimum Pump Cycle Time (Ø)

Peak Flowrate (q)	6250	gpm
	9.0	MGD
Minimum Flowrate	757	gpm
	1.1	MGD

Ø = (V4)/q   Pump Cycle Time

Ø	1.93	min
No. Pumps	3	
Pump Cycle Time per pump	5.79	min

Wright-Pierce

Project: Exeter, NH
Main Pump Station Wet Well Design
Project No. 12883B

Wet Well Design - Maximum Wet Well Elevation at the influent sewer crown (Proposed Conditions)

Maximum Wet Well Elevation	1.26	ft	Elevation of the influent sewer crown (High Water Alarm)
Minimum Wet Well Elevation	-3.40	ft	Elevation at top of pump volute (Pump Off)
Effective Wet Well Volume (V)	8472	gal	

V = (Øq)/4

Minimum Pump Cycle Time (Ø)

Peak Flowrate (q)	6250	gpm
	9.0	MGD
Minimum Flowrate	757	gpm
	1.1	MGD

Ø = (V4)/q Pump Cycle Time

Ø	5.42	min
No. Pumps	3	
Pump Cycle Time per pump	16.27	min

BY DAM DATE 09-15-15 **WRIGHT-PIERCE** Engineering a Better Environment SHEET NO. 1 OF 1

CHCKD. BY ________ DATE ________ PROJECT NO. 12883B

PROJECT EXETER MPS PDR BOOK NO. ________

PROPOSED WET WELL VOLUMES

ELEVATION (FEET)

+1.26 CROWN OF INFLUENT SEWER

−1.74 INVERT OF INFLUENT SEWER

−3.40 MIN WATER LEVEL

VOLUME OF WET WELL NO. 1 TO INVERT OF INFLUENT SEWER

14.38 FT × 8.0 FT × 1.66 FT = 191.0 CF = 1,428.4 GAL

VOLUME OF WET WELL NO. 1 TO CROWN OF INFLUENT SEWER

14.38 FT × 8 FT × 4.66 FT = 536.1 CF = 4,010 GAL

VOLUME OF WET WELL NO. 2 TO INVERT OF INFLUENT SEWER

16.0 FT × 8 FT × 1.66 FT = 212.5 CF = 1,589.4 GAL

VOLUME OF WET WELL NO. 2 TO CROWN OF INFLUENT SEWER

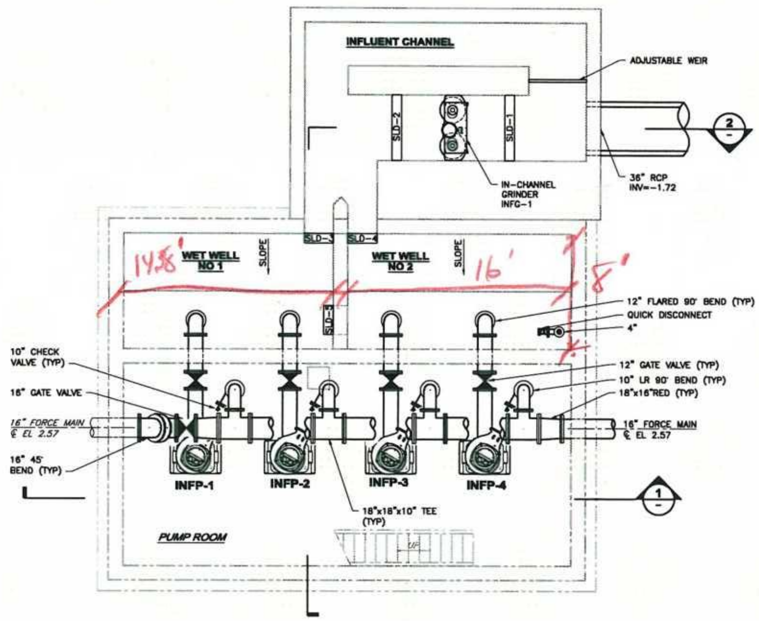
16.0 FT × 8 FT × 4.66 FT = 596.5 CF = 4,461.7 GAL

TOTAL VOLUME OF WET WELL TO INVERT OF INFLUENT SEWER

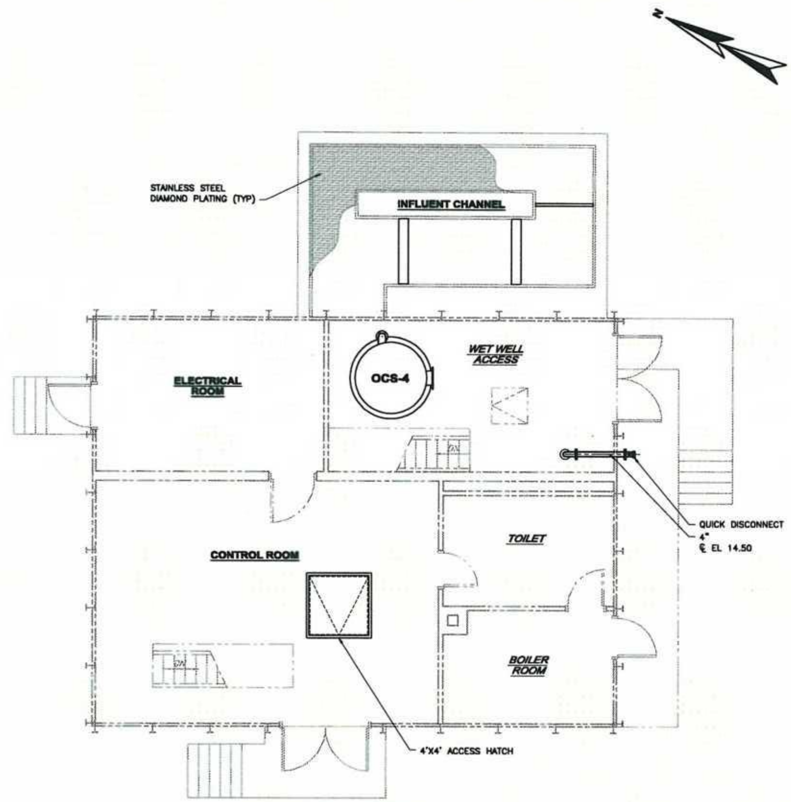
1,428.4 GAL + 1,589.4 GAL = 3,017.8 GAL

TOTAL VOLUME OF WET WELL TO CROWN OF INFLUENT SEWER

4,010 GAL + 4,461.7 GAL = 8,471.7 GAL



LOWER PLAN
SCALE: 1/4"=1'-0"



UPPER PLAN
SCALE: 1/4"=1'-0"

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1.

EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

MODIFICATION PLANS

WRIGHT-PIERCE
Engineering a Better Environment
Offices Throughout New England
888.621.8156 | www.wright-pierce.com

DESIGNED BY:
CAD COORD: APC
CAD:
CHECKED BY:
DATE:
APPROVED BY:
DATE:
PROJECT NO: 12883

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DRAWING
PR-3

BY DAM DATE 09-11-15 **WRIGHT-PIERCE** SHEET NO. 1 OF 1

Engineering a Better Environment

CHCKD. BY ________ DATE ________ PROJECT NO. 12883B

PROJECT Exeter MPS PDR BOOK NO. ________

SUCTION PIPING 12-INCH DIAMETER

FLARE SECTION 19-INCH DIAMETER

$D/3 = 19\text{-INCH}/3 = 6.33\text{ INCH}$

$D/2 = 19\text{-INCH}/2 = 9.5\text{ INCH}$

$AREA_{FLARE} = \pi r^2 = \pi (0.792\text{ FT})^2 = 1.97\text{ FT}^2$

FLOWRATE - 2150 gpm = 4.79 FT³/S

$VELOCITY = \frac{4.79\text{ FT}^3}{S} \Big| \frac{}{1.97\text{ FT}^2} = 2.43\text{ FT/S}$

FROM WASTEWATER ENGINEERING M & E 1981, PAGE 360 TABLE 9-3

VELOCITY	MIN SUBMERGENCE DEPTH
3.3 FT/S	2 FT
2.6 FT/S	1.5 FT

ARRANGEMET IS 90° w/ FLARE SECTION

MIN SUBMERGENCE = 9.5-INCH + 18 INCHES = 27.5 INCHES = 2.3 FT
USE: ABOVE PUMP VOLUTE = -3.40 FT

SUCTION SPACING 19-INCH FLARE SECTION

FROM WALL 1.5 D(MIN) = 1.5 (19-INCH) = 28.5 INCH = 2.375 FT

FROM SUCTION ℄ TO ℄

2.5 D(MIN) = 2.5 (19-INCH) = 47.5 INCH = 3.96 FT

3 D(PREFERRED) = 3 (19-INCH) = 57 INCH = 4.75 FT

BY DAM DATE 9-22-15 **WRIGHT-PIERCE** SHEET NO. 1 OF 3

Engineering a Better Environment

CHCKD. BY ________ DATE ________ PROJECT NO. 12883B

PROJECT Exeter MPS PDR BOOK NO. ________

MINIMUM WATER LEVEL -3.40 (ABOVE PUMP VOLUTE)

INVERT OF INFLUENT SEWER -1.74

TWO PUMP SYSTEM MINIMUM CYCLE TIME IS 10 MINUTES, RESULTING IN 20 MINUTE CYCLE TIME PER PUMP

FOUR PUMP SYSTEM MINIMUM CYCLE TIME IS 5 MINUTES RESULTING IN 20 MINUTE CYCLE TIME PER PUMP.

PUMPS ON VFD $V = \frac{\phi q}{4}$

V = VOLUME BETWEEN LEAD PUMP MIN SPEED ELEVATION AND LEAD PUMP OFF ELEVATION.

ϕ = 5 MIN

q = FLOW OF 1 PUMP OPERATING AT 40 Hz.
= 1817 gpm

$V_{REQ} = \frac{(5\text{ min})(1817\text{ gpm})}{4}$

V_{REQ} = 2,271.25 gal

WET WELL DIMENSIONS = 30.38' * 8' * 1.66' = 403.5 CF
= 3017.8 gal

3017.8 gal ÷ 1.66 FT = 1817.9 gal/FT

1.0 FT BETWEEN LEAD PUMP MIN SPEED AND LEAD PUMP OFF

BY DAM DATE 9-22-15 **WRIGHT-PIERCE** Engineering a Better Environment SHEET NO. 2 OF 3

CHCKD. BY ________ DATE ________ PROJECT NO. 12883B

PROJECT EXETER MPS PDR BOOK NO. ________

	Wet Well Elevation (FT)
Invert of Influent Sewer	-1.74
High-High Alarm	-1.90
High Alarm	-2.00
Standby Pump Start	-2.10
Lag Pump Start	-2.20
Lead Pump Max Speed	-2.30
Lead Pump Min Speed	-2.40
Standby Pump Stop	-2.73
Lag Pump Stop	-3.06
Lead Pump Stop	-3.40
Low Level Alarm	-3.90
Low-Low Level Alarm	-4.40
Bottom of Wet Well	-8.00

BY DAM DATE 9-22-15 **WRIGHT-PIERCE** Engineering a Better Environment SHEET NO. 3 OF 3

CHCKD. BY ______ DATE ______ PROJECT NO. 12583B

PROJECT EXETER MPS PDR BOOK NO. ______

MINIMUM WATER LEVEL -3.40 (ABOVE PUMP VOLUTE)

CROWN OF INFLUENT SEWER 1.26

1.0 FEET BETWEEN LEAD PUMP MIN SPEED AND LEAD PUMP OFF

	WET WELL ELEVATION (FT)
CROWN OF INFLUENT SEWER	1.26
HIGH-HIGH ALARM	0.10
HIGH ALARM	-0.40
STANDBY PUMP START	-0.90
LAG PUMP START	-1.40
LEAD PUMP MAX SPEED	-1.90
LEAD PUMP MIN SPEED	-2.40
STANDBY PUMP STOP	-2.73
LAG PUMP STOP	-3.06
LEAD PUMP STOP	-3.40
LOW LEVEL ALARM	-3.90
LOW-LOW LEVEL ALARM	-4.40
BOTTOM OF WET WELL	-8.00

NOTE: WET WELL FFE IS 2.0 FT

Project: Exeter MPS
Job No. 12883B
Date: 9/17/2015
Calcs by: DAM

Pump Manufacturer:	Flygt
Pump Model:	NT 3301/636
Impeller Size:	9.8"
Pump Speed:	1185

# Pumps	# FM	FM Diam. (in)	Flowrate per Pump (gpm)	Total Flowrate (gpm)	Total Flowrate (MGD)	Head (feet)	Velocity (ft/s)
1	1	16	2725	2725	3.92	71.0	4.31
2	1	16	1750	3500	5.04	83.0	5.53
3	1	16	1290	3870	5.57	89.0	6.11
4	1	16	1010	4040	5.82	93.0	6.38
2	2	16	2650	5300	7.63	72.0	3.99
3	2	16	2150	6450	9.29	78.0	4.86
4	2	16	1740	6960	10.02	83.0	5.24

Project:	Exeter MPS
Job No.	12883B
Date:	9/17/2015
Time:	
Calcs by:	DAM
Checked By:	
File:	
Comments:	
Scenario:	Single 16-inch DI FM

NOTE: If using submersible pumps, ignore suction piping.

Suction Piping

Section 1

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve	1	0.19	0.19
Plug Valve		0.77	0
90° Bend	2	0.30	0.6
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth	1	0.04	0.04
Entrance	1	0.50	0.5
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	1.33

Section 0

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	0

Section 0

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	0

Discharge Piping

Section 1

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve	1	2.50	2.5
Gate Valve		0.19	0
Plug Valve	1	0.77	0.77
90° Bend	2	0.30	0.6
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	3.87

Section 2

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden	1	0.40	0.4
Reducer		0.25	0
Tee - Side	1	1.80	1.8
Tee - Run		0.60	0
		Total	2.2

Section 3

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve	1	0.19	0.19
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run	1	0.60	0.6
		Total	0.79

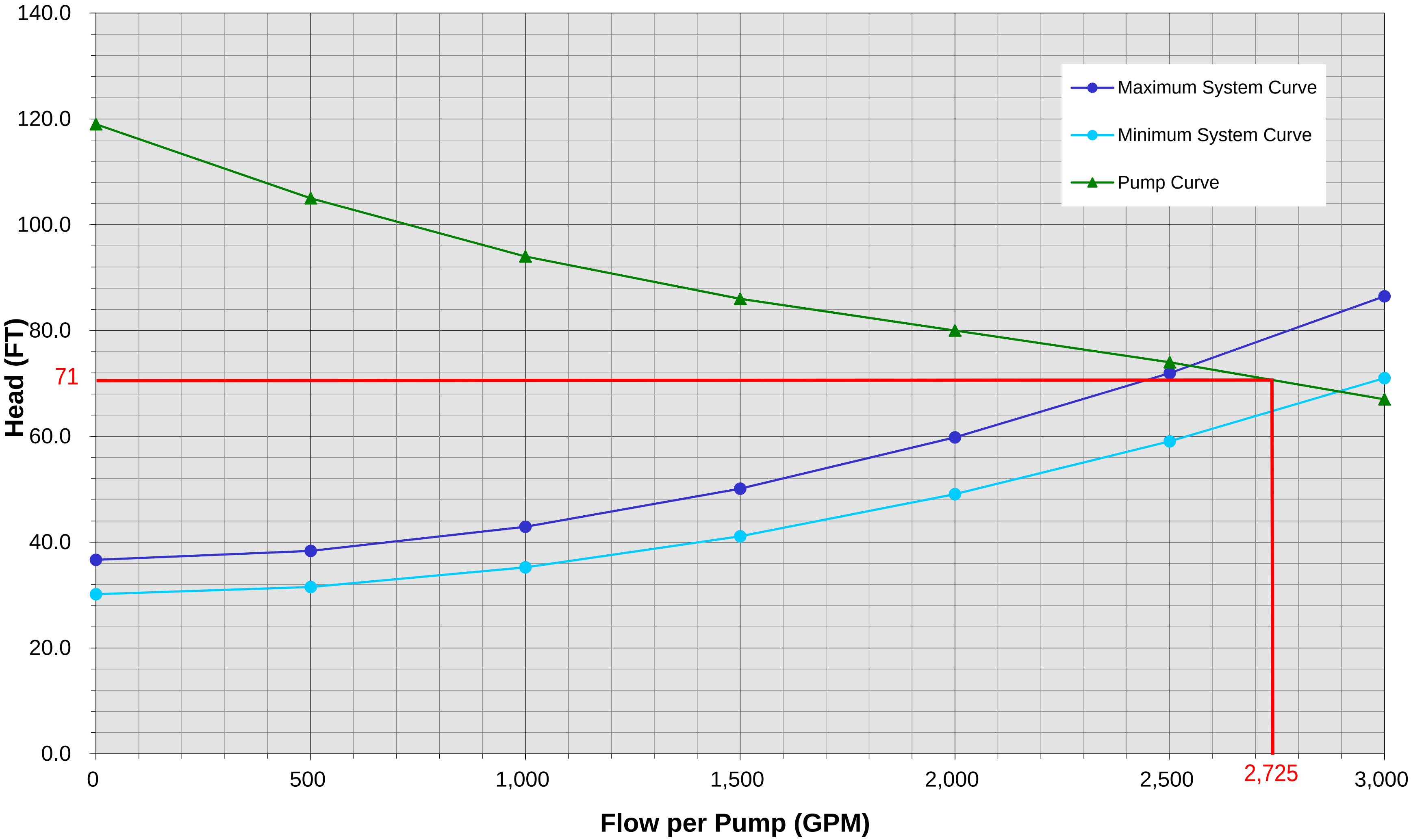
Section	0		
Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	0

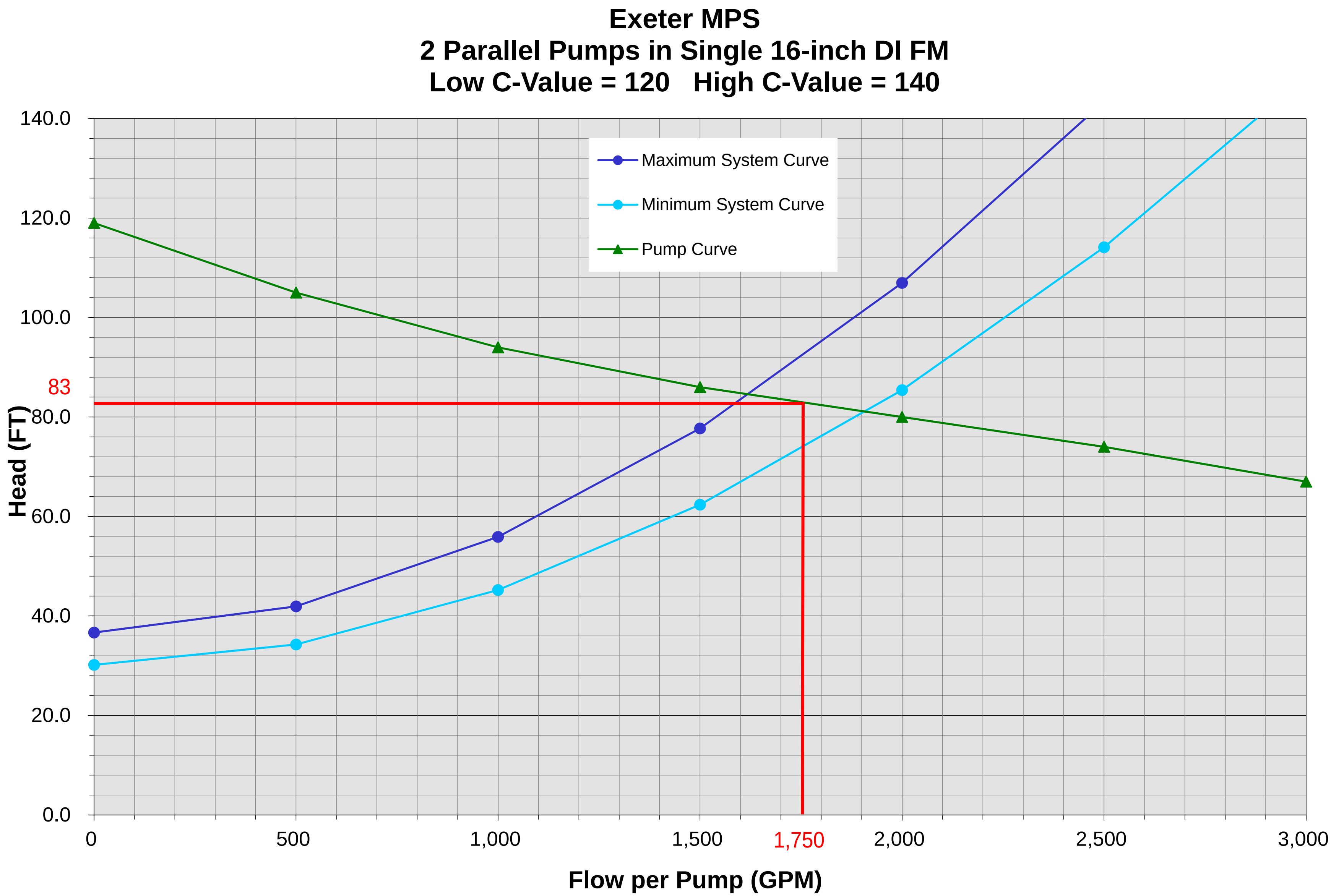
Section	4		
Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run	1	0.60	0.6
		Total	0.6

Section	5		
Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer	1	0.25	0.25
Tee - Side		1.80	0
Tee - Run	1	0.60	0.6
		Total	0.85

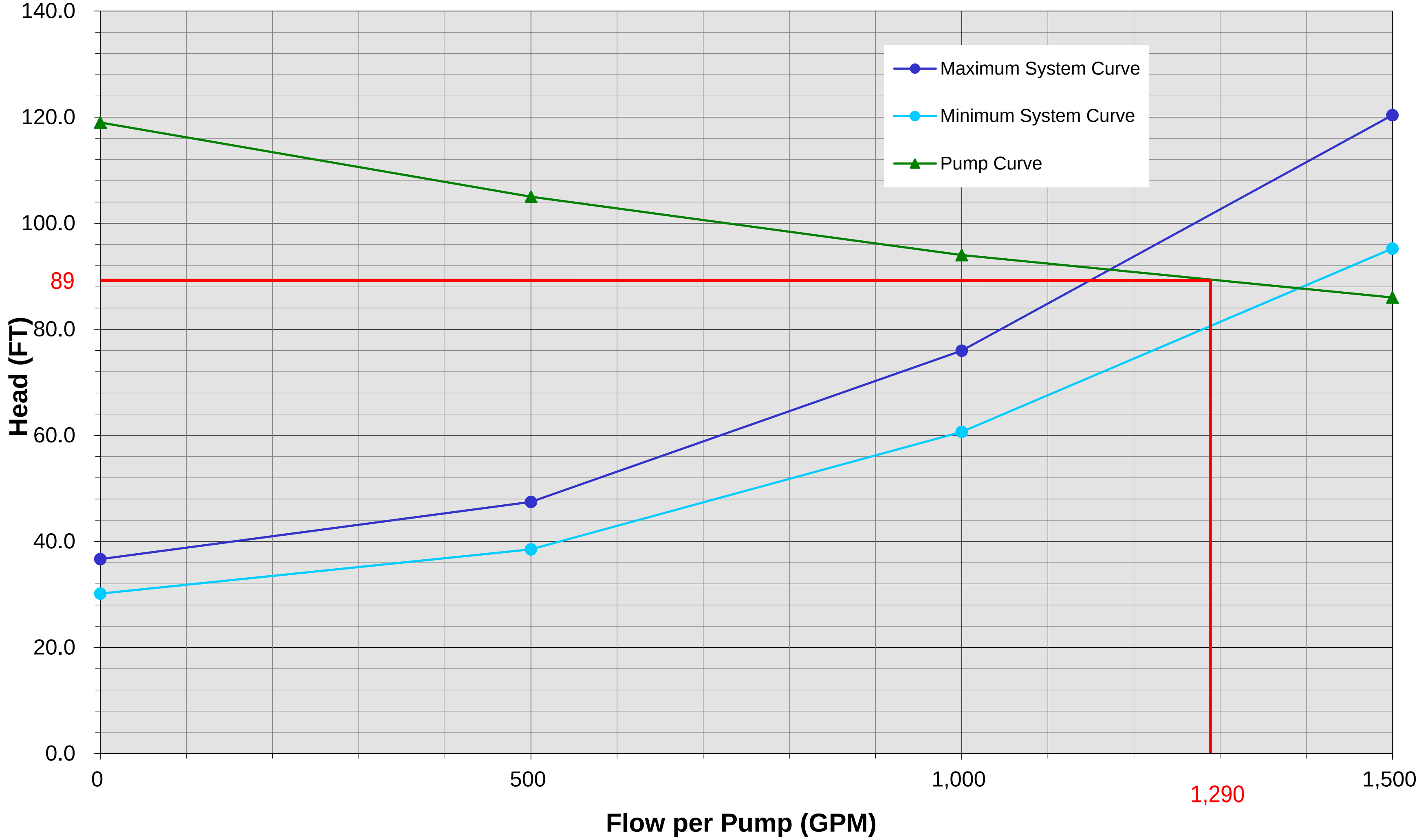
Section	6		
Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve	1	0.19	0.19
Plug Valve		0.77	0
90° Bend	2	0.30	0.6
45° Bend	14	0.20	2.8
22½° Bend	12	0.10	1.2
Bellmouth		0.04	0
Entrance		0.50	0
Exit	1	1.00	1
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	5.79

Exeter MPS
1 Pump Operating in Single 16-inch DI FM
Low C- Value = 120   High C-Value = 140




Exeter MPS
2 Parallel Pumps in Single 16-inch DI FM
Low C-Value = 120 High C-Value = 140
Maximum System Curve
Minimum System Curve
Pump Curve
Head (FT)
140.0
120.0
100.0
83
80.0
60.0
40.0
20.0
0.0
0
500
1,000
1,500
1,750
2,000
2,500
3,000
Flow per Pump (GPM)

Exeter MPS
3 Parallel Pumps Operation in Single 16-inch DI FM
Low C-Value = 120 High C-Value = 140



Project: Exeter MPS
Job No. 12883B
Date: 17-Sep-15
Time: 12:00 AM
Calcs by: DAM
Checked By:
File:
Comments:
Scenario: Single 16-inch DI FM

Low C-Value	120	
High C-Value	140	
Low Suction	-4	feet
High Suction	1.5	feet
Low Discharge	31.66	feet
High Discharge	32.66	feet
Pump Centerline	-3.83	feet
Flow Increment	500	gpm

Note: If elevations are not based on USGS datum, correct elevations so that EL 0.00 is sea level

Maximum Static Head	36.66	feet
Minimum Static Head	30.16	feet
Atmospheric Pressure	34.7	feet
Percent Solids	0	%

Maximum 12% Solids

Suction Piping

Section Number: 1
Number of Pumps Operating: 1

										Minimum Curve			Maximum Curve			
1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Static Head (FT)	C -	Hf (FT)	Head Loss (FT)	C -	Hf (FT)	Head Loss (FT)	NPSHa (FT)
0	0	12	0.0	10	1.33	1	0.0	0	0.2	140	0.0	-5.3	120	0.0	0.2	34.5
500	500	12	1.4	10	1.33	1	0.0	0	0.2	140	0.0	-5.3	120	0.0	0.2	34.4
1000	1000	12	2.8	10	1.33	1	0.2	0	0.2	140	0.0	-5.1	120	0.0	0.4	34.3
1500	1500	12	4.3	10	1.33	1	0.4	0	0.2	140	0.0	-4.9	120	0.1	0.6	34.0
2000	2000	12	5.7	10	1.33	1	0.7	0	0.2	140	0.1	-4.6	120	0.1	0.9	33.7
2500	2500	12	7.1	10	1.33	1	1.0	0	0.2	140	0.1	-4.2	120	0.2	1.4	33.3
3000	3000	12	8.5	10	1.33	1	1.5	0	0.2	140	0.2	-3.7	120	0.2	1.9	32.8
3500	3500	12	9.9	10	1.33	1	2.0	0	0.2	140	0.2	-3.1	120	0.3	2.5	32.1
4000	4000	12	11.3	10	1.33	1	2.7	0	0.2	140	0.3	-2.4	120	0.4	3.2	31.4
4500	4500	12	12.8	10	1.33	1	3.4	0	0.2	140	0.4	-1.6	120	0.5	4.0	30.6
5000	5000	12	14.2	10	1.33	1	4.2	0	0.2	140	0.4	-0.7	120	0.6	4.9	29.7

Discharge Piping

Section Number: 1
Number of Pumps Operating: 1

									Minimum Curve			Maximum Curve		
1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	C -	Hf (FT)	Head Loss (FT)	C -	Hf (FT)	Head Loss (FT)
0	0	10	0.0	8.5	3.87	1	0.0	0	140	0.0	0.0	120	0.0	0.0
500	500	10	2.0	8.5	3.87	1	0.3	0	140	0.0	0.3	120	0.0	0.3
1000	1000	10	4.1	8.5	3.87	1	1.0	0	140	0.0	1.0	120	0.1	1.1
1500	1500	10	6.1	8.5	3.87	1	2.3	0	140	0.1	2.4	120	0.1	2.4
2000	2000	10	8.2	8.5	3.87	1	4.0	0	140	0.2	4.2	120	0.2	4.2
2500	2500	10	10.2	8.5	3.87	1	6.3	0	140	0.3	6.5	120	0.3	6.6
3000	3000	10	12.3	8.5	3.87	1	9.0	0	140	0.4	9.4	120	0.5	9.5
3500	3500	10	14.3	8.5	3.87	1	12.3	0	140	0.5	12.8	120	0.6	12.9
4000	4000	10	16.3	8.5	3.87	1	16.0	0	140	0.6	16.6	120	0.8	16.8
4500	4500	10	18.4	8.5	3.87	1	20.3	0	140	0.7	21.1	120	1.0	21.3
5000	5000	10	20.4	8.5	3.87	1	25.1	0	140	0.9	26.0	120	1.2	26.3

Discharge Piping

Section Number: 2

Number of Pumps Operating: 1

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)
0	0	18	0.0	6.5	2.2	1	0.0	0	140	0.0	0.0	120	0.0	0.0
500	500	18	0.6	6.5	2.2	1	0.0	0	140	0.0	0.0	120	0.0	0.0
1000	1000	18	1.3	6.5	2.2	1	0.1	0	140	0.0	0.1	120	0.0	0.1
1500	1500	18	1.9	6.5	2.2	1	0.1	0	140	0.0	0.1	120	0.0	0.1
2000	2000	18	2.5	6.5	2.2	1	0.2	0	140	0.0	0.2	120	0.0	0.2
2500	2500	18	3.2	6.5	2.2	1	0.3	0	140	0.0	0.4	120	0.0	0.4
3000	3000	18	3.8	6.5	2.2	1	0.5	0	140	0.0	0.5	120	0.0	0.5
3500	3500	18	4.4	6.5	2.2	1	0.7	0	140	0.0	0.7	120	0.0	0.7
4000	4000	18	5.0	6.5	2.2	1	0.9	0	140	0.0	0.9	120	0.0	0.9
4500	4500	18	5.7	6.5	2.2	1	1.1	0	140	0.0	1.1	120	0.0	1.1
5000	5000	18	6.3	6.5	2.2	1	1.4	0	140	0.0	1.4	120	0.1	1.4

Discharge Piping

Section Number: 3

Number of Pumps Operating: 2

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)
0	0	18	0.0	7	0.79	1	0.0	0	140	0.0	0.0	120	0.0	0.0
500	1000	18	1.3	7	0.79	1	0.0	0	140	0.0	0.0	120	0.0	0.0
1000	2000	18	2.5	7	0.79	1	0.1	0	140	0.0	0.1	120	0.0	0.1
1500	3000	18	3.8	7	0.79	1	0.2	0	140	0.0	0.2	120	0.0	0.2
2000	4000	18	5.0	7	0.79	1	0.3	0	140	0.0	0.3	120	0.0	0.3
2500	5000	18	6.3	7	0.79	1	0.5	0	140	0.0	0.5	120	0.1	0.5
3000	6000	18	7.6	7	0.79	1	0.7	0	140	0.1	0.8	120	0.1	0.8
3500	7000	18	8.8	7	0.79	1	1.0	0	140	0.1	1.0	120	0.1	1.1
4000	8000	18	10.1	7	0.79	1	1.2	0	140	0.1	1.3	120	0.1	1.4
4500	9000	18	11.3	7	0.79	1	1.6	0	140	0.1	1.7	120	0.2	1.7
5000	10000	18	12.6	7	0.79	1	2.0	0	140	0.2	2.1	120	0.2	2.2

Discharge Piping

Section Number: 4

Number of Pumps Operating: 3

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)
0	0	18	0.0	6.5	0.6	1	0.0	0	140	0.0	0.0	120	0.0	0.0
500	1500	18	1.9	6.5	0.6	1	0.0	0	140	0.0	0.0	120	0.0	0.0
1000	3000	18	3.8	6.5	0.6	1	0.1	0	140	0.0	0.1	120	0.0	0.2
1500	4500	18	5.7	6.5	0.6	1	0.3	0	140	0.0	0.3	120	0.0	0.3
2000	6000	18	7.6	6.5	0.6	1	0.5	0	140	0.1	0.6	120	0.1	0.6
2500	7500	18	9.5	6.5	0.6	1	0.8	0	140	0.1	0.9	120	0.1	0.9
3000	9000	18	11.3	6.5	0.6	1	1.2	0	140	0.1	1.3	120	0.2	1.4
3500	10500	18	13.2	6.5	0.6	1	1.6	0	140	0.2	1.8	120	0.2	1.8
4000	12000	18	15.1	6.5	0.6	1	2.1	0	140	0.2	2.3	120	0.3	2.4
4500	13500	18	17.0	6.5	0.6	1	2.7	0	140	0.2	2.9	120	0.3	3.0
5000	15000	18	18.9	6.5	0.6	1	3.3	0	140	0.3	3.6	120	0.4	3.7

Discharge Piping

Section Number: 5

Number of Pumps Operating: 3

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Minimum Curve C -	Hf (FT)	Head Loss (FT)	Maximum Curve C -	Hf (FT)	Head Loss (FT)
0	0	18	0.0	4	0.85	1	0.0	0	140	0.0	0.0	120	0.0	0.0
500	1500	18	1.9	4	0.85	1	0.0	0	140	0.0	0.0	120	0.0	0.1
1000	3000	18	3.8	4	0.85	1	0.2	0	140	0.0	0.2	120	0.0	0.2
1500	4500	18	5.7	4	0.85	1	0.4	0	140	0.0	0.4	120	0.0	0.5
2000	6000	18	7.6	4	0.85	1	0.8	0	140	0.0	0.8	120	0.0	0.8
2500	7500	18	9.5	4	0.85	1	1.2	0	140	0.1	1.2	120	0.1	1.2
3000	9000	18	11.3	4	0.85	1	1.7	0	140	0.1	1.8	120	0.1	1.8
3500	10500	18	13.2	4	0.85	1	2.3	0	140	0.1	2.4	120	0.1	2.4
4000	12000	18	15.1	4	0.85	1	3.0	0	140	0.1	3.1	120	0.2	3.2
4500	13500	18	17.0	4	0.85	1	3.8	0	140	0.2	4.0	120	0.2	4.0
5000	15000	18	18.9	4	0.85	1	4.7	0	140	0.2	4.9	120	0.2	5.0

Discharge Piping

Section Number: 6

Number of Pumps Operating: 3

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Static Head (FT)	Minimum Curve C -	Hf (FT)	Head Loss (FT)	TDH (FT)	Maximum Curve C -	Hf (FT)	Head Loss (FT)	TDH (FT)
0	0	16.00	0.0	6350	6.09	1	0.0	0	36.5	140	0.0	35.5	30.2	120	0.0	36.5	36.7
500	1500	16	2.4	6350	6.09	1	0.5	0	36.5	140	7.4	43.4	38.5	120	9.8	46.8	47.5
1000	3000	16	4.8	6350	6.09	1	2.2	0	36.5	140	26.6	64.3	60.7	120	35.4	74.0	76.0
1500	4500	16	7.2	6350	6.09	1	4.9	0	36.5	140	56.3	96.7	95.2	120	74.9	116.3	120.4
2000	6000	16	9.6	6350	6.09	1	8.7	0	36.5	140	95.9	140.0	141.6	120	127.5	172.7	179.8
2500	7500	16	12.0	6350	6.09	1	13.5	0	36.5	140	144.9	193.9	199.3	120	192.7	242.7	253.8
3000	9000	16	14.4	6350	6.09	1	19.5	0	36.5	140	203.0	258.0	268.1	120	270.0	326.0	341.8
3500	10500	16	16.8	6350	6.09	1	26.6	0	36.5	140	270.0	332.1	347.7	120	359.1	422.2	443.6
4000	12000	16	19.1	6350	6.09	1	34.7	0	36.5	140	345.7	415.8	437.8	120	459.8	530.9	558.8
4500	13500	16	21.5	6350	6.09	1	43.9	0	36.5	140	429.8	509.2	538.4	120	571.7	652.1	687.3
5000	15000	16	23.9	6350	6.09	1	54.2	0	36.5	140	522.3	612.0	649.3	120	694.7	785.4	828.8

Project: Exeter MPS
Job No. 12883B
Date: 17-Sep-15
Time: 12:00 AM
Calcs by: DAM
Checked By:
File:
Comments:
Scenario: Single 16-inch DI FM

Pump Manufacturer:	Flygt
Pump Model:	NT 3301/636
Impeller Size:	9.8"
Pump Speed:	1185

Pumps Operating: 3

Q per Pump	Multiple Pump Q	NPSHa	Minimum System Curve	Maximum System Curve	Pump Curve
0	0	34.5	30.2	36.7	119.0
500	1,500	34.4	38.5	47.5	105.0
1,000	3,000	34.3	60.7	76.0	94.0
1,500	4,500	34.0	95.2	120.4	86.0
2,000	6,000	33.7	141.6	179.8	80.0
2,500	7,500	33.3	199.3	253.8	74.0
3,000	9,000	32.8	268.1	341.8	67.0
3,500	10,500	32.1	347.7	443.6	59.0
4,000	12,000	31.4	437.8	558.8	49.0
4,500	13,500	30.6	538.4	687.3	44.0
5,000	15,000	29.7	649.3	828.8	37.0

Note: for parallel pumps operating in the last discharge section, the system curve plotted on the chart represents only the fractional flow contributed by a single pump. (i.e. for two pumps operating, the apparent operating point indicates

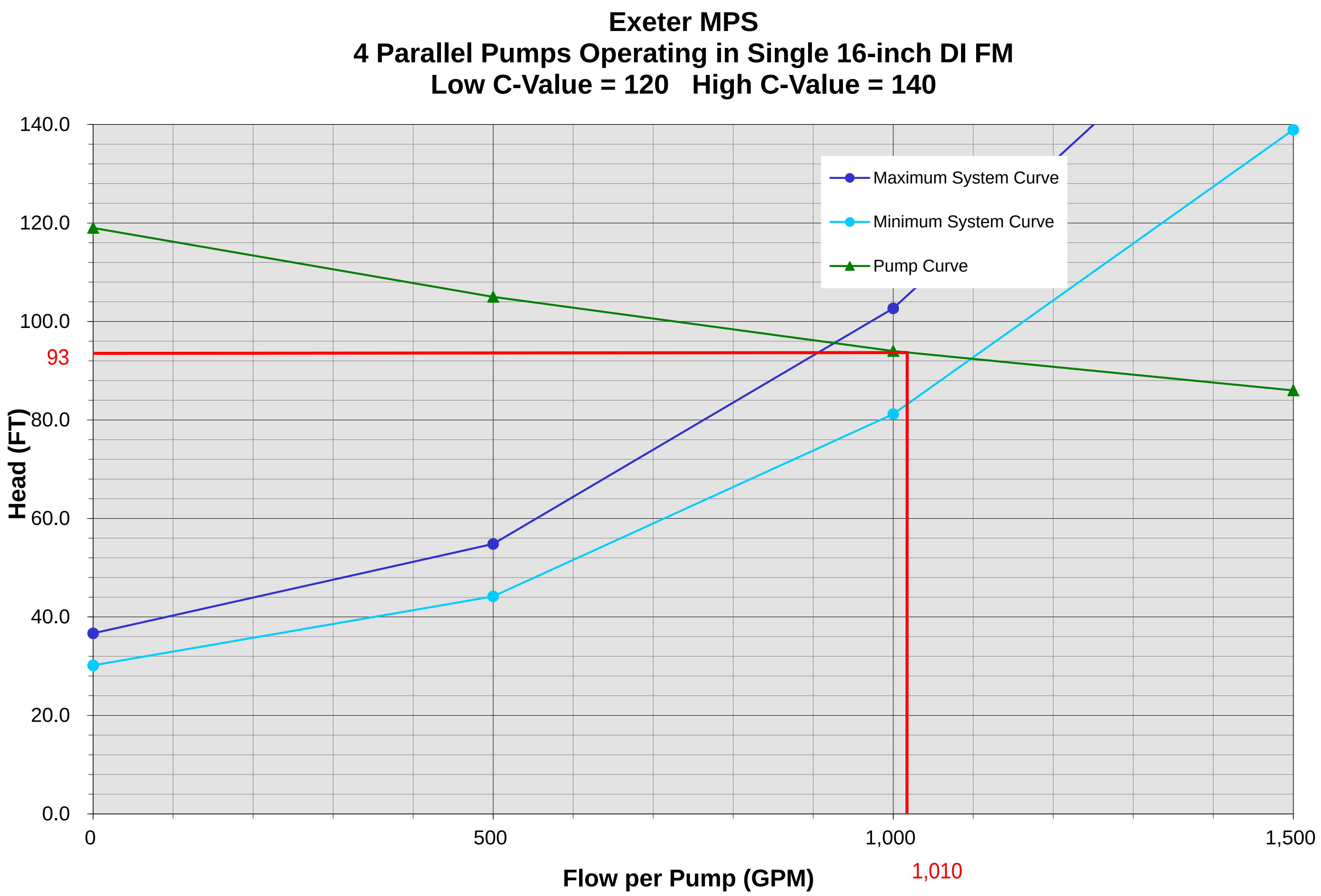
Minimum System Curve				**Min. Operating Point**	
	Flow	Sys. Head	Pump Head		
High		30	119	GPM	
Low		30	119	TDH	
slope				BEP	
intercept				% BEP	0%

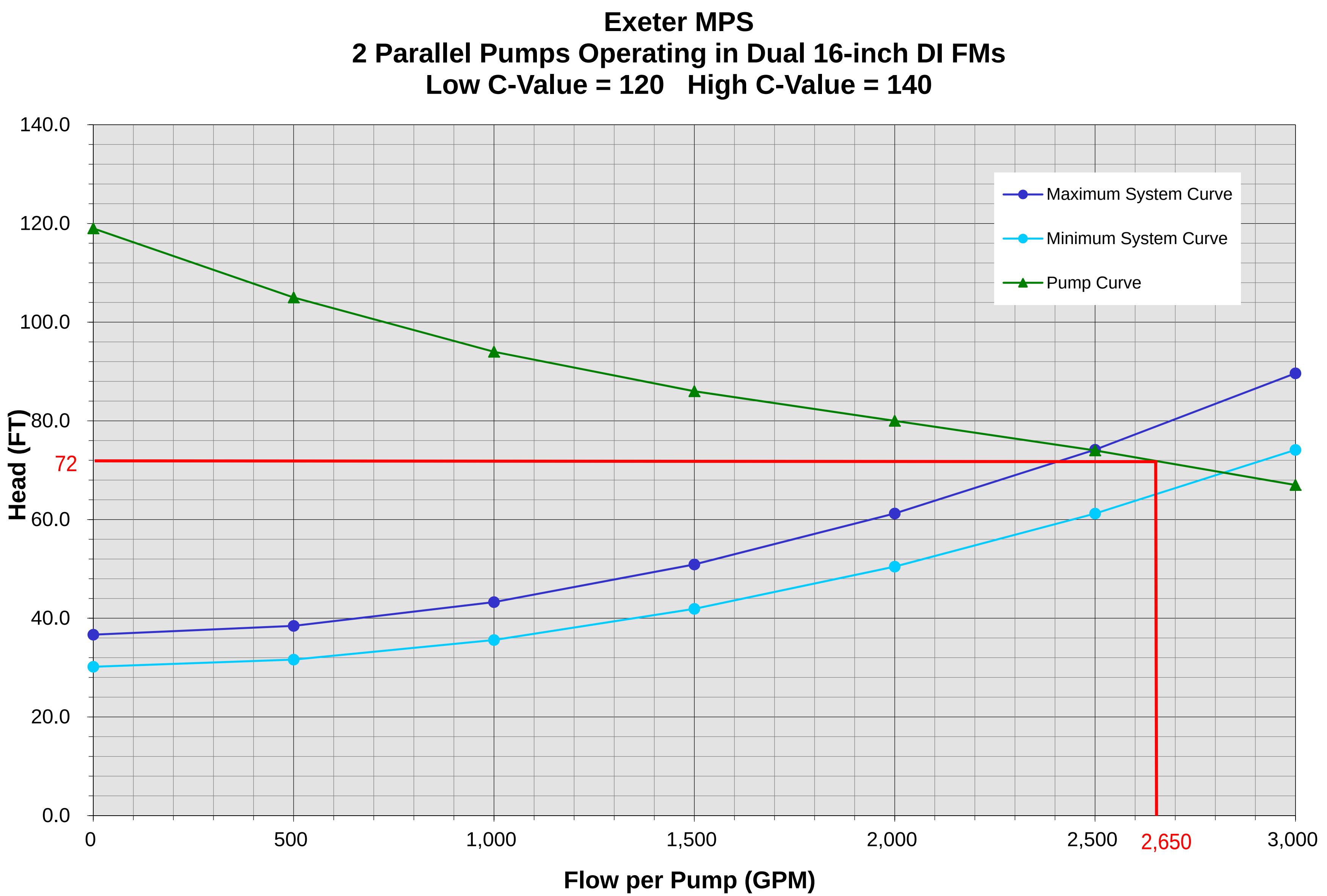
Copy the flow for the system curves at points before and after they cross the pump curve.

Maximum System Curve				**Max. Operating Point**	
	Flow	Sys. Head	Pump Head		
High		37	119	GPM	
Low		37	119	TDH	
slope				BEP	
intercept				% BEP	0%

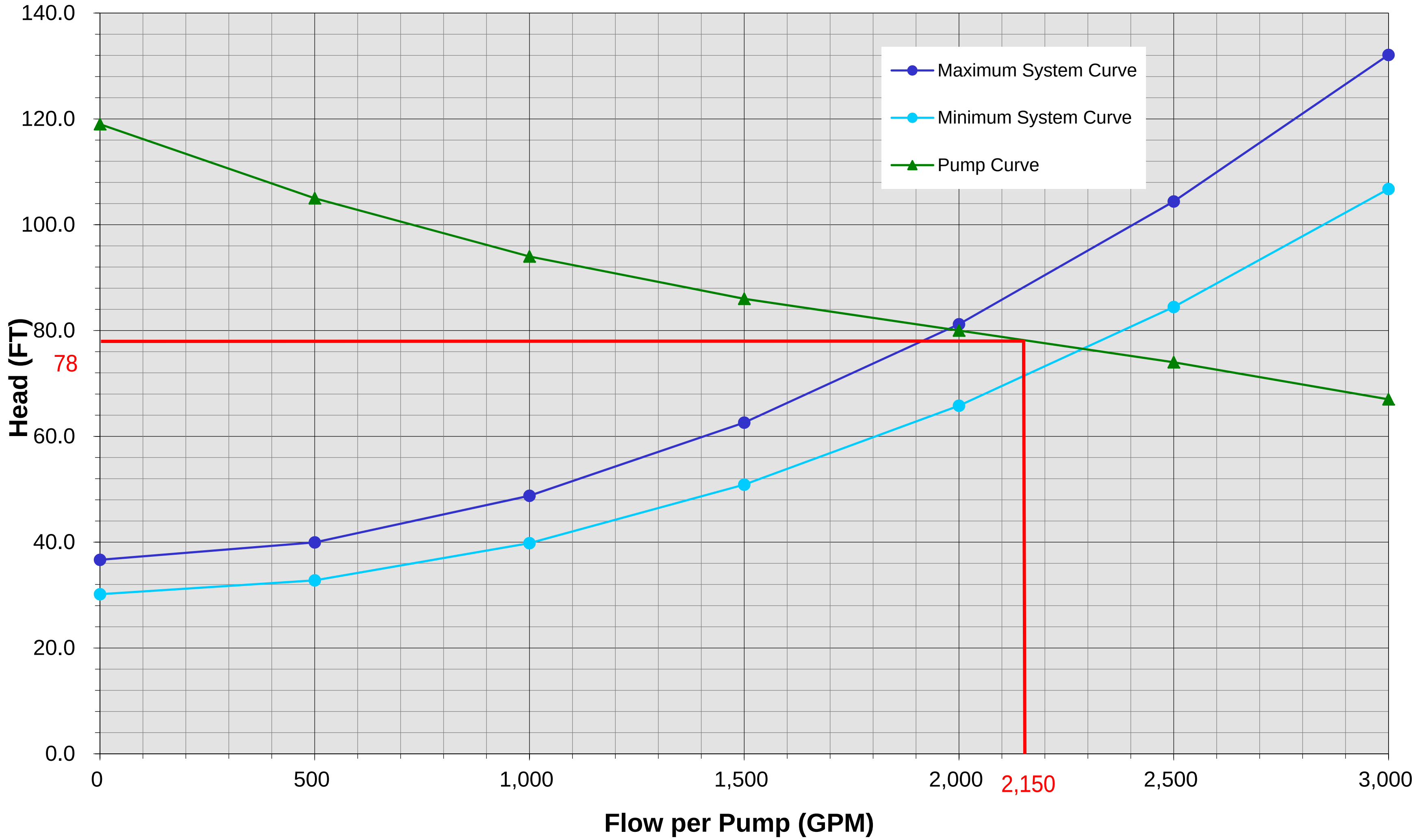
Operating Range	
Low	0
High	0

Note: Plot the system curve on the manufacturer's pump curve to determine operating points, h.p. requirements, NPSHa requirements, efficiencies, etc.


Exeter MPS
4 Parallel Pumps Operating in Single 16-inch DI FM
Low C-Value = 120   High C-Value = 140
Maximum System Curve
Minimum System Curve
Pump Curve
Head (FT)
140.0
120.0
100.0
93
80.0
60.0
40.0
20.0
0.0
0
500
1,000
1,500
1,010
Flow per Pump (GPM)


Exeter MPS
2 Parallel Pumps Operating in Dual 16-inch DI FMs
Low C-Value = 120 High C-Value = 140
Head (FT)
Flow per Pump (GPM)
Maximum System Curve
Minimum System Curve
Pump Curve
72
2,650
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
0
500
1,000
1,500
2,000
2,500
3,000

Exeter MPS
3 Parallel Pumps Operating in Dual 16-inch DI FMs
Low C-Value = 120   High C-Value = 140



Project: Exeter MPS
Job No. 12883B
Date: 17-Sep-15
Time: 12:00 AM
Calcs by: DAM
Checked By:
File:
Comments:
Scenario: Dual 16-inch DI FMs

Low C-Value	120	
High C-Value	140	
Low Suction	-4	feet
High Suction	1.5	feet
Low Discharge	31.66	feet
High Discharg	32.66	feet
Pump Centerli	-3.83	feet
Flow Incremen	500	gpm

Note: If elevations are not based on USGS datum, correct elevations so that EL 0.00 is sea level

Maximum Static Head	36.66	feet
Minimum Static Head	30.16	feet
Atmospheric Pressure	34.7	feet
Percent Solids	0	%

Maximum 12% Solids

Suction Piping

Section Number: 1
Number of Pumps Operatin: 1

										Minimum Curve			Maximum Curve			
1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Static Head (FT)	C -	Hf (FT)	Head Loss (FT)	C -	Hf (FT)	Head Loss (FT)	NPSHa (FT)
0	0	12	0.0	10	1.33	1	0.0	0	0.2	140	0.0	-5.3	120	0.0	0.2	34.5
500	500	12	1.4	10	1.33	1	0.0	0	0.2	140	0.0	-5.3	120	0.0	0.2	34.4
1000	1000	12	2.8	10	1.33	1	0.2	0	0.2	140	0.0	-5.1	120	0.0	0.4	34.3
1500	1500	12	4.3	10	1.33	1	0.4	0	0.2	140	0.0	-4.9	120	0.1	0.6	34.0
2000	2000	12	5.7	10	1.33	1	0.7	0	0.2	140	0.1	-4.6	120	0.1	0.9	33.7
2500	2500	12	7.1	10	1.33	1	1.0	0	0.2	140	0.1	-4.2	120	0.2	1.4	33.3
3000	3000	12	8.5	10	1.33	1	1.5	0	0.2	140	0.2	-3.7	120	0.2	1.9	32.8
3500	3500	12	9.9	10	1.33	1	2.0	0	0.2	140	0.2	-3.1	120	0.3	2.5	32.1
4000	4000	12	11.3	10	1.33	1	2.7	0	0.2	140	0.3	-2.4	120	0.4	3.2	31.4
4500	4500	12	12.8	10	1.33	1	3.4	0	0.2	140	0.4	-1.6	120	0.5	4.0	30.6
5000	5000	12	14.2	10	1.33	1	4.2	0	0.2	140	0.4	-0.7	120	0.6	4.9	29.7

Discharge Piping

Section Number: 1
Number of Pumps Operatin: 1

									Minimum Curve			Maximum Curve		
1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	C -	Hf (FT)	Head Loss (FT)	C -	Hf (FT)	Head Loss (FT)
0	0	10	0.0	8.5	3.87	1	0.0	0	140	0.0	0.0	120	0.0	0.0
500	500	10	2.0	8.5	3.87	1	0.3	0	140	0.0	0.3	120	0.0	0.3
1000	1000	10	4.1	8.5	3.87	1	1.0	0	140	0.0	1.0	120	0.1	1.1
1500	1500	10	6.1	8.5	3.87	1	2.3	0	140	0.1	2.4	120	0.1	2.4
2000	2000	10	8.2	8.5	3.87	1	4.0	0	140	0.2	4.2	120	0.2	4.2
2500	2500	10	10.2	8.5	3.87	1	6.3	0	140	0.3	6.5	120	0.3	6.6
3000	3000	10	12.3	8.5	3.87	1	9.0	0	140	0.4	9.4	120	0.5	9.5
3500	3500	10	14.3	8.5	3.87	1	12.3	0	140	0.5	12.8	120	0.6	12.9
4000	4000	10	16.3	8.5	3.87	1	16.0	0	140	0.6	16.6	120	0.8	16.8
4500	4500	10	18.4	8.5	3.87	1	20.3	0	140	0.7	21.1	120	1.0	21.3
5000	5000	10	20.4	8.5	3.87	1	25.1	0	140	0.9	26.0	120	1.2	26.3

Discharge Piping

Section Number: 2

Number of Pumps Operating: 1

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)
0	0	18	0.0	6.5	2.2	1	0.0	0	140	0.0	0.0	120	0.0	0.0
500	500	18	0.6	6.5	2.2	1	0.0	0	140	0.0	0.0	120	0.0	0.0
1000	1000	18	1.3	6.5	2.2	1	0.1	0	140	0.0	0.1	120	0.0	0.1
1500	1500	18	1.9	6.5	2.2	1	0.1	0	140	0.0	0.1	120	0.0	0.1
2000	2000	18	2.5	6.5	2.2	1	0.2	0	140	0.0	0.2	120	0.0	0.2
2500	2500	18	3.2	6.5	2.2	1	0.3	0	140	0.0	0.4	120	0.0	0.4
3000	3000	18	3.8	6.5	2.2	1	0.5	0	140	0.0	0.5	120	0.0	0.5
3500	3500	18	4.4	6.5	2.2	1	0.7	0	140	0.0	0.7	120	0.0	0.7
4000	4000	18	5.0	6.5	2.2	1	0.9	0	140	0.0	0.9	120	0.0	0.9
4500	4500	18	5.7	6.5	2.2	1	1.1	0	140	0.0	1.1	120	0.0	1.1
5000	5000	18	6.3	6.5	2.2	1	1.4	0	140	0.0	1.4	120	0.1	1.4

Discharge Piping

Section Number: 3

Number of Pumps Operating: 2

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)
0	0	18	0.0	7	0.79	1	0.0	0	140	0.0	0.0	120	0.0	0.0
500	1000	18	1.3	7	0.79	1	0.0	0	140	0.0	0.0	120	0.0	0.0
1000	2000	18	2.5	7	0.79	1	0.1	0	140	0.0	0.1	120	0.0	0.1
1500	3000	18	3.8	7	0.79	1	0.2	0	140	0.0	0.2	120	0.0	0.2
2000	4000	18	5.0	7	0.79	1	0.3	0	140	0.0	0.3	120	0.0	0.3
2500	5000	18	6.3	7	0.79	1	0.5	0	140	0.0	0.5	120	0.1	0.5
3000	6000	18	7.6	7	0.79	1	0.7	0	140	0.1	0.8	120	0.1	0.8
3500	7000	18	8.8	7	0.79	1	1.0	0	140	0.1	1.0	120	0.1	1.1
4000	8000	18	10.1	7	0.79	1	1.2	0	140	0.1	1.3	120	0.1	1.4
4500	9000	18	11.3	7	0.79	1	1.6	0	140	0.1	1.7	120	0.2	1.7
5000	10000	18	12.6	7	0.79	1	2.0	0	140	0.2	2.1	120	0.2	2.2

Discharge Piping

Section Number: 4

Number of Pumps Operating: 3

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)
0	0	18	0.0	6.5	0.6	1	0.0	0	140	0.0	0.0	120	0.0	0.0
500	1500	18	1.9	6.5	0.6	1	0.0	0	140	0.0	0.0	120	0.0	0.0
1000	3000	18	3.8	6.5	0.6	1	0.1	0	140	0.0	0.1	120	0.0	0.2
1500	4500	18	5.7	6.5	0.6	1	0.3	0	140	0.0	0.3	120	0.0	0.3
2000	6000	18	7.6	6.5	0.6	1	0.5	0	140	0.1	0.6	120	0.1	0.6
2500	7500	18	9.5	6.5	0.6	1	0.8	0	140	0.1	0.9	120	0.1	0.9
3000	9000	18	11.3	6.5	0.6	1	1.2	0	140	0.1	1.3	120	0.2	1.4
3500	10500	18	13.2	6.5	0.6	1	1.6	0	140	0.2	1.8	120	0.2	1.8
4000	12000	18	15.1	6.5	0.6	1	2.1	0	140	0.2	2.3	120	0.3	2.4
4500	13500	18	17.0	6.5	0.6	1	2.7	0	140	0.2	2.9	120	0.3	3.0
5000	15000	18	18.9	6.5	0.6	1	3.3	0	140	0.3	3.6	120	0.4	3.7

Discharge Piping

Section Number: 5

Number of Pumps Operating: 3

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	P D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)
0	0	18	0.0	4	0.85	1	0.0	0	140	0.0	0.0	120	0.0	0.0
500	1500	18	1.9	4	0.85	1	0.0	0	140	0.0	0.0	120	0.0	0.1
1000	3000	18	3.8	4	0.85	1	0.2	0	140	0.0	0.2	120	0.0	0.2
1500	4500	18	5.7	4	0.85	1	0.4	0	140	0.0	0.4	120	0.0	0.5
2000	6000	18	7.6	4	0.85	1	0.8	0	140	0.0	0.8	120	0.0	0.8
2500	7500	18	9.5	4	0.85	1	1.2	0	140	0.1	1.2	120	0.1	1.2
3000	9000	18	11.3	4	0.85	1	1.7	0	140	0.1	1.8	120	0.1	1.8
3500	10500	18	13.2	4	0.85	1	2.3	0	140	0.1	2.4	120	0.1	2.4
4000	12000	18	15.1	4	0.85	1	3.0	0	140	0.1	3.1	120	0.2	3.2
4500	13500	18	17.0	4	0.85	1	3.8	0	140	0.2	4.0	120	0.2	4.0
5000	15000	18	18.9	4	0.85	1	4.7	0	140	0.2	4.9	120	0.2	5.0

Discharge Piping

Section Number: 6

Number of Pumps Operating: 1.5

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Static Head (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Minimum Curve TDH (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)	Maximum Curve TDH (FT)
0	0	16.00	0.0	6350	6.09	1	0.0	0	36.5	140	0.0	35.5	30.2	120	0.0	36.5	36.7
500	750	16	1.2	6350	6.09	1	0.1	0	36.5	140	2.0	37.7	32.8	120	2.7	39.3	40.0
1000	1500	16	2.4	6350	6.09	1	0.5	0	36.5	140	7.4	43.4	39.8	120	9.8	46.8	48.8
1500	2250	16	3.6	6350	6.09	1	1.2	0	36.5	140	15.6	52.3	50.9	120	20.8	58.5	62.6
2000	3000	16	4.8	6350	6.09	1	2.2	0	36.5	140	26.6	64.3	65.8	120	35.4	74.0	81.2
2500	3750	16	6.0	6350	6.09	1	3.4	0	36.5	140	40.2	79.1	84.4	120	53.5	93.3	104.4
3000	4500	16	7.2	6350	6.09	1	4.9	0	36.5	140	56.3	96.7	106.7	120	74.9	116.3	132.1
3500	5250	16	8.4	6350	6.09	1	6.6	0	36.5	140	74.9	117.0	132.6	120	99.6	142.7	164.2
4000	6000	16	9.6	6350	6.09	1	8.7	0	36.5	140	95.9	140.0	162.0	120	127.5	172.7	200.6
4500	6750	16	10.8	6350	6.09	1	11.0	0	36.5	140	119.2	165.7	194.9	120	158.6	206.0	241.3
5000	7500	16	12.0	6350	6.09	1	13.5	0	36.5	140	144.9	193.9	231.2	120	192.7	242.7	286.2

Project: Exeter MPS
Job No. 12883B
Date: 17-Sep-15
Time: 12:00 AM
Calcs by: DAM
Checked By:
File:
Comments:
Scenario: Dual 16-inch DI FMs

Pump Manufacturer:	Flygt
Pump Model:	NT 3301/636
Impeller Size:	9.8"
Pump Speed:	1185

Pumps Operating:

Q per Pump	Multiple Pump Q	NPSHa	Minimum System Curve	Maximum System Curve	Pump Curve
0	0	34.5	30.2	36.7	119.0
500	750	34.4	32.8	40.0	105.0
1,000	1,500	34.3	39.8	48.8	94.0
1,500	2,250	34.0	50.9	62.6	86.0
2,000	3,000	33.7	65.8	81.2	80.0
2,500	3,750	33.3	84.4	104.4	74.0
3,000	4,500	32.8	106.7	132.1	67.0
3,500	5,250	32.1	132.6	164.2	59.0
4,000	6,000	31.4	162.0	200.6	49.0
4,500	6,750	30.6	194.9	241.3	44.0
5,000	7,500	29.7	231.2	286.2	37.0

Note: for parallel pumps operating in the last discharge section, the system curve plotted on the chart represents only the fractional flow contributed by a single pump. (i.e. for two pumps operating, the apparent operating point indicates

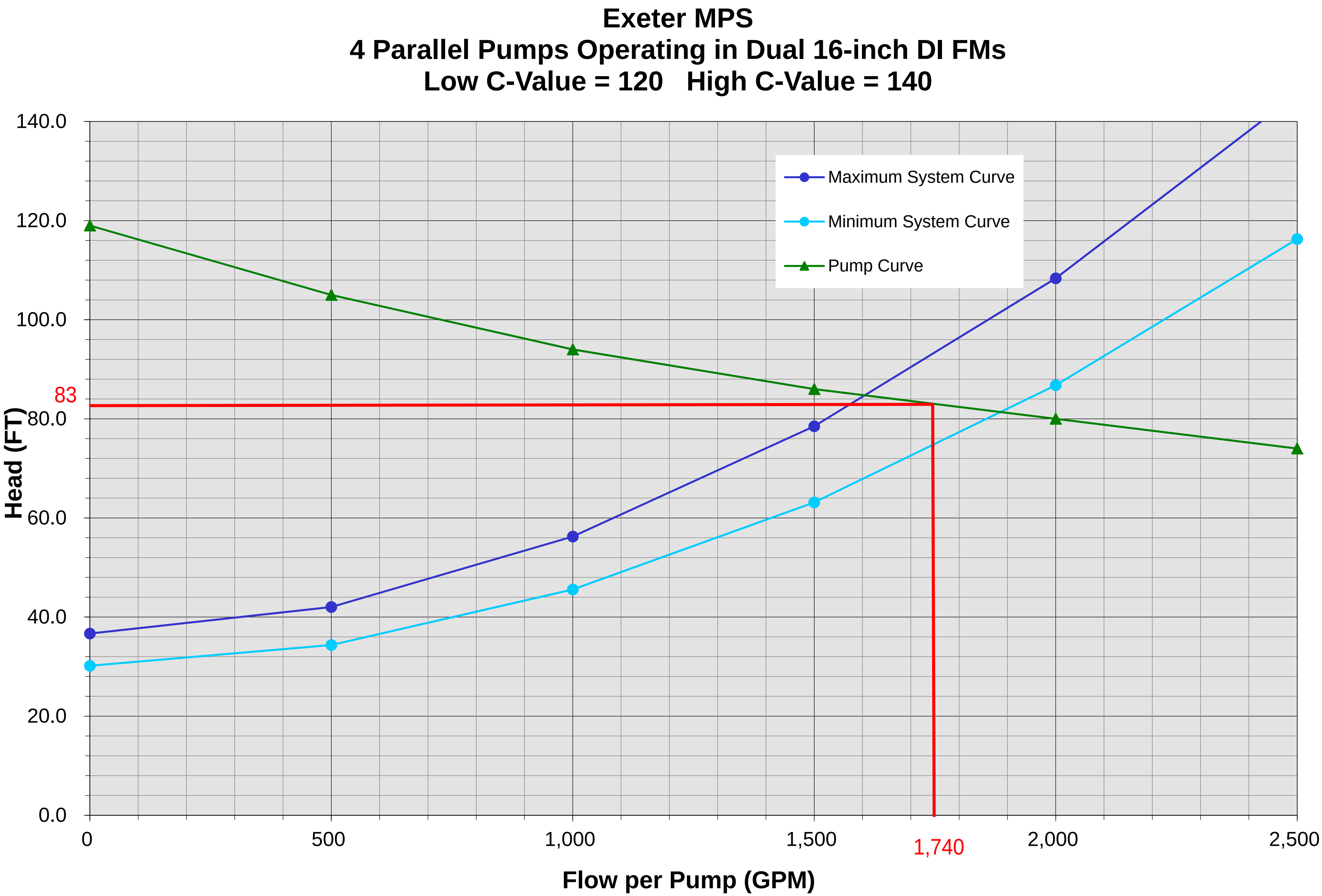
Minimum System Curve				**Min. Operating Point**	
	Flow	Sys. Head	Pump Head		
High		30	119	GPM	
Low		30	119	TDH	
slope				BEP	
intercept				% BEP	0%

Copy the flow for the system curves at points before and after they cross the pump curve.

Maximum System Curve				**Max. Operating Point**	
	Flow	Sys. Head	Pump Head		
High		37	119	GPM	
Low		37	119	TDH	
slope				BEP	
intercept				% BEP	0%

Operating Range	
Low	0
High	0

Note: Plot the system curve on the manufacturer's pump curve to determine operating points, h.p. requirements, NPSHa requirements, efficiencies, etc.


Exeter MPS
4 Parallel Pumps Operating in Dual 16-inch DI FMs
Low C-Value = 120 High C-Value = 140
Maximum System Curve
Minimum System Curve
Pump Curve
Head (FT)
140.0
120.0
100.0
83
80.0
60.0
40.0
20.0
0.0
0
500
1,000
1,500
1,740
2,000
2,500
Flow per Pump (GPM)

Project: Exeter MPS
Job No. 12883B
Date: 17-Sep-15
Time: 12:00 AM
Calcs by: DAM
Checked By:
File:
Comments:
Scenario: Dual 16-inch DI FMs

Low C-Value	120	
High C-Value	140	
Low Suction	-4	feet
High Suction	1.5	feet
Low Discharge	31.66	feet
High Discharge	32.66	feet
Pump Centerline	-3.83	feet
Flow Increment	500	gpm

Note: If elevations are not based on USGS datum, correct elevations so that EL 0.00 is sea level

Maximum Static Head	36.66	feet
Minimum Static Head	30.16	feet
Atmospheric Pressure	34.7	feet
Percent Solids	0	%

Maximum 12% Solids

Suction Piping

Section Number: 1
Number of Pumps Operating: 1

										Minimum Curve			Maximum Curve			
1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Static Head (FT)	C -	Hf (FT)	Head Loss (FT)	C -	Hf (FT)	Head Loss (FT)	NPSHa (FT)
0	0	12	0.0	10	1.33	1	0.0	0	0.2	140	0.0	-5.3	120	0.0	0.2	34.5
500	500	12	1.4	10	1.33	1	0.0	0	0.2	140	0.0	-5.3	120	0.0	0.2	34.4
1000	1000	12	2.8	10	1.33	1	0.2	0	0.2	140	0.0	-5.1	120	0.0	0.4	34.3
1500	1500	12	4.3	10	1.33	1	0.4	0	0.2	140	0.0	-4.9	120	0.1	0.6	34.0
2000	2000	12	5.7	10	1.33	1	0.7	0	0.2	140	0.1	-4.6	120	0.1	0.9	33.7
2500	2500	12	7.1	10	1.33	1	1.0	0	0.2	140	0.1	-4.2	120	0.2	1.4	33.3
3000	3000	12	8.5	10	1.33	1	1.5	0	0.2	140	0.2	-3.7	120	0.2	1.9	32.8
3500	3500	12	9.9	10	1.33	1	2.0	0	0.2	140	0.2	-3.1	120	0.3	2.5	32.1
4000	4000	12	11.3	10	1.33	1	2.7	0	0.2	140	0.3	-2.4	120	0.4	3.2	31.4
4500	4500	12	12.8	10	1.33	1	3.4	0	0.2	140	0.4	-1.6	120	0.5	4.0	30.6
5000	5000	12	14.2	10	1.33	1	4.2	0	0.2	140	0.4	-0.7	120	0.6	4.9	29.7

Discharge Piping

Section Number: 1
Number of Pumps Operating: 1

									Minimum Curve			Maximum Curve		
1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	C -	Hf (FT)	Head Loss (FT)	C -	Hf (FT)	Head Loss (FT)
0	0	10	0.0	8.5	3.87	1	0.0	0	140	0.0	0.0	120	0.0	0.0
500	500	10	2.0	8.5	3.87	1	0.3	0	140	0.0	0.3	120	0.0	0.3
1000	1000	10	4.1	8.5	3.87	1	1.0	0	140	0.0	1.0	120	0.1	1.1
1500	1500	10	6.1	8.5	3.87	1	2.3	0	140	0.1	2.4	120	0.1	2.4
2000	2000	10	8.2	8.5	3.87	1	4.0	0	140	0.2	4.2	120	0.2	4.2
2500	2500	10	10.2	8.5	3.87	1	6.3	0	140	0.3	6.5	120	0.3	6.6
3000	3000	10	12.3	8.5	3.87	1	9.0	0	140	0.4	9.4	120	0.5	9.5
3500	3500	10	14.3	8.5	3.87	1	12.3	0	140	0.5	12.8	120	0.6	12.9
4000	4000	10	16.3	8.5	3.87	1	16.0	0	140	0.6	16.6	120	0.8	16.8
4500	4500	10	18.4	8.5	3.87	1	20.3	0	140	0.7	21.1	120	1.0	21.3
5000	5000	10	20.4	8.5	3.87	1	25.1	0	140	0.9	26.0	120	1.2	26.3

Discharge Piping

Section Number: 2

Number of Pumps Operating: 1

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)
0	0	18	0.0	6.5	2.2	1	0.0	0	140	0.0	0.0	120	0.0	0.0
500	500	18	0.6	6.5	2.2	1	0.0	0	140	0.0	0.0	120	0.0	0.0
1000	1000	18	1.3	6.5	2.2	1	0.1	0	140	0.0	0.1	120	0.0	0.1
1500	1500	18	1.9	6.5	2.2	1	0.1	0	140	0.0	0.1	120	0.0	0.1
2000	2000	18	2.5	6.5	2.2	1	0.2	0	140	0.0	0.2	120	0.0	0.2
2500	2500	18	3.2	6.5	2.2	1	0.3	0	140	0.0	0.4	120	0.0	0.4
3000	3000	18	3.8	6.5	2.2	1	0.5	0	140	0.0	0.5	120	0.0	0.5
3500	3500	18	4.4	6.5	2.2	1	0.7	0	140	0.0	0.7	120	0.0	0.7
4000	4000	18	5.0	6.5	2.2	1	0.9	0	140	0.0	0.9	120	0.0	0.9
4500	4500	18	5.7	6.5	2.2	1	1.1	0	140	0.0	1.1	120	0.0	1.1
5000	5000	18	6.3	6.5	2.2	1	1.4	0	140	0.0	1.4	120	0.1	1.4

Discharge Piping

Section Number: 3

Number of Pumps Operating: 2

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)
0	0	18	0.0	7	0.79	1	0.0	0	140	0.0	0.0	120	0.0	0.0
500	1000	18	1.3	7	0.79	1	0.0	0	140	0.0	0.0	120	0.0	0.0
1000	2000	18	2.5	7	0.79	1	0.1	0	140	0.0	0.1	120	0.0	0.1
1500	3000	18	3.8	7	0.79	1	0.2	0	140	0.0	0.2	120	0.0	0.2
2000	4000	18	5.0	7	0.79	1	0.3	0	140	0.0	0.3	120	0.0	0.3
2500	5000	18	6.3	7	0.79	1	0.5	0	140	0.0	0.5	120	0.1	0.5
3000	6000	18	7.6	7	0.79	1	0.7	0	140	0.1	0.8	120	0.1	0.8
3500	7000	18	8.8	7	0.79	1	1.0	0	140	0.1	1.0	120	0.1	1.1
4000	8000	18	10.1	7	0.79	1	1.2	0	140	0.1	1.3	120	0.1	1.4
4500	9000	18	11.3	7	0.79	1	1.6	0	140	0.1	1.7	120	0.2	1.7
5000	10000	18	12.6	7	0.79	1	2.0	0	140	0.2	2.1	120	0.2	2.2

Discharge Piping

Section Number: 4

Number of Pumps Operating: 3

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)
0	0	18	0.0	6.5	0.6	1	0.0	0	140	0.0	0.0	120	0.0	0.0
500	1500	18	1.9	6.5	0.6	1	0.0	0	140	0.0	0.0	120	0.0	0.0
1000	3000	18	3.8	6.5	0.6	1	0.1	0	140	0.0	0.1	120	0.0	0.2
1500	4500	18	5.7	6.5	0.6	1	0.3	0	140	0.0	0.3	120	0.0	0.3
2000	6000	18	7.6	6.5	0.6	1	0.5	0	140	0.1	0.6	120	0.1	0.6
2500	7500	18	9.5	6.5	0.6	1	0.8	0	140	0.1	0.9	120	0.1	0.9
3000	9000	18	11.3	6.5	0.6	1	1.2	0	140	0.1	1.3	120	0.2	1.4
3500	10500	18	13.2	6.5	0.6	1	1.6	0	140	0.2	1.8	120	0.2	1.8
4000	12000	18	15.1	6.5	0.6	1	2.1	0	140	0.2	2.3	120	0.3	2.4
4500	13500	18	17.0	6.5	0.6	1	2.7	0	140	0.2	2.9	120	0.3	3.0
5000	15000	18	18.9	6.5	0.6	1	3.3	0	140	0.3	3.6	120	0.4	3.7

Discharge Piping

Section Number: 5

Number of Pumps Operatin[g]: 4

									Minimum Curve			Maximum Curve		
1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	C -	Hf (FT)	Head Loss (FT)	C -	Hf (FT)	Head Loss (FT)
0	0	18	0.0	4	P	1	#VALUE!	0	140	0.0	#VALUE!	120	0.0	#VALUE!
500	2000	18	2.5	4	P	1	#VALUE!	0	140	0.0	#VALUE!	120	0.0	#VALUE!
1000	4000	18	5.0	4	P	1	#VALUE!	0	140	0.0	#VALUE!	120	0.0	#VALUE!
1500	6000	18	7.6	4	P	1	#VALUE!	0	140	0.0	#VALUE!	120	0.0	#VALUE!
2000	8000	18	10.1	4	P	1	#VALUE!	0	140	0.1	#VALUE!	120	0.1	#VALUE!
2500	10000	18	12.6	4	P	1	#VALUE!	0	140	0.1	#VALUE!	120	0.1	#VALUE!
3000	12000	18	15.1	4	P	1	#VALUE!	0	140	0.1	#VALUE!	120	0.2	#VALUE!
3500	14000	18	17.7	4	P	1	#VALUE!	0	140	0.2	#VALUE!	120	0.2	#VALUE!
4000	16000	18	20.2	4	P	1	#VALUE!	0	140	0.2	#VALUE!	120	0.3	#VALUE!
4500	18000	18	22.7	4	P	1	#VALUE!	0	140	0.3	#VALUE!	120	0.3	#VALUE!
5000	20000	18	25.2	4	P	1	#VALUE!	0	140	0.3	#VALUE!	120	0.4	#VALUE!

Discharge Piping

Section Number: 6

Number of Pumps Operatin[g]: 2

										Minimum Curve				Maximum Curve			
1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Static Head (FT)	C -	Hf (FT)	Head Loss (FT)	TDH (FT)	C -	Hf (FT)	Head Loss (FT)	TDH (FT)
0	0	16.00	0.0	6350	6.09	1	0.0	0	36.5	140	0.0	35.5	#VALUE!	120	0.0	36.5	######
500	1000	16	1.6	6350	6.09	1	0.2	0	36.5	140	3.5	39.2	#VALUE!	120	4.6	41.4	######
1000	2000	16	3.2	6350	6.09	1	1.0	0	36.5	140	12.6	49.0	#VALUE!	120	16.7	54.2	######
1500	3000	16	4.8	6350	6.09	1	2.2	0	36.5	140	26.6	64.3	#VALUE!	120	35.4	74.0	######
2000	4000	16	6.4	6350	6.09	1	3.9	0	36.5	140	45.3	84.6	#VALUE!	120	60.2	100.6	######
2500	5000	16	8.0	6350	6.09	1	6.0	0	36.5	140	68.4	109.9	#VALUE!	120	91.0	133.5	######
3000	6000	16	9.6	6350	6.09	1	8.7	0	36.5	140	95.9	140.0	#VALUE!	120	127.5	172.7	######
3500	7000	16	11.2	6350	6.09	1	11.8	0	36.5	140	127.5	174.8	#VALUE!	120	169.6	217.9	######
4000	8000	16	12.8	6350	6.09	1	15.4	0	36.5	140	163.3	214.2	#VALUE!	120	217.1	269.1	######
4500	9000	16	14.4	6350	6.09	1	19.5	0	36.5	140	203.0	258.0	#VALUE!	120	270.0	326.0	######
5000	10000	16	16.0	6350	6.09	1	24.1	0	36.5	140	246.7	306.3	#VALUE!	120	328.1	388.7	######

Project: Exeter MPS
Job No. 12883B
Date: 17-Sep-15
Time: 12:00 AM
Calcs by: DAM
Checked By:
File:
Comments:
Scenario: Dual 16-inch DI FMs

Pump Manufacturer:	Flygt
Pump Model:	NT 3301/636
Impeller Size:	9.8"
Pump Speed:	1185

Pumps Operating: 2

Q per Pump	Multiple Pump Q	NPSHa	Minimum System Curve	Maximum System Curve	Pump Curve
0	0	34.5	#VALUE!	#VALUE!	119.0
500	1,000	34.4	#VALUE!	#VALUE!	105.0
1,000	2,000	34.3	#VALUE!	#VALUE!	94.0
1,500	3,000	34.0	#VALUE!	#VALUE!	86.0
2,000	4,000	33.7	#VALUE!	#VALUE!	80.0
2,500	5,000	33.3	#VALUE!	#VALUE!	74.0
3,000	6,000	32.8	#VALUE!	#VALUE!	67.0
3,500	7,000	32.1	#VALUE!	#VALUE!	59.0
4,000	8,000	31.4	#VALUE!	#VALUE!	49.0
4,500	9,000	30.6	#VALUE!	#VALUE!	44.0
5,000	10,000	29.7	#VALUE!	#VALUE!	37.0

Note: for parallel pumps operating in the last discharge section, the system curve plotted on the chart represents only the fractional flow contributed by a single pump. (i.e. for two pumps operating, the apparent operating point indicates

Minimum System Curve				Min. Operating Point	
	Flow	Sys. Head	Pump Head		
High		#VALUE!	119	GPM	
Low		#VALUE!	119	TDH	
slope				BEP	
intercept				% BEP	0%

Copy the flow for the system curves at points before and after they cross the pump curve.

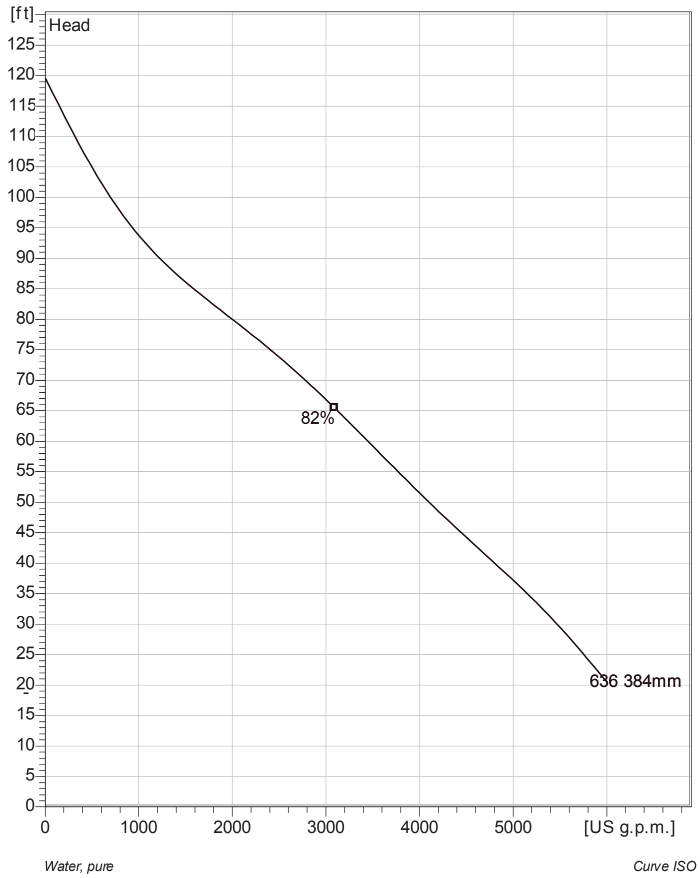
Maximum System Curve				Max. Operating Point	
	Flow	Sys. Head	Pump Head		
High		#VALUE!	119	GPM	
Low		#VALUE!	119	TDH	
slope				BEP	
intercept				% BEP	0%

Operating Range	
Low	0
High	0

Note: Plot the system curve on the manufacturer's pump curve to determine operating points, h.p. requirements, NPSHa requirements, efficiencies, etc.

NT 3301 MT 3~ 636

Technical specification



Note: Picture might not correspond to the current configuration.

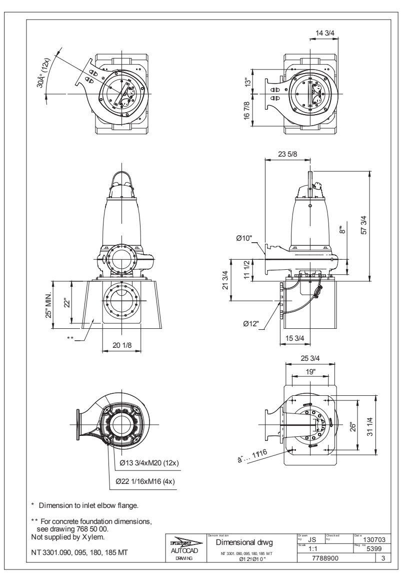
General

Patented self cleaning semi-open channel impeller, ideal for pumping in waste water applications. Possible to be upgraded with Guide-pin® for even better clogging resistance. Modular based design with high adaptation grade.

Impeller

Impeller material	Hard-Iron ™
Discharge Flange Diameter	9 13/16 inch
Inlet diameter	250 mm
Impeller diameter	384 mm
Number of blades	2

Installation: T - Vertical Permanent, Dry



Motor

Motor #	N3301.185 35-25-6AA-D 70hp
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	6
Phases	3~
Rated power	70 hp
Rated current	89 A
Starting current	560 A
Rated speed	1185 1/min
Power factor	
1/1 Load	0.80
3/4 Load	0.75
1/2 Load	0.64
Efficiency	
1/1 Load	91.0 %
3/4 Load	91.5 %
1/2 Load	91.5 %

Configuration

Project	Project ID	Created by	Created on	Last update
			2015-07-01	

NT 3301 MT 3~ 636

Performance curve

Pump

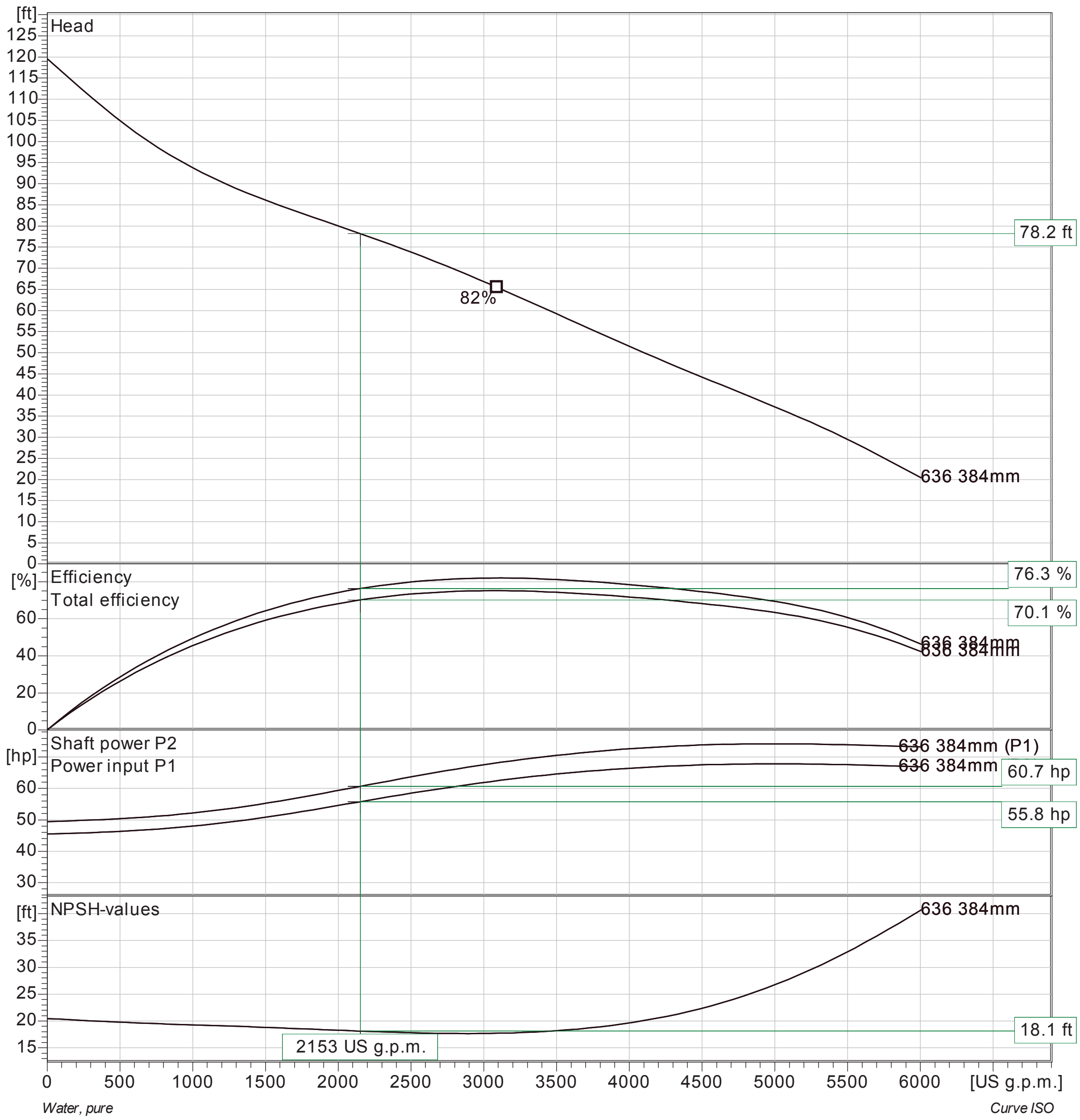
Discharge Flange Diameter	9 13/16 inch
Inlet diameter	250 mm
Impeller diameter	15 1/8"
Number of blades	2

Motor

Motor #	N3301.185 35-25-6AA-D 70hp
Stator variant	1
Frequency	60 Hz
Rated voltage	460 V
Number of poles	6
Phases	3~
Rated power	70 hp
Rated current	89 A
Starting current	560 A
Rated speed	1185 1/min

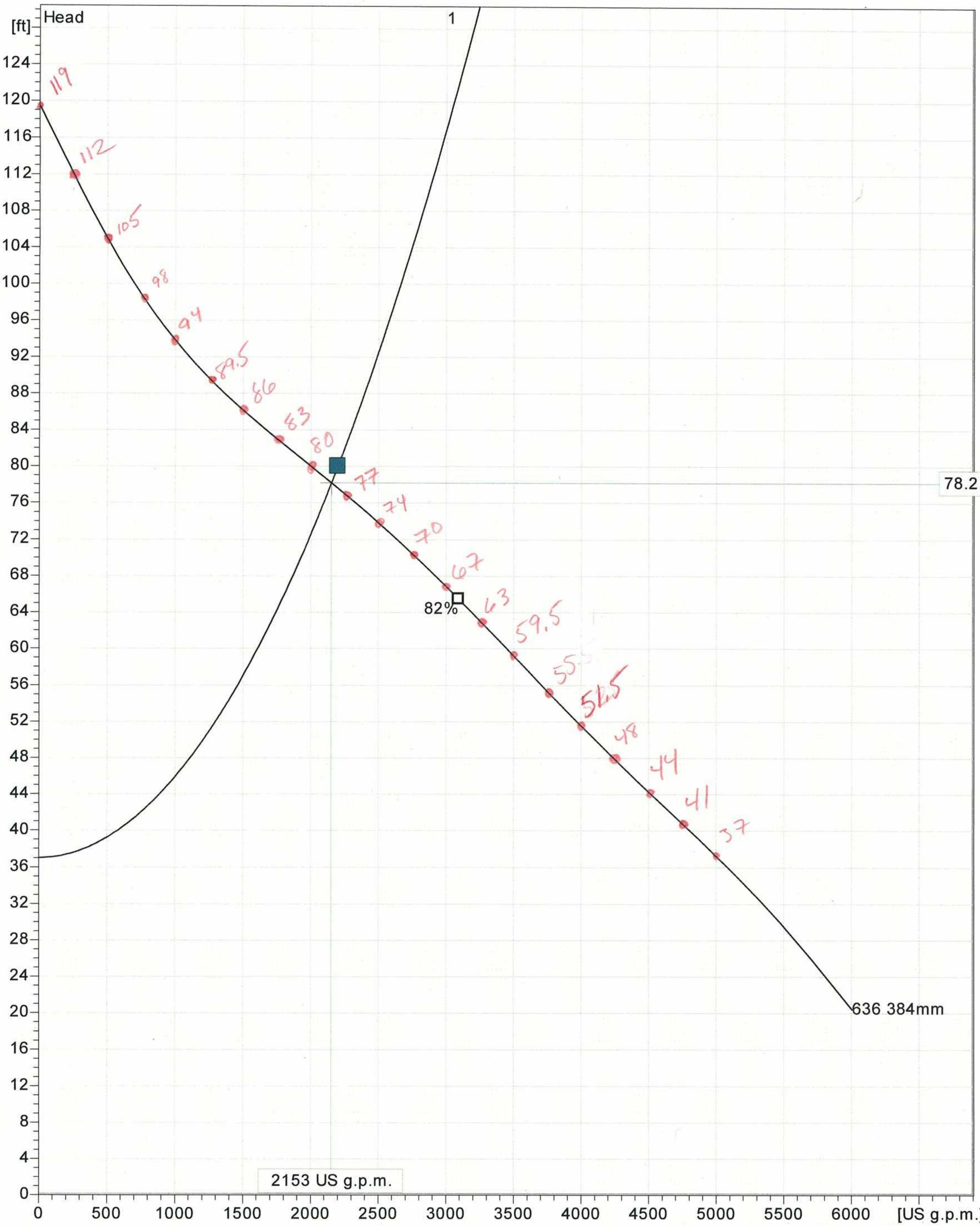
Power factor	
1/1 Load	0.80
3/4 Load	0.75
1/2 Load	0.64

Efficiency	
1/1 Load	91.0 %
3/4 Load	91.5 %
1/2 Load	91.5 %



Project	Project ID	Created by	Created on	Last update
			2015-07-01	

NT 3301 MT 3~ 636
Duty Analysis



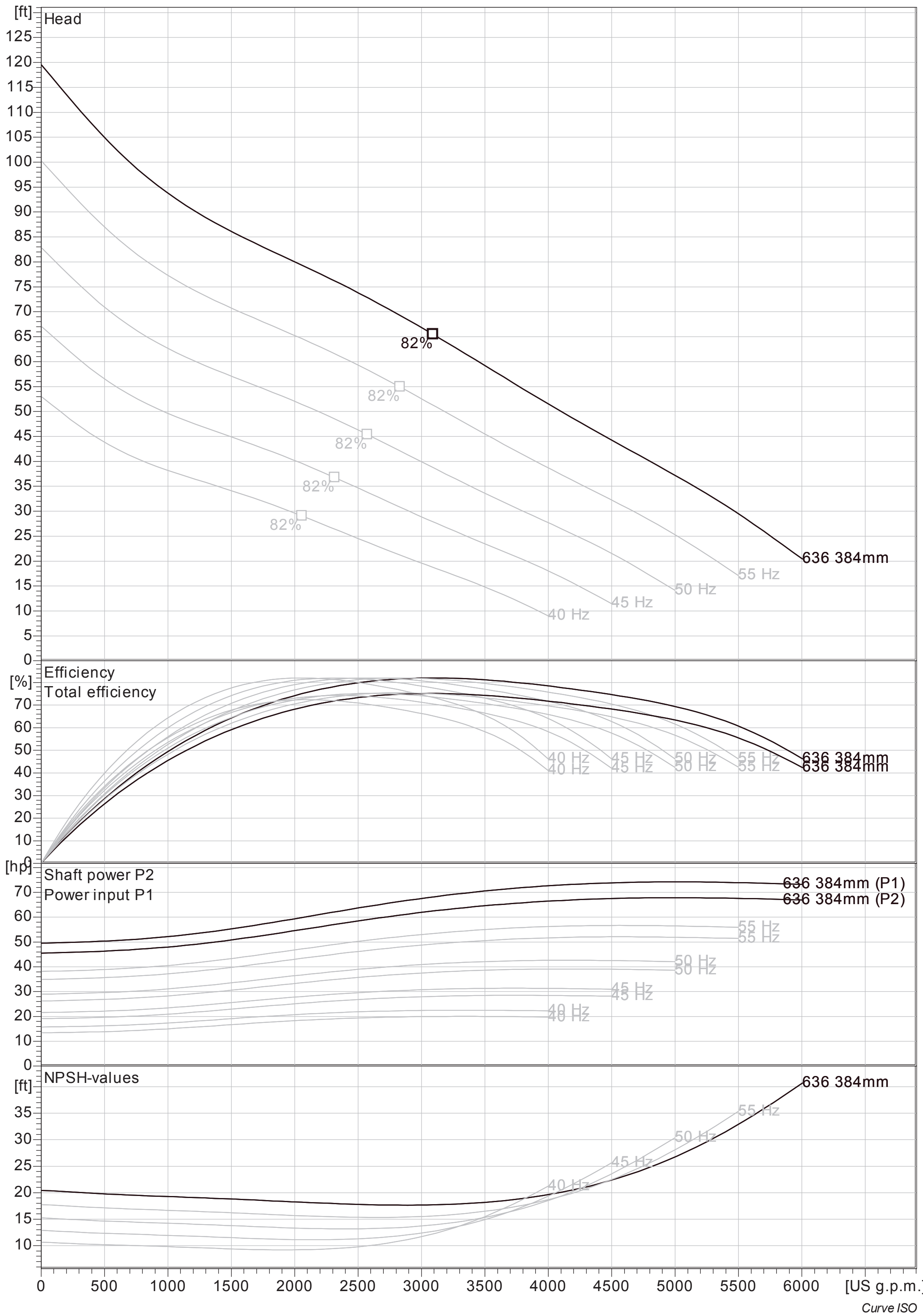
Water, pure
Curve issue 6
Curve ISO

Pumps running /System	Individual pump Flow	Head	Shaft power	Total Flow	Head	Shaft power	Pump eff.	Specific energy	NPSHre
1	2150 US g.p.m.	78.2 ft	55.8 hp	2150 US g.p.m.	78.2 ft	55.8 hp	76.3 %	350 kWh/US MG	18.1 ft

Project	Project ID	Created by	Created on	Last update
			2015-07-01	

NT 3301 MT 3~ 636

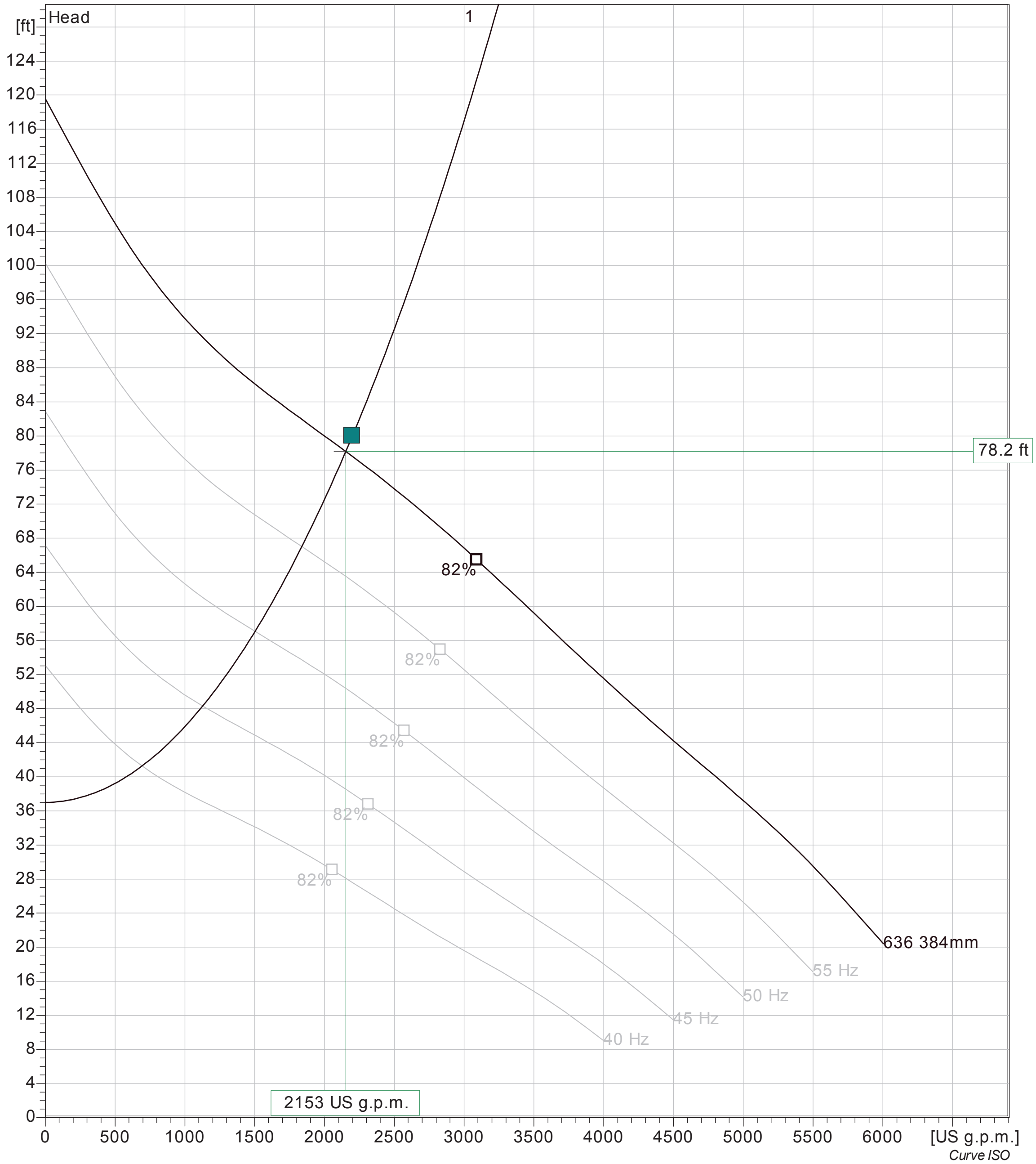
VFD Curve



Project	Project ID	Created by	Created on	Last update
			2015-07-01	

NT 3301 MT 3~ 636

VFD Analysis



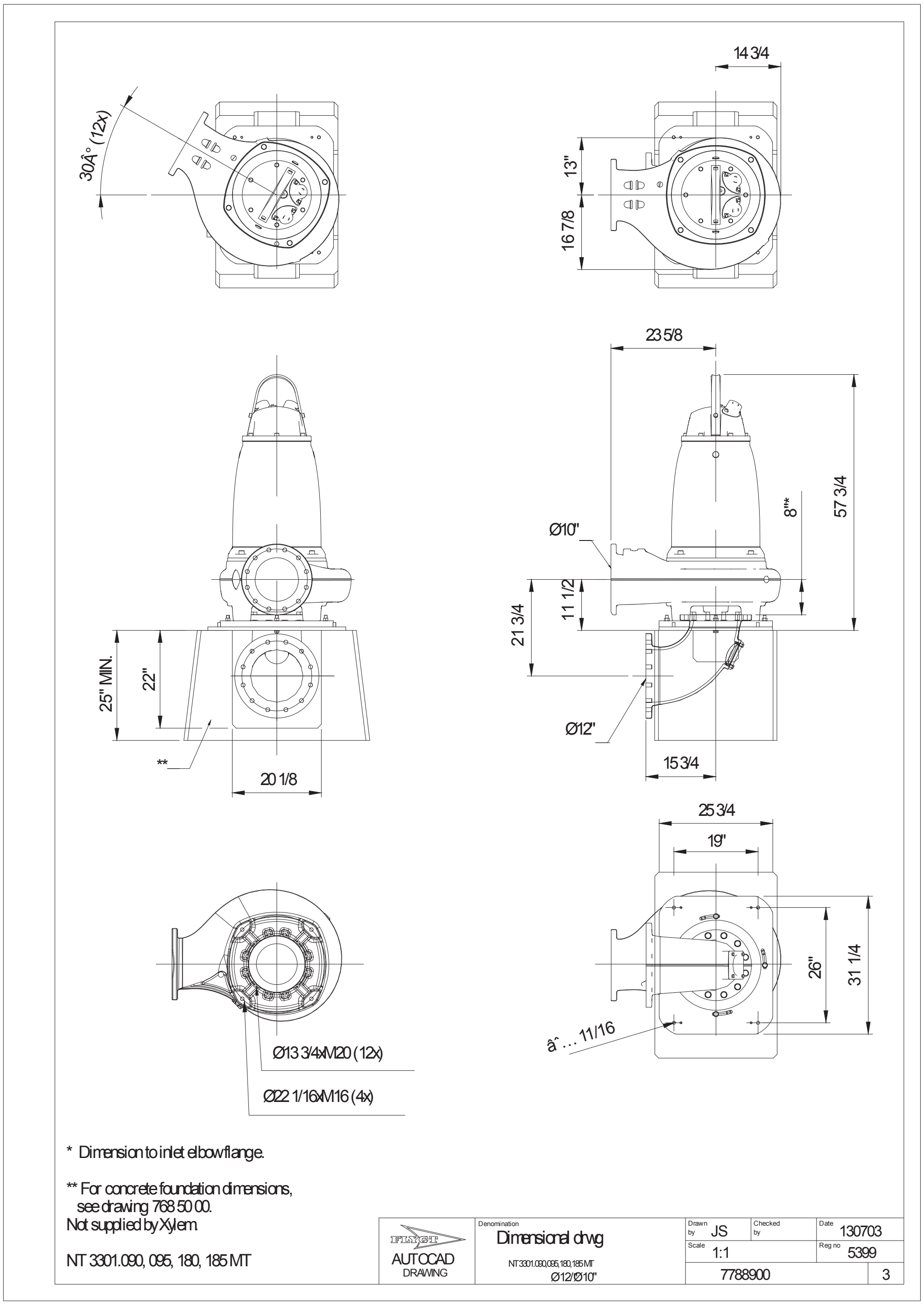
Pumps running /System	Frequency	Flow	Head	Shaft power	Flow	Head	Shaft power	Hyd eff.	Specific energy	NPSHre
1	60 Hz	2150 US g.p.m.	78.2 ft	55.8 hp	2150 US g.p.m.	78.2 ft	55.8 hp	76.3 %	350 kWh/US MG	18.1 ft
1	55 Hz	1840 US g.p.m.	67 ft	42 hp	1840 US g.p.m.	67 ft	42 hp	74.3 %	309 kWh/US MG	15.9 ft
1	50 Hz	1500 US g.p.m.	57.1 ft	30.6 hp	1500 US g.p.m.	57.1 ft	30.6 hp	70.9 %	278 kWh/US MG	13.8 ft
1	45 Hz	1130 US g.p.m.	48.3 ft	21.4 hp	1130 US g.p.m.	48.3 ft	21.4 hp	64.4 %	264 kWh/US MG	11.8 ft
1	40 Hz	694 US g.p.m.	41.3 ft	14.2 hp	694 US g.p.m.	41.3 ft	14.2 hp	50.9 %	297 kWh/US MG	10 ft

Project	Project ID	Created by	Created on	Last update
			2015-07-01	

xylem
Let's Solve Water

NT 3301 MT 3~ 636
Dimensional drawing

FLYGT



Project	Project ID	Created by	Created on	Last update
			2015-07-01	

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE

PROJECT NO.: 12883B

PRELIMINARY DESIGN PACKAGE

System/Subject:	INFLUENT SCREENING		
Calculations By:	MICHAEL CURRY	Date:	7/23/2015
Checked By:	ED LEONARD	Date:	7/20/2015
Revised By:	MICHAEL CURRY	Date:	8/26/2015
Checked By:	ANDY MORRILL	Date:	8/28/2015

Checklist (to be completed by Design Engineer prior to calculation checking):

X	Brief Process Description
X	Graphs/Sketches of System Attached (Plans & Schematics)
X	Design Calculations Attached
X	Design Guidelines/Standards Noted
-	Equations Noted and Referenced
X	Electrical Loads Developed and Identified
X	Process Control Description Developed
X	Preliminary Basis of Design (Support Divisions) Attached
X	Construction Sequence Developed
X	Product Information Attached
-	Manufacturer's Review of Specs and Drawings (If Applicable)
X	Electronic File Location Noted
-	Program(s) Used (Version) Noted
X	Coordinated with Hydraulic Profile (If Applicable)

DESCRIPTION OF EXISTING FACILITIES

Influent screening at the Wastewater Treatment Facility (WWTF) consists of a coarse manual bar rack (1-inch spacing) located in the Grit Building. The Grit Building and bar rack were constructed as part of the 1988 upgrade. The bar rack is periodically manually raked by an operator and collected screenings are transferred to a 5-gallon bucket. The bucket is then transferred to a screenings hopper before being disposed of in an on-site storage container. The contents of the container are periodically disposed of offsite.

FACILITY PLAN RECOMMENDATIONS

The WWTF manual bar rack is still in operation but has reached the end of its useful design life. Based on the alternatives analysis completed in the Facilities Plan (Wright-Pierce, March 2015), new influent screenings will be constructed within a new Headworks Building at the WWTF.

An effective screenings process is crucial to protecting downstream processes. The new influent screening system will consist of a mechanically-cleaned fine screen (1/4-inch preferred) with screenings wash press and a new manually-cleaned bypass bar rack.

CLIENT PREFERENCES

No client preferences have been identified at this time.

DESIGN GUIDELINES (TR-16, NHDES Env-Wq)

<u>TR-16 – Section 5.1.1 (Screening Equipment)</u>:

- Section 5.1.1: Mechanically-cleaned screens should be installed to protect pumps and downstream processes in the WWTF.
- Section 5.1.1.3.4: Unobstructed openings between bars are generally between 0.25 and 1.5 inches for mechanically cleaned bar screens.
- Section 5.1.1.3.8: A passive overflow system bypass shall be provided at a depth corresponding to the maximum design flow through the screening device.
- Section 5.1.1.6: Manually-cleaned screens should be accessible via a platform from which screenings can be raked easily and safely.

Env-Wq – Section 709 (Screening Devices)

- 709.01(a): Each WWTP shall have mechanized screening for influent sewage that operates using automatic controls;
- 709.02(d): Clear openings for mechanical screens shall be ½-inch or less to maximize removal of inert material;
- 709.02(f): Maximum velocities through the screen during wet weather periods shall not exceed 2.5 feet per second (fps);
- 709.02(h.1): If one unit is installed, the unit shall be sized to handle peak hourly design flow;
- 709.02(i): Influent channels shall be equipped with gates to isolate the screening device;
- 709.02(j): Auxiliary manually-cleaned screens shall be provided along with provisions for automatic bypass diversion if the mechanical unit fails.

REVIEW OF DESIGN CONSIDERATION & ALTERNATIVES

As part of the Facilities Plan (March 2015, Wright-Pierce), several mechanical screening technologies were considered including vertical type screens (multi-rake screens, step screens) and rotary drum fine screens. Additional design considerations included bar spacing, hydraulic capacity, durability, and overall cost.

Multi-Rake Bar Screen

Multi-rake bar screens are offered with vertical bar spacing (1/4-inch) and screen influent wastewater one dimensionally. The screen is cleaned by several rake bars offering high screenings removal rates. Screenings are deposited into a wash press for washing, compaction, and dewatering of influent screenings. The multi-rake bar screen has been successfully used in combined sewer communities.

Step Screen

Step screens are offered with a vertical bar spacing (1/4-inch) and screen influent wastewater one dimensionally. The design consists of fixed and movable lamella "plates" which rotate in a vertical motion lifting screenings vertically to a discharge point. Captured screenings form a mat which acts as a filter to retain particles which are smaller than the bar spacing. However, the movable step plate in the screen can be susceptible to interference from grit/gravel. As with the multi-rake bar screen, the step screen requires a screenings wash press for washing, compaction, and dewatering of influent screenings. Step screens are generally less frequently installed in combined sewer applications.

<u>Rotary Drum Fine Screen</u>

Rotary screens are offered in a perforated plate or horizontal bar spacing options (1/4-inch). The perforated plate screens offer enhanced influent screening; however, projected flows for the WWTF exceed capacities for the perforated plate option. Rotary drum fine screens are equipped with an integral screenings washing, compaction and dewatering unit eliminating the need for a separate screenings wash press. Rotary drum fine screens are generally not considered for combined sewer applications.

BASIS OF DESIGN

A multi-rake bar screen (1/4-inch) was chosen as the basis for design due to its high screenings removal rates, ability to handle grit loading, and performance history in combined sewer communities. A screenings wash press will be provided to process screenings from the fine mechanical bar screen.

BASIS OF DESIGN

MECHANICAL FINE SCREEN	
Application:	Raw Influent Wastewater
System Type (Quantity):	Multi-Rake (1)
Clear Bar Spacing:	¼-inch vertical
Design Flows:	
Minimum Month (2018)	1.10 MGD
Peak Instantaneous (2040)	12.5 MGD
Clear Channel Width	3’-0”
Channel Depth	6’-0”
Screenings Discharge Height	3’-0” (Above Channel)
Acceptable Manufacturers:	Huber, Vulcan, or equal

SCREENINGS WASH PRESS	
Application:	Raw Screenings
System Type (Quantity):	Wash Press (2)
Discharge Location	U-trough to cart/hopper
Design Criteria:	
Screenings Capacity:	99 cf/hr (continuous)
Organic Removal:	90% (max.)
Volume Reduction:	50% (min.)
Other Equipment:	Inlet hopper, wash water connections, solenoid manifold, drain pan
Acceptable Manufacturers	Vulcan, Huber, or equal

Acceptable manufacturers include:

- Vulcan Industries
- Huber
- Or equal

BUILDING / STRUCTURE DESCRIPTION

The screening system will be located on the first floor of the new Headworks Building. Flow will enter the influent channel from the Main Pump Station force main and then pass through a mechanical fine screen (multi-rake type). The Headworks Building will include a primary screening channel for the multi-rake screen, and a parallel bypass channel equipped with a manually-cleaned bar rack in the event of advanced screen blinding. The multi-rake screen will discharge to a screenings wash press which will wash, compact, and dewater the screenings. The wash press shall discharge processed screenings through the floor into a screenings cart or roll-off container located on the ground level.

Structural information:

MULTI-RAKE SCREEN	
Height (above channel)	7’-6”
Width (approx.)	3’-9” incl. frame
Length (approx.)	8-feet
Installation Angle	80 degrees
Weight (approx.)	4,750 lb
WASH PRESS	
Dimensions	2’W, 7’L, 2’D’
Discharge Height	6’ (Above Channel)
Weight (approx.)	850 lb

PROCESS CONTROL DESCRIPTION

The mechanical bar screen and wash press shall be located in the influent channel room of the new Headworks Building and shall be rated Class I, Division I, Group D. The units will be controlled by a PLC-based control panel mounted in the Electrical Room of the new Headworks Building. The screen shall have a NEMA 7 rated Local Control Station (LCS) provided with a Hand-Off-Remote switch and ESTOP pushbutton. The screenings wash press shall have a NEMA 7 rated (LCS) with a Hand-Off-Remote switch, Forward-Off-Reverse, and an ESTOP button. The mechanical bar screen shall have two speeds and will be operated based on differential level conditions. The wash press will be controlled automatically in either intermittent batch washing or continuous operation override mode.

The following instruments and panels are anticipated:

ITEM	LOCAL/REMOTE	NEMA	BY DIVISION
Control Panel	Remote	4/12	13
Local Control Stations (2)	Local	7	11-OEM
Solenoid Valves	Local	7	11-OEM
Level Transducers	Local	7	13
Float Switches (High Level)	Local	7	13

The following electrical motors are anticipated:

MULTI-RAKE SCREEN	
Power	2 HP
Speed	Variable
Enclosure	TEFC, Class 1, Division 1
Volts, Phase/Hz	460/3/60
WASH PRESS	
Power	5 HP
Speed	Constant (Forward/Rev)
Enclosure	TEFC, Class 1, Division 1
Volts, Phase/Hz	460/3/60

___X___ Coordinated with NFPA Memo

___X __ Coordinated with Equipment List

CONSTRUCTION SEQUENCING

The screening system will be constructed with the new Headworks Building. Flow to the new Headworks Building is dependent upon the upgrade to the Main Pump Station and installation of the new force main. Temporary bypass pumping is anticipated.

FUTURE EXPANSION CONSIDERATIONS

The screening system will be designed to handle future peak instantaneous flows including potential future flows from Stratham and Newfields (see Preliminary Design Report for specific flow rates).

FILE LOCATION

J:\ENG\NH\Exeter\12883-WWTF\12883B-WW Design\Technical\Process\Design Memos

ATTACHMENTS

- A Equipment Cut Sheets

BUDGETARY PROPOSAL

Project Name: Exeter, NH

Date: July 16, 2015

Huber Contact:
Regional Sales Manager: Frank Scriver
Email Address: Frank@hhusa.net
Phone Number: 905.440.4448

Represented By:
Representative Firm: Walker Wellington
Representative Associate: Rich Russell
Email Address: rich@walkerwellington.com
Phone Number: 207.439.1464

Equipment: RakeMax

- Efficient Removal of High Screening Loading
- Unimpaired by Grit
- Maintenance Free Lower Bearings
- Fully Passivated SS Construction
- Completely Enclosed

HUBER TECHNOLOGY
WASTE WATER Solutions

Huber Technology, Inc.
9735 NorthCross Center Court
Suite A
Huntersville, NC 28078

Phone: (704) 949-1010
Fax: (704) 949-1020

HUBER TECHNOLOGY
WASTE WATER Solutions

DESCRIPTION

RakeMax® Multi-Rake Bar Screen
Model: One (1) x RakeMax 2880x690/6

Hydraulic Conditions:
Peak Hourly Flow: 12.5MGD
DSWL During Normal Peak Flows: 50”
Max. Headloss Across Screen at 30% Blinding: 6”

Blinding	Headloss	Upstream Head	Flow Velocity Between Slots
[%]	inch	inch	ft/sec
0	1	51	4.53
10	2	52	4.93
20	3	53	5.40
30	5	55	5.98
35	7	57	6.23
40	9	59	6.52

Design Information:
Channel Depth: 6’ – 0”
Channel Width: 3’ – 0”
Screen Width: 27.2” (690 mm)
Inclination: 75°
Bar Spacing: 1/4” (6 mm)
Discharge Height Above Channel Invert: 8’ – 2”
Approximate Screen Weight: 2,200lbs

Scope Includes:
- 304 Stainless Steel Construction with Full Submersion Passivation for Superior Corrosion Resistance.
- Teardrop-Shaped Bars
- Type 304 Stainless Steel Chain with Polyamide Rollers
- Cast Iron Flanged Upper Bearings; Silicium Carbide Slide Lower Bearings
- Screen Covers and Supports in 304 Stainless
- Pivoting Scraper Mechanism with Proximity Switch and Polyethylene Blades
- Class 1 Division 1 Motor, 1-HP, 480 VAC, 3 Phase, 60 Hz, S.F. 1.0
- Control Panel, Including:
  - NEMA 4X 304 Stainless Steel Enclosure
  - VFD, Square D Altivar 312 w/ MCP Branch Circuit [Screen - 480VAC, 1HP Max]
  - PLC: AB MicroLogix 1400
  - OIT: AB PanelView Plus 400 Color Touch
  - UL Label
  - Preprogrammed and Factory Tested
  - One (1) HydroRanger 200 Differential Level Controller
  - One (1) 3-hole, NEMA7 LCS (Screen)
- Standard Manufacturer’s Services and Freight to Site Included

HUBER Technology, Inc.
Huber Technology, Inc. · 9735 NorthCross Center Court STE A · Huntersville, NC 28078
Phone (704) 949-1010 · Fax (704) 949-1020 · huber@hhusa.net · www.huber-technology.com

A Member of the HUBER Group

ROTAMAT WAP Screening Wash Press
Model: One (1) x WAP 2

Design Information:
Throughput: $70ft^3/hr$
Volume reduction of up to 70%
Weight reduction of up to 40%
Wash Water Demand: 13gpm @ 60psi
Approximate Weight: 530 lbs

Including:

- 304 Stainless Steel Construction with Full Submersion Passivation for Superior Corrosion Resistance.
- 304 Stainless Steel Screw Auger with Increasing Thickness and Nylon Brushes
- Class 1 Division 1 Motor, 5-HP, 480 VAC, 3 phase, 60 Hz, S.F. 1.15
- Perforated Drain in Compaction and Washing Zones
- Support Legs
- Drain Pan with 3 ½" Connection
- Discharge Pipe with 8" ANSI Flange Connection
- Enclosed Feed Trough with Inspection Door
- Three (3) Washing Points with Two (2) Solenoid Valves, Class 1 Division 2, 2-way brass body, 110 VAC, 60 Hz

Budgetary Pricing:

EQUIPMENT	PRICE
RakeMax® Multi-Rake Bar Screen	Included
Optional ROTAMAT WAP Screening Wash Press	Included
Manufacturer's Standard Services & Freight to Site	Included
TOTAL	***$175,000.00***

Technical Clarifications:

1. Equipment specification is available upon request
2. If there are site-specific hydraulic constrains that must be applied, please consult the manufacturer's representative to ensure compatibility with the proposed system
3. Electrical disconnects required per local NEC code are not included in this proposal
4. Huber Technology warrants all components of the system against faulty workmanship and materials for a period of 12 months from date of start-up or 18 months after shipment whichever occurs first
5. Budget estimate is based on Huber Technology's standard Terms & Conditions and is quoted in US$ unless otherwise stated.
6. Huber has estimated the Control Panel cost based information provided with the RFQ. If control panel information is not provided with RFQ Huber will use a cost and scope of supply based on our standard panel. Huber reserves the right to change the price and scope at time of bid based on the final plans and specifications.

HUBER Technology, Inc.
Huber Technology, Inc. · 9735 NorthCross Center Court STE A · Huntersville, NC 28078
Phone (704) 949-1010 · Fax (704) 949-1020 · huber@hhusa.net · www.huber-technology.com

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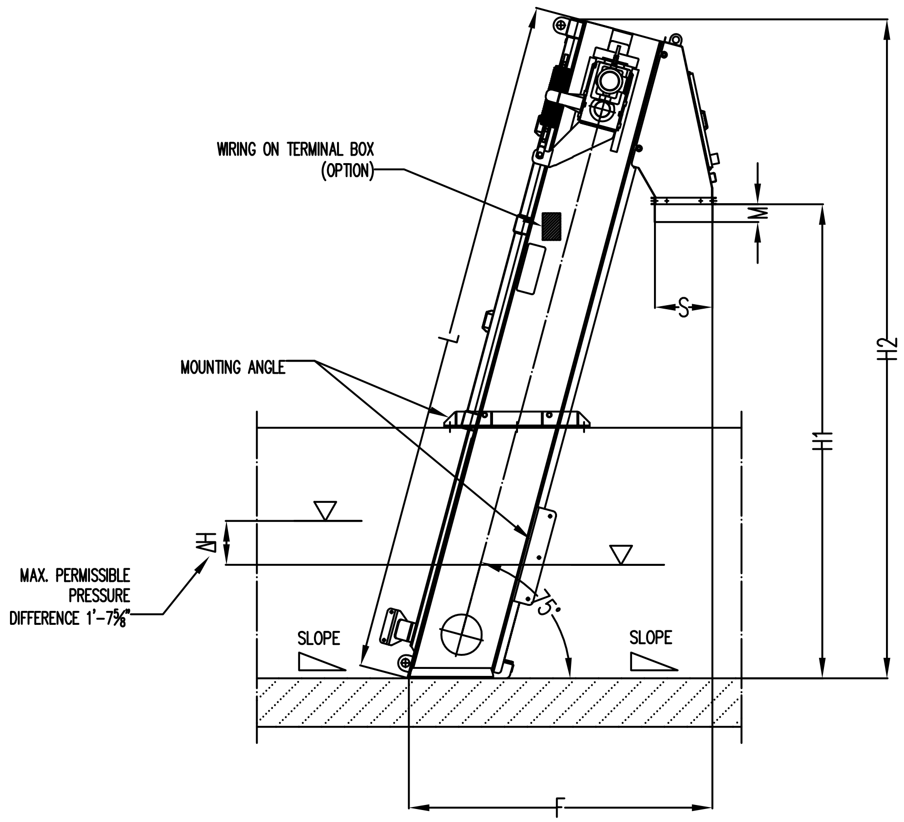
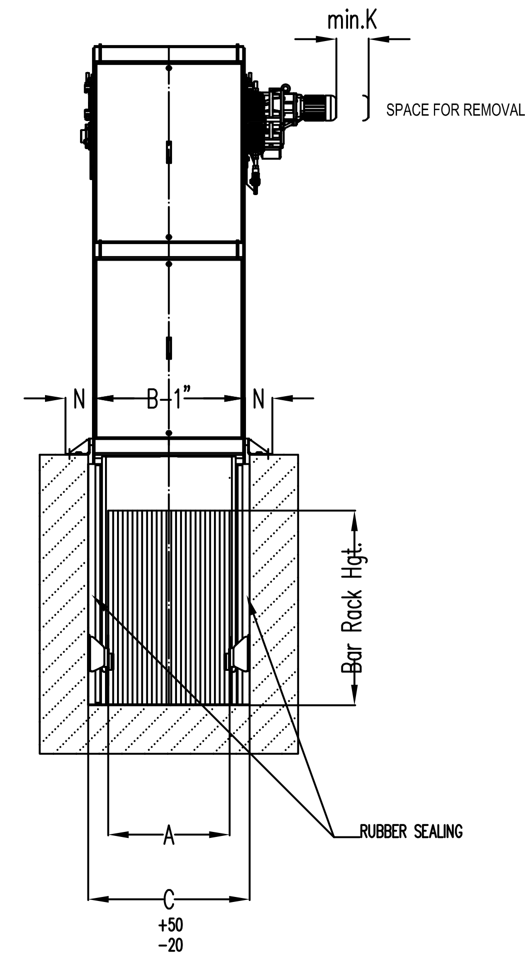
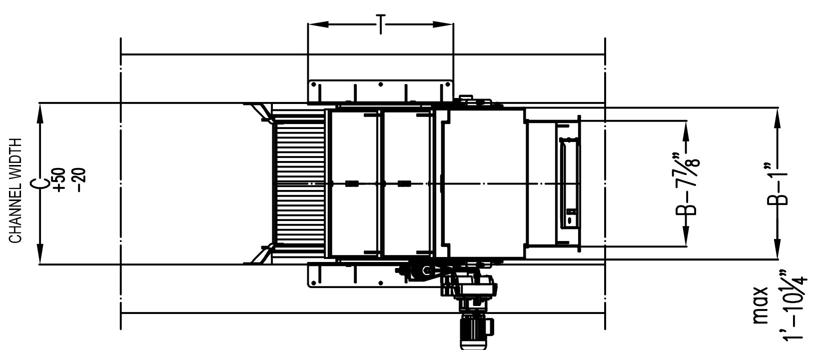
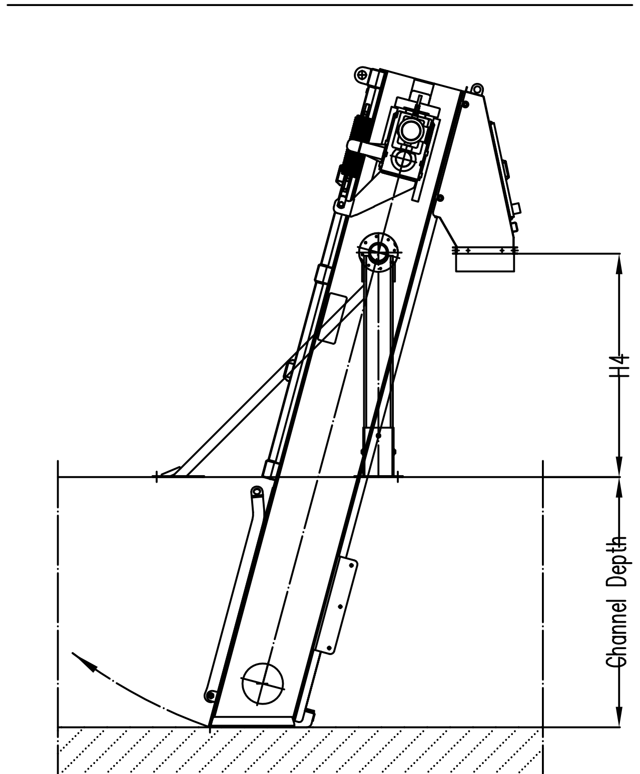
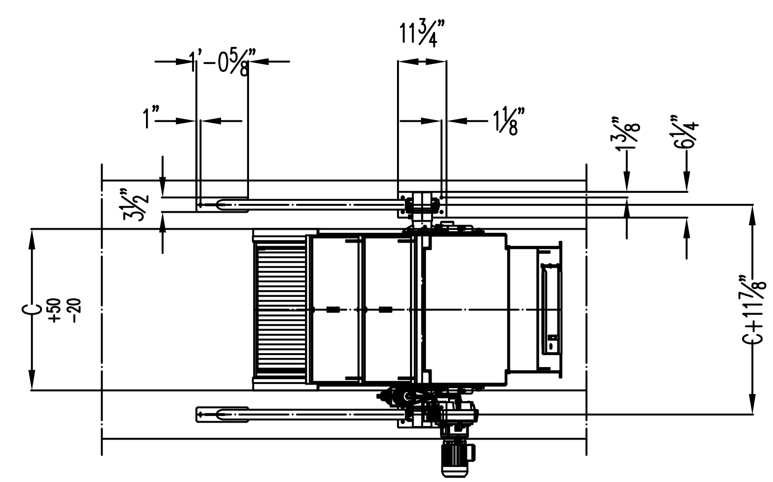






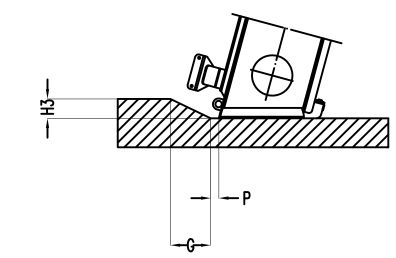
DISCHARGE HEIGHT H4 >= CHANNEL DEPTH



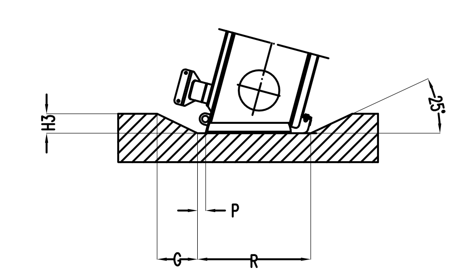


ADDITIONAL SUGGESTIONS FOR HYDRAULIC IMPROVEMENT

STEP IN CHANNEL BOTTOM



RECESS IN CHANNEL BOTTOM



D	G	H3	S	M	N	P	R	T
70°	7⅞"	3⅞"	1' 2"	4⅜"	6¾"	3⅞"	2' 5½"	2' 11⅜"
75°	9⅞"	4¾"	1' 2"	4⅜"	6¾"	3⅞"	2' 5½"	2' 11⅜"
80°/85°	11¾"	5½"	1' 2"	4⅜"	6¾"	3⅞"	2' 5½"	2' 11⅜"

* ONLY WITH PRIOR APPROVAL FROM HUBER ENGINEERING DEPT.

Size	Discharge height H1				Height over all H2				Length L				Width F			
	70°	75°	80°	85°*	70°	75°	80°	85°*	70°	75°	80°	85°*	70°	75°	80°	85°*
	9' 3"	9' 7½"	9' 11¼"	10' 2⅛"	13' 2⅛"	13' 5"	13' 6¾"	13' 7⅜"	13' 11¾"	13' 10⅜"	13' 9⅛"	13' 7⅞"	7' 3½"	6'-5"	5' 6⅜"	4' 7½"

Size	252	352	452	552	652	752	852	952	1052	1152	1252	1352	1452
Sieve width A	9⅞"	1' 1⅞"	1' 5¾"	1' 9¾"	2' 1⅝"	2' 5⅝"	2' 9½	3' 1½"	3' 5⅜"	3' 9⅜"	4' 1¼"	4' 5¼"	4' 9⅛"
Screen width B	1' 6¼"	1' 10¼	2' 2⅛"	2' 6⅛"	2' 10"	3' 2"	2' 5⅞"	3' 9⅞"	4' 1¾"	4' 5¾"	4' 9⅝"	5' 1⅝"	5' 5½"
Channel width C	1' 7⅝"	1' 11⅝"	2' 3½"	2' 7½"	2' 11⅜"	3' 3⅜"	3' 7¼"	3' 11¼"	4' 3⅛"	4' 7⅛"	4' 11"	5' 3"	5' 6⅞"

Size	1552	1652	1752	1852	1952	2052	2152	2252	2352	2452	2552	2652	2752
Sieve width A	5' 1⅛"	5' 5"	5' 9"	6' ⅞"	6' 4⅞"	6' 8¾"	7' ¾"	7' 4⅝"	7' 8⅝"	8' ½"	8' 4½"	8' 8⅜"	9' ⅜"
Screen width B	5' 9½"	6' 1⅜"	6' 5⅜"	6' 9¼"	7' 1¼"	7' 5⅛"	7' 9⅛"	8' 1"	8' 5"	8' 8⅞"	9' ⅞"	9' 4¾"	9' 8¾"
Channel width C	5' 10⅞	6' 2¾"	6' 6¾"	6' 10⅝"	7' 2⅝"	7' 6½"	7' 10½"	8' 2⅜"	8' 6⅜"	8' 10¼"	9' 2¼"	9' 6⅛"	9' 10⅛"

- TRAPEZOIDAL CHANNEL IN FRONT OF RAKEMAX
- THESE ANCHOR BOLTS ARE ONLY PERMISSIBLE IN CONCRETE WITH A RESISTANCE OF >=C20/25<=C50/60.
- IF THERE IS NOT SUFFICIANT ROOM HEIGHT WE RECOMMEND TO PROVIDE AN OPENING IN THE ROOF.

ACCIDENT PREVENTION (RAILINGS, COVER, ETC...ACCORDING TO COUNTRY SPECIFIC REGULATIONS BY OTHERS.

NUMBER AND TYPE OF THE MOUNTING ANGLE/SUPPORT MUST BE ARRANGED ACCORDING TO THE BUILDING/CHANNEL.

NUMBER AND TYPE OF THE RAKEMAX SPLIT MUST BE ARRANGED ACCORDING TO THE BUILDING/CHANNEL.

NOTE:
CHANNEL WALLS MUST BE ABSOLUTELY VERTICAL IN THE AREA OF THE SCREEN. IN THE AREA OF THE SCREEN BOTTOM PLATE THE CHANNEL SURFACE MUST BE PLANE WITH A MAX. TOLERANCE OF ±3mm.

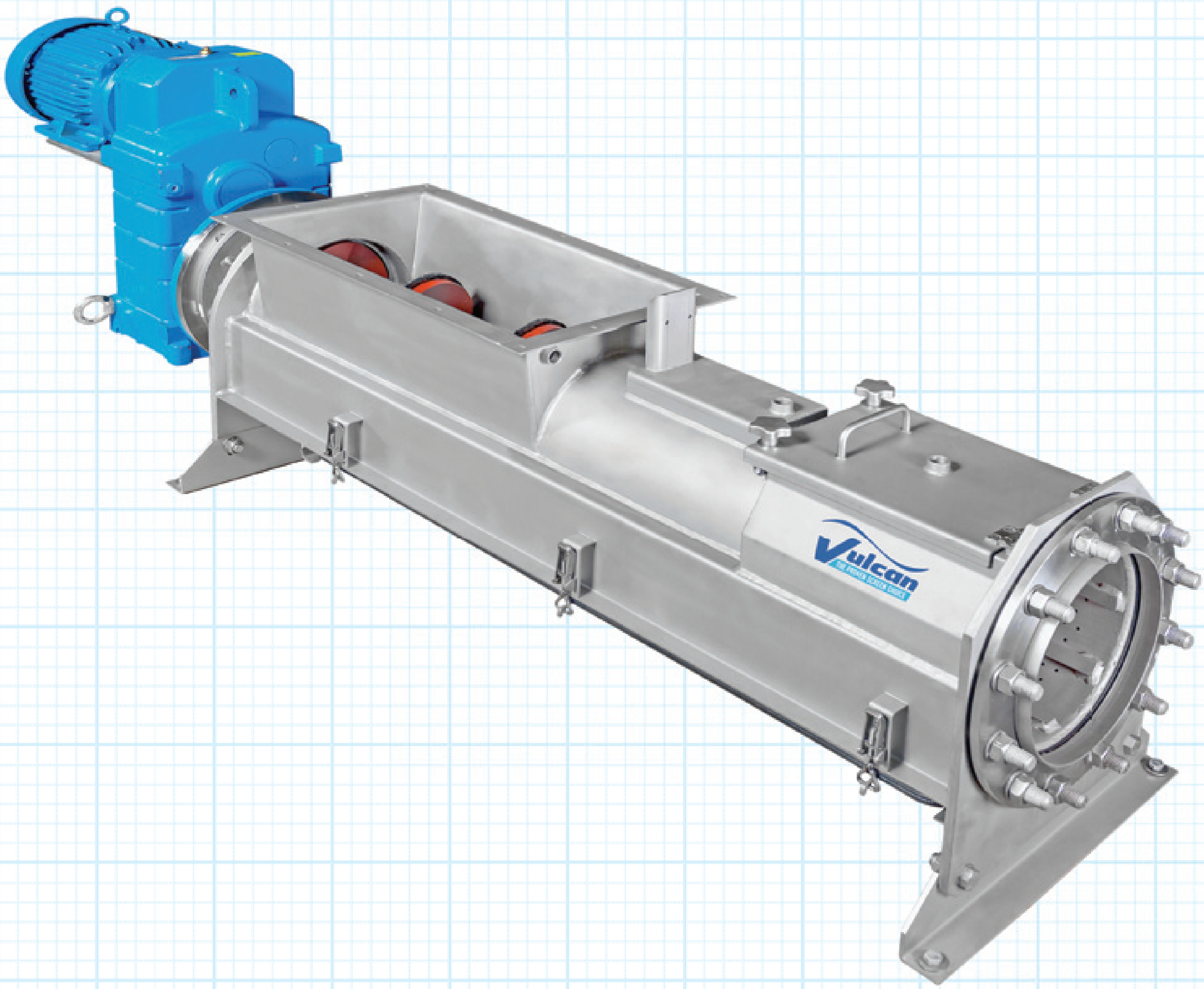
Dimensions are for reference only!
For binding dimensions please refer to the final installation drawings

HUBER TECHNOLOGY
9735 NorthCross Center Court, Suite A
Huntersville, NC 28078
Tel. 704-949-1010
info@huber-technology.com

RAKEMAX® 3300		
Fig No. 1/1	DIMENSIONAL SHEET	Scale: 1/4" = 1'-0"
Project No.		

Model EWP Washing Press

Product Information Guide

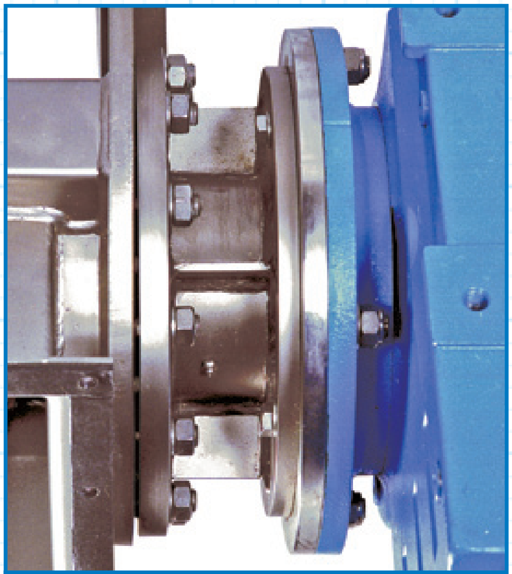


Find more product information at:

vulcanindustries.com

Vulcan
THE PROVEN SCREEN CHOICE

Model EWP Washing Press



A detail of the axial thrust bearing that connects the gear reducer to the press body and the shafted spiral. This bearing handles the load created during compaction and carries the overhung load of the spiral. This protects the gear reducer and extends the life of the unit.

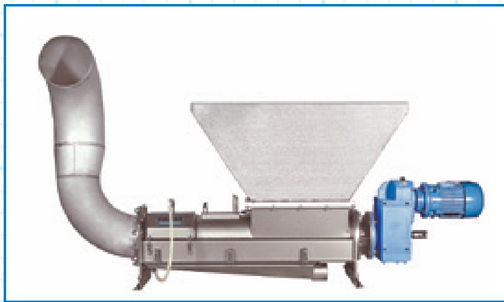
The **Model EWP Washing Press** is a spiral press used to wash organic matter out of screenings material. The Washing Press washes, dewaters, compacts and transports screenings to a conveyor, container or other suitable receiving device.

Construction

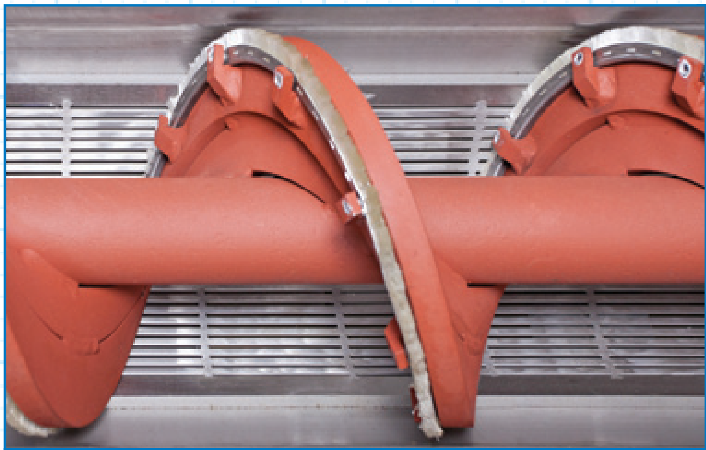
The Washing Press consists of a press body with separate washing and dewatering sections, hollow shaft spiral, axial thrust bearing (see photo on left), gear reducer and motor, drain pan, washwater spray connections and sequencing valves.

The press body is constructed of stainless steel. A wedge wire drain constructed of individual profile bars is mounted on the bottom of the press and extends from the inlet hopper through the washing section. The wedge wire, with 2 mm spacings, guarantees clog-free drainage of the washwater, while ensuring screenings capture.

The spiral, of alloy steel construction, is welded to the hollow shaft. The hollow shaft contains perforations located in the washing zone to introduce washwater to the screenings from the inside out. A nylon brush is attached to the trailing edge of the spiral to ensure debris is thoroughly removed from the drainage area. The drain pan is constructed of stainless steel, and is located directly under the press body. A flushing nozzle periodically rinses the drain pan. Sealed with a gasket, and secured with a latching system, the drain pan is easily removed for service.



Model EWP Washing Press with an inlet hopper and discharge pipe.
The inlet hopper can be directly connected to a primary screening device such as a Model FT Mensch Screen, Model VMR Multi-Rake Screen, or Model ESR Stair Screen, and can be fed by a conveyor or sluice trough. The discharge pipe can be fitted with a bagging assembly, or feed directly into a receiving container.

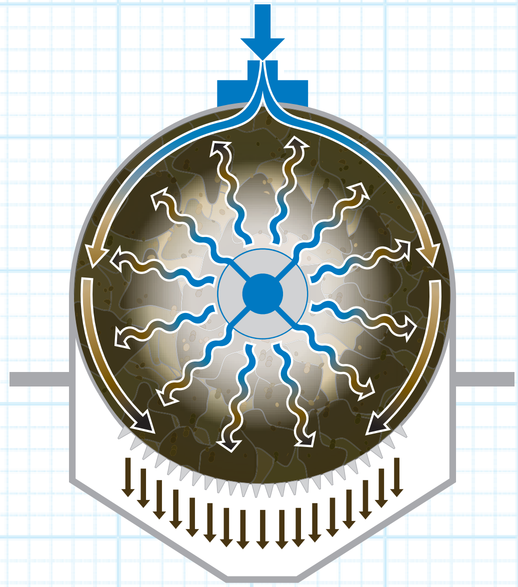


Note the substantial construction of the shafted spiral. A nylon brush is affixed to the trailing edge of the spiral to ensure the drain is clean, even when greasy material is present. Beneath the spiral you can see the wedgewire drain. The profiled bars (See section A-A on the diagram, right page) used in the drain construction allow for greater flow and prevent blinding.
The spiral is cantilevered off the thrust bearing and does not rest in the housing. This reduces wear on the nylon brush and the press body by eliminating metal-to-metal contact.

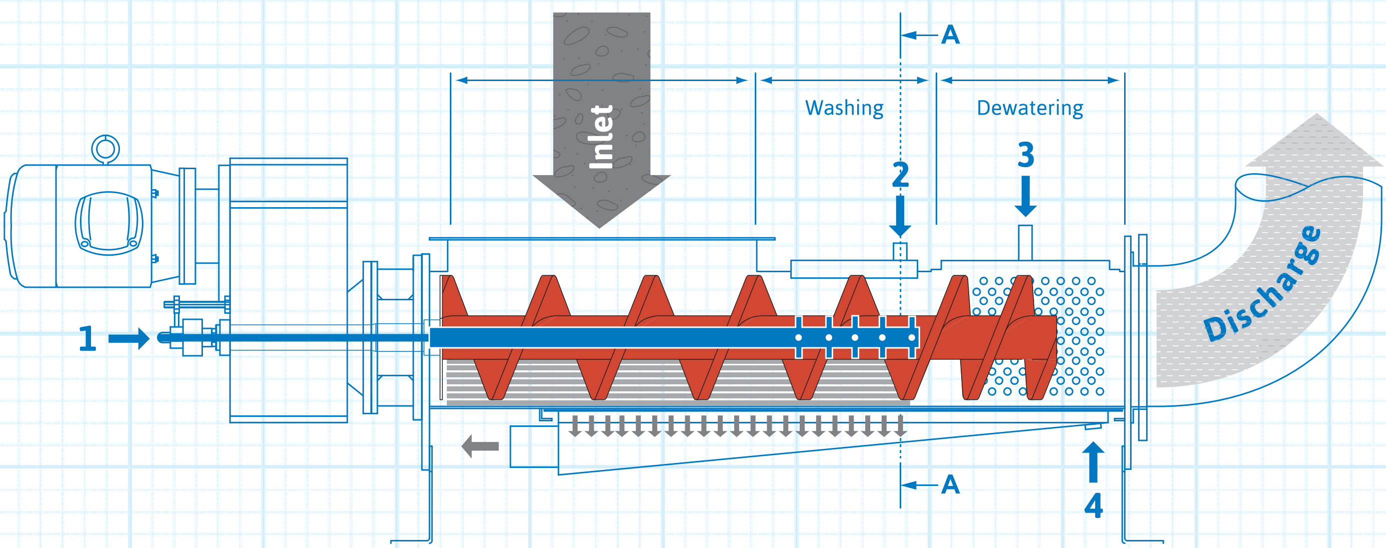
Operation

The Washing Press receives the screenings from a primary screening device, sluice trough, or conveyor through the inlet hopper. The spiral transports the screenings from the inlet to the washing zone where they are compacted and washed. In the washing zone, washwater is injected into the screenings from the openings in the hollow shaft of the spiral, and from a nozzle at the top of the unit.

To maximize washing, after the press compacts the screenings the spiral reverses, pulling apart the compacted screenings. The cycle is repeated a minimum of four times, recompacting the screenings and squeezing out excess washwater and organics. The repetition helps the press achieve up to 90% organic removal from the screenings. As the screenings move into the dewatering zone, the pitch of the spiral decreases, further compacting the screenings for maximum water extraction prior to entering the discharge pipe. From inlet hopper to discharge, the screenings volume is reduced from 70% up to 85%.



▲ Section A-A through the washing zone.



▲ Sequence of Valve Operations

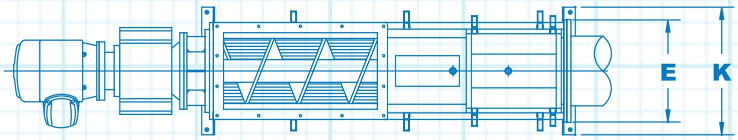
1 Injects washwater into the washing zone through the hollow shaft spiral.

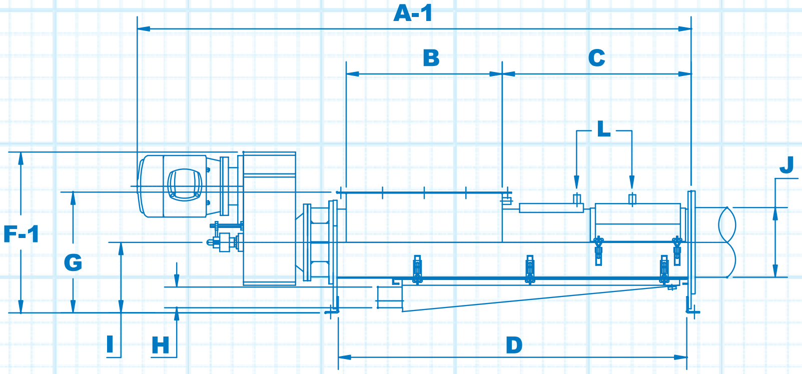
2 Injects washwater into the top of the washing zone.

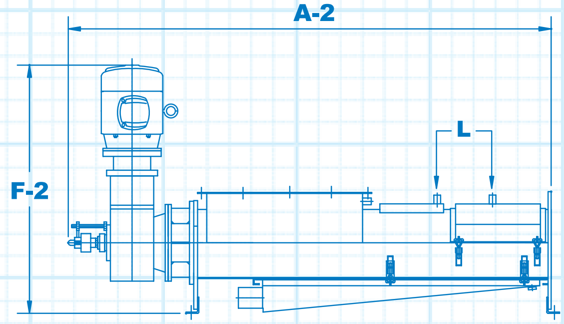
3 Flushes dewatering zone.

4 Flushes drain pan.

Model EWP Washing Press







▲ Parallel Drive Configuration ▲ Right Angle Drive Configuration

Type	A-1	A-2	B	C	D	E	F-1	F-2	G	H	I	J	K	L	MOTOR
EWP 250/600	86″	75″	24″x10″	29″	57″	16″	24″	40″	19″	3″	12″	10″ø	20″	1/2″	5 HP
EWP 250/800	94″	83″	32″x10″	29″	65″	16″	24″	40″	19″	3″	12″	10″ø	20″	1/2″	5 HP
EWP 250/1000	101″	91″	40″x10″	29″	73″	16″	24″	40″	19″	3″	12″	10″ø	20″	1/2″	5 HP
EWP 250/1200	109″	97″	48″x10″	29″	81″	16″	24″	40″	19″	3″	12″	10″ø	20″	1/2″	5 HP
EWP 250/1600	125″	113″	63″x10″	29″	92″	16″	24″	40″	19″	3″	12″	10″ø	20″	1/2″	5 HP
EWP 250/2000	141″	128″	78″x10″	29″	107″	16″	24″	40″	19″	3″	12″	10″ø	20″	1/2″	5 HP
EWP 300/600	98″	85″	24″x12″	34″	58″	19″	30″	50″	22″	4″	13″	12″ø	21″	3/4″	7.5 HP
EWP 300/800	106″	93″	32″x12″	34″	65″	19″	30″	50″	22″	4″	13″	12″ø	21″	3/4″	7.5 HP
EWP 300/1000	113″	100″	40″x12″	34″	73″	19″	30″	50″	22″	4″	13″	12″ø	21″	3/4″	7.5 HP
EWP 300/1200	122″	108″	48″x12″	34″	81″	19″	30″	50″	22″	4″	13″	12″ø	21″	3/4″	7.5 HP
EWP 300/1600	137″	124″	63″x12″	34″	96″	19″	30″	50″	22″	4″	13″	12″ø	21″	3/4″	7.5 HP
EWP 400/600	117″	98″	24″x16″	42″	70″	23.5″	39″	62″	27.5″	4″	14.5″	16″ø	26″	3/4″	10 HP
EWP 400/800	125″	106″	32″x16″	42″	78″	23.5″	39″	62″	27.5″	4″	14.5″	16″ø	26″	3/4″	10 HP
EWP 400/1000	132″	114″	40″x16″	42″	86″	23.5″	39″	62″	27.5″	4″	14.5″	16″ø	26″	3/4″	10 HP
EWP 400/1200	141″	122″	48″x16″	42″	94″	23.5″	39″	62″	27.5″	4″	14.5″	16″ø	26″	3/4″	10 HP

▼ Input Capacity of Raw Screenings

Type	Continuous Mode	Batch Mode
EWP 250	Up to 99 ft^3/hr	Up to 33 ft^3/hr
EWP 300	Up to 159 ft^3/hr	Up to 53 ft^3/hr
EWP 400	Up to 247 ft^3/hr	Up to 82 ft^3/hr

▼ Wash Water Requirements

Type	Requirements
EWP 250	19 gpm at 35 psi minimum – 60 psi maximum
EWP 300	27 gpm at 35 psi minimum – 60 psi maximum
EWP 400	27 gpm at 35 psi minimum – 60 psi maximum

Find more product information at:

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Vulcan THE PROVEN SCREEN CHOICE

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE

PROJECT NO.: 12883B

PRELIMINARY DESIGN PACKAGE

System/Subject:	GRIT REMOVAL SYSTEM		
Calculations By:	MICHAEL CURRY	Date:	8/3/2015
Checked By:	ED LEONARD	Date:	7/20/2015
Revised By:	MICHAEL CURRY	Date:	9/17/2015
Checked By:	ANDY MORRILL	Date:	8/28/2015

Checklist (to be completed by Design Engineer prior to calculation checking):

X Brief Process Description

X Graphs/Sketches of System Attached (Plans & Schematics)

X Design Calculations Attached

X Design Guidelines/Standards Noted

\- Equations Noted and Referenced

X Electrical Loads Developed and Identified

X Process Control Description Developed

X Preliminary Basis of Design (Support Divisions) Attached

X Construction Sequence Developed

X Product Information Attached

\- Manufacturer's Review of Specs and Drawings (If Applicable)

X Electronic File Location Noted

\- Program(s) Used (Version) Noted

X Coordinated with Hydraulic Profile (If Applicable)

DESCRIPTION OF EXISTING FACILITIES

Grit removal at the Wastewater Treatment Facility (WWTF) consists of an aerated grit chamber (22,200-gallons). The grit chamber is aerated by a series of coarse bubble diffusers and fed from two positive displacement blowers. A screw conveyor collects settled grit and conveys it to a sump where it is picked up by the elevator chain and bucket system and deposited into a roll-off container for disposal. Per NHDES/TR-16 regulations, the existing aerated grit chamber geometry is not ideal to prevent short circuiting or to enhance grit removal.

FACILITY PLAN RECOMMENDATIONS

The existing aerated grit chamber does not conform to current design standards and all of the grit removal system equipment has reached the end of its' useful life. Furthermore, the current elevation of the grit removal system is too low to be incorporated within the new hydraulic profile without additional pumping of the influent. Based on the alternatives analysis completed in the Facilities Plan (Wright-Pierce, March 2015), new grit facilities were recommended to be constructed in a new Headworks Building at the WWTF. To allow for proper sizing under average and peak flow conditions, two vortex grit removal systems were recommended. The system would include two grit pumps and two grit classifiers/washers.

CLIENT PREFERENCES

No client preferences have been identified at this time.

DESIGN GUIDELINES (TR-16, NHDES Env-Wq)

<u>TR-16 – Section 5.1.2 (Grit Removal)</u>

- Section 5.1.2.2.1: Grit systems shall provide removal of 95% of particles with a specific gravity of 2.65 that pass through a 65 or larger screen mesh.
- Section 5.1.2.5: For grit pumping applications, recessed impeller style pumps are recommended along with rubber pinch-type check valves. The length of the grit pump suction piping should be minimized and flooded suction pumps should be used whenever possible. Pipe cleanouts and removable couplings should be placed at bends to readily clear blockages. Maintain a pipe velocity of 3-6 ft/second to keep grit moving. Discharge piping should be at least 4-inches in diameter.

- Section 5.1.2.6: For grit pumping applications, recessed impeller style pumps are recommended along with rubber pinch-type check valves. The length of the grit pump suction piping should be minimized and flooded suction pumps should be used whenever possible. Pipe cleanouts and removable couplings should be placed at bends to readily clear blockages.

Env-Wq – Section 709.03 (Grit Removal Facilities)

- Grit removal facilities shall be provided for all WWTFs for protection of downstream processes and equipment;
- The WWTF shall include grit washing and dewatering facilities as necessary;
- Where a single mechanically-operated grit removal device is used, auxiliary manually-operated grit removal equipment shall be provided.

REVIEW OF DESIGN CONSIDERATION & ALTERNATIVES

As part of the Facilities Plan (March 2015, Wright-Pierce), two grit removal technologies were considered: aerated grit removal and vortex grit removal. Design considerations included: treatment capability, effect on downstream processes, and cost.

Aerated Grit Removal

A properly sized aerated grit system is generally more effective than vortex grit removal over a wide range of flows. However, aerated grit technology contributes dissolved oxygen to the secondary influent, which in turn can adversely affect the performance of nutrient removal process. Requirements for the aerated grit system include an aeration chamber (30’x 10’ x 9’), blowers, diffusers, and a grit screw. Aerated grit systems are accompanied by higher operations costs based on aeration requirements.

Vortex Grit Removal

Vortex grit removal is a well-established technology that uses centrifugal forces to separate the grit from the wastewater flow. Vortex units are capable of maintaining grit removal rates across a moderate range of flows (10:1 turndown ratio). Outside of this flow range, grit capture rates may be reduced and grit organic content may be increased. Without the use of aeration, the vortex grit system will not contribute unwanted dissolved oxygen to the secondary influent.

Requirements for the vortex grit removal system include a grit structure (12’ x 12’ x 10’) and a paddle drive assembly. The system benefits from a lower operations cost of a fractional horsepower paddle drive compared to aeration blowers.

A Life Cycle Cost comparison of each grit removal technology indicates that the Vortex Grit System has the lowest cost impact (Attachment A).

BASIS OF DESIGN

A vortex grit removal system was chosen as the basis for design due to downstream operational advantages and overall lower life cycle cost (Attachment A). A single vortex grit unit was found to have the flexibility to capture grit across the projected flow range (1.10 – 12.2 MGD). To mitigate the concerns of increased organic grit content at low flows, a grit washing unit will be installed to help further clean and process grit.

BASIS OF DESIGN

GRIT REMOVAL SYSTEM	
Application:	Screened, influent wastewater
System Type (Quantity):	Mechanically Induced Vortex Grit Unit (1 Unit)
Diameter:	12’-0”
Depth:	13’ – 4”
Design Flows:	
Minimum Month (2018)	1.10 MGD
Peak Instantaneous (2040)	12.5 MGD
Grit Removal Rate	95% of grit > 50 mesh
Equipment:	Grit Paddle Wheel
Acceptable Manufacturers:	Smith and Loveless, Jones and Attwood (Ovivo), or equal

GRIT PUMPING	
Application:	Concentrated Grit Slurry
Pump Type (Quantity):	Centrifugal Recessed Impeller (2 Pumps)
Design Criteria:	250-gpm @ 28 ft TDH

GRIT WASHER	
Application:	Concentrated Grit Slurry
System Type (Quantity):	Grit Washing Tank with Grit Screw (1 Ea.)
Design Criteria:	250-gpm
Organics Removal	> 95%
Dry Solids Output	> 90%

Acceptable Grit Removal System manufacturers include:

- Smith and Loveless
- Jones and Attwood (Ovivo)
- Or equal

Acceptable Grit Pump manufacturers include:

- WEMCO
- Egger
- Or equal

Acceptable Grit Washer manufacturers include:

- Huber
- Lakeside
- Or equal

BUILDING / STRUCTURE DESCRIPTION

The Grit Removal System will be located in the new Headworks Building. Flow will enter the vortex grit system after passing through a mechanical fine screen located within the Building. The grit system will be located in a below-grade concrete chamber with an axial flow propeller (grit paddle). Grit which settles in the chamber will be removed by one of two grit pumps located in the ground floor of the Headworks Building. Grit will be pumped from the grit chamber to a common grit washer located on the first floor. The grit washer shall discharge processed grit to a grit cart or roll-off container.

Structural information:

GRIT CHAMBER	
Upper Chamber	12'-0" diameter
Lower Chamber	6'-8" diameter
Total Height	13'-4"
Total Grit Chamber Assembly	1,960 lbs.

GRIT WASHER	
Length	15'-6"
Width	7'-10"
Total Height	10'-0"
Grit Discharge Height	8'-1"
Grit Washer	
Unloaded (dry weight)	2,360 lbs.
Loaded (with grit slutty)	15,900 lbs. (est.)

PROCESS CONTROL DESCRIPTION

All grit equipment (grit paddle wheel, grit pumps, grit washer) and controls will be located within the new Headworks Building. Manufacturer supplied local control stations will be provided near each piece of equipment and shall include a Hand-Off-Remote switch and an ESTOP pushbutton. The grit system will operate on either a manual or automatic cycle regulated by a programmable logic controller (PLC) based system. The grit paddle wheel separates the grit from the wastewater and deposits the material into a grit hopper. A grit pump then transfers the material to a grit washer where the grit is dewatered, washed and deposited in a cart for storage. The grit paddle wheel will operate continuously. Once the grit system has been activated, the

LEAD grit pump will activate for an adjustable length of time and pump accumulated grit from the grit hopper to the grit washer.

Equipment located within the Headworks Building first floor Grit/Screening Room shall be rated Class 1 Division 1 Group D. The Electrical Room on the first floor shall be unclassified. Equipment located in the lower level Container Room shall be rated Class I, Division I, Group D. The Grit Pump Room and the Storage Room in the lower level shall be unclassified.

The following instruments and panels are anticipated:

ITEM	**LOCAL/REMOTE**	**NEMA**	**BY DIVISION**
Control Valve	Local	7	11-OEM
Float Switch (High Level)	Local	7	13
Local Control Stations	Local	4X, or 7 (location dependent)	11-OEM
Control Panel	Remote (Electrical Room)	1/12	13

Electrical information:

GRIT WHEEL PADDLE	
Power	1.5 HP
Speed	Constant
Enclosure	TEFC, Class 1, Div 1
Volts, Phase/ Hz	460/ 3/ 60

GRIT PUMPS	
Power (each)	10 HP
Speed	Variable
Enclosure	TEFC, Unclassified
Volts, Phase/ Hz	460/ 3/ 60

GRIT WASHER	
Power	0.75 HP (Mixer) 1.5 HP (10-inch Screw)
Speed	Constant
Enclosure	TEFC, Class 1, Div 1
Volts, Phase/ Hz	460/ 3/ 60

X Coordinated with NFPA 820

X Coordinated with Equipment List

CONSTRUCTION SEQUENCING

The Grit Removal system will be constructed with the new Headworks Building. Flow to the new Headworks Building is dependent upon installation of the new Main Pump Station force main. Temporary bypass pumping is not anticipated.

FUTURE EXPANSION CONSIDERATIONS

The Grit Removal System will be designed to handle future peak instantaneous flows including potential future flows from Stratham and Newfields (see Preliminary Design Report for specific flow rates).

FILE LOCATION

J:\ENG\NH\Exeter\12883-WWTF\12883B-WW Design\Technical\Process\Design Memos

ATTACHMENTS

- A Grit System Cost Analysis
- B Grit Pump Calculations
- C Equipment Cut Sheets

TOWN OF EXETER
WWTF UPGRADE - GRIT SYSTEM
JUNE 2015
PDR LEVEL - LIFE CYCLE COST COMPARISON

DESCRIPTION	Qty.	Units	Materials or Material and Labor Unit Cost	Materials or Material and Labor Total Cost	Labor Install %	Labor Total Install	Subtotal
VORTEX GRIT SYSTEM							
CIVIL							
EXCAVATION FOR VORTEX GRIT CHAMBER	100	CY	$100	$10,000	0%	$0	$10,000
STRUCTURAL							
BASE SLAB - VORTEX GRIT	2	CY	$750	$1,500	0%	$0	$1,500
EXTERIOR WALL CONCRETE - VORTEX GRIT:	25	CY	$1,000	$25,000	0%	$0	$25,000
MISC. EXTERIOR CHANNELS (25% of Concrete)	7	CY	$750	$5,250	0%	$0	$5,250
TOP SLAB - VORTEX GRIT	15	CY	$1,250	$12,500	0%	$0	$12,500
HATCH	1	LS	$5,000	$5,000	10%	$500	$5,500
ALUMINUM PLATING	1	LS	$5,000	$5,000	10%	$500	$5,500
PROCESS							
VORTEX GRIT REMOVAL SYSTEM	1	EA	$175,000	$175,000	20%	$35,000	$210,000
GRIT PUMP	2	EA	$15,000	$30,000	20%	$6,000	$36,000
GRIT WASHER	1	EA	$105,000	$105,000	20%	$21,000	$126,000
PLANT WATER ASSEMBLY	1	EA	$5,000	$5,000	20%	$1,000	$6,000
INSTRUMENTATION							
	1	EA	$10,000	$10,000	20%	$2,000	$12,000
						ESTIMATED CAPITAL COST	**$455,250**

*Common items to Aerated grit not included

ANNUAL ELECTRICITY COSTS	PADDLE DRIVE	GRIT PUMP	GRIT WASHER
Total Connected Operating Horsepower (HP)	**1.5**	**5.0**	**3.0**
% of Connected HP as Operating HP	75%	75%	75%
Operating HP	1	4	4
KW/HP	0.746	0.746	0.746
Hours Operating/day	24	4	4
Hours of Operation/year	8760	1460	1460
Total KWH/Yr	7,352	4,084	4,357
Electricity Cost ($/KWH)	$0.13	$0.13	$0.13
Annual Energy Cost	$956	$531	$566

ANNUAL ELECTRICITY COST **$2,053**

PRESENT WORTH	
Capital (Construction Cost)	$460,000
Interest Rate	3.0%
Annual Electricity (year 1)	$2,053
Period (years)	20
Present Worth of O&M costs	$31,000
Total Present Worth	**$491,000**

TOWN OF EXETER
WWTF UPGRADE - GRIT SYSTEM
JUNE 2015
PDR LEVEL - LIFE CYCLE COST COMPARISON

DESCRIPTION	Qty.	Units	Materials or Material and Labor: Unit Cost	Materials or Material and Labor: Total Cost	Labor: Install %	Labor: Total Install	Subtotal
AERATED GRIT SYSTEM							
CIVIL							
EXCAVATION FOR AERATED GRIT CHAMBER	330	CY	$100	$33,000	0%	$0	$33,000
STRUCTURAL							
BASE SLAB - AERATED GRIT	29	CY	$750	$21,750	0%	$0	$21,750
EXTERIOR WALL CONCRETE - VORTEX GRIT:	48	CY	$1,000	$48,000	0%	$0	$48,000
MISC. EXTERIOR CHANNELS (10% of Concrete)	10	CY	$750	$7,500	0%	$0	$7,500
ALUMINUM GRATING OVER CHANNELS	1	LS	$10,000	$10,000	10%	$1,000	$11,000
PROCESS							
GRIT CHAMBER AERATION BLOWERS	2	EA	$12,000	$24,000	20%	$4,800	$28,800
GRIT CHAMBER AERATION DIFFUSERS	1	EA	$7,500	$7,500	20%	$1,500	$9,000
GRIT SCREW	1	EA	$75,000	$75,000	20%	$15,000	$90,000
MISC AIR PIPING	1	EA	$10,000	$10,000	20%	$2,000	$12,000
GRIT PUMP	2	EA	$15,000	$30,000	20%	$6,000	$36,000
GRIT WASHER	1	EA	$105,000	$105,000	20%	$21,000	$126,000
PLANT WATER ASSEMBLY	1	EA	$5,000	$5,000	20%	$1,000	$6,000
INSTRUMENTATION							
	1	EA	$15,000	$15,000	20%	$3,000	$18,000
						ESTIMATED CAPITAL COST	**$447,050**

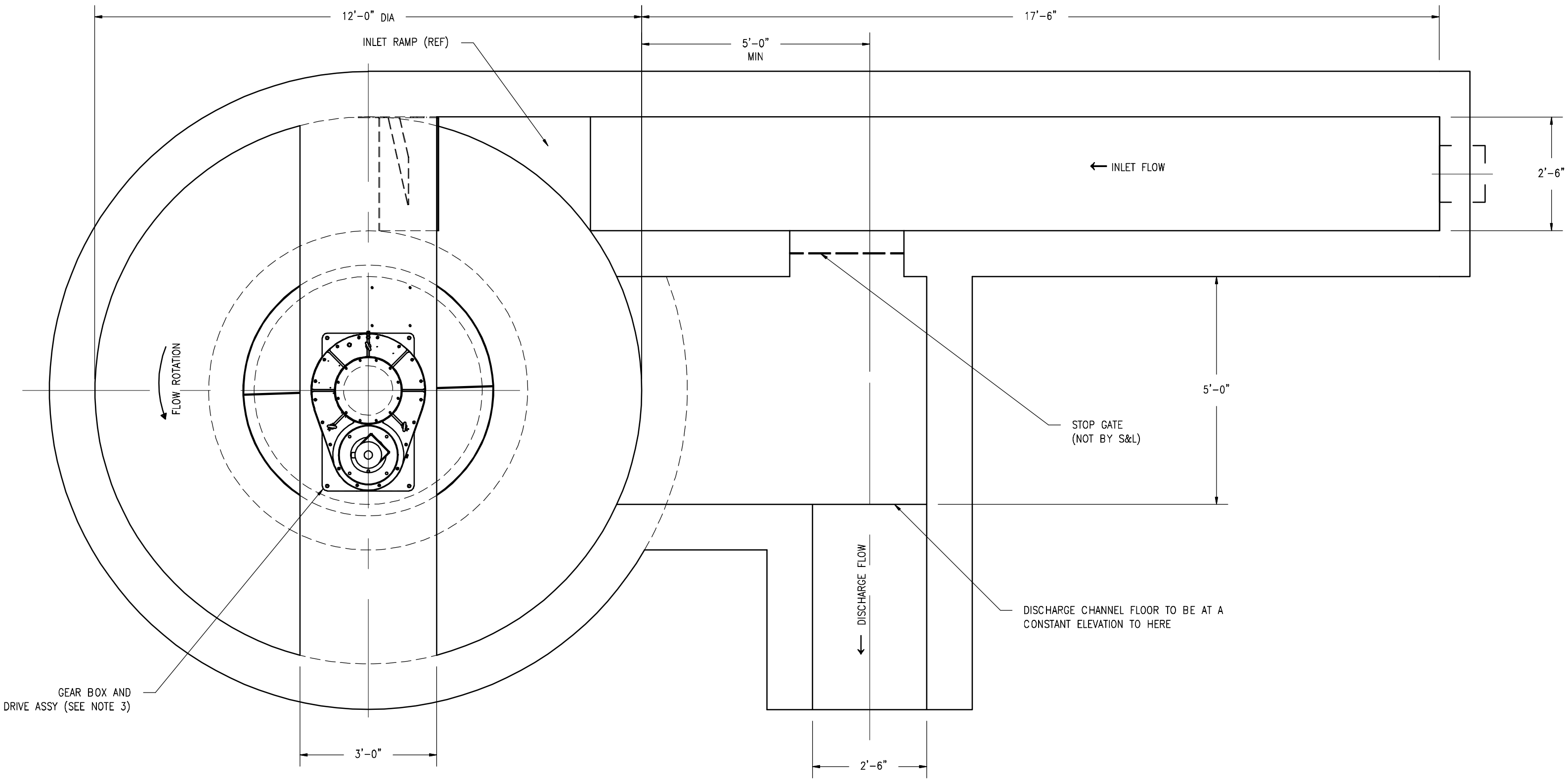
*Common items to Vortex grit not included

ANNUAL ELECTRICITY COSTS	BLOWERS	GRIT PUMP	GRIT SCREW	GRIT WASHER
Total Connected Operating Horsepower (HP)	**5.0**	**5.0**	**3.0**	**3.0**
% of Connected HP as Operating HP	75%	75%	50%	75%
Operating HP	4	4	4	4
KW/HP	0.746	0.746	0.746	0.746
Hours Operating/day	24	4	4	4
Hours of Operation/year	8760	1460	1460	1460
Total KWH/Yr	24,506	4,084	4,357	4,357
Electricity Cost ($/KWH)	$0.13	$0.13	$0.13	$0.13
Annual Energy Cost	$3,186	$531	$566	$566

ANNUAL ELECTRICITY COST **$4,849**

PRESENT WORTH	
Capital (Construction Cost)	$450,000
Interest Rate	3.0%
Annual Electricity (year 1)	$4,849
Period (years)	20
Present Worth of O&M costs	$73,000
Total Present Worth	**$523,000**

Does not include costs associated with larger anoxic zone/mixing capacity to account for imparted oxygen



EQUIPMENT WT:

PADDLE DRIVE MOTOR	70 LBS
GEAR REDUCER	130 LBS
TURNTABLE BEARING/GEAR CASE	1000 LBS
AIR BELL	40 LBS
DRIVE TUBE	480 LBS
PROPELLER	60 LBS
2-PIECE FLOOR PLATE	90 LBS

NOTES:

1. CONCRETE, REINFORCING AND GRATING OR HANDRAILS (IF REQUIRED) NOT BY S&L.
2. SEE NOTES ON DESIGN FOR HYDRAULIC REQUIREMENTS.
3. SEE SHEET 2 FOR SECTIONAL ELEVATION.
4. SEE ENGINEERING ORDER FOR PROJECT SPECIFIC REQUIREMENTS.
5. COPYRIGHT (C) 2015 SMITH & LOVELESS, INC.

SHEET 1 OF 2

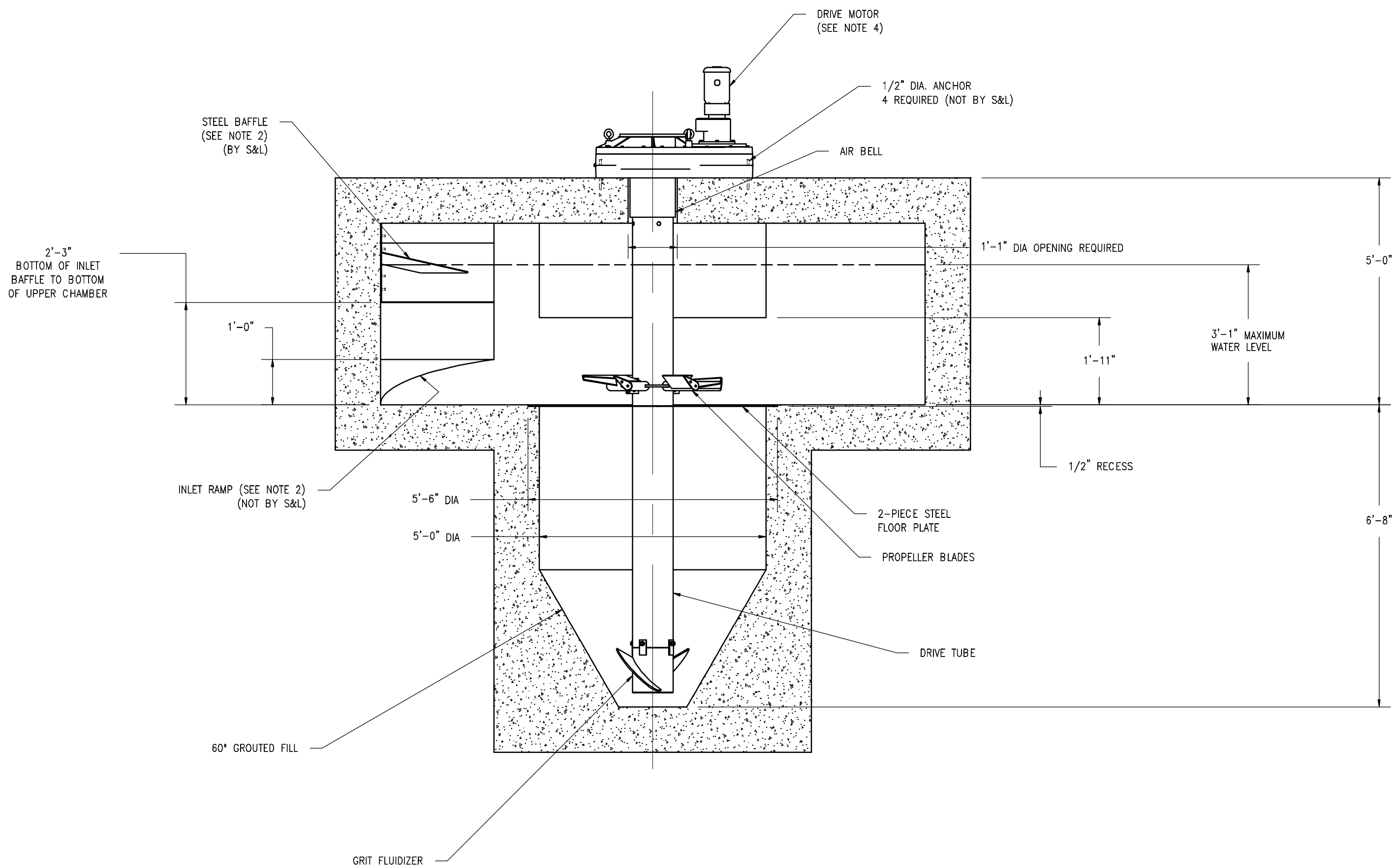
LET	ECN NO	DATE	BY APPV'D			
				DRAWN BY: BMJ	DATE: 02/17/2015	ALLOWABLE TOLERANCES
				CHECKED BY: ACM	DATE: 02/17/2015	FRACTIONS ±1/16"
				APPROVED BY: ACM	DATE: 02/17/2015	DECIMALS ~
				SCALE: NTS	CODE:	ANGLES ±0°-30'
ORIGINAL ISSUE				© Smith & Loveless, Inc. 2015		

FOR EDSON, CAN

PISTA® GRIT REMOVAL SYSTEM 270
CCW MODEL 12.0

SIZE	U/M EA	WT.
FILE NAME C22102-03-001.dwg		PLOT SCALE 1:1
SERIAL NO INQ22102	DWG NO C22102-03-001	REV

Smith & Loveless, Inc.



ELEVATION VIEW

LET	ECN NO	DATE	BY APPV'D	DRAWN BY: BMJ	DATE: 02/17/2015	ALLOWABLE TOLERANCES	FOR EDSON, CAN
				CHECKED BY: ACM	DATE: 02/17/2015	FRACTIONS ±1/16"	PISTA® GRIT REMOVAL SYSTEM 270 CCW MODEL 12.0
				APPROVED BY: ACM	DATE: 02/17/2015	DECIMALS ~	SIZE / U/M EA / WT.
				SCALE: NTS	CODE:	ANGLES ±0°-30'	FILE NAME C22102-03-001.dwg / PLOT SCALE 1:1
ORIGINAL ISSUE				© Smith & Loveless, Inc. 2015			SERIAL NO INQ22102 / DWG NO C22102-03-001 / REV

Smith & Loveless, Inc.

BUDGET PROPOSAL

Project Name: Exeter, NH

Equipment: RoSF4 size 2

Date: July 17, 2015

Huber Contact:
Northeast Regional Sales Manager : Frank Scriver
Email Address: frank@hhusa.net
Phone Number: (980) 219-1861 (Frank)

Represented By:
Representative Firm: Walker Wellington
Representative Associate: Rich Russell
Email Address: rich@walkerwellington.com
Phone Number: (603)498-6409

Huber Technology, Inc.
9735 NorthCross Center Court
Suite A
Huntersville, NC 28078

Phone: (704) 949-1010
Fax: (704) 949-1020

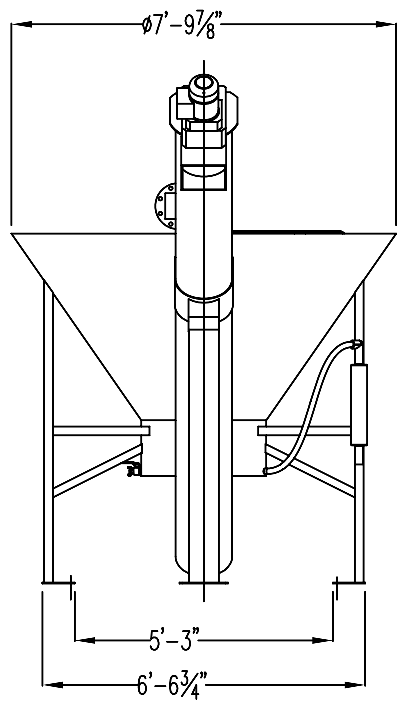
DESCRIPTION
COANDA® Grit Washer Unit Model: RoSF4 Size: ***2*** Quantity: ***1***
Design Information: • Pump Feed Rate: ***250*** GPM • 95% minimum capture of 200 microns and larger grit • 5% maximum volatile content in washed grit • 15% maximum water content is washed grit product

Including:
• 304 Stainless Steel Construction
• Grit washing tank fully-enclosed with perforated plate bottom to generate a fluidized bed in the tank.
• Coanda® tulip chamber with inspection hatch, and mixer; 8" (200mm) diameter inlet; 10" (250 mm) diameter outlet; 3" (76 mm) diameter drain
• 4" (100 mm) diameter organics outlet and 1.5" (38 mm) diameter pressure probe connection, including pressure probe
• Grit discharge screw transport tube with shafted grit screw conveyor angled at 30°; grit discharge chute to be angled at a minimum of 45° from horizontal
• Grit screw conveyor motor, 1.5 hp, 480 VAC, 3 phase, 60 Hz, S.F. 1.15, Class 1 Division 1 motor
• Mixer motor, 0.75 HP, 480 VAC, 3 phase, 60 Hz, S.F. 1.15, Class Class 1 Division 1
• Electrical Control Panel:
    o Allen Bradley MicroLogix PLC
    o Allen Bradley C400 HMI
    o Panel Rating: NEMA 4X
• One NEMA 7 Local Control System for each unit
• Standard manufacturer's services have been included. Additional manufacturer's services are available on a per diem rate upon request

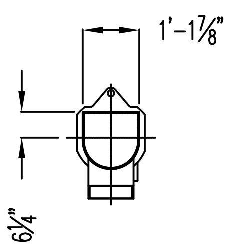
Budgetary Price: $115,000.00 each

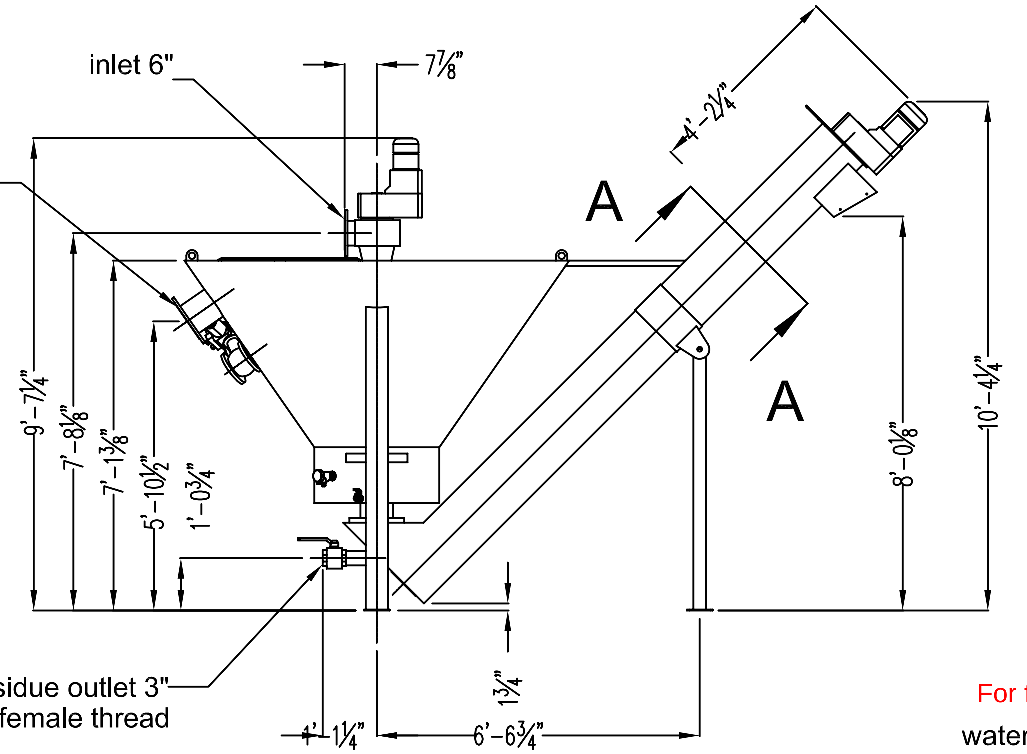
Notes

1. Equipment specification is available upon request
2. If there are site-specific hydraulic constrains that must be applied, please consult the manufacturer's representative to ensure compatibility with the proposed system
3. Electrical disconnects required per local NEC code are not included in this proposal
4. Huber Technology warrants all components of the system against faulty workmanship and materials for a period of 12 months from date of start-up or 18 months after shipment which ever occurs first
5. Budget estimate is based on Huber Technology's standard Terms & Conditions and is quoted in **USD** unless otherwise stated
6. Huber has estimated the Control Panel cost based information provided with the RFQ. If control panel information is not provided with RFQ Huber will use a cost and scope of supply based on our standard panel. Huber reserves the right to change the price and scope at time of bid based on the final plans and specifications.

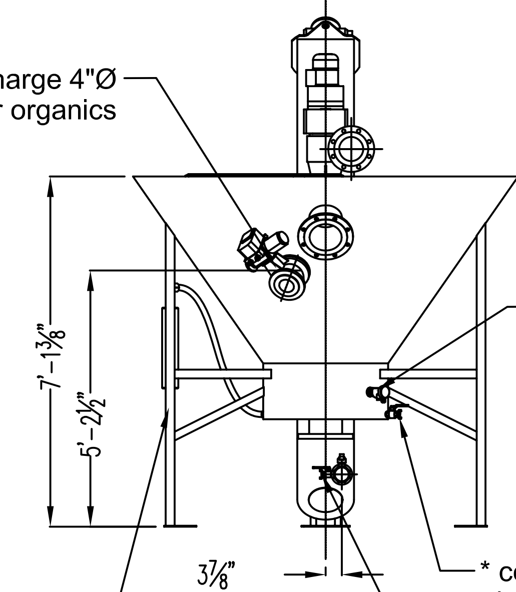


A-A





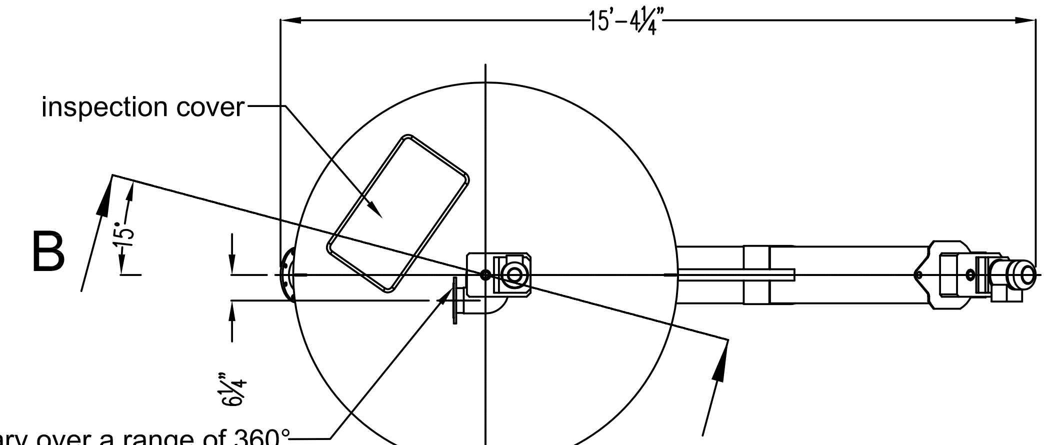
3inch drain to drain the tank and the auger.



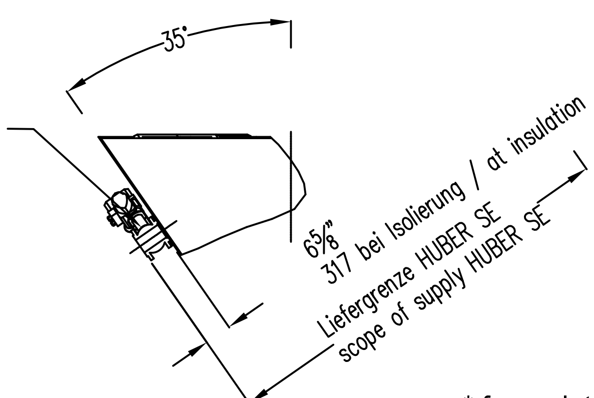
For flushing the tank.

For flushing the bottom of the auger.

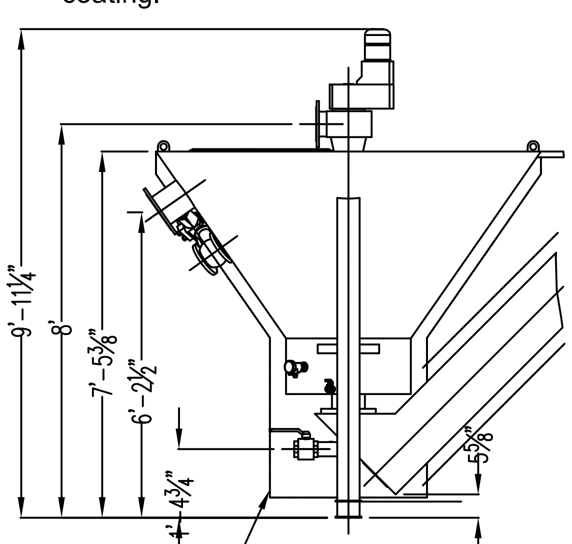
B-B



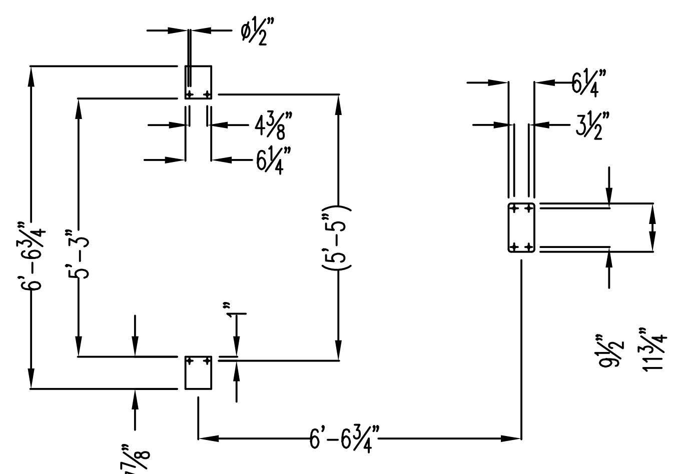
discharge 4"Ø
NOTE:
Due to concentration of organics, the pipe for organics discharge must be led back in front of mechanical treatment (provide flushing).



NOTE:
if the grit washing plant is heated, the tank legs must be extended by 100 mm due to the trace heating coating.



Bohrbild
drilling points



NOTE:
the inlet to the plant must be supported to the building

* for maintenance only, no pipe connection required

Dimensions are for reference only!

The firm standing of the plant is only guaranteed after dowelling!

HUBER TECHNOLOGY 9735 NorthCross Center Court, Suite A Huntersville, NC 28078 Tel. 704-949-1010 info@huber-technology.com	RoSF4 size 2 Grit Washer		
	Fig No. 1/1	Dimensional Sheet	Scale: 1/4" = 1'-0"
	Project No.	Drawing No. RoSF4 size 2_2010.dwg	

Project:	Exeter WWTF Upgrade Preliminary Design
Job No.	12883B
Date:	9/21/2015
Time:	
Calcs by:	MAC
Checked By:	
File:	
Comments:	Headworks Bldg Lower Level to First Floor
Scenario:	Grit Pumps

NOTE: If using submersible pumps, ignore suction piping.

Suction Piping

Section

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	0

Section

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	0

Section

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	0

Section 1

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve	1	0.77	0.77
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance	1	0.50	0.5
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Wye Branch	2	1.00	2
Tee - Run		0.60	0
		Total	3.27

Discharge Piping

Section

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	0

Section

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	0

Section

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	0

Section 1

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve	1	2.50	2.5
Gate Valve		0.19	0
Plug Valve	1	0.77	0.77
90° Bend	2	0.30	0.6
45° Bend	2	0.20	0.4
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit	1	1.00	1
Sudden	1	0.40	0.4
Reducer		0.25	0
Tee - Side		1.80	0
Wye Branch	2	1.00	2
Tee - Run		0.60	0
		Total	7.67

Project:	Exeter WWTF Upgrade Preliminary Design
Job No.	12883B
Date:	21-Sep-15
Time:	12:00 AM
Calcs by:	MAC
Checked By:	
File:	
Comments:	Headworks Bldg Lower Level to First Floor
Scenario:	Grit Pumps

Low C-Value	110	
High C-Value	150	
Low Suction	31	feet
High Suction	33	feet
Low Discharge	42	feet
High Discharge	42	feet
Pump Centerline	23	feet
Flow Increment	50	gpm

Note: If elevations are not based on USGS datum, correct elevations so that EL 0.00 is sea level

Approximate elevations. To confirm once layout has been finalized

Maximum Static Head	11	feet
Minimum Static Head	9	feet
Atmospheric Pressure	34.0	feet
Percent Solids	3	%

Maximum 12% Solids

Suction Piping
Section Number
Number of Pumps Operating:

SINGLE PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. HI (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)
0	0		0.0		0	1	0.0		150	0.0	0.0	110	0.0	0.0
50	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
100	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
150	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
200	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
250	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
300	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
350	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
400	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
450	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
500	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0

Suction Piping
Section Number
Number of Pumps Operating:

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. HI (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)
0	0		0.0		0	1	0.0		150	0.0	0.0	110	0.0	0.0
50	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
100	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
150	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
200	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
250	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
300	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
350	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
400	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
450	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
500	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0

Suction Piping
Section Number
Number of Pumps Operating:

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. HI (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)
0	0		0.0		0	1	0.0		150	0.0	0.0	110	0.0	0.0
50	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
100	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
150	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
200	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
250	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
300	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
350	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
400	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
450	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
500	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0

Suction Piping

Section Number: 1

Number of Pumps Operating: 1

										Minimum Curve			Maximum Curve			
1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Static Head (FT)	C -	Hf (FT)	Head Loss (FT)	C -	Hf (FT)	Head Loss (FT)	NPSHa (FT)
0	0	4	0.0	15	3.27	1	0.0		-8.0	150	0.0	-10.0	110	0.0	-8.0	42.0
50	50	4	1.3	15	3.27	3.25	0.3	0	-8.0	150	0.1	-9.7	110	0.1	-7.6	41.5
100	100	4	2.6	15	3.27	2.45	0.8	0	-8.0	150	0.2	-9.0	110	0.4	-6.8	40.8
150	150	4	3.8	15	3.27	2.05	1.5	0	-8.0	150	0.4	-8.1	110	0.7	-5.8	39.8
200	200	4	5.1	15	3.27	1.95	2.6	0	-8.0	150	0.6	-6.8	110	1.1	-4.3	38.3
250	250	4	6.4	15	3.27	1.875	3.9	0	-8.0	150	0.9	-5.2	110	1.6	-2.5	36.5
300	300	4	7.7	15	3.27	1.8	5.4	0	-8.0	150	1.2	-3.4	110	2.1	-0.5	34.5
350	350	4	8.9	15	3.27	1.7	6.9	0	-8.0	150	1.5	-1.6	110	2.7	1.6	32.4
400	400	4	10.2	15	3.27	1.7	9.0	0	-8.0	150	1.9	0.9	110	3.4	4.4	29.5
450	450	4	11.5	15	3.27	1.7	11.4	0	-8.0	150	2.4	3.8	110	4.2	7.6	26.3
500	500	4	12.8	15	3.27	1.7	14.1	0	-8.0	150	2.9	7.0	110	5.2	11.2	22.7

Discharge Piping

Section Number

Number of Pumps Operating:

									Minimum Curve			Maximum Curve		
1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	C -	Hf (FT)	Head Loss (FT)	C -	Hf (FT)	Head Loss (FT)
0	0		0.0		0	1	0.0		150	0.0	0.0	110	0.0	0.0
50	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
100	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
150	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
200	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
250	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
300	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
350	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
400	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
450	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
500	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0

Discharge Piping

Section Number

Number of Pumps Operating:

									Minimum Curve			Maximum Curve		
1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	C -	Hf (FT)	Head Loss (FT)	C -	Hf (FT)	Head Loss (FT)
0	0		0.0		0	1	0.0		150	0.0	0.0	110	0.0	0.0
50	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
100	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
150	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
200	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
250	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
300	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
350	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
400	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
450	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
500	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0

Discharge Piping

Section Number

Number of Pumps Operating:

									Minimum Curve			Maximum Curve		
1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	C -	Hf (FT)	Head Loss (FT)	C -	Hf (FT)	Head Loss (FT)
0	0		0.0		0	1	0.0		150	0.0	0.0	110	0.0	0.0
50	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
100	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
150	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
200	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
250	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
300	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
350	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
400	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
450	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0
500	0	0	0.0	0	0	1	0.0	0	150	0.0	0.0	110	0.0	0.0

Discharge Piping

Section Number	1
Number of Pumps Operating:	1

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Static Head (FT)	Minimum Curve C -	Hf (FT)	Head Loss (FT)	TDH (FT)	Maximum Curve C -	Hf (FT)	Head Loss (FT)	TDH (FT)
0	0	4	0.0	45	7.67	1	0.0		19.0	150	0.0	19.0	9.0	110	0.0	19.0	11.0
50	50	4	1.3	45	7.67	3.25	0.6	0	19.0	150	0.2	19.9	10.2	110	0.4	20.0	12.5
100	100	4	2.6	45	7.67	2.45	1.9	0	19.0	150	0.6	21.5	12.6	110	1.1	22.0	15.2
150	150	4	3.8	45	7.67	2.05	3.6	0	19.0	150	1.1	23.7	15.6	110	2.0	24.6	18.8
200	200	4	5.1	45	7.67	1.95	6.1	0	19.0	150	1.8	26.9	20.1	110	3.3	28.3	24.0
250	250	4	6.4	45	7.67	1.875	9.1	0	19.0	150	2.7	30.8	25.5	110	4.7	32.8	30.3
300	300	4	7.7	45	7.67	1.8	12.6	0	19.0	150	3.6	35.2	31.7	110	6.4	37.9	37.4
350	350	4	8.9	45	7.67	1.7	16.2	0	19.0	150	4.5	39.7	38.1	110	8.0	43.2	44.7
400	400	4	10.2	45	7.67	1.7	21.1	0	19.0	150	5.8	45.9	46.8	110	10.2	50.4	54.8
450	450	4	11.5	45	7.67	1.7	26.7	0	19.0	150	7.2	52.9	56.7	110	12.7	58.5	66.1
500	500	4	12.8	45	7.67	1.7	33.0	0	19.0	150	8.7	60.7	67.7	110	15.5	67.5	78.7

Project: Exeter WWTF Upgrade Preliminary Design
Job No. 12883B
Date: 21-Sep-15
Time: 12:00 AM
Calcs by: MAC
Checked By:
File:
Comments: Headworks Bldg Lower Level to First Floor
Scenario: Grit Pumps

Pump Manufacturer:	Egger Turo Pumps		
Pump Model:	TV 61-80-H6		
Impeller Size:	8.07 inches		
Pump Speed:	1160	Pumps Operating:	1

Design Point		
Flow (gpm)	250	Grit Wasl
Head (ft)	28	ft

Q per Pump	Multiple Pump Q	NPSHa	Minimum System Curve	Maximum System Curve	Pump Curve
0	0	42.0	9.0	11.0	
50	50	41.5	10.2	12.5	32.00
100	100	40.8	12.6	15.2	31.50
150	150	39.8	15.6	18.8	30.00
200	200	38.3	20.1	24.0	29.0
250	250	36.5	25.5	30.3	28.0
300	300	34.5	31.7	37.4	27.0
350	350	32.4	38.1	44.7	
400	400	29.5	46.8	54.8	
450	450	26.3	56.7	66.1	
500	500	22.7	67.7	78.7	

Note: for parallel pumps operating in the last discharge section, the system curve plotted on the chart represents only the fractional flow contributed by a single pump. (i.e. for two pumps operating, the apparent operating point indicates one-half the total flow.)

Minimum System Curve				**Min. Operating Point**	
	Flow	Sys. Head	Pump Head		
High		9	0	GPM	
Low		9	0	TDH	
slope				BEP	
intercept				% BEP	0%

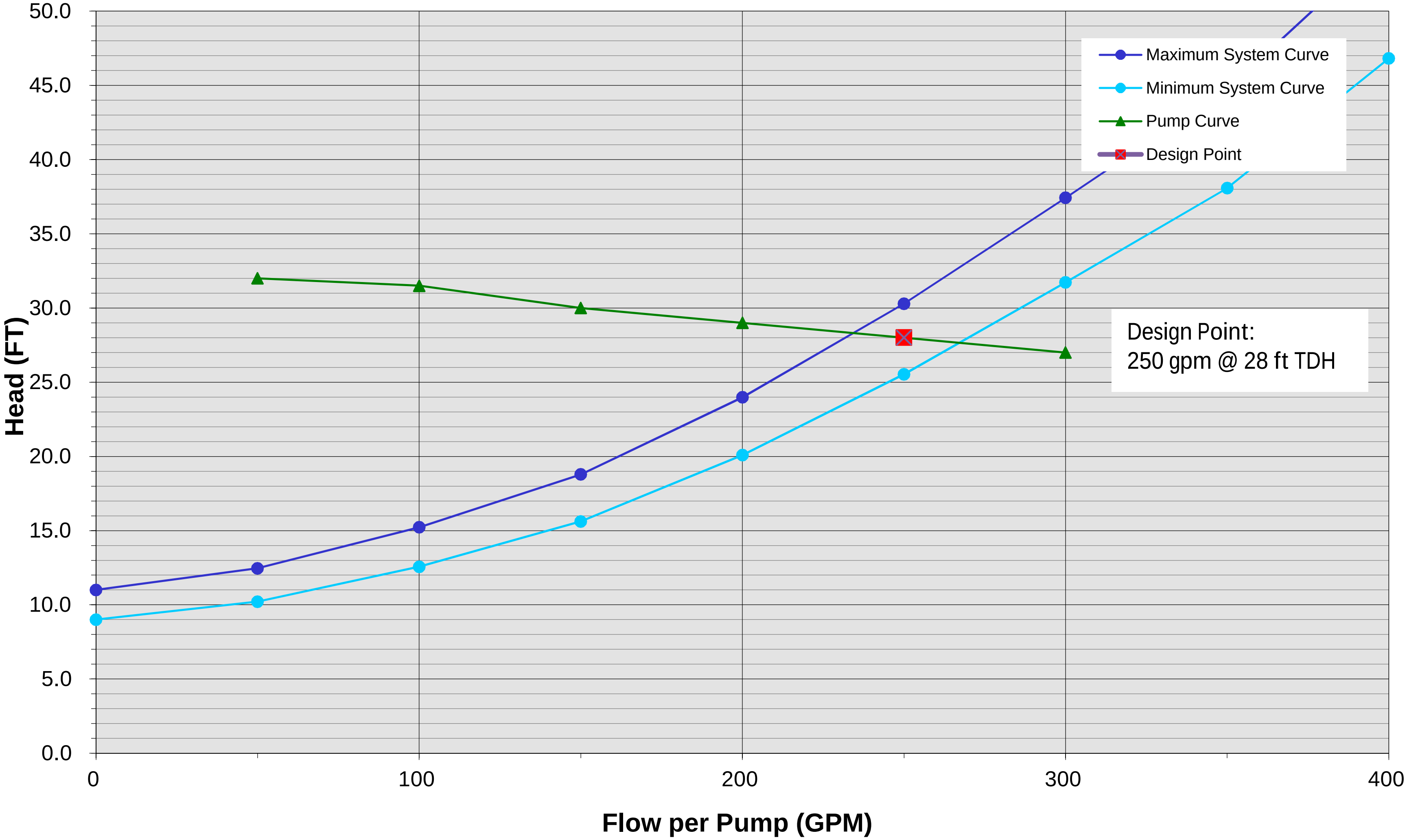
Copy the flow for the system curves at points before and after they cross the pump curve.

Maximum System Curve				**Max. Operating Point**	
	Flow	Sys. Head	Pump Head		
High		11	0	GPM	
Low		11	0	TDH	
slope				BEP	
intercept				% BEP	0%

Operating Range	
Low	0
High	0

Note: Plot the system curve on the manufacturer's pump curve to determine operating points, h.p. requirements, NPSHa requirements, efficiencies, etc.

Exeter WWTF Upgrade Preliminary Design Grit Pumps
1 Pump Operating in Last Discharge Section
Low C-Value = 110, High C-Value = 150



EGGER TURO PUMPS
North America, Inc.
Salt Lake City-UT 84119

Phone : 1.801.972.9591
Fax : 1.801.972.9374
eric@eggerpumps.com

Technical data sheet
TV 61-80 H6 LB 3B

Offer no.:	**15151 Rev A**
Order no.	
Serial no./quantity	2 Piece
Delivery date:	

EGGER

Customer	**Aqua Solutions**	Date / Our ref.:	2015-08-24 -
Person/Dept.		Customer order	
ZIP/City	**Falmout, ME 04105**	Project / Installation	Exeter, NH
		Item no.	

A1	**Duty points**									*Test values referring to*
A2	**Liquid**	**Grit slurry**					Min.	**Nominal**	Max.	Water
A3	Solids	Type			**Capacity**	**US g.p.m.**		**250**		----
A4		Weight %			Suction static geod.	ft				----
A5		Particle Ø	inch		Suction pressure	psi				----
A6	Gas content		Volume %		Discharge static geod.	ft				----
A7	pH-value at Tw				Discharge pressure	psi				----
A8	**Working temp. = Tw**		**°F**		**Differential head**	**ft**		**28**		
A9	**Specific gravity**		**lb/ft³**	**62.315**	NPSH$_A$ (Installation)	ft				----
A10	**Kinematic viscosity at Tw**		**ft²/s**	**1.08E-5**	NPSH$_R$ (Pump)	ft		10.4		
A11	Vapour pressure at Tw		psi	0.319	**Nominal speed**	**rpm**		**1160**		
A12	Freezing point		°F		**Nominal efficiency**	**%**		**48**		
A13	Altitude of installation		ASL ft	< 339037	**Absorbed power**	**hp**		**3.7**		

B1	**PUMP**					
B2	**Pump designation**	**TV 61-80 H6 LB 3B**	Impeller type	Vortex impeller		z = 8
B3	Design	Horizontal, dry installation	**Characteristic curve no.**	020.01.0603-01		
B4	**Arrangement drawing no.**	MT 820.03-0680-04	Max. free Ø passage through pump		inch	3.15
B5	**Sectional drawing no.**	910.00.0000-00	Closed valve head		ft	**33.2**
B6	Additional drawings no.		**Minimum flow**		**US g.p.m.**	32.1
B7	Suction-flange: Nominal diamet./pressure	**4"** 150lbs	**Impeller Ø**	**designed**	inch	**8.07**
B8	Suction-flange: Dimensions	ANSI B16.5		Min. / Max.	7.01	9.33
B9	Suction-flange: Face	DIN 2526 Form D (RF)	Additional absorbed power		hp	
B10	Outlet branch: Nominal diamet./pressure	**3"** 150lbs	**Recommended motor power**		**hp**	**10**
B11	Outlet branch: Dimensions	ANSI B16.5	**Max. casing working pressure**		**psi**	**101**
B12	Outlet branch: Face	DIN 2526 Form D (RF)	Casing test pressure at 20°C		psi	152
B13	**Ex protection acc. Dir. 94/9/EG**	**–**	**Liquid temp. Admissible min. / max. °C**	°F	**-5**	**257**
B14	Bearing / Lubrication		Max. design speed		rpm	1200
B15	PUMP	Ball / roller bearing - oil bath lubrication	Sound pressure level (A) pump/-incl.motor		dB	**85**
B16						
B17						
B18	Motor	Ball / roller bearing - grease lubrication	Direction of rotation seen from drive-end			cw
B19						

C1	**Pump materials**			**Pump dimensions**	
C2		**DIN / EN** *(binding)*		Base plate L x B inch	59.055 x 20.472
C3	Casing	HG 25.3	A532 IIIa		
C4	Casing cover	HG 25.3	A532 IIIa	**Shaft sealing**	
C5	Impeller	HG 25.3	A532 IIIa	**Sectional drawing no.**	981.02.0000-02
C6	Wear disc	without		**Arrangement**	Gland packing
C7	Wear plate	without		Manufacturer p.s./m.s.	Burgmann
C8	Shaft, sealed	CK 45	1040	Type a. size p.s./m.s.	48x68x10x10
C9	Shaft sleeve	GGK-FP, EUT 12496		Material code p.s./m.s.	GORE-GFO
C10	Elastomers	NBR		Barrier liquid/pressure psi	
C11	Coupling guard	Steel, closed		Flushing / Flow rate US g.p.m.	
C12	Base plate	U-profile-steel		Circulation acc. API-plan	
C13	Paint: Specification	Standard R-842-1			
C14	Paint: Colour	**RAL 5015 (blue)**			

D1	**COUPLING**							
D2	Manufacturer / Type	**Rexnord**	**Omega**	Spacer length inch	**6**	bored p.s.	inch	**1**
D3	Specialities			Explosion protection	No	bored m.s.	inch	**2**

F1	**MOTOR**							
F2	Manufacturer / Type	**GE**	**M7546**		Design	IM B3	Frame size	**256T**
F3	Execution				Explosion protection	–	Protection class	IP 55
F4	Rating hp	**10**	Tension V	460	Frequency Hz	60	Speed **rpm**	**1160**
F5	Starting		Nom. current A	16.2				
F6	Specialities				Protection roof		Thermal protection	
G1	Remarks concerning technical data sheet: see next page							

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Performance curves: TV 61-80 H6 LB 3B

EGGER

Offer no.:	15151 Rev A
Order no.	
Serial no./quantity	2Piece
Delivery date:	

Data sheet pos. no 1.1 Page 1 of 1

Customer	Aqua Solutions	Date / Our ref.:	2015-08-24
Person/Dept.		Customer order	
ZIP/City	Falmout, ME 04105	Project / Installation	Exeter, NH
		Item no.	

Impeller

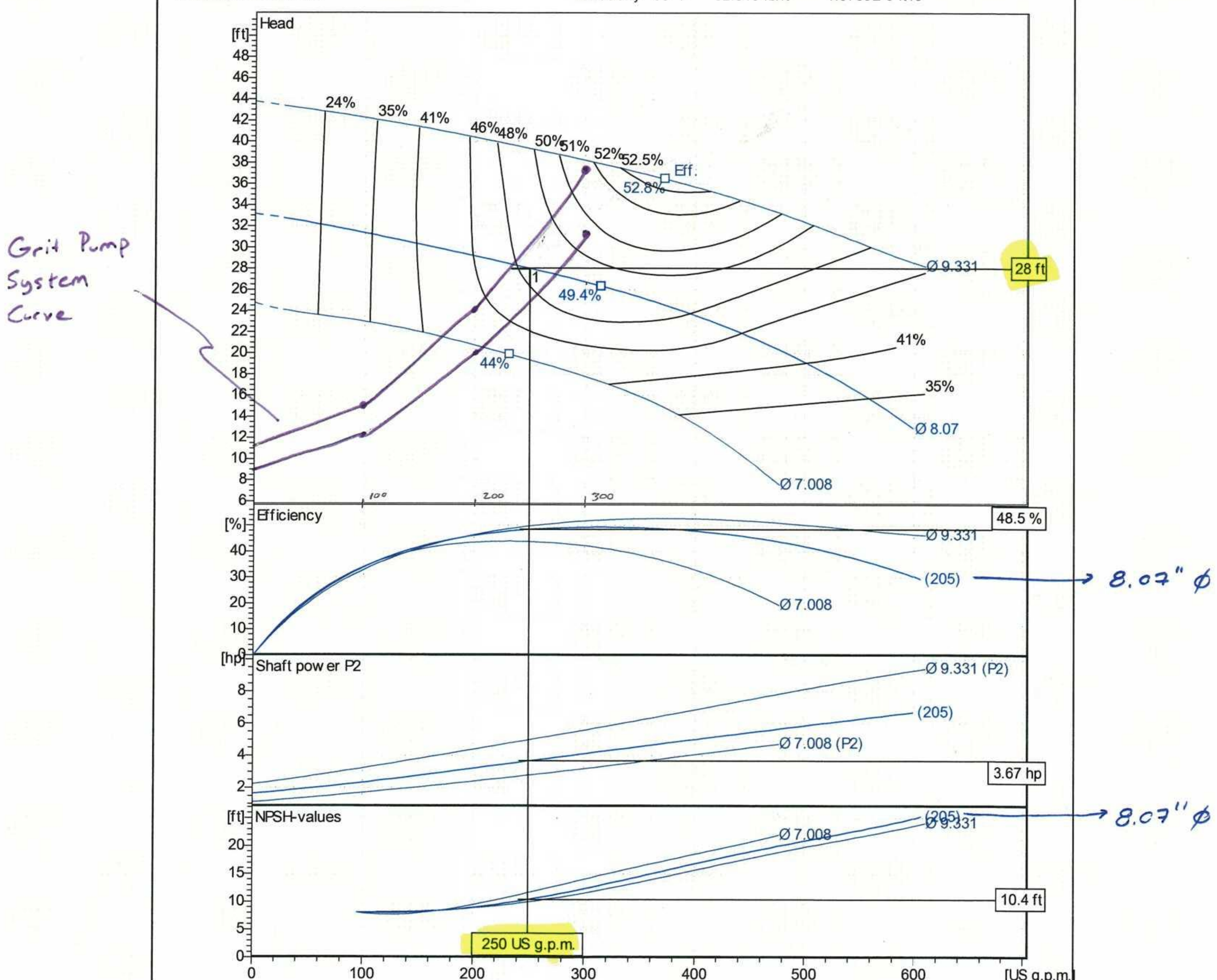
Model number 020.01.0603-01

Type:	No. of vanes	Max.	Min.	Sel. Ø:	Free passage:	Bearing bracket:
Vortex impeller	8	9.3307 inch	7.0079 inch	8.07	3 inch	LB 3B

Operating data

Speed:	Frequency:	Duty point:		Suction port:	Discharge port:
1160 rpm	60 Hz	Q = 250 US g.p.m.	H = 28 ft	DN100	DN80

Power data referred to: Grit slurry 68 °F 62.315 lb/ft³ 1.0769E-5 ft²/s



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TV 61-80 H6 LB 3B

Offer no.:	15151 Rev A	Data sheet pos. no.	1.1 Page 1 of 1
Order no.		Date / Our ref.:	2015-08-24
Serial no./quantity		Customer order	
Delivery date:		Project / Installation	Exeter, NH

EGGER

Measures and weights not binding

Customer	Aqua Solutions	Serial no./quantity	2Piece
Person/Dept.		Delivery date:	
ZIP/City	Falmout, ME 04105	Item no.	

Total weight

793 lb

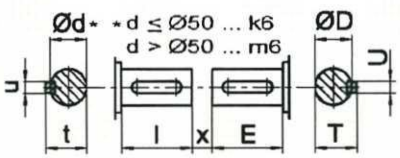
Connections

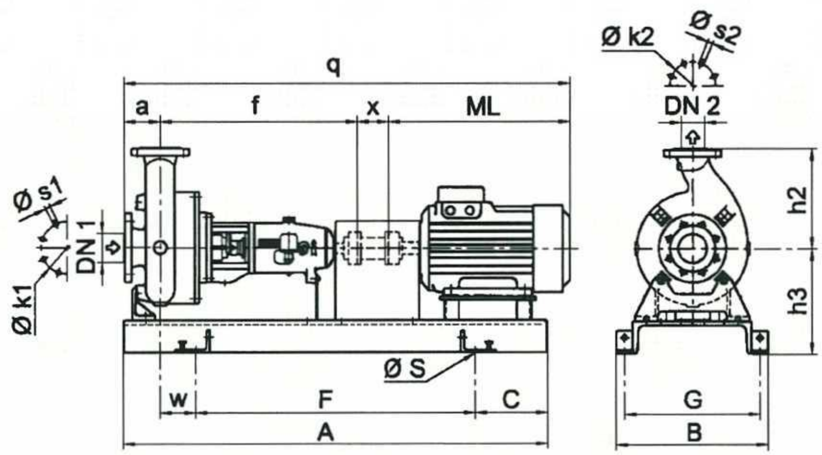
Suction flange	**Outlet branch**
4" 150lbs	3" 150lbs
ANSI B16.5 8 Drilled holes	ANSI B16.5 8 Drilled holes

with spacer coupling (LB3)

MT 820.03-0680-04

Wellenende / Bouts d'arbres / Shaft ends





Dimensions in inch

a	4.9213	x	5.5118
A	59.055		
B	20.472		
C	9.8425		
d	1.378		
D	1.6535		
DN1	3.937		
DN2	3.1496		
E	4.3307		
f	26.969		
F	39.37		
G	18.11		
h2	11.811		
h3	13.189		
k1	7.0866		
k2	6.2992		
l	3.1496		
ML	24.055		
q	61.457		
S	0.74803		
s1	0.70866		
s2	0.70866		
t	1.5079		
T	1.7717		
u	0.3937		
U	0.47244		
w	4.4488		

MOTOR	Manufacturer / Type GE / M7546	Design IM B3	Frame size 256T

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE

PROJECT NO.: 12883B

PRELIMINARY DESIGN PACKAGE

System/Subject:	INFLUENT EQUALIZATION		
Calculations By:	JEFF MERCER	Date:	6/11/2015
Checked By:	ED LEONARD	Date:	6/16/2015
Revised By:	JEFF MERCER	Date:	6/22/2015
Checked By:		Date:	

Checklist (to be completed by Design Engineer prior to calculation checking):

x	Brief Process Description
x	Graphs/Sketches of System Attached (Plans & Schematics)
x	Design Calculations Attached
x	Design Guidelines/Standards Noted
-	Equations Noted and Referenced
x	Electrical Loads Developed and Identified
x	Process Control Description Developed
-	Preliminary Basis of Design (Support Divisions) Attached
-	Construction Sequence Developed
-	Product Information Attached
-	Manufacturer's Review of Specs and Drawings (If Applicable)
x	Electronic File Location Noted
-	Program(s) Used (Version) Noted
x	Coordinated with Hydraulic Profile (If Applicable)

DESCRIPTION OF EXISTING FACILITIES

Influent Equalization (IEQ) does not currently exist at the Exeter WWTF. Influent Flow from the Main Pump Station is conveyed to the plant and distributed to one of three treatment lagoons with the following characteristics:

LAGOON NO. 1 SUMMARY		
Volume at Average Design Flow (MG)		26.0
Water Surface Area (acres)		9.01
Water Surface Elevation (ft)	Average Design Flow	25.40
	Peak Design Flow	25.60
Maximum Depth (ft)		9.6
Bottom Elevation (ft)		16.0
Freeboard (ft)		2.4

Lagoon piping consists of 24-inch diameter ductile iron pipe. During normal flow conditions, flow goes from Lagoon No. 1, through Lagoon No. 2, through Lagoon No. 3, and then to disinfection. During high flow conditions Lagoon No. 1 and No. 2 have a bypass outlet structure to avoid overtopping the embankments. Lagoon No. 1 uses fourteen 15-hp floating aerators, Lagoon No. 2 uses eight 10-hp floating aerators and Lagoon No. 3 uses five 7.5-hp floating aerators. The floating aerators in Lagoon No. 1 and No. 2 were replaced in 1995, while the aerators in Lagoon No. 3 are original. Each lagoon is equipped with two solar powered 0.5-hp SolarBee circulators (six total) installed in 2000. Although the lagoons have never been drained, dewatering sumps exist to gravity drain the lagoons. Lagoon No. 2 dewatering sump is presently inoperable due to the riser section having tipped over during a winter freeze and thaw cycle.

Between 2012 and 2014 Underwood Engineers monitored groundwater elevations using three monitoring wells. Information was collected in the spring and fall months when groundwater levels are typically highest. Based on data collected, groundwater contours were approximated for the site, including Lagoon No. 1 which had elevations from 7 to 11 feet or about 9 to 5 feet below the bottom of Lagoon No. 1.

FACILITY PLAN RECOMMENDATIONS

The Facility Plan recommended that two 1 Million gallon offline equalization tanks be constructed within Lagoon No. 1. IEQ will limit influent flows to less than 6.6 MGD after passing through preliminary treatment (Headworks). Diversion will occur at a diversion structure located between the new Headworks and IEQ. Flow will be returned upstream of the diversion structure for secondary treatment via three submersible pumps located in a pump station adjacent between the IEQ tanks. The tanks will be isolated and connected via the pump station.

CLIENT PREFERENCES

The client has not indicated any preferences for IEQ at this time.

DESIGN GUIDELINES (TR-16, EPA MANUAL, ETC.)

The NHDES WQ-700 design standards include the following requirements for Influent Equalization (Env-Wq 710):

- Critical equipment shall be provided with a standby unit per 3 units.
  - *It is yet to be determined if this system is classified as critical.*
- Tanks shall be located downstream of pretreatment facilities.
- Equalization capacity shall be sufficient to dampen expected flow and strength variations to the extent that is economically advantageous
- Aeration or mechanical mixing equipment shall be provided to maintain adequate mixing, using corner fillets and hopper bottoms to alleviate sludge/grit accumulation.
- Aeration equipment shall be sized to maintain 10 scfm/1000 cf of dissolved oxygen at all times.
- Influent Equalization shall include multiple tanks with sufficient flow control for removal of a single unit from service.
- Equalization tanks shall allow the entire tank contents to be drained at a controlled rate and introduced to the remainder of the treatment process.
- Instrumentation shall be provided to measure and indicate liquid levels and flow rates.

Additional recommendations from TR-16 include:

- Mechanical mixing equipment should provide 0.15-0.3 horsepower per 1,000 cubic feet of storage volume
- Aeration equipment should provide 10-30 SCFM per 1,000 cubic feet of storage volume and maintain a dissolved oxygen content of 1.0 mg/l.

REVIEW OF DESIGN CONSIDERATION & ALTERNATIVES

Lagoon No. 1 has a total volume of approximately 26.0 million gallons which could be used for IEQ; however, the actual volume used has implications for upstream and downstream processes. A full range of usable storage volumes from 1.0 million to 26.0 million gallons were compared based on the resultant forward flow, maintenance requirements, and construction capital costs. **Figure 1** shows the required volume using anticipated future annual average flow rates and desired maximum forward flowrate. The 2MG IEQ option was selected to cap influent flows at 6.6 MGD assuming a maximum Main Pump Station flow of 11.0 MGD. Based on estimated peak hour flow trends shown in **Figure 2**, the IEQ will be used infrequently.

A second option to cap flows at 6.0 MGD was analyzed. This option would require two 2.0 million gallon IEQ tanks for a total volume of 4.0 MG. It would have a similar layout to the 2.0 MG option except it would extend further into Lagoon No. 1.

The volume and equalization values are based on the projected flows in the Exeter Wastewater Facilities Plan (W-P, 2015). Future average daily flow rates were estimated using the max-day peaking factor and influent flow rates from 2012 to 2014.

FIGURE 1: IEQ STORAGE MODEL

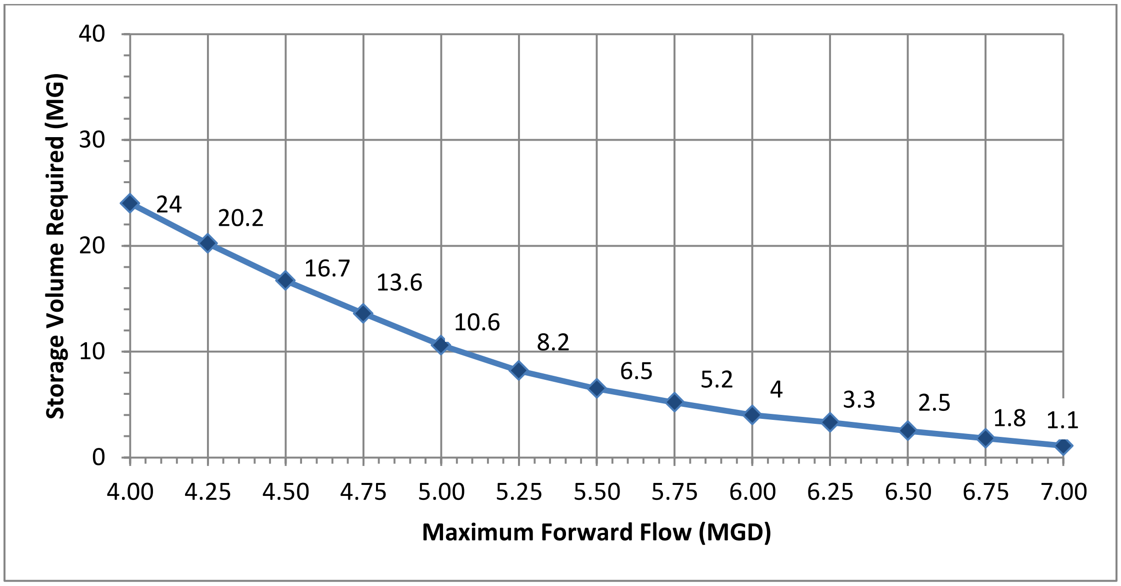
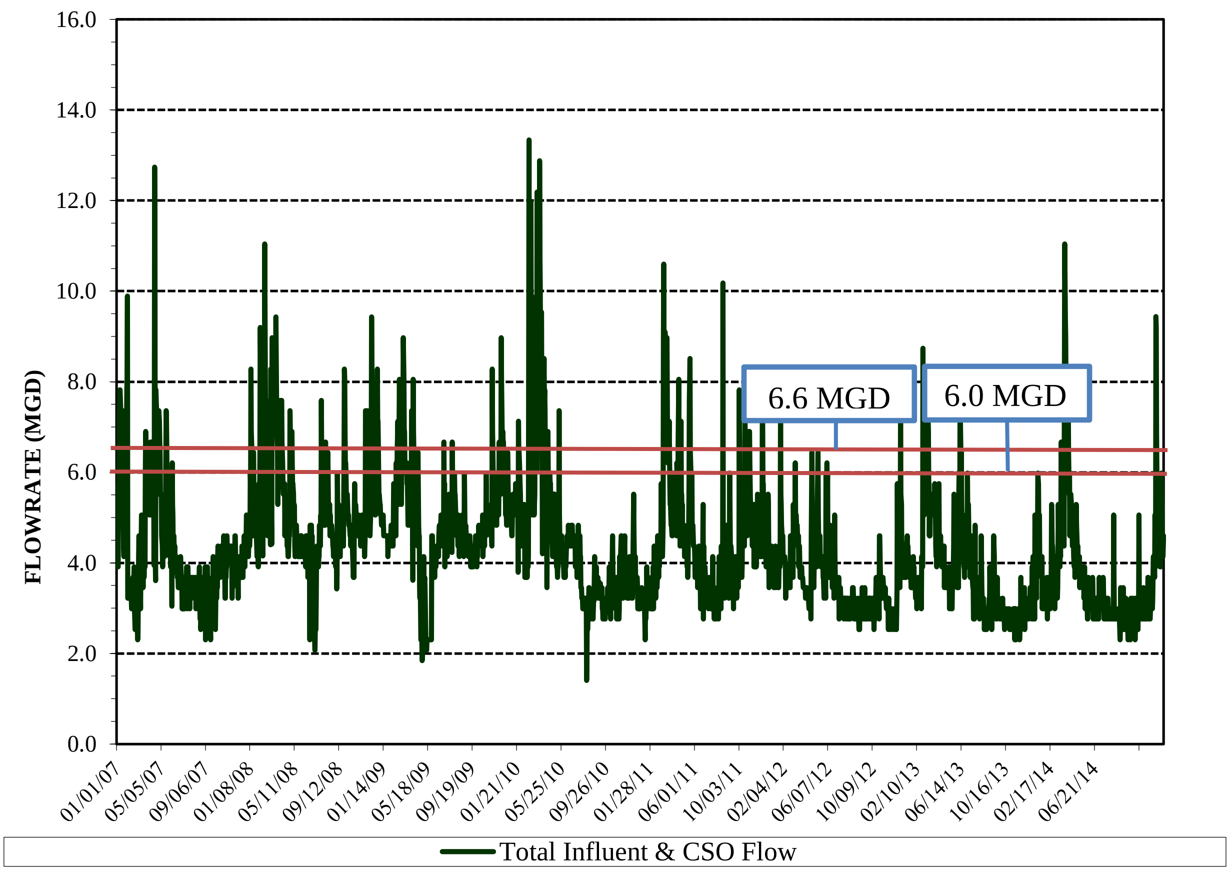


FIGURE 2: ESTIMATED PEAK HOUR FLOWRATE TO WWTF



The IEQ mechanical systems include submersible pumps and eight floating mechanical mixers. The submersible pumps shall return stored flow from the IEQ to the influent structure. The pumps are sized to return flow in a single day (between 22-24 hours). The pumps will run off VFDs so the operators can control the volume of flow to be returned to the influent flow stream. The mechanical mixers will maintain solids suspension to prevent sedimentation. Two 16-inch sluice gates will be provided at the pump wet well to isolate each IEQ tank. Two 12-inch overflow pipes will be provided (one for each tank) such that volume in excess of the IEQ capacity will flow by gravity to the supplemental equalization in remaining Lagoon No. 1. Underflow ports with gate valves shall allow the supplemental equalization to be drained back to the Headworks via the IEQ pump station.

The Town has several options for reuse of existing mechanical mixers. The facility has 10HP and 15HP mixers, as well as solar-powered mixers. During final design it will be determined which units will be best for re-use within the IEQ basins based on operator preference, minimum depth requirement, and equipment condition.

The existing diversion structures (structure 105 and 101) at Lagoon No. 1 will be reused to convey flows to either IEQ Tank No.1 or IEQ Tank No. 2. Each structure contains a manually operated sluice gate. The pipe leading to existing Lagoon No. 2 and 3 in Structure 101 (IEQ Tank No. 2) will be capped.

BASIS OF DESIGN

IEQ TANKS	
Application	Store Preliminary Treated Wastewater
Type	Lined Earthen Basin, rectangular shape
Liner Type	HDPE
Location	Southern portion of Lagoon No. 1
Number	2
Embankment Top Elev.	28.0-ft (existing)
Max Water Surface Elev.	25.5-ft (existing)
Bottom Elev.	16.0-ft (existing)
Freeboard	2.5-ft (existing)
Sidewater Depth	9.5-ft (existing)
Effective Depth	7.0-ft
Volume, each	1 MG (Option 1), 2 MG (Option 2)
Flow Isolation	Sluice gate on each IEQ Tank, In/Out
Mixing/Aeration	Floating Surface Aerators

PUMPS		
	Option 1	**Option 2**
Application	Return stored flow to influent diversion structure	
Type	Submersible, non-clog centrifugal	
Number	3 (lead-lag-standby)	
Design Condition	700 gpm each @ 36-ft TDH	1,400 gpm each @ 61-ft TDH
Minimum Flow	350 gpm each @ 23-ft TDH	700 gpm each @ 25-ft TDH
Motor	1755 rpm, 20 HP	1760 rpm, 30 HP
Discharge Diameter	6-inch pump, 8-inch header, 10/12-inch forcemain	
Other:	VFD, magnetic flow meter	
Acceptable Manufacturers	Flygt, Fairbanks-Morse	

MIXING	
Application	Completely mix tank contents
Type/Number	Floating mixer / 8
Motor, HP	To be determined
Acceptable Manufacturers	Existing equipment

BUILDING / STRUCTURE DESCRIPTION

A new dividing wall and inner partition wall will need to be created to divide Lagoon No. 1 into IEQ No. 1 and IEQ No.2. The dividing wall shall span the full Lagoon No. 1 width and be constructed of earthen material rated for utility truck traffic. The dividing partition shall be constructed of concrete with no walkway or railings between IEQ No. 1 and IEQ No. 2. The IEQ tanks shall slope to an enclosed sump for three submersible pumps. The pump wet well will have two 16-inch gates for tank isolation. Each pump will have sliderails for removal with a portable davit crane with removable grating above the pumps. The valve vault adjacent to the pump wet well will be enclosed with aluminum access hatches.

Structural information:

Pumps	
Weight (approx.)	500 lb
Mixers	
Weight (approx.)	1,300 lb, floating
Wetwell	
TOC elevation	13.0-ft
Freeboard Depth	2.5-ft
Dimensions, LxWxH	10-ft by 8-ft by 11.5-ft
Valve Vault	
TOC elevation, inner	20.0-ft
TOC elevation, outer	28-ft
Dimensions, LxWxH	10-ft by 8-ft by 7-ft

PROCESS CONTROL DESCRIPTION

Each tank will require a level element for high and low water. The IEQ space is classified as Class 1 / Division 2, (NFPA 820, Table 5.2.3.c).

Each pump will have a local control station with a HAND-OFF-REMOTE switch, run indicator lights, and an E-STOP push button. In HAND, the pump will run continuously at a preset speed set at the VFD. In OFF, the pump will not operate. In REMOTE, the pump control will be from the PLC operator interface or from the SCADA system. Pump activation will be determined by an ON/OFF level set point in the pump wet well or through HAND operation.

The mixers will have a local control station with a HAND-OFF-REMOTE switch, run indicator lights, and an E-STOP push button. In HAND, the mixer will run continuously. In OFF, the mixer will not operate. In REMOTE, the mixer control will be from the PLC operator interface or from the SCADA system.

The following instruments, control stations, and control panels are anticipated:

Equipment	Local/Remote	NEMA	By Division	Range
Flow Meter (8-inch)	local	7 (Class 1/Div 2)	13	150 to 1800 gpm
Level Elements (2)	local	Class 1/Div 1	13	0 to 14-ft
Float Switches (4)	local	Class 1/Div 1	13	-
Pump LCS	local	4X	16	-
Mixer LCS	local	4X	16	-

A magnetic flow meter will be located on the common discharge header to monitor discharge of equalized flow.

Electrical information:

IEQ Pumps	
Number	3
Power	20 HP (Option 1), 30 HP (Option 2)
Speed	Variable
Enclosure	SUBM, Class 1, Div 1
Volts, Phase/ Hz	460/ 3/ 60
Mixers	
Number	8
Power	To be determined
Speed	3600 rpm
Enclosure	Explosion Proof
Volts, Phase/ Hz	460/ 3/ 60

x Coordinated with NFPA Memo

x Coordinated with Equipment List

CONSTRUCTION SEQUENCING

The IEQ system should be constructed to coincide with the completion of the Main Pump Station upgrades. Upon completion of the Main Pump Station upgrades, the influent flow capacity will be higher than the secondary treatment processes are designed for; therefore, influent equalization should be available in the event flows exceed the anticipated design flow of 6.6 MGD.

Flows will not require bypass pumping; however, Lagoon No. 1 will need to be emptied and bypassed via existing gates to Lagoon No. 2 or to the proposed secondary treatment system.

FUTURE EXPANSION CONSIDERATIONS

Should the Exeter WWTF wish to expand IEQ volume, additional basins could be constructed within the Lagoon No. 1 footprint. The new basins could have separate pumps or be hydraulically connected to the existing tanks.

FILE LOCATION

12883B-WW Design\Technical\Process\Design memos

ATTACHMENTS

- No attachments

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE

PROJECT NO.: 12883B

PRELIMINARY DESIGN PACKAGE

System/Subject:	Primary Treatment		
Calculations By:	William Hankins	Date:	6/11/2015
Checked By:		Date:	
Revised By:		Date:	
Checked By:		Date:	

Checklist (to be completed by Design Engineer prior to calculation checking):

Y	Brief Process Description
N/A	Graphs/Sketches of System Attached (Plans & Schematics)
N/A	Design Calculations Attached
Y	Design Guidelines/Standards Noted
N/A	Equations Noted and Referenced
N/A	Electrical Loads Developed and Identified
N/A	Process Control Description Developed
Y	Preliminary Basis of Design (Support Divisions) Attached
N/A	Construction Sequence Developed
N/A	Product Information Attached
N/A	Manufacturer's Review of Specs and Drawings (If Applicable)
Y	Electronic File Location Noted
N/A	Program(s) Used (Version) Noted
Y	Coordinated with Hydraulic Profile (If Applicable)

DESCRIPTION OF EXISTING FACILITIES

The Town of Exeter's wastewater treatment facility (WWTF) does not current employ primary treatment.

FACILITY PLAN RECOMMENDATIONS

The proposed WWTF treatment process does not include primary treatment. The Facility Plan recommended planning for and providing sufficient space on the site for future primary treatment. The review of the proposed nutrient removal treatment approach was conducted as part of the preliminary design effort (technical memorandum A-7). That analysis also concluded that primary treatment is not a cost effective approach.

CLIENT PREFERENCES

None

DESIGN GUIDELINES (TR-16, EPA MANUAL, ETC.)

Not applicable, see below

DESIGN GUIDELINES (NHDES Env-Wq)

The New Hampshire Code of Administrative Rules chapter Env-Wq 700 Standard of Design and Construction for Sewerage and Wastewater Treatment Facilities establishes minimum technical standards for the design of wastewater treatment facilities. The following standards are pertinent to the planning of future primary treatment facilities:

- If primary settling tanks are part of the WWTP design, a minimum of 2 primary settling tanks shall be provided.
- Primary settling tanks shall have a minimum side water depth of 12 feet.
- Average surface overflow rates for primary settling tanks shall not exceed 1,200 gpd/sf for WWTPs having an average design flow greater than 1 mgd, unless reduced primary removal rates are provided in the design loadings for subsequent secondary treatment units.
- Surface overflow rates for peak hourly flow shall not exceed 3,000 gpd/sf.

REVIEW OF DESIGN CONSIDERATION & ALTERNATIVES

Not Applicable

BASIS OF DESIGN

Primary treatment is the process of physically removing particles from the wastewater stream prior to secondary treatment. Typically, primary treatment can remove a large portion of the influent total suspended solids and a moderate level of particulate BOD, nitrogen and phosphorus. Primary treatment can be achieved through various treatment devices. However, for this planning level basis of design memorandum, it has been assumed that traditional primary settling devices would be the most likely technology employed in the future. Primary treatment settling devices are most often circular or rectangular. Space will be provided on-site for both circular and rectangular settling tanks. Furthermore, space will be allocated in the hydraulic profile to allow for the future inclusion of the primary treatment system while maintaining gravity flow through the facility.

The future primary treatment facilities will include a new primary treatment splitter structure, two primary settling tanks and a below grade pump gallery with three primary sludge pumps. The basis of design for the future settling tanks are identified in Table 1.

TABLE 1

PRIMARY SETTLING TANKS	
Application:	Removal of particulate material
Type:	Clarifier
Number of Units	2
Total Surface Area, sf	3,180 (2 units each 45ft in diameter)
Average Surface Overflow Rate, gpd/sf	944
Peak Hour Surface Overflow Rate, gpd/sf	2,076
Estimated annual average primary sludge, lbs/day	4,620

BUILDING / STRUCTURE DESCRIPTION

Not Applicable

PROCESS CONTROL DESCRIPTION

Not Applicable

CONSTRUCTION SEQUENCING

Not Applicable

FUTURE EXPANSION CONSIDERATIONS

Not Applicable

FILE LOCATION

ATTACHMENTS

None

WRIGHT-PIERCE
Engineering a Better Environment

MEMORANDUM

TO:	File	DATE:	May 21, 2015 Rev. Aug 26, 2015
FROM:	Ed Leonard, Doug Hankins	PROJECT NO.:	12883B
SUBJECT:	Exeter NH – BNR Treatment Options and Comparative Analysis		

INTRODUCTION

The Wastewater Facilities Plan (March 2015) considered numerous process alternatives to achieve the requirements of the Town's NPDES permit and Administrative Order on Consent (AOC). Two process alternatives were identified for further consideration – Four Stage Bardenpho and Sequencing Batch Reactors. The initial task of the design phase is to select the wastewater treatment process and to determine whether there will be any phased implementation of the nutrient removal process. This memorandum summarizes the initial steps of this task.

BACKGROUND

Within the two major process alternatives, there are numerous sub-alternatives that can be considered to allow for refinement of the recommended plan – either for process selection or phasing or both. These opportunities are present in large part due to the fact that the site is essentially a "green-field" site with large existing lagoons that offer the ability to mitigate peak flows via influent equalization.

As summarized in the Wastewater Facilities Plan, a common element to these sub-alternatives is to create new influent equalization basins (approximately 2.0-million gallons of storage capacity) for off-line storage of peak flows in excess of 6.6-mgd. This volume could be increased to approximately 3.5-million gallons, which would reduce the peak flow cap to 6.0-mgd. We would not recommend increasing the influent equalization basin volume beyond 3.5-million gallons as it could have deleterious impacts on the nitrogen removal process.

It is important to note that the MLE process has been re-introduced in this analysis as a phased implementation option and not as a stand-alone option. The Wastewater Facilities Plan concluded that Bardenpho was more cost-effective on the "pounds of nitrogen removed per dollar spent" metric that the Town favored.

It is also important to note that phasing is being considered in order to mitigate the significant cost impact of the project. The phasing plan will need to explicitly identify the future upgrade requirements as well as the trigger for implementation of that future project. The phasing plan is not intended to relinquish currently licensed capacity in the NPDES permit.

The comparative analyses described herein have been under development from April 2015 thru July 2015.

FLOWS AND LOADS FOR COMPARATIVE ANALYSES

The design flows and loads used for the comparative analyses are summarized below in Table 1.

TABLE 1
FLOWS AND LOADS SUMMARY FOR COMPARATIVE ANALYSES

	Flow	BOD		TSS		TKN		TP	
	mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Annual Average	3.0	224	5,600	256	6,400	40	1,000	6.0	150
Maximum Month	5.1	172	7,300	226	9,600	31	1,300	4.7	200
Maximum Day	6.6	183	10,100	209	11,520	33	1,800	4.9	270
Peak Instantaneous*	6.6	-	-	-	-	-	-	-	-

*Peak instantaneous flow managed via influent equalization.

TREATMENT REQUIREMENTS AND OBJECTIVES

The effluent requirements are identified in the NPDES permit and the AOC. The effluent objectives for each of the processes are identified below in Table 2. As described in the Wastewater Facilities Plan, a separate stage process (e.g., filters, denitrification filters, etc.) would be needed to achieve the NPDES permit limit.

TABLE 2
TREATMENT REQUIREMENTS AND OBJECTIVES

	NPDES Limit	AOC Limit	Objective Bardenpho	Objective MLE	Objective SBR
BOD	30 mg/l	n/a	10 mg/l	10 mg/l	10 mg/l
TSS	30 mg/l	n/a	10 mg/l	10 mg/l	10 mg/l
TN	3 mg/l*	8 mg/l*	4.0± mg/l*	8 mg/l*	5 mg/l*

*Seasonal rolling average

PRELIMINARY PHASING CONSTRAINTS

We contacted NHDES to get initial input on acceptable initial flow rates for a phased implementation approach. The flow rates posed to NHDES were 2.1-mgd and 2.6-mgd, based on the information contained in Table 2-12, Figure 6-3 and Table 6-3 in the Wastewater Facilities Plan. NHDES indicated that 2.1-mgd would be considered too low as an initial phase but that 2.5 to 2.6-mgd would be considered more reasonable. Given this input, process alternatives will be considered which provide for 2.5-mgd of capacity in the initial phase.

MODELING METHODOLOGY

A "steady-state" computer process model was developed in BioWIN 4.0 in order to analyze two process alternatives: the Modified-Ludzack Ettinger (MLE) process (exogenous) and the Four-Stage Bardenpho process (exogenous/endogenous). Process sizing for the Sequencing Batch Reactor (SBR) was conducted by the Manufacturer. The modeling effort used the following key inputs and assumptions:

- Since the MLE and Bardenpho processes do not currently exist at the Exeter WWTF, it is not possible to develop a calibrated model; accordingly, default kinetic and stoichiometric process parameters were utilized. In some cases, default parameters were adjusted based on experience. The model results are used primarily as a tool to analyze applicable upgrade options.
- The model incorporated site-specific influent flow and load data as well as site-specific process tank sizing and configurations. The influent wastewater temperature was set at 10 degrees C to simulate spring conditions. The aerobic solids retention time was held at 12 days for each process configuration to provide for complete nitrification at 10°C.
- Typical dissolved oxygen levels were set at 2.0 mg/l under annual average and maximum month conditions, with a minimum value of 1.0 mg/l under peak day loads.
- Peak daily and peak hourly flows were capped at 6.6 MGD based on the assumption that influent equalization will be incorporated at the WWTF.
- The Bardenpho process was sized to produce 3.5-mg/l effluent total nitrogen at maximum month flows and loads at 10degC. Tank sizes will be set to minimize chemical use as well as adverse impacts (e.g., ammonia re-release in the secondary anoxic zone, improper ratios of aerated to unaerated zones, etc.).
- The interim MLE process was sized to produce 8-mg/l effluent total nitrogen at maximum month flows and loads at 10degC.
- The SBR process was sized by a manufacturer (AquaAerobics) to produce 5-mg/l effluent total nitrogen at maximum month flows and loads at 10degC.
- A separate stage denitrification filter will be required for the SBR process to reliably achieve the 3 mg/l effluent total nitrogen limit; whereas a separate stage traditional filter will be required for the Bardenpho process.
- Supplemental alkalinity is expected for all alternatives.

PROCESS ANALYSIS

The *Wastewater Facilities Plan* includes a listing of numerous potential configurations of initial/future capacity, number of treatment trains, mixed liquor concentrations and whether primary clarifiers were included or not. Based on the NHDES input described above, we have refined this listing. Process descriptions and advantages/disadvantages for the Modified Ludzack-Ettinger, Bardenpho and Sequencing Batch Reactor process are located in the March 2015 Facility Plan Report. Therefore, this information is not included herein. Detailed process modeling and analysis has been completed to ascertain the recommended design criteria/process sizing for comparison of the previously presented alternatives. The five identified options are identified as follows:

Option 1 – MLE Phased to Bardenpho in the Future
- **Phase 1 –** MLE configuration (2.5 mgd annual average capacity)
- **Phase 2 –** Implement either A or B:
  - **A –** Bardenpho configuration (3.0 mgd annual average capacity)
  - **B –** Bardenpho configuration with primary clarifiers (3.0 mgd annual average capacity)
- **Future –** Future traditional filter to achieve effluent TN less than 3-mg/l.

Option 2 – Bardenpho Phased Installation
- **Phase 1 –** Bardenpho configuration (2.5 mgd annual average capacity)
- **Phase 2 –** Implement either A or B:
  - **A –** Bardenpho configuration (3.0 mgd annual average capacity)
  - **B –** Bardenpho configuration with primary clarifiers (3.0 mgd annual average capacity)
- **Future –** Future traditional filter to achieve effluent TN less than 3-mg/l.

Option 3 – Bardenpho Not Phased
- **Current –** Bardenpho configuration (3.0 mgd annual average capacity)
- **Future** - Future traditional filter to achieve effluent TN less than 3-mg/l.

Option 4 – SBR Phased
- **Phase 1 –** SBR process (2.5 mgd annual average capacity)
- **Phase 2** - SBR process (3.0 mgd annual average capacity)
- **Future** - Future denitrification filter to achieve effluent TN less than 3-mg/l.

Option 5 – SBR Not Phased
- **Current** - SBR process (3.0 mgd annual average capacity)
- **Future** - Future denitrification filter to achieve effluent TN less than 3-mg/l.

A more detailed description of each process option is provided below.

Option 1 – MLE Phased to Bardenpho in the Future

This option includes the installation of a MLE process with future conversion to a Bardenpho process. Phase 1 will achieve an effluent total nitrogen concentration of less than 8.0 mg/l at an annual average flow rate of 2.5 mgd. A subsequent expansion (Phase 2A or 2B) would be required to achieve the full build out capacity of 3.0 mgd and an effluent total nitrogen concentration of 3.5 mg/l. Phase 1 would consist of the following major components:

a. Flow splitter box to distribute flow between treatment tanks
b. Two concrete tanks for the activated sludge treatment process, with a total volume of 2.16 million gallons. Treatment tanks will be configured with an aeration tank component partitioned into anoxic and oxic zones. Anoxic zones will have submersible and or top mounted mixers. The oxic zones will have an internal recycle pump to recycle nitrate rich mixed liquor to the anoxic zone for denitrification.
    i. The MLE process is designed to accommodate an annual average design flow rate of 2.5 mgd.
    ii. The MLE process is designed to operate at a mixed liquor concentration between 2,000 mg/l and 3,800 mg/l (max month condition at 10°C).
    iii. The MLE process will achieve an effluent total nitrogen concentration less than 8.0 mg/l.
c. Three 70-foot diameter secondary clarifiers and influent splitter box, with a total volume of 1.38 million gallons.
d. Two aerobic sludge storage tanks with a total volume of 0.20 million gallons.
e. Supplemental alkalinity storage and feed system.
f. Supplemental carbon and feed system

The Phase 1 MLE process can be expanded either through the implementation of Phase 2A or Phase 2B. In general, Phase 2A includes an expansion of the aeration tanks while Phase 2B includes the addition of primary clarifiers.

Phase 2A would consist of the following major components:

a. One additional concrete tank for the activated sludge treatment process, for a total volume of 3.23 million gallons. All three treatment tanks will be reconfigured as a four stage Bardenpho process (i.e., the addition of a post anoxic zone and post aerobic zone). Anoxic zones will have submersible and or top mounted mixers.
    i. The Bardenpho process is designed to accommodate an annual average design flow rate of 3.0 mgd.
    ii. The Bardenpho process is designed to operate at a mixed liquor concentration between 2,000 mg/l and 3,700 mg/l (max month condition at 10°C).

iii. The Bardenpho process will achieve an effluent total nitrogen concentration less than 3.5 mg/l.
iv. The Bardenpho process may be able to achieve compliance with a future total nitrogen limit of 3.0 mg/l without the need for a tertiary filter (will depend on the site specific performance of the secondary clarification system and non-biodegradable organic nitrogen levels.

b. One additional aerobic sludge storage tanks for a total volume of 0.30 million gallons.

Phase 2B would consist of the following major components:

a. Three 45-foot diameter primary clarifiers and influent splitter box, with a total volume of 0.33 million gallons.
b. Both activated sludge treatment tanks will be reconfigured as a four stage Bardenpho process (i.e., the addition of a post anoxic zone and post aerobic zone). Anoxic zones will have submersible and or top mounted mixers.
    i. The Bardenpho process is designed to accommodate an annual average design flow rate of 3.0 mgd.
    ii. The Bardenpho process is designed to operate at a mixed liquor concentration between 2,000 mg/l and 3,500 mg/l (max month condition at 10°C).
    iii. The Bardenpho process will achieve an effluent total nitrogen concentration less than 3.5 mg/l.
    iv. The Bardenpho process may be able to achieve compliance with a future total nitrogen limit of 3.0 mg/l without the need for a tertiary filter (will depend on the site specific performance of the secondary clarification system and non-biodegradable organic nitrogen levels.
c. One circular gravity thickener, with a total volume of 0.06 million gallons.

Option 2 – Bardenpho Phased Installation
This option includes the installation of a Bardenpho process with future expansion to increase the facilities rated capacity. Phase 1 will achieve an effluent total nitrogen concentration of 3.5 mg/l at an annual average flow rate of 2.5 mgd. A subsequent expansion (Phase 2A or 2B) would be required to achieve the full build out capacity of 3.0 mgd while maintaining an effluent total nitrogen concentration of 3.5 mg/l. Phase 1 would consist of the following major components:

a. Flow splitter box to distribute flow between treatment tanks
b. Two concrete tanks for the activated sludge treatment process, with a total volume of 2.55 million gallons. Treatment tanks will be configured with an aeration tank component partitioned into four (two anoxic and two oxic) zones. Anoxic zones will have submersible and or top mounted mixers. The first oxic zones will have an internal recycle pump to recycle nitrate rich mixed liquor to the anoxic zone for denitrification.

    i. The Bardenpho process is designed to accommodate an annual average design flow rate of 2.5 mgd.
    ii. The Bardenpho process is designed to operate at a mixed liquor concentration between 2,000 mg/l and 3,900 mg/l (max month condition at 10°C).
    iii. The Bardenpho process will achieve an effluent total nitrogen concentration less than 3.5 mg/l.

c. Three 70-foot diameter secondary clarifiers and influent splitter box, with a total volume of 1.38 million gallons.
d. Two aerobic sludge storage tanks with a total volume of 0.20 million gallons.
e. Supplemental alkalinity storage and feed system.
f. Supplemental carbon and feed system

The Phase 1 Bardenpho process can be expanded either through the implementation of Phase 2A or Phase 2B. In general, Phase 2A includes an expansion of the aeration tanks while Phase 2B includes the addition of primary clarifiers.

Phase 2A would consist of the following major components:

b. One additional concrete tank for the activated sludge treatment process, for a total volume of 3.83 million gallons. All three treatment tanks will be configured as a four stage Bardenpho process.
    i. The Bardenpho process is designed to accommodate an annual average design flow rate of 3.0 mgd.
    ii. The Bardenpho process is designed to operate at a mixed liquor concentration between 2,000 mg/l and 3,300 mg/l (max month condition at 10°C).
    iii. The Bardenpho process will achieve an effluent total nitrogen concentration less than 3.5 mg/l.
    iv. The Bardenpho process may be able to achieve compliance with a future total nitrogen limit of 3.0 mg/l without the need for a tertiary filter (will depend on the site specific performance of the secondary clarification system and non-biodegradable organic nitrogen levels.
d. One additional aerobic sludge storage tanks for a total volume of 0.30 million gallons.

Phase 2B would consist of the following major components:

a. Three 45-foot diameter primary clarifiers and influent splitter box, with a total volume of 0.33 million gallons.
b. No modifications to the activated sludge treatment trains are anticipated.
    i. The Bardenpho process is designed to accommodate an annual average design flow rate of 3.0 mgd.

   ii. The Bardenpho process is designed to operate at a mixed liquor concentration between 2,000 mg/l and 3,400 mg/l (max month condition at 10°C).
   iii. The Bardenpho process will achieve an effluent total nitrogen concentration less than 3.5 mg/l.
   iv. The Bardenpho process may be able to achieve compliance with a future total nitrogen limit of 3.0 mg/l without the need for a tertiary filter (will depend on the site specific performance of the secondary clarification system and non-biodegradable organic nitrogen levels.
e. One circular gravity thickener, with a total volume of 0.06 million gallons.

Option 3 – Bardenpho not Phased

Option 3 includes the installation of a four-stage Bardenpho process sized to handle the design annual average flow rate of 3.0 mgd. The four-stage Bardenpho process will achieve an effluent total nitrogen concentration of 3.5 mg/l. Option 3 would consist of the following major components:

a. Flow splitter box to distribute flow between treatment tanks
b. Three concrete tanks for the activated sludge treatment process, with a total volume of 2.96 million gallons. Treatment tanks will be configured with an aeration tank component partitioned into four (two anoxic and two oxic) zones. Anoxic zones will have submersible and or top mounted mixers. The first oxic zones will have an internal recycle pump to recycle nitrate rich mixed liquor to the anoxic zone for denitrification.
   i. The Bardenpho process is designed to accommodate an annual average design flow rate of 3.0 mgd.
   ii. The Bardenpho process is designed to operate at a mixed liquor concentration between 2,000 mg/l and 3,900 mg/l (max month condition at 10°C).
   iii. The Bardenpho process will achieve an effluent total nitrogen concentration less than 3.5 mg/l.
c. Three 70-foot diameter secondary clarifiers and influent splitter box, with a total volume of 1.38 million gallons.
d. Three aerobic sludge storage tanks with a total volume of 0.30 million gallons.
e. Supplemental alkalinity storage and feed system.
f. Supplemental carbon and feed system

Option 4 – SBR Phased Installation

This option includes the installation of the Sequencing Bath Reactor process. Phase 1 will achieve an effluent total nitrogen concentration of 5.0 mg/l at an annual average flow rate of 2.5 mgd. Phase 2 includes a facility expansion to achieve a design rated annual average capacity of 3.0 mgd through additional SBR tanks. However, a reduction in effluent total nitrogen levels (5.0 mg/l) is not achieved in Phase 2. A subsequent expansion (denitrification filters) would be required to reliably achieve an effluent total nitrogen concentration less than 5.0 mg/l. Phase 1 would consist of the following major components:

a. Flow splitter box to distribute flow between treatment tanks
b. Three concrete tanks for the SBRs, with a total volume of 3.53 million gallons. Treatment tanks will include installation of the SBR equipment including diffuser assemblies, mixers, transfer pumps, and decanters.
    i. The SBR process is designed to accommodate an annual average design flow rate of 2.5 mgd.
    ii. The SBR process is designed to operate at a mixed liquor concentration between 2,000 mg/l and 4,500 mg/l.
    iii. The SBR process will achieve an effluent total nitrogen concentration of 5.0 mg/l.
c. Secondary equalization tank or basin (0.3 million gallons) and equipment including coarse diffusers and effluent transfer pumps.
d. Three aerobic sludge storage tanks with a total volume of 0.30 million gallons.
e. Supplemental alkalinity storage and feed system.
f. Supplemental carbon storage and feed system.

Phase 2 would consist of the following major components:

a. Flow splitter box to distribute flow between treatment tanks
b. One additional concrete tank for the SBRs, for a total volume of 4.70 million gallons. Treatment tanks will include installation of the SBR equipment including diffuser assemblies, mixers, transfer pumps, and decanters.
    i. The SBR process is designed to accommodate an annual average design flow rate of 3.0 mgd.
    ii. The SBR process is designed to operate at a mixed liquor concentration between 2,000 mg/l and 4,500 mg/l.
    iii. The SBR process will achieve an effluent total nitrogen concentration of 5.0 mg/l.
c. One additional aerobic sludge storage tank for a total volume of 0.40 million gallons.

Option 5 – SBR Not Phased

This option includes the installation of the Sequencing Bath Reactor (SBR) process. The SBR process will be sized to handle the design annual average flow rate of 3.0 mgd. The Sequencing Bath Reactor process has the ability to achieve an effluent total nitrogen concentration of 5.0 mg/l. subsequent expansion (denitrification filters) would be required to reliably achieve an effluent total nitrogen concentration less than 5.0 mg/l. This option would consist of the following major components:

a. Flow splitter box to distribute flow between treatment tanks

b. Three concrete tanks for the SBRs, for a total volume of 4.50 million gallons. Treatment tanks will include installation of the SBR equipment including diffuser assemblies, mixers, transfer pumps, and decanters.
   i. The SBR process is designed to accommodate an annual average design flow rate of 3.0 mgd.
   ii. The SBR process is designed to operate at a mixed liquor concentration between 2,000 mg/l and 4,500 mg/l.
   iii. The SBR process will achieve an effluent total nitrogen concentration of 5.0 mg/l.

c. Secondary equalization tank or basin (0.3 million gallons) and equipment including coarse diffusers and effluent transfer pumps.
d. Four aerobic sludge storage tanks for a total volume of 0.40 million gallons.
e. Supplemental alkalinity storage and feed system.
f. Supplemental carbon storage and feed system.

COMPARATIVE COST ESTIMATES

A planning-level analysis was performed for each of the nitrogen removal options. Each option was developed to a consistent level of conservatism based on the future wastewater flows and loads presented in this memorandum. The processes were considered to reliably achieve the effluent TN concentrations identified in **Table 2**, which were used in the calculations of estimated pounds of TN removed per year as well as cost per pound of TN removed.

Comparative capital cost estimates are presented in **Table 3**, comparative annual operations and maintenance cost estimates are presented in **Table 4** and comparative present worth costs are presented in **Table 5**. All costs are presented in Fall 2014 dollars (ENR CCI 9846). All tables are provided at the end of this memorandum.

The costs presented herein are comparative and do not include all project components (e.g., Influent Equalization, Headworks, Disinfection, Sludge Dewatering, facility-wide electrical service and distribution, etc.). Project costs include contingency and technical services.
Each of the options has a "pathway to 3 mg/l". The costs presented herein summarize the capital costs to achieve the effluent total nitrogen concentrations identified previously. The "pathway to 3 mg/l" differs for each process alternative. Options 1, 2 and 3 would require a traditional filter in the future to achieve an effluent TN limit of 3.0 mg/l. Options 4 and 5 should be expected to require a tertiary denitrification filter in the future to achieve an effluent TN limit of 3.0 mg/l.

PRESENTATION TO TOWN OFFICIALS – MAY/JUNE 2015

During two meetings in May 2015 with DPW staff as well as some members of the Board of Selectmen (BOS), the Water & Sewer Advisory Committee (WSAC) and the Department of Environmental Services (DES), Wright-Pierce presented several options for WWTF Upgrades using either the Bardenpho process (flow-through) or the Sequencing Batch Reactor process (batch) and using various phased implementation approaches. By the end of the second meeting, the Town concluded that:

- The Bardenpho process was a better selection for the Town given the WWTF size and effluent requirements (i.e., Options 1, 2 or 3).
- The Bardenpho process constructed as one project (Option 3) rather than the phased approaches identified at the time was the preferred approach given the lowest life-cycle cost.
- The same presentation should be made to the BOS and WSAC for their input and approval.

A combined BOS/WSAC meeting was held on June 17, 2015 to present the information (see attached powerpoint presentation). At the conclusion of this meeting, the BOS/WSAC affirmed the conclusion to move forward with the design of a Bardenpho process (Option 3); however, while the BOS/WSAC agreed that phasing Options 1 and 2 were not ideal options, they wanted to continue to evaluate phasing options. During the meeting, Wright-Pierce outlined a potential phasing scenario that involved construction of a larger Influent Equalization Basin in a phased implementation approach ("Option 6").

ADDITIONAL COMPARATIVE ANALYSIS – OPTION 3 VS OPTION 6

The following paragraphs summarize the common and different features of Option 3 and Option 6. It is important to note that both options ultimately provide for the following common features delivered under different timeframes:

- Design annual average capacity of 3.0-mgd;
- Peak hour capacity of up to 12.5-mgd (in combination with the Main Pump Station Upgrade and potential regional partners) through the screening and grit removal processes;
- Influent equalization to minimize/eliminate CSOs (in combination with the Main Pump Station Upgrade) and to cap the peak day forward flow 6.6-mgd;
- Effluent TN <5-mg/l using the Bardenpho process;
- Three aeration tanks and three secondary clarifiers;
- Site layout which allows for *future* primary clarifiers, if desired;
- Site layout which allows for *future* fourth aeration tank and fourth secondary clarifier, if desired;
- Site layout which allow for *future* tertiary treatment to achieve effluent TN <3-mg/l, if required;

The differences between Option 3 and Option 6/ Phase 1 are identified below:

- The volume for influent equalization is increased from 2.0-MG (Option 3) to 4.0-MG (Option 6) in order to allow for a reduction in the peak day flow from 6.6-mgd (Option 3) to 6.0-mgd (Option 6).
- The reduction in the Phase 1 peak day flow rate allows for two aeration tanks and three secondary clarifiers to be constructed.
- The aeration tanks would be configured such that the operators can easily switch between a Bardenpho process and a MLE process (i.e., without moving large equipment or baffle walls). When operated as a Bardenpho process the Phase 1 annual average capacity is 2.2-mgd and when operated as an MLE process the Phase 1 annual average capacity is 2.65-mgd.
- The Town would operate in a Bardenpho configuration until it reaches an annual average flow of approximately 2.2-mgd (or appropriate influent TKN load). At that time, the Town would need to switch to the MLE process during the colder months in order to maintain nitrification through the winter. As flows continue to increase, the WWTF would remain in the MLE process for more of the year. Since the AOC provides an interim effluent TN limit of 8 mg/l, this approach is consistent with the AOC. Based on our understanding of the AOC, we anticipate that it will remain in place for at least 10 to 15 years.
- At the "trigger flow" (or trigger load), the Town would begin the process of obtaining funding approvals through the municipal appropriations process for design and construction of the third aeration tank.
- When the third aeration tank is completed, the design annual average capacity would be 3.0-mgd (in a Bardenpho configuration), the design peak day flow rate will be increased to 6.6-mgd and the effluent TN will be reduced back to <5-mg/l.

Option 6 is similar to Option 2 (in that it is also a phased Bardenpho); however, the primiary difference is that Option 6 allowed for a lower peak day forward flow in the initial years based on increasing the volume of the Influent Equalization Basin. Option 6 has a slightly lower initial capacity, a lower initial cost and a much lower ultimate cost than Option 2.

CONCLUSIONS

The AOC requires that the Town evaluate nitrogen removal progress and make a recommendation regarding treatment level identified in the NPDES permit by 2023. Given that the Town needs to evaluate treatment level over the next 10 years, the Town is also interested in considering treatment capacity. Based on growth projections in the Wastewater Facilities Plan and the Rockingham Planning Commission, there is a long-term need for the Town's licensed capacity; however, this capacity will not likely be needed until later in the planning period or beyond. The Town is interested in deferring the cost of constructing capacity that will not be needed for many years but not at the expense of losing its permitted capacity. Based on our analysis, the estimated costs are summarized as follows:

- Capital cost for **Option 3** (3.0-mgd capacity in a single project) is $39.8M (ENR CCI 9846).
- Capital cost for **Option 6** (3.0-mgd capacity in two phases) is $40.4M; however, the first phase would be $35.8M (ENR CCI 9846). Said another way, Option 6 will save $4.0M now with the potential to cost an extra $0.6M later.
- Present worth cost for **Option 3** and **Option 6** are approximately equivalent.

PRESENTATION TO TOWN OFFICIALS – AUGUST 10, 2015

A combined BOS/WSAC meeting was held on August 10, 2015 to discuss Option 3 vs Option 6 (see attached powerpoint presentation). The Town elected to deliberate further on this decision but asked that EPA and DES provide a written response to the following question:

> *Can the Town maintain its NPDES permit capacity of 3.0-mgd if it constructs the project in a phased manner where the first phase has a capacity which is less than 3.0-mgd if the permit is modified to identify a specific flow and load condition at which point the process of planning, designing, funding and constructing the upgrade to the full design capacity must begin?*

CORRESPONDENCE FROM EPA/DES

Wright-Pierce submitted a letter dated August 12, 2015 to DES on behalf of the Town (attached). EPA and DES each provided written responses (copies attached).

CLOSING

The Town BOS and WSAC met on August 24, 2015 to evaluate the merits of both options. No decisions were made at that meeting. The Town continues to evaluate both options.

TABLE 3
COMPARATIVE CAPITAL COSTS (Options 1 through 5)

	Units	OPTION 1 - MLE PHASED TO BARDENPHO IN THE FUTURE			OPTION 2 - BARDENPHO PHASED INSTALLATION			OPTION 3 - BARDENPHO	OPTION 4 - SBR PHASED INSTALLATION		OPTION 5 - SBR
		PHASE 1 - MLE Process	PHASE 2A - Bardenpho Process without Primary Clarifiers	PHASE 2B - Bardenpho Process with Primary Clarifiers	PHASE 1 - Bardenpho Process	PHASE 2A - Bardenpho Process without Primary Clarifiers	PHASE 2B - Bardenpho Process with Primary Clarifiers	Bardenpho without Primary Clarifiers	PHASE 1 - SBR	PHASE 2 - SBR	
Primary Clarifiers ($x/gal)	$14.75										
Volume	mgal	0.00	0.00	0.33	0.00	0.00	0.33	0.00	0.00	0.00	0.00
Total Project Costs	$	$0	$0	$4,870,000	$0	$0	$4,870,000	$0	$0	$0	$0
BNR Basins ($x/gal)	$4.10										
Volume	mgal	2.16	3.23	2.16	2.55	3.83	2.56	2.96	0.00	0.00	0.00
Total Project Costs	$	$8,860,000	$13,240,000	$8,860,000	$10,460,000	$15,700,000	$10,500,000	$12,140,000	$0	$0	$0
Secondary Clarifiers ($x/gal)	$4.80										
Volume	mgal	1.38	1.38	1.38	1.38	1.38	1.38	1.38	0.00	0.00	0.00
Total Project Costs	$	$6,620,000	$6,620,000	$6,620,000	$6,620,000	$6,620,000	$6,620,000	$6,620,000	$0	$0	$0
SBR Tanks	$3.80										
Volume	mgal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.53	4.70	4.50
Total Project Costs	$	$0	$0	$0	$0	$0	$0	$0	$14,030,000	$17,990,000	$16,860,000
Gravity Thickener ($x/gal)	$14.75										
Volume	mgal	0.00	0.00	0.06	0.00	0.00	0.06	0.00	0.00	0.00	0.00
Total Project Costs	$	$0	$0	$830,000	$0	$0	$830,000	$0	$0	$0	$0
Aerobic Sludge Storage Tank ($x/gal)	$5.00										
Volume	mgal	0.20	0.30	0.20	0.20	0.30	0.20	0.30	0.30	0.40	0.40
Total Project Costs	$	$1,000,000	$1,500,000	$1,000,000	$1,000,000	$1,500,000	$1,000,000	$1,500,000	$1,500,000	$2,000,000	$2,000,000
Total Project Cost **		**$16,480,000**	**$21,848,000**	**$22,750,000**	**$18,080,000**	**$24,394,000**	**$24,394,000**	**$20,260,000**	**$15,530,000**	**$20,436,000**	**$18,860,000**
** Note, project costs are only for comparison between options and do not include all project components (e.g., Influent Equalization, Headworks, Disinfection, Sludge Dewatering, facility-wide electrical service and distribution, etc.). Project costs include contingency and technical services.											
Overall Project Costs											
BNR-Related Items		$16,480,000	$21,848,000	$22,750,000	$18,080,000	$24,394,000	$24,394,000	$20,260,000	$15,530,000	$20,436,000	$18,860,000
Est. Add. Project Components for WWTF ***		$19,570,000	$19,570,000	$19,570,000	$19,570,000	$19,570,000	$19,570,000	$19,570,000	$19,570,000	$19,570,000	$19,570,000
Total Project Costs to Achieve 5-mg/l TN ***		**$36,050,000**	**$41,418,000**	**$42,320,000**	**$37,650,000**	**$43,964,000**	**$43,964,000**	**$39,830,000**	**$35,100,000**	**$40,006,000**	**$38,430,000**
Est. Add. Project Components for 3-mg/l TN ****			$6,070,000					$6,070,000		$11,533,000	$11,533,000
Total Project Costs to Achieve 3-mg/l TN			**$47,488,000**					**$45,900,000**		**$51,539,000**	**$49,963,000**

*** Note, based on Wastewater Facilities Plan (March 2015) project costs for Option 3.

**** Note, based on Wastewater Facilities Plan (March 2015) project costs for advanced treatment steps.

TABLE 4
COMPARATIVE OPERATIONS & MAINTENANCE COSTS (Options 1 through 5)

	Levelized Unit Cost	Unit	OPTION 1 - MLE PHASED TO BARDENPHO IN THE FUTURE			OPTION 2 - BARDENPHO PHASED INSTALLATION			OPTION 3 - BARDENPHO	OPTION 4 - SBR PHASED INSTALLATION		OPTION 5 - SBR
			PHASE 1 - MLE Process	PHASE 2A - Bardenpho Process without Primary Clarifiers	PHASE 2B - Bardenpho Process with Primary Clarifiers	PHASE 1 - Bardenpho Process	PHASE 2A - Bardenpho Process without Primary Clarifiers	PHASE 2B - Bardenpho Process with Primary Clarifiers	Bardenpho without Primary Clarifiers	PHASE 1 - SBR	PHASE 2 - SBR	
Electricity for Mechanical Equipment												
Annual Average		scfm	1,816	2,070	1,730	1,700	1,940	1,560	2,065	-	-	-
Total Operating Horsepower - Blowers		HP	81.4	92.8	77.5	76.2	87.0	69.9	92.6	-	-	-
Energy Use - Blowers		kwh/d	1,457	1,661	1,388	1,364	1,557	1,252	1,657	-	-	-
Energy Use - Mixers, IR, RS		kwh/d	519	779	627	627	779	627	779	-	-	-
Energy Use - Total		kwh/d	1,977	2,440	2,015	1,991	2,336	1,879	2,436	2,450	2,700	2,700
Annual Power Cost	$0.13	/kWh	**$94,500**	**$116,700**	**$96,300**	**$95,200**	**$111,700**	**$89,800**	**$116,500**	**$117,100**	**$129,100**	**$129,100**
Methanol												
Annual Average		gpd	90	100	120	85	70	70	115	0	50	50
Annual Cost of Methanol	$1.89	/gal	**$62,000**	**$69,000**	**$83,000**	**$59,000**	**$48,000**	**$48,000**	**$79,000**	**$0**	**$34,000**	**$34,000**
Sludge Processing												
Total Sludge Production		lbs/day	3,391	4,023	5,652	3,340	3,936	5,500	4,067	4,300	5,400	5,400
Dewatered Sludge Percent Solids		%	19%	19%	24%	19%	19%	24%	19%	19%	19%	19%
Dewatered Sludge		wtpd	9	11	12	9	10	11	11	11	14	14
Polymer of Dewatering at BFP's		gpd	14	16	23	13	16	22	16	17	22	22
Annual Polymer Cost	$5.50	/gal	$27,000	$32,000	$45,000	$27,000	$32,000	$44,000	$33,000	$35,000	$43,000	$43,000
Annual Cost for Sludge Hauling/Dewatering	$100	/WT	$326,000	$386,000	$430,000	$321,000	$378,000	$418,000	$391,000	$413,000	$519,000	$519,000
Total Annual Cost			**$353,000**	**$418,000**	**$475,000**	**$348,000**	**$410,000**	**$462,000**	**$424,000**	**$448,000**	**$562,000**	**$562,000**
Personel												
Additional Manhours		people/yr	0.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
Annual Cost	$70,400	per yr	**$0**	**$0**	**$70,400**	**$0**	**$0**	**$70,400**	**$0**	**$0**	**$0**	**$0**
Hydraulic Grade Line												
Hydraulic Grade Line Adjustment		ft	0	0	0	0	0	0	0	10	10	10
Total Operating Horsepower		HP								8.6	10.3	10.3
Annual Pumping Cost	$0.13	/kWh	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$7,400**	**$8,800**	**$8,800**
Total Annual O&M Costs **			**$509,500**	**$603,700**	**$724,700**	**$502,200**	**$569,700**	**$670,200**	**$619,500**	**$572,500**	**$733,900**	**$733,900**

** Note, project costs are only for comparison between options and do not include all project components (e.g., Influent Equalization, Headworks, Disinfection, Sludge Dewatering, facility-wide electrical service and distribution, etc.). Project costs include contingency and technical services.

TABLE 5
COMPARATIVE PRESENT WORTH COSTS (Options 1 through 5)

	OPTION 1 - MLE PHASED TO BARDENPHO IN THE FUTURE			OPTION 2 - BARDENPHO PHASED INSTALLATION			OPTION 3 - BARDENPHO	OPTION 4 - SBR PHASED INSTALLATION		OPTION 5 - SBR
	PHASE 1 - MLE Process	**PHASE 2A - Bardenpho Process without Primary Clarifiers**	PHASE 2B - Bardenpho Process with Primary Clarifiers	PHASE 1 - Bardenpho Process	PHASE 2A - Bardenpho Process without Primary Clarifiers	PHASE 2B - Bardenpho Process with Primary Clarifiers	**Bardenpho without Primary Clarifiers**	PHASE 1 - SBR	PHASE 2 - SBR	**SBR without Primary Clarifiers**
Capital Costs **	$16,480,000	$21,848,000	$22,750,000	$18,080,000	$24,394,000	$24,394,000	$20,260,000	$15,530,000	$20,436,000	$18,860,000
SRF Loan Rate	3.168%	3.168%	3.168%	3.168%	3.168%	3.168%	3.168%	3.168%	3.168%	3.168%
Loan Term, years	20	20	20	20	20	20	20	20	20	20
Capital Recover (A/P, i%, n)	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068
Annual Debt Payment **	**$1,125,000**	**$1,491,000**	**$1,553,000**	**$1,234,000**	**$1,665,000**	**$1,665,000**	**$1,383,000**	**$1,060,000**	**$1,395,000**	**$1,287,000**
Annual O&M Costs	$509,500	$603,700	$724,700	$502,200	$569,700	$670,200	$619,500	$572,500	$733,900	$733,900
Discount Rate	3.70%	3.70%	3.70%	3.70%	3.70%	3.70%	3.70%	3.70%	3.70%	3.70%
Term, years	10	10	10	10	10	10	20	10	10	20
Uniform Series Present Worth (P/A. i%, n)	8.233	8.233	8.233	8.233	8.233	8.233	13.959	8.233	8.233	13.959
Single Payment Present Worth (P/F, i%, n)		0.695	0.695		0.695	0.695			0.695	
Present Worth of O&M Costs	$4,194,900	$3,456,300	$4,149,100	$4,134,800	$3,261,700	$3,837,000	$8,647,400	$4,713,600	$4,201,700	$10,244,200
Total Present Worth of O&M Costs **	**4,194,900**	**7,651,200**	**8,344,000**	**4,134,800**	**7,396,500**	**7,971,800**	**8,647,400**	**4,713,600**	**8,915,300**	**10,244,200**
Total Present Worth **	**$20,674,900**	**$29,499,200**	**$31,094,000**	**$22,214,800**	**$31,790,500**	**$32,365,800**	**$28,907,400**	**$20,243,600**	**$29,351,300**	**$29,104,200**
Cost per Nitrogen Removed										
Effluent Total Nitrogen Achieved, mg/l	7.5	3.5	3.5	3.5	3.5	3.5	3.5	5.0	5.0	5.0
lbs Nitrogen Removed per Year (Total, inf to eff)	247,333	333,329	333,329	277,774	333,329	333,329	333,329	266,359	319,631	319,631
Construction Cost/lbs of Nitrogen Removed per year	$67	$66	$68	$65	$73	$73	$61	$58	$64	$59
O&M Cost/lbs of Nitrogen Removed per year	$2.06	$1.81	$2.17	$1.81	$1.71	$2.01	$1.86	$2.15	$2.30	$2.30
Total Present Worth/lbs of Nitrogen Removed per year	$84	$88	$93	$80	$95	$97	$87	$76	$92	$91

** Note, project costs are only for comparison between options and do not include all project components (e.g., Influent Equalization, Headworks, Disinfection, Sludge Dewatering, facility-wide electrical service and distribution, etc.). Project costs include contingency and technical services.

TABLE 6
COMPARATIVE PRESENT WORTH COSTS (Options 3 and 6)

	OPTION 3 - BARDENPHO	OPTION 6 - BARDENPHO PHASED INSTALLATION		New Material - 8/26/2015 OPTION 3 - BARDENPHO NOT PHASED	
	Bardenpho without Primary Clarifiers	PHASE 1 - Bardenpho and MLE Process	PHASE 2 - Bardenpho Process without Primary Clarifiers	PHASE 1 - Bardenpho and MLE Process	PHASE 2 - Bardenpho Process without Primary Clarifiers
Capital Costs **	$20,260,000	$16,224,000	$20,824,000	$20,260,000	$20,260,000
SRF Loan Rate	3.168%	3.168%	3.168%	3.168%	3.168%
Loan Term, years	20	20	20	20	20
Capital Recover (A/P, i%, n)	0.068	0.068	0.068	0.068	0.068
Annual Debt Payment **	**$1,383,000**	**$1,108,000**	**$1,422,000**	**$1,383,000**	**$1,383,000**
Annual O&M Costs	$619,500	$441,100	$604,700	$465,500	$619,500
Discount Rate	3.70%	3.70%	3.70%	3.70%	3.70%
Term, years	20	10	10	10	10
Uniform Series Present Worth (P/A. i%, n)	13.959	8.233	8.233	8.233	8.233
Single Payment Present Worth (P/F, i%, n)			0.695		0.695
Present Worth of O&M Costs	$8,647,400	$3,631,800	$3,462,000	$3,832,600	$3,546,800
Total Present Worth of O&M Costs **	**8,647,400**	**3,631,800**	**7,093,800**	**3,832,600**	**7,379,400**
Total Present Worth **	**$28,907,400**	**$19,855,800**	**$27,917,800**	**$24,092,600**	**$27,639,400**
Cost per Nitrogen Removed					
Effluent Total Nitrogen Achieved, mg/l	3.5	3.5	3.5	3.5	3.5
lbs Nitrogen Removed per Year (Total, inf to eff)	333,329	244,441	333,329	244,441	333,329
Construction Cost/lbs of Nitrogen Removed per year	$61	$66	$62	$83	$61
O&M Cost/lbs of Nitrogen Removed per year	$1.86	$1.80	$1.81	$1.90	$1.86
Total Present Worth/lbs of Nitrogen Removed per year	$87	$81	$84	$99	$83

** Note, project costs are only for comparison between options and do not include all project components (e.g., Influent Equalization, Headworks, Disinfection, Sludge Dewatering, facility-wide electrical service and distribution, etc.). Project costs include contingency and technical services.

August 12, 2015
W-P Project No. 12883B

Ms. Gloria Andrews, PE
Wastewater Engineering Bureau
Department of Environmental Services
29 Hazen Drive/ P.O. Box 95
Concord, NH 03302-0095

Subject: Town of Exeter – WWTF Upgrade
Phased Construction and Maintenance of Permitted Capacity

Dear Gloria:

We are making substantial progress on Exeter's WWTF Upgrade Preliminary Design Report (PDR) and expect to be completed in approximately one month. The Town has been very engaged in the preliminary design process and has decided to move forward with a Bardenpho process. This process is expected to produce effluent total nitrogen between 3.5 to 5 mg/l, which is better than that required under the AOC.

The Town has numerous and significant financial obligations related to its wastewater infrastructure under its AOC (for nitrogen) and AO (for CMOM). It is also facing what are expected to be significant costs related to non-point source nitrogen management and stormwater management associated with the MS4 program. As we have discussed on several conversations, the Town is considering options to improve the near-term affordability of the project. As you are aware, the cost of constructing treatment capacity is significant and one near-term cost saving concept which has been discussed is phasing the construction of treatment capacity.

On behalf of the Town, we are looking for written input from DES and EPA on the following question:

> ***Can the Town maintain its NPDES permit capacity of 3.0-mgd if it constructs the project in a phased manner where the first phase has a capacity which is less than 3.0-mgd if the permit is modified to identify a specific flow and load condition at which point the process of planning, designing, funding and constructing the upgrade to the full design capacity must begin?***

Attached please find a summary of such an approach for Exeter. We are continuing to refine the specifics of this proposal based on the Town's on-going influent sampling program (note that this refinement may result in an increase in the capacity of the initial phase); however, we believe the attached information provides suitable information to address the question.

In order to complete the PDR in the next month, we need to address this phasing/permit capacity question. Exeter's Board of Selectmen is scheduled to discuss this topic again on August 24. If at all possible, it would be great to have the DES/EPA input by that date.

If you have any questions or need any additional information, please contact me.

Very truly yours,

WRIGHT-PIERCE

Edward J. Leonard, PE
Project Manager

Attachment

cc: Daniel Arsenault – USEPA
Jennifer Perry, PE – Town of Exeter
Michael Jeffers – Town of Exeter
File (12883A-1)

EXETER – WWTF AND MAIN PUMP STATION UPGRADE
SUMMARY OF OPTION 3 VS OPTION 6
Wright-Pierce, 20 July 2015, rev 11 Aug 2015

BACKGROUND

During two meetings in May 2015 with DPW staff as well as some members of the Board of Selectmen (BOS), the Water & Sewer Advisory Committee (WSAC) and the Department of Environmental Services (DES), Wright-Pierce presented several options for WWTF Upgrades using either the Bardenpho process (flow-through) or the Sequencing Batch Reactor process (batch) and using various phased implementation approaches. By the end of the second meeting, the Town concluded that:

- The Bardenpho process was a better selection for the Town given the WWTF size and effluent requirements (i.e., Options 1, 2 or 3).
- The Bardenpho process constructed as one project (Option 3) rather than the phased approaches identified at the time – Option 1 (MLE process expanded to Bardenpho in the future) or Option 2 (smaller Bardenpho expanded to a larger Bardenpho in the future). Option 3 was the preferred approach given the lowest life-cycle cost.
- The same presentation should be made to the BOS and WSAC for their input and approval.

A combined BOS/WSAC meeting was held on June 17, 2015 to present the information (see attached powerpoint presentation). At the conclusion of this meeting, the BOS/WSAC affirmed the conclusion to move forward with the design of a Bardenpho process (Option 3); however, while the BOS/WSAC agreed that phasing Options 1 and 2 were not ideal options, they wanted to continue to evaluate phasing options. During the meeting, Wright-Pierce outlined a potential phasing scenario that involved construction of a larger Influent Equalization Basin in a phased implementation approach ("Option 6"). Option 6 is similar to Option 2 (in that it is also a phased Bardenpho); however, Option 6 has a slightly lower initial capacity, a lower initial cost and a much lower ultimate cost.

A combined BOS/WSAC meeting was held on August 10, 2015 to discuss Option 3 vs Option 6 (see attached powerpoint presentation). The Town is continuing to deliberate on this question. This memorandum provides a comparison of Option 3 vs Option 6.

COMPARISON OF OPTION 3 VS OPTION 6

It is important to note that both options ultimately provide for the following <u>common</u> features delivered under different timeframes:

- Design annual average capacity of 3.0-mgd;
- Peak hour capacity of up to 12.5-mgd (in combination with the Main Pump Station Upgrade and potential regional partners) through the screening and grit removal processes;
- influent equalization to minimize/eliminate CSOs (in combination with the Main Pump Station Upgrade) and to cap the peak day forward flow 6.6-mgd;
- Effluent TN <5-mg/l using the Bardenpho process;
- Three aeration tanks and three secondary clarifiers;
- Site layout which allows for *future* primary clarifiers, if desired;
- Site layout which allows for *future* fourth aeration tank and fourth secondary clarifier, if desired;
- Site layout which allow for *future* tertiary treatment to achieve effluent TN <3-mg/l, if required;

The differences between Option 3 and Option 6/ Phase 1 are identified below:

- The volume for influent equalization is increased from 2.0-MG (Option 3) to 4.0-MG (Option 6) in order to allow for a reduction in the peak day flow from 6.6-mgd (Option 3) to 6.0-mgd (Option 6).
- The reduction in the Phase 1 peak day flow rate allows for two aeration tanks and three secondary clarifiers to be constructed.
- The aeration tanks would be configured such that the operators can easily switch between a Bardenpho process and a MLE process (i.e., without moving large equipment or baffle walls). When operated as a Bardenpho process the Phase 1 annual average capacity is 2.2-mgd and when operated as an MLE process the Phase 1 annual average capacity is 2.65-mgd.
- The Town would operate in a Bardenpho configuration until it reaches an annual average flow of approximately 2.2-mgd (or appropriate influent TKN load). At that time, the Town would need to switch to the MLE process during the colder months in order to maintain nitrification through the winter. As flows continue to increase, the WWTF would remain in the MLE process for more of the year. Since the AOC provides an interim effluent TN limit of 8 mg/l, this approach is consistent with the AOC. Based on our understanding of the AOC, we anticipate that it will remain in place for at least 10 to 15 years.
- At the "trigger flow" (or trigger load), the Town would begin the process of obtaining funding approvals through the municipal appropriations process for design and construction of the third aeration tank.
- When the third aeration tank is completed, the design annual average capacity would be 3.0-mgd (in a Bardenpho configuration), the design peak day flow rate will be increased to 6.6-mgd and the effluent TN will be reduced back to <5-mg/l.

CONCLUSIONS

The AOC requires that the Town evaluate nitrogen removal progress and make a recommendation regarding treatment level identified in the NPDES permit by 2023. Given that the Town needs to evaluate treatment level over the next 10 years, the Town is also interested in considering treatment capacity. Based on growth projections in the Wastewater Facilities Plan and the Rockingham Planning Commission, there is a long-term need for the Town's licensed capacity; however, this capacity will not likely be needed until later in the planning period or beyond. The Town is interested in deferring the cost of constructing capacity that will not be needed for many years but not at the expense of losing its permitted capacity.

Based on our analysis, the estimated costs are summarized as follows:

- Capital cost for Option 3 (3.0-mgd capacity in a single project) is $39.8M (ENR CCI 9846).
- Capital cost for Option 6 (3.0-mgd capacity in two phases) is $40.4M; however, the first phase would be $35.8M (ENR CCI 9846). Said another way, Option 6 will save $4.0M now with the potential to cost an extra $0.6M later.
- Present worth cost for Option 3 and Option 6 are approximately equivalent.

Town of Exeter
WWTF - Preliminary Design Phase
Nutrient Removal Process Analysis

Presented By:
Ed Leonard, PE
Doug Hankins, PE

May 22, 2015
June 17, 2015

WRIGHT-PIERCE
Engineering a Better Environment

Purpose of this Meeting

1. Discuss Wastewater Facilities Plan recommendations
2. Select the biological treatment process
3. Select the phasing strategy

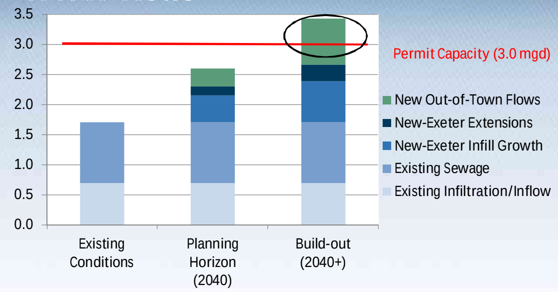
2

Effluent Nitrogen Requirements

- NPDES Permit
  - Issued in 2012 by EPA
  - Achieve <3 mg/l TN, seasonal rolling average
- AOC (Administrative Order on Consent)
  - Legal agreement with the EPA in 2013
  - Achieve 'interim limit' of <8mg/l TN, seasonal rolling average

3

Wastewater Facilities Plan
WWTF Flows



May need to limit future out-of-town flows
and/or reduce I/I flows,
and/or negotiate a higher permit limit

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Wastewater Facilities Plan
Nitrogen Removal Alternatives

Identified:

More Common	Less Common
Modified Ludzack-Ettinger (MLE)	Moving Bed Bioreactor (MBBR)
Four-Stage Bardenpho	Biolac
Sequencing Batch Reactor (SBR)	BioMag
Oxidation Ditch	Rotating Biological Contactors (Aerobic/Anoxic)
Schreiber Cyclic Aeration	De-ammonification
Integrated Fixed Film Activated Sludge (IFAS)	Trickling Filters
Membrane Bioreactors (MBR)	Breakpoint Chlorination
Denitrification Filters	Air Stripping

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Wastewater Facilities Plan
On-Site Nitrogen Removal Alternatives

Evaluated:

- Option 1 – MLE with Denitrification Filter
- Option 2 – Bardenpho with Traditional Filter
- Option 3 – SBR with Denitrification Filter
- Option 4 – Biolac with Denitrification Filter

All options have a 'pathway to 3 mg/l'

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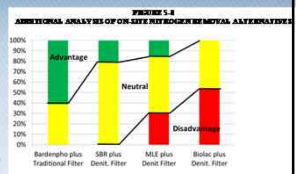
Wastewater Facilities Plan
On-Site Nitrogen Removal Alternatives

Conclusions:

- For 8mg/l, low PW is MLE
- For 5mg/l, low PW is SBR
- For 3mg/l, low PW is Bpho
- Bpho most cost-effective as $$ per lb TN removed
- Bpho most advantageous process when considering non-cost factors



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Wastewater Facilities Plan
On-Site Nitrogen Removal Alternatives

Recommended:

- Implement Bardenpho or SBR (carried costs for Bpho)
- Evaluate phasing approaches (2.1 mgd, 2.5 mgd, etc.)

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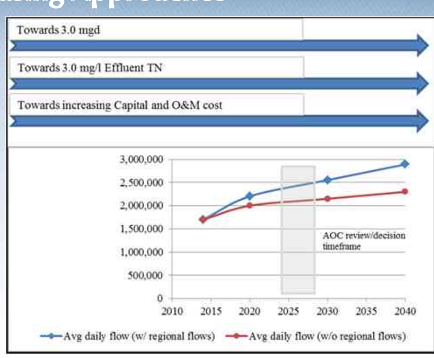
Wastewater Facilities Plan
Phasing Approaches



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Wastewater Facilities Plan Phasing Approaches

TABLE 6-3
POTENTIAL PHASING OPPORTUNITIES FOR ON-SITE ALTERNATIVES

Alternative	Initial Project	Future Project
2A	Construct Bardenpho for 3.0-mgd	Add Filters for 3.0-mgd
2B	Construct MLE for 3.0-mgd	Expand to Bardenpho, add Filters for 3.0-mgd
2C	Construct Bardenpho for 2.1-mgd	Expand and add Filters for 3.0-mgd
2D	Construct MLE for 3.0-mgd	Add Primary Clarifiers, re-rate to Bardenpho for 3.0-mgd, add Filters for 3.0-mgd
2E	Construct Bardenpho for 2.1-mgd now	Add Primary Clarifiers, re-rate to Bardenpho for 3.0-mgd, add Filters for 3.0-mgd
3A	Construct SBR for 3.0-mgd	Add Denit Filter for 3.0-mgd
3B	Construct SBR for 2.1-mgd	Add 3rd SBR and Denit Filter for 3.0-mgd

Note: The recommended plan is Alternative 2A "Initial Project".

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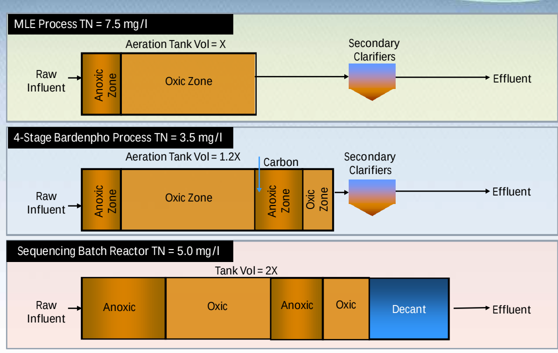
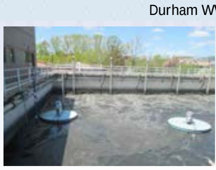
Process Configurations



Flow-Through vs Batch Process


Durham WWTF - Durham, NH




Pease WWTF - Portsmouth, NH

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Pre-Design Phase Process Alternatives

Short Listed:

- Option 1 – MLE Phased to **Bardenpho** in the Future
- Option 2 – **Bardenpho** Phased Installation
- Option 3 – **Bardenpho** not Phased
- Option 4 – **SBR** Phased
- Option 5 – **SBR** not Phased

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On-Site WWTF Process Alternatives

Short Listed:

- **Option 1 – MLE Phased to Bardenpho in the Future**
- **Option 2 – Bardenpho Phased Installation**
- Option 3 – Bardenpho not Phased
- Option 4 – SBR Phased
- Option 5 – SBR not Phased

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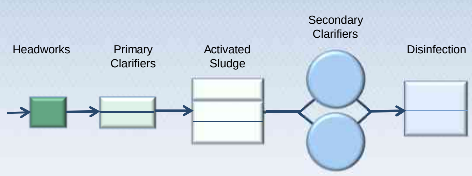
Phased Treatment Approach

Phase 1 – 2.5 mgd Annual Average
Phase 2 – 3.0 mgd Annual Average



- **Phase 1 – Two aeration tanks, no primary clarifiers**
- **Phase 2A – Three aeration tanks, no primary clarifiers**
- **Phase 2B – Two aeration tanks, two primary clarifiers**

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Phase 1 – 2.5 mgd Annual Average Capacity (MLE and Bardenpho)

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Phase 2A – 3.0 mgd Annual Average Capacity (MLE and Bardenpho)

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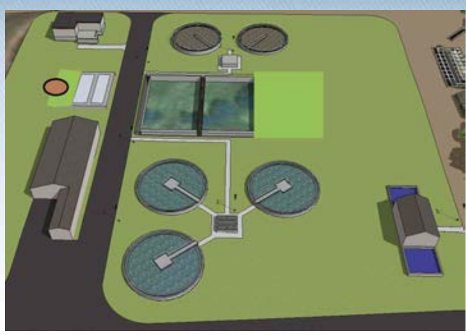
Phase 2B – 3.0 mgd Annual Average Capacity (MLE and Bardenpho)



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On-Site WWTF Process Alternatives

Short Listed:

- Option 1 – MLE Phased to Bardenpho in the Future
- Option 2 – Bardenpho Phased Installation
- Option 3 – Bardenpho not Phased
- Option 4 – SBR Phased
- Option 5 – SBR not Phased

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Option 3 – 3.0 mgd Annual Average Capacity (Bardenpho)

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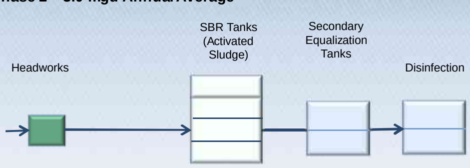
Phased Treatment Approach - SBR

Phase 1 – 2.5 mgd Annual Average
Phase 2 – 3.0 mgd Annual Average



- **Phase 1 – Three SBR tanks, no primary clarifiers**
- **Phase 2 – Four SBR tanks, no primary clarifiers**

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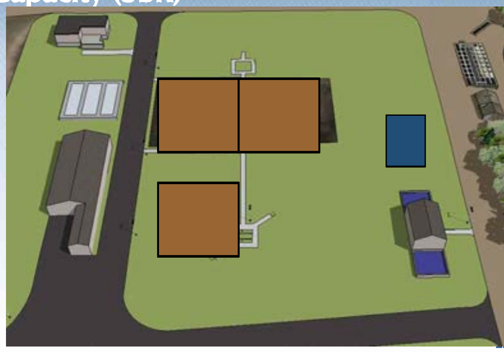
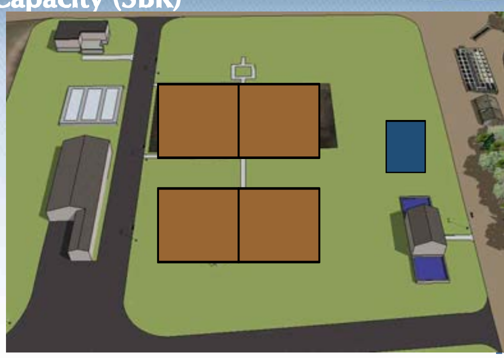
Option 4 – 2.5 mgd Annual Average Capacity (SBR)



Option 4 – 3.0 mgd Annual Average Capacity (SBR)



Option 5 – 3.0 mgd Annual Average Capacity (SBR)

Advantages and Disadvantages

Alternatives	Advantages	Disadvantages
MLE Process	• Expandable to a 4-stage Bardenpho process	• Cannot meet 5.0 mg/l or 3.0 mg/l total nitrogen
Bardenpho without Primary clarifiers	• Can achieve TN ≈ 3.5 mg/l • Future tertiary upgrade may be avoidable	• Large aeration tanks
Bardenpho with primary clarifiers	• Can achieve TN ≈ 3.5 mg/l • Tertiary upgrade may be avoidable • Reduces aeration tank size	• Two additional processes (primary clarifiers, gravity thickeners) • Greatest complexity of the four alternatives
Sequencing Batch Reactors	• Simplest operation if PLCs operational. • Greatest degree of automation • Can achieve TN ≈ 5.0 mg/l	• Complex operation if PLC controllers fail. • Cannot meet a future 3.0 mg/l total nitrogen limit without denitrification filters

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Equipment Differences

	Option 3 Bardenpho	Option 5 SBR
Blowers	(3) 150 HP Blowers	(5) 200 HP PD Blowers (1) 25 HP PD Blower
Mixers	(12) 3 HP mixers	(3) 50 HP Floating mixers
Pumps	(3) 5 HP pumps (4) 10 HP pumps (2) 5 HP pumps	(3) 7.5 HP pumps (4) 30 HP pumps
Other	(3) 1 HP Drives	(3) Decanting Assemblies
Total Devices and connected HP	**(27) 554 HP**	**(19) 1,318 HP**

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Comparative Cost Estimating

- Capital Cost
  - Annual Debt Payment
- Annual O&M Cost
  - Total Present Worth of O&M Costs
- Total Present Worth (or 'Life Cycle Cost')
- Present Worth Cost per pound TN removed

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Comparative Cost Estimating Results

	2.5-mgd Capital	3.0-mgd Capital	3.0-mgd PW	PW per Lb N Removed
1A – MLE to Bardenpho w/o Primary	$16.5M	$21.8M	$29.5M	$88
1B – MLE to Bardenpho with Primary	$16.5M	$22.8M	$31.1M	$93
2A – Bardenpho Phased w/o Primary	$18.1M	$24.4M	$31.8M	$95
2B – Bardenpho Phased with Primary	$18.1M	$24.4M	$32.4M	$97
3 – Bardenpho Not Phased	-	$20.3M	$28.9M	$87
4 – SBR Phased	$15.5M	$20.4M	$29.4M	$92
5 – SBR Not Phased	-	$18.9M	$29.1M	$91

- Phasing with primary clarifiers is not worth considering further (Option 1B, 2B).
- Phasing Bardenpho is not worth considering further (Option 2A). Saves $2.1M in initial capital but increases total capital cost by $4.1M over Option 3.
- Option 1 is best phasing option. Saves $3.7M in initial capital but increases total capital cost by $1.6M over Option 3.
- Phasing SBR is not worth considering further (Option 4). Saves $3.4M in initial capital but increases total capital cost by $1.5M over Option 5.

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Cost Summary - Shortlist

	Option 1A		Option 3	Option 5
Comparative Costs	MLE–P1	Bpho-P2	Bpho	SBR
Capital Cost	$16.5M	$21.8M	$20.3M	$18.9M
Annual O&M	$0.51M	$0.60M	$0.62M	$0.73M
Total Present Worth	$20.7M	$29.5M	$28.9M	$29.1M
PW per Lb N Removed	$84	$88	$87	$91
Total 'Current' Capital Cost (<5mg/l)	$36.1M	$41.4M	$39.8M	$38.4M
Cost for Future Upgrade	n/a	$6.1M	$6.1M	$11.6M
Total Future Capital Cost (<3.0 mg/l, 3.0 mgd)	n/a	$47.5M	$45.9M	$50.0M

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Recommendations

- Option 3 – Bardenpho for 3.0 mgd is recommended
  - Lowest present worth for TN 5 mg/l
  - Lowest present worth per pound TN removed per year
  - Lowest capital cost to achieve future TN 3 mg/l
  - Lower annual O&M costs than SBR alternatives
- Consider Option 1 – MLE phased to Bardenpho
  - If capital cost savings over-ride future cost premium
- Option 5 would be recommended if effluent limit was TN 5 mg/l

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Pre-Design
Additional Cost Saving Opportunities

- Larger influent equalization basin? Maybe
- 2 vs 3 aeration tanks? Not recommended
- Higher MLSS? Not recommended
- Rectangular secondary clarifiers? Maybe
- 2 vs 3 secondary clarifiers? Maybe

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Questions & Discussion

Town of Exeter
WWTF - Preliminary Design Phase
Nutrient Removal Process Analysis

Presented By:
Ed Leonard, PE
Doug Hankins, PE

August 10, 2015

WRIGHT-PIERCE
Engineering a Better Environment

TOWN OF EXETER FOUNDED 1638 NEW HAMPSHIRE

Purpose of this Meeting

1. Follow-up on decisions and questions from the June 17 combined BOS/WSAC meeting
2. Select the phasing strategy

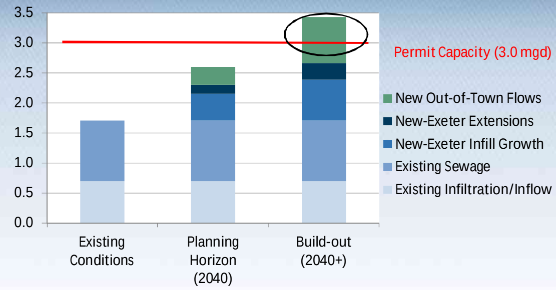
2

Effluent Nitrogen Requirements

- NPDES Permit
  - Issued in 2012 by EPA
  - Achieve <3 mg/l TN, seasonal rolling average
- AOC (Administrative Order on Consent)
  - Legal agreement with the EPA in 2013
  - Achieve 'interim limit' of <8mg/l TN, seasonal rolling average

3

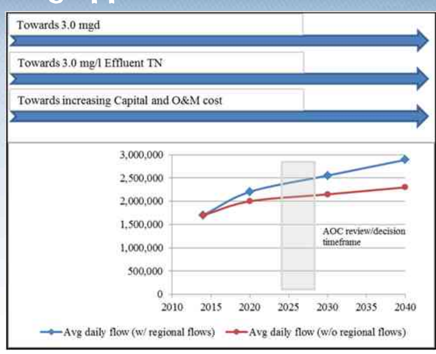
Wastewater Facilities Plan
WWTF Flows



May need to limit future out-of-town flows
and/or reduce I/I flows,
and/or negotiate a higher permit limit

4

Wastewater Facilities Plan
Phasing Approaches



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Pre-Design Phase
Process Alternatives

Short Listed:

- Option 1 – MLE Phased to **Bardenpho** in the Future
- Option 2 – **Bardenpho** Phased Installation
- Option 3 – **Bardenpho** not Phased
- Option 4 – **SBR** Phased
- Option 5 – **SBR** not Phased

6

Pre-Design Phase Process Alternatives

Short Listed:

- Option 1 – MLE Phased to **Bardenpho** in the Future
- Option 2 – **Bardenpho** Phased Installation
- Option 3 – **Bardenpho** not Phased
- Option 4 – **SBR** Phased
- Option 5 – **SBR** not Phased
- Option 6 – **Bardenpho** Phased with Larger Equalization

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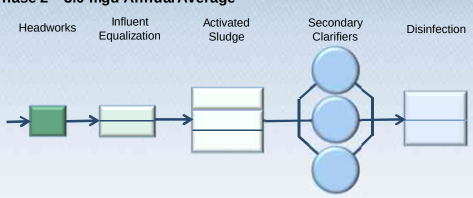
Option 6 - Phased Treatment Approach

Phase 1 – 2.2/2.65 mgd Annual Average (Bardenpho/MLE)
Phase 2 – 3.0 mgd Annual Average



- **Phase 1 – Two aeration tanks; three secondary clarifiers; larger Influent Equalization**
- **Phase 2 – Third aeration tank**

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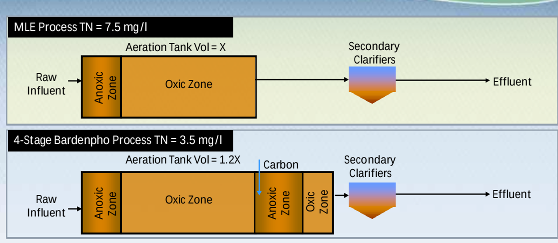
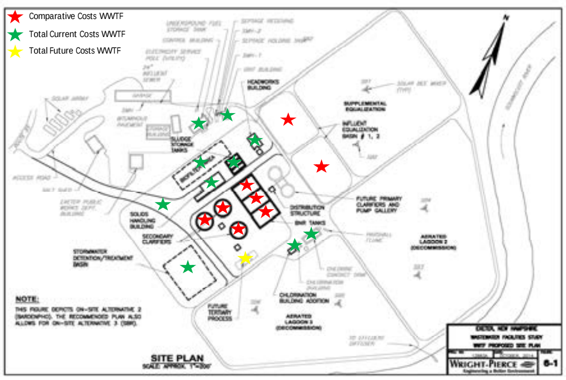
Process Configurations



Comparative Cost Estimating

- Capital Cost
  - Annual Debt Payment
- Annual O&M Cost
  - Total Present Worth of O&M Costs
- Total Present Worth (or 'Life Cycle Cost')
- Present Worth Cost per pound TN removed

10



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Comparative Cost Estimating Results

	2.20/2.65-mgd Capital	3.0-mgd Capital	3.0-mgd PW	PW per Lb N Removed
3 – Bardenpho Not Phased	-	$20.3M	$28.9M	$87
6 – Bardenpho Phased	$16.2M	$20.8M	$27.9M	$84

- Option 6:
  - Requires two projects
  - Will save ~$4.0M now and cost an extra $0.6M later.
  - Has a lower 20-yr present worth
  - Has a lower cost per pound TN removed

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WWTF Cost Summary

	Option 3	Option 6	
Comparative Costs			
Capital Cost	$20.3M	$16.2M	$20.8M
Annual O&M	$0.62M	$0.44M	$0.61M
Total Present Worth	$28.9M	$19.9M	$27.9M
PW per Lb N Removed	$87	$81	$84
Total 'Current' Capital Cost (<5mg/l)	$39.8M	$35.8M	$40.4M
Cost for Future Upgrade	$6.1M	n/a	$6.1M
Total Future Capital Cost (<3.0 mg/l, 3.0 mgd)	$45.9M	n/a	$46.4M

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Advantages and Disadvantages

Alternatives	Advantages	Disadvantages
Option 3	• One project • Can achieve TN ≈ 3.5 mg/l • Lower capital in long term	• Higher capital in near term
Option 6	• Lower capital in near term • Lower 20-yr PW in long term • Can achieve TN ≈ 3.5 mg/l	• Higher capital in long term • Two projects • May need to run MLE for a few years prior to second phase. • More equipment and labor associated with larger IEQ • Needs NHDES approval on the phasing plan to not lose NPDES permit capacity

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Project Costs for Components of the Recommended Plan (March 2015)

	WWTF	Main PS, FM, WM	Lagoon Decomm.	Total
For 3mgd, <8mg/l	$36.29M	$5.07M	$6.97M	$48.33M
For 3mgd, <5mg/l	$39.83M	$5.07M	$6.97M	$51.87M
For 3mgd, 3mg/l	$45.90M	$5.07M	$6.97M	$57.94M
Range	$9.61M	-	-	$9.61M

The process analysis presented herein relates only to the WWTF portion of the Recommended Plan (highlighted in green).

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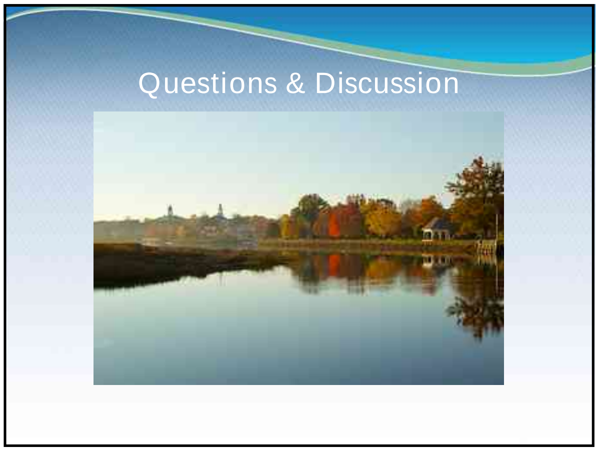

Questions & Discussion

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
5 POST OFFICE SQUARE SUITE 100
BOSTON, MASSACHUSETTS 02109-3912

August 20, 2015

Mr. Edward J. Leonard, PE
Senior Project Manager
Wright-Pierce
75 Washington Street, Suite 202
Portland, Maine 04101

RE: Town of Exeter – NPDES Permit No. NH0100871
Phase Construction and Permitted Capacity

Dear Mr. Leonard:

This letter is in response to your August 12, 2015 letter to Gloria Andrews of NHDES in which you asked the following:

> Can the Town maintain its NPDES permit capacity of 3.0 mgd if it constructs the project in a phased manner where the first phase has a capacity which is less than 3.0 mgd if the permit is modified to identify a specific flow and load condition at which point the process of planning, designing, funding and constructing the upgrade that the full design capacity must begin?

Your letter indicated that this approach would provide near term cost savings for the Town.

Based upon your letter, the Town would first build a facility that would be able to operate as a Bardenpho or MLE process. The design flow for the plant operating in Bardenpho mode would be 2.2 mgd whereas the design flow for MLE operation would be 2.65. At a "trigger flow" (or trigger load) the Town would begin the process of obtaining funding for design and construction of a third aeration tank which would increase the design flow of the Bardenpho process to 3.0 mgd which is the currently permitted design flow of the treatment plant.

Based upon the information you provided the NPDES permit for the Town of Exeter could be reissued with tiered effluent limits. In a tiered permit scenario, the first tier would contain effluent limits based upon the initial design flow of 2.65 mgd and the second tier would contain the limits for the final design flow of 3.0 mgd. The existing permit expires on March 1, 2018.

Federal regulations found at 40 CFR 122.45(b)(1) state that in the case of POTWs, permit effluent limitations, standards or prohibitions shall be calculated based upon the design flow. Therefore, in order to meet these requirements and include the second tier in the permit, we would request that you provide documentation that your facility has been designed to treat 2.65 mgd and to be readily expanded to 3 mgd.

Please note that while EPA could accommodate Exeter's request for a permit which provides for an eventual 3 mgd flow, as long as documentation is provided, the Town must also comply with all condition of Administrative Order on Consent No. 13-010 issued to the Town on June 24, 2013. Additionally, the Town must meet all the requirements under New Hampshire Code of Administrative Rules Env-Wq 700 Standards of Design and Construction for Sewerage and Wastewater Treatment Facilities.

Should you have any questions or wish to discuss this matter further please contact Dan Arsenault of my staff at (617) 918-1562.

Sincerely,

Ellen Weitzler

Ellen Weitzler, PE, Chief
Municipal NPDES Permits Section

cc:

Stergios Spanos, NHDES
Tracy Wood, NHDES

The State of New Hampshire
DEPARTMENT OF ENVIRONMENTAL SERVICES

NHDES

Thomas S. Burack, Commissioner

August 21, 2015

Mr. Edward J. Leonard, PE
Wright-Pierce
230 Commerce Way, Suite 302
Portsmouth, NH 03801

Subject: Town of Exeter-WWTF Upgrade/WWEB Project No. D2015-0806
Phased Construction and Maintenance of Permitted Capacity

Dear Mr. Leonard:

In your letter dated August 12, 2015, addressed to Gloria Andrews of our Design Review Section, you asked whether Exeter can maintain its NPDES permit capacity of 3.0 mgd if it constructs its WWTF upgrade project in a phased manner. You indicated that the first phase would have a capacity of less than 3.0 mgd and the permit would identify the specific flow and load conditions at which point the process of planning, designing, funding, and constructing the upgrade to the full design capacity must begin. You indicated in your letter that this phased approach would provide near-term cost savings for Exeter.

N.H. Code Admin. Rules Env-Wq 700 establishes design and construction standards for wastewater treatment facilities. Env-Wq 707.04, Basis of Design Report: Project Need. states that for existing and proposed projects, the basis of design report shall address the need for the project based on a description or analysis of certain conditions, which are listed as (a) through (f). Env-Wq 707.04(b) states "The design period for the WWTP, which shall be not less than 20 years unless a shorter design period is shown to be more cost effective when taken into consideration construction of additional facilities needed to meet the peak demand for the 20-year design period." Env-Wq 707.04(c)(1) further states that the design period evaluation shall include an evaluation of future expansion requirements in excess of the planning period, when laying out and designing major treatment units and WWTP hydraulics. Env-Wq 707.04(e) states that present and proposed future discharge permit limits, if any shall be considered in the Basis of Design Report.

Based on the above excerpts, a tiered construction approach may be allowed if it is shown to be more cost effective. However, there are many considerations to this approach, including but not limited to the following.

- Exeter must address and meet all requirements of EPA AOC 13-010 as related to its WWTF Upgrade Project.
- Exeter must meet all applicable requirements of Env-Wq 700, including without limitation:
    - Env-Wq 708.05(a) WWTP Design and Layout must include locations of foreseeable future facilities on construction drawings.

  - Env-Wq 708.05(b) WWTP hydraulics, sizing of conduits connecting unit processes, and flow distribution shall provide for future expansion.
- Exeter must meet the 80 percent design flow capacity or design loading capacity permit requirement for all permit conditions.
- Exeter must consider the time to design, bid and construct additional facilities required to meet varying flow and loading conditions while maintaining compliance with EPA AOC 13-010.

As you know, EPA issues National Pollutant Discharge Elimination Permits pursuant to its authority under the Federal Clean Water Act, as amended (33 U.S.C. §§1251 *et seq*.; the "CWA"), and in particular CWA section 402. DES typically adopts the federal NPDES permit as the state discharge permit required by RSA 485-A:13,I.(a).

EPA may not issue a permit until a state certification is granted or waived in accordance with the CWA, section 401(a)(1) and pursuant to 40 CFR section 124.55. As part of the certification process, DES must certify that the permit meets state water quality standards. DES certified Exeter's current permit for 3.0 mgd and included additional language beseeching EPA to provide flexibility to the community to meet permit requirements. This proposal for a tiered approach adheres to the spirit of that language. Assuming conditions remain essentially the same in the future, we anticipate that DES will be able to certify a tiered permit with one set of limits based on a design flow of 3.0 mgd and another set of interim limits (with lower effluent loadings) based on an interim flow that is less than 3.0 mgd.

Stergios Spanos of DES has spoken with EPA about your question. EPA will be responding separately about the tiered approach proposed by Exeter.

Sincerely,

Tracy L. Wood

Tracy L. Wood, PE
Administrator
Wastewater Engineering Bureau

cc: Ellen Weitzler, EPA
Dan Arsenault, EPA
Stergios Spanos, PE, Permits & Compliance Section Supervisor, WEB, DES
Gloria Andrews, PE, Design Review, WEB, DES

WRIGHT-PIERCE
Engineering a Better Environment

MEMORANDUM

TO:	File	DATE:	August 26, 2015
FROM:	Ed Leonard	PROJECT NO.:	12883B
SUBJECT:	Exeter NH – Updates to Design Loads		

The March 2015 *Wastewater Facilities Plan* (the "Study") identified the future flows based on growth projections which are described in detail in Section 2 of the Facilities Plan. The growth projections were made based on meeting held in Spring 2014. The future flow projections are summarized in Table 1 below.

TABLE 1
EXISTING AND PROJECTED FLOWS IN FACILITIES PLAN

Category	Current (gpd)	Design (Ex. WWTF) (gpd)	Planning Horizon (2040) (gpd)	Theoretical Build-out (2040+) (gpd)
Existing – Sewage	1,000,000		1,000,000	1,000,000
Existing – I/I	700,000		700,000	700,000
Sewered Growth/Extensions	0		600,000	963,000
Septage	0		3,000	3,000
New Flows - Other Towns	0		300,000	777,000
Total	**1,700,000**	**3,000,000**	**2,603,000**	**3,443,000**

Pollutant loads were estimated based on a review of existing flows and pollutant loads as well as on an estimate of wastewater concentrations for key wastewater constituents for residential, commercial and industrial growth categories. The existing and projected flows and loads presented in the Facilities Plan are summarized in Table 2 and Table 3 below.

TABLE 2
EXISTING FLOWS AND LOADS (2011-2014) IN FACILITIES PLAN

	Flow	**BOD**		**TSS**		**TKN**		**TP**	
	mgd	**mg/l**	**lb/day**	**mg/l**	**lb/day**	**mg/l**	**lb/day**	**mg/l**	**lb/day**
Annual Average	1.71	150	2,138	178	2,544	21	306	3.2	45
Maximum Month	2.88	145	3,484	151	3,632	13	320	2.4	57
Maximum Day	3.75	135	4,210	140	4,376	15	480	2.5	77
Instantaneous Peak	5.65	-	-	-	-	-	-	-	-

TABLE 3
FLOWS AND LOADS "WITH SEPTAGE" (2040+) IN FACILITIES PLAN

	Flow	BOD		TSS		TKN		TP	
	mgd	**mg/l**	**lb/day**	**mg/l**	**lb/day**	**mg/l**	**lb/day**	**mg/l**	**lb/day**
Annual Average	3.0	224	5,600	256	6,400	28	710	4.8	120
Maximum Month	5.1	167	7,100	263	11,200	22	940	3.5	150
Maximum Day	6.6	149	8,200	243	13,40	20	1,120	3.8	210
Instantaneous Peak	9.75	-	-	-	-	-	-	-	-

Some components of the projected flows and loads were adjusted upward for the "comparative analyses" which began early in the design phase. This adjustment was made to account for higher observed wastewater concentrations during Spring 2015. The "comparative analysis" flows and loads are summarized in Table 4 below.

TABLE 4
FLOWS AND LOADS "WITH SEPTAGE" (2040+) FOR COMPARATIVE ANALYSES

	Flow	BOD		TSS		TKN		TP	
	mgd	**mg/l**	**lb/day**	**mg/l**	**lb/day**	**mg/l**	**lb/day**	**mg/l**	**lb/day**
Annual Average	3.0	224	5,600	256	6,400	40	1,000	6.0	150
Maximum Month	5.1	172	7,300	226	9,600	31	1,300	4.7	200
Maximum Day	6.6	183	10,100	209	11,520	33	1,800	4.9	270
Instantaneous Peak*	6.6	-	-	-	-	-	-	-	-

*Peak instantaneous flow managed via influent equalization

As a point of comparison, the original design flows and loads for the existing aerated lagoon WWTF are summarized in Table 5 below (Source: HTA O&M Manual, 1991). The existing flows and loads are substantially below these values.

TABLE 5 - EXISTING WWTF DESIGN LOADS

	Flow	BOD		TSS		TKN		TP	
	mgd	**mg/l**	**lb/day**	**mg/l**	**lb/day**	**mg/l**	**lb/day**	**mg/l**	**lb/day**
Annual Average	3.0	184	4,600	208	5,100	-	-	-	-
Maximum Month	-	-	-	-	-	-	-	-	-
Maximum Day	-	-	-	-	-	-	-	-	-
Instantaneous Peak	7.5	-	-	-	-	-	-	-	-

These original projections had a lower pollutant load associated with the projected design average flow of 3.0-mgd.

The future flows presented in the theoretical build-out column of Table 2-12 in the Study are optimistic growth projections that exceed Exeter's 3.0-mgd NPDES permit capacity. These future projections indicate that there is more potential demand for capacity then there is available capacity.

The stated assumption in the Study was that, if Stratham and Newfields are connected and if all three towns reach the projected wastewater flows identified herein, then additional I/I flows will need to be "mined out" to create the capacity or less growth would be allowed. This assumption increases the future loadings significantly because approximately 440,000 gpd of 'clean water' is replaced with 440,000 gpd of sewage with its associated organic loading.

Ultimately, the Town is looking to maintain is 3.0-mgd NPDES permit capacity. Given that unused wastewater treatment capacity is expensive to build and maintain, it is appropriate to adjust the design capacity flows and loads to reflect the existing 3.0-mgd permitted flow. The adjustment was made by reducing the theoretical build-out allocations as follows:

- For Exeter, from 1.96-mgd to 1.76-mgd.
- For Stratham, from 0.66-mgd to 0.46-mgd (if approved by the Town of Exeter).
- For Newfields, from 0.117-mgd to 0.075-mgd (if approved by the Town of Exeter).
- Existing Infiltration/Inflow was held constant at 0.7-mgd.

As a part of the preliminary design process, the projected loads were revisited and were refined based on more realistic assessments of loading contributions. These adjustments were made for the various wastewater constituents (BOD_5, TSS, TKN, TP). A comparison of BOD_5 loads for current conditions, existing WWTF design conditions, projected conditions in the Facilities Plan and the revised projected conditions is provided in Table 6 below. ***The updated loadings do not change the conclusions developed as a part of the "comparative analysis" documented in separate technical memoranda.***

The revised loads are more appropriate so as to not over-design/over-build the facility. Accordingly, the revised flows and loads that will be used in the Preliminary Design Report are summarized in Tables 7 and 8 below.

TABLE 6 - COMPARISON OF BOD_5 LOADINGS UNDER VARIOUS SCENARIOS

Category	Current (lbs/day)	Original Design (lb/day)	Study (2040+) (lbs/day)	Revised (2040+) (lbs/day)	Revised (2040) (lbs/day)	Revised (Phase 1) (lbs/day)
Sewage *	2,140	4,600	4,110	4,110	3,830	3,830
Septage	0	In above	200	In above	In above	In above
Future Sewage - Stratham **	n/a	n/a	1,100	765	420	170
Future Sewage - (Newfields)	n/a	n/a	190	125	80	0
Total	**2,140**	**4,600**	**5,600**	**5,000**	**4,330**	**4,000**

*Includes existing flows from Exeter, Stratham and Hampton as well as future flows for Exeter.
** The revised scenarios assume 460,000 gpd, 250,000 gpd and 100,000 gpd from Stratham under 2040+, 2040 and Phase 1 conditions, respectively.

TABLE 7 – DESIGN FLOWS AND LOADS SUMMARY – FULL FACILITY

	Flow	BOD		TSS		TKN		TP	
	Mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Annual Average	3.0	200	5,000	236	5,900	33	815	4.8	120
Maximum Month	4.5	176	6,600	205	7,700	28	1,060	4.0	150
Maximum Day	6.6	183	10,100	196	10,800	27	1,470	3.6	200
Instantaneous Peak*	6.6	-	-	-	-	-	-	-	-

*Peak instantaneous flow managed via influent equalization

TABLE 8 – DESIGN FLOWS AND LOADS SUMMARY – PHASE 1, IF APPLICABLE

	Flow	BOD		TSS		TKN		TP	
	Mgd	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day	mg/l	lb/day
Annual Average	2.6	197	4,000	231	4,600	30	655	4.2	90
Maximum Month	4.0	166	5,540	195	6,500	25	850	3.6	120
Maximum Day	5.5	184	8,460	198	9,060	26	1,180	3.6	166
Instantaneous Peak*	6.0	-	-	-	-	-	-	-	-

*Peak instantaneous flow managed via influent equalization

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE

PROJECT NO.: 12883B

PRELIMINARY DESIGN PACKAGE

System/Subject:	Activated Sludge System		
Calculations By:	DLS	Date:	6/19/15
Checked By:	EJL/WDH	Date:	7/29/15
Revised By:	DLS	Date:	9/18/15
Checked By:	WDH	Date:	9/18/15

Checklist (to be completed by Design Engineer prior to calculation checking):

X Brief Process Description

X Graphs/Sketches of System Attached (Plans & Schematics)

X Design Calculations Attached

X Design Guidelines/Standards Noted

X Equations Noted and Referenced

X Electrical Loads Developed and Identified

X Process Control Description Developed

X Preliminary Basis of Design (Support Divisions) Attached

X Construction Sequence Developed

X Product Information Attached

X Manufacturer's Review of Specs and Drawings (If Applicable)

X Electronic File Location Noted

X Program(s) Used (Version) Noted

X Coordinated with Hydraulic Profile (If Applicable)

DESCRIPTION OF EXISTING FACILITIES

Secondary treatment is currently accomplished using three aerated lagoons with a total volume of 76 million gallons. The lagoons use floating aerators to provide aeration. The existing lagoons cannot be configured to reliably achieve the nitrogen removal requirements identified in the NPDES permit or the AOC (due to lower effluent requirements and specific calendar year time frames). The lagoons will be replaced by an activated sludge treatment system to meet these specified limits and timeframes.

FACILITY PLAN RECOMMENDATIONS

The Facility Plan recommended construction of three trains of activated sludge/ nitrogen removal process, including mixers, pumps, blowers, fine bubble diffused aeration systems, instrumentation (air flow, dissolved oxygen, ORP, nitrate, ammonia, TSS), control systems, flow splitter structures and site piping. The two alternatives for process configuration recommended were the Four-stage Bardenpho process and the Sequencing Batch Reactor (SBR). Peak flow to the secondary system will be limited by influent equalization.

CLIENT PREFERENCES

The Four-Stage Bardenpho process with 2 trains (up to 4 in the future) was selected as documented in a separate memo.

DESIGN GUIDELINES (TR-16, EPA MANUAL, ETC.)

Design of the activated sludge system follows recommendations from TR-16 Section 6.3 *Suspended Growth Systems*, specifically (but not limited to) the following:

- Three-compartment anoxic selectors and relative sizing for efficient denitrification and bulking sludge control
- A minimum of 4:1 length:width for a diffused aeration basin
- Redundancy: Total aeration volume should be divided among two or more units capable of individual operation
- Guidelines for sizing aeration equipment

- Guidelines for design of secondary clarification and return sludge rates using solids flux analysis (State Point)

DESIGN GUIDELINES (NHDES Env-Wq)

Design of the activated sludge system follows recommendations from NHDES Env-Wq Section 713.01 to .05 *Activated Sludge Design,* specifically (but not limited to) the following:

- All activated sludge designs shall include provisions for the control of bulking sludge and filamentous micro-organisms

- The return sludge rate shall be varied by means of variable speed motors, drives, or timers. The maximum return sludge capacity shall be obtained with the largest pump out of service

- Waste sludge pumping facilities shall be provided with a minimum capacity not less than 25 percent of design average rate of wastewater flow, or a minimum of 10 gallons per minute, whichever is larger. Waste sludge pumps shall function satisfactorily at 0.5 percent of design annual average wastewater flow.

- Each aeration drop leg shall be equipped with: 1) flow control valves and 2) air flow measurement capability

- To increase energy efficiency:

    - Provide multiple blowers for diffused air systems for meeting the entire range of required flows including meeting turndown to avoid overaerating at minimum flows

    - If current peak aeration demands are below peak design aeration demands, provide capacity to meet current demands while accommodating room for future demands

    - Aeration tank sizing based on rational calculations based primarily on solids retention time (SRT) and MLSS levels while also considering other factors

- Aeration tanks shall have probes to monitor dissolved oxygen in place, to control power consumption and match oxygen demand with oxygen supply

- Sidewater depths for secondary settling tanks 40 to 75 feet in diameter shall be 14 feet deep minimum

REVIEW OF DESIGN CONSIDERATION & ALTERNATIVES

A phased approach to secondary treatment will be provided as follows:

- Phase 1: 2 trains of Four-Stage Bardenpho (rated for an annual average flowrate of 2.2 MGD) with a total aeration tank volume of 1.8 MG. Process capability to change to MLE (rated for rated for an annual average flowrate of 2.65 MGD)

- Phase 2: 3 trains of Four-Stage Bardenpho (rated for rated for an annual average flowrate of 3 MGD) with a total aeration tank volume of 2.7 MG.

<u>Process Configuration</u>

The first-phase would include:

- two rectangular aeration tanks (each 190 feet internal length by 72 feet internal width by 18 feet sidewater)
- internal recycle pumps
- anoxic mixing
- three circular secondary clarifiers (70-foot diameter by 16-foot sidewater depth with sludge header withdrawal mechanism)
- secondary scum pump station
- four return sludge pumps (three duty/one standby)
- two waste sludge pumps (one duty/one standby)
- three aeration blowers (two duty/one standby).

This equipment will be in the Solids Handling Building, the Aeration Tanks and Clarifiers.
The second phase will consist of a third train of Four-Stage Bardenpho tanks, mixers, and a fourth aeration blower.

Aeration System

Blowers

Blower alternatives include traditional positive displacement (Roots style), rotary screw blowers (Aerzen, Atlas-Copco), multi-stage centrifugal (Spencer, Hoffman-Lamson), geared high-speed single-stage centrifugal (Siemens Turblex), and high-speed turbo blowers (Aerzen, HSI). Aeration requirements for the secondary system are provided in Table 1.

TABLE 1. AERATION REQUIREMENTS FOR EXETER WWTF

	INITIAL BARDENPHO				INITIAL MLE			DESIGN			
	MIN	AVG	Max Month	Max Day	AVG	Max Month	Max Day	MIN	AVG	Max Month	Max Day
YEAR	2015	2015	2015	2015	2015	2015	2015	2040	2040	2040	2040
PRIMARY EFFLUENT											
FLOW, MGD	**1.20**	**2.20**	**2.89**	**6.60**	**2.65**	**4.50**	**4.50**	**2.00**	**3.00**	**5.10**	**6.60**
BOD_5 LBS/D	**2,242**	**3,615**	**4,569**	**7,023**	**4,357**	**5,538**	**7,023**	**3,000**	**5,000**	**6,600**	**10,100**
TKN PRIMARY EFF, LBS/D	**400**	**550**	**688**	**980**	**663**	**834**	**980**	**500**	**1,000**	**1,300**	**1,800**
AOR, LBS/D	**3,343**	**4,920**	**6,408**	**9,592**	**6,216**	**8,040**	**9,823**	**4,382**	**7,272**	**9,144**	**15,288**
SOR, LBS/D	**8,295**	**12,827**	**16,340**	**24,876**	**16,206**	**22,780**	**28,545**	**11,328**	**18,959**	**23,317**	**39,651**
TOTAL AIR REQD. SCFM	**1,021**	**1,600**	**2,104**	**3,309**	**2,086**	**3,031**	**3,797**	**1,532**	**2,365**	**3,002**	**5,275**
QUANTITY OF AIR, ICFM *	**1,035**	**1,754**	**2,306**	**3,755**	**2,287**	**3,438**	**4,308**	**1,567**	**2,592**	**3,291**	**5,984**
NUMBER OF BLOWERS	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**4**	**4**	**4**	**4**
NUMBER IN SERVICE	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**3**
ACTUAL CAPACITY ICFM	**2,200**	**2,200**	**2,200**	**2,200**	**2,200**	**2,200**	**2,200**	**2,200**	**2,200**	**2,200**	**2,200**
TOTAL CAPACITY ICFM	**2,200**	**2,200**	**4,400**	**4,400**	**4,400**	**4,400**	**4,400**	**2,200**	**4,400**	**4,400**	**6,600**
HEAD, PSIG	**10.1**	**10.1**	**10.1**	**10.1**	**10.1**	**10.1**	**10.1**	**10.1**	**10.1**	**10.1**	**10.1**

*Min Day ICFM at 68 degrees F, 36 percent relative humidity, 14.68 psi atmospheric and 0.2 psi intake loss.
*Average ICFM at 90 degrees F, 90 percent relative humidity, 14.68 psi atmospheric and 0.2 psi intake loss.
*Max month ICFM at 90 degrees F, 90 percent relative humidity, 14.68 psi atmospheric and 0.2 psi intake loss.
*Max Day ICFM at 100 degrees F, 90 percent relative humidity, 14.68 psi atmospheric and 0.2 psi intake loss.

From Table 1, in order to meet the range of airflows, one blower is utilized at minimum conditions and two blowers at maximum day conditions, with a design point of 2,000 scfm (2,200 icfm @100 degrees F, 90 % humidity, 14.68 psi atmospheric, with 0.2 psi intake loss) @ 10.1 psi. At this size blower (150 hp or less), positive displacement(PD) blowers typically are the most cost-effective. These include dual-lobe PD blowers (Roots style), tri-lobe PD (Aerzen or Kaeser), or rotary screw PD (Aerzen, Robuschi, Kaeser, Atlas-Copco). While dual- and tri-lobe are marginally less expensive than screw-hybrid PDs, the screw-hybrids offer substantially higher energy efficiencies, particularly at turndown to 35-40 percent. *Screw-hybrid PDs are selected for energy efficiency and turndown capabilities.*

Diffusion

Alternatives for providing air to the system include fine- and coarse- bubble diffused aeration, mechanical aerators (traditional and slow-speed mixer-aerators). Fine bubble diffusion is established as the most energy-efficient method to provide oxygen requirements. *Fine-bubble diffusion is selected as it provides the highest efficiency of aeration with the least capital cost.*

Fine-bubble diffusion provided by 9-inch EPDM membrane disks is typically the most inexpensive diffused aeration technology and has become the industry standard. Alternatives to the EPDM disk include:

- PTFE membrane disks
- EPDM and PTFE membrane tube diffusers
- polyurethane ultra-fine bubble strip diffusers

The alternatives all offer advantages over the EPDM membrane disks but typically at a cost premium. PTFE is subject to less fouling and calcification, enabling the disk or tube to sustain efficiency over a longer duration. Life-cycle cost savings may be realized by installing Teflon-membrane diffusers (as manufactured by SSI), as these are reported to be more durable and need less frequent replacement. *This should be evaluated during value engineering.* Polyurethane ultra-fine bubble strip diffusers provide higher energy efficiency and longer production life. The advantages conferred by this alternative are typically better realized at larger wastewater treatment facilities that require large numbers of diffusers and higher energy expenditure. *Therefore, fine-bubble diffusion using the EPDM disk is selected to provide the most cost-effective solution.*

Anoxic Mixing

Anoxic mixing can be provided by the following:

- Submersible mixers
- Floating mixers
- Hyperboloid mixers
- Large bubble mixing

Based on experience with previous Wright-Pierce projects, installation of mixing using submersible mixers with rails and cranes is expected to be slightly less expensive than hyperboloid mixing based on budget proposals obtained from mixer manufacturers, but require significantly higher operating and maintenance costs, as they are prone to water intrusion/seal failure. Therefore, the total life cycle costs are typically lower for hyperboloid mixers than submersibles.

Hyperboloid mixers are selected for the advantages of low maintenance and low energy requirements. However, cost savings (both capital and operation and maintenance) may be achieved by incorporating large-bubble anoxic mixing. Large bubble mixing systems have been installed and are operating at full-scale municipal wastewater BNR applications in Warren, MI, and Abington, PA. *This alternative should be considered during value engineering.*

Secondary Clarification

Major alternatives to secondary clarification include shape of basins (rectangular, circular) and sludge withdrawal mechanism types. Mechanism types include:

- Suction header (Towbro)
- Spiral blades
- Draft tubes

Circular clarifiers with suction header sludge withdrawal mechanisms are selected for ease of sludge collection (single point sludge collection for RAS and WAS), maintenance, and equipment reliability.

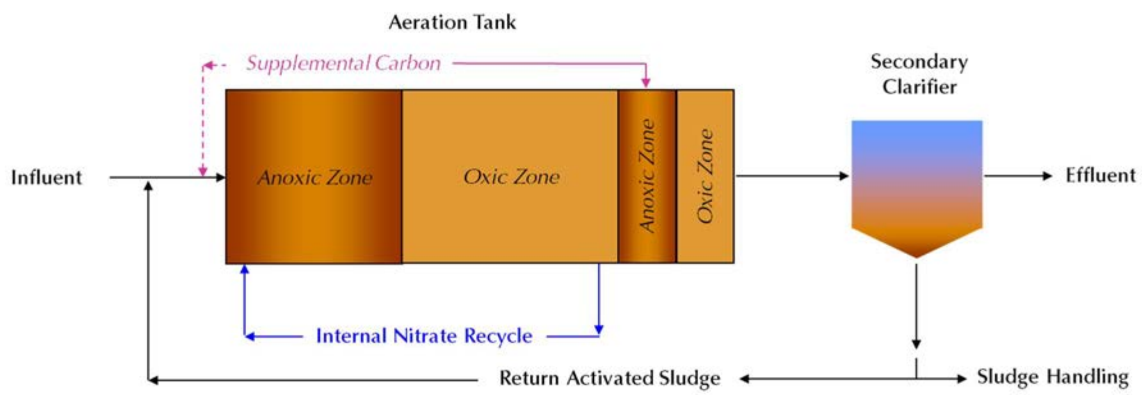
BASIS OF DESIGN

This section outlines the preliminary design basis for the activated sludge process at Exeter.

Aeration Tanks

The aeration tanks will be conventional plug flow employing the Four-Stage Bardenpho process. A schematic of the process is illustrated in Figure 1.

FIGURE 1
4-STAGE BARDENPHO PROCESS SCHEMATIC



Design criteria for the tanks and associated equipment are as follows.

AERATION TANKS	
Application:	Activated Sludge
Type:	Conventional plug flow utilizing the Four-Stage Bardenpho Biological Nutrient Removal process
Total Volume per train:	1 MG
Dimensions:	170’ long x 38’ wide by 18’ deep
Number of Trains:	2 Current/3 Design
Design Capacity:	2.2 MGD Bardenpho (Phase I)/2.65 MGD MLE (Phase I)/3 MGD (Phase II)
Hydraulic Residence Times, design Annual Average flow	Pre-anoxic : 3.4 hours
	Oxic: 12.4 hours
	Post-anoxic: 3.3 hours
	Re-aeration: 0.7 hours
Design Aerobic Solids Residence Time, design maximum month loading	12 days
Design MLSS concentration, design maximum month loading	4,100 mg/L

BLOWERS	
Application:	Activated Sludge
Type:	Screw-hybrid Positive Displacement
Unit Capacity:	2,200 icfm (100 degrees F, 90 % humidity, 14.68 psi atmospheric, with 0.2 psi intake loss)
TDH:	10.1 psi
Minimum Turndown Capability:	35-40%
Unit Motor HP:	150 HP
Acceptable Manufacturer(s):	Aerzen, Atlas-Copco, Robuschi, Kaeser
Number of units	Current - 3 (2 duty, 1 standby) Future – 4 (3 duty, 1 standby)

FINE-BUBBLE DIFFUSION	
Application:	Activated Sludge
Type:	EPDM membrane 9-inch disk.
Solids Concentration:	1,000 to 5,000 mg/L
Number of Grids:	12
Total number of diffusers:	1,800 to 2,000
Acceptable Manufacturer(s):	Sanitaire, SSI, EDI

ANOXIC MIXING	
Application:	Activated Sludge
Type:	Low-speed hyperboloid mixers, top-mounted
Solids Concentration:	1,000 to 5,000 mg/L
Number of Units:	10 (5 per tank)
Sizes:	Anoxic Zones 1A/2A: 0.75 HP Anoxic Zones 1B/2B: 1.0 HP Swing 1C/2C: 2.0 HP Swing Zones 1E/2E: 2.0 HP Swing Zones 1F/2F: 2.0 HP
Acceptable Manufacturer(s):	Invent

INTERNAL NITRATE RECYCLE PUMPING	
Application:	Activated Sludge
Type:	Propeller pumps, low rpm with gear reducers
Solids Concentration:	1,000 to 5,000 mg/L TSS
Number of Units:	2 (1 for each tank).
Minimum Capacity:	1,040 gal/min @ 2 ft TDH
Maximum Capacity:	4,160 gal/min @ 3 ft TDH
Motor HP	10 HP
Acceptable Manufacturer(s):	Wilo, Landia

SECONDARY CLARIFIERS	
Application:	Activated Sludge
Type:	Circular, Suction header sludge collector
Size:	70 feet diameter
Number of Units:	3
Sidewater Depth:	16 ft. sidewater, 18 ft. sidewall
Drive HP:	0.5 HP
Acceptable Manufacturer(s):	Ovivo, Hi-Tech, ClearStream

RETURN SLUDGE PUMPING	
Application:	Activated Sludge
Type:	Horizontal Solids Handling Centrifugal
Solids Concentration:	5,000 to 15,000 mg/L TSS
Number of Units:	4 (3 duty, 1 standby). 1 reserved future
Minimum Capacity:	500 gal/min @ 15 ft TDH
Maximum Capacity:	925 gal/min @ 20 ft TDH
Motor HP:	10 HP
Acceptable Manufacturer(s):	Fairbanks Morse, ITT A-C, KSB

WASTE SLUDGE PUMPING	
Application:	Activated Sludge
Type:	Horizontal Solids Handling Centrifugal
Solids Concentration:	5,000 to 15,000 mg/L TSS
Average solids wasted:	4,500 lb/d @ 10,000 mg/L
Average wasted volume:	50,000 gpd
Average waste pumping duration:	4 hours/day
Number of Units:	2 (1 duty, 1 standby).
Minimum Capacity:	125 gal/min @ 12 ft TDH
Maximum Capacity:	225 gal/min @ 15 ft TDH
Motor HP:	3 HP
Acceptable Manufacturer(s):	Fairbanks Morse, ITT A-C, KSB

SECONDARY SCUM PUMPING	
Application:	Activated Sludge
Type:	Submersible chopper pump
Solids Concentration:	5,000 to 20,000 mg/L TSS
Number of Units:	1 pump
Minimum Capacity:	250 gal/min @ 50 ft TDH
Acceptable Manufacturer(s):	Vaughan

BUILDING / STRUCTURE DESCRIPTION

Aeration Tank Influent Splitter Box

See memo A-2 Hydraulic Profile and Flow Diversion

Aeration Tanks

Aeration tanks will consist of two separate tanks divided into seven sub-compartments. The tanks will be cast-in-place concrete, constructed with top of tanks above grade several feet, which will require access via stairs, raised platforms, and handrails. The tanks will support top-mounted hyperboloid mixers using galvanized steel bridges and support columns (provided by mixer manufacturer). Tanks will also support internal recycle pumps with guide rails off of the sidewall with lifting cranes supported by raised platforms. Space will be reserved for one future tank of similar dimensions. Aeration tank effluent channels will be attached to downstream tanks with raised slabs.

Structural information:

Tank	
Volume	907,000 gallons each tank
Dimensions, inner	36’ W, 190’ L, 22’ D
Sidewater depth	18’
Freeboard	4’
Raised platform walkway width	5’

Solids Handling Building

Blowers will be installed on the basement of the Solids Handling Building. RAS and WAS pumps will also be installed on the basement of the Solids Handling Building.

Equipment : Blowers	
Height	8.0-feet (max point)
Width (approx.)	3.5-feet
Length (approx.)	16-feet (including valves)
Weight (approx.)	6,000 lb
TOTAL WEIGHT	18,000 lb
Equipment : RAS Pumps	
Weight (approx.)	1,120 lb
Number	4
TOTAL WEIGHT	4,480 lb
Equipment : WAS Pumps	
Weight (approx.)	570 lb
Number	2
TOTAL WEIGHT	1,140 lb

Secondary Clarifiers

Secondary clarifiers will be 70’ inner diameter circular with inset launders. Clarifiers will be center feed and have a minimum bottom slope of ¼ to 1/8:12. Tank will require access to center platform via a bridge and railings (provided by mechanism manufacturer).

Tank	
Number	3
Depth	18’ sidewall (16’ sidewater)
Dimensions, inner	70’ diameter (inner)
Freeboard	2’

Scum pumping station

Secondary scum pumping will be installed in a precast 6-ft diameter circular manhole or adjacent to splitter structure #3. The pump will be installed with a slide rail and hoist.

PROCESS CONTROL DESCRIPTION

Aeration Blowers

The aeration blowers will be installed in the blower room of the solids handling building which will be unclassified. The blowers will be controlled by OEM local control panels with OITs mounted on each blower enclosure with a minimum rating of NEMA 1/12. These will serve as Hand-Off-Automatic switches. An ESTOP pushbutton for each blower will be provided. The blower local control panel will monitor the status and alarm conditions of the blower and provide a means to manually start/stop and control the discharge capacity of the blower through the local OIT.

VFDs and motor starters for the blowers will be installed in a separate electrical room that is unclassified. The Equipment in this room will be rated NEMA 1/12.

A central aeration control panel with PLC and SCADA functionality will integrate control of the individual blowers and provide blower staging and operation in accordance with manufacturer's requirement to maintain an air header pressure setpoint. When the local blower control panel is in automatic mode, the blower will be Start/Stop by the ACP. The ACP will stage the blowers and provide a speed setpoint to provide the required header pressure (as monitored by pressure transmitters on the discharger header line) and a continuous range of air flow to the aeration tanks. The ACP shall use cascading PID control to maintain the header pressure setpoint through air flow control and air flow through blower speed.

The Aeration Control PLC, will start and stop blowers in a staged sequence based on system demand. The blowers will operate in a Lead-Lag-Standby sequence. The operator will designate the Lead and Lag blowers and the remaining blower will automatically be designated as Standby. The Lead-Lag-Standby selection will automatically alternate each time the Lead blower is cycled and shut down. Auto alternation will be able to be enabled or disabled.

Aeration Control Valves

Each aeration drop leg will be provided with an air flow meter and electrically-actuated control valve to control the amount of air flowing through each diffuser grid. Each aeration control valve will be provided with a Local-Off-Remote switch at the valve on top of the aeration tanks. Each valve and switch will be rated as NEMA 4X unclassified as installed greater than 18 inches above the tank sidewall. In remote and auto control the PLC in the aeration control panel will control the flow rate of air going to each zone by modulating the zone's butterfly valve. The PLC will automatically adjust the airflow rate to maintain a DO setpoint using a PID algorithm

Anoxic Mixers

Each anoxic mixer will have a local control station and e-stop mounted at the aeration tank support platform on top of the aeration tanks. The LCS will be unclassified as installed greater than 18 inches above the tank sidewall. The mixers will be manual start/stop from either the local control station or from the SCADA system.

Internal Recycle Pumping

Each internal recycle pump will have a local control station and e-stop mounted at the aeration tank support platform on top of the aeration tanks. The pumps will be manual start/stop from either the local control station or from the SCADA system. Recycle pumps will have VFDs installed in the electrical room of the Solids Handling Building.

When in Remote mode (and in virtual automatic mode in SCADA), pump speed shall be paced proportional to influent flow rate.

Secondary Clarifier Drives

Each clarifier drive will have local control stations (Local-Off-Remote) with E-Stop pushbuttons. Drives will be Class 1 Div 2, LCS will be NEMA 7/4X. In Remote mode (and in virtual automatic mode in SCADA), the clarifier drive will be interlocked from running with a torque alarm.

Return Sludge pumps

Each pump will have local control station (Local-Off-Remote) and E-stop (unclassified, NEMA 1/12). Each pump is operated at variable speeds using a VFD. Pumping flow is monitored using a mag meter. In Remote mode (and in virtual automatic mode in SCADA), the pumps shall operate to maintain an operator-adjusted flow setpoint at the meter. Alternatively the flow setpoint will be set as a calculated ratio to the influent flow. The PLC will start and stop pumps in a staged sequence based on the flow setpoint. The pumps will operate in a Lead-Lag-Standby sequence. The operator will designate the Lead and Lag pumps and the remaining pump will automatically be designated as Standby.

Waste Sludge pumps

Each pump will have local control station (Local-Off-Remote) and E-stop (unclassified, NEMA 1/12). Each pump is operated at variable speeds using a VFD. Pumping flow is monitored using a mag meter. In Remote mode (and in virtual automatic mode in SCADA), the pumps shall operate to maintain an operator-adjusted flow setpoint at the meter. The operator will designate the Duty and Standby pumps. In Auto, the operation of WAS pumps will be interlocked with high-level alarm at the sludge storage tanks.

Scum pump

The submersible skimmings pump will have a local control station (Local-Off-Remote) and E-stop mounted above the skimmings wetwell (unclassified, NEMA 4X). In Remote mode (and in virtual automatic mode in SCADA) the pump will operate on a repeat cycle timer. Level in the well is monitored by a pressure transmitter (Class 1/Div 1) with associated level alarms.

The following instruments, control panels, and local control stations are anticipated:

Item	Local/Remote	NEMA	By Division	Range/Units
Local Blower Panel 1	Local	1/12	11-OEM	
Local Blower Panel 2	Local	1/12	11-OEM	
Local Blower Panel 3	Local	1/12	11-OEM	
Aeration Flow Meter 1-1	local	4X	13	TBD
Aeration Flow Meter 1-2	local	4X	13	TBD
Aeration Flow Meter 1-3	local	4X	13	TBD
Aeration Flow Meter 1-4	local	4X	13	TBD
Aeration Flow Meter 2-1	local	4X	13	TBD
Aeration Flow Meter 2-2	local	4X	13	TBD
Aeration Flow Meter 2-3	local	4X	13	TBD
Aeration Flow Meter 2-4	local	4X	13	TBD
Dissolved Oxygen Probe 1-1	local	4X	13	0 to 10 mg/L
Dissolved Oxygen Probe 1-2	local	4X	13	0 to 10 mg/L
Dissolved Oxygen Probe 1-3	local	4X	13	0 to 10 mg/L
Dissolved Oxygen Probe 2-1	local	4X	13	0 to 10 mg/L
Dissolved Oxygen Probe 2-2	local	4X	13	0 to 10 mg/L
Dissolved Oxygen Probe 2-3	local	4X	13	0 to 10 mg/L
ORP Probe 1-1	local	4X	13	-500 to +500 mV

Item	Local/Remote	NEMA	By Division	Range/Units
ORP Probe 1-2	local	4X	13	-500 to +500 mV
ORP Probe 1-1	local	4X	13	-500 to +500 mV
ORP Probe 1-2	local	4X	13	-500 to +500 mV
pH Probe 1	local	4X	13	0 to 14 S.U.
pH Probe 2	local	4X	13	0 to 14 S.U.
Online nitrate	local	4X	13	0 to 14 S.U.
Aeration Control Valve 1-1	local	4X	11-OEM	Quarter Turn
Aeration Control Valve 1-2	local	4X	11-OEM	Quarter Turn
Aeration Control Valve 1-3	local	4X	11-OEM	Quarter Turn
Aeration Control Valve 1-4	local	4X	11-OEM	Quarter Turn
Aeration Control Valve 2-1	local	4X	11-OEM	Quarter Turn
Aeration Control Valve 2-2	local	4X	11-OEM	Quarter Turn
Aeration Control Valve 2-3	local	4X	11-OEM	Quarter Turn
Aeration Control Valve 2-4	local	4X	11-OEM	Quarter Turn
Local Control Station Aeration Control Valve 1-1	local	4X	15-OEM	n/a
Local Control Station Aeration Control Valve 1-2	local	4X	15-OEM	n/a

Item	Local/Remote	NEMA	By Division	Range/Units
Local Control Station Aeration Control Valve 1-3	local	4X	15-OEM	n/a
Local Control Station Aeration Control Valve 1-4	local	4X	15-OEM	n/a
Local Control Station Aeration Control Valve 1-5	local	4X	15-OEM	n/a
Local Control Station Aeration Control Valve 1-6	local	4X	15-OEM	n/a
Local Control Station Aeration Control Valve 2-1	local	4X	15-OEM	n/a
Local Control Station Aeration Control Valve 2-2	local	4X	15-OEM	n/a
Local Control Station Aeration Control Valve 2-3	local	4X	15-OEM	n/a
Local Control Station Aeration Control Valve 2-4	local	4X	15-OEM	n/a
Local Control Station Aeration Control Valve 2-5	local	4X	15-OEM	n/a
Local Control Station Aeration Control Valve 2-6	local	4X	15-OEM	n/a
Local Control Station Anoxic Mixer 1-1	local	4X	16	n/a

Item	Local/Remote	NEMA	By Division	Range/Units
Local Control Station Anoxic Mixer 1-2	local	4X	16	n/a
Local Control Station Anoxic Mixer 1-3	local	4X	16	n/a
Local Control Station Anoxic Mixer 1-4	local	4X	16	n/a
Local Control Station Anoxic Mixer 1-5	local	4X	16	n/a
Local Control Station Anoxic Mixer 2-1	local	4X	16	n/a
Local Control Station Anoxic Mixer 2-2	local	4X	16	n/a
Local Control Station Anoxic Mixer 2-3	local	4X	16	n/a
Local Control Station Anoxic Mixer 2-4	local	4X	16	n/a
Local Control Station Anoxic Mixer 2-5	local	4X	16	n/a
Local Control Station Internal Nitrate Recycle Pump 1	local	7	16	n/a
Local Control Station Internal Nitrate Recycle Pump 2	local	7	16	n/a
Local Control Station Secondary Clarifier Drive 1	local	4X	16	n/a
Local Control Station Secondary Clarifier Drive 2	local	4X	16	n/a

Item	Local/Remote	NEMA	By Division	Range/Units
Local Control Station Secondary Clarifier Drive 3	local	4X	16	n/a
Torque Overload Alarm Secondary Clarifier Drive 1	local	4X, Class 1 Div 2	11 (OEM)	n/a
Torque Overload Alarm Secondary Clarifier Drive 2	local	4X, Class 1 Div 2	11 (OEM)	n/a
Torque Overload Alarm Secondary Clarifier Drive 3	local	4X, Class 1 Div 2	11 (OEM)	n/a
Local Control Station RAS Pump 1	local	4X	16	n/a
Local Control Station RAS Pump 2	local	4X	16	n/a
Local Control Station RAS Pump 3	local	4X	16	n/a
Local Control Station WAS Pump 1	local	4X	16	n/a
Local Control Station WAS Pump 2	local	4X	16	n/a
Local Control Station Skimmings Pump	local	4X	16	n/a
Level Element, Skimmings	local	4X	16	0 to 20 ft

Electrical information:

BLOWERS	
Power	150 HP
Speed	Variable
Enclosure	Unclassified, TEFC
Volts, Phase/ Hz	460/ 3/ 60

X Coordinated with NFPA Memo

X Coordinated with Equipment List

ANOXIC MIXERS	
Power	Multiple (see Design Criteria)
Speed	Constant
Enclosure	TEFC, Class 1, Div 2
Volts, Phase/ Hz	460/ 3/ 60

X Coordinated with NFPA Memo

X Coordinated with Equipment List

INTERNAL NITRATE RECYCLE PUMPS	
Power	10 HP
Speed	Variable
Enclosure	Submersible, Class 1, Div 2
Volts, Phase/ Hz	460/ 3/ 60

X Coordinated with NFPA Memo

X Coordinated with Equipment List

RAS PUMPS	
Power	10 HP
Speed	Variable
Enclosure	Unclassified, TEFC
Volts, Phase/ Hz	460/ 3/ 60

X Coordinated with NFPA Memo

X Coordinated with Equipment List

WAS PUMPS	
Power	3 HP
Speed	Variable
Enclosure	Unclassified, TEFC
Volts, Phase/ Hz	460/ 3/ 60

X Coordinated with NFPA Memo

X Coordinated with Equipment List

SECONDARY CLARIFIER DRIVES	
Power	0.5 HP
Speed	Constant
Enclosure	TEFC, Class 1, Div 2
Volts, Phase/ Hz	{460/ 3/ 60}

X Coordinated with NFPA Memo

X Coordinated with Equipment List

SCUM PUMP	
Power	10 HP
Speed	Constant
Enclosure	Submersible, Class 1, Div 1
Volts, Phase/ Hz	460/ 3/ 60

X Coordinated with NFPA Memo

X Coordinated with Equipment List

CONSTRUCTION SEQUENCING

Construction of secondary system should not effect current plant operations.

FUTURE EXPANSION CONSIDERATIONS

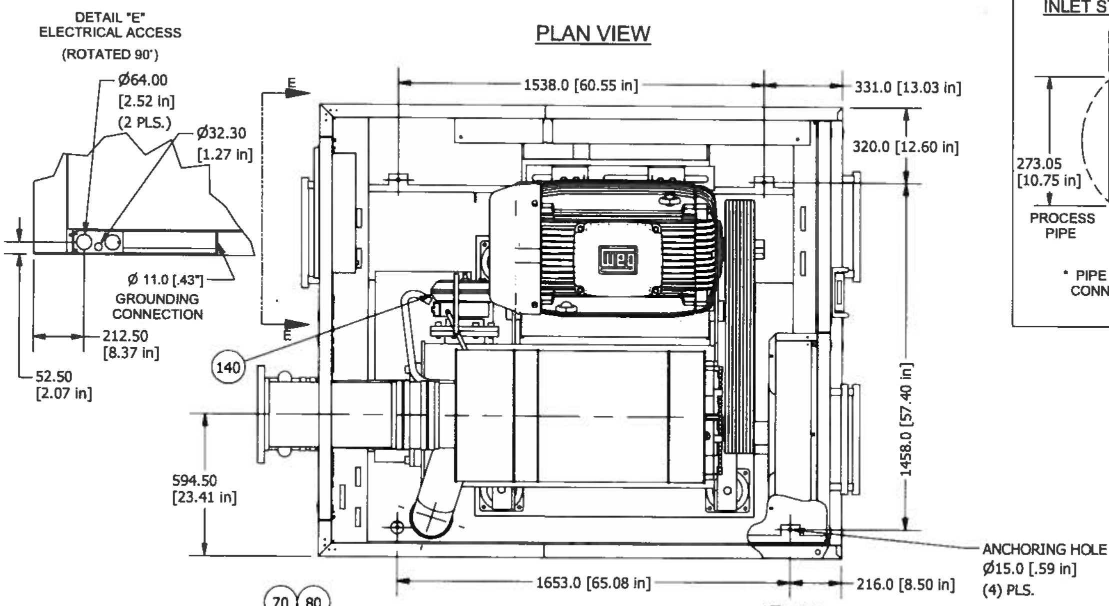
For future expansion, footprint will be left available onsite for as many as two additional aeration trains. Space will be reserved for an extra blower in the Solids Handling Building basement. No additional secondary clarifiers are expected to be required.

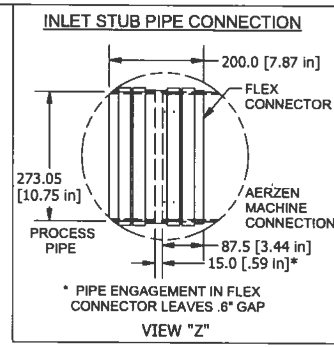
FILE LOCATION

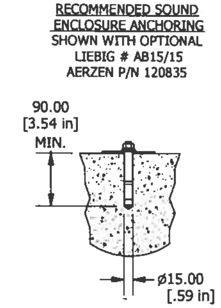
J:\ENG\NH\Exeter\12883-WWTF\12883B-WW Design\Technical\Process\Design Memos\ A-8 Activated Sludge Systemv2.docx

ATTACHMENTS

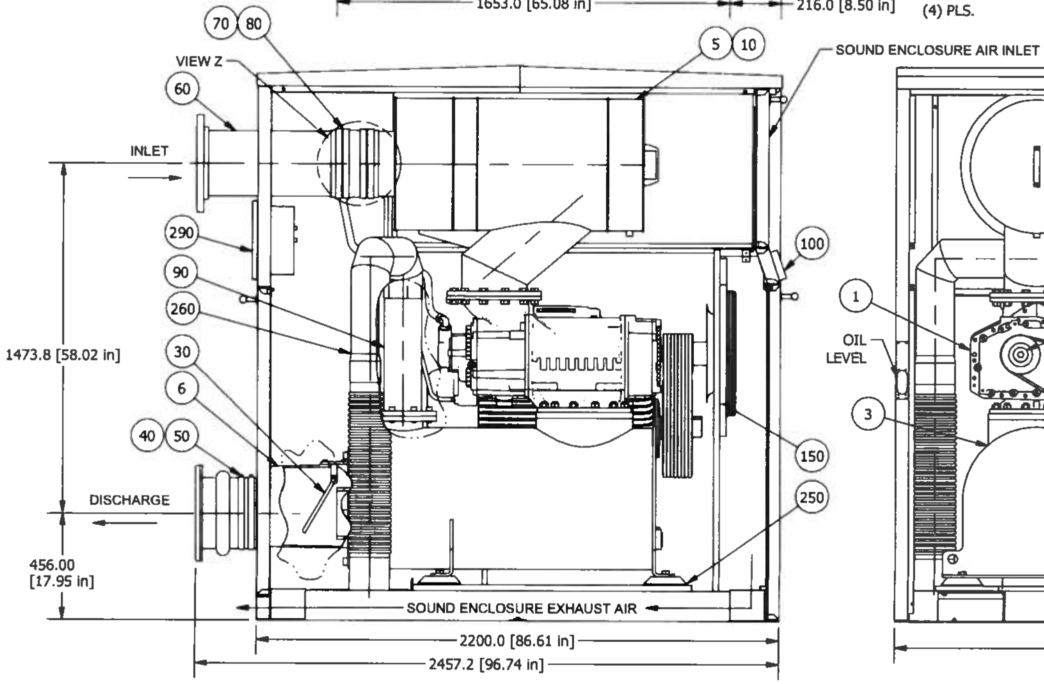
- A Equipment Cut Sheets
    - Blowers
    - Return Sludge Pumps
    - Waste Sludge Pumps
    - Scum Pump
    - Internal Recycle Pumps
    - Anoxic Mixers
- B Calculations
    - Biowin Model Output
    - Aeration Calcs
    - State Point Analysis

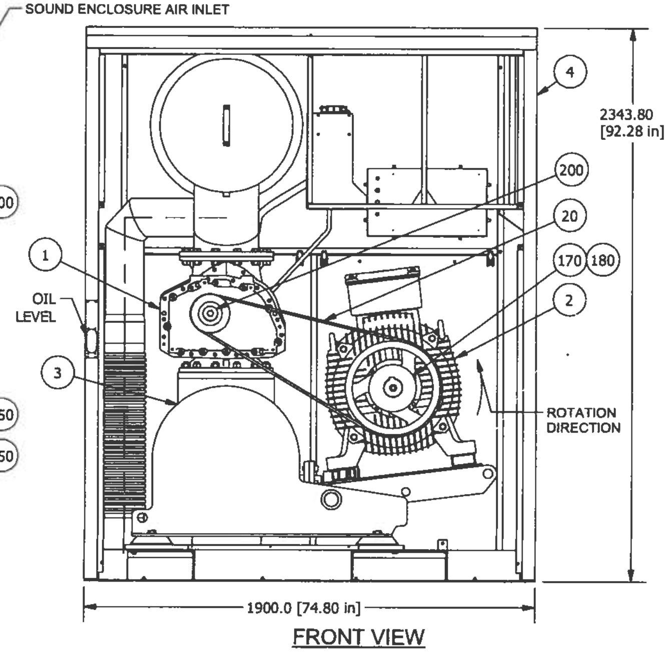






ITEM	QTY	DESCRIPTION
1	1	D-75-L DELTA HYBRID STAGE
2	1	MOTOR, F-3 FRAME
3	1	BASE FRAME
4	1	SOUND ENCLOSURE
5	1	INLET FILTER/SILENCER ASSEMBLY
6	1	DISCHARGE HOUSING
10	1	INLET FILTER ELEMENT (NOT SHOWN)
20	-	DRIVE BELTS (SEE JOB SPECIFIC DATA)
30	1	ONE-WAY VALVE
40	1	EXPANSION JOINT w/ 10"-150# ANSI FLANGE
50	2	CLAMPS FOR EXPANSION JOINT
60	1	STUB PIPE w/ 10"-150# ANSI FLANGE
70	1	INLET FLEX CONNECTOR
80	4	CLAMPS FOR INLET FLEX CONNECTOR
90	1	SAFETY RELIEF VALVE
100	-	INSTRUMENTATION (SEE JOB SPECIFIC DATA)
140	1	UNLOADING VALVE (OPTIONAL)
150	1	S.E. VENTILATION FAN
170	1	MOTOR SHEAVE BUSHING
180	1	MOTOR SHEAVE
200	1	STAGE SHEAVE
250	4	VIBRATION ISOLATORS
260	1	SAFETY RELIEF VALVE HOSE
290	1	ELECTRICAL CONTROL PANEL (SEE JOB SPECIFIC DATA)





NOTES

1. TOLERANCE ON DIMENSIONS = ±12mm [0.5"]
2. WEIGHT: PACKAGE WEIGHT 2144 Kg (4717 Lbs.)
   MOTOR WEIGHT__________
   TOTAL
3. REMOVABLE PANEL WEIGHT:
   PANELS DO NOT EXCEED APPROX 20 Kg (45 Lbs)
4. CUSTOMER PIPING TO BE INDEPENDENTLY SUPPORTED
5. LIFTING OF PACKAGE: AFTER REMOVING FRONT & REAR DOORS, FROM FRONT SIDE THROUGH FORK LIFT POCKET IN BASE
6. FREE SPACE FOR MAINTENANCE WORK AT FRONT AND REAR SIDE OF UNIT APPROX. 800mm [32"]
7. FOR ADDITIONAL INFORMATION SEE JOB SPECIFIC DATA PACKAGE

NOTICE:

AERZEN
AERZEN USA CORP.
108 INDEPENDENCE WAY, COATESVILLE PA 19320
(610) 380-0244 PH (610) 380-0278 FAX

TITLE
D 75 L - DELTA HYBRID
DN-250 PRESSURE w/ S.E.
ANSI INLET & DISCHARGE CONNECTION (F3 MOTOR)

DATE	DRAWN BY:	CHECKED BY:	P.M. APPROVAL:	SCALE:
04/12/2011	JPS	DLM		MODEL SPACE 1:1

DRAWING NO.: GB-006036-210 REV: 1 / 1

AERZEN USA CORPORATION
108 Independence Way
Coatesville, PA 19320
Tel. (610) 380-0244 ♦ Fax. (610) 380-0278

AERZEN

AERZEN Reference Number: E02-24361.R1
Re: Exeter, NH WWTP

7-Aug-15

To: Donald Song, PE Firm - Wright Pierce email - don.song@wright-pierce.com phone - 207-523-1412	*AERZEN* Proposal Prepared By: Name - Eric Bennett email - ebennett@aerzenusa.com phone - (484) 288-6366
AERZEN Representative Info: Name - Mike W. Loncoski of Aqua Solutions e-mail - mloncoski@aquasolutionsinc.net phone - (207) 828-5559	*AERZEN* Regional Manager: Name - Tom McCurdy e-mail - tmccurdy@aerzenusa.com phone - (610) 656-1683

This scope of supply does NOT include the following items: MCC starter, VFD, External Controls, Isolation Valves and Installation Hardware.

Hybrid Option		**D 75L**	
Performance Data:		**Design**	**Min**
Intake volume, handled at intake condition	icfm	2,269	256
Volume handled at normal condition	scfm	2,001	226
Relative humidity	Φ	90%	90%
Intake pressure (abs.)	psia	14.48	14.48
Pressure difference	psig	10.1	10.1
Intake temperature	°F	100	100
Discharge temperature	°F	244	291
Main rotor speed	rpm	5,827	2,000
% of maximum	%	97%	33%
Motor Speed	rpm	3,570	1,225
Power consumption at coupling	bHp	120.4	24.0
Motor Rating	HP	**150**	
Blower max rotor speed	rpm	6,000	
Tolerance on flow & power	± 5 %		
Sound pressure level w/o enclosure	dB(A)	103	
Sound pressure level w/ enclosure	dB(A)	76	
measured in free field at 3ft. distance from the outline of the unit (tol. ± 2 dB(A)).			

Weights & Dimensions:

Inlet connection	ANSI flange	12"
Discharge connection	ANSI EPDM	10"
Blower pkg weight	lbs.	6,148
Envelope dim.*	LxWxH in.	87x75x93
460VAC Cooling Fan	kW	0.38
AERtronic	kW	0.2

* non binding dimensions includes, inlet filter silencer, relief valve, check valve, and flex connector

AERZEN USA CORPORATION
108 Independence Way
Coatesville, PA 19320
Tel. (610) 380-0244 ♦ Fax. (610) 380-0278

AERZEN Reference Number: E02-24361.R1
Re: Exeter, NH WWTP

7-Aug-15

Hybrid Option **D 75L**

Aerzen Delta Hybrid Blower Package consists of the following components, assembled in our factory.

1 Aerzen Rotary Lobe Compressor D Series
1 base frame with integrated reactive type silencer
1 hinged motor support as automatic belt tensioning device
1 set of vibration isolating mounts
1 intake filter-silencer
1 narrow V-belt drive with guard
1 spring loaded pressure relief valve
1 discharge manifold with externally accessible integrated check valve
1 flexible connector with clamps for schedule 40 pipe, discharge
1 flexible connector with clamps for schedule 40 pipe, intake

Scope of Supply

3 compact blower package as listed above
3 electric motor per NEMA, TEFC, 460v / 60Hz, premium efficiency, T-Stat
3 acoustic hood with integral 460V cooling fan
3 set of sensors (P1, P2, T2 & Oil Temp) w/AERtronic Control (460VAC, 10Amp), EM4, E-Stop

Spare Parts

3 air filter, 3 belt set,

Mfg Services

1 trip(s), 4 day(s) total installation assistance

Freight & Packaging

3 freight to jobsite
3 domestic packaging

TOTAL for 3 unit(s)

Pricing: **DAP Jobsite**
Terms: **This offer is subject to Aerzen Standard Terms and Conditions (A2-001-USA January 2009)**
Warranty: **24 months after start up or 30 months after delivery, which ever comes first on Aerzen package***

*Maintenance must be performed per the Instruction Manual using Aerzen spare parts.
*Equipment not manufactured by Aerzen will carry the manufacturer's standard warranty.

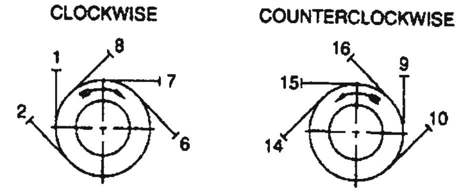
WARNING

DO NOT OPERATE THIS MACHINE WITHOUT PROTECTIVE GUARD IN PLACE. ANY OPERATION OF THIS MACHINE WITHOUT PROTECTIVE GUARD CAN RESULT IN SEVERE BODILY INJURY.

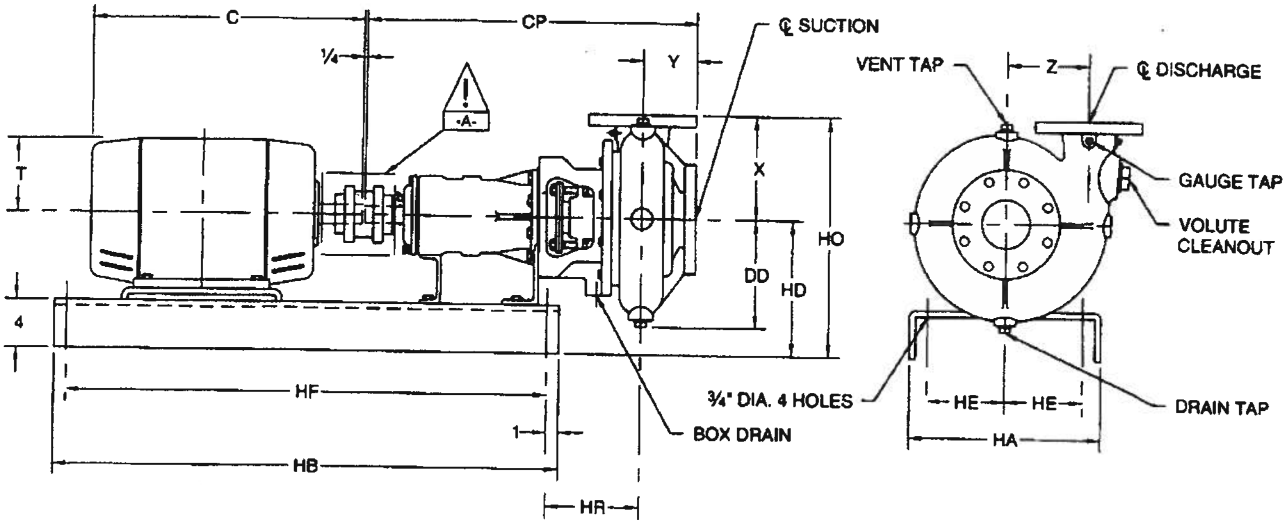
-A- SUPPLIED BY FMPC -B- SUPPLIED BY OTHERS

MOTOR DIMENSIONS	
C	T

AVAILABLE DISCHARGE POSITIONS



POSITIONS #1 OR #9 ARE STANDARD WHEN VIEWED FROM THE DRIVER END UNLESS OTHERWISE SPECIFIED. CLOCKWISE ROTATION DISCHARGE POSITION #1 SHOWN.



WAS →

PUMP	FRAME		SUCT	DISCH	X	Y	Z	CP	DD	HA	HB	HD	HE	HF	HO	HR
	PUMP	MOTOR														
2" B5421	T20	143T-145T	2	2	6½	4	5¼	26⁵⁄₁₆	6⅝	16	36	11¼	6½	34	17¾	7¹⁄₁₆
3" B5421	T20	143T-184T	3	3	7¼	4¼	5¾	26⅞	7¼	16	36	11¼	6½	34	18½	7⁵⁄₁₆
4" B5421	T20	143T-215T	4	4	8½	4½	6⅞	27½	9	16	36	11¼	6½	34	19¾	7¾
4" B5421	T20	254T-256T	4	4	8½	4½	6⅞	27½	9	16	42	11¼	6½	40	19¾	7¾
2" B5422	T20	143T-215T	2	2	8	4¾	6⅝	27⅛	8	16	36	11¼	6½	34	19¼	7⅛
3" B5422	T20	143T-215T	3	3	9	5	7¼	27⅝	8⅞	16	36	11¼	6½	34	20¼	7⅜
3" B5422	T20	254T-256T	3	3	9	5	7¼	27⅝	8⅞	16	42	11¼	6½	40	20¼	7⅜
4" B5422	T20	143T-215T	4	4	10	5¼	7⅞	28⅜	10	16	36	11¼	6½	34	21¼	7⅞
4" B5422	T20	254T-256T	4	4	10	5¼	7⅞	28⅜	10	16	42	11¼	6½	40	21¼	7⅞

NOTES.

(1) ALL FLANGES ARE 125# ANSI DRILLING UNLESS NOTED.
(2) ALL DIMENSIONS ARE IN INCHES UNLESS NOTED.
(3) 5400'S AND 5400K'S ARE DIMENSIONALLY IDENTICAL.
(4) BASES ARE DESIGNED TO BE COMPLETELY FILLED WITH GROUT.
(5) SUCTION GAUGE CONNECTIONS ARE NOT AVAILABLE AND SHOULD BE LOCATED ON ADJACENT SUCTION PIPING.
(6) NOT FOR CONSTRUCTION, INSTALLATION, OR APPLICATION PURPOSES UNLESS CERTIFIED DIMENSIONS SHOWN MAY VARY DUE TO NORMAL MANUFACTURING TOLERANCES

CUSTOMER				P.O. NO.		Fairbanks Morse Pump Corporation
JOB NAME				TAG NAME		
PUMP SIZE AND MODEL		GPM	TDH	RPM	ROTATION	DISCH POS
MOTOR	HP	FRAME	PHASE	HERTZ	VOLTS	ENCLOSURE
CERTIFIED FOR			CERTIFIED BY		DATE	

SETTING PLAN
B5421 & B5422
WITH BENT FORM BASE

DWG NO 5420S041 REV NO 0

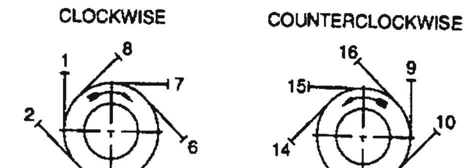
⚠ WARNING

DO NOT OPERATE THIS MACHINE WITHOUT PROTECTIVE GUARD IN PLACE. ANY OPERATION OF THIS MACHINE WITHOUT PROTECTIVE GUARD CAN RESULT IN SEVERE BODILY INJURY.

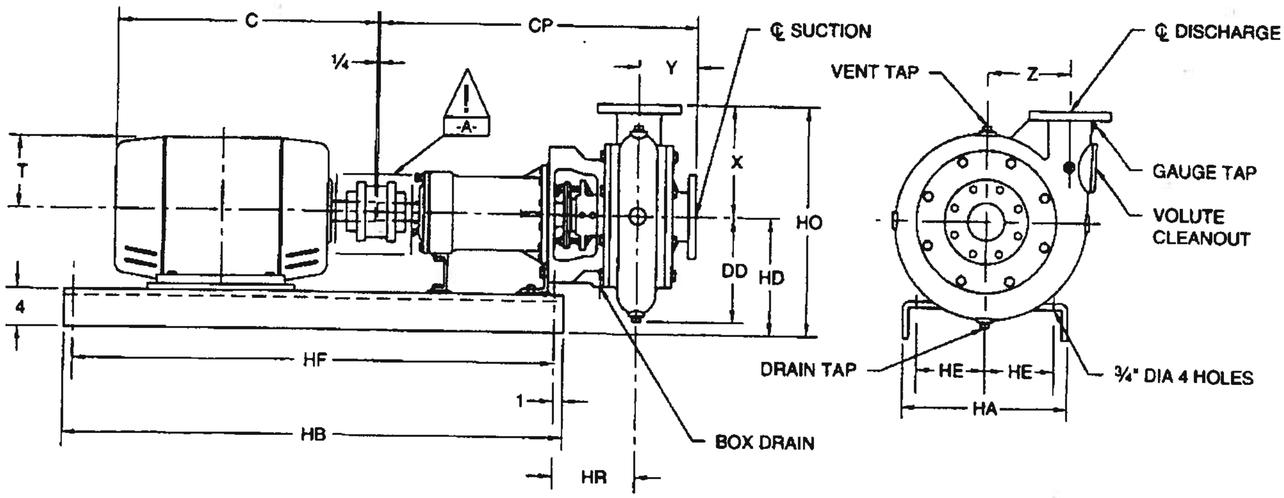
-A- SUPPLIED BY FMPC -B- SUPPLIED BY OTHERS

MOTOR DIMENSIONS	
C	T

AVAILABLE DISCHARGE POSITIONS



POSITIONS #1 OR #9 ARE STANDARD WHEN VIEWED FROM THE DRIVER END UNLESS OTHERWISE SPECIFIED. CLOCKWISE ROTATION DISCHARGE POSITION #1 SHOWN.



PUMP	FRAME		SUCT	DISCH	X	Y	Z	CP	DD	HA	HB	HD	HE	HF	HO	HR
	PUMP	MOTOR														
3" B5423	T30	143T-184T	3	3	11	5½	7¾	33¼	9¾	16	36	12⅜	6½	34	23⅜	8⅜
3" B5423	T30	213T-215T	3	3	11	5½	7¾	33¼	9¾	16	42	12⅜	6½	40	23⅜	8⅜
3" B5423	T30	254T-286T	3	3	11	5½	7¾	33¼	9¾	16	48	12⅜	6½	46	23⅜	8⅜
3" B5423	T30	324TS-326T	3	3	11	5½	7¾	33¼	9¾	18	54	12⅝	7½	52	23⅝	8⅜
4" B5423	T30	143T-184T	4	4	12	6¼	9	34½	11¼	16	36	12⅜	6½	34	24⅜	8⅞
4" B5423	T30	213T-215T	4	4	12	6¼	9	34½	11¼	16	42	12⅜	6½	40	24⅜	8⅞
4" B5423	T30	254T-286T	4	4	12	6¼	9	34½	11¼	16	48	12⅜	6½	46	24⅜	8⅞
4" B5423	T30	324TS-326T	4	4	12	6¼	9	34½	11¼	18	54	12⅝	7½	52	24⅝	8⅞
5" B5423	T30	182T-184T	5	5	13	7¼	9½	36	12¼	16	36	12⅜	6½	34	25⅜	9⅜
5" B5423	T30	213T-215T	5	5	13	7¼	9½	36	12¼	16	42	12⅜	6½	40	25⅜	9⅜
5" B5423	T30	254T-286T	5	5	13	7¼	9½	36	12¼	16	48	12⅜	6½	46	25⅜	9⅜
5" B5423	T30	324TS-326T	5	5	13	7¼	9½	36	12¼	18	54	12⅝	7½	52	25⅝	9⅜
6" B5423	T30	213T-215T	6	6	12	9	9	37¾	12½	16	42	12⅝	6½	40	24⅝	9⅜
RAS → 6" B5423	T30	254T-286T	6	6	12	9	9	37¾	12½	16	48	12⅝	6½	46	24⅝	9⅜
6" B5423	T30	324TS-326T	6	6	12	9	9	37¾	12½	18	54	12⅝	7½	52	24⅝	9⅜
6" B5423	T30	364TS-364T	6	6	12	9	9	37¾	12½	20	54	13⅝	8½	52	25⅝	9⅜

NOTES:

(1) ALL FLANGES ARE 125# ANSI DRILLING UNLESS NOTED.
(2) ALL DIMENSIONS ARE IN INCHES UNLESS NOTED.
(3) 5400'S AND 5400K'S ARE DIMENSIONALLY IDENTICAL.
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(6) NOT FOR CONSTRUCTION, INSTALLATION, OR APPLICATION PURPOSES UNLESS CERTIFIED. DIMENSIONS SHOWN MAY VARY DUE TO NORMAL MANUFACTURING TOLERANCES.

CUSTOMER | P.O. NO
JOB NAME | TAG NAME
PUMP SIZE AND MODEL | GPM | TDH | RPM | ROTATION | DISCH POS
MOTOR | HP | FRAME | PHASE | HERTZ | VOLTS | ENCLOSURE
CERTIFIED FOR | CERTIFIED BY | DATE

Fairbanks Morse Pump Corporation

SETTING PLAN
B5423
WITH BENT FORM BASE

DWG NO 5420S045 REV NO 0

1/1/92

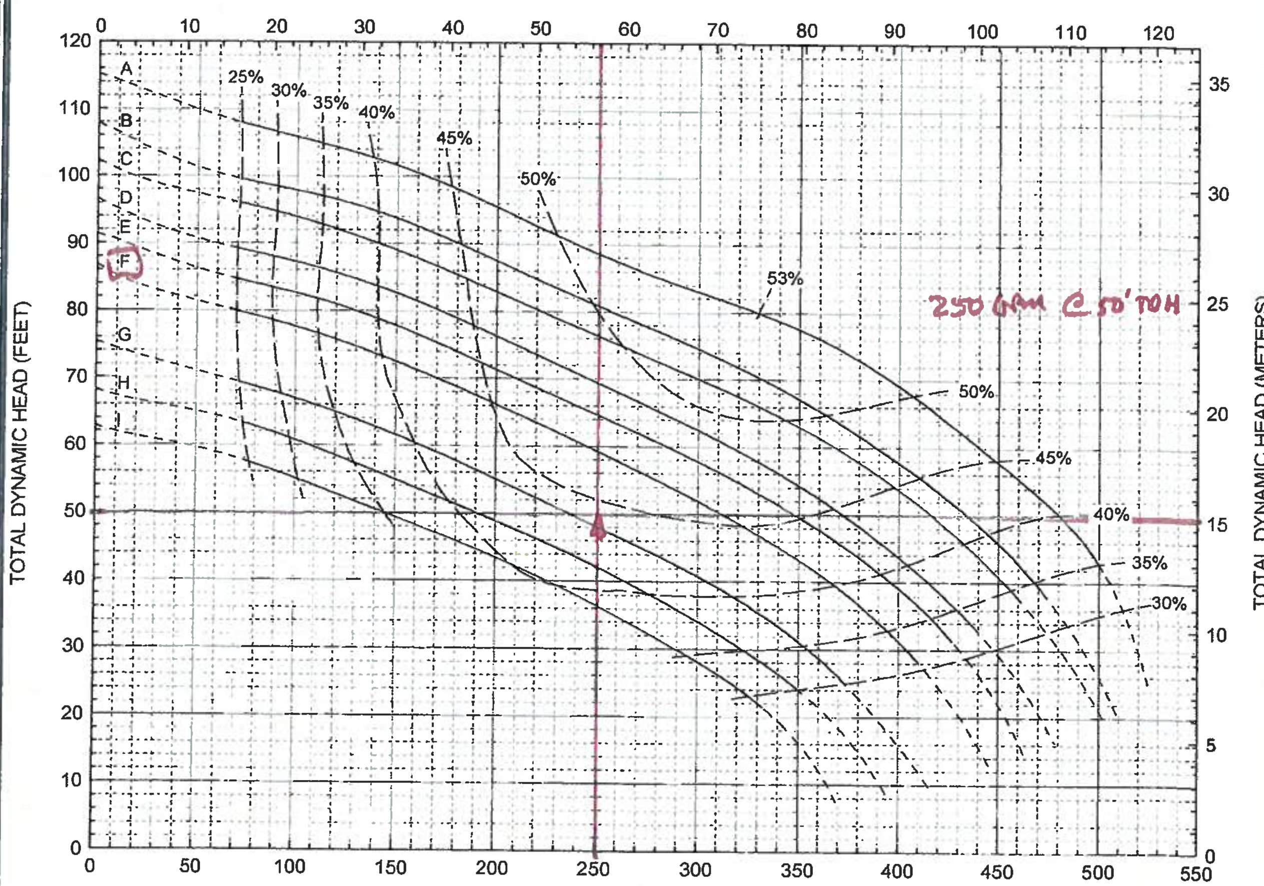
Vaughan E Series Chopper Pump PERFORMANCE CURVE

Models:
~~SE3P~~
S3PR

Back-Pull-Out Casing
3-Blade Impeller
3" Discharge
6" Suction

CURVE	POWER (HP)	SPEED (RPM)	IMPELLER DIAMETER
A	20*	1740	10.30" (262 mm)
B	15	1745	10.00" (254 mm)
C	15	1745	9.70" (246 mm)
D	15	1745	9.50" (241 mm)
E	15	1745	9.20" (234 mm)
F	10	1755	9.00" (229 mm)
G	10	1755	8.50" (216 mm)
H	7.5	1730	8.20" (208 mm)
I	7.5	1730	8.00" (203 mm)

DO NOT OPERATE PUMP IN DOTTED PORTION OF CURVES. CURVES SUBJECT TO CHANGE WITHOUT NOTICE. EFFICIENCIES SHOWN ARE NOMINAL BOWL. GUARANTIED MINIMUM EFFICIENCIES PER H.I. LEVEL B. CURVES ARE BASED ON SUBMERSIBLE MOTOR SPEEDS. *EXCEEDS 15 HP AFTER 460 GPM.



Form V370-S3P-1750 8/09

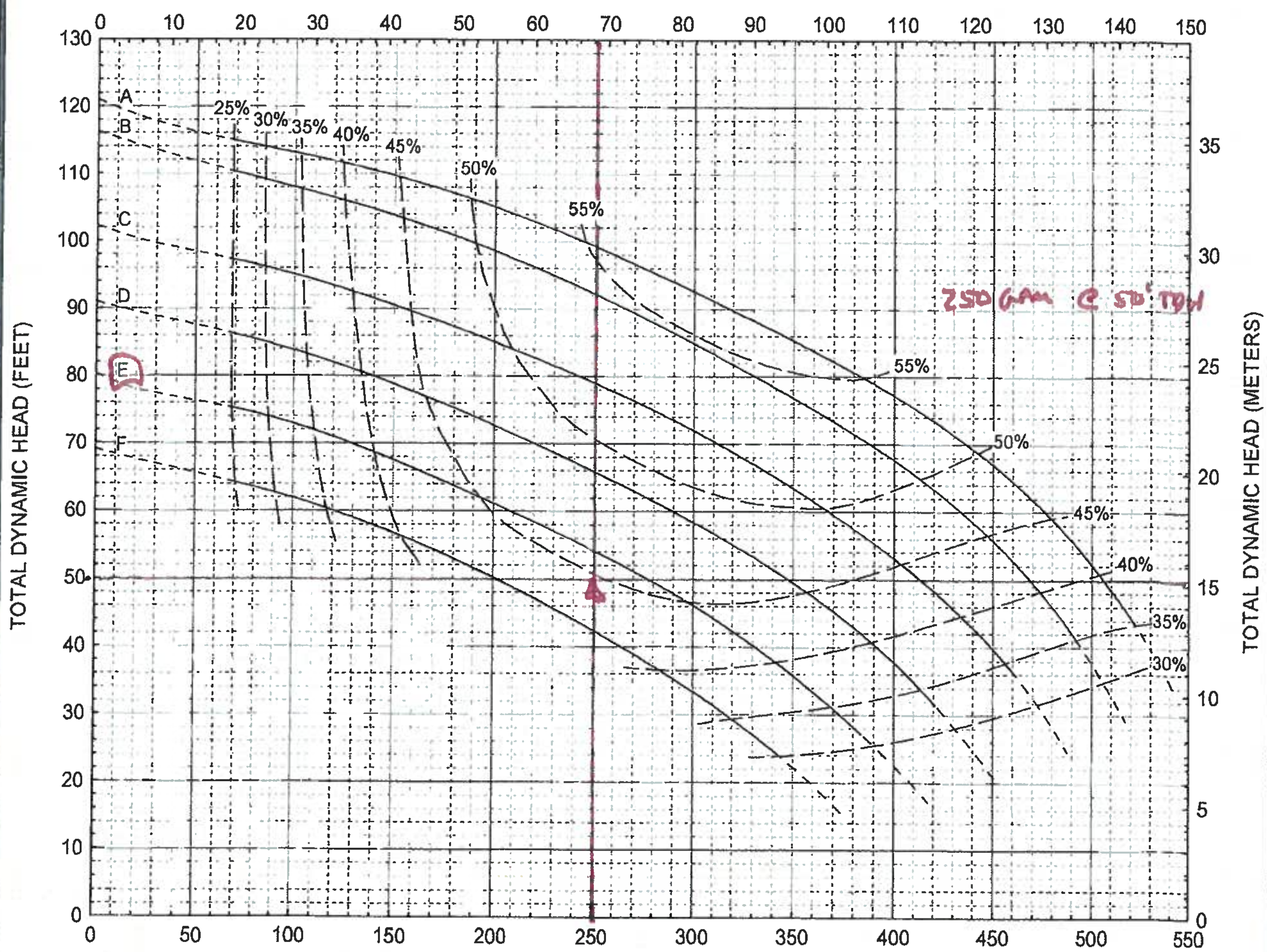
Vaughan E Series Chopper Pump PERFORMANCE CURVE

Models:
V3P
V3PR ←
C3P*
*max 3' long

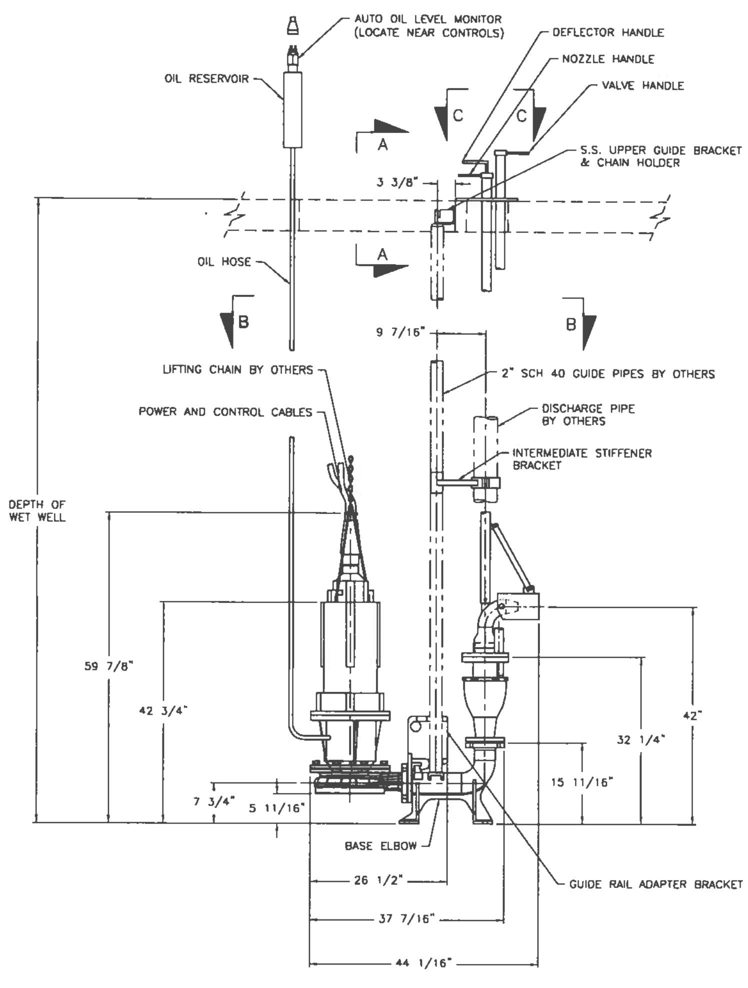
3-Blade Impeller
3" Discharge
6" Suction

CURVE	POWER (HP)	SPEED (RPM)	IMPELLER DIAMETER
A	20*	1760	10.30" (262 mm)
B	15	1765	10.00" (254 mm)
C	15	1765	9.50" (241 mm)
D	15	1765	9.00" (229 mm)
→ E	10	1765	8.50" (216 mm)
F	7.5	1765	8.00" (203 mm)

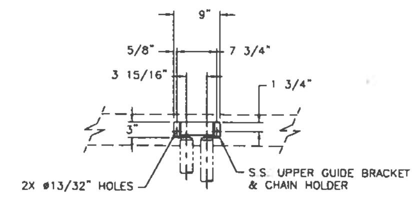
DO NOT OPERATE PUMP IN DOTTED PORTION OF CURVES. CURVES SUBJECT TO CHANGE WITHOUT NOTICE. EFFICIENCIES SHOWN ARE NOMINAL BOWL. GUARANTEED MINIMUM EFFICIENCIES PER H.I. LEVEL B. CURVES ARE BASED ON PREMIUM EFFICIENT TEFC MOTOR SPEEDS. *EXCEEDS 15 HP AFTER 440 GPM.



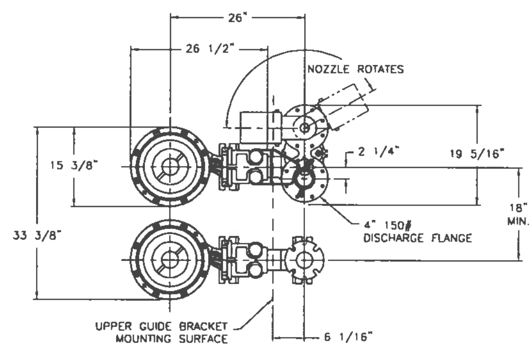
Form V242XE-3P-1750 2/11



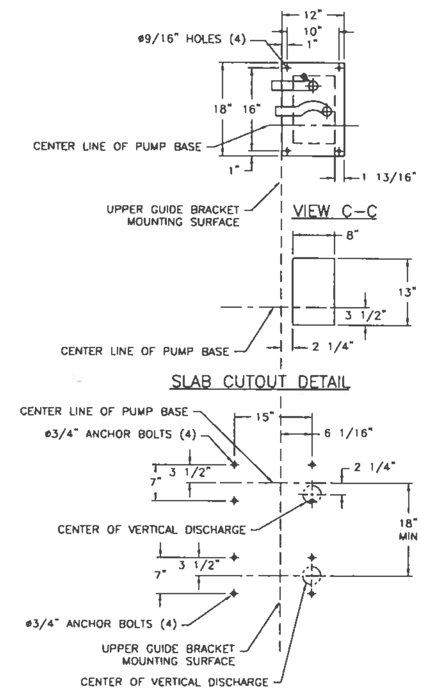
(S3PR SHOWN)



VIEW A–A



SECTION B–B



ANCHOR BOLT DETAIL

NOTES:

1. PUMP WEIGHT: 272 LBS
2. MOTOR WEIGHT: 335 LBS
3. TOTAL WEIGHT: 607 LBS
4. PERFORMANCE REQUIRED: GPM @ TDH
5. MOTOR: . RPM
   POWER: V, PH, HZ
   ENCLOSURE: SUBMERSIBLE
   MANUFACTURED BY: RELIANCE
6. SURFACE PREPARATION:

Vaughan

OUTLINE DIMENSIONS
MODEL: S3PR2– & S3P2–

Recirculation pump RZP 60-3

WILO EMU

WILO EMU GmbH
Heimgartenstraße 1-3 D-95030 Hof/Saale
Telefon +49 9281 974-0 Telefax +49 9281 96528
www.wiloemu.com E-Mail: info@wiloemu.com

Technical data of the recirculation pump RZP 60-3 (60Hz)

Technical changes reserved !

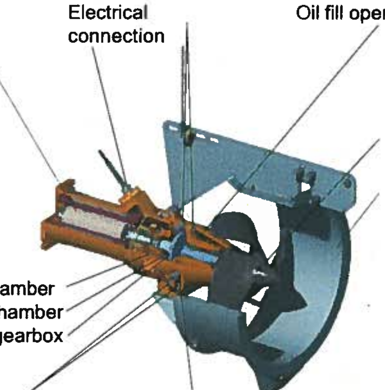
Electrical-Motor

Manufacturer:	WILO EMU GmbH, Hof (Saale)
Type:	submersible motor according to DIN/VDE 0530 (IEC 34) T17...R(Ex), T17...V(Ex)
Voltage:	max. 660V possible
Frequency:	max. 60Hz possible (higher frequencies on request)
Protection type:	IP 68 (IEC 34)
Ex-proof:	FM

Motor data at 460V 60Hz:

Type:	**4/12R**	**4/16R**	**4/24R**	**2/22R**
Rated power (kW):	5,5	7,5	11,5	12,0
Max. power input (kW):	7,1	9,4	14,2	14,0
Rated speed (rpm):	1680	1680	1700	3480
Efficiency (%):	78,0	80,0	82,0	86,0
Power factor (cos φ):	0,86	0,87	0,85	0,86
Rated current 3 ~ 460V (A):	10,3	14,0	21,0	20,5
Starting current, direct 3 ~ 460V (A):	45,0	65,0	110	105
Starting torque (Nm):	67,0	98,0	150	76,0
Moment of inertia (kg/m²):	0,0108	0,0134	0,0134	0,0116
Current supply cable, direct 230V	7x2,5	4x4/ 2x1,5	4x6/ 2x1,5	4x6/ 4x1,5
Current supply cable, direct 460V	7x1,5	7x2,5	7x2,5	7x2,5

Insulation class: F (155°C)
Max. temperature of the liquid: 40°C
(higher temperature of the liquid on request)
Max. installation depth: 12,5 m
(higher installation depth on request)
Max. starts per hour: 15
Materials: casing 0.6025 (A 48-83)
shafts 1.4021 (AISI 420)
Bearings: 1 grooved ball bearing
1 double row inclined ball bearing
Filling sealing chamber (white oil): 1,1 L (IEC 296 Cl. 2)



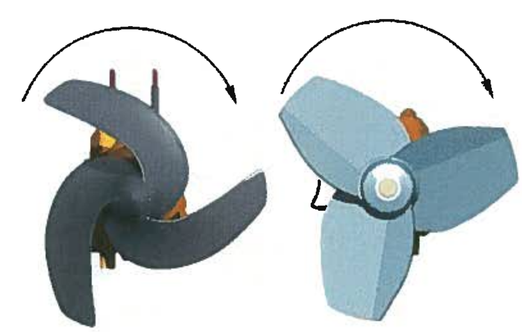
Essential construction elements of a Recirculation pump

Planetary Gearbox

Modulus: m 2,0 according to DIN 780/P10 (ISO 54)
Machining of teeth: sun and planetary wheels hardened and ground, pounded annular gear
Type of bearings: 3 needle roller bearings (planetary)
1 double row inclined ball bearing and
1 grooved ball bearing (output shaft)
Life L_{h10}: >100 000 service hours according to ISO 281
Lubrication: oil bath lubrication CLP-gearbox oil
Viscosity: ISO VG 220
Fillings: prechamber 1,2 L
gearbox chamber 0,5 L
Materials: housing 0.6025 (A 48-83)
shafts 1.4462 (S 31803(AISI))
sun wheel 1.7131 (SAE 5115)
planetary wheel 1.7131 (SAE 5115)
hollow gear 1.5216
Transmissions: i = 3,000 to 7,500

Propeller

Manufacturer: WILO EMU GmbH, Hof (Saale)
Type: 3-blade propeller
Material: polyurethane
Options: welded propeller made of St 37 (1.0037 / A 283) and 1.4571 (AISI 316 Ti)
Blade profile: backwards bent therefore clogging free
Propeller diameter (mm): 600
Speeds: 370 to 580 rpm (460V 60Hz) depending on gearbox transmission and the number of poles



Sealing

Liquid - prechamber:	mechanical shaft seal SiC / SiC
Prechamber - gearbox:	radial shaft sealing ring NBR
Gearbox - sealing chamber:	mechanical shaft seal SiC / SiC
Sealing chamber - motor:	radial shaft sealing ring NBR

Abmessungen für Rezirkulationspumpe RZP 60-3

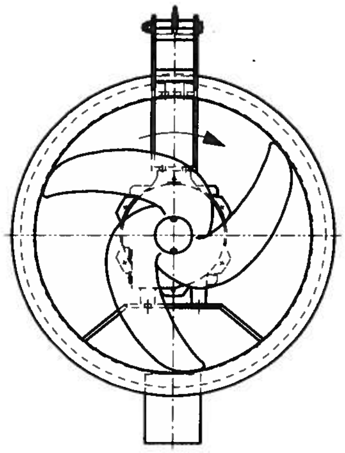
Dimensions of Recirculation pump **RZP 60-3**

Dimensions de la pompe de récirculation **RZP 60-3**

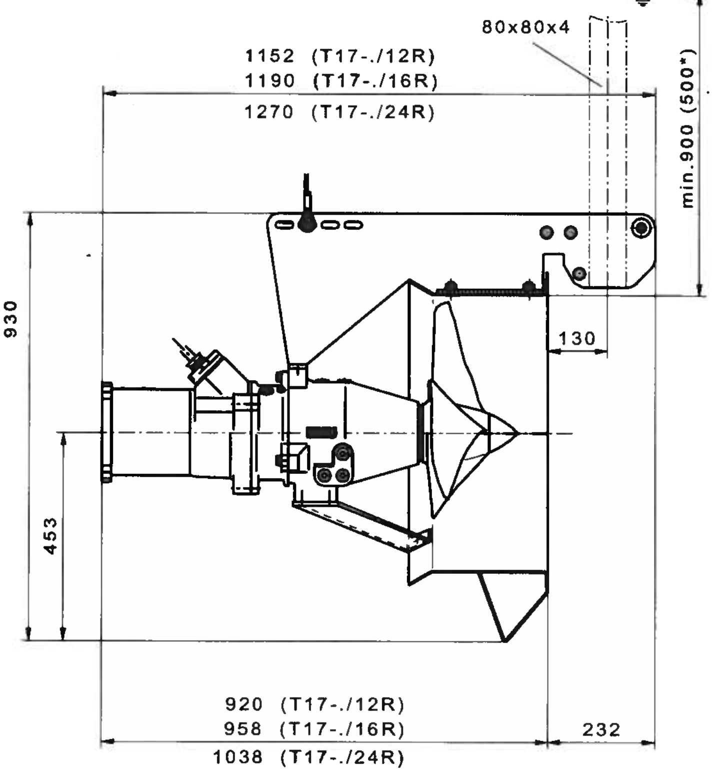
WILO *EMU*

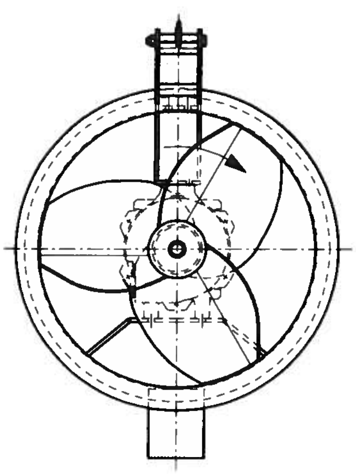
Heimgartenstraße 1-3 D-95030 Hof/Saale
Telefon +49 9281 974-0 Fax +49 9281 96528
www.wiloemu.com E-Mail: info@wiloemu.com

*) bei geringer Motorleistung und sehr guten Fließbedingungen
at low rating and very good flow conditions
à puissance du moteur basse et à conditions de fluage favorables

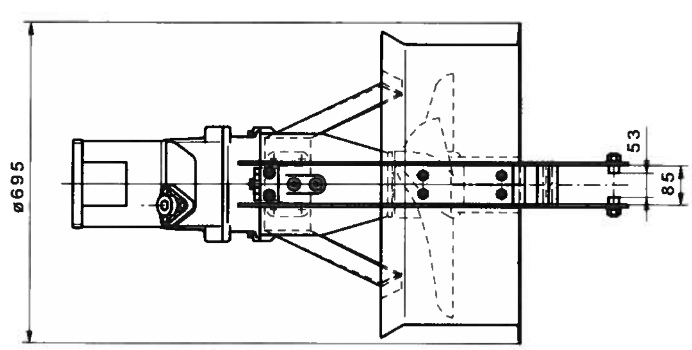


Polyurethan-Propeller
polyurethane-propeller
hélice en polyuréthane





Schweißpropeller aus Stahl
welded propeller made of steel
hélice soudée en acier

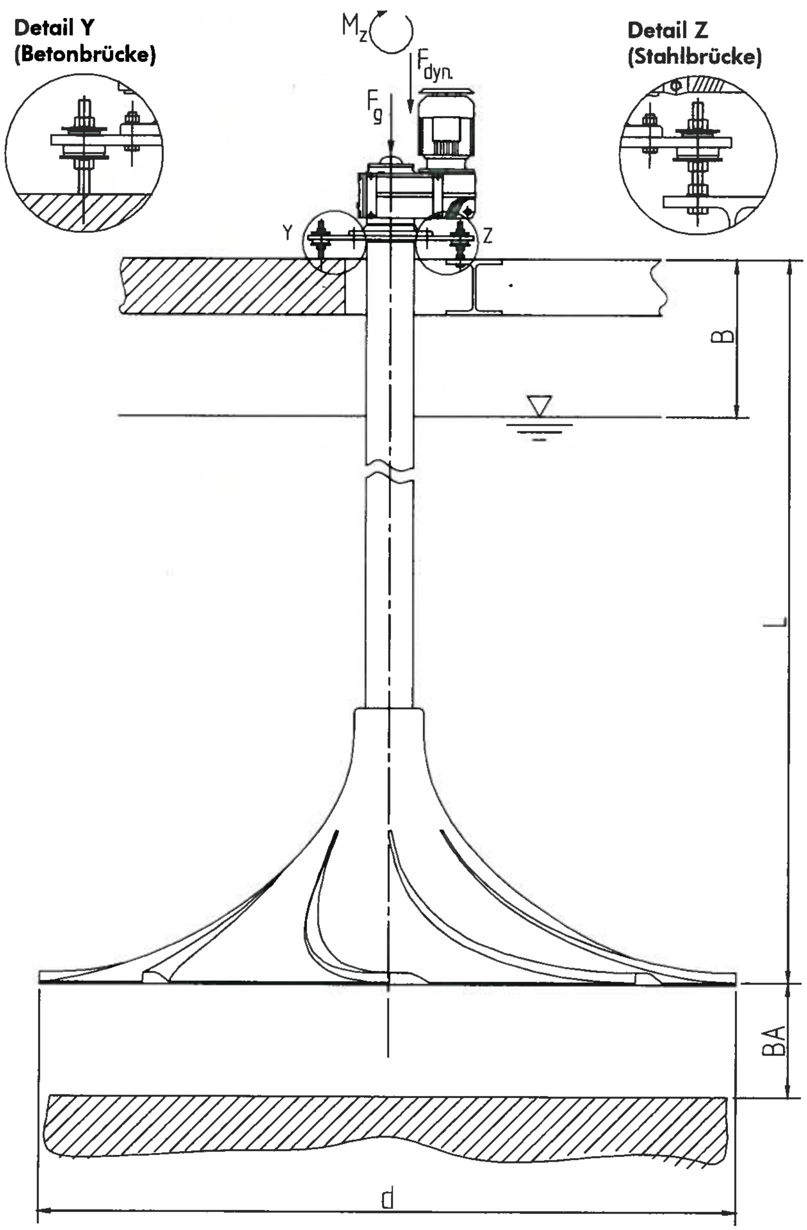


Maßstab: 1:15 Technische Änderungen vorbehalten - Technical changes reserved - Modifications techniques réservées

Datum: 8.9.2003 Wi

Mb011.prt

Appendix A – Mixer Layout Drawing



2.2 Design

The **HYPERCLASSIC®** Mixer consists of a non-clogging Hyperboloid-body, a shaft and a motor with a mounting base. The mixer is supplied including all necessary parts for assembly on either a steel or a concrete bridge. The individual parts are easy to install and guarantee quick installation. Figure 2 shows the design in detail.

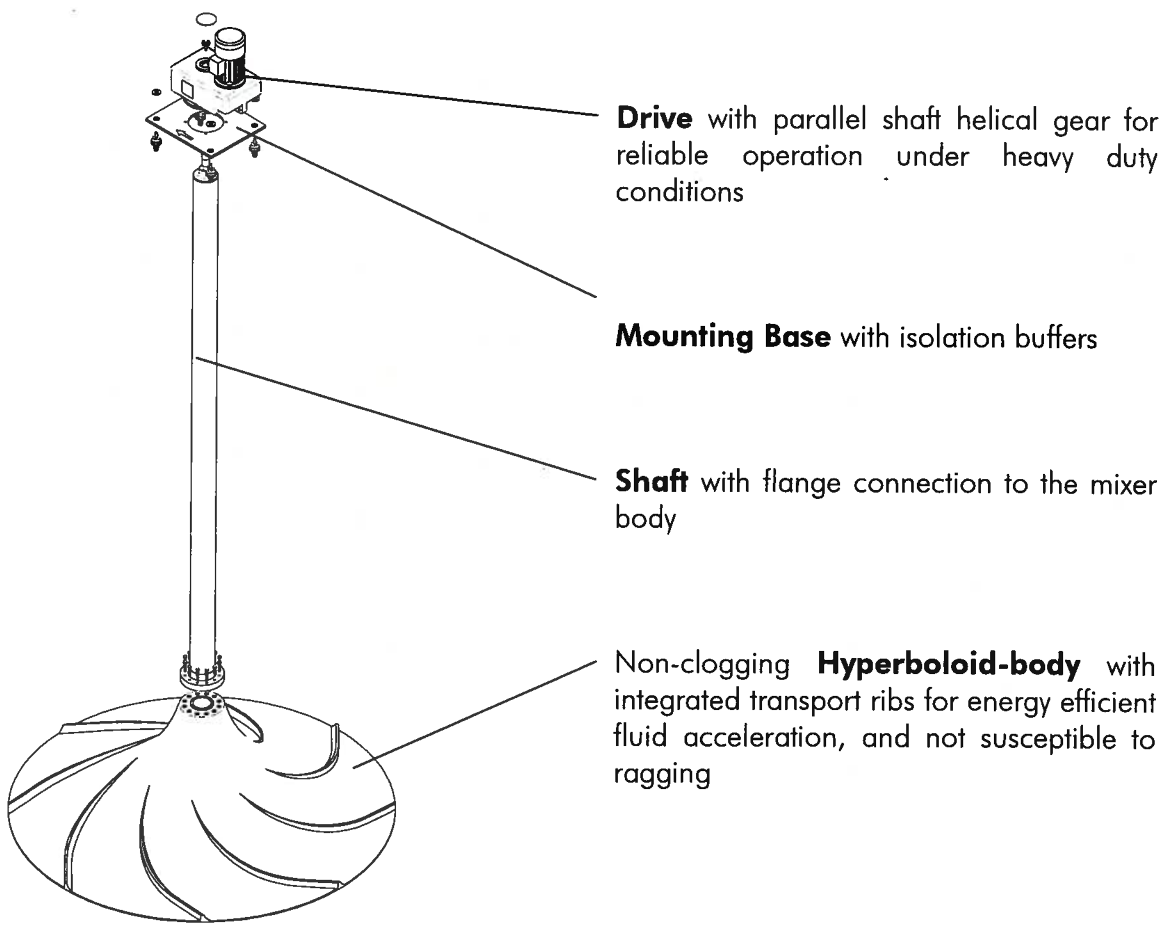


Figure 2: Exploded view on a Hyperboloid Mixer with top mounted drive

HYPERCLASSIC® Mixers are stable and dimensioned in such a way that a bottom guide bushing is not required. This means that all parts requiring maintenance are located above the water surface and are easily accessible.

JOB NAME: EXETER WWTF DATE: 05/07/15 LAST UPDATE
JOB NO.: 12883
CALC. BY: DLS
CHKD. BY: DATE: THIS UPDATE

FILE NAME: DIFFUSED AIR DESIGN PH1.xls **BOLD** =USER ENTRY
AERATION SYSTEM CALCULATIONS =CALCULATION
Based on procedure as provided by USEPA, in Design Manual: Fine Pore Aeration Systems
EPA/625/1-89/023, Eq. (5-5)

	INITIAL BARDENPHO MIN	INITIAL BARDENPHO AVG	INITIAL BARDENPHO Max Month	INITIAL BARDENPHO Max Day	INITIAL MLE AVG	INITIAL MLE Max Month	INITIAL MLE Max Day	DESIGN MIN	DESIGN AVG	DESIGN Max Month	DESIGN Max Day
YEAR	2015	2015	2015	2015	2015	2015	2015	2035	2035	2035	2035
PRIMARY EFFLUENT											
FLOW, MGD	**1.20**	**2.20**	**2.89**	**6.60**	**2.65**	**4.50**	**4.50**	**2.00**	**3.00**	**5.10**	**6.60**
BOD_5 LBS/D	**2242**	**3615**	**4569**	**7023**	**4357**	**5538**	**7023**	**3000**	**5000**	**6600**	**10100**
PEAK FACTOR	0.6	1.0	1.3	1.9	1.2	1.5	1.9	0.6	1.0	1.3	2.0
LBS OXYGEN/ LB BOD	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
BOD_{ult} LBS/D	3,363	5,423	6,854	10,535	6,536	8,307	10,535	4,500	7,500	9,900	15,150
SRT, days	**13**	**13**	**10**	**10**	**13**	**13**	**13**	**13**	**13**	**12**	**12**
LBS OXYGEN FOR BOD LBS/D	3363	5423	6854	10535	6536	8307	10535	4500	7500	9900	15150
# Sludge/# BOD Applied	**0.4**	**0.4**	**0.45**	**0.35**	**0.4**	**0.45**	**0.45**	**0.4**	**0.4**	**0.45**	**0.35**
SLUDGE PRODUCTION LB/D	504	812	1285	1536	979	1400	1775	674	1124	1727	2055
LBS OXYGEN/LBS SLUDGE	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
LBS OXYGEN	715	1,154	1,825	2,182	1,390	1,988	2,521	957	1,596	2,452	2,918
N SYNTH. LB/D	45	73	116	138	88	126	160	61	101	155	185
TKN PRIMARY EFF LBS/D	**400**	**550**	**688**	**980**	**663**	**834**	**980**	**500**	**1000**	**1300**	**1800**
TKN SEC EFF LBS/D	**40**	**73**	**96**	**220**	**88**	**150**	**150**	**67**	**100**	**170**	**220**
TKN OXID, LBS/D	315	403	476	621	486	558	670	373	799	974	1395
PEAK FACTOR	0.7	1.0	1.3	1.8	1.2	1.5	1.8	0.5	1.0	1.3	1.8
LBS OXYGEN/LBS OF TKN	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
LBS OXYGEN FOR TKN, LBS	1447	1856	2189	2857	2238	2566	3082	1714	3674	4483	6416
DENITRIFICATION CREDIT (?)	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
NO-3 N SEC EFFLUENT LB/D	5	9	12	55	133	225	225	67	100	170	220
OXYGEN CREDIT LB/D	**886**	**1128**	**1327**	**1619**	**1012**	**952**	**1272**	**875**	**1998**	**2300**	**3360**
AOR WWTR OXYGEN REQD. LBS/D	**3,209**	**4,997**	**5,891**	**9,592**	**6,371**	**7,934**	**9,823**	**4,382**	**7,581**	**9,630**	**15,288**
LBS OXYGEN/LB OF INF. BOD	1.43	1.38	1.29	1.37	1.46	1.43	1.40	1.46	1.52	1.46	1.51
AOR from BIOWIN	**3343**	**4,920**	**6,408**		**6,216**	**8,040**			**7272**	**9144**	
WASTEWATER TEMPERATURE C	**14**	**18**	**10**	**20**	**18**	**10**	**20**	**14**	**18**	**10**	**20**
ALTITUDE FT	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**
Pb BAROMETRIC PRESS. PSIA	14.68	14.68	14.68	14.68	14.68	14.68	14.68	14.68	14.68	14.68	14.68
DIFFUSER DEPTH FT	**17.4**	**17.4**	**17.4**	**17.4**	**17.4**	**17.4**	**17.4**	**17.4**	**17.4**	**17.4**	**17.4**
CL OPERATING D. O. MG/L	**2.0**	**2.0**	**2.0**	**1.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**1.0**
C* SAT,20 D. O. @ SEA LEVEL	9.09	9.09	9.09	9.09	9.09	9.09	9.09	9.09	9.09	9.09	9.09
C* SAT. DO @ WWTEMP MG/L	10.31	9.47	11.29	9.09	9.47	11.29	9.09	10.31	9.47	11.29	9.09
α ALPHA	**0.5**	**0.5**	**0.5**	**0.45**	**0.5**	**0.45**	**0.45**	**0.5**	**0.5**	**0.5**	**0.45**
ß BETA	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**
EFFECTIVE DEPTH, %	**37.5%**	**37.5%**	**37.5%**	**37.5%**	**37.5%**	**37.5%**	**37.5%**	**37.5%**	**37.5%**	**37.5%**	**37.5%**
Pvt VAPOR PRESSURE, PSIA	0.26	0.26	0.18	0.26	0.26	0.18	0.26	0.18	0.26	0.18	0.26
C^*_∞ 20	10.86	10.86	10.85	10.86	10.86	10.85	10.86	10.85	10.86	10.85	10.86
Ω =Pb/Ps	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
i= C*sat T/ C*sat 20	1.13	1.04	1.24	1.00	1.04	1.24	1.00	1.13	1.04	1.24	1.00
SOTR STD OXYGEN REQD. LBS/D $SOTR = \frac{AOTR}{C * Ø^{α}}$											
$C = (ß * i * Ω * C^*_\infty 20 - CL) / C^*_\infty 20$	0.892	0.804	0.994	0.857	0.804	0.994	0.765	0.892	0.804	0.994	0.857
Ø = 1.024^T -20	0.867	0.954	0.789	1.000	0.954	0.789	1.000	0.867	0.954	0.789	1.000
AOR/SOR = C * Ø * α	0.387	0.384	0.392	0.386	0.384	0.353	0.344	0.387	0.384	0.392	0.386
SOR STD. OXYGEN REQD. LBS/D	8,295	12,827	16,340	24,876	16,206	22,780	28,545	11,328	18,959	23,317	39,651

JOB NAME: EXETER WWTF　　DATE: 05/07/15 LAST UPDATE
JOB NO.: 12883
CALC. BY: DLS
CHKD. BY: WDH　　DATE: 09/18/15 THIS UPDATE

FILE NAME: DIFFUSED AIR DESIGN PH1.xls　　**BOLD** =USER ENTRY
AERATION SYSTEM CALCULATIONS　　=CALCULATION
Based on procedure as provided by USEPA, in Design Manual: Fine Pore Aeration Systems
EPA/625/1-89/023, Eq. (5-5)

	INITIAL BARDENPHO				INITIAL MLE			DESIGN			
	MIN	AVG	Max Month	Max Day	AVG	Max Month	Max Day	MIN	AVG	Max Month	Max Day
YEAR	2015	2015	2015	2015	2015	2015	2015	2035	2035	2035	2035
PRIMARY EFFLUENT											
FLOW, MGD	**1.20**	**2.20**	**2.89**	**6.60**	**2.65**	**4.50**	**4.50**	**2.00**	**3.00**	**5.10**	**6.60**
BOD_5 LBS/D	**2242**	**3615**	**4569**	**7023**	**4357**	**5538**	**7023**	**3000**	**5000**	**6600**	**10100**
PEAK FACTOR	0.6	1.0	1.3	1.9	1.2	1.5	1.9	0.6	1.0	1.3	2.0
LBS OXYGEN/ LB BOD	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
BOD_{ult} LBS/D	3,363	5,423	6,854	10,535	6,536	8,307	10,535	4,500	7,500	9,900	15,150
SRT, days	**13**	**13**	**10**	**10**	**13**	**13**	**13**	**13**	**13**	**12**	**12**
LBS OXYGEN FOR BOD LBS/D	3363	5423	6854	10535	6536	8307	10535	4500	7500	9900	15150
# Sludge/# BOD Applied	**0.4**	**0.4**	**0.45**	**0.35**	**0.4**	**0.45**	**0.45**	**0.4**	**0.4**	**0.45**	**0.35**
SLUDGE PRODUCTION LB/D	504	812	1285	1536	979	1400	1775	674	1124	1727	2055
LBS OXYGEN/LBS SLUDGE	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42
LBS OXYGEN	715	1,154	1,825	2,182	1,390	1,988	2,521	957	1,596	2,452	2,918
N SYNTH. LB/D	45	73	116	138	88	126	160	61	101	155	185
TKN PRIMARY EFF LBS/D	**400**	**550**	**688**	**980**	**663**	**834**	**980**	**500**	**1000**	**1300**	**1800**
TKN SEC EFF LBS/D	**40**	**73**	**96**	**220**	**88**	**150**	**150**	**67**	**100**	**170**	**220**
TKN OXID, LBS/D	315	403	476	621	486	558	670	373	799	974	1395
PEAK FACTOR	0.7	1.0	1.3	1.8	1.2	1.5	1.8	0.5	1.0	1.3	1.8
LBS OXYGEN/LBS OF TKN	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
LBS OXYGEN FOR TKN, LBS	1447	1856	2189	2857	2238	2566	3082	1714	3674	4483	6416
DENITRIFICATION CREDIT (?)	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
NO-3 N SEC EFFLUENT LB/D	**5**	**9**	**12**	**55**	**133**	**225**	**225**	**67**	**100**	**170**	**220**
OXYGEN CREDIT LB/D	**886**	**1128**	**1327**	**1619**	**1012**	**952**	**1272**	**875**	**1998**	**2300**	**3360**
AOR WWTR OXYGEN REQD. LBS/D	**3,209**	**4,997**	**5,891**	**9,592**	**6,371**	**7,934**	**9,823**	**4,382**	**7,581**	**9,630**	**15,288**
LBS OXYGEN/LB OF INF. BOD	1.43	1.38	1.29	1.37	1.46	1.43	1.40	1.46	1.52	1.46	1.51
AOR from BIOWIN	**3343**	**4,920**	**6,408**		**6,216**	**8,040**			**7272**	**9144**	
WASTEWATER TEMPERATURE C	**14**	**18**	**10**	**20**	**18**	**10**	**20**	**14**	**18**	**10**	**20**
ALTITUDE FT	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**	**33**
Pb BAROMETRIC PRESS. PSIA	14.68	14.68	14.68	14.68	14.68	14.68	14.68	14.68	14.68	14.68	14.68
DIFFUSER DEPTH FT	**17.4**	**17.4**	**17.4**	**17.4**	**17.4**	**17.4**	**17.4**	**17.4**	**17.4**	**17.4**	**17.4**
CL OPERATING D. O. MG/L	**2.0**	**2.0**	**2.0**	**1.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**1.0**
C* SAT,20 D. O. @ SEA LEVEL	9.09	9.09	9.09	9.09	9.09	9.09	9.09	9.09	9.09	9.09	9.09
C* SAT. DO @ WWTEMP MG/L	10.31	9.47	11.29	9.09	9.47	11.29	9.09	10.31	9.47	11.29	9.09
α ALPHA	**0.5**	**0.5**	**0.5**	**0.45**	**0.5**	**0.45**	**0.45**	**0.5**	**0.5**	**0.5**	**0.45**
ß BETA	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**	**0.95**
EFFECTIVE DEPTH, %	**37.5%**	**37.5%**	**37.5%**	**37.5%**	**37.5%**	**37.5%**	**37.5%**	**37.5%**	**37.5%**	**37.5%**	**37.5%**
Pvt VAPOR PRESSURE, PSIA	0.26	0.26	0.18	0.26	0.26	0.18	0.26	0.18	0.26	0.18	0.26
C^*_∞ 20	10.86	10.86	10.85	10.86	10.86	10.85	10.86	10.85	10.86	10.85	10.86
Ω =Pb/Ps	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
i= C*sat T/ C*sat 20	1.13	1.04	1.24	1.00	1.04	1.24	1.00	1.13	1.04	1.24	1.00
SOTR STD OXYGEN REQD. LBS/D $SOTR = \frac{AOTR}{C * Ø^{α}}$											
$C = (ß * i * Ω * C^*_\infty 20 - CL) / C^*_\infty 20$	0.892	0.804	0.994	0.857	0.804	0.994	0.765	0.892	0.804	0.994	0.857
Ø = 1.024^T -20	0.867	0.954	0.789	1.000	0.954	0.789	1.000	0.867	0.954	0.789	1.000
AOR/SOR = C * Ø * α	0.387	0.384	0.392	0.386	0.384	0.353	0.344	0.387	0.384	0.392	0.386
SOR STD. OXYGEN REQD. LBS/D	8,295	12,827	16,340	24,876	16,206	22,780	28,545	11,328	18,959	23,317	39,651

JOB NAME:	EXETER WWTF		DATE:	05/07/15
JOB NO.:	12883			
CALC. BY:	DLS			
CHKD. BY:	WDH			

FILE NAME: DIF_AIR.XLS

	INITIAL BARDENPHO				INITIAL MLE			FUTURE			
	MIN	AVG	Max	Max Day	AVG	Max	Max Day	MIN	AVG	Max	Max Day
YEAR	2015	2015	2015	2015	2015	2015	2015	2035	2035	2035	2035
BOD LOAD LBS/D	2242	3615	4569	7023	4357	5538	7023	3000	5000	6600	10100
SOR STD. OXYGEN REQD. LBS/D	**8,295**	**12,827**	**16,340**	**24,876**	**16,206**	**22,780**	**28,545**	**11,328**	**18,959**	**23,317**	**39,651**
LBS BOD/1000CF	***2.4***	***3.9***	***4.9***	***7.5***	***4.7***	***5.9***	***7.5***	***3.2***	***5.3***	***7.1***	***10.8***
OXYGEN TRANSFER EFF. % *	**33.0%**	**32.0%**	**31.0%**	**30.0%**	**31.0%**	**30.0%**	**30.0%**	**33.0%**	**32.0%**	**31.0%**	**30.0%**
GROSS OXYGEN REQD. LBS/D	25,137	40,084	52,711	82,921	52,276	75,933	95,150	34,327	59,246	75,216	132,168
STD. WEIGHT OF AIR LBS/CFT	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075
PROCESS AIR REQD. SCFM	**1,003**	**1,600**	**2,104**	**3,309**	**2,086**	**3,031**	**3,797**	**1,370**	**2,365**	**3,002**	**5,275**
AIR SUPPLY RATIO CF/LB BOD	*644*	*637*	*663*	*679*	*690*	*788*	*779*	*658*	*681*	*655*	*752*
AUX. AIR REQD. CFM	18	0	0	0	0	0	0	162	0	0	0
TOTAL AIR REQD. SCFM	**1,021**	**1,600**	**2,104**	**3,309**	**2,086**	**3,031**	**3,797**	**1,532**	**2,365**	**3,002**	**5,275**
AIR TEMP. F *	**68**	**90**	**90**	**100**	**90**	**100**	**100**	**68**	**90**	**90**	**100**
RHA	**36%**	**90%**	**90%**	**90%**	**90%**	**90%**	**90%**	**90%**	**90%**	**90%**	**90%**
WEIGHT OF AIR LBS/CFT *	0.0741	0.0711	0.0711	0.0699	0.0711	0.0699	0.0699	0.0741	0.0711	0.0711	0.0699
OXYGEN CONTENT OF DRY AIR	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232	0.232
OXYGEN AVAIL. LBS /CFT	0.0172	0.0165	0.0165	0.0162	0.0165	0.0162	0.0162	0.0172	0.0165	0.0165	0.0162
TA DEG R	528.00	550.00	550.00	560.00	550.00	560.00	560.00	528.00	550.00	550.00	560.00
PB PSIA *	14.68	14.68	14.68	14.68	14.68	14.68	14.68	14.68	14.68	14.68	14.68
PA PSIA (AT INTAKE) *	**14.48**	**14.48**	**14.48**	**14.48**	**14.48**	**14.48**	**14.48**	**14.48**	**14.48**	**14.48**	**14.48**
PVA PSIA	0.2600	0.7000	0.7000	0.9500	0.7000	0.9500	0.9500	0.2600	0.7000	0.7000	0.9500
TS DEG R	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00	528.00
PS PSIA	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70	14.70
RHS	36%	36%	36%	36%	36%	36%	36%	36%	36%	36%	36%
PVS PSIA	0.3391	0.3391	0.3391	0.3391	0.3391	0.3391	0.3391	0.3391	0.3391	0.3391	0.3391
QUANTITY OF AIR, ICFM *	**1,035**	**1,754**	**2,306**	**3,755**	**2,287**	**3,438**	**4,308**	**1,567**	**2,592**	**3,291**	**5,984**
NUMBER OF BLOWERS	3	3	3	3	3	3	3	4	4	4	4
NUMBER IN SERVICE	1	1	2	2	2	2	2	1	1	2	3
UNIT BLOWER CAP. ICFM	1,035	1,754	1,153	1,877	1,143	1,719	2,154	1,567	2,592	1,645	1,995
ACTUAL CAPACITY ACFM	**2,200**	**2,200**	**2,200**	**2,200**	**2,200**	**2,200**	**2,200**	**2,200**	**2,200**	**2,200**	**2,200**
HEAD, PSIG	**10.1**	**10.1**	**10.1**	**10.1**	**10.1**	**10.1**	**10.1**	**10.1**	**10.1**	**10.1**	**10.1**
BLOWER/MOTOR COMB. EFF.	**0.70**	**0.70**	**0.70**	**0.70**	**0.70**	**0.70**	**0.70**	**0.60**	**0.70**	**0.70**	**0.60**
HP EACH	73.9	73.9	73.9	73.9	73.9	73.9	73.9	86.2	73.9	73.9	86.9
TOTAL AIR AVAILABLE CFM	2,200	2,200	4,400	4,400	4,400	4,400	4,400	2,200	2,200	4,400	6,600
AERATION AIR AVAILABLE CFM	2,182	2,200	4,400	4,400	4,400	4,400	4,400	2,038	2,200	4,400	6,600
AERATION AIR AVAIL. CFD	3,141,793	3,168,000	6,336,000	6,336,000	6,336,000	6,336,000	6,336,000	2,934,526	3,168,000	6,336,000	9,504,000
AIR RATIO CF/LB BOD	1,401	876	1,387	902	1,454	1,144	902	978	634	960	941
TOTAL AVAIL STD OX. LBS/D	17,719	17,639	34,176	33,074	34,176	33,074	33,074	15,067	17,639	34,176	49,611
UNIT HP	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
OPERATING HP	74	74	148	148	148	148	148	86	74	148	261
AERATION VOLUME ON LINE	**935,640**	**935,640**	**935,640**	**935,640**	**935,640**	**935,640**	**935,640**	**935,640**	**935,640**	**935,640**	**935,640**
MGAL	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
1000 CFT	935.6	935.6	935.6	935.6	935.6	935.6	935.6	935.6	935.6	935.6	935.6
KLa	0.65	1.00	1.27	1.94	1.26	1.77	2.22	0.88	1.48	1.82	3.09
MIXING CFM/1000 CFT *	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**
SCFM REQUIRED FOR MIXING(BY	**14,035**	**14,035**	**14,035**	**14,035**	**14,035**	**14,035**	**14,035**	**14,035**	**14,035**	**14,035**	**14,035**
TANK AREA (SF)	**8,512**	**8,512**	**8,512**	**8,512**	**10,640**	**10,640**	**10,640**	**12,768**	**12,768**	**12,768**	**12,768**
MIXING AIR REQ'D (SCFM/SQ.FT	**0.12**	**0.12**	**0.12**	**0.12**	**0.12**	**0.12**	**0.12**	**0.12**	**0.12**	**0.12**	**0.12**
SCFM REQUIRED FOR MIXING (BY	**1,021**	**1,021**	**1,021**	**1,021**	**1,277**	**1,277**	**1,277**	**1,532**	**1,532**	**1,532**	**1,532**

Option 6 - Bardenpho Phased
Phase 1 - Bardenpho

	Initial Minimum Day	Initial Minimum Month	Initial Annual Average	Initial Max Month
Raw Influent				
Flow rate, mgd	1	1.2	2.2	3.3
Peak Day Flow Rate, mgd	6.0	6.0	6.0	6.0
Peak Secondary Instan. Flow Rate, mgd	6	6	6	6
Peak Primary Instan. Flow Rate, mgd	6	6	6	6
BOD, mg/L	224	224	197	166
TSS, mg/L	256	256	231	195
VSS, mg/L	215	215	190	160
TKN, mg/L	40	40	30	25
NH3, mg/L	32	32	24	20
NOx, mg/L	0	0	0	0
P, mg/L	6.0	6.0	4.2	4.7
Ortho P, mg/L	3	3	2.1	2.4
BOD, lbs/day	1,868	2,242	3,615	4,569
TSS, lbs/day	2,135	2,562	4,238	5,367
VSS, lbs/day	1,793	2,152	3,486	4,404
TKN, lbs/day	334	400	550	688
NH3, lbs/day	267	320	440	550
NOx, lbs/day	0	0	0	0
P, lbs/day	50	60	77	129
Ortho P, lbs/day	25	30	39	65
DO, mg/l				
Influent Alkalinity, mg/l	160.0	160.0	160.0	160.0
Additional Alkalinity Required, mg/l	65.0	65.0	65.0	65.0
Assumed Influent pH (lower range of data set)	6.8	6.8	6.8	6.8
Temp, C	16	16	16	10

Option 6 - Bardenpho Phased

Phase 1 - Bardenpho

	Initial Minimum Day	Initial Minimum Month	Initial Annual Average	Initial Max Month
Aeration Tanks				
No. of Tanks	2	2	2	2
Total Volume, Mgal	1.81	1.81	1.81	1.81
Volume, Anaerobic, Mgal	0.00	0.00	0.00	0.00
SRT, Anaerobic Zone, day	0.0	0.0	0.0	0.0
HRT, Anaerobic Zone, hrs	0.0	0.0	0.0	0.0
Volume, Anoxic, Mgal	0.307	0.307	0.307	0.307
SRT, Anoxic Zone, day	2.5	2.5	2.5	2.7
HRT, Anoxic Zone, hrs	7.4	6.1	3.4	2.2
Volume, Oxic, Mgal	1.140	1.140	1.140	1.291
HRT, OxicZone, hr	27.4	22.8	12.4	9.4
SRT, Oxic Zone	9.45	9.44	9.45	11.42
MLVSS, Oxic Zone, mg/L	1,066	1,268	1,974	2,675
MLSS, OxicZone, mg/L	1,529	1,816	2,878	3,848
Volume, Post-Anoxic, Mgal	0.302	0.302	0.302	0.151
SRT, Post-Anoxic Zone, day	1.0	1.0	1.0	0.5
HRT, Post-Anoxic Zone, hrs	7.2	6.0	3.3	1.1
Volume, Re-aeration, Mgal	0.07	0.07	0.07	0.07
HRT, Re-aeration, hr	1.6	1.3	0.7	0.5
SRT, Re-aeration, days	0.54	0.54	0.54	0.57
Total Aerobic SRT, days	9.98	9.98	9.99	11.99
Unaerated Tank Percentage, %	34%	34%	34%	25%
SRT (total), day	13.5	13.5	13.5	15.2
Aeration				
Actual Oxygen Required, lbs/day	2,760	3,343	4,920	6,408
Airflow rate, cfm	536	788	1,268	1,717

Option 6 - Bardenpho Phased

Phase 1 - Bardenpho

	Initial Minimum Day	Initial Minimum Month	Initial Annual Average	Initial Max Month
Chemical Addition				
Ferric Chloride to P.C, lbs/day				
Ferric Chloride to S.C., lbs/day				
Supplemental Carbon, lbs BOD/day				
Supplemental Carbon, gal methanol/day	20	20	0	0
Supplemental Carbon, gal microC2000/day	26	26	0	0
Supplemental Alkalinity, lb/d as CaCO3	542	651	1,193	1,789
Mag Hydroxide Req'd, gal/day	41	49	90	135
Mag Hydroxide Req'd, gal/month	1,223	1,467	2,690	4,035
Secondary Clarifier				
RAS, mgd	0.60	0.76	1.38	2.12
WAS, mgd	0.0500	0.0500	0.0500	0.0400
RAS TSS, mg/L	3,800	4,560	7,247	9,701
WAS TSS, mg/L	3,800	4,560	7,247	9,701
WAS TSS, lb/d	1,539	1,829	2,896	3,630
No. of New Tanks	2	2	3	3
Diameter, ft	70	70	70	70
Total Surface, ft^2	7,693	7,693	11,540	11,540
SOR ave, $gal/ft^2/d$	130	156	191	286
SOR peak day, $gal/ft^2/d$	780	780	520	520
SOR peak instant, $gal/ft^2/d$	780	780	520	520
SLR ave, $lb/ft^2/d$	1.7	2.4	4.6	9.2
SLR peak day, $lb/ft^2/d$	11	13	15	23
SLR peak instant, $lb/ft^2/d$	11	13	15	23
Final Effluent				
Effluent pH	7.00	7.00	7.00	7.00
Effluent CBOD5, mg/L	5	5	5	5
Effluent TKN, mg/L	2.0	2.0	2.0	2.1
Effluent NH3, mg/L	1.0	1.0	1.0	1.0
Effluent NOx, mg/L	1.5	1.7	1.4	2.4
Effluent TN, mg/L	3.5	3.7	3.4	4.5
Effluent TSS, mg/L	10	10	10	10
Effluent TN, lb/d	29	37	62	124
Effluent TP, mg/l	3.1	3.1	1.7	1.6
Total Sludge Dewatered, lbs/day	1,390	1,653	2,600	3,280

Bardenpho Phased

Phase 1 - MLE

	Initial Annual Average	Design Annual Average w/ one unit out of service	Initial Max Month
Raw Influent			
Flow rate, mgd	2.65	2.65	4
Peak Day Flow Rate, mgd	6.0	6.0	6.0
Peak Secondary Instan. Flow Rate, mgd	6	6	6
Peak Primary Instan. Flow Rate, mgd	6	6	6.6
BOD, mg/L	197	197	166
TSS, mg/L	231	231	195
VSS, mg/L	190	190	160
TKN, mg/L	30	30	25
NH3, mg/L	24	24	20
NOx, mg/L	0	0	0
P, mg/L	4.2	4.2	4.7
Ortho P, mg/L	2.1	2.1	2.4
BOD, lbs/day	4,354	4,354	5,538
TSS, lbs/day	5,105	5,105	6,505
VSS, lbs/day	4,199	4,199	5,338
TKN, lbs/day	663	663	834
NH3, lbs/day	530	530	667
NOx, lbs/day	0	0	0
P, lbs/day	93	93	157
Ortho P, lbs/day	46	46	78
DO, mg/l			
Influent Alkalinity, mg/l	160.0	160.0	160.0
Additional Alkalinity Required, mg/l	65.0	65.0	65.0
Assumed Influent pH (lower range of data set)	6.8	6.8	6.8
Temp, C	16	16	10

Bardenpho Phased

Phase 1 - MLE

	Initial Annual Average	Design Annual Average w/ one unit out of service	Initial Max Month
Aeration Tanks			
No. of Tanks	2	1	2
Total Volume, Mgal	1.81	0.91	1.81
Volume, Anaerobic, Mgal	0.00	0.00	0.00
SRT, Anaerobic Zone, day	0.0	0.0	0.0
HRT, Anaerobic Zone, hrs	0.0	0.0	0.0
Volume, Anoxic, Mgal	0.307	0.073	0.145
SRT, Anoxic Zone, day	2.0	0.7	1.0
HRT, Anoxic Zone, hrs	2.8	0.7	0.9
Volume, Oxic, Mgal	1.442	0.84	1.604
HRT, OxicZone, hr	13.1	7.6	9.6
SRT, Oxic Zone	9.57	8.00	11.52
MLVSS, Oxic Zone, mg/L	1,968	2,878	2,868
MLSS, OxicZone, mg/L	2,718	3,969	3,829
Volume, Post-Anoxic, Mgal	0.000	0.00	0.000
SRT, Post-Anoxic Zone, day	0.0	0.0	0.0
HRT, Post-Anoxic Zone, hrs	0.0	0.0	0.0
Volume, Re-aeration, Mgal	0.07	0.00	0.07
HRT, Re-aeration, hr	0.6	0.0	0.4
SRT, Re-aeration, days	0.43	0.00	0.47
Total Aerobic SRT, days	10.00	8.00	11.99
Unaerated Tank Percentage, %	17%	8%	8%
SRT (total), day	12.0	8.7	13.0
Aeration			
Actual Oxygen Required, lbs/day	6,216		8,040
Airflow rate, cfm	1,645		2,267

Bardenpho Phased

Phase 1 - MLE

	Initial Annual Average	Design Annual Average w/ one unit out of service	Initial Max Month
Chemical Addition			
Ferric Chloride to P.C, lbs/day			
Ferric Chloride to S.C., lbs/day			
Supplemental Carbon, lbs BOD/day			
Supplemental Carbon, gal methanol/day	0		0
Supplemental Carbon, gal microC2000/day	0	0	0
Supplemental Alkalinity, lb/d as CaCO3	1,437	1,437	2,168
Mag Hydroxide Req'd, gal/day	108	108	163
Mag Hydroxide Req'd, gal/month	3,240	3,240	4,891
Secondary Clarifier			
RAS, mgd	1.66	1.70	2.54
WAS, mgd	0.0650	0.0400	0.0600
RAS TSS, mg/L	6,824	10,002	9,651
WAS TSS, mg/L	6,824	10,002	9,651
WAS TSS, lb/d	3,417	3,454	4,445
No. of New Tanks	3	3	3
Diameter, ft	70	70	70
Total Surface, ft^2	11,540	11,540	11,540
SOR ave, $gal/ft^2/d$	230	230	347
SOR peak day, $gal/ft^2/d$	520	520	520
SOR peak instant, $gal/ft^2/d$	520	520	520
SLR ave, $lb/ft^2/d$	5.2	7.6	11.1
SLR peak day, $lb/ft^2/d$	15	22	24
SLR peak instant, $lb/ft^2/d$	15	22	24
Final Effluent			
Effluent pH	7.00	7.00	7.00
Effluent CBOD5, mg/L	5	5	5
Effluent TKN, mg/L	2.1	2.1	2.2
Effluent NH3, mg/L	1.0	1.0	1.0
Effluent NOx, mg/L	4.5	4.3	6.7
Effluent TN, mg/L	6.6	6.4	8.9
Effluent TSS, mg/L	10	10	10
Effluent TN, lb/d	146	141	297
Effluent TP, mg/l	1.7	1.8	2.5
Total Sludge Dewatered, lbs/day	3,095		4,036

Bardenpho Phased

Phase 2 -Bardenpho

	Design Annual Average	Design Annual Average w/ one unit out of service	Design Max Month
Raw Influent			
Flow rate, mgd	3	3	4.5
Peak Day Flow Rate, mgd	6.6	6.6	6.6
Peak Secondary Instan. Flow Rate, mgd	6.6	6.6	6.6
Peak Primary Instan. Flow Rate, mgd	6.6	6.6	6.6
BOD, mg/L	200	200	176
TSS, mg/L	236	236	205
VSS, mg/L	200	200	165
TKN, mg/L	33	33	28
NH3, mg/L	26	26	22
NOx, mg/L	0	0	0
P, mg/L	4.8	4.8	4.0
Ortho P, mg/L	2.4	2.4	2.0
BOD, lbs/day	5,004	5,004	6,605
TSS, lbs/day	5,905	5,905	7,694
VSS, lbs/day	5,004	5,004	6,192
TKN, lbs/day	826	826	1,051
NH3, lbs/day	661	661	841
NOx, lbs/day	0	0	0
P, lbs/day	120	120	150
Ortho P, lbs/day	60	60	75
DO, mg/l			
Influent Alkalinity, mg/l	160.0	160.0	160.0
Additional Alkalinity Required, mg/l	65.0	65.0	65.0
Assumed Influent pH (lower range of data set)	6.8	6.8	6.8
Temp, C	16	16	10

Bardenpho Phased

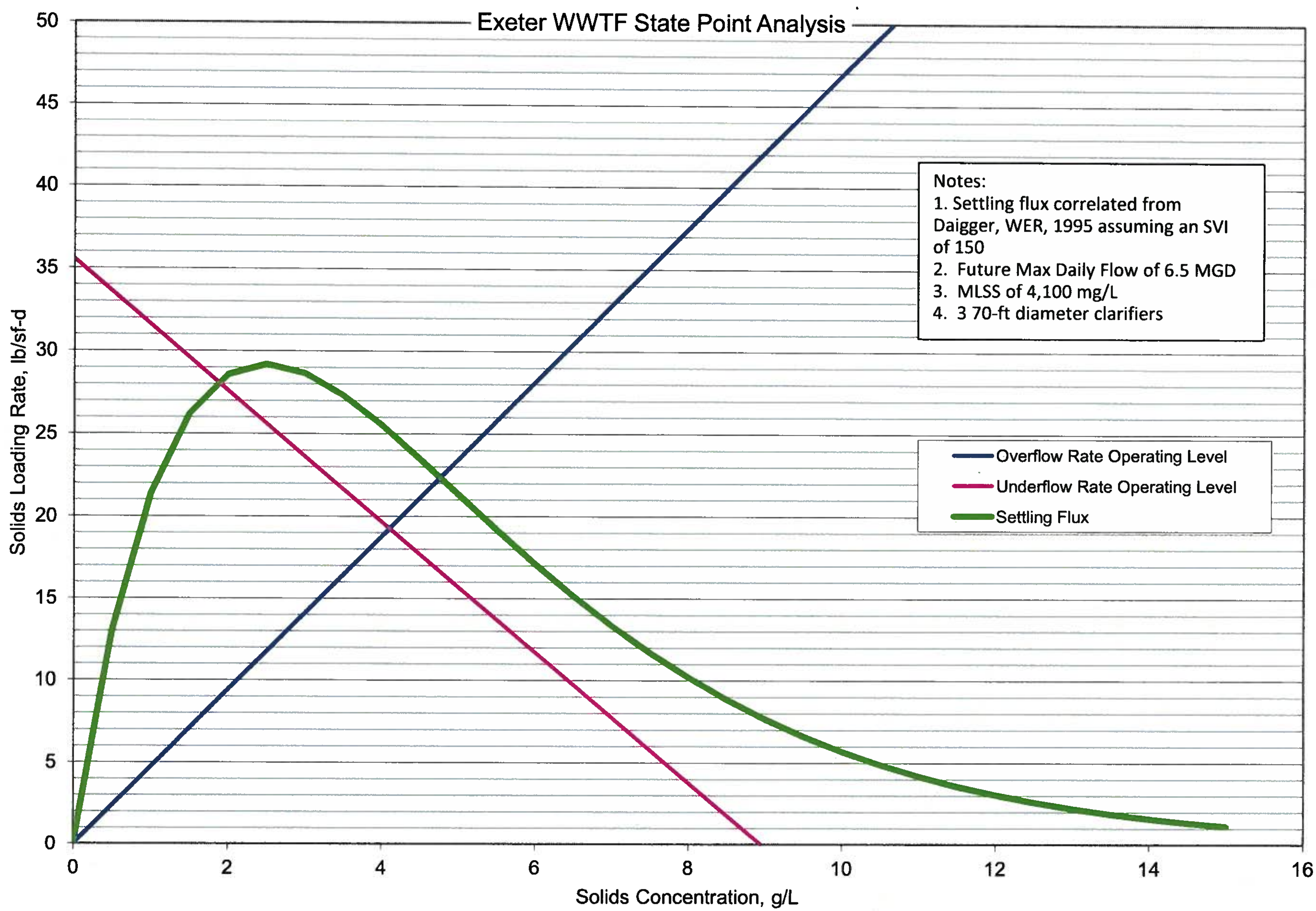
Phase 2 -Bardenpho

	Design Annual Average	Design Annual Average w/ one unit out of service	Design Max Month
Aeration Tanks			
No. of Tanks	3	2	3
Total Volume, Mgal	2.72	1.81	2.72
Volume, Anaerobic, Mgal	0.00	0.00	0.00
SRT, Anaerobic Zone, day	0.0	0.0	0.0
HRT, Anaerobic Zone, hrs	0.0	0.0	0.0
Volume, Anoxic, Mgal	0.459	0.307	0.459
SRT, Anoxic Zone, day	2.6	2.5	3.0
HRT, Anoxic Zone, hrs	3.7	2.5	2.4
Volume, Oxic, Mgal	1.71	1.140	1.71
HRT, OxicZone, hr	13.7	9.1	9.1
SRT, Oxic Zone	9.53	9.45	11.32
MLVSS, Oxic Zone, mg/L	1,973	2,917	2,766
MLSS, OxicZone, mg/L	2,695	4,055	4,083
Volume, Post-Anoxic, Mgal	0.45	0.302	0.45
SRT, Post-Anoxic Zone, day	1.5	1.0	1.5
HRT, Post-Anoxic Zone, hrs	3.6	2.4	2.4
Volume, Re-aeration, Mgal	0.10	0.07	0.10
HRT, Re-aeration, hr	0.8	0.5	0.5
SRT, Re-aeration, days	0.54	0.54	0.64
Total Aerobic SRT, days	10.07	9.99	11.96
Unaerated Tank Percentage, %	34%	34%	34%
SRT (total), day	14.1	13.5	16.5
Aeration			
Actual Oxygen Required, lbs/day	7,272		9,144
Airflow rate, cfm	1,877		2,502

Bardenpho Phased

Phase 2 -Bardenpho

	Design Annual Average	Design Annual Average w/ one unit out of service	Design Max Month
Chemical Addition			
Ferric Chloride to P.C, lbs/day			
Ferric Chloride to S.C., lbs/day			
Supplemental Carbon, lbs BOD/day			
Supplemental Carbon, gal methanol/day	75	100	0
Supplemental Carbon, gal microC2000/day	98	130	0
Supplemental Alkalinity, lb/d as CaCO3	1,626	1,626	2,439
Mag Hydroxide Req'd, gal/day	122	122	183
Mag Hydroxide Req'd, gal/month	3,668	3,668	5,503
Secondary Clarifier			
RAS, mgd	1.88	1.90	2.87
WAS, mgd	0.0700	0.0500	0.0600
RAS TSS, mg/L	6,792	10,246	10,300
WAS TSS, mg/L	6,792	10,246	100,300
WAS TSS, lb/d	4,032	4,080	5,143
No. of New Tanks	3	3	3
Diameter, ft	70	70	70
Total Surface, ft^2	11,540	11,540	11,540
SOR ave, $gal/ft^2/d$	572	572	572
SOR peak day, $gal/ft^2/d$	11540	11540	11540
SOR peak instant, $gal/ft^2/d$	11,540	11,540	11,540
SLR ave, $lb/ft^2/d$	5.8	8.8	13.3
SLR peak day, $lb/ft^2/d$	17	25	28
SLR peak instant, $lb/ft^2/d$	17	25	28
Final Effluent			
Effluent pH	7.00	7.00	7.00
Effluent CBOD5, mg/L	5	5	5
Effluent TKN, mg/L	2.5	2.5	2.3
Effluent NH3, mg/L	1.0	1.0	1.0
Effluent NOx, mg/L	0.5	0.5	1.5
Effluent TN, mg/L	3.0	3.0	3.8
Effluent TSS, mg/L	10	10	10
Effluent TN, lb/d	75	75	143
Effluent TP, mg/l	2.1	2.7	1.9
Total Sludge Dewatered, lbs/day	3,677		4,697


Exeter WWTF State Point Analysis
Solids Loading Rate, lb/sf-d
Solids Concentration, g/L
0
5
10
15
20
25
30
35
40
45
50
0
2
4
6
8
10
12
14
16
Notes:
1. Settling flux correlated from Daigger, WER, 1995 assuming an SVI of 150
2. Future Max Daily Flow of 6.5 MGD
3. MLSS of 4,100 mg/L
4. 3 70-ft diameter clarifiers
Overflow Rate Operating Level
Underflow Rate Operating Level
Settling Flux

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE

PROJECT NO.: 12883B

PRELIMINARY DESIGN PACKAGE

System/Subject:	Tertiary Treatment		
Calculations By:	William Hankins	Date:	6/11/2015
Checked By:		Date:	
Revised By:		Date:	
Checked By:		Date:	

Checklist (to be completed by Design Engineer prior to calculation checking):

Y	Brief Process Description
N/A	Graphs/Sketches of System Attached (Plans & Schematics)
N/A	Design Calculations Attached
Y	Design Guidelines/Standards Noted
N/A	Equations Noted and Referenced
N/A	Electrical Loads Developed and Identified
N/A	Process Control Description Developed
N/A	Preliminary Basis of Design (Support Divisions) Attached
N/A	Construction Sequence Developed
N/A	Product Information Attached
N/A	Manufacturer's Review of Specs and Drawings (If Applicable)
Y	Electronic File Location Noted
N/A	Program(s) Used (Version) Noted
Y	Coordinated with Hydraulic Profile (If Applicable)

DESCRIPTION OF EXISTING FACILITIES

The Town of Exeter's wastewater treatment facility (WWTF) does not current employ tertiary treatment.

FACILITY PLAN RECOMMENDATIONS

The proposed WWTF treatment process does not include tertiary treatment. The Facility Plan recommended planning for and providing sufficient space on the site for future tertiary treatment. The review of the proposed nutrient removal treatment approach was conducted as part of the preliminary design effort (technical memorandum A-7). The proposed 4-stage Bardenpho process is designed to achieve, on average, an effluent total nitrogen concentration of 3.5 mg/l. The expected effluent total nitrogen concentration of 3.5 mg/l is the sum of the following components:

- Effluent Ammonia: 1.0 mg/l
- Effluent Nitrate and Nitrite: 0.5 mg/l
- Effluent Soluble Organic Nitrogen: 1.0 mg/l
- Effluent Particulate Organic Nitrogen; 1.0 mg/l

The effluent ammonia concentration will vary throughout the year as a function of wastewater temperature and influent flow variability, but 1.0 mg/l is a conservative annual average estimate. Effluent nitrate and nitrite is a function of the amount of available carbon in the wastewater (either in the influent or supplemental added). A well-functioning 4-stage Bardenpho process should achieve an effluent nitrate plus nitrite concentration of 0.5 mg/l.

Due to the lack of an operating activated sludge process at the Exeter, NH WWTF it is unknown what the actual specific effluent soluble organic nitrogen concentration will be. This value can vary from 0.5 mg/l (mostly residential wastewater) to as high as 3.0 mg/l (communities with a significant portion of the wastewater from industrial sources). Effluent particulate organic nitrogen is a function of the WWTF performance (i.e., how well the WWTF staff operate the facility) and the frequency and magnitude of wet weather flows (impacts the amount of particulate material in the secondary clarifier effluent).

It is recommended that the Town of Exeter plan for the possible need for a future tertiary treatment process to achieve a consistent effluent total nitrogen below 3.0 mg/l. The proposed tertiary treatment process would consist of an effluent filtration device to remove the particulate solids (i.e., particulate organic nitrogen) that are not removed via the secondary clarification process.

Ultimately, the 4-stage Bardenpho process should achieve an annual average effluent total nitrogen limit of 3.5 mg/l, but it may be able to reliably an effluent total nitrogen concentration less than 3.0 mg/l. Once operational, site specific process performance and effluent organic nitrogen levels can be verified to ascertain the need for a future tertiary filtration process. The potential does exist that the proposed Bardenpho process could reliably achieve an effluent total nitrogen concentration less than 3.0 mg/l.

CLIENT PREFERENCES

None

DESIGN GUIDELINES (TR-16, EPA MANUAL, ETC.)

Not applicable, see below

DESIGN GUIDELINES (NHDES Env-Wq)

The New Hampshire Code of Administrative Rules chapter Env-Wq 700 Standard of Design and Construction for Sewerage and Wastewater Treatment Facilities establishes minimum technical standards for the design of wastewater treatment facilities. However, the NH code does not include technical standards for tertiary filtration processes.

REVIEW OF DESIGN CONSIDERATION & ALTERNATIVES

Not Applicable

BASIS OF DESIGN

Tertiary treatment for nitrogen removal can be categorized as either a combined biological and physical nitrogen removal process or physical removal process. The inclusion of a 4-stage Bardenpho process upstream eliminates the need to install a future combined biological and physical nitrogen removal tertiary process. Thus, the proposed process will provide physical removal of the particulate material in the effluent of the secondary clarifiers (i.e., filtration). In the future, a coagulant and/or polymer aid may be necessary to increase the particle size for proper removal through the tertiary process.

There is a wide variety of tertiary treatment filtration only technologies that can be utilized at the facility for the removal of particulate material include sand filtration systems, cloth filtration systems and high rate clarification systems. A specific tertiary technology has not been selected at this time. However, for future planning purposes, space will be allocated on the site for a future tertiary facility and in the hydraulic profile (to allow for future gravity flow through the process). A total of 6 feet of hydraulic head was allocated to allow for flow splitting and process headloss assuming a sand filtration system.

BUILDING / STRUCTURE DESCRIPTION

Depending on the technology selected, the tertiary treatment facility will include several process tanks, space allocation for ancillary pumps and equipment and electrical systems. A new building is envisioned for the tertiary treatment system.

PROCESS CONTROL DESCRIPTION

Not Applicable

CONSTRUCTION SEQUENCING

Not Applicable

FUTURE EXPANSION CONSIDERATIONS

Not Applicable

FILE LOCATION

ATTACHMENTS

None

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE

PROJECT NO.: 12883B

PRELIMINARY DESIGN PACKAGE

System/Subject:	UV DISINFECTION		
Calculations By:	KYLE COOLIDGE	Date:	7-10-2015
Checked By:		Date:	
Revised By:		Date:	
Checked By:		Date:	

Checklist (to be completed by Design Engineer prior to calculation checking):

X	Brief Process Description
X	Graphs/Sketches of System Attached (Plans & Schematics)
	Design Calculations Attached
X	Design Guidelines/Standards Noted
	Equations Noted and Referenced
X	Electrical Loads Developed and Identified
X	Process Control Description Developed
X	Preliminary Basis of Design (Support Divisions) Attached
X	Construction Sequence Developed
X	Product Information Attached
X	Manufacturer's Review of Specs and Drawings (If Applicable)
X	Electronic File Location Noted
	Program(s) Used (Version) Noted
X	Coordinated with Hydraulic Profile (If Applicable)

DESCRIPTION OF EXISTING FACILITIES

The existing sodium hypochlorite disinfection system was constructed in 1988 (27 years old) and consists of:

- Traditional below grade concrete two-channel (3-pass) Chlorine Contact Tank,
- Sodium hypochlorite (12%) Chlorination System with chemical feed and carrier water pumps, and
- Sodium bisulfite (38%) Dechlorination System with chemical feed and carrier water pumps.

FACILITY PLAN RECOMMENDATIONS

Wright-Pierce recommends the following with regards to Ultraviolet (UV) disinfection:

1. Remove the existing chlorination and dechlorination chemical feed systems from the Control Building and from the Chlorination Building.
2. Provide a UV disinfection system retrofitted in the existing Chlorine Contact Tank.
3. Rename the "Chlorine Contact Tank" to the "Disinfection Tank".
4. Repairs cracks in the Disinfection Tank concrete.
5. Per NHDES regulations, construct a ventilated building around the UV disinfection system for year-round operation and name it "Disinfection Building".
6. Provide instrumentation (level, flow, turbidity), controls and SCADA connectivity for the UV disinfection system.
7. Provide new electrical service and main power distribution to the Plant Water Building Electrical Room and Disinfection Building.
8. Provide local disconnects and ESTOPS at process equipment.
9. Upgrade the remainder of the electrical systems to include energy efficient lighting (interior and exterior), emergency lighting/exit signs, receptacles, and fire alarm system (if required by the Fire Chief).
10. Comprehensively upgrade the Plant Water Building and building systems, including: repairing the minor cracks in the exterior masonry walls; cleaning the moss and organic growth at the base of the walls; installing new sealants at the control joints and around the perimeter of all wall penetrations; replacing the shingle roofing and eave flashing;

replacing vinyl siding at gable ends; replacing existing doors; repainting the interior surfaces; providing separation of electrical gear from process spaces; and upgrading the heating, ventilating and plumbing systems.

REVIEW OF DESIGN CONSIDERATION & ALTERNATIVES

Disinfection alternatives were considered in the March 2015 Facility Plan. *Ultraviolet (UV) disinfection was selected for the design for the reasons stated below under client preferences.*

CLIENT PREFERENCES

The Client has selected the UV disinfection alternative for the following reasons:

- Easier to operate.
- Hazardous chemical storage not required.
- No toxic byproducts produced and discharged to the environment (water or air).
- No risk of overdosing chemicals.
- No issues with chloramine formation due to partial nitrification.

DESIGN GUIDELINES

The final design of the UV disinfection system will be in accordance with the *New Hampshire Department of Environmental Services Chapter Env-Wq 700 Standards of Design And Construction for Sewerage and Wastewater Treatment Facilities* and *New England Interstate Water Pollution Control Commission Technical Report 16*. Key guidelines are summarized below:

- Automatic cleaning systems are strongly recommended. If an automatic cleaning system consists only of a mechanical cleaning component (i.e., wipers), a chemical cleaning tank (dip tank) should also be provided.
- Each UV reactor should also have a water level sensor and a safety interlock that automatically shuts off the UV lamps if a low-water level is measured.
- A UV system must be capable of delivering the design dose and disinfecting effluent at peak instantaneous flows with one bank of modules out of service.

- For systems that require continuous, uninterrupted disinfection, [and do not have means to temporarily store/stop effluent flow] more than one UV reactor (channel) is required to allow maintenance of channel.
- Provisions shall be made for the ease of the following tasks:
  - Removal and inspection of UV lamps for maintenance or replacement without draining the UV channel.
  - Cleaning the lamp sleeves.
  - Draining and cleaning the UV channel while maintaining adequate disinfection or storing forward flow.
  - Measuring UV transmittance.
- The UV system shall be connected to the WWTP's standby power source and shall be equipped with an uninterruptible power supply to power unit during transfers to and from the standby power source.

BASIS OF DESIGN

Ultraviolet (UV) Disinfection is an effective, safe, and environmentally friendly method to disinfect wastewater. UV rays emitted from bulbs submersed in the wastewater attack the bacteria, viruses, and protozoa, thereby disinfecting the water before it is discharged. The latest UV disinfection bulb, or lamp, technology for municipal UV disinfection systems in the flow range specific to Exeter WWTF is the "low pressure high output" lamp. These new lamps have a much higher intensity than the original "low pressure" systems, with the higher intensity lamps reducing the number of lamps required. These lamps also have a much quicker "on" time than the old technology (e.g. ranges from 20 to 165 seconds to full UV disinfection dose). Lamps can be installed horizontal, diagonal, or vertical to the flow. The effectiveness of the UV disinfection system is dependent on the characteristics of the wastewater, residence time, and radiation intensity. A summary of the UV disinfection system basis of design for Exeter is provided in Table 1 below.

There are several alternatives for maintaining disinfection during an emergency loss of power:

- Include uninterruptible power supply (UPS) with UV system.
- Provide backup hypochlorite disinfection system and dechlorination system.

- Divert all flow to equalization.

Uninterruptible power supply was selected for reliability, ease of maintenance, and quick response time.

Consideration was given to the size of the UPS system:

- Cost of UPS to power control system during transfer to standby power: $2,000 (similar downtime as conventional hypochlorite disinfection systems).
- Cost of UPS to power control system AND all lamps during transfer to standby power: $50,000 (no downtime).

A UPS system to power control system only during transfer to standby power was selected based on ability to maintain continuous control system functionality similar to conventional hypochlorite disinfection for a reasonable cost.

Basis for sizing the Uninterruptible Power Supply:

- Switching to emergency power may leave the UV system without power for maximum 30 seconds.
- Switching back to utility power requires maximum of 5 seconds of power outage (min 5 minute delay between).

Table 1

UV Disinfection System Basis of Design

System Configuration	Submerged in channel
Bulb Type:	Low Pressure, High Intensity
Bulb Orientation	Horizontal/Diagonal/Vertical TBD
Minimum Flow:	1.00 mgd
Average Daily Flow:	3.25 mgd
Peak Hourly Flow:	6.6 mgd
Future Peak Hourly Flow:	8.8 mgd
Fecal Coliform Limit (year round):	14 Colonies/100ml, monthly average
Enterococci Limit:	Report Colonies/100ml
Total Suspended Solids:[1]	<15 mg/l 30 day average, <30 mg/l max day
UV Transmittance Minimum: [1]	65%
Minimum Output:	30,000 µW-s/cm^2 at peak flow at 65% lamp output
Channel Size:	5’ concrete, with baffles as needed
Cleaning Type:	Chemical/Mechanical
Materials of Construction:	304 stainless steel
Electrical Enclosures:	NEMA 4X Stainless Steel (Unclassified)
Power Supply:	480V/ 3ph/ 60hz with Uninterruptible Power Supply (UPS) to provide continuous disinfection.
Maximum Power Consumption	60 kVA
Flow Pacing:	Variable intensity

1. Testing cannot be completed to confirm transmissivity due to biological process upgrades will not be constructed before UV system online.

EQUIPMENT PROCUREMENT

Typically if there are two or more manufacturers that meet the design criteria for a project, the construction bid package will include a specification that either manufacturer can comply with so as to create a competitive bidding environment. Individual UV systems are more “proprietary" than many other equipment systems, therefore procurement methods for these must be carefully considered. Channel size requirements, bulb orientation, maintenance procedures and hydraulics through each system are sufficiently different so that writing one specification to cover all types of lamp configurations could necessitate redesigning portions of the system after the project has been bid, unless two systems are designed. In general there are three approaches to specifying equipment:

1. *Design around one system:* Selecting a specific configuration and designing around that type of system is the most efficient from an engineering design perspective; it does make the Owner vulnerable to higher prices due to reduced competition. Regulatory agencies (and Funding agencies) may not allow the Owner to specify proprietary systems and may require that at least three Manufacturers be named to encourage competition. Manufacturer's know their equipment will be specified and therefore may increase the price.
2. *Design two systems:* This approach would offer the most competitive bidding situation; however, this approach would result in additional engineering effort.
3. *Pre-selection of equipment (Evaluated Bid):* This provides the Owner with the opportunity to have greater control in the selection of the UV system manufacturer and allow the Engineer to design around a single system. This clarifies the engineering design and improves the quality of the project, reducing the chance for costly redesigns or change orders. Cost can be considered as part of the pre-selection process, eliminating the items noted above. While a traditional competitive bid considers just capital costs, a pre-selection process allows for an analysis and comparison of operations and maintenance costs and present value life cycle costs.

Based on the items noted above, WP recommends that the Owner consider pre-selecting UV disinfection equipment during the final design phase.

BUILDING / STRUCTURE DESCRIPTION

NHDES regulations require that the UV system be housed in a building. A structure will be constructed over half of the Chlorine Contact Tank to house the UV system and shelter it from the weather. The building will have doors for egress and garage door for the removal of equipment.

Windows will be minimized to prevent light penetration which may result in growth of algae in the channel. Structural steel will be galvanized for corrosion protection and the building will be placed on a concrete curb to raise it above grade and increase the life of the structure.

The UV channel will be covered with aluminum plating to provide a working surface for the operators.

PROCESS CONTROL DESCRIPTION

The UV manufacturer will provide an integrated control panel with PLC to monitor and control the UV disinfection system. Key features of the control system include:

- Dose pacing –automatic, flow-based variation of lamp intensity to provide proper disinfection levels to conserving power across the ranges of flows and to extend lamp life. The effluent Parshall flume will provide the flow signal to the UV system for dose pacing.
- Warning alarms and automatic shutdown to protect equipment shall be provided. Lamp output in the contact area shall be monitored, and a low dosage warning signal shall be furnished.

The control system will be integrated with the SCADA system so it can be monitored and controlled by the operators at the Control Building.

CONSTRUCTION SEQUENCING

The UV disinfection system must be constructed and commissioned prior to eliminating the existing chemical disinfection system. The following work items must occur sequentially, otherwise temporary power or temporary disinfection system may be required:

1. Construct UV disinfection system in Disinfection Tank.
2. Construct new electrical gear in Electrical Room in Plant Water Building.
3. Commission new UV disinfection system.
4. Demolish chemical system in Control Building.

One chlorine contact channel will be taken offline during the construction of the UV disinfection system. Flow diversion and bypass pumping will need to be coordinated with site piping upgrades. Acceptance testing will be conducted for a 5-day period to ensure the system controls are functioning properly, and that adequate disinfection is achieved.

FUTURE EXPANSION CONSIDERATIONS

The UV disinfection system concrete channel will be designed to add a fourth future UV bank and additional modules to allow for a future peak flow of 8.8 MGD.

FILE LOCATION

j:\eng\nh\exeter\12883-wwtf\12883b-ww design\technical\process\design memos\a-x uv disinfection.docx

ATTACHMENTS

A. Product Data

Aquaray® 40 HO Vertical Lamp Ultraviolet Disinfection System

Budget Proposal For
Exeter, NH

Prepared for:
Wright-Pierce

June 1, 2015

OZONIA NORTH AMERICA, LLC
600 WILLOW TREE ROAD
LEONIA, NJ 07605 USA
TEL 201 676-2525 | FAX 201 346-5460

June 1, 2015

To: Jeff Mercer
Wright - Pierce
75 Washington Ave, Suite 202
Portland, ME 04101

Re: Aquaray® 3X Vertical Lamp Ultraviolet Disinfection Equipment
Exeter, NH

Mr. Mercer

Ozonia is pleased to submit our proposal for the Aquaray® 40 HO Vertical Lamp ultraviolet disinfection system for the above referenced project. The Aquaray® 40 HO Vertical Lamp System has been proven through extensive use worldwide (over 400 Aquaray installations) to be a very effective and reliable UV disinfection system. The system's many features make operation and maintenance cost effective, easy, and safe. These features include:

- Third-Party validated (Hydroqual Inc.) UV system performance
- Fully automated operation. Only requires a 4-20 mA flow signal
- Easy maintenance without the need to remove equipment from channel for lamp and ballast replacement.
- Highest turndown of any UV system in the market. Automatic dose control is achieved turning on/off lamps in relation to a flow signal, ensuring that the plant is operated economically while still providing the required performance.
- Lowest lamp replacement cost of any UV system in the market ($25 per lamp)

Ozonia proposes the following two options for the above referenced UV project:

Option 1: 6.6 MGD Peak Flow
For a peak hour flow of 6.6 MGD and a minimum UV transmittance of 65%, Ozonia proposes to furnish a total of five (5) Aquaray 40 HO modules to be installed in one (1) UV disinfection channel. The UV channel will have UV modules mounted one (1) across by five (5) banks in series (4 duty + 1 standby). At peak flow of 6.6 MGD, the UV channel will have four (4) banks in service and the fifth bank on standby.

Option 2: 8.8 MGD Peak Flow
For a peak hour flow of 8.8 MGD and a minimum UV transmittance of 65%, Ozonia proposes to furnish a total of eight (8) Aquaray 40 HO modules to be installed in two (2) UV disinfection channels. Each UV channel will have UV modules mounted one (1) across by four (4) banks in series. At peak flow of 8.8 MGD, each UV channel will have three (3) banks in service and the fourth bank on standby.

If you have any questions or require any additional information, please don't hesitate to contact our Representative below or the undersigned.

Local Sales Representative:

AQUA SOLUTIONS INC
Mr. Mike Loncoski
Tel: 207-828-5559
Cell: 207-831-4935
Email: mloncoski@aquasolutionsinc.net

Ozonia Regional Manager

INFILCO DEGREMONT INC
Mr. Paul Ravelli
Tel: 856-761-2407
Email: paul.ravelli@infilcodegremont.com

Sincerely,
For OZONIA NORTH AMERICA

Jo Anne Salera
Municipal Sales/ Applications Engineering Manager
Ph: 201-676-2488
Email: joanne.salera@ozonia.com

DEGREMONT TECHNOLOGIES

Degremont Technologies is a world leader in the water and wastewater treatment market and offers a full array of integrated water solutions. The group is composed of several leading equipment companies such as ***Ozonia North America***, Infilco Degremont and Anderson Water Systems and is part of the larger Degremont Group, which employs more than 3,000 people in over 70 countries, serving over 1 billion people with water and wastewater solutions. Degremont is subsidiary of Suez Environnment, a the leading global water and waste services company with sales of over $17 billion.

Degremont Technologies provides solutions in the areas of headworks, biosolids, disinfection, membrane filtration, separations and biofiltration. ***Ozonia North America*** has its headquarters in Leonia, New Jersey and is the disinfection equipment and solutions provider for the group offering a wide range of UV and ozone products. Other companies within the group offer a variety of products with longstanding market names such as the Climber Screen® Mechanical Bar Screen, ABW® Traveling Bridge Filter, and Cannon® Digester Mixing System.

AQUARAY® 40 HO (High Output) SYSTEM DESCRIPTION

The Aquaray 40 "HO" system is latest generation and improvement of the previous Aquaray® VLS design which has been in use since 1986. The Aquaray® 40 "HO" VLS is based on the arrangement of the original Aquaray® 40 VLS "Type-B" design. The vertical lamp orientation and configuration has been proven, through general use and extensive pilot studies, to be a very effective form of disinfection. The system also has many features that make it easy and safe to operate and maintain.

The low pressure, low intensity lamps of the original Aquaray® 40 VLS have been replaced with new low pressure, high output lamps - requiring fewer lamps to treat the same capacity. Fewer lamps guarantee considerable savings on capital, operation, and maintenance costs.

UV DOSAGE ENHANCEMENT:

The ultraviolet dosage is the product of the ultraviolet intensity multiplied by the time (in seconds) that the water is in contact with that UV intensity. Based on completed bioassays, the Aquaray® HO VLS system can treat more than twice the flow compared to the standard low pressure low intensity lamps in the older Aquaray® 40 configuration with the same UV dosage (uWatts-secs/cm^2) requirement. Flow deflection baffles have been added to enhance the disinfection performance capability of the Aquaray® HO VLS system.

HIGH OUTPUT LAMP ARRANGEMENT:

The ultraviolet lamps are mounted vertically so that all electrical connections are made out of the water and within the protection of a NEMA 4X stainless steel enclosure. Unlike other designs, all the lamps are easily accessed through the lid of this enclosure. Therefore, routine service such as lamp changes can be made without having to remove the lamp modules from the channel.

The lamps are also mounted in a uniform staggered array, three inch on center across the channel and five inch on center along the channel. This ensures a semi-tortuous path so that every particle of water will come into intimate contact with the most intense point of lamp output.

MODULE ARRANGEMENT:

The number and layout of the modules within the channel is determined based on the required UV dosage and a UV path for the water that eliminates any possibility of hydraulic short-circuiting.

See “DESIGN BRIEF” for details of module arrangement for this project.

CONTROL AND MONITORING:

Electronic lamp control is utilized to minimize power consumption. Electronic lamp control assemblies are conveniently mounted in the Aquaray® High Output Module’s NEMA-4X enclosure. This locates the assemblies close to the high output lamps, which minimizes the effect of outside interference such as radio waves, lightning, and voltage spikes.

With our Aquaray® High Output Module each individual lamp is monitored through the use of an on-board computer called a Data Controller Assembly (DCA). The DCA gathers and stores information relative to individual lamp hours and cycles. A non-volatile memory is included so that a possible relocation of the module will not result in a loss or misdirection of valuable lamp data.

The benefits of recording the individual lamp history may not be immediately apparent. UV lamps are guaranteed to provide a minimum operating life measured in terms of active operating hours, usually up to 13,000 hours. If a lamp fails electrically before the guarantee, our end-of-lamp life conditional warranty provides for a replacement at a cost pro-rated to the actual use achieved with the original lamp. For example, if a lamp fails at mid-life the replacement will be provided at half price.

A Power Distribution and Data Center (PDDC) included which houses the load center enclosure and GFCI Breakers for each high output module. The PDDC also includes an Allen Bradley CompactLogix PLC and Panelview 1000 Plus Operator Interface. Each Aquaray ® High Output module in the UV disinfection channel receives power from the load center locally mounted at the PDDC via a single power cable with waterproof plug-in connectors.

Each Aquaray® High Output module is fully independent and capable of automatic, fail safe operation in case of a control fault. This “default on” design ensures continuous disinfection even under emergency conditions.

FLOW PACING:

Flow Pacing is a system whereby lamp rows are switched on and off in relation to plant flow variations. The Aquaray® 40 HO System provides for very fine adjustments of the number of High Output lamps in service. Adjustments are made in direct proportion to the flow, with switching increments as low as 3%. To take full advantage of this feature we take a control signal, usually from the plant flow meter, and switch the lamps on or off as the flow changes.

The advantage of being able to switch the lamps by row is two fold:

- Energy Conservation
- Lamp Conservation

In our system each lamp requires 165 Watts. You realize immediate savings by activating only the minimum number of lamps required.

SYSTEM CLEANING:

Any UV system gradually accumulates a coating on the quartz sleeves housing the lamps. This routine fouling must be removed periodically. The Aquaray® 40 HO VLS offers a fully automatic, in-channel cleaning system which reduces maintenance. The automatic wiping system is to be operated once daily and the wipers are to be replaced once every two years. This system is included in our proposal.

SERVICE:

Every piece of equipment within a wastewater plant requires service. The Aquaray® 40 HO VLS has been developed to permit easy troubleshooting and quick replacement of components. The majority of maintenance activities can be carried out while the equipment is still located within the channel. The recommended spares included in this proposal will ensure that the system can be maintained efficiently and brought back to full operation in the shortest possible time.

AQUARAY® 40 "HO" VERTICAL LAMP SYSTEM

DESIGN BRIEF

PLANT INFORMATION AND DESIGN BASIS;

Project Name .... Exeter, NH
Option 1: Peak Flow, MGD.................................. 6.6 MGD
Average Flow, MGD .... 2.9 MGD
Minimum Month Flow, MGD .... 1.6 MGD
Maximum Month Flow, MGD .... 5.0 MGD
Option 2: Peak Flow, MGD.................................... 8.8 MGD
Minimum UV Transmittance 65%
Maximum TSS, mg/L... <15 mg/L (30-day average)
Maximum Mean Particle Size .... 30 microns
Required Effluent, MPN/100 ML
Fecal Coliform .... < 14 CFU /100 mL (Max monthly)
Minimum MS-2 Bioassay UV Dose......................... 50 mJ/cm^2

SUMMARY:

Based on the information in the design table below, the proposed options for the UV system will provide a minimum UV dosage of 50,000 uWatts-secs/cm^2 with one (1) UV bank out of service. The dosage calculation takes into account several factors including the end of lamp life, the quartz sleeve transmittance factor, and the peak capacity.

Ozonia proposes the following two options for the above referenced UV project:

Option 1: 6.6 MGD Peak Flow
For a peak hour flow of 6.6 MGD and a minimum UV transmittance of 65%, Ozonia proposes to furnish a total of five (5) Aquaray 40 HO modules to be installed in one (1) UV disinfection channel. The UV channel will have UV modules mounted one (1) across by five (5) banks in series (4 duty + 1 standby). At peak flow of 6.6 MGD, the UV channel will have four (4) banks in service and the fifth bank on standby.

Option 2: 8.8 MGD Peak Flow
For a peak hour flow of 8.8 MGD and a minimum UV transmittance of 65%, Ozonia proposes to furnish a total of eight (8) Aquaray 40 HO modules to be installed in two (2) UV disinfection channels. Each UV channel will have UV modules mounted one (1) across by four (4) banks in series. At peak flow of 8.8 MGD, each UV channel will have three (3) banks in service and the fourth bank on standby.

Each Aquaray® 40 HO module includes 40 Low Pressure High Output Lamps, arranged in five rows of eight lamps each.

PROPOSED AQUARAY® 40 HO VERTICAL LAMP SYSTEM DESIGN:

	Option 1: 6.6 MGD Peak	Option 2: 8.8 MGD Peak
Peak Flow, MGD	6.6 MGD	8.8 MGD
% UV Transmission	65%	65%
Minimum MS-2 Bioassay UV Dose, uWatts-secs/cm^2	> 50,000	> 50,000
System Designation	Aquaray 40 "HO" High Output	Aquaray 40 "HO" High Output
Number of Channels	1	2
Number of Modules Across (Modules per Bank)	1	1
Number of Modules in Series (Number of Banks)	5 (4 duty +1 standby)	4 (3 duty +1 standby)
Channel Width, in.	24.5 inches	24.5 inches
Channel Length, ft.	30.5 feet	26 feet
Channel Depth, in.	72 inches	72 inches
Water Depth Range, in.	57.5 to 62 inches	57.5 to 62 inches
Aquaray® Modules/Channel	5	4
Total Number of Modules	5	8
Number of Lamps/Module	40	40
Total Number of Lamps	200	320
Headloss at Peak Flow across the UV modules	4.04 inches @ 6.6 MGD	2.66 inches @8.8 MGD
Power Consumption per Lamp, W	165 watts	165 watts
Power Consumption at Peak Hour Flow, kW	23.76 kW @ 6.6 MGD	39.6 kW @ 8.8 MGD
Power Consumption at Average Flow, kW	17.16 kW @ 2.9 MGD	17.16 kW @ 2.9 MGD
Power Consumption at Min Month Flow, kW	13.2 kW @ 1.6 MGD	13.2 kW @ 1.6 MGD
Power Consumption at Max Month Flow, kW	21.12 kW @ 5 MGD	31.68 kW @ 5 MGD
Total Installed Power, kW	33 kW	52.8 kW

SPARE PART REPLACEMENT COST:

UV Lamps (13,000 hour warranty)	$25
Sleeves (5 year warranty)	$25
Ballasts (5 year warranty)	$150

SCOPE OF SUPPLY AND BUDGET PRICE

We propose to furnish the following equipment for the Aquaray® 40 HO Vertical Lamp ultraviolet disinfection system described in the previous sections:

- Aquaray® 40 HO Vertical UV Modules with Automatic Wiping System
- UV Intensity Sensors
- Mounting Rail/Eye Shields, 304 stainless steel
- Power Distribution & Data Center(s) (PDDC) – Includes Allen Bradley CompactLogix PLC with Panelview 1000 Plus Operator Interface.
- Wireway
- Stepdown Transformer(s)
- Interconnecting Cables between the Modules and the Power Distribution and Data Control Center
- Lamp Row by Row Flow Pacing
- In-Channel Cleaning System (automatic cleaning wipers)
- Level Control Weirs
- Cleaning Tank
- Lifting Spreader Bar
- Anchor Bolts
- Recommended Spare Parts

The following will also be included:

- Freight to the jobsite
- Start-up service: five (5) days in two (2) trips
- Four (4) O&M manuals

Note that the following items are to be provided by others (unless indicated otherwise above):

- Channel Grating
- Slide Gates
- Remote Computer System
- Installation
- Embedded Conduits
- Sampling and Effluent Performance Testing
- UVT Analyzer

BUDGET PRICE: Our current budget estimating price, not including the optional adders above, is (PRICE TO BE PROVIDED BY OZONIA REPRESENTATIVE). This price will be valid for one (1) year; payment terms will be as below and commercial terms and conditions are given on the following page. The price is in accordance with the Scope of Supply and terms of this proposal and any changes may require the price to be adjusted.

Payment Terms:

10% Net Cash, Payable in thirty (30) days from date of submittal of initial drawings for approval;

80% Net Cash, Payable in progress payments thirty (30) days from dates of respective shipments of the Products;

10% Net Cash, Payable in thirty (30) days from Product installation and acceptance or Ninety (90) days after date of final Product delivery, whichever occurs first.

SCHEDULE: Approval drawings and data can be submitted approximately 4-6 weeks after agreement to all terms, as evidenced by OZONIA's receipt of this proposal, fully executed; or, in the event that Purchaser issues a Purchase Order, OZONIA's receipt of fully executed letter agreement. OZONIA estimates that shipment of the Products can be made in approximately 14-16 weeks after OZONIA has received from Purchaser final approval of all submittal drawings and data.

Typical Aquaray® 40 "HO" Vertical Lamp Ultraviolet Disinfection System Installations

Plant Location:	Selkirk, MB
Peak Flow:	12 MGD
Number of Channels:	2
Number of Modules:	3 per channel (6 total)

Typical Aquaray® 40 "HO" Vertical Lamp Ultraviolet Disinfection System Installations

Plant Location: Broomfield, CO

Peak Flow: 18 MGD

Number of Channels: 3

Number of Modules: 3 per channel (9 total)

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE

PROJECT NO.: 12883B

PRELIMINARY DESIGN PACKAGE

System/Subject:	HYPOCHLORITE FOR RETURN SLUDGE LINE		
Calculations By:	JEFF MERCER	Date:	8/4/15
Checked By:	ED LEONARD	Date:	8/7/2015
Revised By:		Date:	
Checked By:		Date:	

Checklist (to be completed by Design Engineer prior to calculation checking):

- x Brief Process Description
- \- Graphs/Sketches of System Attached (Plans & Schematics)
- x Design Calculations Attached
- x Design Guidelines/Standards Noted
- \- Equations Noted and Referenced
- x Electrical Loads Developed and Identified
- x Process Control Description Developed
- x Preliminary Basis of Design (Support Divisions) Attached
- x Construction Sequence Developed
- \- Product Information Attached
- \- Manufacturer's Review of Specs and Drawings (If Applicable)
- x Electronic File Location Noted
- \- Program(s) Used (Version) Noted
- \- Coordinated with Hydraulic Profile (If Applicable)

DESCRIPTION OF EXISTING FACILITIES

The Exeter WWTF does not currently have a return activated sludge system.

FACILITY PLAN RECOMMENDATIONS

The Facility Plan did not cover details pertaining to the addition of hypochlorite to the return sludge line.

CLIENT PREFERENCES

The client has not stated any preferences for the addition of hypochlorite to the return sludge line at this time.

DESIGN GUIDELINES

The NHDES WQ-700 design standards do not have any requirements related to the addition of hypochlorite to the RSL.

TR-16 does not provide any recommendations.

References for RSL chlorine dosage includes:

1. D. Jenkins, M.G. Richard and G. Daigger, Lewis Publishers (1993). *Causes and Control of Activated Sludge Bulking and Foaming, Second Edition*. Boca Raton, FL: Lewis Publishers.

2. Black & Veatch. (2011). *White's Handbook of Chlorination and Alternative Disinfectants.* Overland Park, KS: John Wiley & Sons.

REVIEW OF DESIGN CONSIDERATION & ALTERNATIVES

The addition of hypochlorite to the return sludge line allows operators to chlorinate return sludge to control floc formation in the aeration tanks. Using the return sludge discharge main header as an application point provides hydraulic mixing and contact with microorganisms in the return sludge stream.

Typical dosages range from 2 to 8 lbs of chlorine per 1,000 pounds of mixed liquor volatile suspended solids per day. There are currently two secondary treatment options (Option 3 and Option 6) with slightly different MLVSS concentrations and aeration volumes. Chlorine will be fed from a 330 gallon tote with 12.5% chlorine concentration. The dosage/concentration will be controlled by the operators and the pumps will be paced based on the return sludge flow rate. The exact dosage will be based on operator experience and monitoring effects within the secondary treatment system. Approximate dosages are summarized in **Table 1** below. Using these preliminary calculations a peristaltic chemical feed pump can be sized for 0.9 to 16 gph of 12.5% chlorine solution which equates to a chlorine concentration of 1.5 to 6.0 mg/l of flow to the aeration tanks.

TABLE 1: CHLORINE DOSAGE

Option 3	MLVSS (mg/l)	Oxic Volume (MG)	MLVSS (lbs)	Chlorine (mg/l)	Chlorine (lbs/d)	Chlorine Solution (gpd)	Pump Rate (gph)
Min Day	1,052	1.24	10,880	2	22	21	0.9
Design Ave	2,057	1.86	31,909	6	191	184	7.7
Max Month	2,983	2.04	50,752	8	406	389	16
Option 6							
Min Day	956	1.38	11,003	2	22	21	0.9
Design Ave	1,883	2.07	32,507	6	195	187	7.8
Max Month	3,081	1.5	38,543	8	308	296	12

BASIS OF DESIGN

CHLORINE FEED PUMP	
Application	Inject RSL with Chlorine solution
Number/Type	1 / peristaltic tubing pump
Design Flow	Minimum of 0.5 to 20 gph
Discharge Pressure	30 psi
Discharge Piping	Marprene II tubing or equal
Pump Speed	220 rpm
Speed Control Ratio, min	2200:1
Power	120V/1ph/60hz
Acceptable Manufacturer(s)	Watson Marlow, Flowrox

BUILDING / STRUCTURE DESCRIPTION

The hypochlorite feed pump will be located in the Solids Handling Building lower floor adjacent to the return sludge pumps. Space will be retained for a second future pump and chemical drum. The pumps will be located on top of the drum and draw directly from them and discharge into the common RSL discharge header.

A containment area will be constructed with a minimum of 425 gallons of storage (two days of chemical at design average). The sump will be covered with FRP grating and the chemical contianer located over the sump.

Structural information:

Chemical Pumps	
Weight (approx.)	<50 lb
Containment Sump	
Volume	426 gal
Dimensions	6-ft by 9.5-ft by 1-ft

PROCESS CONTROL DESCRIPTION

The Solids Handling Building Lower Level pump room will be designated a NEMA 4X (Unclassified) space.

Chemical Feed Pump

The chemical feed pump will have local controls at the pump through a PLC/HMI with a MANUAL/AUTO selector. In manual, the operator will control the pump speed at the pump. In Auto, the operator sets the desired hypochlorite concentration and the pump speed will vary based on RSL feed rate and influent flow rate (total) to maintain the desired concentration. The pumps will be able to receive a 4-20ma signal from a nearby PLC to enable remote control through SCADA.

The following instruments, control stations, and control panels are anticipated:

Item	**Local/Remote**	**NEMA**	**By Division**	**Range**
Float Switch (containment)	Local	Unclassified/4X	13	-
Pump LCS (on pump)	Local	Unclassified/4X	11-OEM	-

Electrical information:

	Chemical Feed Pump
Number	1
Power	n/a
Speed	variable
Enclosure	4X
Volts, Phase/ Hz	120/ 1/ 60

x Coordinated with NFPA Memo

x Coordinated with Equipment List

CONSTRUCTION SEQUENCING

The Hypochlorite system for the RSL piping may be constructed at the same time as the return sludge pumps and piping.

FUTURE EXPANSION CONSIDERATIONS

Space will be retained for a second drum and pump for future needs. The containment area will be sized for two drums.

FILE LOCATION

12883B-WW Design\Technical\Process\Design Memos

Revolutionary pumphead technology

The unique design of the patented ReNu™ pumphead enables accurate and repeatable flow for fluids of wide ranging viscosities. **No-tools maintenance** means quick, safe and easy pumphead replacement with no specialist training or maintenance technicians.

The contained pumphead design with integral leak detection reduces wastage and eliminates operator exposure to chemicals.

Accurate, versatile chemical pumps

Optional HMI protective screen

Rugged IP66 pump drive, designed for industrial environments

Easy access high-visibility interface
Keypad and 3.5" TFT colour display provide easy access and high-visibility status indication. Configurable in 7 languages

Two models in the range
Qdos 30 and Qdos 60

Reduce your chemical costs
Accurate, linear and repeatable flow, with varying process conditions. Keeps pumping even when gassing-off occurs or when the chemical contains solids. No need to over-meter chemicals

Simplify your system design
High suction lift and viscous handling eliminates the need for flooded suction, day tanks and specialist piping systems

Safe maintenance
The sealed ReNu pumphead with integral leak detection eliminates operator exposure to chemicals. No chemicals on the floor, no parts to clean and rebuild

Replace your pump in seconds
Process uptime is maximised with **no-tools maintenance** quick and easy pumphead replacement

Low maintenance
No valves or seals to clog, leak or corrode, giving minimal maintenance. Drop-in replacement for diaphragm metering pumps

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE

PROJECT NO.: 12883B

PRELIMINARY DESIGN PACKAGE

System/Subject:	SLUDGE DEWATERING SYSTEM		
Calculations By:	MICHAEL CURRY	Date:	8/3/2015
Checked By:	TIM VADNEY/ED LEONARD	Date:	8/25/2015
Revised By:	MICHAEL CURRY	Date:	9/17/2015
Checked By:	ANDY MORRILL	Date:	8/28/2015

Checklist (to be completed by Design Engineer prior to calculation checking):

X Brief Process Description

X Graphs/Sketches of System Attached (Plans & Schematics)

X Design Calculations Attached

X Design Guidelines/Standards Noted

- Equations Noted and Referenced

X Electrical Loads Developed and Identified

X Process Control Description Developed

X Preliminary Basis of Design (Support Divisions) Attached

X Construction Sequence Developed

X Product Information Attached

- Manufacturer's Review of Specs and Drawings (If Applicable)

X Electronic File Location Noted

- Program(s) Used (Version) Noted

X Coordinated with Hydraulic Profile (If Applicable)

DESCRIPTION OF EXISTING FACILITIES

The Exeter WWTF currently stores all biosolids in the three aerated lagoons. No biosolids have ever been processed or disposed of from the three aerated lagoons.

FACILITY PLAN RECOMMENDATIONS

The Facility Plan recommended construction of the following:

- Solids Handling Building with truck bay and sludge conveyers
- Two (2) mechanical dewatering units
- Two (2) sludge feed pumps
- Two (2) Polymer make-down systems

CLIENT PREFERENCES

Based on a site visit to a local installation, the client has indicated that centrifuges would be an acceptable dewatering technology.

DESIGN GUIDELINES (NHDES Env-Wq)

Excerpts from pertinent design guidelines can be found below:

<u>TR-16 – Chapter 11 (Residuals Management and Treatment)</u>

- Section 4.5.3.2: Nonslip floor surfaces are desirable in polymer-handling areas.
- Section 11.2.1.2: Duplicate pumping and conveying units should be provided for redundancy.
- Section 11.2.1.4: Pump suction and discharge lines should be a minimum of 6-inches in diameter. Pipe velocities should be at least 3 fps at design flow.
- Section 11.2.2.2: Sludge grinders and or fine screens should be considered prior to process equipment such centrifuges, sludge mixing devices, or positive displacement pumps. Grinders are typically installed on the suction side of the pump to reduce clogging.
- Section 11.2.2.4: Provisions should be made for cleaning, draining, venting, and flushing sludge piping.

- Section 11.9.2.1: At small plants, centrifuge operation should not exceed 30 hours per week. This allows for conditioning, cleanup, and delays.
- Section 11.9.2.2: Sludge storage tanks preceding centrifuges should be provided. Each centrifuge should be fed by a separate variable speed pump. Means for measuring the quantity of sludge processed should be provided. Storage, makeup, dilution, and feed equipment for polymers should be provided.
- Section 11.9.2.3: Special considerations should be given to centrifuge operating noise.

Env-Wq – Section 716 (Sludge Handling and Disposal)

- 716.05(a): Sludge storage facilities shall be designed to control odors;
- 716.12(d): Facilities shall be provided to allow the wetting, mixing, and dilution of concentration or dry conditioning agents and for the ageing, storage, and mixing of dilute material in sufficient volume for at least one day of sludge conditioning.
- 716.12(e, f): Positive displacement pumps shall be used to control conditioning feed rate. Duplicate systems shall be provided.
- 716.13(a): Mechanical devices acceptable to dewater sludge include belt filter press, centrifuge, rotary press, pressure filter press, and screw press;
- 716.13(d): For facilities in which sludge is not available for pilot testing, successful performance from multiple similar facilities shall be documented;
- 716.13(e): Mechanical dewatering units shall be capable of handling maximum weekly sludge production in 30 hours, unless the equipment is design for continuous operation;
- 716.13(h): Sludge conveyers shall be provided with emergency pull cords along the entire length;
- 716.13(m): Sludge storage shall precede all mechanical dewatering units.

REVIEW OF DESIGN CONSIDERATION & ALTERNATIVES

Dewatering Equipment Design Data

Sludge dewatering technology selection is based on the proposed WWTF producing secondary sludge from an activated sludge process (see Technical Memorandum A-8). From Table 1, sludge generation quantities are expected to range from approximately 2,309 lbs/day (startup annual average) to 5,230 lbs/day (future maximum month). These values have been developed using existing operating data and BioWIN process simulation model.

TABLE 1: PROJECTED SLUDGE QUANTITIES

PARAMETER	STARTUP ANNUAL AVERAGE (2018)[1]	DESIGN ANNUAL AVERAGE (2040)[1]	DESIGN MAX MONTH (2040)[1]
Secondary Sludge (% Solids)[1]	0.71	0.73	1.03
Secondary Sludge (gal/week)	272,959	466,920	426,183
Secondary Sludge (gal/day)	38,994	66,703	60,883
Secondary Sludge (dry lbs/day) [1,2,3]	2,309	4,061	5,230
Total Solids (dry tons/day)	1.2	2.0	2.6

Notes:
1. Secondary sludge solids percentage estimated based on assumed decanting capability of new sludge storage tanks.
2. Sludge generation modeled using BioWIN
3. Future design conditions assume Bardenpho configuration with TN effluent limit of 3 mg/L (methanol addition)

A key factor in sizing solids handling equipment is the number of hours per day and the number of days per week that dewatering will occur. The dewatering schedule will affect capital costs, the level of staffing required, the annual operating budget, and the ability of staff to perform other operations. Conventional sizing of solids handling equipment requires 30-35 hours of sludge dewatering per week.

Longer dewatering times will allow the use of smaller equipment, which reduces the capital, O&M, and labor costs. Sludge holding tank capacity also affects the dewatering schedule: more storage capacity equals more schedule flexibility. Many activated sludge plants waste sludge daily. Maintaining a relatively constant sludge age is good operating practice and this can be accomplished by wasting at a constant rate.

Newer dewatering technologies often allow a much higher level of automation (i.e. the ability of the dewatering system to adjust the sludge feed rate and polymer dosing to compensate for varying feed solids concentrations). This means that the dewatering equipment can run unattended for longer periods of time provided that support systems are reliable and are also automated with alarms and safety cutouts. A constant sludge supply and available space in the dewatered sludge container are also required.

Table 2 summarizes the equipment capacities that would be required under varying dewatering schedules to meet each of the design conditions.

TABLE 2: COMPARISON OF DEWATERING OPERATING SCHEDULES VS. CAPACITY

PARAMETER	STARTUP ANNUAL AVERAGE (2018)[2]	DESIGN ANNUAL AVERAGE (2040)[2]	DESIGN MAX MONTH (2040)[2]
7 Hour, 3 Day Per Week Operation (assume 21 hrs/week, 152 processing days)			
Hydraulic Loading Rate (GPM)	127	220	228
Solids Loading Rate (lb/hour)	770	1,354	1,743
7 Hour, 4 Day Per Week Operation (assume 28 hrs/week, 208 processing days)			
Hydraulic Loading Rate (GPM)	95	165	171
Solids Loading Rate (lb/hour)	577	1,015	1,308
7.5 Hour, 4 Day Per Week Operation (3) (NHDES scenario) (assume 30 hrs/week, 208 processing days)			
Hydraulic Loading Rate (GPM)	89	154	159
Solids Loading Rate (lb/hour)	539	948	1,220
7 Hour, 5 Day Per Week Operation (assume 35 hrs/week, 260 processing days)			
Hydraulic Loading Rate (GPM)	76	132	137
Solids Loading Rate (lb/hour)	462	812	1,046
10 Hour, 3 Day Per Week Operation (assume 30 hrs/week, 208 processing days)			
Hydraulic Loading Rate (GPM)	89	154	159
Solids Loading Rate (lb/hour)	539	948	1,220

Notes:

1. Operating schedules based on sludge production rates generated using a BioWin model of an activated sludge process (Bardenpho).
2. Secondary sludge percent solids estimated to be 1.21% , 1.23%, and 1.53% solids for startup annual average, design annual average, and design max month conditions respectively. Percentages estimated after sludge storage tank decant.

3. This option was included to reflect the NHDES ENV-WQ 716.10 requirement that mechanical dewatering unit(s) be capable of handling the maximum weekly sludge production in 30 hours.
4. Based on the low solids concentration of the sludge feed, mechanical dewatering units were sized based on the hydraulic feed rate as opposed to solids loading.

Due to the Town's current level of staffing and previous experience, a targeted dewatering schedule of seven hours per day, three to four days per week is recommended. Based on the Town's dewatering schedule preference and the values calculated in Table 2, the recommended sizing criteria for the dewatering system upgrade have been summarized in Table 3 below.

TABLE 3: SLUDGE DEWATERING SIZING CRITERIA

CRITERIA	STARTUP ANNUAL AVERAGE	DESIGN ANNUAL AVERAGE
Operation Schedule	21 hrs/week	30 hrs/week
Solids Loading Rate	770 lbs/hr	948 lbs/hr
Solids Concentration	1.21%	1.53%
Hydraulic Loading Rate	127 GPM	154 GPM

Dewatering Equipment Alternatives

Using the sizing criteria in Table 1, the following technologies were selected for mechanical dewatering evaluation:

- Rotary Drum Press (RDP)
- Centrifuge
- Screw Press

The following is a brief description of each technology.

Rotary Drum Press

The rotary drum press (RDP) was introduced into the Canadian WWTF market about 20 years ago and has proven to be an effective dewatering device for municipal wastewater sludge. RDP technology involves feeding flocculated sludge between two parallel, rotating, stainless steel screens that rotate very slowly on a single shaft (typically between 1 to 3 rpm). Filtrate passes through the screens as the flocculated sludge is advanced within the channel. The frictional force at the sludge/screen interface coupled with increased pressure caused by the outlet restriction produces the dewatered sludge cake.

The solids content performance of the rotary press is highly dependent on sludge throughput and feed solids concentration. The new WWTF is projected to have feed solids concentrations ranging from 0.7-1.5% solids. The projected cake solids production at solids concentrations of less than 1% is estimated at 12-14% cake solids. Comparatively, cake solids production using the same feed solids concentration is estimated at 17-19% cake solids for other dewatering technologies (e.g., screw press, centrifuge). As a result, the rotary drum press was removed from the selection process due to the higher feed solids requirements.

Centrifuge

Centrifuges have had a long and strong presence in the municipal sludge dewatering market. They have been the preferred dewatering technology for large facilities and have also been used at a significant number of smaller facilities, particularly for application which only dewater secondary sludge.

Centrifuge technology consists of feeding flocculated sludge into a cylindrical bowl assembly rotating between 2,200 and 3,500 revolutions per minute (RPM). The solids are driven by centrifugal force to the bowl wall and then transported to the solids discharge chute via a metal screw feeder. Clarified liquid (centrate) flows backwards to the liquid discharge chute. Centrifuges are capable of achieving high cake solids production (19%) at high throughputs for secondary sludge. As a result, operating times for centrifuges are less than that of screw presses for the same throughput (See Table 2). Centrifuges use large motors to accelerate the mass of wet sludge (mostly water) to high rotational speeds and therefore have high energy costs. The centrifuge has the smallest space requirements and is enclosed, minimizing odor control issues.

Centrifuges are able to self-compensate for small changes in feed solids by monitoring the torque and speed requirements of the inner scroll drive relative to the outer main bowl drive. In constant torque differential mode, the speed can be adjusted to remove or retain more solids as the weight of solids in the bowl changes. This reduces the need for constant oversight during operation of the centrifuge resulting in lower operating labor. The constant torque mode provides consistent cake solids.

The market is very competitive since there are multiple manufacturers with significant ranges in price, size, capacity and features. Centrifuges are manufactured by several reputable manufacturers including, but not limited to, Andritz, Alfa-Laval, Centrysis and Westfalia Separator. A significant number of wastewater treatment facilities use centrifuges to process their secondary sludge including: Sanford Sewer District, ME; Newington; NH; Farmington, NH; and Freeport, ME.

Screw Press

Screw presses have been used extensively in industrial applications, especially in the pulp and paper industry, and their use for municipal sludge dewatering has been increasing rapidly in recent years. Screw presses have generally been used to dewater a blend of primary and secondary sludge. However, they are capable of achieving moderate cake solids production (17%) with a straight secondary sludge feed. There are several manufacturers of screw presses including Huber Technology, Inc. and FKC Co. Ltd., and Ishigaki Co.. Each manufacturer has considerable differences in their dewatering capabilities.

The screw press consists of a screw with a conical shaft and flights that can vary in pitch and taper. The solids are fed into the space between the screw and a screw basket. Clarified liquid (filtrate) is discharged through the screen. The conditioned sludge can be fed either by gravity or under pressure. With a gravity feed, the conditioned sludge flows from the floc tank to the open feed box on top of the screw. Sludge dewaters first by gravity drainage out through the bottom. With a pressured feed, the conditioned sludge is pumped to the inlet to maintain the desired inlet feed pressure. The screw moves the solids, and gradually increases the pressure. The discharge pressure can be controlled to help produce the desired cake solids.

Dewatering Equipment Summary

Table 4 below, summarizes the manufacturers and equipment evaluated.

TABLE 4: SLUDGE DEWATERING EQUIPMENT ALTERNATIVES SUMMARY

ITEM	CENTRIFUGE	SCREW PRESS
Dewatering Units Required[1]	2	3
Total Operating Time, hrs/week		
Startup Annual Average	18	33
Design Annual Average	31	52
Design Max Month	32	61
Total Connected HP. Per unit	100	5
Hydraulic Loading Rate, gpm/unit	160	90
Throughput, lbs/hr/unit	950	550
Polymer, lb (active)/dry ton	30	25
Expected Solids Content, %	18-20	16-18

Notes:
1. Number of units includes one redundant unit @ design annual average flows.

Table 5 below, summarizes the advantages and disadvantages of each dewatering technology.

TABLE 5: SLUDGE DEWATERING EQUIPMENT ADVANTAGES AND DISADVANTAGES

TECHNOLOGY	ADVANTAGES	DISADVANTAGES
Screw Press	• Low energy/power requirements • Reduced parts wear due to slow rotation (< 10 RPM) • Low noise level • Enclosed system minimizes odor	• Large foot print • Requires additional unit based on reduced feed throughput • Sensitive to changes in feed solids content • Reduced cake solids production at low feed solids content (< 1.5%)
Centrifuge	• Small footprint/building requirements • Automatically adjusts to changes in feed solids content • Enclosed system minimizes odor	• High energy/power costs • Highest potential for parts wear due to slow rotation • High noise level

Based on projected operating schedules, equipment throughput, and client feedback; a life-cycle cost analysis was completed for centrifuges and screw presses. The number of dewatering units required was determined by assuming a 30-35 hour per week dewatering schedule with one redundant unit. The equipment selections presented below were provided by each manufacturer. Table 5 summarizes the 20-year life-cycle cost including capital cost and annual costs related to operation and maintenance (Attachment C).

TABLE 6: SLUDGE DEWATERING EQUIPMENT LIFE CYCLE COST

ITEM[1]	CENTRIFUGE		SCREW PRESS	
Manufacturer and Model	Westfalia CF 6000	Centrysis CS 21-4HC	Huber RoS3 Q800	FKC BHX-1050
No. of Units	2	2	3	3
Equipment Capital Cost (Total)	$800,00	$794,000	$1,050,000	$1,028,000
Annual Costs:				
Equipment Debt Service	$59,000	$59,000	$78,000	$61,000
Electricity	$23,000	$20,700	$1,900	$1,200
Transportation Disposal	$390,000	$390,000	$435,000	$435,000
Polymer Usage	$76,000	$76,000	$63,000	$63,000
Labor O&M	$8,200	$8,200	$10,800	$10,800
Total Annual Cost	$556,000	$554,000	$589,000	571,000
Total Costs (20 year period)	**$11,124,000**	**$11,078,000**	**$11,774,000**	**$11,420,000**

Notes:
1. Refer to Attachment C for a detailed Life Cycle Cost Analysis and supporting data.

The cost analysis indicates similar lift-cycle costs for the centrifuge option (2 units) and screw press option (3 units). The centrifuge was chosen as the dewatering equipment design basis based on the type of sludge being processed (secondary) and targeted dewatering operating hours.

Sludge Grinders

Sludge grinders will be installed on the suction side of the sludge feed pumps to protect the pumps and dewatering centrifuges from any debris that may make its way through the mechanical fine screens. Multiple in-line sludge grinder types are available for this application and will be further reviewed during subsequent phases of design.

Sludge Feed Pumps

The centrifuge feed pumps will pump waste activated sludge from the new sludge storage tanks to the sludge dewatering system. Double disc, rotary lobe, and progressing cavity pumps were considered for this application. Based on overall footprint, maintenance requirements, and pump feed considerations, rotary lobe pumps were chosen as the basis for design.

Polymer Feed System

Polymer is added to raw sludge to improve dewatering characteristics. Three types of polymers were considered for this application: liquid solution (Mannich), dry polymer, emulsion poylmer. Mannich polymers were eliminated from consideration due to substantial storage tank requirements. Dry polymer systems require a system for dry feeding, mixing, and ageing, and dilution. Dry systems carry a high capital cost and require a large footprint. Emulsion polymer units allow for direct feed of the polymer eliminating the need for a dry feeding system.

Emulsion polymer was chosen as the basis for design based on ease of operation, equipment/storage footprint requirements, and cost. The emulsion polymer make-down skid shall consist of a neat polymer pump, in-line mechanical mixing device, ageing tank, and dilute polymer pumps. The ageing tank and dilute polymer pumps allow the emulsion polymer addition time to activate and can decrease overall polymer consumption. Progressive cavity pumps are favored over other types of positive displacement pumps due to the lack of feed pulsation.

Based on the unknown nature of secondary sludge produced at the WWTF, it is difficult to predict what type of polymer will be required. Therefore, space will be provided in the polymer feed system area to allow for future accommodation of a dry polymer system if required.

Sludge Conveyors

TR-16 recommends the use of a closed conveyor system; therefore, an open belt-type conveyor systems has been eliminated from consideration because of the odor and humidity it would emit into the Dewatering Room and Container Bay. Shaftless screw conveyors are the industry standard, therefore have been selected for this application.

Potassium Permanganate System (Future)

Potassium permanganate (permanganate) is a powerful oxidant commonly used to help control odors associated with sludge handling (hydrogen sulfide). Permanganate is generally purchased in a dry crystalline form that must be mixed prior to use. Space will be provided for a potassium permanganate saturator on the first floor of the Solids Handling Building.

BASIS OF DESIGN

Based on the alternatives analysis above, the centrifuge technology was chosen as the basis for design for sludge dewatering equipment.

BASIS OF DESIGN CRITERIA

SLUDGE GRINDERS	
Application:	Waste Activated Sludge
Number of Units:	Two (2)
Type:	In-line
Size	6-inch
Capacity:	200 gal/min
Acceptable Manufacturers:	JWC, Franklin Miller, or equal

SLUDGE FEED PUMPS	
Application:	Waste Activated Sludge
Number of Units:	Two (2)
Type:	Rotary Lobe, Positive Displacement
Solids Concentration:	Decanted aerated secondary sludge (1% solids avg, 0.70-1.5% typical solids range, 5% max solids)
Size	6-inch
Capacity:	200 gal/min @ 49 ft TDH
Ancillary Equipment:	Magnetic Flow Meter
Acceptable Manufacturers:	Boerger, Lobeline, or equal

CENTRIFUGE	
Application:	Waste Activated Sludge (0.75 – 1.5% solids)
Number of Units:	Two (2)
Type:	Centrifuge
Bowl Size:	21-inches (min.)
Capacity:	160 gal/min; 950 lbs/hr
Acceptable Manufacturers:	Westfalia, Centrysis, or equal

SHAFTLESS SCREW CONVEYERS	
Application:	Dewatered secondary sludge
Number of Units:	Four (4)
Sludge Characteristics:	13-20% solids, 10% air voids, 60% max fill ratio
Bulk Wet Density:	50-70 pcf
Type:	Shaftless screw, UHMW-PE Liner
Capacity:	
SC-1, SC-2:	170 cf/hour, 1,015 lbs/hr
SC-3, SC-4:	340 cf/hour, 2,031 lbs/hr
Ancillary Equipment:	Pneumatic Slide Gates (3 total on SC-4)
Acceptable Manufacturers:	Spirac, JVD, or equal

POLYMER SYSTEM	
Application:	Sludge feed (WAS)
Number of Units:	Two (2) polymer blending units including neat polymer pumps Two (2) dilute polymer pumps
Type:	Emulsion polymer
Neat Polymer Feed:	1.5 – 7.0 GPH
Water Feed:	150 - 2,500 GPH
Dilute Polymer Ageing:	15-20 minutes
Polymer Aging Tank Size:	800-gallons
Dilute Polymer Feed:	150 - 2,500 GPH
Ancillary Equipment:	Mechanical in-line mixer
Acceptable Manufacturers:	Polyblend, Velodyne, or equal

PERMANGANATE SYSTEM (FUTURE)	
Application:	Sludge Feed Odor Control
Number of Units:	One (1) Saturator Unit (tank, flow distributor, two feed pumps)
Type:	Potassium Permanganate Saturator
Solution Feed Rate:	2.0 – 22.5 GPH
Water Feed:	2.0 – 22.5 GPH
Polymer Aging Tank Size:	110-gallons
Ancillary Equipment:	Internal baffles, strainers, control box with solenoid valve
Acceptable Manufacturers:	Northeast Pump & Instrument or equal

BUILDING / STRUCTURE DESCRIPTION

The sludge dewatering equipment including the polymer system will be installed on the first floor of the new Solids Handling Building. Each centrifuge will discharge dewatered sludge to a dedicated screw conveyer (SC-1,2) that will discharge to a common screw conveyer (SC-3). The common screw conveyer will discharge to a truck loading conveyer (SC-4) located in the Container Bay equipped with three electrical slide gates. The sludge feed pumps and sludge grinders will be installed in the basement of the Solids Handling Building.

Structural information:

CENTRIFUGE	
Height (approx.)	7.25-feet (without concrete pedestals)
Width (approx.)	4.25-feet
Length (approx.)	17.5-feet (including inlet piping)
Centrifuge Weight (each)	12,450 lb
TOTAL WEIGHT	24,900 lb

PROCESS CONTROL DESCRIPTION

The Sludge Dewatering System including centrifuges and polymer system will be controlled by manufacturer supplied Control Panel mounted within the Control Room. Local control stations will be provided near each piece of equipment with a Local-Off-Remote switch and ESTOP pushbutton. The Control Panel will control sludge feed pumps, sludge grinders, polymer feed units, centrifuges and conveying screws by programmable logic controller (PLC) based control system. Cake dryness is controlled and monitored by torque control in the centrifuge PID loop. In addition to controlling equipment, the Control Panel will also monitor the Sludge Storage Tanks level. The Dewatering System will be connected to the WWTF SCADA system and will allow for the Operators to monitor the status of the equipment and alarm conditions.

The Dewatering System will be initiated manually. If all equipment is in Remote, all associated equipment shall start and stop automatically. Centrifuge feed pumps will pump waste activated sludge from the new Sludge Storage Tanks to one of two Centrifuges. A local control station will be provided for each pump and will contain manual and automatic controls for the sludge feed pumps (Local-Off-Remote and Estop). In the Local position, the pumps will be controlled from the Local Control Station. In the Remote mode, initiation of the pump start sequence will be automatically initiated from the Dewatering System Control Panel.

The following instruments, control panels, and local control stations are anticipated:

ITEM (LOCATION)	**LOCAL/REMOTE**	**NEMA**	**BY DIVISION**	**RANGE**
Flow Meter (Solids Handling Basement)	Local	4X	13	0 to 400 gpm
Control Panel - Dewatering (Dewatering Area)	Remote	4X	11-OEM	n/a
Local Control Station - Centrifuge (Dewatering Area)	Local	4X	11-OEM	n/a
Local Control Station - Polymer (Dewatering Area)	Local	4X	11-OEM	n/a
Transducer – Polymer Tank (Dewatering Area)	Local	4X	11-OEM	0 - 10 ft.
Local Control Station - Pumps (Solids Handling Basement)	Local	4X	16	n/a

Local Control Station - Grinder (Solids Handling Basement)	Local	4X	16	n/a
Local Control Station - Conveyer (Dewatering Area)	Local	4X	16	n/a

Electrical information:

GRINDER	
Power	2 HP
Speed	Constant, reversing
Enclosure	TEFC, NEMA 4X
Volts, Phase/ Hz	460/ 3/ 60

CENTRIFUGE	
Power	60 HP (Bowl) 40 HP (Scroll)
Speed	Variable
Enclosure	TEFC, NEMA 4X
Volts, Phase/ Hz	460/ 3/ 60

SLUDGE FEED PUMPS	
Power	10 HP
Speed	Variable
Enclosure	TEFC, NEMA 4X
Volts, Phase/ Hz	460/ 3/ 60

SLUDGE CONVEYERS	
Power	1.5 to 7.5 HP
Speed	Constant
SC-1, 2, 4	Reversing
SC-3	Non-reversing
Enclosure	TEFC, NEMA 4X
Volts, Phase/ Hz	460/ 3/ 60

POLYMER SYSTEM	
Neat Polymer Pumping/Mixing	
Power	1 HP (Pump & Mixer)
Speed	Variable
Enclosure	TEFC, NEMA 4X
Volts, Phase/ Hz	120/ 3/ 60
Dilute Polymer Pumping	
Power	3 HP
Speed	Variable
Enclosure	TEFC, NEMA 4X
Volts, Phase/ Hz	460/ 3/ 60

PERMANGANATE SYSTEM (FUTURE)	
Power	Fractional HP (Two pumps)
Speed	Variable
Enclosure	TEFC, NEMA 4X
Volts, Phase/ Hz	120/ 3/ 60

X Coordinated with NFPA Memo

X Coordinated with Equipment List

CONSTRUCTION SEQUENCING

The Sludge Dewatering System will be constructed with the new Solids Handling Building. Flow to the dewatering system is dependent upon construction of the new Sludge Storage Tanks. This system will need to be completed when the activated sludge system is put on-line.

FUTURE EXPANSION CONSIDERATIONS

The Sludge Dewatering System is sized to accommodate the current and future loads identified in the PDR.

FILE LOCATION

J:\ENG\NH\Exeter\12883-WWTF\12883B-WW Design\Technical\Process\Design Memos

ATTACHMENTS

- A Equipment Cut Sheets
- B Calculations
- C Cost Comparison

Decanter GEA Westfalia Separator **ecoforce water**Master CF 6000

Technical Data | Dewatering and thickening of industrial and municipal sewage sludges

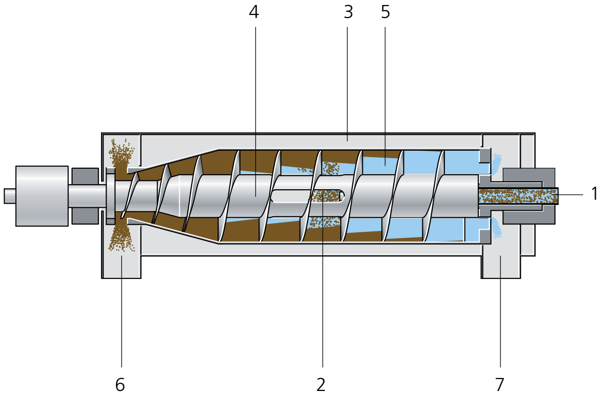
The decanter **water**Master CF 6000 from GEA Westfalia Separator is a continuously operating centrifuge with horizontal solid-wall bowl developed specifically for the requirements of dewatering and thickening industrial and municipal sewage sludges. The frame is of open design with gravity discharge of the clarified phase.

Features

- All product-contacting parts are made of stainless CrNiMo steel
- Super deep pond design
- Minimal power consumption
- Highest g-force for maximum dewatering
- Innovative adjustable scroll drive with the following features:
  - GEA Westfalia Separator **summation**-drive with intelligent kinematics for high differential speeds and torques
  - High efficiency of the drive since the variable speed motor feeds in energy and does not brake
  - Very sensitive regulation of the torque, even with fluctuating feed conditions
  - Automatic adjustment of the differential speed due to the frequency-controlled variable speed motor
- The scroll can be operated also with stationary bowl
- Gentle feed geometry for optimum flocculation and low wear
- Maximum dewatering due to the deep pond design and highest g-force
- Low space requirement
- Good accessibility to all components
- Easy to operate and maintain

Technical Data waterMaster CF 6000

Operating principles and constructional features

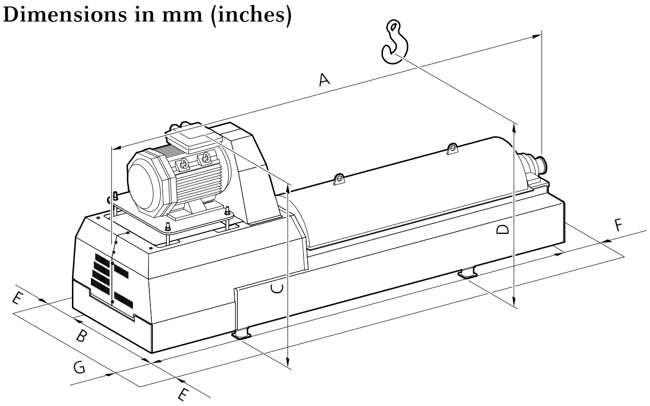


1 Product feed
2 Distributor
3 Bowl
4 Scroll
5 Separation chamber
6 Solids discharge
7 Discharge of the clarified liquid phase

Bowl	
g-volume*	up to 1300 m³
L/D ratio	4.0
Speed	3500 min^{-1}
g-force, (z)	3770
Main drive motor	
Rating	75 to 160 kW (with FC)
Speed at 50 Hz	1500 min^{-1}
Speed at 60 Hz	1800 min^{-1}
Secondary motor	
Rating at 50 Hz	22 to 55 kW (with FC)
Weights	
Decanter, complete	net approx. 8600 kg (18,960 lb)

*depending on bowl version

Dimensions in mm (inches)



A	B
5000 mm (197 in)	1375 mm (54 in)
C	**D**
2100 mm (83 in)	> 2600 mm (> 102 in)
E	**F**
> 500 mm (> 20 in)	> 1600 mm (> 63 in)
G	
> 700 mm (> 28 in)	

Standard scope of delivery

- 3-phase AC motor
- Feed flow control
- Process control (PLC)
- Motor control (MCC)
- Oil plus air lubrication for bowl bearing
- Vibration control sensors
- Monitoring of bowl bearing temperature
- Gearbox **summation**drive

Options

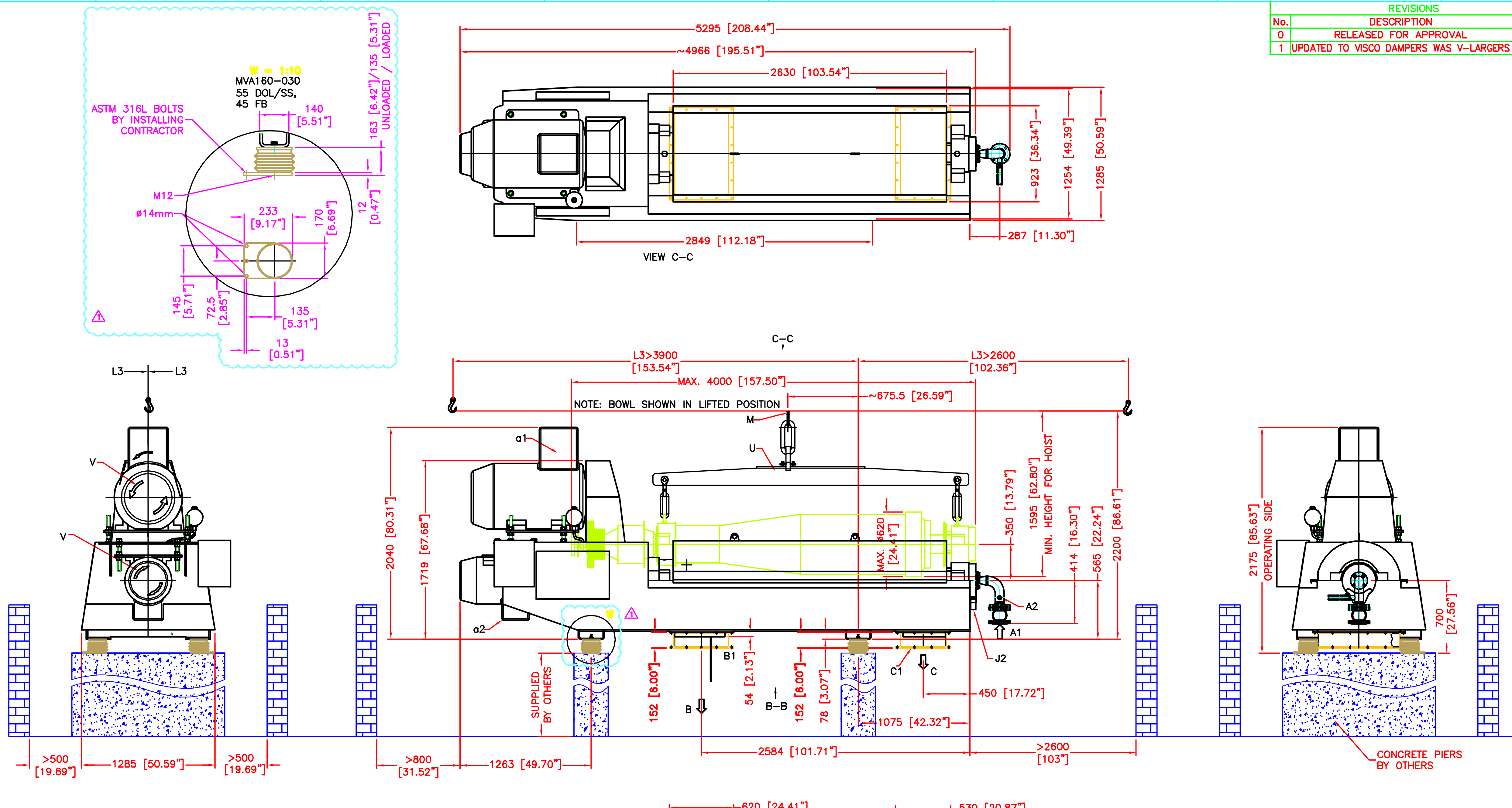
- Energy jets for energy savings
- Additional process equipment like tanks, valves, pumps and control instruments
- GEA Westfalia Separator we**watch**® condition monitoring for preventive maintenance

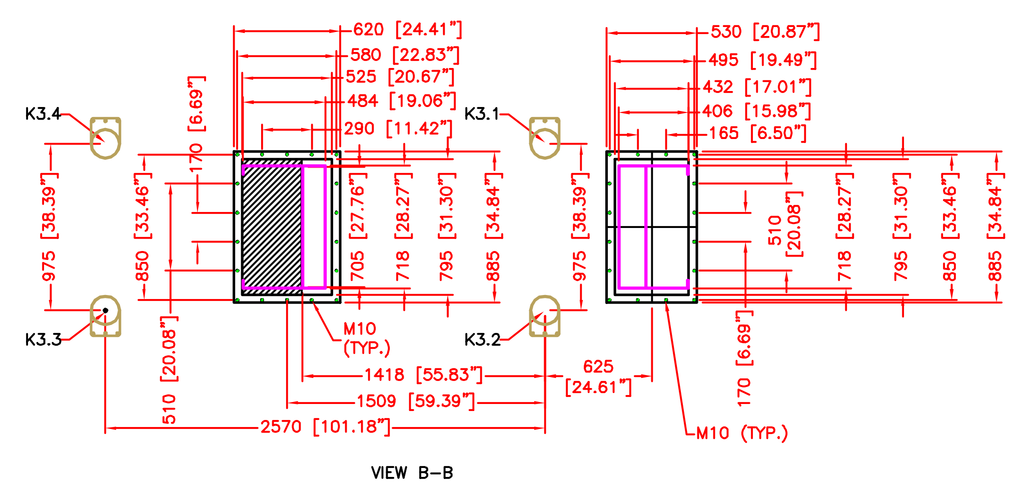
GEA Mechanical Equipment

GEA Westfalia Separator Group GmbH

Werner-Habig-Straße 1, 59302 Oelde, Germany
Phone: +49 2522 77-0, Fax: +49 2522 77-2950
www.westfalia-separator.com

REVISIONS			
No.	DESCRIPTION	DATE	APPROVED
0	RELEASED FOR APPROVAL	18/OCT/13	JDH
1	UPDATED TO VISCO DAMPERS WAS V-LARGERS	18/DEC/14	JDH





	kg	lbs
Centrifuge	4200	9240
Main Motor	670	1474
Gear Box	255	561
Bowl Filling	525	1155
Total	5650	12430

Static Load Complete Decanter (lbs)	Maximum Static Load per leg (lbs)	Vertical Dynamic Load per leg (lbs)		Horizontal Dynamic Load per leg (lbs)
		At Operating Speed (+/-3%)	When Crossing Resonance Frequency (+/-10%)	
14916	3729	447	1492	225

1. The model CF6000 has 4 legs. For calculation of structural loads, the load is assumed to be distributed evenly.
2. The loads are reported below the viscodampers
3. The dynamic loads are oscillating at a frequency equal to the bowl speed.
4. The resonance frequency of the entire centrifuge is in the range of 8 - 15 Hz.
5. The Bowl Filling is the weight of the product in a full bowl assuming a specific gravity of 1.5
6. A safety factor of 1.2 has been applied to the static load to allow for variations in machine designs and product buildup

WESTFALIA NUMBER	CUSTOMER NUMBER	CUSTOMER	END USE	MACHINE	QTY
				CF 6000	1

GEA Mechanical Equipment US, Inc. Westfalia Separator Division
100 FAIRWAY COURT, NORTHVALE, NEW JERSEY 07647

Drawn: PHUONG P. Date: 16/OCT/13
Checked E.E.: Date:
Checked M.E.: Date:
Approved: JDH Date: 18/OCT/13

Title: STANDARD
INSTALLATION PLAN
CF 6000-00-35

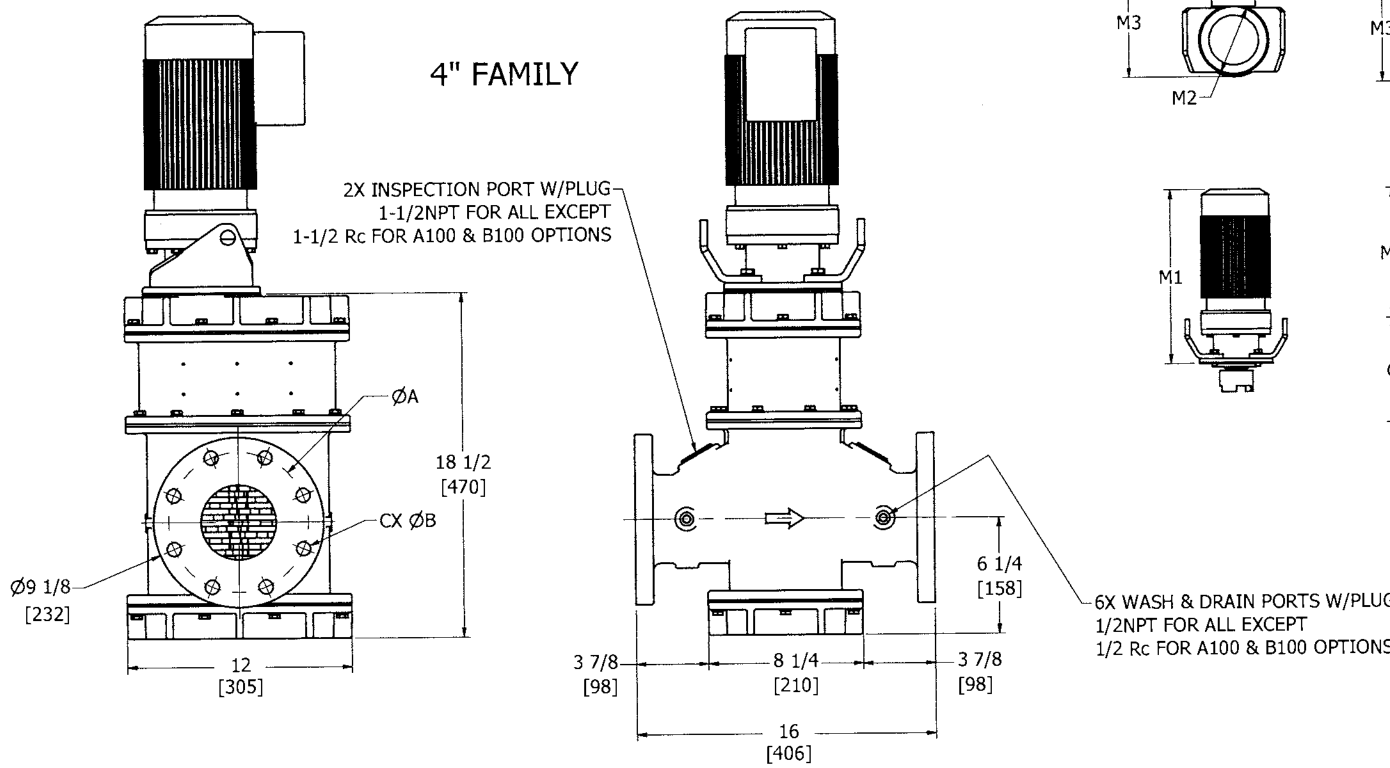
Size: D | F.S.C.M. No.: | Dwg. No. 9149-4100-917 | Rev. 1
Scale: 1 : 20 | M/F: 9149-4100-487 QUOTE #: | Sheet: 1 OF 3

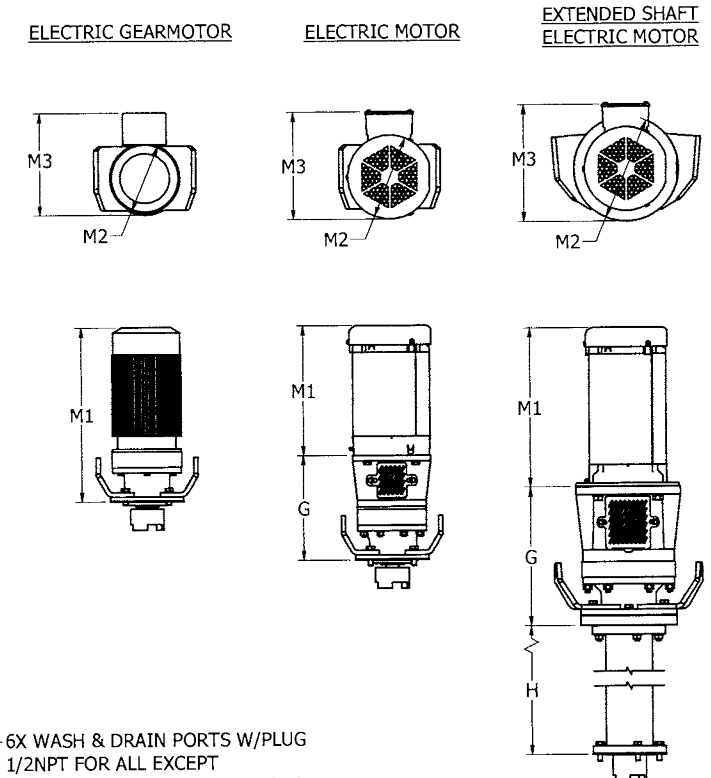
DRAWING NO. **10000-CD**

NOTES UNLESS OTHERWISE SPECIFIED:

1. INTERPRET DRAWING IN ACCORDANCE WITH ASME Y14.5M-1994 STANDARDS.
2. MAXIMUM WORKING PRESSURE 90 PSI (6 BAR).
3. WEIGHT OF UNIT LESS DRIVE:
   - 4" FAMILY: 215 LB [97.5 KG]
   - 6" FAMILY: 235 LB [106.6.8 KG]

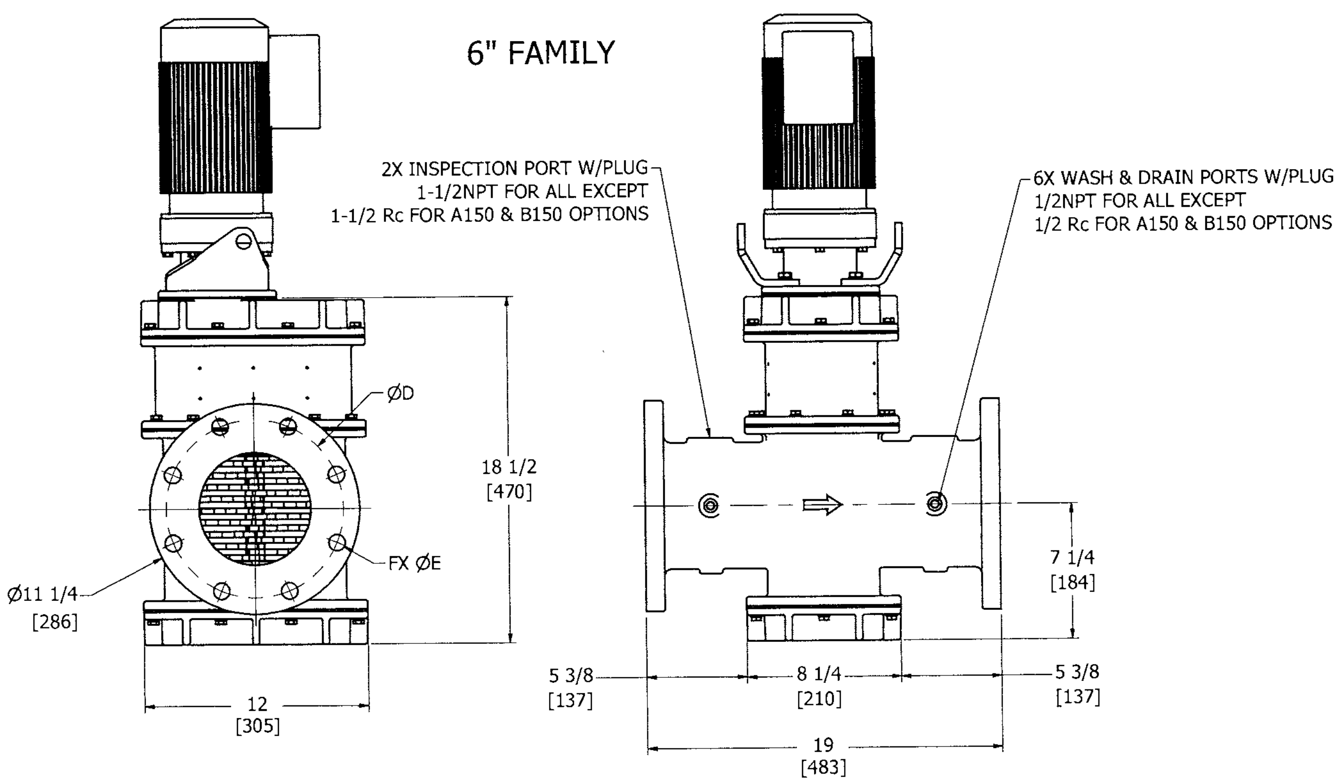
REVISION HISTORY								
ZONE	REV	DESCRIPTION	ECO NO.	DATE	CHK	PE	MFG	QC
ALL	A	INITIAL RELEASE	01-1048	10-3-14	CG	CG	N/A	N/A
A1, C2	B	UPDATED PRODUCT NAME TO 10K IN-LINE MUFFIN MONSTER. ADDED 08 TO MODEL NUMBERS AND FIXED DESCRIPTIONS IN THE SPECIFICATIONS COLUMN OF THE TABLE	01-1056	11-10-14	KM	[illegible]	NA	NA





4" FAMILY FLANGE DIMENSIONS				
MODEL NO.	**SPECIFICATION**	**A**	**B**	**C**
10000-0804-DI	ANSI CLASS 150	7-1/2"	3/4"	8
10000-08AS100-DI	AS 2129 TABLE D	178 mm	18 mm	4
10000-08BS100-DI	BS PN16	180 mm	18 mm	8
10000-08JIS100-DI	JIS 10K	175 mm	19 mm	8
10000-08JWA100-DI	JWA 7.5K	195 mm	19 mm	4
6" FAMILY FLANGE DIMENSIONS				
MODEL NO.	**SPECIFICATION**	**D**	**E**	**F**
10000-0806-DI	ANSI CLASS 150	9-1/2"	7/8"	8
10000-08AS150-DI	AS 2129 TABLE D	235 mm	18 mm	8
10000-08BS150-DI	BS PN16	240 mm	22 mm	8
10000-08JIS150-DI	JIS 10K	240 mm	23 mm	8
10000-08JWA150-DI	JWA 7.5K	247 mm	19 mm	6

DRIVE DIMENSIONS				
TYPE	M1	M2	M3	WEIGHT
2 HP [1.5KW] ELECTRIC GEARMOTOR				LB [KG]
TEFC	14-15/16 [380]	Ø6-5/16 [160]	9 [229]	54 [24.5]
3 HP [2.2 KW] ELECTRIC GEARMOTOR				
TEFC	16-15/16 [430]	Ø6-13/16 [173]	9-9/16 [243]	88 [39.9]
2 HP[1.5 KW] ELECTRIC MOTOR/SPEED REDUCER				
TEFC	11-3/16 [284]	Ø7-3/16 [183]	9-3/8 [238]	41 [18.6]
SUPER-E	10-7/8 [276]	Ø8 [203]	10-3/8 [264]	59 [26.8]
WASHDOWN DUTY	13-3/8 [340]	Ø7-3/16 [183]	9-5/16 [237]	41 [18.6]
XPFC	13-1/8 [333]	Ø7-1/8 [181]	10-3/16 [259]	60 [27.2]
3 HP [2.2 KW] ELECTRIC MOTOR/SPEED REDUCER				
TEFC	13-7/16 [341]	Ø7-3/16 [183]	9-5/16 [237]	60 [27.2]
SUPER-E	13-1/8 [333]	Ø8-1/2 [216]	11-15/16 [303]	98 [44.5]
WASHDOWN DUTY	13-7/16 [341]	Ø7 [178]	9-5/16 [237]	62 [28.1]
XPFC	16-1/4 [413]	Ø8-5/8 [219]	11-13/16 [300]	91 [41.3]



CONTROLLED

REDUCER SPOOL DIMENSION INCLUDING ADAPTER (G)	
2 HP	9 [229]
3 HP	11-15/16 [303]

EXTENDED SHAFT LENGTHS (H)														
12 [305]	18 [457]	24 [610]	30 [762]	36 [914]	42 [1067]	48 [1219]	54 [1372]	60 [1524]	66 [1676]	72 [1829]	78 [1981]	84 [2134]	90 [2286]	96 [2438]

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES [MM]
FRACTIONS ± 1/8 | DECIMALS .XX ± .XXX± | ANGLES ± °
MATERIAL
FINISH 250 (CAST) 125 (MACHINED) UNLESS OTHERWISE SPECIFIED
DO NOT SCALE DRAWING

CONTRACT NO.		
APPROVALS		DATE
DRAWN	K. S. MOIR	10/03/14
CHECKED	C. GLAUBERMAN	10/23/14
MANUF.		
Q.C.		

JWC ENVIRONMENTAL
290 PAULARINO AVE, COSTA MESA, CA 92626

IN-LINE CONFIGURATION
DRIVE OPTIONS
10K IN-LINE MUFFIN MONSTER

SIZE D | DRAWING NO. 10000-CD | REV B
SCALE: NTS | CAD MODEL: A10000-CD-01 | SHEET 1 OF 1

Project:	EXETER NH - WWTF UPGRADE
Job No.	12883B
Date:	28-Aug-15
Time:	6:22 PM
Calcs by:	MAC
Checked By:	
File:	
Comments:	
Scenario:	1 Pump, SST to Centrifuge

NOTE: If using submersible pumps, ignore suction piping.

Suction Piping

Section

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	0

Section

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	0

Section 1 — 6" tank to pump reducer

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve	2	0.77	1.54
90° Bend	1	0.30	0.3
45° Bend	1	0.20	0.2
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance	1	0.50	0.5
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side	2	1.80	3.6
Tee - Run		0.60	0
		Total	6.14

Section 2 — 6" header to pump

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit	1	1.00	1
Sudden		0.40	0
Reducer	1	0.25	0.25
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	1.25

Discharge Piping

Section

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	0

Section

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend		0.30	0
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	0

Section 1 — 4"disch to 3" flange

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve	4	0.77	3.08
90° Bend	6	0.30	1.8
45° Bend	1	0.20	0.2
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit		1.00	0
Sudden		0.40	0
Reducer	1	0.25	0.25
Tee - Side	2	1.80	3.6
Tee - Run	1	0.60	0.6
		Total	9.53

Section 2 — 3-inch section pre-Centrifuge

Fitting	Quantity	K-Factor	Total K
Butterfly Valve		0.46	0
Check Valve		2.50	0
Gate Valve		0.19	0
Plug Valve		0.77	0
90° Bend	1	0.30	0.3
45° Bend		0.20	0
22½° Bend		0.10	0
Bellmouth		0.04	0
Entrance		0.50	0
Exit	1	1.00	1
Sudden		0.40	0
Reducer		0.25	0
Tee - Side		1.80	0
Tee - Run		0.60	0
		Total	1.3

Project: EXETER NH - WWTF UPGRADE
Job No. 12883B
Date: 28-Aug-15
Time: 6:22 PM
Calcs by: MAC
Checked By:
File:
Comments:
Scenario: 1 Pump, SST to Centrifuge

Low C-Value	110	
High C-Value	130	
Low Suction	5	feet
High Suction	20	feet
Low Discharge	30	feet
High Discharge	30	feet
Pump Centerline	9	feet
Flow Increment	50	gpm

Note: If elevations are not based on USGS datum, correct elevations so that EL 0.00 is sea level

Maximum Static Head	25	feet
Minimum Static Head	10	feet
Atmospheric Pressure	34.0	feet
Percent Solids	6.0	%

Maximum 12% Solids

Suction Piping
Section Number: 1
Number of Pumps Operating: 1

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)
0	0	6	0.0	62	6.14	1	0.0	5	130	0.0	5.0	110	0.0	5.0
50	50	6	0.6	62	6.14	3.4	0.1	5	130	0.1	5.2	110	0.1	5.2
100	100	6	1.1	62	6.14	10.25	1.3	5	130	0.7	6.9	110	0.9	7.2
150	150	6	1.7	62	6.14	13.95	3.9	5	130	1.9	10.8	110	2.6	11.5
200	200	6	2.3	62	6.14	7	3.4	5	130	1.6	10.1	110	2.2	10.7
250	250	6	2.8	62	6.14	5.3	4.1	5	130	1.9	10.9	110	2.6	11.6
300	300	6	3.4	62	6.14	4.4	4.9	5	130	2.2	12.0	110	3.0	12.8
350	350	6	4.0	62	6.14	3.95	5.9	5	130	2.6	13.6	110	3.6	14.5
400	400	6	4.5	62	6.14	3.65	7.2	5	130	3.1	15.3	110	4.2	16.4
450	450	6	5.1	62	6.14	3.5	8.7	5	130	3.7	17.4	110	5.0	18.7
500	500	6	5.7	62	6.14	3.5	10.7	5	130	4.5	20.2	110	6.1	21.8

Suction Piping
Section Number: 2
Number of Pumps Operating: 1

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Static Head (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)	NPSHa (FT)
0	0	6	0.0	5	1.25	1	0.0		4.0	130	0.0	-11.0	110	0.0	4.0	24.0
50	50	6	0.6	5	1.25	3.4	0.0	0	4.0	130	0.0	-11.0	110	0.0	4.0	23.7
100	100	6	1.1	5	1.25	10.25	0.3	0	4.0	130	0.1	-10.7	110	0.1	4.3	21.5
150	150	6	1.7	5	1.25	13.95	0.8	0	4.0	130	0.2	-10.1	110	0.2	5.0	16.5
200	200	6	2.3	5	1.25	7	0.7	0	4.0	130	0.1	-10.2	110	0.2	4.9	17.4
250	250	6	2.8	5	1.25	5.3	0.8	0	4.0	130	0.2	-10.0	110	0.2	5.0	16.3
300	300	6	3.4	5	1.25	4.4	1.0	0	4.0	130	0.2	-9.8	110	0.2	5.2	14.9
350	350	6	4.0	5	1.25	3.95	1.2	0	4.0	130	0.2	-9.6	110	0.3	5.5	13.0
400	400	6	4.5	5	1.25	3.65	1.5	0	4.0	130	0.2	-9.3	110	0.3	5.8	10.8
450	450	6	5.1	5	1.25	3.5	1.8	0	4.0	130	0.3	-8.9	110	0.4	6.2	8.1
500	500	6	5.7	5	1.25	3.5	2.2	0	4.0	130	0.4	-8.5	110	0.5	6.7	4.4

Discharge Piping
Section Number: 1
Number of Pumps Operating: 1

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)
0	0	6	0.0	85	9.53	1	0.0	5	130	0.0	5.0	110	0.0	5.0
50	50	6	0.6	85	9.53	3.4	0.2	5	130	0.1	5.2	110	0.1	5.3
100	100	6	1.1	85	9.53	10.25	2.0	5	130	0.9	7.9	110	1.2	8.2
150	150	6	1.7	85	9.53	13.95	6.0	5	130	2.6	13.6	110	3.6	14.6
200	200	6	2.3	85	9.53	7	5.3	5	130	2.3	12.6	110	3.1	13.4
250	250	6	2.8	85	9.53	5.3	6.3	5	130	2.6	13.9	110	3.5	14.8
300	300	6	3.4	85	9.53	4.4	7.5	5	130	3.0	15.5	110	4.1	16.6
350	350	6	4.0	85	9.53	3.95	9.2	5	130	3.6	17.8	110	4.9	19.1
400	400	6	4.5	85	9.53	3.65	11.1	5	130	4.2	20.4	110	5.8	21.9
450	450	6	5.1	85	9.53	3.5	13.5	5	130	5.1	23.6	110	6.9	25.4
500	500	6	5.7	85	9.53	3.5	16.7	5	130	6.1	27.8	110	8.4	30.0

Discharge Piping
Section Number: 2
Number of Pumps Operating: 1

1 PUMP, Q (GPM)	MULTIPLE PUMP, Q (GPM)	D (IN)	V (FPS)	L (FT)	K -	SF -	Hm (FT)	Misc. Hl (FT)	Static Head (FT)	Minimum Curve C -	Minimum Curve Hf (FT)	Minimum Curve Head Loss (FT)	Minimum Curve TDH (FT)	Maximum Curve C -	Maximum Curve Hf (FT)	Maximum Curve Head Loss (FT)	Maximum Curve TDH (FT)
0	0	3	0.0	2	1.3	1	0.0		21.0	130	0.0	21.0	21.0	110	0.0	21.0	36.0
50	50	3	2.3	2	1.3	7	0.7	0	21.0	130	0.1	21.8	22.3	110	0.2	21.9	37.4
100	100	3	4.5	2	1.3	3.65	1.5	0	21.0	130	0.2	22.7	27.8	110	0.3	22.8	43.5
150	150	3	6.8	2	1.3	3.2	3.0	0	21.0	130	0.4	24.4	39.7	110	0.6	24.6	56.6
200	200	3	9.1	2	1.3	3	5.0	0	21.0	130	0.7	26.7	40.2	110	0.9	26.9	56.9
250	250	3	11.3	2	1.3	3	7.8	0	21.0	130	1.0	29.8	45.6	110	1.4	30.2	62.7
300	300	3	13.6	2	1.3	3	11.2	0	21.0	130	1.4	33.6	52.4	110	1.9	34.1	69.8
350	350	3	15.9	2	1.3	3	15.3	0	21.0	130	1.9	38.2	60.9	110	2.5	38.8	78.9
400	400	3	18.2	2	1.3	3	20.0	0	21.0	130	2.4	43.4	70.7	110	3.3	44.2	89.3
450	450	3	20.4	2	1.3	3	25.3	0	21.0	130	3.0	49.2	82.3	110	4.0	50.3	101.6
500	500	3	22.7	2	1.3	3	31.2	0	21.0	130	3.6	55.8	96.4	110	4.9	57.1	116.7

Project: EXETER NH - WWTF UPGRADE
Job No. 12883B
Date: 28-Aug-15
Time: 6:22 PM
Calcs by: MAC
Checked By:
File:
Comments:
Scenario: 1 Pump, SST to Centrifuge

Pump Manufacturer: Lobeline
Pump Model: Tri-lobe
Impeller Size:
Pump Speed:

Pumps Operating: 1

Q per Pump	Multiple Pump Q	NPSHa	Minimum System Curve	Maximum System Curve	Pump Curve
0	0	24.0	21.0	36.0	
50	50	23.7	22.3	37.4	
100	100	21.5	27.8	43.5	
150	150	16.5	39.7	56.6	
200	200	17.4	40.2	56.9	
250	250	16.3	45.6	62.7	
300	300	14.9	52.4	69.8	
350	350	13.0	60.9	78.9	
400	400	10.8	70.7	89.3	
450	450	8.1	82.3	101.6	
500	500	4.4	96.4	116.7	

Note: for parallel pumps operating in the last discharge section, the system curve plotted on the chart represents only the fractional flow contributed by a single pump. (i.e. for two pumps operating, the apparent operating point indicates

Minimum System Curve				**Min. Operating Point**	
	Flow	Sys. Head	Pump Head		
High		21	0	GPM	
Low		21	0	TDH	
slope				BEP	
intercept				% BEP	0%

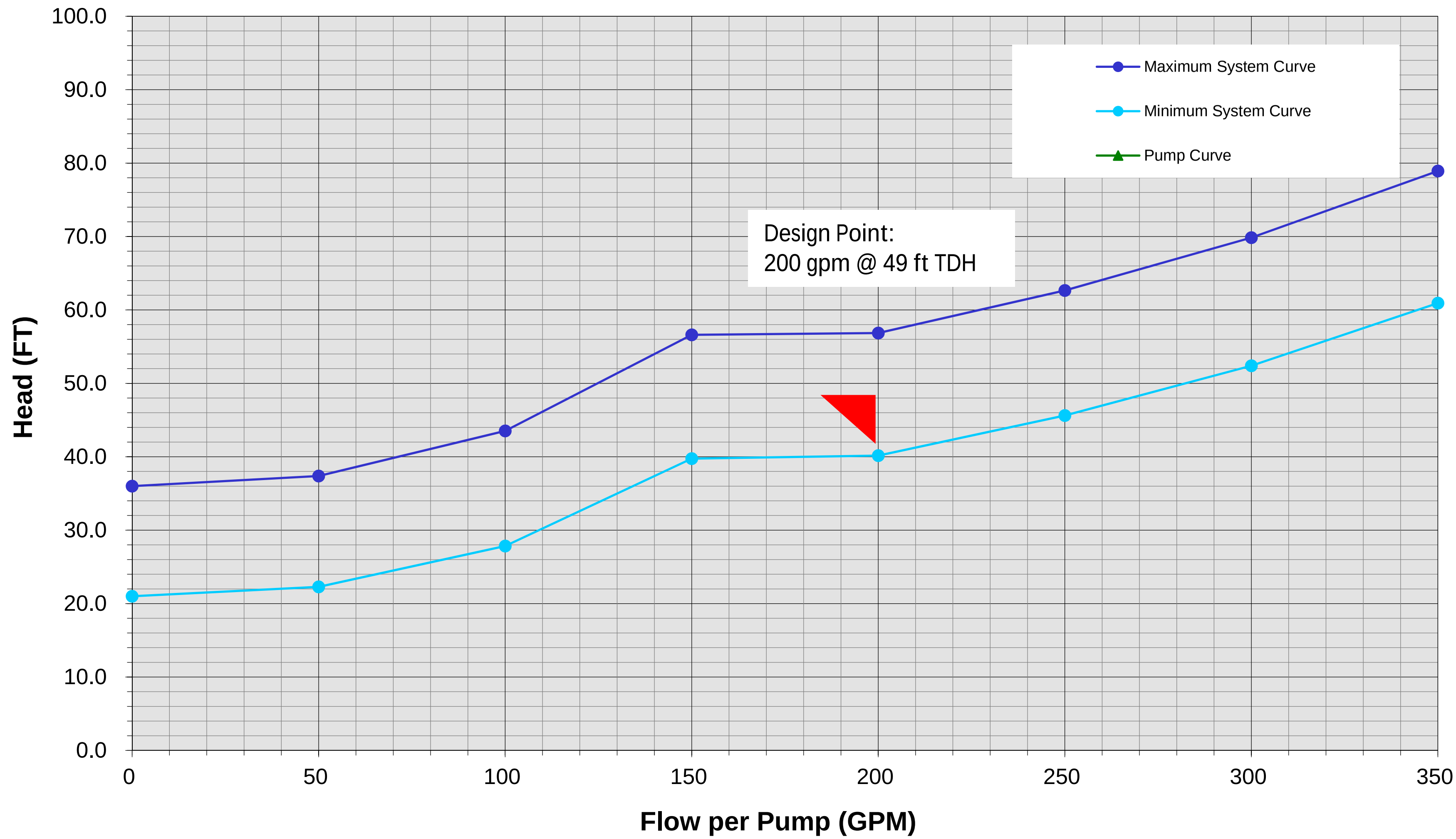
Copy the flow for the system curves at points before and after they cross the pump curve.

Maximum System Curve				**Max. Operating Point**	
	Flow	Sys. Head	Pump Head		
High		36	0	GPM	
Low		36	0	TDH	
slope				BEP	
intercept				% BEP	0%

Operating Range	
Low	0
High	0

Note: Plot the system curve on the manufacturer's pump curve to determine operating points, h.p. requirements, NPSHa requirements, efficiencies, etc.

EXETER NH - WWTF UPGRADE 1 Pump, SST to Centrifuge
1 Pump Operating in Last Discharge Section
Low C-Value = 110, High C-Value = 130



Pumps & Systems

TORNADO® Rotary Lobe Pumps

High Performance, Reliability, Maintenance in Place

NETZSCH Pumps & Systems – Solutions you can trust

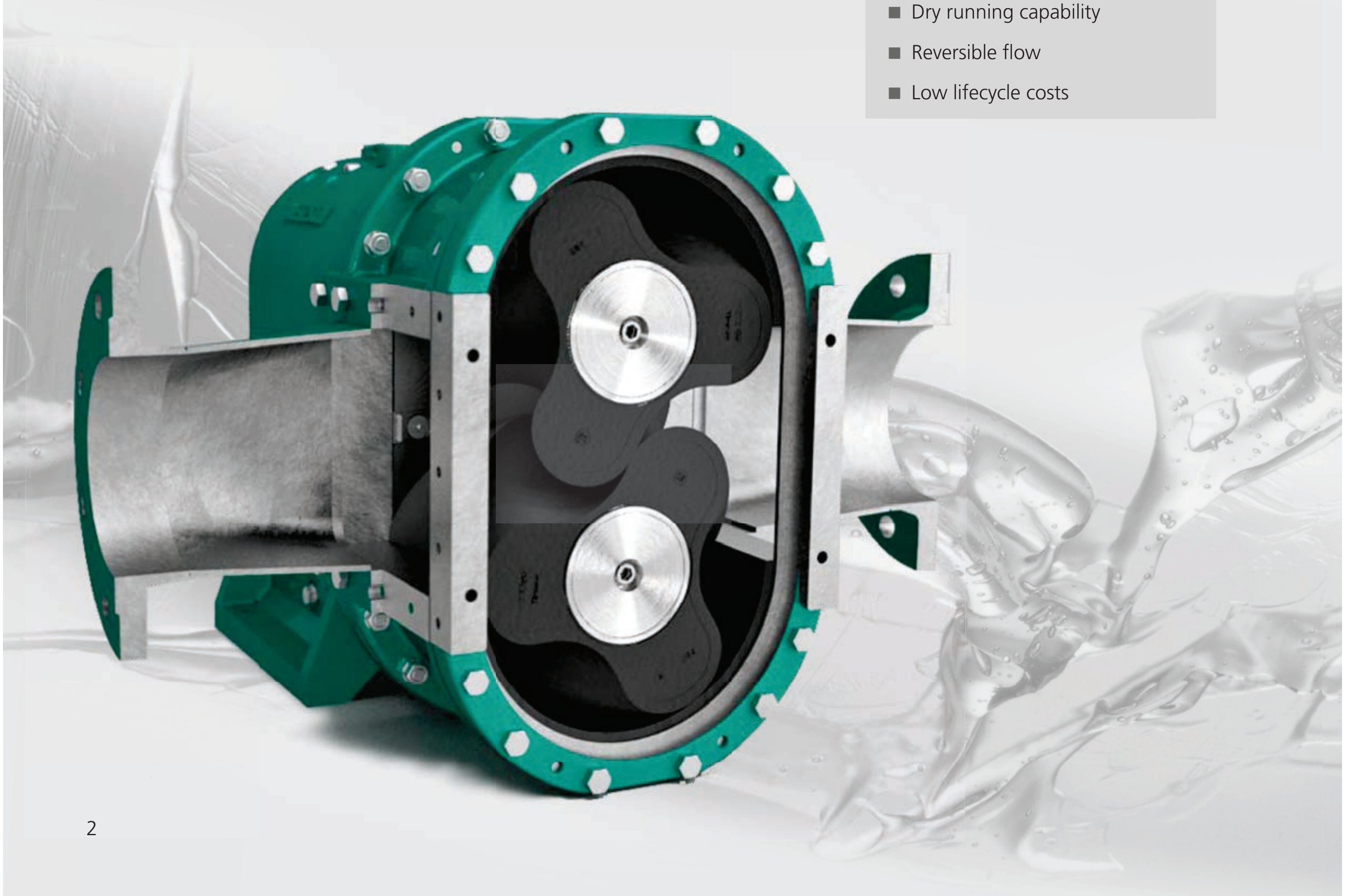
TORNADO® – high performance, reliability, maintenance in place

High performance rotary lobe pump with maximum operational reliability

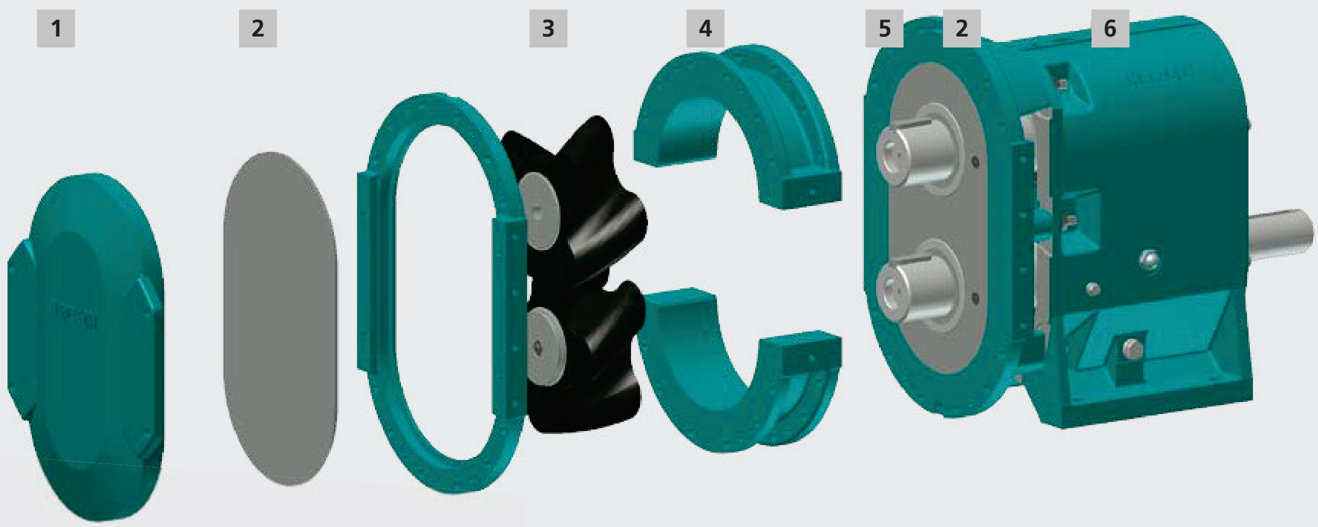
The NETZSCH TORNADO® positive displacement, self priming, valve-less pumps offer high performance and are selected and configured for the individual requirements of each application. They are designed for intermittent or continuous operation and provide gentle pumping of the pumped product and are ideally suited to transfer, process and dosing applications.

Advantages

- Maximum operational reliability: the NETZSCH GSS-Technology
- User maintenance in place
- Small installation and maintenance envelope; compact construction
- Installation flexibility
- High suction lift capability – up to 26 ft wc (8 mwc)
- Dry running capability
- Reversible flow
- Low lifecycle costs



Our design – your benefit: low life cycle costs



1 Front Cover

Rotors, cover seal and product seals can be accessed for inspection, service or replacement by simply removing the front cover. Disassembly of the inlet and outlet pipework and pump housing is not necessary.

2 Wear Plates

Abrasion and chemically resistant, replaceable wear plates are fitted on both sides of the rotors.

3 Rotors

Straight-sided or helical rotors are selected to suit individual application requirements. Rotors are available as bi-lobe, tri-lobe or four-lobe and wide a range of materials are available.

4 Housing Crescents

Modular construction allows for the crescents to be simply replaced should wear occur. Pump life can be further extended with the option of replaceable crescent liners.

5 Product Seals

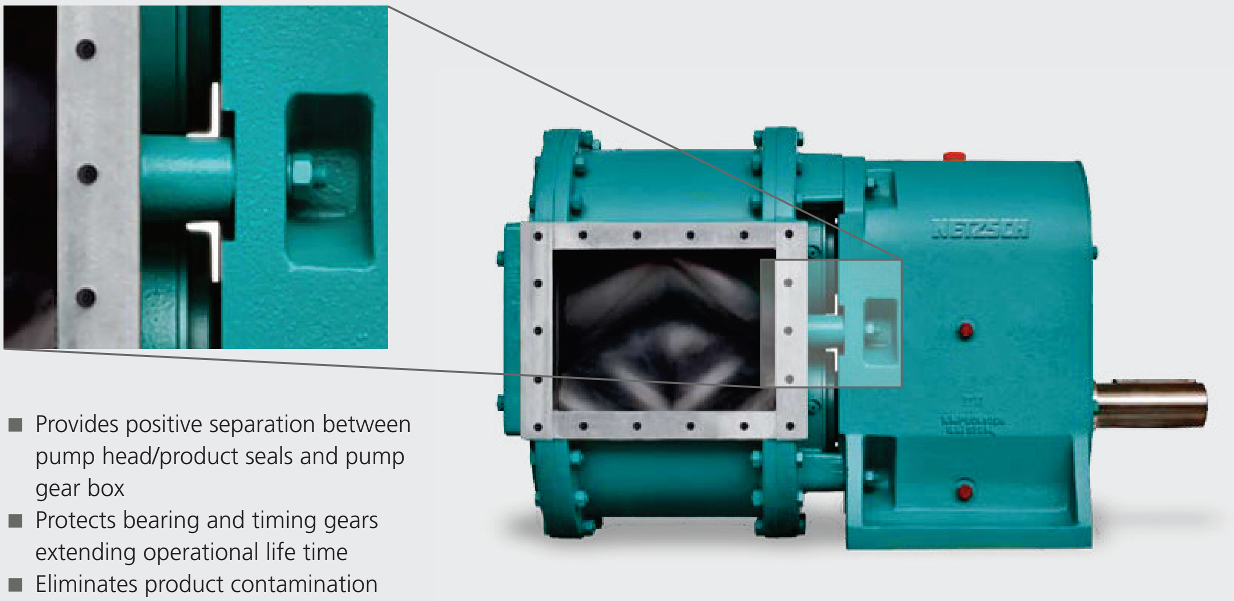
Wide range of product seals and materials are available, which are selected to suit individual application requirements. Seal arrangements include easy access connections for seal quench or flush.

6 Pump Gear Box

The patented gear box design includes NETZSCH GSS-Technology separating the pump head from the gear box which eliminates cross contamination between the pump product and gear box lubricant.

The NETZSCH GSS-Technology – open gap between pumphead and pump gear box

NETZSCH GSS-Technology – Gear box Security System



- Provides positive separation between pump head/product seals and pump gear box
- Protects bearing and timing gears extending operational life time
- Eliminates product contamination into gear box in the unlikely event of product seal failure
- Eliminates the risk of gear oil contamination into the pumped product
- Reduces total cost of ownership

A broad application spectrum

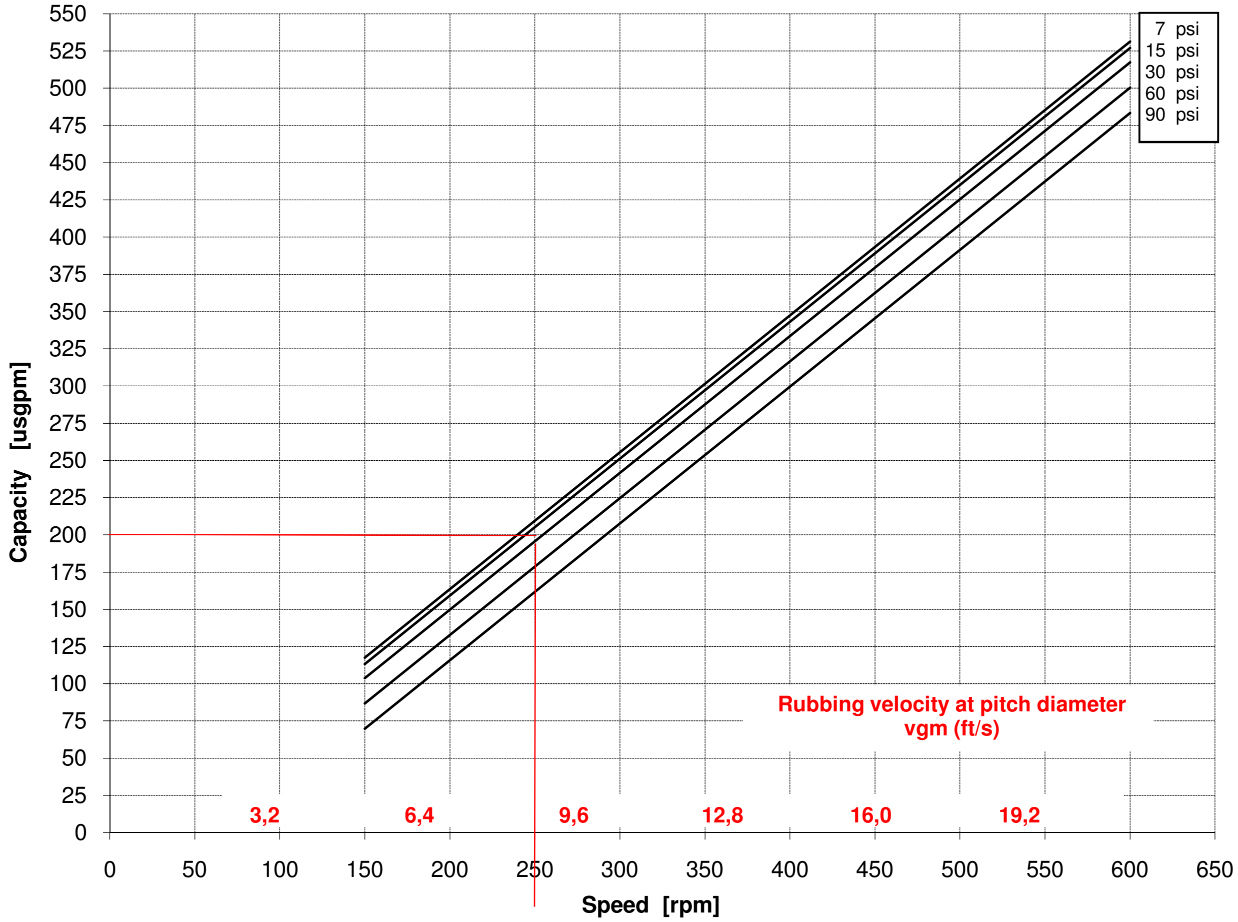
NETZSCH TORNADO® pumps are suitable for a wide range of applications but are particularly good for liquids which:

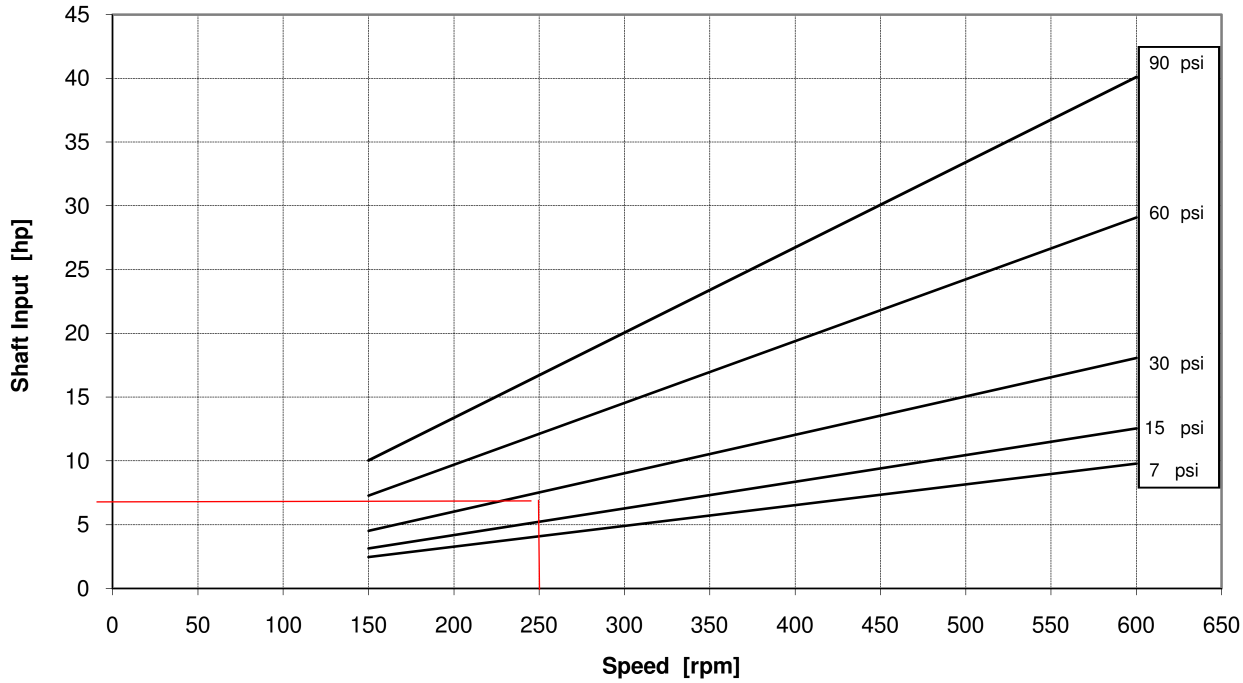
- Contain large solids, solids up to 3“(70 mm) in diameter can be pumped
- Have a wide range of viscosities, from 1 cps up to 1 million cps (1 mPas up to 1 million mPas)
- Are shear sensitive, i.e. thixotropic, dilatent, pseudoplastic, etc
- Are fibrous and/or abrasive
- Are lubricating or non-lubricating

Rotary Lobe Pump

TORNADO® XLB-1

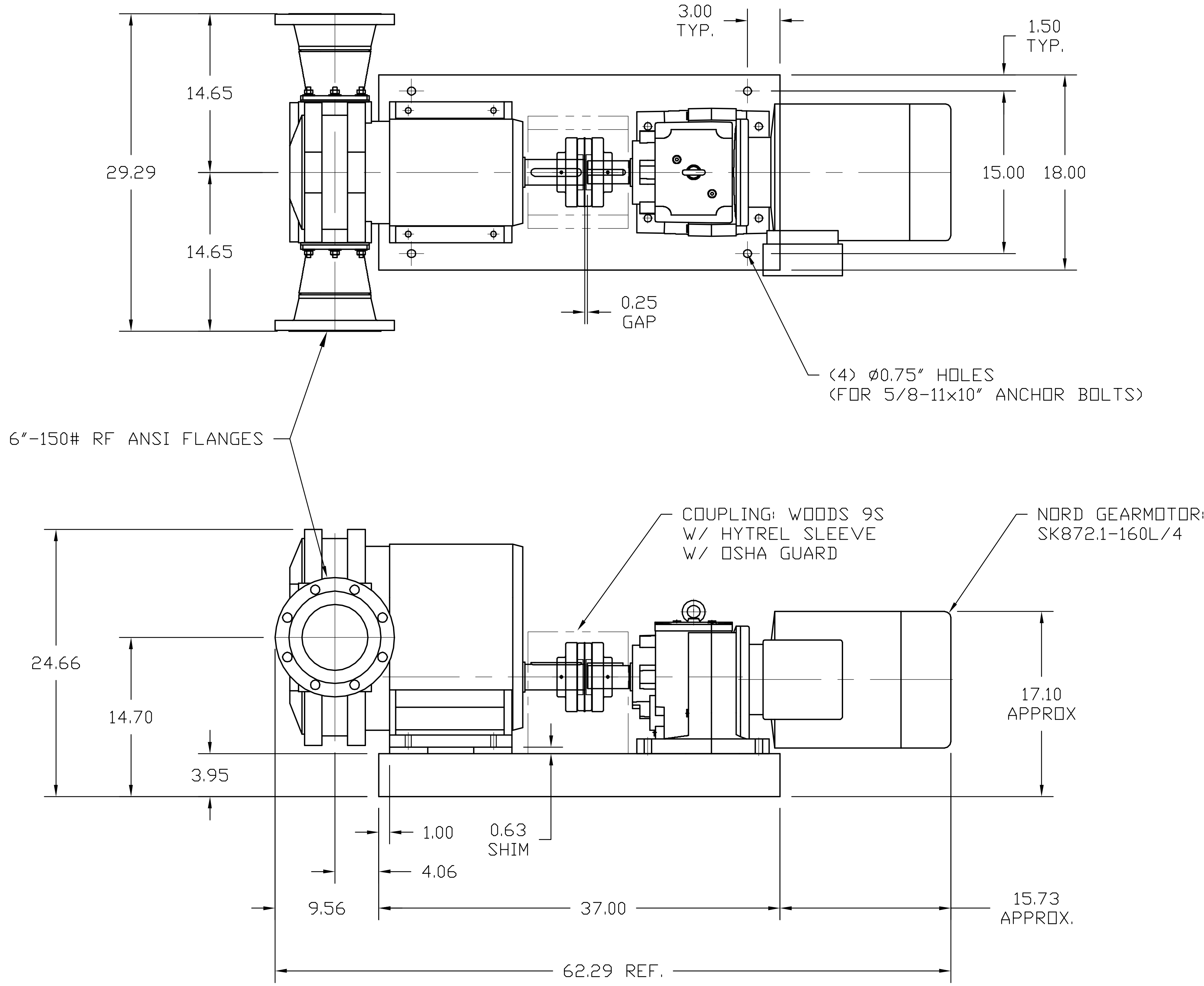
NETZSCH





Performance curve for water at 20℃

Ref. TL1XXAB 0611



NOTES:

A) DO NOT SCALE.
B) TOLERANCE ± 0.25"
C) ALL DIMENSIONS ARE IN INCHES.
D) BASEPLATE FABRICATION–STRUCTURAL STEEL.

PROPRIETARY: DRAWING MAY NOT BE USED OR REPRODUCED WITHOUT WRITTEN AUTHORIZATION OF NETZSCH INCORPORATED

REV.	DESCRIPTION	BY	DATE	APP'D.
			/ /	
			/ /	
			/ /	
			/ /	

NETZSCH Pumps North America, LLC.
EXTON, PA. 19341-1393

TITLE XLB-1 IN-LINE W/ STRAIGHT FLANGES	
DRAWN J L DATE 06/19/12	CHK'D DATE
SCALE 1:12	APP'D DATE / /
SHEET NUMBER 1 of 1	SIZE B
ORDER/PROJECT NUMBER	DRAWING NUMBER 31483910 SHT REV

CLIENT:	**EXETER, NH**				
JOB NAME:	**PDR**				
JOB NO.:	**12883B**				
CALC. BY:	**MAC**		**DATE:**	**8/26/2015**	
CHKD. BY:			**DATE:**		

SLUDGE DEWATERING CONVEYER DESIGN

			CONVEYER 1	**CONVEYER 2**	**CONVEYER 3**	**CONVEYER 4**
LOCATION		FROM	Centrifuge-1	Centrifuge-2	SC-2	SC-3
		TO	SC-2	SC-2	SC-3	SC-4 (truck loading)
DRY SOLIDS CONTENT			**12%**	**12%**	**12%**	**12%**
MAXIMUM FILL RATIO			**60%**	**60%**	**60%**	**60%**
BULK WET DENSITY (lbs/cf, min)			**50**	**50**	**50**	**50**
SOLIDS FEED RATE	**gpm**		**165**	**165**	**330**	**330**
	dry lbs/hour		**1,015**	**1,015**	**2,031**	**2,031**
	cubic ft/hour		**169**	**169**	**338**	**338**

CLIENT:	**EXETER, NH**			
JOB NAME:	**PDR**			
JOB NO.:	**12883B**			
CALC. BY:	**MAC**	**DATE:**	**8/26/2015**	
CHKD. BY:		**DATE:**		

SLUDGE DEWATERING CONVEYER DESIGN

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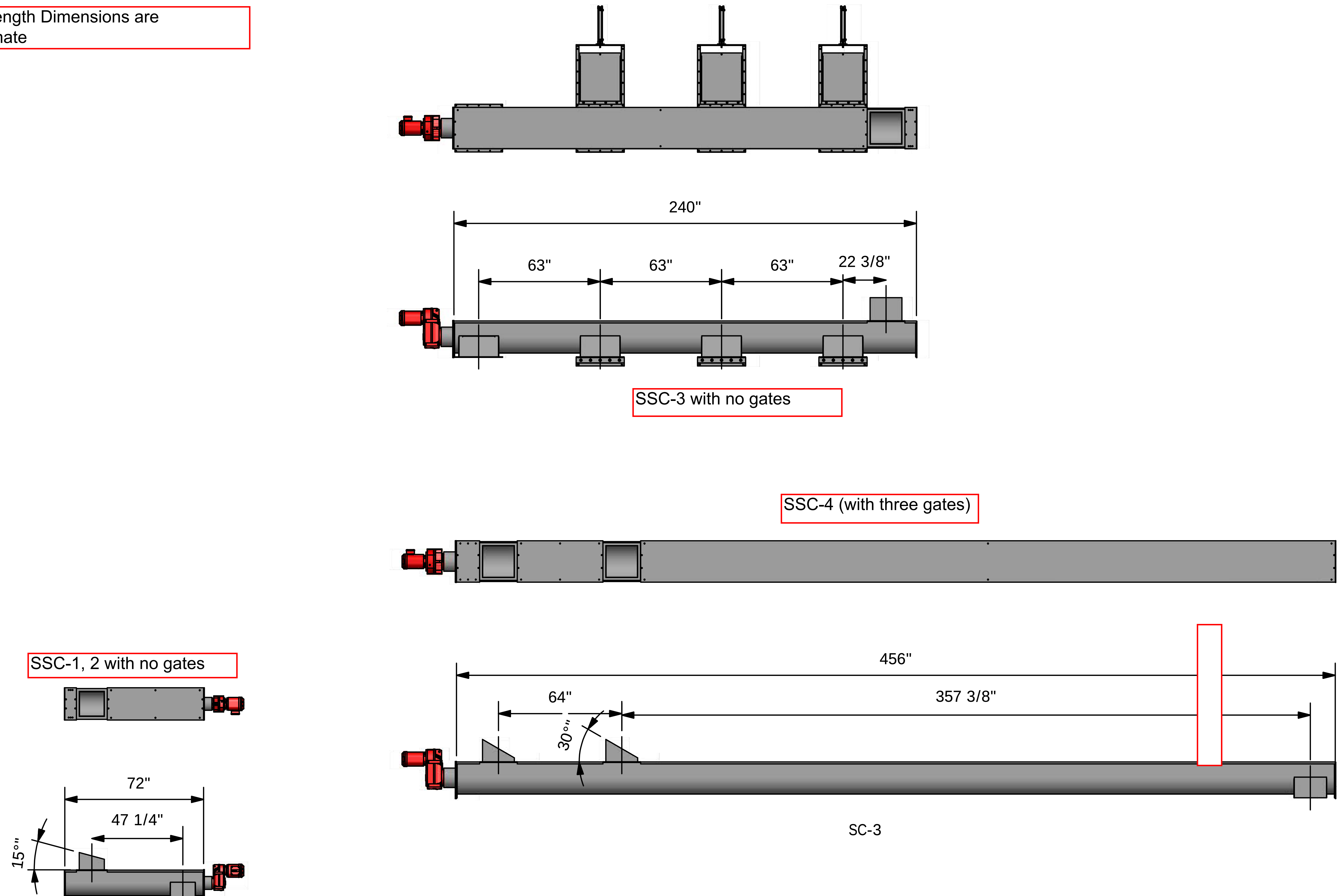
BULK WET DENSITY (lbs/cf, min)			**50**	**50**	**50**	**50**
SOLIDS FEED RATE	**gpm**		**165**	**165**	**330**	**330**
	dry lbs/hour		**1,015**	**1,015**	**2,031**	**2,031**
	cubic ft/hour		**169**	**169**	**338**	**338**



REV	DATE	DESCRIPTION	BY	CHK

CONFIDENTAL INFORMATION THIS DRAWING AND DESIGN IS SUPPLIED AS CONFIDENTIAL INFORMATION AS SPECIFIED IN THE CONTRACT OR AS CONFIDENTIAL INFORMATION AS DEFINED IN SPIRAC INC TERMS AND CONDITIONS OF COMPONENT SALES

SPIRAC (USA) INC.
75 Jackson Street Suite 300
Newnan, GA 30263
ph (770) 632-9833
fax (770) 632-9833

TOLERANCES EXCEPT WHERE OTHERWISE STATED:-

UP TO 120 IN	±1/8 in
120 IN AND OVER	±1/4 in
HOLE CENTERS	±1/16 in
CLEARANCE HOLE DIA	±1/16 in
ALL ANGLES	±1°

DIMENSIONS IN INCHES DO NOT SCALE

EXETER, NH
U320-SPX/SS & U420-SPX/SS
SC-1, SC-2, SC-3 & SC-4

DRAWN: SW	CHECKED:
DATE: 8.4.15	
SHEET: 1	SCALE: NTS
DWG. No. 50-1511	REV. 0

JOB NAME: **EXETER NH** DATE: 08/03/15
JOB NO 12883B
CALC. BY: MAC
CHKD. BY:
CHKD. BY:

FILE NAME: POLYMER.XLS
POLYMER FEED SYSTEM - LIQUID

	2018 Startup Annual Average	2018 Startup Annual Average	2040 Design Average Day	2040 Design Average Day	2040 Design Max Month	2040 Design Max Month		
INPUT								
	18-20% Cake Solids						Estimated based on Centrifuge Manuf. input and reported Sanford cake solids	
SOLIDS CONCENTRATION (%)	0.75	1.50	1.00	1.50	1.25	1.50	WAS Range after SST decanting .75-1.5%	
NUMBER OF POLYMER SYSTEMS OPERATING	1	1	1	1	2	2		
SOLIDS LOADING RATE (LBS/HR)	577	577	1,015	1,015	654	654	See Dewatering Throughput Spreadsheet.	
SOLIDS LOADING RATE (TONS/HR)	0.29	0.29	0.51	0.51	0.33	0.33		
HYDRAULIC SLUDGE FEED RATE (GPM)	154	77	203	135	105	87	Centrifuge	
POLYMER DOSAGE RATE (LBS. POLY./TON DRY SOLIDS)	35	35	35	35	35	35	TYP VALUE	Westfailia recommended 35 lb/dry ton
POLYMER IN FINAL SOLUTION (% by volume)	0.75	0.25	0.75	0.27	0.75	0.25	TYP VALUE	0.25 - 1% according to Emulsion Polymer Sheet
OUTPUT								
SLUDGE FEED RATE (GPM)	153.81	76.91	202.89	135.26	104.52	87.10		
Active polymer required, lbs/hr	10.10	10.10	17.77	17.77	11.44	11.44		
% Active polymer	35%	35%	35%	35%	35%	35%	4% to 6% for Mannich, 40/% to 75% dispersion Ciba, 25 to 35% emulsions	
NEAT POLYMER REQUIRED (GPH)	3.40	3.40	5.99	5.99	3.85	3.85		
NEAT POLYMER REQUIRED (GPM)	0.0567	0.0567	0.0998	0.0998	0.0642	0.0642		
DILUTION WATER REQUIRED (GPH)	450	1358	792	2211	510	1538		
DILUTION WATER REQUIRED (GPM)	7.5	22.6	13.2	36.9	8.5	25.6		
SOLUTION REQUIRED (GPH)	453.8	1361.4	798.2	2217.1	514.0	1541.9		
% poly by weight	0.27%	0.09%	0.27%	0.10%	0.27%	0.09%	TYP VALUE	1/10% TO 2/10%.

Polymer Dose

POLYMER FEED RANGE REQUIRED	3.4	TO	5.99	GPH	35 lbs/dry ton
WATER FEED RANGE REQUIRED	450	TO	2211	GPH	
SOLUTION FEED RATE REQUIRED	454	TO	2217	GPH	

TANK SIZING (POTENTIAL FUTURE)

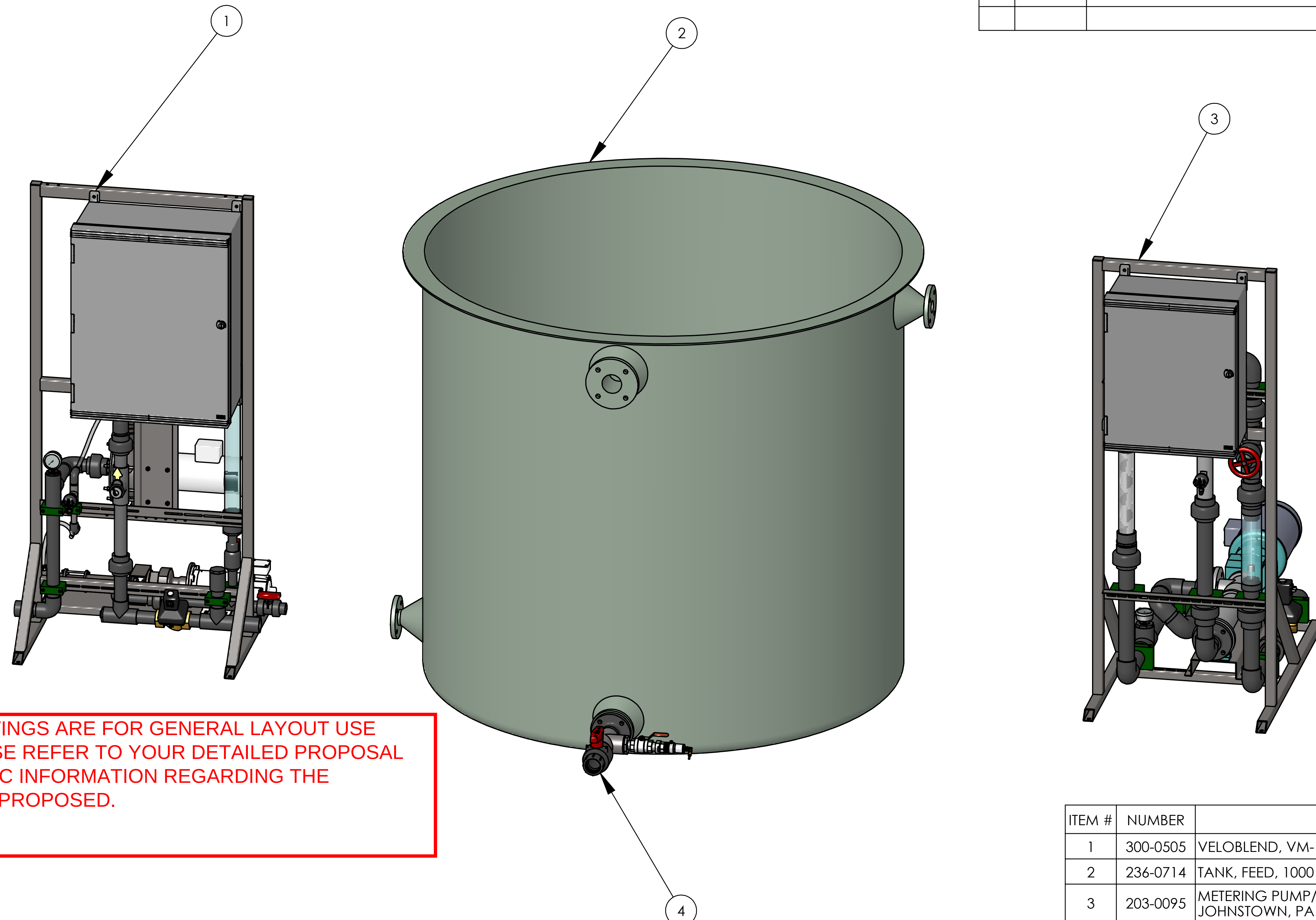
Ageing Time	20 minutes	10-20 min. per Emulsion Spec
Tank Size	739 gal	

POLYMER FEED RANGE REQUIRED	3.8	TO	6.55	GPH	
WATER FEED RANGE REQUIRED	497	TO	2419	GPH	35 lbs/dry ton
SOLUTION FEED RATE REQUIRED	501	TO	2425	GPH	

POLYMER FEED RANGE REQUIRED	2.7	TO	4.68	GPH	
WATER FEED RANGE REQUIRED	266	TO	1866	GPH	25 lbs/dry ton
SOLUTION FEED RATE REQUIRED	268	TO	1871	GPH	

POLYMER FEED RANGE REQUIRED	1.6	TO	2.81	GPH	
WATER FEED RANGE REQUIRED	159	TO	1120	GPH	15 lbs/dry ton
SOLUTION FEED RATE REQUIRED	161	TO	1122	GPH	

REVISIONS				
REV	ECO	DESCRIPTION	DATE	APPROVED
A	SO 2390	INITIAL RELEASE	4/3/15	B HEALY



NOTE: DRAWINGS ARE FOR GENERAL LAYOUT USE ONLY. PLEASE REFER TO YOUR DETAILED PROPOSAL FOR SPECIFIC INFORMATION REGARDING THE EQUIPMENT PROPOSED.

NOTES -

1) DRAWING LAYOUT FOR DESCRIPTIVE PURPOSES ONLY ACTUAL LAYOUT TO BE DETERMINED BY OTHERS

2) USE FLEXIBLE CONNECTIONS ON TANK

3) CHEMICALS SUPPLIED BY OTHERS

4) ALL PLUMBING AND ELECTRICAL INTERCONNECTIONS TO BE INSTALLED BY OTHERS

ITEM #	NUMBER	DESCRIPTION	QTY
1	300-0505	VELOBLEND, VM-15P-3000-RwB-1-D-2, JOHNSTOWN, PA	1
2	236-0714	TANK, FEED, 1000 GAL, FRP, FLAT BOTTOM, OPEN TOP	1
3	203-0095	METERING PUMP/POST DILUTION ASSY, 25 GPM, JOHNSTOWN, PA	1
4	182-0471	SENSOR ASSY, LEVEL, PRESSURE, 0-105 IN H2O, IFM, 2" FLANGE, WITH DRAIN VALVE	1

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES:
DECIMALS .XX = ±.015 .XXX = ±.005
ANGLES ± 1°
63 √ MINIMUM
FILLET RADII TO BE .005 MAXIMUM
BREAK ALL EDGES .005/.010
MATERIAL

FILENAME 310-0004

DO NOT SCALE DRAWING

CAD GENERATED DRAWING, INTERPRET DRAWING PER ASME Y14.5M - 2009

APPROVALS	DATE
MODELED B HEALY	4/3/2015
DRAWN B HEALY	4/3/2015
PROJECT MGR C HEUSEL	4/3/2015
PURCHASING MGR D RICARDO	4/3/2015
QUAL ENG	

VELODYNE
VELOCITY DYNAMICS, LLC.

VELOBLEND BATCHING SYSTEM, JOHNSTOWN, PA

SIZE B | DWG. NO. 310-0004 | REV. A

SCALE 1:18 | CAD FILE: | SHEET 1 OF 1

ATTACHMENT C: BIOSOLIDS COST ANALYSIS

CLIENT: **EXETER, NH**
JOB NAME: **PDR**
JOB NO.: **12883B**
CALC. BY: **MAC** **DATE:** **08/26/15**
CHKD. BY: **DATE:**

BIOSOLIDS COST ANALYSIS

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
	Dewatering	Dewatering	Dewatering	Dewatering	Dewatering	Dewatering
	Cake Disposal	Cake Disposal	Cake Disposal	Cake Disposal	Cake Disposal	Cake Disposal
Technology	**Centrifuge**	**Centrifuge**	**Centrifuge**	**Screw Press**	**Screw Press**	**Screw Press**
Manufacturer	Westfalia (CF 6000)	Centrysis (CS 21-4HC)	Westfalia (CF 7000)	Huber (Q800)	Ishigaki (A-906)	FKC (BHX-1050X5500L)
Capital Cost	**$800,000**	**$794,000**	**$1,000,000**	**$1,050,000**	**$1,027,500**	**$825,000**
Number of Units	2	2	2	3	3	3
Interest Rate	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
Period (years)	20	20	20	20	20	20
Annual Debt Service	**$59,000**	**$59,000**	**$74,000**	**$78,000**	**$76,000**	**$61,000**
Annual O&M Costs						
1) Annual Energy Cost						
Total Connected Operating Horsepower (HP)	**200**	**180**	**250**	**15**	**9**	**9**
% of Connected HP as Operating HP	75%	75%	75%	75%	75%	75%
Operating HP	150	135	188	11	7	7
KW/HP	0.746	0.746	0.746	0.746	0.746	0.746
Total capacity (lb/hr) - @ 0.75% solids	1,816	1,816	3,027	1,650	1,650	1,650
Hours of Operation/year (Design Avg)	814	814	488	896	896	896
Total KWH/Yr	161,889	145,700	121,417	13,367	8,020	8,020
Electricity Cost ($/KWH)	$0.14	$0.14	$0.14	$0.14	$0.14	$0.14
Annual Energy Cost	**$23,000**	**$20,700**	**$17,200**	**$1,900**	**$1,200**	**$1,200**
2) Disposal and Transportation Cost (Design Avg)						
Total Dry Solids (ton/year)	739	739	739	739	739	739
Expected Cake Solids	19%	19%	19%	17%	17%	17%
Sludge Qty (Wet Tons/yr)	3,890	3,890	3,890	4,348	4,348	4,348
$/Wet Ton	$100	$100	$100	$100	$100	$100
Annual Disposal Cost	**$390,000**	**$390,000**	**$390,000**	**$435,000**	**$435,000**	**$435,000**
3) Polymer Costs						
Polymer Use (active lb/dry ton)	30	30	30	25	25	25
Polymer Cost ($/active lb)	$3.40	$3.40	$3.40	$3.40	$3.40	$3.40
Polymer Cost ($/dry ton solids)	$102	$102	$102	$85	$85	$85
Annual Polymer Cost	**$76,000**	**$76,000**	**$76,000**	**$63,000**	**$63,000**	**$63,000**
4) Operations and Maintainance						
Oversight as % of Operating hours	20%	20%	20%	25%	25%	25%
Cleanup as % of Operating hours	5%	5%	5%	5%	5%	5%
Labor cost, $/hr	$40	$40	$40	$40	$40	$40
Total Annual O&M Cost	**$8,200**	**$8,200**	**$4,900**	**$10,800**	**$10,800**	**$10,800**

Notes:
(1) Disposal and transportation cost based on budgetary price provided by Synagro for thickened sludge (6%) and RMI for dewatered sludge (22%).

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Total Annual O&M Cost (1+2+3+4)	**$497,200**	**$494,900**	**$488,100**	**$510,700**	**$510,000**	**$510,000**
Annual Debt Service	**$59,000**	**$59,000**	**$74,000**	**$78,000**	**$76,000**	**$61,000**
Total Annual Cost (Loan + O&M)	**$556,200**	**$553,900**	**$562,100**	**$588,700**	**$586,000**	**$571,000**
Total Cost (over 20 year period)	**$11,124,000**	**$11,078,000**	**$11,242,000**	**$11,774,000**	**$11,720,000**	**$11,420,000**
Capital (Construction Cost)	$800,000	$794,000	$1,000,000	$1,050,000	$1,027,500	$825,000
Interest Rate	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
Inflation Rate (g)	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
Annual O&M (year 1)	$497,200	$494,900	$488,100	$510,700	$510,000	$510,000
Period (years)	20	20	20	20	20	20
Present Worth of O&M costs	$6,758,000	$6,726,000	$6,634,000	$6,941,000	$6,932,000	$6,932,000
Total Present Worth	**$7,558,000**	**$7,520,000**	**$7,634,000**	**$7,991,000**	**$7,960,000**	**$7,757,000**

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE

PROJECT NO.: 12883B

PRELIMINARY DESIGN PACKAGE

System/Subject:	SLUDGE STORAGE TANKS		
Calculations By:	MICHAEL CURRY	Date:	8/4/2015
Checked By:	TIM VADNEY/ED LEONARD	Date:	8/25/2015
Revised By:	MICHAEL CURRY	Date:	8/26/2015
Checked By:	ANDY MORRILL	Date:	8/28/2015

Checklist (to be completed by Design Engineer prior to calculation checking):

X Brief Process Description

X Graphs/Sketches of System Attached (Plans & Schematics)

X Design Calculations Attached

X Design Guidelines/Standards Noted

X Equations Noted and Referenced

X Electrical Loads Developed and Identified

X Process Control Description Developed

X Preliminary Basis of Design (Support Divisions) Attached

X Construction Sequence Developed

X Product Information Attached

\- Manufacturer's Review of Specs and Drawings (If Applicable)

X Electronic File Location Noted

\- Program(s) Used (Version) Noted

\- Coordinated with Hydraulic Profile (If Applicable)

DESCRIPTION OF EXISTING FACILITIES

The existing Facility is equipped with a Sludge Storage Lagoon. This Lagoon has never been used for its intended purpose of storing sludge from Lagoons No. 1, No. 2 and No. 3. Prior to becoming the Sludge Storage Lagoon, it was Lagoon No. 1 and a Stormwater Holding Pond.

FACILITY PLAN RECOMMENDATIONS

The Facility plan recommended providing a sludge storage system sized for 5 days of storage at design annual average conditions with instrumentation (level), decanting and aeration systems. The decanting system is assumed to consist of telescoping valves. The aeration system shall consist of two positive displacement blowers with diffused aeration grid sized for 30 to 50 scfm per thousand cubic feet of tank volume.

CLIENT PREFERENCES

No client preferences have been identified at this point.

DESIGN GUIDELINES (TR-16, NHDES Env-Wq)

<u>TR-16 – Section 11 (Residuals Treatment and Management)</u>:

- Section 11.1.4: To reduce the need for designing the sludge process for maximum daily sludge production, provisions for sludge storage should be considered. Sludge storage will also provide operating flexibility during equipment outages.
- Section 11.1.4.2: A sludge storage system should be equipped with mixing devices to prevent separation of solids and to provide a more uniform feed to the dewatering device. Provisions for adding line, chlorine, or air to prevent septicity and resulting odors is desirable. Decanting systems to provide thicker solids and flushing water to clean out tanks are necessary.
- Section 11.5.4: Typically, a minimum mixing and oxygen requirement for waste activated sludge (WAS) is 25-30 cubic feet per minutes per 1,000 cubic feet of tank volume. This volume should be provided with the largest blower out of service. If diffusers are used, the non-clog type is recommended.
- Section 11.9.2.2: Sludge storage or blending tanks preceding the centrifuges should e provided. Also necessary are a means for feeding chemical conditioners, and sufficient

aeration or mechanical agitation to prevent development of anaerobic conditions and associated odors.

Env-Wq – Section 716 (Sludge Handling)

- 716.05(a): Sludge storage facilities shall be designed to control odors so that odors do not create a nuisance at the property boundary;
- 716.05(b): For facilities that transport sludge to another facility as the means of disposal, storage capacity shall be designed to accommodate at least 5 days of sludge production based on maximum month design sludge generation rate; (NOTE: A waiver from NHDES may allow a reduced the required storage capacity)
- 716.08(c): A minimum mixing requirement of 30 cubic feet of air per minute per 1,000 cubic feet of tank volume shall be provided;
- 716.08(g): Multiple tanks shall be designed to operate in series or in parallel;
- 716.13(m): Sludge storage shall precede all mechanical dewatering unis and shall be provided by the use of holding tanks.

REVIEW OF DESIGN CONSIDERATION & ALTERNATIVES

Projected sludge generation rates for the WWTF are shown below:

PROJECTED SLUDGE QUANTITIES			
PARAMETER	**STARTUP ANNUAL AVERAGE (2018)[1]**	**DESIGN ANNUAL AVERAGE (2040)[1]**	**DESIGN MAX MONTH (2040)[1]**
Secondary Sludge (% Solids)[1]	0.71	0.73	1.03
Secondary Sludge (gal/week)	272,959	466,920	426,183
Secondary Sludge (gal/day)	38,994	66,703	60,883
Secondary Sludge (dry lbs/day) [1,2,3]	2,309	4,061	5,230
Total Solids (dry tons/day)	1.2	2.0	2.6

Notes:
1. Secondary sludge solids percentage estimated does not include increased solids content expected from decanting capability of new sludge storage tanks.
2. Sludge generation modeled using BioWIN
3. Future design conditions assume Bardenpho configuration with TN effluent limit of 3 mg/L

Two sludge storage tanks (SSTs) will be constructed at the new WWTF. The tanks will have a total storage volume of 300,000-gallons and will provide the following storage capacities:

SLUDGE STORAGE CAPACITY			
SCENARIO	SOLIDS PERCENTAGE[1]	SLUDGE STORAGE TIME (Before Decant)	SLUDGE STORAGE TIME (After Decant[3])
Start Up Annual Average:	0.7 % solids	7.7 days	13.1
Design Annual Average[1]:	0.7 % solids	4.5 days	7.5
Design Maximum Month[1]:	1.0 % solids	4.9 days	7.3

Notes:
1. Solids percentages reflect projected characteristics of waste activated sludge before SST decant.
2. Storage time may be change based on changes in waste activated sludge solids % and decant operations.
3. Assumes solids percentage increase of + 0.5% by decanting.

The SSTs will be separated by a sluice gate mounted on the common wall. The sluice gate will allow the tanks to operate separately or as an equalized single tank. The SSTs will be mixed to maintain sludge consistency and aerated minimize odor generation. Each SST will be equipped with a decanting system to draw off excess water (supernatant). SST decanting can allow the WWTF to increase sludge storage capacity and increase dewatered cake solids. Decanting systems (telescoping valve vs. submersible pump) will be further evaluated in final design.

Mixing

Mixing SSTs can be accomplished mechanically (mixing impeller) or by aeration (blowers/diffusers). Mechanical mixing has the advantage of generally having a lower initial and operation cost compared to aeration mixing. However, mechanical mixing does not supply adequate oxygen required to minimize odor generation. An aeration system is able to both mix and oxygenate the SSTs.

Aeration would be provided by a diffused aeration system consisting of new blowers, a stainless steel piping network, and a diffuser grid located along the bottom of the SSTs. The diffuser grid network would consist of fine bubble membrane diffusers mounted directly to PVC piping. The air is forced across the diffusers resulting in air bubbles that travel through the liquid to the surface of the sludge. Diffusers are designed to “collapse” when the air is turned off acting as a check valve.

Blowers

New blowers will be required to provide air to the sludge storage tanks. One blower will be dedicated to each SST with cross connections to allow for operator flexibility.

Positive displacement blowers are the industry standard for sludge mixing/ aerating applications and have a low initial cost. The blower displaces a constant volume of air against varying pressure conditions and easily adapts to changes in tank level and temperature. The required aeration rates are listed below:

REQUIRED SLUDGE STORAGE TANK AERATION		
Operating Level, ft - Sludge Depth	**Total Air Requirements at 30-40 SCFM/1,000 ft³ of Tank Volume**	**Air Requirements per Blower (Two blowers total)**
17-ft (High level)	1,200 – 1,600 SCFM	600 – 800 SCFM
12-ft (Average)	850 – 1,130 SCFM	425 – 565 SCFM

Notes:
1. TR-16 recommends a minimum of 30 scfm/1,000 cf tank. Manufacturer recommends 40 scfm/1,000 cf tank.

BASIS OF DESIGN

Mixing (Diffusers)

Fine bubble membrane type diffusers were chosen as the basis for design based on the system's ability to simultaneously mix and aerate and the system's proven success in sludge mixing/aerating applications.

Blowers

The basis of design for this project are positive displacement blowers due to their relatively low equipment cost, small footprint and proven success in fluctuating sludge mixing/aerating applications.

BASIS OF DESIGN

SLUDGE STORAGE TANK DIFFUSERS	
Application:	Waste Activated Sludge Storage (0.5-1.5% solids)
Type:	Diffused Aeration System, membrane discs
Number of Grids:	2 (1 grid per tank)
Number of Diffusers:	462 per grid, 924 total
Process Criteria:	
Air Flow, SCFM/1000 CF Tank Vol.	30 – 40
Air Flow, SCFM	425 – 800 per tank
Diffuser Submergence, ft	4-17 ft
Acceptable Manufacturer(s):	Sanitaire, Aquarius, or equal

SLUDGE STORAGE TANK BLOWERS	
Application:	Sludge Storage Tank Diffused Aeration
Type:	Positive Displacement
Number of Blowers:	Two (2)
Process Criteria:	
Air Flow, ICFM	425 – 800 per blower
Maximum Inlet Air Temperature, °F	90
Barometric Pressure, psia	14.7
Discharge Pressure, psig	9.5 psi
Acceptable Manufacturer(s):	Roots, Aerzen, or equal

BUILDING / STRUCTURE DESCRIPTION

The two SSTs will be constructed adjacent to the Solids Handling Building and share a common wall. The SSTs will have a concrete slab cover equipped with six hatches (three for each tank) to access level switches, sumps, and decanting devices (valves or pumps). The floor of the tanks will be gradually sloped towards a sludge collection sump. Steps to access the top of the SSTs will be required along with handrails.

The SST Blowers will be located in the Lower Level of the Solids Handling Building.

Structural information:

Equipment: Blowers	
Height	5.75-feet (max point)
Width (approx.)	5.0-feet
Length (approx.)	5.0-feet
TOTAL WEIGHT	1,775 lb
Tank	
Volume	300,000 gal. total (150,000 gal. per tank)
Dimensions	50'W, 50'L, 17' SWD
Freeboard	2'-0"

PROCESS CONTROL DESCRIPTION

The Sludge Storage Tank blowers will be controlled by a Division 13 supplied control panel mounted in the Solids Handling Lower Level. A local control station with a Local-Off-Remote switch and ESTOP pushbutton will be provided near each blower unit. The blowers will operate on a repeat cycle timer function with an off time period for settling/decant. Equipment located at the Solids Handling Lower Level shall be unclassified rated NEMA 1/12. Each Sludge Storage Tank will contain float switches and submersible pressure transducers to monitor tank levels.

The following instruments, control panels, and local control stations are anticipated:

ITEM (LOCATION)	LOCAL/REMOTE	NEMA	BY DIVISION	RANGE
Transducer (Sludge Storage Tank)	Local	7	13	0 - 20 ft.
Float Switch (Sludge Storage Tank)	Local	7	13	n/a
High Pressure Switch (Solids Handling – Lower Level)	Local	1/12	11-OEM	n/a
Control Panel (Solids Handling – Lower Level)	Remote	1/12	13	n/a
Local Control Station - Blowers (Solids Handling – Lower Level)	Local	1/12	13	n/a

Electrical information:

Equipment: Blowers	
Power	60 HP
Speed	Variable
Enclosure	TEFC, Unclassified
Volts, Phase/ Hz	460/ 3/ 60

X Coordinated with NFPA Memo

X Coordinated with Equipment List

CONSTRUCTION SEQUENCING

The Sludge Storage System will be constructed alongside the new Solids Handling Building. This system will need to be completed when the activated sludge system is put on-line to allow for the sludge processing.

FUTURE EXPANSION CONSIDERATIONS

The Sludge Storage Tank System is sized to accommodate the current and future loads identified in the PDR.

FILE LOCATION

J:\ENG\NH\Exeter\12883-WWTF\12883B-WW Design\Technical\Process\Design Memos

ATTACHMENTS

- A Equipment Cut Sheets
- B Calculations

EXETER WWTF UPGRADE
SLUDGE STORAGE TANK SIZING

Calc By: JRM Date: 6/17/2014
Rev By: MAC Date: 8/26/2015
Chkd By: Date:

TOTAL SLUDGE PRODUCTION (GALLONS)

	START UP ANNUAL AVERAGE (2018) SOLIDS GENERATION	DESIGN ANNUAL AVERAGE (2040) SOLIDS GENERATION	DESIGN MAX MONTH (2040) SOLIDS GENERATION	
Secondary Bio (lb/d)	2,309	4,061	5,230	Biowin Model for Revised Flows and Loads
Tertiary Chem (lb/d)	-	-	-	Assess SST expansion in future
Total (lb/d)	**2,309**	**4,061**	**5,230**	NOTE: USES REDUCED BIOWIN LOADINGS PER WEB COMMENTS

Indicates achievable sludge storage scenarios based on identified conditions.

% WITHOUT SST DECANT

START UP ANNUAL AVERAGE	**0.71%**	**0.73%**	**1.03%**
STORAGE CAPACITY @ SOLIDS PERCENTAGE:			
1 DAYS	38,971	37,903	26,863
2 DAYS	77,942	75,806	53,727
3 DAYS	116,912	113,709	80,590
4 DAYS	155,883	151,612	107,453
5 DAYS	194,854	189,516	134,317

Solids Concentrations from Biowin Model for Option 3, BPhp w/o phasing (WAS)
% Solids Required for Storage Time @ 300,000 gallons 0.46% — Storage Time 5 days
Sludge Storage Time @ Desired SST Tank Size 7.70

DESIGN ANNUAL AVERAGE (2040)			
STORAGE CAPACITY @ SOLIDS PERCENTAGE:	**0.71%**	**0.73%**	**1.03%**
1 DAYS	68,541	66,663	47,246
2 DAYS	137,081	133,326	94,493
3 DAYS	205,622	199,989	141,739
4 DAYS	274,163	266,651	188,986
5 DAYS	342,703	333,314	236,232

Solids Concentrations from Biowin Model for Option 3, BPhp w/o phasing (WAS)
% Solids Required for Storage Time @ 300,000 gallons 0.81% — Storage Time 5 days
Sludge Storage Time @ Desired SST Tank Size 4.50

DESIGN MAX MONTH (2040)			
STORAGE CAPACITY @ SOLIDS PERCENTAGE:			
	0.71%	**0.73%**	**1.03%**
1 DAYS	88,271	85,852	60,847
2 DAYS	176,542	171,705	121,694
3 DAYS	264,812	257,557	182,541
4 DAYS	353,083	343,410	243,387
5 DAYS	441,354	429,262	304,234

Solids Concentrations from Biowin Model for Option 3, BPhp w/o phasing (WAS)
% Solids Required for Storage Time @ 300,000 gallons 1.04% — Storage Time 5 days
Sludge Storage Time @ Desired SST Tank Size 4.93

TANK SIZING

MAX CAPACITY	**300,000**	gallons
Number	2	
Width	**25.0**	feet
SWD	**17**	feet
Length	47.2	feet
MIN CAPACITY	211,765	gallons
Number	2	
Width	**25.0**	feet
SWD	**12**	feet
Length	47.2	feet

BLOWER SIZING

Max Air Requirements		
40,107	cf	
30	scfm/1000cf	40
1,200	scfm	1,600
2	blowers	2
600	scfm each	800

Avg. Air Requirements		
28,311	cf	
30	scfm/1000cf	40
850	scfm	1,130
2	blowers	2
425	scfm each	565

NOTES:
Minimum of 30 SCFM for WAS per Env Wq 713.05
Sanitaire recommends 40 scfm for WAS

EXETER WWTF UPGRADE
SLUDGE STORAGE TANK SIZING

Calc By: JRM Date: 6/17/2014
Rev By: MAC Date: 8/26/2015
Chkd By: Date:

TOTAL SLUDGE PRODUCTION (GALLONS)

	START UP ANNUAL AVERAGE (2018) SOLIDS GENERATION	DESIGN ANNUAL AVERAGE (2040) SOLIDS GENERATION	DESIGN MAX MONTH (2040) SOLIDS GENERATION
Secondary Bio (lb/d)	2,548	4,442	6,011
Tertiary Chem (lb/d)	-	-	-
Total (lb/d)	**2,309**	**4,061**	**5,230**

Biowin Model for Option 3, Bardenpho w/o Phasing (WAS only)
Assess SST expansion in future
NOTE: USES REDUCED BIOWIN LOADINGS PER WEB COMMENTS

Indicates achievable sludge storage scenarios based on identified conditions.

% WITH SST DECANT

START UP ANNUAL AVERAGE
STORAGE CAPACITY @ SOLIDS PERCENTAGE:

	1.21%	**1.23%**	**1.53%**
1 DAYS	22,867	22,495	18,084
2 DAYS	45,734	44,991	36,169
3 DAYS	68,601	67,486	54,253
4 DAYS	91,469	89,981	72,338
5 DAYS	114,336	112,477	90,422

Solids Concentrations from Biowin Model for Option 3, BPhp w/o phasing (WAS)
% Solids Required for Storage Time @ 300,000 gallons — 0.46% — Storage Time 5 days
Sludge Storage Time @ Desired SST Tank Size 13.12

DESIGN ANNUAL AVERAGE (2040)
STORAGE CAPACITY @ SOLIDS PERCENTAGE:

	1.21%	**1.23%**	**1.53%**
1 DAYS	40,218	39,564	31,806
2 DAYS	80,436	79,128	63,613
3 DAYS	120,654	118,692	95,419
4 DAYS	160,872	158,256	127,226
5 DAYS	201,090	197,821	159,032

Solids Concentrations from Biowin Model for Option 3, BPhp w/o phasing (WAS)
% Solids Required for Storage Time @ 300,000 gallons — 0.81% — Storage Time 5 days
Sludge Storage Time @ Desired SST Tank Size 7.58

DESIGN MAX MONTH (2040)
STORAGE CAPACITY @ SOLIDS PERCENTAGE:

	1.21%	**1.23%**	**1.53%**
1 DAYS	51,795	50,953	40,962
2 DAYS	103,591	101,906	81,925
3 DAYS	155,386	152,859	122,887
4 DAYS	207,181	203,812	163,849
5 DAYS	258,976	254,765	204,811

Solids Concentrations from Biowin Model for Option 3, BPhp w/o phasing (WAS)
% Solids Required for Storage Time @ 300,000 gallons — 1.04% — Storage Time 5 days
Sludge Storage Time @ Desired SST Tank Size 7.32

TANK SIZING

MAX CAPACITY	**300,000**	gallons
Number	2	
Width	**25.0**	feet
SWD	**17**	feet
Length	47.2	feet

MIN CAPACITY	211,765	gallons
Number	2	
Width	**25.0**	feet
SWD	**12**	feet
Length	47.2	feet

BLOWER SIZING

Max Air Requirements

40,107	cf	
30	scfm/1000cf	40
1,200	scfm	1,600
2	blowers	2
600	scfm each	800

Avg. Air Requirements

28,311	cf	
30	scfm/1000cf	40
850	scfm	1,130
2	blowers	2
425	scfm each	565

NOTES:
Minimum of 30 SCFM for WAS per Env Wq 713.05
Sanitaire recommends 40 scfm for WAS

Diffused Aeration Equipment

for

Exeter WWTP

SST

Prepared For:

Wright Pierce

99 Main Street
Topsham, ME 04086

Represented By:
The Maher Corporation
192 Pleasant Street
Rockland, MA 02370
781 421-2600

Sanitaire #23739-13s
July 30, 2015
ig K:\s23739-13\2015.7.30 SST setup.aer

Sanitaire Aeration Design Inputs for: Exeter WWTP, Sanitaire #23739-13s

Tank Geometry

2 Trains each Consisting of:

Parameter	Units	Pass 1
Parallel Reactors		1
Pass Process		Aerobic
SWD	ft	17.0
Submergence	ft	16.2
Volume	ft^3	19,975.0
Reactor Geometry:		Rect
Length	ft	47.0
Width	ft	25.0

Oxygen/Air Distribution

	Zone	1
	Pass	1
Min		100.0%

Oxygenation

Parameter	Units	30 scfm/kcf	40 scfm/kcf
No. Trains Operating		2	2
Air Rate	scfm	1,198.5	1,598.0
Unit Air Rate	scfm/kcf	30.0	40.0

Standard Oxygen Correction Factor Parameters

Parameter	Units	30 scfm/kcf	40 scfm/kcf
Site Elevation	FASL	10	10
Ambient Pressure	PSIA	14.70	14.70
Water Temperature	°C	***20***	***20***

Notes:

Bold, Italicized text indicate assumptions made by Sanitaire

A - Indicates Actual (AOR) Requirement.

S - Indicates Standard Condition (SOR) Oxygen requirement.

If the AOR/SOR parameter is not given, then its value will be evaluated later if suitable alpha, beta, D.O., theta, pressure, and temperature data is supplied.

Round tanks are evaluated as rectangular tanks diameter equal to length and equal surface area.

Annular tanks are evaluated as rectangular tanks of width equal to the annular width and equal surface area.

Sanitaire Project Name: Exeter WWTP
Sanitaire Project #23739-13s
Design Summary

		Operating Point & O2 Distribution	
	Units	30 scfm/kcf Min	40 scfm/kcf Min
No. Trains in Operation		2	2
No. Grids in Operation		2	2
No. Operating Diffusers		924	924
SOR	lb/day	10,266	13,288
SOTE	%	34.2	33.2
Total Air Rate	scfm	1,199	1,598
Min.Diffuser Air Rate	scfm/diff.	1.3	1.73
Max. Diffuser Air Rate	scfm/diff.	1.3	1.73
Static Pressure	psig	7.01	7.01
Diffuser DWP @ Min Air	psig	0.5	0.54
Diffuser DWP @ Max Air	psig	0.5	0.54
Pressure @ Top of Dropleg	psig	7.61	7.73
Est. Blower Efficiency		70%	70%
Est. Motor Efficiency		90%	90%
Shaft Power	Bhp	50.16	67.72
Est. Motor Electrical Load	kW	41.58	56.13
Est. Standard Aeration Efficiency	#SOR/BHP-hr	8.53	8.18

Notes:

(1) Design air is the maximum of process air or mixing air

(2) Delivered oxygen based on design air

(3) Brake Horsepower based on adiabatic compression, 70% mechanical efficiency and 0.30 psi lineloss

(4) Performance based on diffuser density (At/Ad), submergence, and diffuser unit air flow.

(5) Diffuser Air Flow based on Active Valve Modulation

(6) Blower Pressure Capability also requires consideration of:

A. The Air Main headloss (piping, fittings, valves, instrumentation, etc.) between the blower and the aeration assembly dropleg connections.

B. Potential for increased headloss resulting from diffuser fouling and/or aging. Please refer to the US EPA Fine Pore Design Manual (EPA/625/1-89/023), WEF Manual of Practice FD-13, and other

technical publications for a detailed discussion on this subject. Note that this headloss consideration relates to all Fine Pore systems regardless of supplier or type of diffuser element.

C. Increased diffuser submergence during Peak Flow conditions.

(7) Air Flow defined at 20°C

(8) Fine Mixing air based on MOP/8 0.12 scfm/ft²

Sanitaire Project Name: Exeter WWTP
Sanitaire Project #23739-13s

Consulting Engineer: Wright Pierce
Operating Condition: 30 scfm/kcf
Oxygen Distribution: Min

Aeration System Design

Parameter	Units	Zone 1	Totals/Overall
Pass		1	
SWD	ft	17.00	
Subm	ft	16.19	
Volume	ft^3	19,975.0	39,950.0
No. Parallel Tanks		1	
No. Trains in Operation		2	
Grid Count		1	2
Dropleg Diameter	inches	6	
At/Ad		6.20315	
Diffuser Density	% Floor	16.12%	
Diffusers/Grid		462	924

Oxygen Transfer

Parameter	Units	Zone 1	Totals/Overall
Diffuser Type		SSII-9	
Alpha			
Beta			
Theta			
D.O.	mg/l		
Water Temp	°C	20	
AOR/SOR			
Oxygen Distribution	%/Zone	100.0%	100.0%
AOR	lb/day		
SOR	lb/day		
Air Rate (7)	scfm	1,198.5	1,198.5

Performance

Parameter	Units	Zone 1	Totals/Overall
Mixing Criteria	$scfm/ft^2$	0.12	
Safety Factor	%		
Mixing Air (8)	scfm	282.0	
Process Air (for SOR)	scfm	1,198.5	
Design Air (1,7)	scfm	1,198.5	1,198.5
Diffuser Air Rate	scfm/Diff.	1.30	1.30
Delivered SOR	lb/day	10,265.6	10,265.6
Delivered SOTE	%	34.2%	34.2%
Pressure @ Top of Dropleg	psig	7.61	7.61
Shaft Power	Bhp	50.2	50.2

Notes:

(1) Design air is the maximum of process air or mixing air

(2) Delivered oxygen based on design air

(3) Brake Horsepower based on adiabatic compression, 70% mechanical efficiency and 0.30 psi lineloss

(4) Performance based on diffuser density (At/Ad), submergence, and diffuser unit air flow.

(5) Diffuser Air Flow based on Active Valve Modulation

(6) Blower Pressure Capability also requires consideration of:

A. The Air Main headloss (piping, fittings, valves, instrumentation, etc.) between the blower and the aeration assembly dropleg connections.

B. Potential for increased headloss resulting from diffuser fouling and/or aging.

Please refer to the US EPA Fine Pore Design Manual (EPA/625/1-89/023), WEF Manual of Practice FD-13, and other technical publications for a detailed discussion on this subject. Note that this headloss consideration relates to all Fine Pore systems regardless of supplier or type of diffuser element.

C. Increased diffuser submergence during Peak Flow conditions.

(7) Air Flow defined at 20°C

(8) Fine Mixing air based on MOP/8 0.12 $scfm/ft^2$

Sanitaire Project Name: Exeter WWTP
Sanitaire Project #23739-13s

Consulting Engineer: Wright Pierce
Operating Condition: 40 scfm/kcf
Oxygen Distribution: Min

Aeration System Design

Parameter	Units	Zone 1	Totals/Overall
Pass		1	
SWD	ft	17.00	
Subm	ft	16.19	
Volume	ft³	19,975.0	39,950.0
No. Parallel Tanks		1	
No. Trains in Operation		2	
Grid Count		1	2
Dropleg Diameter	inches	6	
At/Ad		6.20315	
Diffuser Density	% Floor	16.12%	
Diffusers/Grid		462	924

Oxygen Transfer

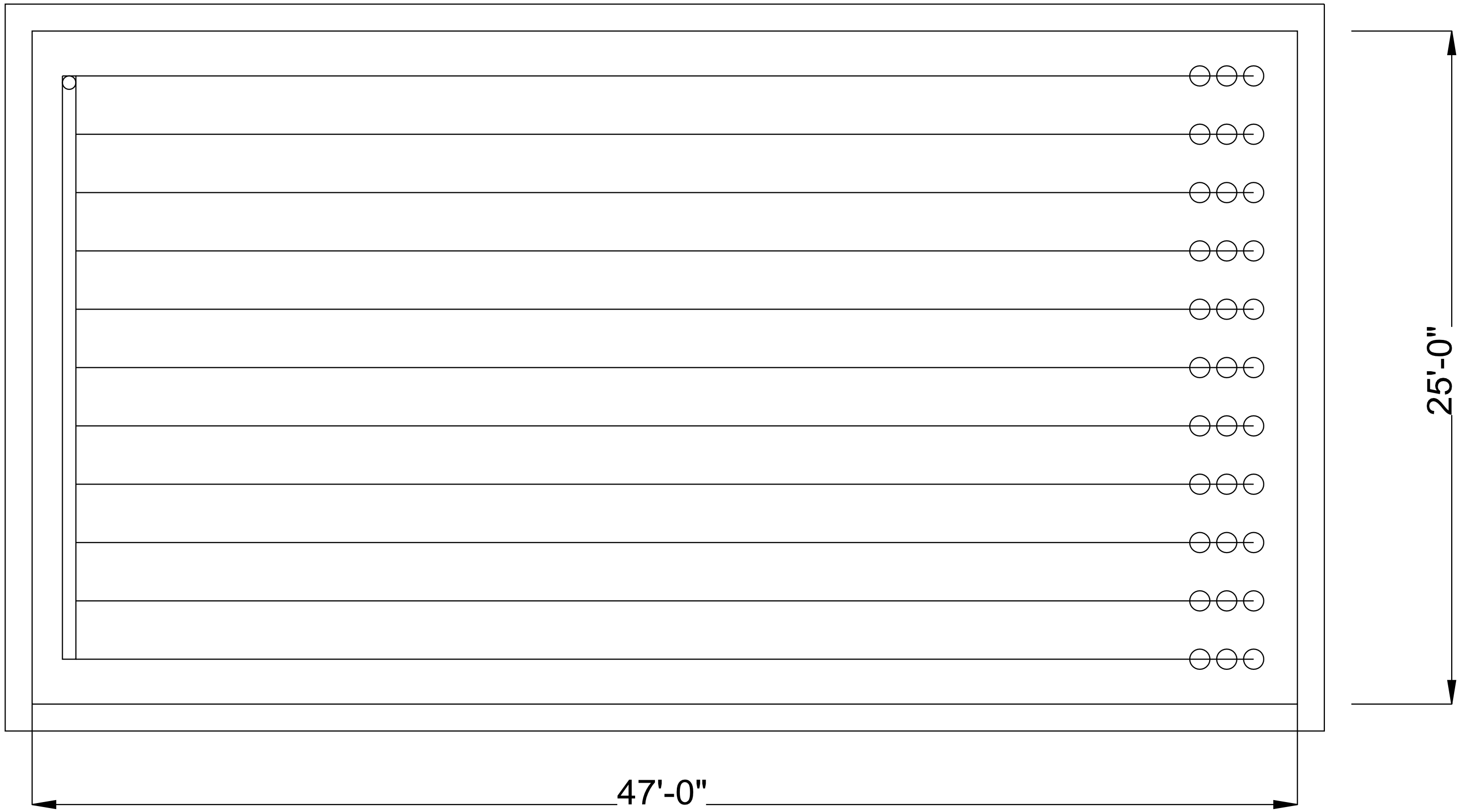
Parameter	Units	Zone 1	Totals/Overall
Diffuser Type		SSII-9	
Alpha			
Beta			
Theta			
D.O.	mg/l		
Water Temp	°C	20	
AOR/SOR			
Oxygen Distribution	%/Zone	100.0%	100.0%
AOR	lb/day		
SOR	lb/day		
Air Rate (7)	scfm	1,598.0	1,598.0

Performance

Parameter	Units	Zone 1	Totals/Overall
Mixing Criteria	scfm/ft²	0.12	
Safety Factor	%		
Mixing Air (8)	scfm	282.0	
Process Air (for SOR)	scfm	1,598.0	
Design Air (1,7)	scfm	1,598.0	1,598.0
Diffuser Air Rate	scfm/Diff.	1.73	1.73
Delivered SOR	lb/day	13,287.5	13,287.5
Delivered SOTE	%	33.2%	33.2%
Pressure @ Top of Dropleg	psig	7.73	7.73
Shaft Power	Bhp	67.7	67.7

Notes:

(1) Design air is the maximum of process air or mixing air
(2) Delivered oxygen based on design air
(3) Brake Horsepower based on adiabatic compression, 70% mechanical efficiency and 0.30 psi lineloss
(4) Performance based on diffuser density (At/Ad), submergence, and diffuser unit air flow.
(5) Diffuser Air Flow based on Active Valve Modulation
(6) Blower Pressure Capability also requires consideration of:
A. The Air Main headloss (piping, fittings, valves, instrumentation, etc.) between the blower and the aeration assembly dropleg connections.
B. Potential for increased headloss resulting from diffuser fouling and/or aging.
Please refer to the US EPA Fine Pore Design Manual (EPA/625/1-89/023), WEF Manual of Practice FD-13, and other technical publications for a detailed discussion on this subject. Note that this headloss consideration relates to all Fine Pore systems regardless of supplier or type of diffuser element.
C. Increased diffuser submergence during Peak Flow conditions.
(7) Air Flow defined at 20°C
(8) Fine Mixing air based on MOP/8 0.12 scfm/ft²



Single Train Information

Grid No	Grid Count	Drop Leg Ø"	Header Count	Header Spc,ft.	Header Len,ft.	Discs/ Grid	At/ Ad	Discs/ Train
1	1	6	11	2.17	44.25	462	6.20	462

Total Discs/Train 462

Note: Some headers may be omitted for clarity

PRELIMINARY - THIS DRAWING IS NOT INTENDED FOR CONTRACT DOCUMENTS, SUBMITTALS OR CONSTRUCTION

Sanitaire a xylem brand BROWN DEER, WISCONSIN 53223	CUST NO.		Exeter WWTP 9" Disc Aeration System	DRAWN BY IM	DATE 7/30/15	MODEL	JOB 23739-13s
	DWG NO.			CHKD BY	DATE		SHEET
				APPVD BY	DATE		

Project:	Exeter NH WWTF
Job No.	12883B
Date:	8/26/2015
Time:	
Calcs by:	MAC
Checked by:	
File:	
Comments:	SST Blowers
Scenario:	Summer - Max Depth

Air Piping
Headloss Determination

Node: Summary
Reach:
Description: Peak Day Warm Weather, 90F, 90% RH

Conditions:

	Atmospheric	Standard
Elev. Above Sea (ft)	8.0	
Pressure	14.70	14.7
Pa w/ Storm	14.41	N/A
Relative humidity	90%	36%
Temperature (C)	32	20
Dewpoint (C)	30	4
Vapor Pressure (psi)	0.63	0.12

Depth (ft)	16	Total Depth - Height of Diffusers
Depth (psi)	6.7	
Additional Headloss (psi)	0	--> air control valve/flow meter (confirm headloss with Instrumentation)
Headloss thru Dropleg	0	--> confirm with aeration system manf
Headloss thru Manifold	0	--> confirm with aeration system manf
Headloss thru Distributor	0	--> confirm with aeration system manf
Headloss thru Diffuser	0.54	--> Max Headloss per Sanitaire, 7/30/2015
Ambient Temperature (deg F)	90	Summer Temp
Flow Increment (scfm)	30	
Blower Efficiency (%)	70%	
Discharge Pressure (psi)	9.50	Includes max backpressure + ~1.5 PSI safety factor

System Summary

Standard Air Flow (scfm)	Actual Air Flow (acfm)	System Head Loss (in)	System Head Loss (psi)	Combined Static Head Loss (psi)	Head Loss (psi)	Inlet Air Flow (icfm)	2 Blowers Inlet Air Flow (icfm)
0	0	#DIV/0!	#DIV/0!	7.26	#DIV/0!	0	0
30	32	0.01	0.00	7.26	7.26	32	64
60	64	0.03	0.00	7.26	7.26	64	128
90	96	0.06	0.00	7.26	7.26	96	191
120	128	0.10	0.00	7.26	7.26	128	255
150	159	0.16	0.01	7.26	7.26	159	319
180	191	0.22	0.01	7.26	7.27	191	383
210	223	0.30	0.01	7.26	7.27	223	447
240	255	0.38	0.01	7.26	7.27	255	510
270	287	0.48	0.02	7.26	7.28	287	574
300	319	0.59	0.02	7.26	7.28	319	638
330	351	0.71	0.03	7.26	7.28	351	702
360	383	0.84	0.03	7.26	7.29	383	766
390	415	0.98	0.04	7.26	7.29	415	829
420	447	1.13	0.04	7.26	7.30	447	893
450	478	1.29	0.05	7.26	7.31	478	957
480	510	1.46	0.05	7.26	7.31	510	1021
510	542	1.64	0.06	7.26	7.32	542	1085

540	574	1.83	0.07	7.26	7.33	574	1148
570	606	2.03	0.07	7.26	7.33	606	1212
600	638	2.24	0.08	7.26	7.34	638	1276
630	670	2.46	0.09	7.26	7.35	670	1340
660	702	2.68	0.10	7.26	7.36	702	1403
690	734	2.92	0.11	7.26	7.36	734	1467
720	766	3.16	0.11	7.26	7.37	766	1531
750	797	3.42	0.12	7.26	7.38	797	1595
780	829	3.68	0.13	7.26	7.39	829	1659
810	861	3.96	0.14	7.26	7.40	861	1722
840	893	4.24	0.15	7.26	7.41	893	1786
870	925	4.53	0.16	7.26	7.42	925	1850
900	957	4.84	0.17	7.26	7.43	957	1914
930	989	5.15	0.19	7.26	7.45	989	1978
960	1021	5.47	0.20	7.26	7.46	1021	2041
990	1053	5.81	0.21	7.26	7.47	1053	2105
1020	1085	6.15	0.22	7.26	7.48	1085	2169
1050	1116	6.50	0.23	7.26	7.49	1116	2233
1080	1148	6.86	0.25	7.26	7.51	1148	2297
1110	1180	7.23	0.26	7.26	7.52	1180	2360
1140	1212	7.62	0.28	7.26	7.53	1212	2424
1170	1244	8.01	0.29	7.26	7.55	1244	2488
1200	1276	8.41	0.30	7.26	7.56	1276	2552
1230	1308	8.82	0.32	7.26	7.58	1308	2616
1260	1340	9.24	0.33	7.26	7.59	1340	2679
1290	1372	9.67	0.35	7.26	7.61	1372	2743
1320	1403	10.10	0.37	7.26	7.62	[illegible]	[illegible]
1350	1435	10.55	0.38	7.26	7.64	[illegible]	[illegible]
1380	1467	11.01	0.40	7.26	7.66	1467	2935
1410	1499	11.48	0.41	7.26	7.67	1499	2998
1440	1531	11.96	0.43	7.26	7.69	1531	3062
1470	1563	12.44	0.45	7.26	7.71	1563	3126
1500	1595	12.94	0.47	7.26	7.73	1595	3190
1530	1627	13.45	0.49	7.26	7.74	1627	3254
1560	1659	13.96	0.50	7.26	7.76	1659	3317
1590	1691	14.49	0.52	7.26	[illegible]	1691	3381
1620	1722	15.02	0.54	7.26	7.80	1722	3445
1650	1754	15.57	0.56	7.26	7.82	1754	3509
1680	1786	16.12	0.58	7.26	7.84	1786	3573
1710	1818	16.68	0.60	7.26	7.86	1818	3636
1740	1850	17.26	0.62	7.26	7.88	1850	3700
1770	1882	17.84	0.64	7.26	7.90	1882	3764
1800	1914	18.43	0.67	7.26	7.93	1914	3828
1830	1946	19.03	0.69	7.26	7.95	1946	3892
1860	1978	19.64	0.71	7.26	7.97	1978	3955
1890	2010	20.26	0.73	7.26	7.99	2010	4019
1920	2041	20.89	0.75	7.26	8.01	2041	4083
1950	2073	21.53	0.78	7.26	8.04	2073	4147
1980	2105	22.18	0.80	7.26	8.06	2105	4210
2010	2137	22.84	0.83	7.26	8.08	2137	4274
2040	2169	23.51	0.85	7.26	8.11	2169	4338
2070	2201	24.18	0.87	7.26	8.13	2201	4402
2100	2233	24.87	0.90	7.26	8.16	2233	4466
2130	2265	25.57	0.92	7.26	8.18	2265	4529
2160	2297	26.27	0.95	7.26	8.21	2297	4593
2190	2329	26.99	0.97	7.26	8.23	2329	4657
2220	2360	27.71	1.00	7.26	8.26	2360	4721

Used for design + 1.5 PSI

Project:	Exeter NH WWTF
Job No.	12883B
Date:	8/26/2015
Time:	
Calcs by:	MAC
Checked by:	
Comments:	SST Blowers
Scenario:	Summer - Max Depth

SUCTION/ INLET PIPING

Node 1

Location:	Inlet
Diameter (in.):	6
Length (ft.):	35
% Flow:	100%
Discharge Pressure:	0

Fitting	Quantity	K Value	Total
Entrance	1	0.5	0.5
Exit		1	0
90 Deg elbow	2	0.3	0.6
45 Deg Bend	2	0.2	0.4
Reducer/Increaser		0.2	0
But Valve		0.2	0
Check Valve		2	0
Tee Run	1	0.6	0.6
Tee Branch		1.8	0
Misc. "k"		10	0
		Total	**2.1**

Node 2

Location:	Inlet
Diameter (in.):	8
Length (ft.):	10
% Flow:	50%
Discharge Pressure:	0

Fitting	Quantity	K Value	Total
Entrance		0.5	0
Exit		1	0
90 Deg ell		0.3	0
45 Deg Bend		0.2	0
Reducer/Increaser	1	0.2	0.2
But Valve		0.2	0
Check Valve		2	0
Tee Run	1	0.6	0.6
Tee Branch		1.8	0
Misc. "k"		10	0
		Total	**0.8**

DISCHARGE/ OUTLET PIPING

Node 3

Location:	Outlet
Diameter (in.):	6
Length (ft.):	3
% Flow:	50%
Discharge Pressure:	9.5

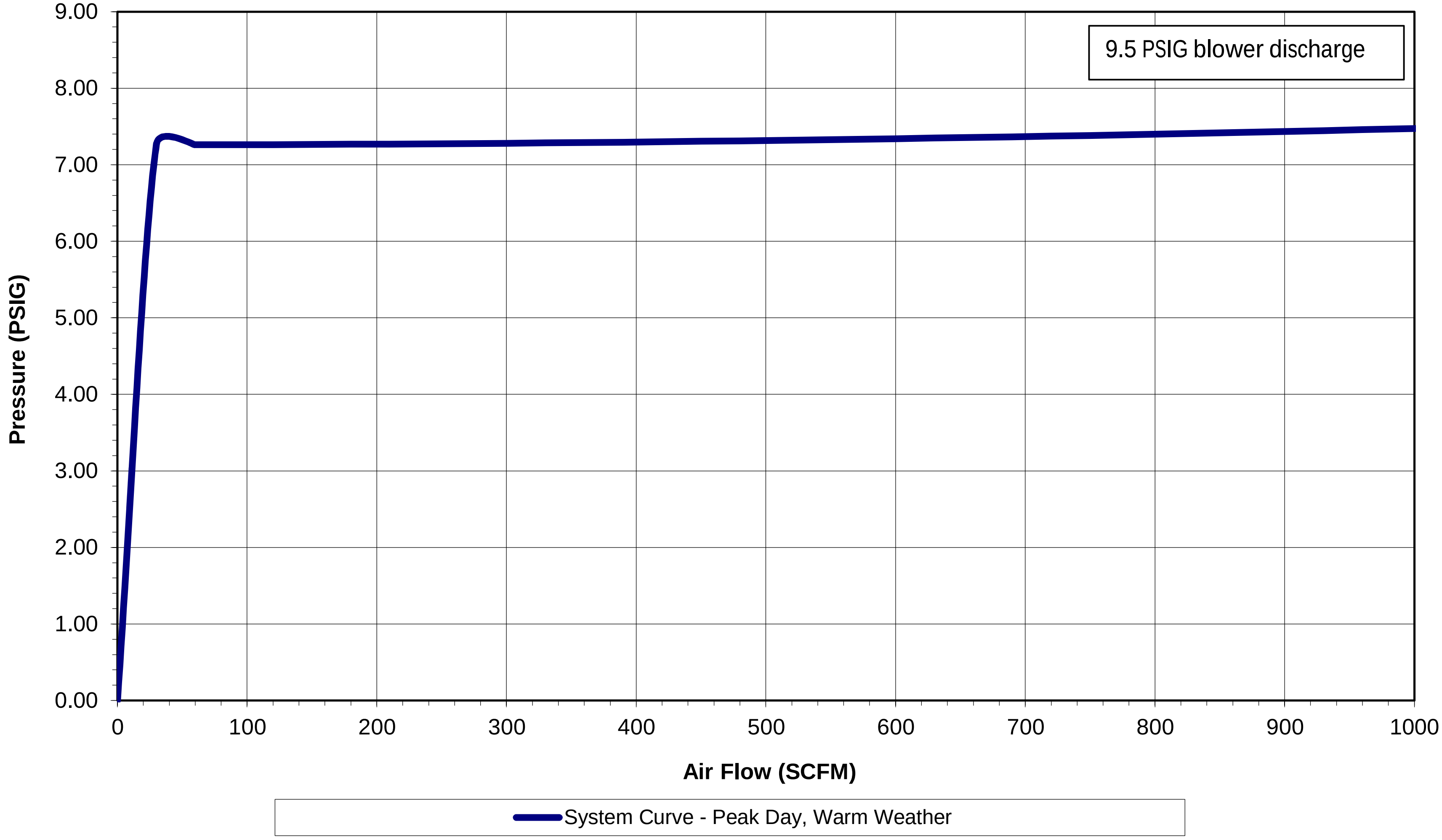
Fitting	Quantity	K Value	Total
Entrance		0.5	0
Exit		1	0
90 Deg ell		0.3	0
45 Deg Bend		0.2	0
Reducer/Increaser	1	0.2	0.2
But Valve		0.2	0
Check Valve		2	0
Tee Run		0.6	0
Tee Branch		1.8	0
Misc. "k"		10	0
		Total	**0.2**

Node 4

Location:	Outlet
Diameter (in.):	8
Length (ft.):	60
% Flow:	50%
Discharge Pressure:	9.5

Fitting	Quantity	K Value	Total
Entrance		0.5	0
Exit		1	0
90 Deg ell		0.3	0
45 Deg Bend		0.2	0
Reducer/Increaser		0.2	0
But Valve	1	0.2	0.2
Check Valve		2	0
Tee Run	1	0.6	0.6
Tee Branch		1.8	0
Misc. "k"		10	0
		Total	**0.8**

Sludge Storage Aeration System Curve



Project:	Exeter NH WWTF
Job No.	12883B
Date:	8/26/2015
Time:	0
Calcs by:	MAC
Checked by:	0
File:	0
Comments:	SST Blowers
Scenario:	Summer - Max Depth

Air Piping - Headloss Determination

Node: 1
Reach: Blower Discharge to Reducer
Description:
% of Flow: 100%

Conditions:

	Actual	Standard
Pressure	14.70	14.7
Pa w/ Storm	14.41	N/A
Relative humidity	90%	36%
Temperature (C)	32	20
Vapor Pressure (psi)	0.6287	0.117991

Blower Efficiency: 70%
Discharge Pressure: 0.00 lbf / in^2
no pressure change prior to compression

References from Summary and/or Losses Tabs

Actual Air Flow (acfm)	Diameter (ft)	Diameter (in)	Atmospheric Pressure PSIA	Actual Pressure PSIA	Temp1 @ ambient (F)	Temp2 @ blower (F)	Viscosity (centipose)	Re	e/D	Fo	F	Air Velocity (ft/min)	Velocity Head (in)	Length (ft)	Total K - value	Minor Head Loss (in)	Major Head loss (in)	Total Head Loss (in)	Total Head Loss (psi)
0	0.50	6	14.70	#DIV/0!	90	90	0.0186	0	0.00	#DIV/0!	#DIV/0!	0.00	0.0000	35	2.10	0.00000	#DIV/0!	#DIV/0!	#DIV/0!
32	0.50	6	14.70	14.70	90	90	0.0186	8114	0.00	0.0329	0.0327	162.54	0.0016	35	2.10	0.00334	0.00363	0.00697	0.00025
64	0.50	6	14.70	14.70	90	90	0.0186	16227	0.00	0.0273	0.0273	325.07	0.0064	35	2.10	0.01335	0.01214	0.02549	0.00092
96	0.50	6	14.70	14.69	90	90	0.0186	24341	0.00	0.0246	0.0247	487.61	0.0143	35	2.10	0.03003	0.02475	0.05478	0.00198
128	0.50	6	14.70	14.69	90	90	0.0186	32454	0.00	0.0230	0.0231	650.14	0.0254	35	2.10	0.05338	0.04113	0.09452	0.00341
159	0.50	6	14.70	14.69	90	90	0.0186	40568	0.00	0.0218	0.0220	812.68	0.0397	35	2.10	0.08341	0.06108	0.14449	0.00522
191	0.50	6	14.70	14.69	90	90	0.0186	48681	0.00	0.0210	0.0211	975.22	0.0572	35	2.10	0.12011	0.08444	0.20456	0.00739
223	0.50	6	14.70	14.69	90	90	0.0186	56795	0.00	0.0203	0.0204	1137.75	0.0779	35	2.10	0.16349	0.11111	0.27460	0.00992
255	0.50	6	14.70	14.68	90	90	0.0186	64908	0.00	0.0197	0.0198	1300.29	0.1017	35	2.10	0.21353	0.14100	0.35453	0.01281
287	0.50	6	14.70	14.68	90	90	0.0186	73022	0.00	0.0192	0.0193	1462.83	0.1287	35	2.10	0.27025	0.17402	0.44428	0.01605
319	0.50	6	14.70	14.68	90	90	0.0186	81135	0.00	0.0188	0.0189	1625.36	0.1589	35	2.10	0.33365	0.21013	0.54377	0.01964
351	0.50	6	14.70	14.67	90	90	0.0186	89249	0.00	0.0184	0.0185	1787.90	0.1922	35	2.10	0.40371	0.24925	0.65296	0.02359
383	0.50	6	14.70	14.67	90	90	0.0186	97362	0.00	0.0181	0.0182	1950.43	0.2288	35	2.10	0.48045	0.29135	0.77180	0.02788
415	0.50	6	14.70	14.66	90	90	0.0186	105476	0.00	0.0178	0.0179	2112.97	0.2685	35	2.10	0.56386	0.33638	0.90024	0.03252
447	0.50	6	14.70	14.66	90	90	0.0186	113589	0.00	0.0175	0.0176	2275.51	0.3114	35	2.10	0.65395	0.38430	1.03824	0.03751
478	0.50	6	14.70	14.65	90	90	0.0186	121703	0.00	0.0173	0.0174	2438.04	0.3575	35	2.10	0.75070	0.43508	1.18578	0.04284
510	0.50	6	14.70	14.65	90	90	0.0186	129816	0.00	0.0170	0.0172	2600.58	0.4067	35	2.10	0.85413	0.48868	1.34281	0.04851
542	0.50	6	14.70	14.64	90	90	0.0186	137930	0.00	0.0168	0.0170	2763.11	0.4592	35	2.10	0.96424	0.54508	1.50932	0.05452
574	0.50	6	14.70	14.64	90	90	0.0186	146043	0.00	0.0167	0.0168	2925.65	0.5148	35	2.10	1.08101	0.60425	1.68526	0.06088
606	0.50	6	14.70	14.63	90	90	0.0186	154157	0.00	0.0165	0.0166	3088.19	0.5736	35	2.10	1.20446	0.66617	1.87063	0.06758
638	0.50	6	14.70	14.62	90	90	0.0186	162270	0.00	0.0163	0.0164	3250.72	0.6355	35	2.10	1.33458	0.73080	2.06539	0.07461
670	0.50	6	14.70	14.61	90	90	0.0186	170384	0.00	0.0162	0.0163	3413.26	0.7007	35	2.10	1.47138	0.79814	2.26952	0.08199
702	0.50	6	14.70	14.61	90	90	0.0186	178497	0.00	0.0160	0.0161	3575.80	0.7690	35	2.10	1.61485	0.86816	2.48300	0.08970
734	0.50	6	14.70	14.60	90	90	0.0186	186611	0.00	0.0159	0.0160	3738.33	0.8405	35	2.10	1.76499	0.94084	2.70582	0.09775
766	0.50	6	14.70	14.59	90	90	0.0186	194724	0.00	0.0158	0.0159	3900.87	0.9151	35	2.10	1.92180	1.01616	2.93796	0.10613
797	0.50	6	14.70	14.58	90	90	0.0186	202838	0.00	0.0156	0.0157	4063.40	0.9930	35	2.10	2.08529	1.09411	3.17940	0.11486
829	0.50	6	14.70	14.57	90	90	0.0186	210951	0.00	0.0155	0.0156	4225.94	1.0740	35	2.10	2.25545	1.17467	3.43012	0.12391
861	0.50	6	14.70	14.56	90	90	0.0186	219065	0.00	0.0154	0.0155	4388.48	1.1582	35	2.10	2.43228	1.25783	3.69011	0.13331
893	0.50	6	14.70	14.55	90	90	0.0186	227178	0.00	0.0153	0.0154	4551.01	1.2456	35	2.10	2.61578	1.34357	3.95935	0.14303
925	0.50	6	14.70	14.54	90	90	0.0186	235292	0.00	0.0152	0.0153	4713.55	1.3362	35	2.10	2.80596	1.43187	4.23783	0.15309
957	0.50	6	14.70	14.53	90	90	0.0186	243405	0.00	0.0151	0.0152	4876.08	1.4299	35	2.10	3.00281	1.52273	4.52555	0.16349
989	0.50	6	14.70	14.52	90	90	0.0186	251519	0.00	0.0150	0.0151	5038.62	1.5268	35	2.10	3.20634	1.61614	4.82248	0.17421
1021	0.50	6	14.70	14.51	90	90	0.0186	259632	0.00	0.0150	0.0150	5201.16	1.6269	35	2.10	3.41653	1.71207	5.12861	0.18527
1053	0.50	6	14.70	14.50	90	90	0.0186	267746	0.00	0.0149	0.0149	5363.69	1.7302	35	2.10	3.63340	1.81053	5.44393	0.19666
1085	0.50	6	14.70	14.49	90	90	0.0186	275859	0.00	0.0148	0.0149	5526.23	1.8366	35	2.10	3.85695	1.91149	5.76844	0.20838
1116	0.50	6	14.70	14.48	90	90	0.0186	283973	0.00	0.0147	0.0148	5688.77	1.9463	35	2.10	4.08716	2.01495	6.10211	0.22044
1148	0.50	6	14.70	14.46	90	90	0.0186	292086	0.00	0.0146	0.0147	5851.30	2.0591	35	2.10	4.32405	2.12090	6.44495	0.23282
1180	0.50	6	14.70	14.45	90	90	0.0186	300200	0.00	0.0146	0.0146	6013.84	2.1751	35	2.10	4.56761	2.22933	6.79694	0.24554
1212	0.50	6	14.70	14.44	90	90	0.0186	308313	0.00	0.0145	0.0146	6176.37	2.2942	35	2.10	4.81785	2.34023	7.15807	0.25859
1244	0.50	6	14.70	14.42	90	90	0.0186	316427	0.00	0.0144	0.0145	6338.91	2.4166	35	2.10	5.07476	2.45358	7.52834	0.27196
1276	0.50	6	14.70	14.41	90	90	0.0186	324540	0.00	0.0144	0.0144	6501.45	2.5421	35	2.10	5.33834	2.56939	7.90773	0.28567
1308	0.50	6	14.70	14.40	90	90	0.0186	332654	0.00	0.0143	0.0144	6663.98	2.6708	35	2.10	5.60859	2.68764	8.29623	0.29970
1340	0.50	6	14.70	14.38	90	90	0.0186	340767	0.00	0.0142	0.0143	6826.52	2.8026	35	2.10	5.88551	2.80833	8.69385	0.31407
1372	0.50	6	14.70	14.37	90	90	0.0186	348881	0.00	0.0142	0.0143	6989.05	2.9377	35	2.10	6.16911	2.93145	9.10056	0.32876
1403	0.50	6	14.70	14.35	90	90	0.0186	356994	0.00	0.0141	0.0142	7151.59	3.0759	35	2.10	6.45939	3.05698	9.51637	0.34378
1435	0.50	6	14.70	14.34	90	90	0.0186	365108	0.00	0.0141	0.0141	7314.13	3.2173	35	2.10	6.75633	3.18493	9.94126	0.35913
1467	0.50	6	14.70	14.32	90	90	0.0186	373221	0.00	0.0140	0.0141	7476.66	3.3619	35	2.10	7.05995	3.31528	10.37523	0.37481
1499	0.50	6	14.70	14.31	90	90	0.0186	381335	0.00	0.0140	0.0140	7639.20	3.5096	35	2.10	7.37024	3.44803	10.81827	0.39081
1531	0.50	6	14.70	14.29	90	90	0.0186	389448	0.00	0.0139	0.0140	7801.74	3.6606	35	2.10	7.68720	3.58318	11.27038	0.40714
1563	0.50	6	14.70	14.27	90	90	0.0186	397562	0.00	0.0139	0.0139	7964.27	3.8147	35	2.10	8.01084	3.72071	11.73155	0.42380
1595	0.50	6	14.70	14.26	90	90	0.0186	405675	0.00	0.0138	0.0139	8126.81	3.9720	35	2.10	8.34115	3.86061	12.20176	0.44079
1627	0.50	6	14.70	14.24	90	90	0.0186	413789	0.00	0.0138	0.0138	8289.34	4.1324	35	2.10	8.67813	4.00290	12.68103	0.45810
1659	0.50	6	14.70	14.22	90	90	0.0186	421902	0.00	0.0137	0.0138	8451.88	4.2961	35	2.10	9.02179	4.14754	13.16933	0.47574
1691	0.50	6	14.70	14.20	90	90	0.0186	430016	0.00	0.0137	0.0137	8614.42	4.4629	35	2.10	9.37212	4.29456	13.66667	0.49371
1722	0.50	6	14.70	14.18	90	90	0.0186	438129	0.00	0.0137	0.0137	8776.95	4.6329	35	2.10	9.72912	4.44392	14.17304	0.51200
1754	0.50	6	14.70	14.17	90	90	0.0186	446243	0.00	0.0136	0.0137	8939.49	4.8061	35	2.10	10.09279	4.59564	14.68843	0.53062
1786	0.50	6	14.70	14.15	90	90	0.0186	454356	0.00	0.0136	0.0136	9102.02	4.9824	35	2.10	10.46314	4.74970	15.21284	0.54956
1818	0.50	6	14.70	14.13	90	90	0.0186	462470	0.00	0.0135	0.0136	9264.56	5.1620	35	2.10	10.84016	4.90610	15.74626	0.56883
1850	0.50	6	14.70	14.11	90	90	0.0186	470583	0.00	0.0135	0.0135	9427.10	5.3447	35	2.10	11.22385	5.06484	16.28869	0.58843
1882	0.50	6	14.70	14.09	90	90	0.0186	478697	0.00	0.0135	0.0135	9589.63	5.5306	35	2.10	11.61422	5.22591	16.84012	0.60835
1914	0.50	6	14.70	14.07	90	90	0.0186	486810	0.00	0.0134	0.0135	9752.17	5.7196	35	2.10	12.01125	5.38930	17.40055	0.62859
1946	0.50	6	14.70	14.05	90	90	0.0186	494924	0.00	0.0134	0.0134	9914.71	5.9119	35	2.10	12.41497	5.55501	17.96998	0.64917
1978	0.50	6	14.70	14.03	90	90	0.0186	503037	0.00	0.0133	0.0134	10077.24	6.1073	35	2.10	12.82535	5.72304	18.54839	0.67006
2010	0.50	6	14.70	14.00	90	90	0.0186	511151	0.00	0.0133	0.0134	10239.78	6.3059	35	2.10	13.24241	5.89338	19.13579	0.69128
2041	0.50	6	14.70	13.98	90	90	0.0186	519264	0.00	0.0133	0.0133	10402.31	6.5077	35	2.10	13.66614	6.06602	19.73216	0.71282
2073	0.50	6	14.70	13.96	90	90	0.0186	527378	0.00	0.0132	0.0133	10564.85	6.7126	35	2.10	14.09654	6.24097	20.33751	0.73469
2105	0.50	6	14.70	13.94	90	90	0.0186	535491	0.00	0.0132	0.0132	10727.39	6.9208	35	2.10	14.53362	6.41822	20.95184	0.75689
2137	0.50	6	14.70	13.92	90	90	0.0186	543605	0.00	0.0132	0.0132	10889.92	7.1321	35	2.10	14.97737	6.59776	21.57513	0.77940
2169	0.50	6	14.70	13.89	90	90	0.0186	551718	0.00	0.0131	0.0132	11052.46	7.3466	35	2.10	15.42779	6.77959	22.20738	0.80224
2201	0.50	6	14.70	13.87	90	90	0.0186	559832	0.00	0.0131	0.0132	11214.99	7.5642	35	2.10	15.88488	6.96371	22.84860	0.82541
2233	0.50	6	14.70	13.85	90	90	0.0186	567945	0.00	0.0131	0.0131	11377.53	7.7851	35	2.10	16.34865	7.15011	23.49876	0.84889
2265	0.50	6	14.70	13.82	90	90	0.0186	576059	0.00	0.0131	0.0131	11540.07	8.0091	35	2.10	16.81909	7.33879	24.15789	0.87270
2297	0.50	6	14.70	13.80	90	90	0.0186	584172	0.00	0.0130	0.0131	11702.60	8.2363	35	2.10	17.29621	7.52975	24.82595	0.89684
2329	0.50	6	14.70	13.77	90	90	0.0186	592286	0.00	0.0130	0.0130	11865.14	8.4667	35	2.10	17.77999	7.72297	25.50297	0.92129
2360	0.50	6	14.70	13.75	90	90	0.0186	600399	0.00	0.0130	0.0130	12027.68	8.7002	35	2.10	18.27045	7.91847	26.18892	0.94607

Project:	Exeter NH WWTF
Job No.	12883B
Date:	42242
Time:	0
Calcs by:	MAC
Checked by:	0
File:	0
Comments:	SST Blowers
Scenario:	Summer - Max Depth

Air Piping - Headloss Determination

Node: 2

Reach: Tee to far Blower suction

Description:

% of Flow: 50%

Conditions:

	Actual	Standard
Pressure	14.70	14.7
Pa w/ Storm	14.41	N/A
Relative humidity	90%	36%
Temperature (C)	32	20
Vapor Pressure (psi)	0.6287	0.117991

Blower Efficiency: 70%

Discharge Pressure: 0.00 lbf / in^2

no pressure change prior to compression

References from Summary and/or Losses Tabs

Actual Air Flow (ft^3/min)	Diameter (ft)	Diameter (in)	Atmospheric Pressure PSIA	Actual Pressure PSIA	Temp1 @ ambien (F)	Temp2 @ blower (F)	Viscosity (centipose)	Re	e/D	Fo	F	Air Velocity (ft/min)	Velocity Head (in)	Length (ft)	Total K - value	Minor Head Loss (in)	Major Head loss (in)	Total Head Loss (in)	Total Head Loss (psi)
0	0.67	8	14.70	#DIV/0!	90	90	0.0186	0	0.00	#DIV/0!	#DIV/0!	0.00	0.0000	10	0.80	0.00000	#DIV/0!	#DIV/0!	#DIV/0!
16	0.67	8	14.70	14.70	90	90	0.0186	3043	0.00	0.0443	0.0432	45.71	0.0001	10	0.80	0.00010	0.00008	0.00018	0.00001
32	0.67	8	14.70	14.70	90	90	0.0186	6085	0.00	0.0357	0.0353	91.43	0.0005	10	0.80	0.00040	0.00027	0.00067	0.00002
48	0.67	8	14.70	14.70	90	90	0.0186	9128	0.00	0.0318	0.0316	137.14	0.0011	10	0.80	0.00090	0.00054	0.00144	0.00005
64	0.67	8	14.70	14.70	90	90	0.0186	12170	0.00	0.0294	0.0294	182.85	0.0020	10	0.80	0.00161	0.00089	0.00249	0.00009
80	0.67	8	14.70	14.70	90	90	0.0186	15213	0.00	0.0277	0.0277	228.57	0.0031	10	0.80	0.00251	0.00131	0.00382	0.00014
96	0.67	8	14.70	14.70	90	90	0.0186	18255	0.00	0.0264	0.0265	274.28	0.0045	10	0.80	0.00362	0.00180	0.00542	0.00020
112	0.67	8	14.70	14.70	90	90	0.0186	21298	0.00	0.0254	0.0255	319.99	0.0062	10	0.80	0.00493	0.00236	0.00728	0.00026
128	0.67	8	14.70	14.70	90	90	0.0186	24341	0.00	0.0246	0.0247	365.71	0.0080	10	0.80	0.00643	0.00298	0.00942	0.00034
144	0.67	8	14.70	14.70	90	90	0.0186	27383	0.00	0.0239	0.0240	411.42	0.0102	10	0.80	0.00814	0.00367	0.01181	0.00043
159	0.67	8	14.70	14.70	90	90	0.0186	30426	0.00	0.0233	0.0235	457.13	0.0126	10	0.80	0.01005	0.00442	0.01448	0.00052
175	0.67	8	14.70	14.70	90	90	0.0186	33468	0.00	0.0228	0.0229	502.85	0.0152	10	0.80	0.01217	0.00523	0.01740	0.00063
191	0.67	8	14.70	14.70	90	90	0.0186	36511	0.00	0.0224	0.0225	548.56	0.0181	10	0.80	0.01448	0.00610	0.02058	0.00074
207	0.67	8	14.70	14.70	90	90	0.0186	39553	0.00	0.0219	0.0221	594.27	0.0212	10	0.80	0.01699	0.00703	0.02403	0.00087
223	0.67	8	14.70	14.69	90	90	0.0186	42596	0.00	0.0216	0.0217	639.99	0.0246	10	0.80	0.01971	0.00802	0.02773	0.00100
239	0.67	8	14.70	14.69	90	90	0.0186	45638	0.00	0.0212	0.0214	685.70	0.0283	10	0.80	0.02262	0.00907	0.03169	0.00114
255	0.67	8	14.70	14.69	90	90	0.0186	48681	0.00	0.0209	0.0211	731.41	0.0322	10	0.80	0.02574	0.01017	0.03591	0.00130
271	0.67	8	14.70	14.69	90	90	0.0186	51724	0.00	0.0207	0.0208	777.13	0.0363	10	0.80	0.02906	0.01133	0.04039	0.00146
287	0.67	8	14.70	14.69	90	90	0.0186	54766	0.00	0.0204	0.0205	822.84	0.0407	10	0.80	0.03258	0.01254	0.04512	0.00163
303	0.67	8	14.70	14.69	90	90	0.0186	57809	0.00	0.0202	0.0203	868.55	0.0454	10	0.80	0.03630	0.01381	0.05011	0.00181
319	0.67	8	14.70	14.69	90	90	0.0186	60851	0.00	0.0199	0.0201	914.27	0.0503	10	0.80	0.04022	0.01513	0.05535	0.00200
335	0.67	8	14.70	14.69	90	90	0.0186	63894	0.00	0.0197	0.0199	959.98	0.0554	10	0.80	0.04434	0.01651	0.06085	0.00220
351	0.67	8	14.70	14.69	90	90	0.0186	66936	0.00	0.0195	0.0197	1005.69	0.0608	10	0.80	0.04866	0.01794	0.06660	0.00241
367	0.67	8	14.70	14.69	90	90	0.0186	69979	0.00	0.0193	0.0195	1051.41	0.0665	10	0.80	0.05319	0.01942	0.07261	0.00262
383	0.67	8	14.70	14.69	90	90	0.0186	73022	0.00	0.0192	0.0193	1097.12	0.0724	10	0.80	0.05791	0.02096	0.07887	0.00285
399	0.67	8	14.70	14.69	90	90	0.0186	76064	0.00	0.0190	0.0191	1142.83	0.0785	10	0.80	0.06284	0.02254	0.08538	0.00308
415	0.67	8	14.70	14.69	90	90	0.0186	79107	0.00	0.0188	0.0190	1188.55	0.0850	10	0.80	0.06797	0.02418	0.09215	0.00333
431	0.67	8	14.70	14.69	90	90	0.0186	82149	0.00	0.0187	0.0188	1234.26	0.0916	10	0.80	0.07329	0.02587	0.09916	0.00358
447	0.67	8	14.70	14.69	90	90	0.0186	85192	0.00	0.0185	0.0187	1279.97	0.0985	10	0.80	0.07882	0.02761	0.10643	0.00384
463	0.67	8	14.70	14.69	90	90	0.0186	88234	0.00	0.0184	0.0185	1325.69	0.1057	10	0.80	0.08455	0.02940	0.11396	0.00412
478	0.67	8	14.70	14.69	90	90	0.0186	91277	0.00	0.0183	0.0184	1371.40	0.1131	10	0.80	0.09049	0.03124	0.12173	0.00440
494	0.67	8	14.70	14.69	90	90	0.0186	94319	0.00	0.0182	0.0183	1417.11	0.1208	10	0.80	0.09662	0.03314	0.12975	0.00469
510	0.67	8	14.70	14.69	90	90	0.0186	97362	0.00	0.0180	0.0182	1462.83	0.1287	10	0.80	0.10295	0.03508	0.13803	0.00499
526	0.67	8	14.70	14.69	90	90	0.0186	100405	0.00	0.0179	0.0181	1508.54	0.1369	10	0.80	0.10949	0.03707	0.14656	0.00529
542	0.67	8	14.70	14.69	90	90	0.0186	103447	0.00	0.0178	0.0179	1554.25	0.1453	10	0.80	0.11622	0.03911	0.15533	0.00561
558	0.67	8	14.70	14.69	90	90	0.0186	106490	0.00	0.0177	0.0178	1599.97	0.1540	10	0.80	0.12316	0.04120	0.16436	0.00594
574	0.67	8	14.70	14.69	90	90	0.0186	109532	0.00	0.0176	0.0177	1645.68	0.1629	10	0.80	0.13030	0.04333	0.17363	0.00627
590	0.67	8	14.70	14.69	90	90	0.0186	112575	0.00	0.0175	0.0176	1691.39	0.1721	10	0.80	0.13764	0.04552	0.18316	0.00662
606	0.67	8	14.70	14.69	90	90	0.0186	115617	0.00	0.0174	0.0175	1737.11	0.1815	10	0.80	0.14518	0.04775	0.19294	0.00697
622	0.67	8	14.70	14.69	90	90	0.0186	118660	0.00	0.0173	0.0175	1782.82	0.1912	10	0.80	0.15292	0.05004	0.20296	0.00733
638	0.67	8	14.70	14.69	90	90	0.0186	121703	0.00	0.0172	0.0174	1828.53	0.2011	10	0.80	0.16087	0.05237	0.21323	0.00770
654	0.67	8	14.70	14.69	90	90	0.0186	124745	0.00	0.0172	0.0173	1874.25	0.2113	10	0.80	0.16901	0.05475	0.22376	0.00808
670	0.67	8	14.70	14.69	90	90	0.0186	127788	0.00	0.0171	0.0172	1919.96	0.2217	10	0.80	0.17735	0.05717	0.23453	0.00847
686	0.67	8	14.70	14.69	90	90	0.0186	130830	0.00	0.0170	0.0171	1965.67	0.2324	10	0.80	0.18590	0.05965	0.24554	0.00887
702	0.67	8	14.70	14.69	90	90	0.0186	133873	0.00	0.0169	0.0170	2011.38	0.2433	10	0.80	0.19465	0.06217	0.25681	0.00928
718	0.67	8	14.70	14.69	90	90	0.0186	136915	0.00	0.0168	0.0170	2057.10	0.2545	10	0.80	0.20359	0.06473	0.26833	0.00969
734	0.67	8	14.70	14.69	90	90	0.0186	139958	0.00	0.0168	0.0169	2102.81	0.2659	10	0.80	0.21274	0.06735	0.28009	0.01012
750	0.67	8	14.70	14.69	90	90	0.0186	143000	0.00	0.0167	0.0168	2148.52	0.2776	10	0.80	0.22209	0.07001	0.29210	0.01055
766	0.67	8	14.70	14.69	90	90	0.0186	146043	0.00	0.0166	0.0167	2194.24	0.2896	10	0.80	0.23165	0.07271	0.30436	0.01100
781	0.67	8	14.70	14.68	90	90	0.0186	149086	0.00	0.0166	0.0167	2239.95	0.3017	10	0.80	0.24140	0.07547	0.31687	0.01145
797	0.67	8	14.70	14.68	90	90	0.0186	152128	0.00	0.0165	0.0166	2285.66	0.3142	10	0.80	0.25135	0.07827	0.32962	0.01191
813	0.67	8	14.70	14.68	90	90	0.0186	155171	0.00	0.0164	0.0165	2331.38	0.3269	10	0.80	0.26151	0.08111	0.34262	0.01238
829	0.67	8	14.70	14.68	90	90	0.0186	158213	0.00	0.0164	0.0165	2377.09	0.3398	10	0.80	0.27186	0.08400	0.35587	0.01286
845	0.67	8	14.70	14.68	90	90	0.0186	161256	0.00	0.0163	0.0164	2422.80	0.3530	10	0.80	0.28242	0.08694	0.36936	0.01334
861	0.67	8	14.70	14.68	90	90	0.0186	164298	0.00	0.0162	0.0164	2468.52	0.3665	10	0.80	0.29318	0.08992	0.38310	0.01384
877	0.67	8	14.70	14.68	90	90	0.0186	167341	0.00	0.0162	0.0163	2514.23	0.3802	10	0.80	0.30414	0.09295	0.39709	0.01434
893	0.67	8	14.70	14.68	90	90	0.0186	170384	0.00	0.0161	0.0162	2559.94	0.3941	10	0.80	0.31530	0.09603	0.41132	0.01486
909	0.67	8	14.70	14.68	90	90	0.0186	173426	0.00	0.0161	0.0162	2605.66	0.4083	10	0.80	0.32666	0.09915	0.42580	0.01538
925	0.67	8	14.70	14.68	90	90	0.0186	176469	0.00	0.0160	0.0161	2651.37	0.4228	10	0.80	0.33822	0.10231	0.44053	0.01591
941	0.67	8	14.70	14.68	90	90	0.0186	179511	0.00	0.0160	0.0161	2697.08	0.4375	10	0.80	0.34998	0.10552	0.45550	0.01645
957	0.67	8	14.70	14.68	90	90	0.0186	182554	0.00	0.0159	0.0160	2742.80	0.4524	10	0.80	0.36195	0.10877	0.47072	0.01700
973	0.67	8	14.70	14.68	90	90	0.0186	185596	0.00	0.0159	0.0160	2788.51	0.4676	10	0.80	0.37411	0.11207	0.48618	0.01756
989	0.67	8	14.70	14.68	90	90	0.0186	188639	0.00	0.0158	0.0159	2834.22	0.4831	10	0.80	0.38648	0.11541	0.50189	0.01813
1005	0.67	8	14.70	14.68	90	90	0.0186	191681	0.00	0.0158	0.0159	2879.94	0.4988	10	0.80	0.39905	0.11880	0.51785	0.01871
1021	0.67	8	14.70	14.68	90	90	0.0186	194724	0.00	0.0157	0.0158	2925.65	0.5148	10	0.80	0.41181	0.12223	0.53405	0.01929
1037	0.67	8	14.70	14.68	90	90	0.0186	197767	0.00	0.0157	0.0158	2971.36	0.5310	10	0.80	0.42478	0.12571	0.55049	0.01989
1053	0.67	8	14.70	14.68	90	90	0.0186	200809	0.00	0.0156	0.0157	3017.08	0.5474	10	0.80	0.43796	0.12923	0.56718	0.02049
1069	0.67	8	14.70	14.67	90	90	0.0186	203852	0.00	0.0156	0.0157	3062.79	0.5642	10	0.80	0.45133	0.13279	0.58412	0.02110
1085	0.67	8	14.70	14.67	90	90	0.0186	206894	0.00	0.0155	0.0156	3108.50	0.5811	10	0.80	0.46490	0.13640	0.60130	0.02172
1100	0.67	8	14.70	14.67	90	90	0.0186	209937	0.00	0.0155	0.0156	3154.22	0.5983	10	0.80	0.47867	0.14005	0.61873	0.02235
1116	0.67	8	14.70	14.67	90	90	0.0186	212979	0.00	0.0155	0.0156	3199.93	0.6158	10	0.80	0.49265	0.14375	0.63640	0.02299
1132	0.67	8	14.70	14.67	90	90	0.0186	216022	0.00	0.0154	0.0155	3245.64	0.6335	10	0.80	0.50683	0.14749	0.65431	0.02364
1148	0.67	8	14.70	14.67	90	90	0.0186	219065	0.00	0.0154	0.0155	3291.36	0.6515	10	0.80	0.52120	0.15127	0.67247	0.02429
1164	0.67	8	14.70	14.67	90	90	0.0186	222107	0.00	0.0153	0.0154	3337.07	0.6697	10	0.80	0.53578	0.15510	0.69088	0.02496
1180	0.67	8	14.70	14.67	90	90	0.0186	225150	0.00	0.0153	0.0154	3382.78	0.6882	10	0.80	0.55056	0.15897	0.70953	0.02563

Project:	Exeter NH WWTF
Job No.	12883B
Date:	8/26/2015
Time:	
Calcs by:	MAC
Checked by:	
File:	
Comments:	SST Blowers
Scenario:	Summer - Max Depth

Air Piping - Headloss Determination

Node: 3
Reach: Outlet to 6X8 reducer
Description:
% of Flow: 50%

Conditions:

References from Summary and/or Losses Tabs

	Actual	Standard
Pressure	14.70	14.7
Pa w/ Storm	14.41	N/A
Relative humidity	90%	36%
Temperature (C)	32	20
Vapor Pressure (psi)	0.6287	0.11799098

Blower Efficiency: 70%
Discharge Pressure: 9.50 lbf / in^2

Actual Air Flow (ft^3/min)	Diameter (ft)	Diameter (in)	Temp1 @ ambient (F)	Temp2 @ blower (F)	Viscosity (centipose)	Re	e/D	Fo	F	Air Velocity (ft/min)	Velocity Head (in)	Length (ft)	Total K - value	Minor Head Loss (in)	Major Head loss (in)	Total Head Loss (in)	Total Head Loss (psi)
0	0.50	6	90	209	0.0219	0	0.00	#DIV/0!	#DIV/0!	0.00	0.0000	3	0.20	0.00000	#DIV/0!	#DIV/0!	#DIV/0!
16	0.50	6	90	209	0.0219	3441	0.00	0.0426	0.0416	81.27	0.0005	3	0.20	0.00011	0.00013	0.00024	0.00001
32	0.50	6	90	209	0.0219	6881	0.00	0.0344	0.0342	162.54	0.0022	3	0.20	0.00043	0.00044	0.00087	0.00003
48	0.50	6	90	209	0.0219	10322	0.00	0.0307	0.0306	243.80	0.0048	3	0.20	0.00097	0.00089	0.00186	0.00007
64	0.50	6	90	209	0.0219	13763	0.00	0.0285	0.0285	325.07	0.0086	3	0.20	0.00172	0.00147	0.00319	0.00012
80	0.50	6	90	209	0.0219	17204	0.00	0.0269	0.0269	406.34	0.0134	3	0.20	0.00269	0.00217	0.00486	0.00018
96	0.50	6	90	209	0.0219	20644	0.00	0.0257	0.0257	487.61	0.0194	3	0.20	0.00387	0.00299	0.00686	0.00025
112	0.50	6	90	209	0.0219	24085	0.00	0.0247	0.0248	568.88	0.0263	3	0.20	0.00527	0.00392	0.00919	0.00033
128	0.50	6	90	209	0.0219	27526	0.00	0.0239	0.0240	650.14	0.0344	3	0.20	0.00688	0.00496	0.01184	0.00043
144	0.50	6	90	209	0.0219	30967	0.00	0.0232	0.0234	731.41	0.0435	3	0.20	0.00871	0.00611	0.01481	0.00054
159	0.50	6	90	209	0.0219	34407	0.00	0.0227	0.0228	812.68	0.0538	3	0.20	0.01075	0.00736	0.01811	0.00065
175	0.50	6	90	209	0.0219	37848	0.00	0.0222	0.0223	893.95	0.0650	3	0.20	0.01301	0.00871	0.02172	0.00078
191	0.50	6	90	209	0.0219	41289	0.00	0.0217	0.0219	975.22	0.0774	3	0.20	0.01548	0.01016	0.02565	0.00093
207	0.50	6	90	209	0.0219	44730	0.00	0.0214	0.0215	1056.49	0.0909	3	0.20	0.01817	0.01172	0.02989	0.00108
223	0.50	6	90	209	0.0219	48170	0.00	0.0210	0.0211	1137.75	0.1054	3	0.20	0.02107	0.01336	0.03444	0.00124
239	0.50	6	90	209	0.0219	51611	0.00	0.0207	0.0208	1219.02	0.1210	3	0.20	0.02419	0.01511	0.03930	0.00142
255	0.50	6	90	209	0.0219	55052	0.00	0.0204	0.0205	1300.29	0.1376	3	0.20	0.02752	0.01695	0.04447	0.00161
271	0.50	6	90	209	0.0219	58493	0.00	0.0201	0.0203	1381.56	0.1554	3	0.20	0.03107	0.01888	0.04996	0.00180
287	0.50	6	90	209	0.0219	61933	0.00	0.0199	0.0200	1462.83	0.1742	3	0.20	0.03483	0.02091	0.05575	0.00201
303	0.50	6	90	209	0.0219	65374	0.00	0.0196	0.0198	1544.09	0.1941	3	0.20	0.03881	0.02303	0.06184	0.00223
319	0.50	6	90	209	0.0219	68815	0.00	0.0194	0.0196	1625.36	0.2150	3	0.20	0.04301	0.02524	0.06825	0.00247
335	0.50	6	90	209	0.0219	72255	0.00	0.0192	0.0194	1706.63	0.2371	3	0.20	0.04741	0.02754	0.06825	0.00247
351	0.50	6	90	209	0.0219	75696	0.00	0.0190	0.0192	1787.90	0.2602	3	0.20	0.05204	0.02993	0.06825	0.00247
367	0.50	6	90	209	0.0219	79137	0.00	0.0189	0.0190	1869.17	0.2844	3	0.20	0.05688	0.03241	0.06825	0.00247
383	0.50	6	90	209	0.0219	82578	0.00	0.0187	0.0188	1950.43	0.3096	3	0.20	0.06193	0.03497	0.06825	0.00247
399	0.50	6	90	209	0.0219	86018	0.00	0.0185	0.0187	2031.70	0.3360	3	0.20	0.06720	0.03763	0.06825	0.00247
415	0.50	6	90	209	0.0219	89459	0.00	0.0184	0.0185	2112.97	0.3634	3	0.20	0.07268	0.04037	0.06825	0.00247
431	0.50	6	90	209	0.0219	92900	0.00	0.0182	0.0184	2194.24	0.3919	3	0.20	0.07838	0.04319	0.06825	0.00247
447	0.50	6	90	209	0.0219	96341	0.00	0.0181	0.0182	2275.51	0.4215	3	0.20	0.08429	0.04610	0.06825	0.00247
463	0.50	6	90	209	0.0219	99781	0.00	0.0180	0.0181	2356.77	0.4521	3	0.20	0.09042	0.04910	0.06825	0.00247
478	0.50	6	90	209	0.0219	103222	0.00	0.0178	0.0180	2438.04	0.4838	3	0.20	0.09676	0.05218	0.06825	0.00247
494	0.50	6	90	209	0.0219	106663	0.00	0.0177	0.0179	2519.31	0.5166	3	0.20	0.10332	0.05535	0.06825	0.00247
510	0.50	6	90	209	0.0219	110104	0.00	0.0176	0.0177	2600.58	0.5505	3	0.20	0.11010	0.05860	0.06825	0.00247
526	0.50	6	90	209	0.0219	113544	0.00	0.0175	0.0176	2681.85	0.5854	3	0.20	0.11708	0.06193	0.06825	0.00247
542	0.50	6	90	209	0.0219	116985	0.00	0.0174	0.0175	2763.11	0.6214	3	0.20	0.12429	0.06535	0.06825	0.00247
558	0.50	6	90	209	0.0219	120426	0.00	0.0173	0.0174	2844.38	0.6585	3	0.20	0.13171	0.06884	0.06825	0.00247
574	0.50	6	90	209	0.0219	123867	0.00	0.0172	0.0173	2925.65	0.6967	3	0.20	0.13934	0.07242	0.06825	0.00247
590	0.50	6	90	209	0.0219	127307	0.00	0.0171	0.0172	3006.92	0.7359	3	0.20	0.14719	0.07609	0.06825	0.00247
606	0.50	6	90	209	0.0219	130748	0.00	0.0170	0.0171	3088.19	0.7763	3	0.20	0.15525	0.07983	0.06825	0.00247
622	0.50	6	90	209	0.0219	134189	0.00	0.0169	0.0171	3169.46	0.8177	3	0.20	0.16353	0.08365	0.06825	0.00247
638	0.50	6	90	209	0.0219	137630	0.00	0.0169	0.0170	3250.72	0.8601	3	0.20	0.17202	0.08756	0.06825	0.00247
654	0.50	6	90	209	0.0219	141070	0.00	0.0168	0.0169	3331.99	0.9037	3	0.20	0.18073	0.09154	0.06825	0.00247
670	0.50	6	90	209	0.0219	144511	0.00	0.0167	0.0168	3413.26	0.9483	3	0.20	0.18966	0.09561	0.06825	0.00247
686	0.50	6	90	209	0.0219	147952	0.00	0.0166	0.0167	3494.53	0.9940	3	0.20	0.19880	0.09975	0.06825	0.00247
702	0.50	6	90	209	0.0219	151392	0.00	0.0165	0.0167	3575.80	1.0407	3	0.20	0.20815	0.10398	0.06825	0.00247
718	0.50	6	90	209	0.0219	154833	0.00	0.0165	0.0166	3657.06	1.0886	3	0.20	0.21772	0.10828	0.06825	0.00247
734	0.50	6	90	209	0.0219	158274	0.00	0.0164	0.0165	3738.33	1.1375	3	0.20	0.22750	0.11266	0.06825	0.00247
750	0.50	6	90	209	0.0219	161715	0.00	0.0163	0.0164	3819.60	1.1875	3	0.20	0.23750	0.11713	0.06825	0.00247
766	0.50	6	90	209	0.0219	165155	0.00	0.0163	0.0164	3900.87	1.2386	3	0.20	0.24772	0.12167	0.06825	0.00247
781	0.50	6	90	209	0.0219	168596	0.00	0.0162	0.0163	3982.14	1.2907	3	0.20	0.25814	0.12628	0.06825	0.00247
797	0.50	6	90	209	0.0219	172037	0.00	0.0161	0.0162	4063.40	1.3439	3	0.20	0.26879	0.13098	0.06825	0.00247
813	0.50	6	90	209	0.0219	175478	0.00	0.0161	0.0162	4144.67	1.3982	3	0.20	0.27965	0.13575	0.06825	0.00247
829	0.50	6	90	209	0.0219	178918	0.00	0.0160	0.0161	4225.94	1.4536	3	0.20	0.29072	0.14060	0.06825	0.00247
845	0.50	6	90	209	0.0219	182359	0.00	0.0160	0.0161	4307.21	1.5101	3	0.20	0.30201	0.14553	0.06825	0.00247
861	0.50	6	90	209	0.0219	185800	0.00	0.0159	0.0160	4388.48	1.5676	3	0.20	0.31351	0.15053	0.06825	0.00247
877	0.50	6	90	209	0.0219	189241	0.00	0.0158	0.0159	4469.74	1.6262	3	0.20	0.32523	0.15562	0.06825	0.00247
893	0.50	6	90	209	0.0219	192681	0.00	0.0158	0.0159	4551.01	1.6858	3	0.20	0.33717	0.16077	0.06825	0.00247
909	0.50	6	90	209	0.0219	196122	0.00	0.0157	0.0158	4632.28	1.7466	3	0.20	0.34932	0.16601	0.06825	0.00247
925	0.50	6	90	209	0.0219	199563	0.00	0.0157	0.0158	4713.55	1.8084	3	0.20	0.36168	0.17132	0.06825	0.00247
941	0.50	6	90	209	0.0219	203004	0.00	0.0156	0.0157	4794.82	1.8713	3	0.20	0.37426	0.17670	0.06825	0.00247
957	0.50	6	90	209	0.0219	206444	0.00	0.0156	0.0157	4876.08	1.9353	3	0.20	0.38705	0.18217	0.06825	0.00247
973	0.50	6	90	209	0.0219	209885	0.00	0.0155	0.0156	4957.35	2.0003	3	0.20	0.40006	0.18770	0.06825	0.00247

Project:	Exeter NH WWTF
Job No.	12883B
Date:	8/26/2015
Time:	
Calcs by:	MAC
Checked by:	
File:	
Comments:	SST Blowers
Scenario:	Summer - Max Depth

Air Piping - Headloss Determination

Node: 4
Reach: 6X8 reducer to top of diffuser drop leg
Description:
% of Flow: 50%

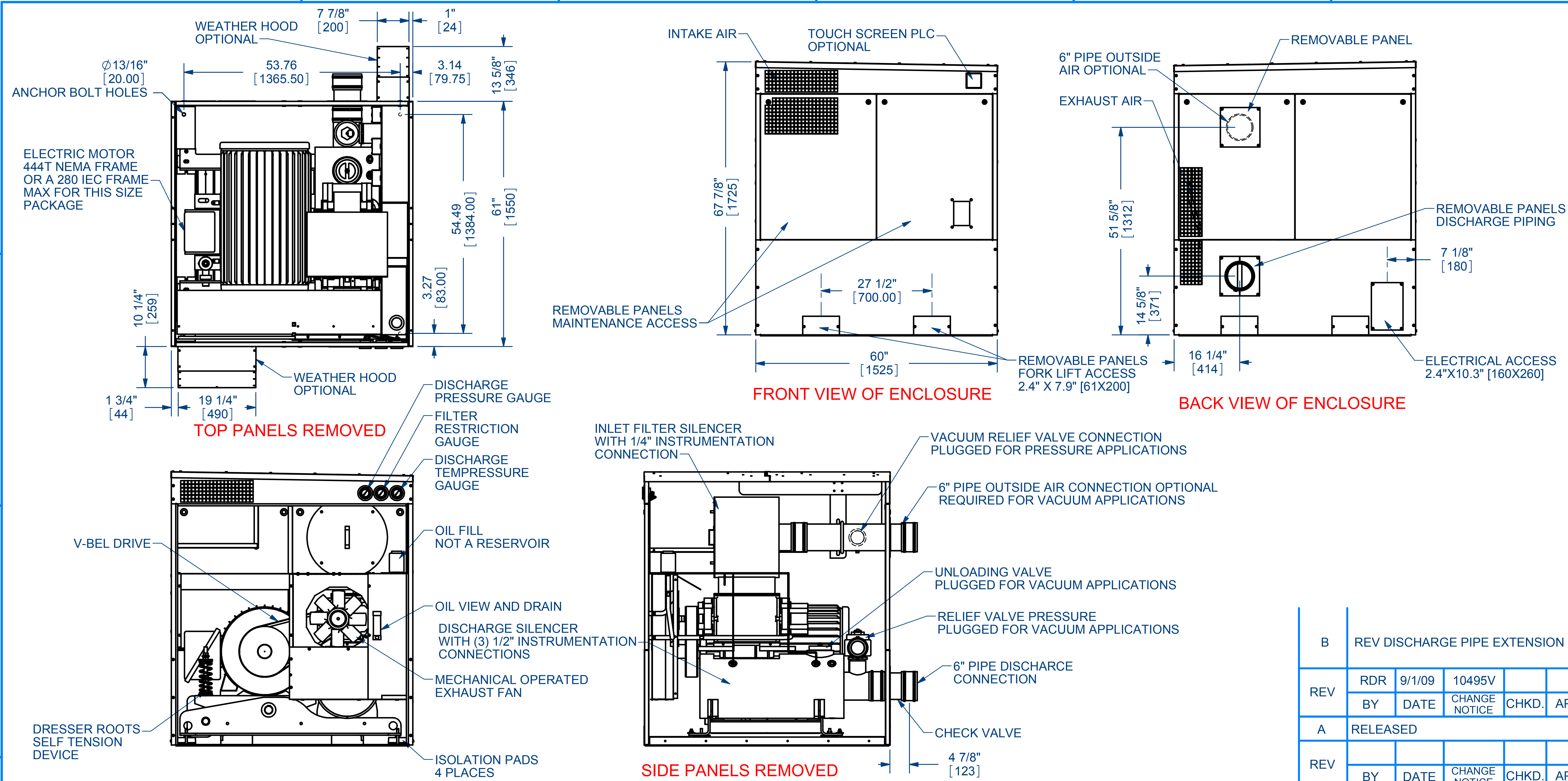
Conditions:

References from Summary and/or Losses Tabs

	Actual	Standard
Pressure	14.70	14.7
Pa w/ Storm	14.41	N/A
Relative humidity	90%	36%
Temperature (C)	32	20
Vapor Pressure (psi)	0.6287	0.11799098

Blower Efficiency: 70%
Discharge Pressure: 9.50 lbf / in^2

Actual Air Flow (ft^3/min)	Diameter (ft)	Diameter (in)	Temp1 @ ambient (F)	Temp2 @ blower (F)	Viscosity (centipose)	Re	e/D	Fo	F	Air Velocity (ft/min)	Velocity Head (in)	Length (ft)	Total K - value	Minor Head Loss (in)	Major Head loss (in)	Total Head Loss (in)	Total Head Loss (psi)
0	0.67	8	90	209	0.0219	0	0.00	#DIV/0!	#DIV/0!	0.00	0.0000	60	0.80	0.00000	#DIV/0!	#DIV/0!	#DIV/0!
16	0.67	8	90	209	0.0219	2581	0.00	0.0468	0.0454	45.71	0.0002	60	0.80	0.00014	0.00069	0.00083	0.00003
32	0.67	8	90	209	0.0219	5161	0.00	0.0375	0.0370	91.43	0.0007	60	0.80	0.00054	0.00227	0.00281	0.00010
48	0.67	8	90	209	0.0219	7742	0.00	0.0333	0.0331	137.14	0.0015	60	0.80	0.00122	0.00456	0.00578	0.00021
64	0.67	8	90	209	0.0219	10322	0.00	0.0307	0.0306	182.85	0.0027	60	0.80	0.00218	0.00750	0.00968	0.00035
80	0.67	8	90	209	0.0219	12903	0.00	0.0289	0.0289	228.57	0.0043	60	0.80	0.00340	0.01107	0.01447	0.00052
96	0.67	8	90	209	0.0219	15483	0.00	0.0276	0.0276	274.28	0.0061	60	0.80	0.00490	0.01522	0.02012	0.00073
112	0.67	8	90	209	0.0219	18064	0.00	0.0265	0.0266	319.99	0.0083	60	0.80	0.00667	0.01993	0.02660	0.00096
128	0.67	8	90	209	0.0219	20644	0.00	0.0256	0.0257	365.71	0.0109	60	0.80	0.00871	0.02520	0.03391	0.00122
144	0.67	8	90	209	0.0219	23225	0.00	0.0249	0.0250	411.42	0.0138	60	0.80	0.01102	0.03100	0.04202	0.00152
159	0.67	8	90	209	0.0219	25806	0.00	0.0243	0.0244	457.13	0.0170	60	0.80	0.01361	0.03732	0.05093	0.00184
175	0.67	8	90	209	0.0219	28386	0.00	0.0237	0.0238	502.85	0.0206	60	0.80	0.01646	0.04415	0.06062	0.00219
191	0.67	8	90	209	0.0219	30967	0.00	0.0232	0.0234	548.56	0.0245	60	0.80	0.01959	0.05149	0.07108	0.00257
207	0.67	8	90	209	0.0219	33547	0.00	0.0228	0.0229	594.27	0.0287	60	0.80	0.02300	0.05932	0.08232	0.00297
223	0.67	8	90	209	0.0219	36128	0.00	0.0224	0.0225	639.99	0.0333	60	0.80	0.02667	0.06763	0.09431	0.00341
239	0.67	8	90	209	0.0219	38708	0.00	0.0221	0.0222	685.70	0.0383	60	0.80	0.03062	0.07643	0.10705	0.00387
255	0.67	8	90	209	0.0219	41289	0.00	0.0217	0.0219	731.41	0.0435	60	0.80	0.03483	0.08570	0.12053	0.00435
271	0.67	8	90	209	0.0219	43869	0.00	0.0214	0.0216	777.13	0.0492	60	0.80	0.03933	0.09544	0.13476	0.00487
287	0.67	8	90	209	0.0219	46450	0.00	0.0212	0.0213	822.84	0.0551	60	0.80	0.04409	0.10563	0.14972	0.00541
303	0.67	8	90	209	0.0219	49031	0.00	0.0209	0.0210	868.55	0.0614	60	0.80	0.04912	0.11629	0.16541	0.00598
319	0.67	8	90	209	0.0219	51611	0.00	0.0207	0.0208	914.27	0.0680	60	0.80	0.05443	0.12740	0.18183	0.00657
335	0.67	8	90	209	0.0219	54192	0.00	0.0204	0.0206	959.98	0.0750	60	0.80	0.06001	0.13896	0.18183	0.00657
351	0.67	8	90	209	0.0219	56772	0.00	0.0202	0.0204	1005.69	0.0823	60	0.80	0.06586	0.15097	0.18183	0.00657
367	0.67	8	90	209	0.0219	59353	0.00	0.0200	0.0202	1051.41	0.0900	60	0.80	0.07198	0.16341	0.18183	0.00657
383	0.67	8	90	209	0.0219	61933	0.00	0.0199	0.0200	1097.12	0.0980	60	0.80	0.07838	0.17630	0.18183	0.00657
399	0.67	8	90	209	0.0219	64514	0.00	0.0197	0.0198	1142.83	0.1063	60	0.80	0.08505	0.18961	0.18183	0.00657
415	0.67	8	90	209	0.0219	67094	0.00	0.0195	0.0197	1188.55	0.1150	60	0.80	0.09199	0.20337	0.18183	0.00657
431	0.67	8	90	209	0.0219	69675	0.00	0.0194	0.0195	1234.26	0.1240	60	0.80	0.09920	0.21754	0.18183	0.00657
447	0.67	8	90	209	0.0219	72255	0.00	0.0192	0.0193	1279.97	0.1334	60	0.80	0.10668	0.23215	0.18183	0.00657
463	0.67	8	90	209	0.0219	74836	0.00	0.0191	0.0192	1325.69	0.1430	60	0.80	0.11444	0.24718	0.18183	0.00657
478	0.67	8	90	209	0.0219	77417	0.00	0.0189	0.0191	1371.40	0.1531	60	0.80	0.12247	0.26263	0.18183	0.00657
494	0.67	8	90	209	0.0219	79997	0.00	0.0188	0.0189	1417.11	0.1635	60	0.80	0.13077	0.27849	0.18183	0.00657
510	0.67	8	90	209	0.0219	82578	0.00	0.0187	0.0188	1462.83	0.1742	60	0.80	0.13934	0.29477	0.18183	0.00657
526	0.67	8	90	209	0.0219	85158	0.00	0.0185	0.0187	1508.54	0.1852	60	0.80	0.14818	0.31147	0.18183	0.00657
542	0.67	8	90	209	0.0219	87739	0.00	0.0184	0.0186	1554.25	0.1966	60	0.80	0.15730	0.32858	0.18183	0.00657
558	0.67	8	90	209	0.0219	90319	0.00	0.0183	0.0185	1599.97	0.2084	60	0.80	0.16669	0.34609	0.18183	0.00657
574	0.67	8	90	209	0.0219	92900	0.00	0.0182	0.0183	1645.68	0.2204	60	0.80	0.17635	0.36401	0.18183	0.00657
590	0.67	8	90	209	0.0219	95480	0.00	0.0181	0.0182	1691.39	0.2329	60	0.80	0.18629	0.38234	0.18183	0.00657
606	0.67	8	90	209	0.0219	98061	0.00	0.0180	0.0181	1737.11	0.2456	60	0.80	0.19649	0.40107	0.18183	0.00657
622	0.67	8	90	209	0.0219	100642	0.00	0.0179	0.0180	1782.82	0.2587	60	0.80	0.20697	0.42021	0.18183	0.00657
638	0.67	8	90	209	0.0219	103222	0.00	0.0178	0.0180	1828.53	0.2721	60	0.80	0.21772	0.43974	0.18183	0.00657
654	0.67	8	90	209	0.0219	105803	0.00	0.0177	0.0179	1874.25	0.2859	60	0.80	0.22874	0.45967	0.18183	0.00657
670	0.67	8	90	209	0.0219	108383	0.00	0.0176	0.0178	1919.96	0.3000	60	0.80	0.24003	0.48000	0.18183	0.00657
686	0.67	8	90	209	0.0219	110964	0.00	0.0176	0.0177	1965.67	0.3145	60	0.80	0.25160	0.50072	0.18183	0.00657
702	0.67	8	90	209	0.0219	113544	0.00	0.0175	0.0176	2011.38	0.3293	60	0.80	0.26344	0.52183	0.18183	0.00657
718	0.67	8	90	209	0.0219	116125	0.00	0.0174	0.0175	2057.10	0.3444	60	0.80	0.27555	0.54334	0.18183	0.00657
734	0.67	8	90	209	0.0219	118705	0.00	0.0173	0.0174	2102.81	0.3599	60	0.80	0.28793	0.56524	0.18183	0.00657
750	0.67	8	90	209	0.0219	121286	0.00	0.0172	0.0174	2148.52	0.3757	60	0.80	0.30059	0.58753	0.18183	0.00657
766	0.67	8	90	209	0.0219	123867	0.00	0.0172	0.0173	2194.24	0.3919	60	0.80	0.31351	0.61020	0.18183	0.00657
781	0.67	8	90	209	0.0219	126447	0.00	0.0171	0.0172	2239.95	0.4084	60	0.80	0.32671	0.63326	0.18183	0.00657
797	0.67	8	90	209	0.0219	129028	0.00	0.0170	0.0172	2285.66	0.4252	60	0.80	0.34018	0.65670	0.18183	0.00657
813	0.67	8	90	209	0.0219	131608	0.00	0.0170	0.0171	2331.38	0.4424	60	0.80	0.35393	0.68053	0.18183	0.00657
829	0.67	8	90	209	0.0219	134189	0.00	0.0169	0.0170	2377.09	0.4599	60	0.80	0.36794	0.70474	0.18183	0.00657
845	0.67	8	90	209	0.0219	136769	0.00	0.0168	0.0170	2422.80	0.4778	60	0.80	0.38223	0.72934	0.18183	0.00657
861	0.67	8	90	209	0.0219	139350	0.00	0.0168	0.0169	2468.52	0.4960	60	0.80	0.39679	0.75431	0.18183	0.00657
877	0.67	8	90	209	0.0219	141930	0.00	0.0167	0.0168	2514.23	0.5145	60	0.80	0.41162	0.77966	0.18183	0.00657
893	0.67	8	90	209	0.0219	144511	0.00	0.0167	0.0168	2559.94	0.5334	60	0.80	0.42673	0.80539	0.18183	0.00657
909	0.67	8	90	209	0.0219	147092	0.00	0.0166	0.0167	2605.66	0.5526	60	0.80	0.44210	0.83149	0.18183	0.00657
925	0.67	8	90	209	0.0219	149672	0.00	0.0165	0.0167	2651.37	0.5722	60	0.80	0.45775	0.85798	0.18183	0.00657
941	0.67	8	90	209	0.0219	152253	0.00	0.0165	0.0166	2697.08	0.5921	60	0.80	0.47367	0.88483	0.18183	0.00657
957	0.67	8	90	209	0.0219	154833	0.00	0.0164	0.0165	2742.80	0.6123	60	0.80	0.48987	0.91206	0.18183	0.00657
973	0.67	8	90	209	0.0219	157414	0.00	0.0164	0.0165	2788.51	0.6329	60	0.80	0.50633	0.93966	0.18183	0.00657
989	0.67	8	90	209	0.0219	159994	0.00	0.0163	0.0164	2834.22	0.6538	60	0.80	0.52307	0.96764	0.18183	0.00657
1005	0.67	8	90	209	0.0219	162575	0.00	0.0163	0.0164	2879.94	0.6751	60	0.80	0.54008	0.99598	0.18183	0.00657
1021	0.67	8	90	209	0.0219	165155	0.00	0.0162	0.0163	2925.65	0.6967	60	0.80	0.55736	1.02470	0.18183	0.00657
1037	0.67	8	90	209	0.0219	167736	0.00	0.0162	0.0163	2971.36	0.7186	60	0.80	0.57491	1.05378	0.18183	0.00657
1053	0.67	8	90	209	0.0219	170317	0.00	0.0161	0.0162	3017.08	0.7409	60	0.80	0.59274	1.08323	0.18183	0.00657
1069	0.67	8	90	209	0.0219	172897	0.00	0.0161	0.0162	3062.79	0.7635	60	0.80	0.61084	1.11305	0.18183	0.00657
1085	0.67	8	90	209	0.0219	175478	0.00	0.0160	0.0162	3108.50	0.7865	60	0.80	0.62921	1.14323	0.18183	0.00657
1100	0.67	8	90	209	0.0219	178058	0.00	0.0160	0.0161	3154.22	0.8098	60	0.80	0.64785	1.17378	0.18183	0.00657
1116	0.67	8	90	209	0.0219	180639	0.00	0.0160	0.0161	3199.93	0.8335	60	0.80	0.66676	1.20469	0.18183	0.00657
1132	0.67	8	90	209	0.0219	183219	0.00	0.0159	0.0160	3245.64	0.8574	60	0.80	0.68595	1.23597	0.18183	0.00657
1148	0.67	8	90	209	0.0219	185800	0.00	0.0159	0.0160	3291.36	0.8818	60	0.80	0.70541	1.26761	0.18183	0.00657
1164	0.67	8	90	209	0.0219	188380	0.00	0.0158	0.0159	3337.07	0.9064	60	0.80	0.72514	1.29961	0.18183	0.00657
1180	0.67	8	90	209	0.0219	190961	0.00	0.0158	0.0159	3382.78	0.9314	60	0.80	0.74514	1.33198	0.18183	0.00657



REV	BY	DATE	CHANGE NOTICE	CHKD.	APP
B	REV DISCHARGE PIPE EXTENSION				
	RDR	9/1/09	10495V		
A	RELEASED				

DIMENSIONS AND DATA
CERTIFIED

PURCHASE ORDER ____
PROJECT ____
LOCATION ____
EQUIPMENT No. ____
ROOTS ORDER No. ____
CERTIFIED BY ____
DATE ____

		DATE
DR.	RDR	5/5/09
CHKD.		
APP.		
DBV	RDR	5/5/09
SCALE 1/2"=1'-0"		
CAD FILE / DIRECTORY		
93964A21		
MISC		

DO NOT SCALE FOR DIMENSIONS
ALL DIMENSIONS SHOWN IN BRACKETS [] ARE MILLIMETERS

ORDER No.

EASYAIR EAX2 PACKAGE OUTLINE

FOR EAX2 150 RAMX 155,225,280

DRESSER Roots

Dresser Roots, Dresser, Inc.
Connersville, IN USA

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED
ANCHOR BOLT LOCATIONS ±.13 [3.30]
BLOWER INLET & DISCHARGE LOCATIONS ±.25 [6.35]
ALL OTHER DIMENSIONS REFERENCE

93964021
SHEET 1 OF 1

REV A

GBSIZE

Company: The MAHER Corporation
Address: 192 Pleasant Street Rockland, MA 02370
P: 781-421-2600 F: 781-878-1219
Contact: Pete Kibble

Project: Exeter, NH Sludge Blower

ROOTS BLOWER PERFORMANCE REPORT : Program Version 6.30 Release Date 4/26/2012

Program Mode: SELECTION Run Date: 07/23/2015

>>>>>>>>> Easy Air X2 Selection Report <<<<<<<<

AMBIENT CONDITIONS:

Gas	AIR	
Relative Humidity	85%	
Molecular Weight	28.525	
k-Value	1.391	
Specific Gravity	.985	
Ambient Temperature	90	deg F
Ambient Pressure	14.7	PSIA
Elevation	0	feet

STANDARD CONDITIONS:

Pressure	14.7	PSIA
Temperature	68	deg F
Relative Humidity	36	%

SELECTED UNIT DETAIL: Model 225 RAM X

	Min Speed	Design	Des/Max
Speed, RPM	1569	3690	77.7%
System Inlet Volume, ICFM	275	861	
Actual Blower Inlet Volume, ICFM	275	866	+/-5%
Standard Volume, SCFM	255	800	
Mass/Weight Flow, #/min	19.51	61.16	+/-5%
System Inlet Temperature, deg F	90.0	90.0	
System Inlet Pressure, PSIA	14.700	14.700	
Inlet Pressure Losses, PSI	0.009	0.086	Calc
Blower Inlet Pressure, PSIA	14.691	14.614	Calc
Blower Discharge Pressure, PSIG	10.014	10.132	Calc
Discharge Press. Losses, PSI	0.014	0.132	Calc
System Discharge Pressure, PSIG	10.000	10.000	
Blower Diff. Press., PSI	10.023	10.218	68.1%
Power @Blower Shaft, BHP	19.38	48.70	+/-5%
Power @Mtr Shft(belt loss 2%, +5% Tol), BHP	20.76	52.16	
Temperature Rise, deg F	165.2	132.4	55.2%
Discharge Temperature, deg F	255.2	222.4	
System Discharge Volume, ACFM	212	632	
Relief Valve Setting, PSIG	12.0	12.0	78.1%
Power, Blower @ RV Setting, BHP	23.19	57.66	
Power, Motor Shaft @RV Accumul, BHP	25.50	63.43	
Temp. Rise @ Relief Setting, deg F	209.2	159.6	66.5%
Disch. Temp @ Relief Setting, deg F	299.2	249.6	
V-Belt: Est. B10 Brg Life, hours	1659391	661741	
Est. Free Field Noise, dBa	84.9	94.6	
Measured as sound press. level per ISO 2151:2004E with +/-3 dBA tol.			
Volumetric Efficiency, %	62.6	83.9	

SELECTED PACKAGE DETAIL: EasyAir X2 Model Series: EAX2 150

Size (w x d x h)	60.03in x 61.02in x 67.91in
Est. Free Field Noise w/ encl	77.2 dBa @ design speed conditions
	69.2 dBa @ min speed conditions

Measured as sound press. level per ISO 2151:2004E with +/-3 dBA tol.

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE

PROJECT NO.: 12883B

PRELIMINARY DESIGN PACKAGE

System/Subject:	YARD PUMP STATION		
Calculations By:	MDB	Date:	7/27/2015
Checked By:	EJL	Date:	7/29/2015
Revised By:	MDB	Date:	8/27/2015
Checked By:	EJL	Date:	8/27/2015

Checklist (to be completed by Design Engineer prior to calculation checking):

X	Brief Process Description
X	Graphs/Sketches of System Attached (Plans & Schematics)
X	Design Calculations Attached
X	Design Guidelines/Standards Noted
	Equations Noted and Referenced
X	Electrical Loads Developed and Identified
X	Process Control Description Developed
X	Preliminary Basis of Design (Support Divisions) Attached
X	Construction Sequence Developed
X	Product Information Attached
	Manufacturer's Review of Specs and Drawings (If Applicable)
X	Electronic File Location Noted
	Program(s) Used (Version) Noted
N/A	Coordinated with Hydraulic Profile (If Applicable)

DESCRIPTION OF EXISTING FACILITIES

There is currently no yard pump station.

FACILITY PLAN RECOMMENDATIONS

No yard pump station was specifically identified during the facility plan.

CLIENT PREFERENCES

The Client would prefer a yard pump station that utilizes suction lift pumps located above grade in a manufacturer-provided enclosure.

DESIGN GUIDELINES

TR-16: None

NHDES Env-Wq: None

REVIEW OF DESIGN CONSIDERATION & ALTERNATIVES

No alternatives were considered.

BASIS OF DESIGN

An evaluation was conducted to determine expected flows at the yard pump station from unit processes. Total flows were summarized, and then maximum flows that can be expected simultaneously were estimated. Sanitary and floor drain flows from the following locations are expected to discharge to the yard pump station:

- Garage
- Public Works Office Building
- Control Building
- Solids Handling Building
- Maintenance Building
- Storage Building

Flows from the following unit processes are expected to discharge to the yard pump station:

- Dewatering Centrate and Sludge Storage Tanks Decant
- Seal Water (RAS Pumps, WAS Pumps, Dewatering Feed Pumps)

Total maximum online flow was estimated to be approximately 650 gpm. Of this, approximately 400 gpm is generated from the dewatering process and flows in the Solids Handling Building. A triplex system was achieved to meet the expected flow demands. One pump operating is sized to handle approximately 450 gpm, allowing for one pump to handle expected centrate flows plus miscellaneous site flows. The triplex pump system will operate in a Lead-Lag-Standby mode, allowing pumps to operate as demand to the system change. Total Yard Pump Station capacity is approximately 700 gpm, which is conservatively sized to handle the maximum expected online flow.

The discharge location of the Yard Pump Station will be either Junction Structure No. 2 or the Headworks Building.

Electrical information:

Power	10 HP each
Speed	Constant, 1250 rpm
Enclosure	TEFC
Volts, Phase/ Hz	460V/ 3 ph/ 60 Hz

KEY SPECIFICATION ITEMS:

A. The contractor shall furnish and install one factory built skid mounted automatic pump station. The station shall be complete with all equipment specified herein and be factory assembled on a steel base. The principle items of equipment shall include self-priming, horizontal, centrifugal, V-belt motor driven sewage pumps, valves, and piping.

1. Pump Schedule:
    - (1) Number of Units: Three
    - (2) Capacity:
        - a. One Pump Operating: 450 gpm at 30 feet TDH
        - b. Two Pumps Operating: 350 gpm each
    - (3) Minimum shutoff head: 40 feet
    - (4) Static suction lift : 18 feet
    - (5) Reprime lift: 18 feet

(6) Drive: Constant Speed
(7) Speed: 1,250 rpm
(8) Motor: 10 HP, TEFC, 460V, 3 phase, 60 Hz
(9) Seal face materials: Tungsten titanium carbide alloy (stationary and rotating)
(10) Remarks: 4-inch suction, 4-inch discharge; Gorman-Rupp Super-T4A-B-4 or equal

2. Programmable Logic Controller (PLC)
   a. Control logic shall be accomplished using an OEM-PLC. PLC shall monitor alarms and statuses.
3. Operator Interface Terminal (OIT)
   a. Provide an OIT to continuously indicate status of equipment, change operational parameters, and indicate alarm status. OIT shall be fully compatible with PLC provided.
   b. Minimum 6.5" LCD touchscreen display, color active matrix with 18-bit resolution.
4. Magnetic Flow Meter
   a. 4-inch diameter

BUILDING / STRUCTURE DESCRIPTION

The concrete wet well will be circular, approximately 8-feet in diameter by 10-feet deep with a rectangular top slab. Pumps and controls will be mounted directly above the wet well and include a manufacturer-provided 8-foot by 12-foot fiberglass enclosure.

PROCESS CONTROL DESCRIPTION

The Yard Pump Station will be designed to be able to run automatically through a PLC and SCADA, and manually through the manufacturer provided control panel. The three pumps will run in a lead/lag/standby mode. The lag pump will typically only be used when the influent to the yard pump station exceeds the pumping capacity of the lead pump to draw down the wetwell level. The pumps will be flow-paced control to maintain a constant wet well elevation.

The three pumps can be run in Automatic Alternation Mode. This will alternate which pump acts as the lead pump and lag pump. The alternation occurs each time the lead pump is cycled and shut down. Upon the next startup, this lead pump will be alternated and act as a lag pump for the next cycle. Alternately, the operator can select which pump is the lead pump and lag pump via a virtual selector switch at the OIT and SCADA.

Flow meter information will be indicated at SCADA as flow rate and totalized flow.

CONSTRUCTION & SEQUENCING

Construction of the yard pump station should be coordinated with construction of the sludge storage tanks.

FUTURE EXPANSION CONSIDERATIONS

No future expansion is foreseen at this time.

FILE LOCATION

\\wp\wp-fs\vol4\ENG\NH\Exeter\12883-WWTF\12883B-WW Design\Technical\Process\Design Memos\A-13 Yard Pump Station.docx

ATTACHMENTS

- Yard Pump Station Flow Summary
- Pump Station Example Product Cut-Sheet
- 1-Pump System Curve
- Multi-pump System Curve

Yard Pump Station Flows
Exeter NH WWTF Upgrade
12883B
8/27/2015

Location	Estimated Average Flow (gpm)	Max Estimated Online Flow (gpm)	Comments
General DPW Site Sanitary Flows (Existing)			
Sanitary Flows	*1.0*	*28*	See Notes 3 and 4
Plant Water Building			
Sump Pump	25	25	
Storage Building			
Floor Drains	*20*	*20*	
Maintenance Building			
Floor Drains	*20*	*20*	
Solids Handling Building			
Sanitary Flows	0.50	5	
RAS Pump Seal Water (3)	1	3	
WAS Pump Seal Water (2)	1	2	
DFP Seal Water (2)	1	2	
Basement Sump Pump	25	25	Basement trench drain
Vac Truck Floor Drains	20	20	20 GPM washdown hosebib
Centrate	200	400	Centrate calculated as 2 X DFP rate + 25 gpm each flushing water
Sludge Storage Tanks			
Telescoping decanter	0	100	Estimate based on 6-inch decant pipe
Future Tertiary Process			
Backwashing	-	-	Future tertiary system to have dedicated pumping system
Sum	315	650	

Notes

1. *Italics indicate existing flows.* Normal text indicates new flows.
2. Existing Sanitary Flow Conditions

Design flows for Town Offices (per NHDES Subsurface Disposal)	15	gpd per Employee
Assumed Peaking Factor	10	
Exeter DPW # of Employees (Current)	36	
Exeter WWTF # of Employees (Current)	3	
Exeter WWTF # of Employees (Future)	6	

3. DPW sanitary site flows estimated from 2014 water meter readings. Peaking factor in Note 2 assumed
4. DPW site includes sanitary flows from all existing buildings (DPW Office, Garage, Control Building, and Grit Building)
5. No flows to the Yard Pump Station are expected from the Headworks Building and Chlorine Contact Tank

D S

Self Priming Centrifugal Pump

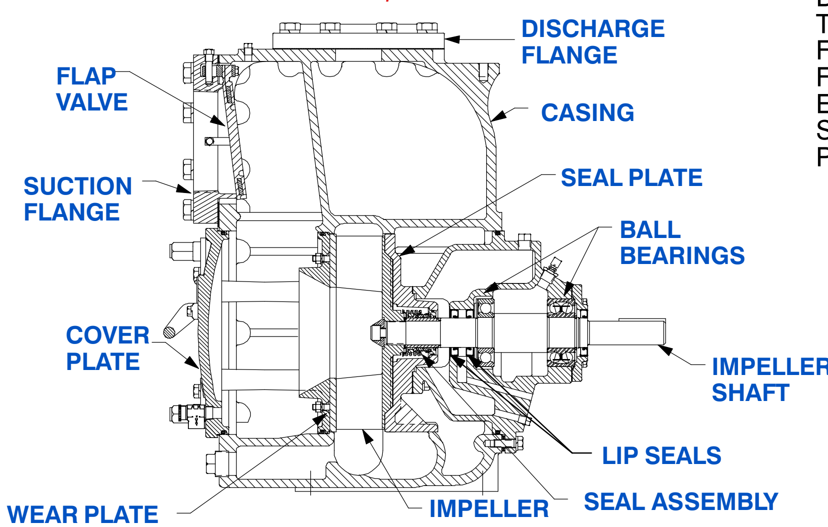
Model T6A3S-B

Super T SERIES
VARIOUS PATENTS APPLY

Size 6" x 6"

PUMP SPECIFICATIONS
Size: 6" x 6" (152 mm x 152 mm) NPT - Female.
Casing: Gray Iron 30.
Maximum Operating Pressure 79 psi (545 kPa).*
Semi-Open Type, Two Vane Impeller: Ductile Iron 65-45-12.
Handles 3" (76,2 mm) Diameter Spherical Solids.
Impeller Shaft: Alloy Steel 4150.
Shaft Sleeve: Alloy Steel 4130.
Replaceable Wear Plate: Carbon Steel 1026.
Removable Adjustable Cover Plate: Gray Iron 30; 62 lbs. (28 kg).
Flap Valve: Neoprene W/Nylon and Steel Reinforcing.
Seal Plate: Gray Iron 30.
Bearing Housing: Gray Iron 30.
Radial Bearing: Open Single Row Ball.
Thrust Bearing: Open Double Row Ball.
Bearing and Seal Cavity Lubrication: SAE 30 Non-Detergent Oil.
Flanges: 125# Gray Iron 30.
Gaskets: Buna-N, Compressed Synthetic Fibers, PTFE, Vegetable Fiber, Cork, and Rubber.
O-Rings: Buna-N.
Hardware: Standard Plated Steel.
Brass Pressure Relief Valve.
Bearing and Seal Cavity Oil Level Sight Gauges.
Optional Equipment: Metal Bellows Seal. Automatic Air Release Valve. 120V/240V Casing Heater. High Pump Temperature Shutdown Kit. G-R Hard Iron Casing. Self-Cleaning Wear Plate.
Gray Iron 30 Suction and Discharge Spool Flanges:
6" ASA **(Specify Model T6A3S-B /F)**.
150 mm DIN 2527 (PN16) **(Specify Model T6A3S-B /FM)**.
**Consult Factory for Applications Exceeding Maximum Pressure and/or Temperature Indicated.*

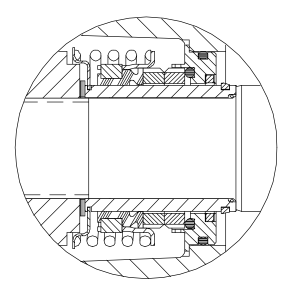
Shown with Optional Suction & Discharge Spool Flanges (Available in ASA or DIN Standard Sizes).



SEAL SPECIFICATIONS

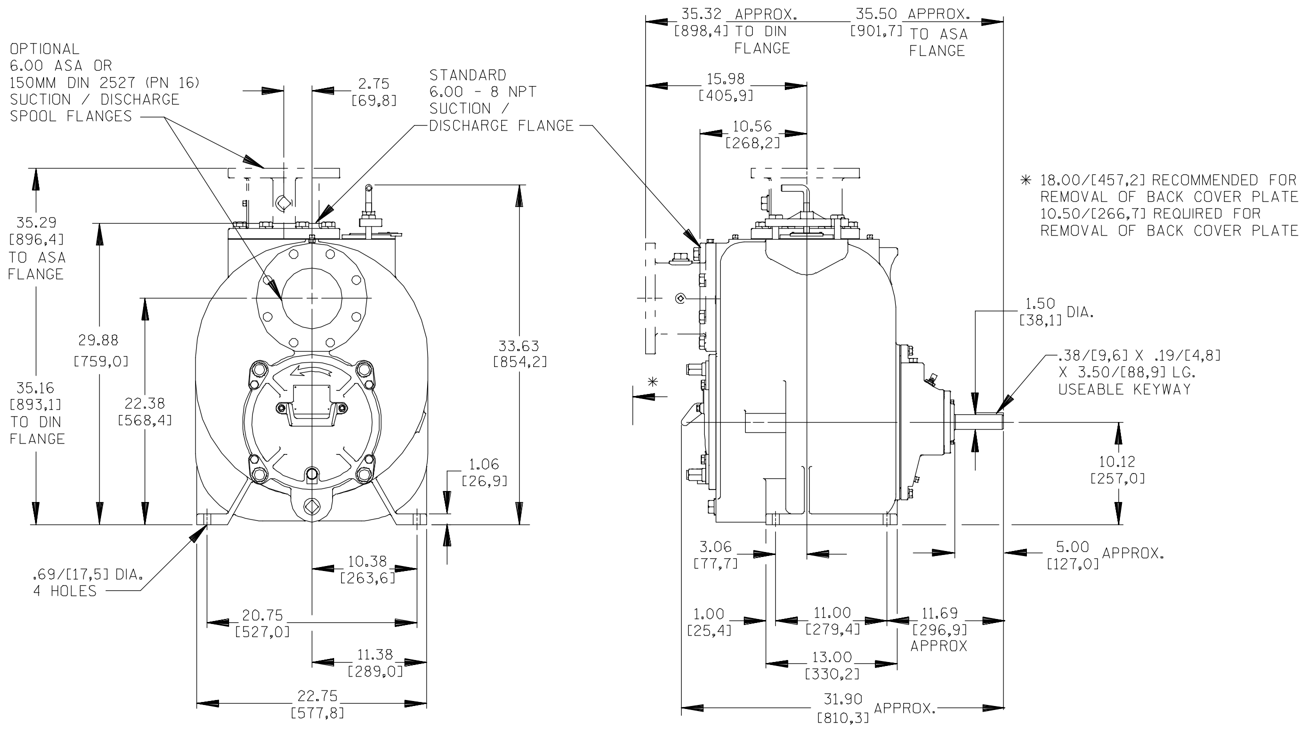
Cartridge Type, Mechanical, Oil-Lubricated, Double Floating, Self-Aligning. Tungsten Titanium Carbide Rotating and Stationary Faces. Stainless Steel 316 Stationary Seat. Fluorocarbon Elastomers (DuPont Viton® or Equivalent). Stainless Steel 18-8 Cage and Spring. Maximum Temperature of Liquid Pumped, 160°F (71°C).*

SEAL DETAIL



THE GORMAN-RUPP COMPANY • MANSFIELD, OHIO
GORMAN-RUPP OF CANADA LIMITED • ST. THOMAS, ONTARIO, CANADA
www.grpumps.com
Specifications Subject to Change Without Notice
Printed in U.S.A.

Specification Data	APPROXIMATE DIMENSIONS and WEIGHTS	NET WEIGHT: 855 LBS. (388 KG.)*
SECTION 55, PAGE 2200		SHIPPING WEIGHT: 910 LBS. (413 KG.)*
		EXPORT CRATE: 32.5 CU. FT. (0,92 CU. M.)
		*ADD 25 LBS. (11,3 KG.) W/EACH SPOOL FLANGE



OPTIONAL ASA OR DIN STANDARD SUCTION & DISCHARGE SPOOL FLANGES AVAILABLE

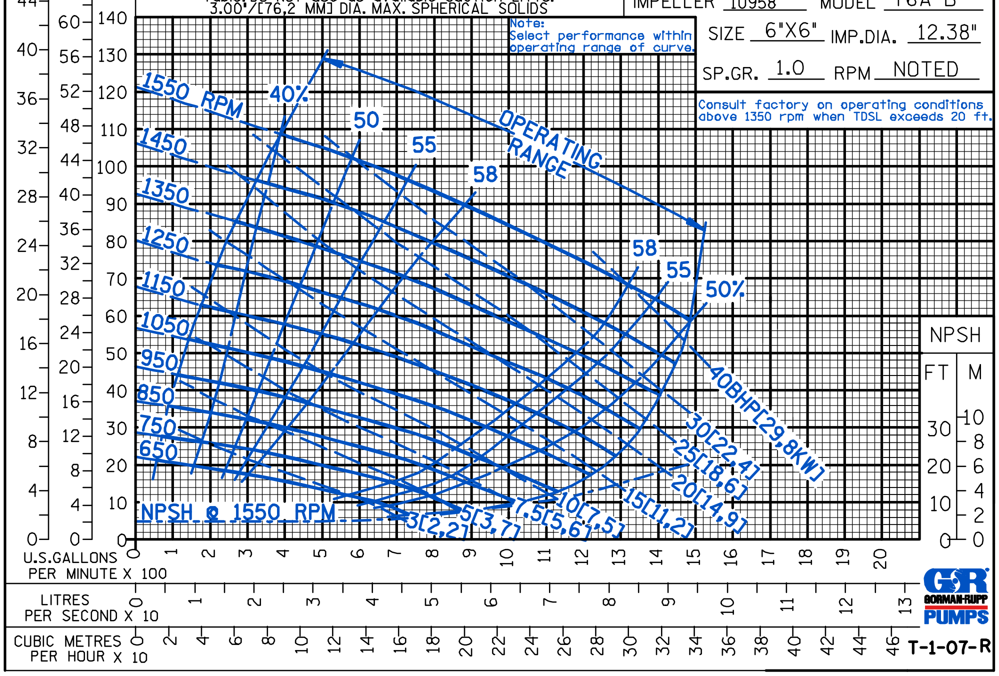
PERFORMANCE CURVE

REPRIMING LIFTS

RPM	650	750	850	950	1050	1150-1250	1350	1450	1550
FEET	8	9	12	14	18	21	22	23	25
METERS	2,4	2,7	3,7	4,3	5,5	6,4	6,7	7,0	7,6

Figure NPSH required prior to using above table. DO NOT use as available Suction Lifts.
3.00"/[76,2 MM] DIA. MAX. SPHERICAL SOLIDS

VOLUTE 10957E 10957C CURVE T6A-B-4
IMPELLER 38615-087 10958 MODEL T6A-B
SIZE 6"X6" IMP.DIA. 12.38"
SP.GR. 1.0 RPM NOTED



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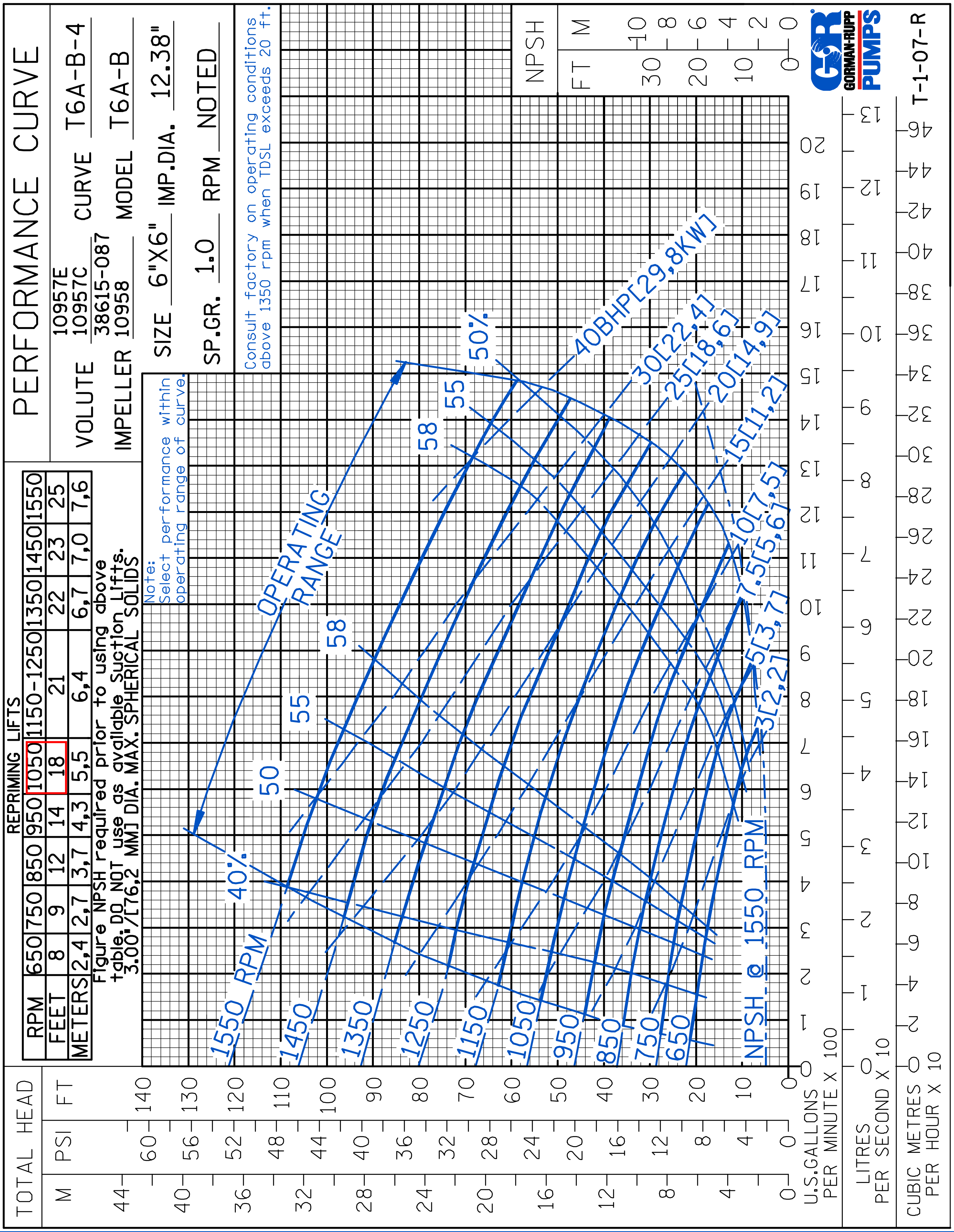
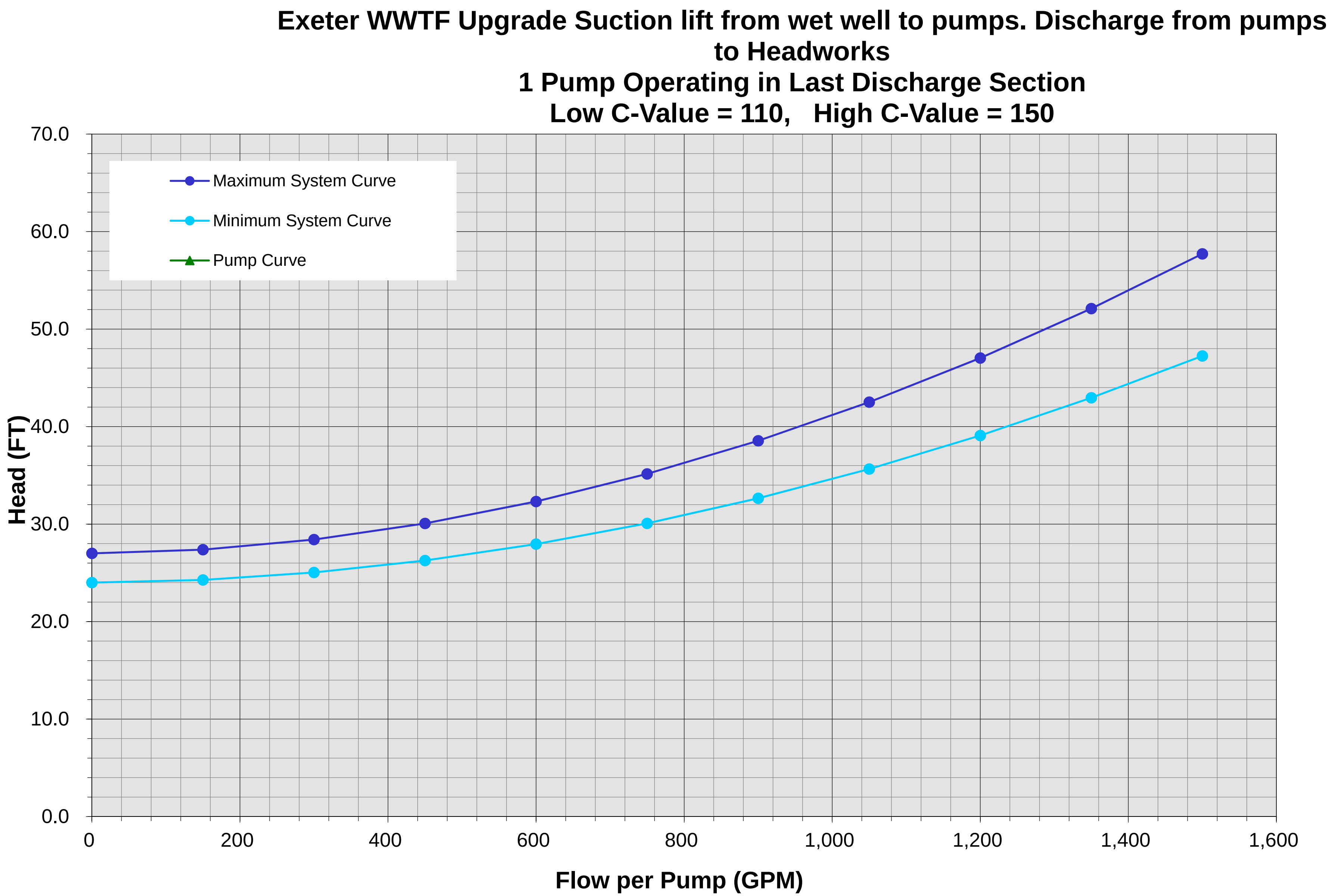
C D S W

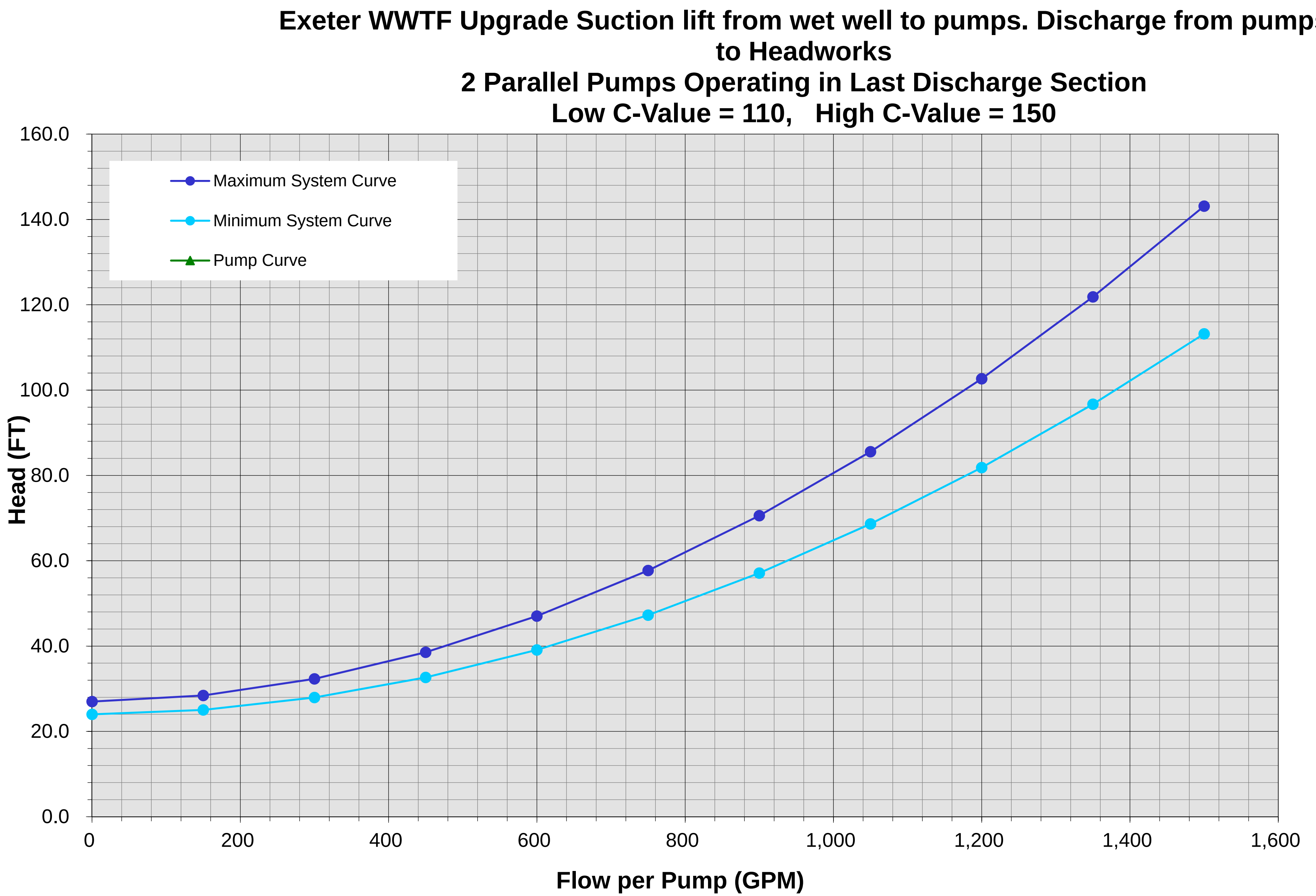


REPRIMING LIFTS

RPM	650	750	850	950	1050	1150-1250	1350	1450	1550
FEET	8	9	12	14	18	21	22	23	25
METERS	2,4	2,7	3,7	4,3	5,5	6,4	6,7	7,0	7,6



Exeter WWTF Upgrade Suction lift from wet well to pumps. Discharge from pumps to Headworks
1 Pump Operating in Last Discharge Section
Low C-Value = 110, High C-Value = 150
Maximum System Curve
Minimum System Curve
Pump Curve
Head (FT)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
200
400
600
800
1,000
1,200
1,400
1,600
Flow per Pump (GPM)



Exeter WWTF Upgrade Suction lift from wet well to pumps. Discharge from pumps to Headworks
2 Parallel Pumps Operating in Last Discharge Section
Low C-Value = 110, High C-Value = 150
Maximum System Curve
Minimum System Curve
Pump Curve
Head (FT)
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
0
200
400
600
800
1,000
1,200
1,400
1,600
Flow per Pump (GPM)

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE

PROJECT NO.: 12883B

PRELIMINARY DESIGN PACKAGE

System/Subject:	PLANT WATER		
Calculations By:	KYLE COOLIDGE CHEALSEA DEAN	Date:	7/8/2015
Checked By:		Date:	
Revised By:	KYLE COOLIDGE	Date:	9/1/2015
Checked By:		Date:	

Checklist (to be completed by Design Engineer prior to calculation checking):

	Brief Process Description
X	Graphs/Sketches of System Attached (Plans & Schematics)
X	Design Calculations Attached
X	Design Guidelines/Standards Noted
	Equations Noted and Referenced
X	Electrical Loads Developed and Identified
X	Process Control Description Developed
X	Preliminary Basis of Design (Support Divisions) Attached
X	Construction Sequence Developed
X	Product Information Attached
	Manufacturer's Review of Specs and Drawings (If Applicable)
X	Electronic File Location Noted
	Program(s) Used (Version) Noted
	Coordinated with Hydraulic Profile (If Applicable)

DESCRIPTION OF EXISTING FACILITIES

The existing plant water system is located in the valve pit (basement) of the Chlorination Building. The valve pit is accessed through a 5 foot by 6 foot hatch on the main floor using the attached ladder. The plant water pumps are fed from the Chlorine Contact Tank by an 8 inch pipe. The plant water system consists of two 10-hp process water pumps, a 4-inch diameter ductile iron force main to a 1,000 gallon hydro-pneumatic storage tank located in the Control Building. The current system capacity is 200 gpm at 80 psi. Plant water is supplied to the Septage Holding Tank, Grit Building, yard hydrants and as carrier water for the sodium hypochlorite and sodium bisulfite chemical systems.

FACILITY PLAN RECOMMENDATIONS

Upgrade the existing plant water system with a new system to provide continuous use of effluent for on-site unit operations. A summary of the upgrade is:

1. New package triplex plant water booster pump station with basket strainer, valves, piping, instrumentation and controls.
2. The new system will reuse the existing 1,000 gallon hydro-pneumatic tank located in the Control Building. The location of the hydro-pneumatic tank will be evaluated during final design.
3. Utilize existing 8” suction piping from Chlorine Contact Tank (3 fps@ 450 gpm). Route portion of suction piping to the new UV channel after disinfection and provide new valve inside Plant Water Building for isolation.
4. New discharge piping to distribute plant water to new structures/areas.
5. Demolish all existing piping and equipment in Chlorination Building to make room for new equipment.
6. Locate new plant water system in basement of Plant Water Building (formerly Chlorination Building).
7. Add permanent stairs for access to valve pit and eliminate confined space.
8. Add heating and ventilation to basement for continuous occupancy.
9. Add dehumidifier to control moisture in basement.
10. New magnetic flow meter in basement.

11. Process water (potable water) will be piped to the plant water system for redundancy.
12. Seal water for pumps in Solids Handling Building will be process water.

CLIENT PREFERENCES

None.

DESIGN GUIDELINES

TR-16:

- Where a separate non-potable water supply will be provided (such as plant effluent water), a backflow prevention device will not be necessary; however, all sill cocks and hose bibs should be posted with a permanent OSHA-approved sign indicating the water is not safe for drinking.
- If reused water is used for toilet flushing, it is absolutely essential that cross connections be prevented. Appropriate measures such as backflow prevention and air gaps are required.
- Consider minimizing the number of backflow devices required by providing a separate non-potable, in-plant water system using a single backflow protection device.

NHDES Env-Wq:

- The number of backflow devices required shall be minimized by providing a separate, non-potable, in-plant water system using a single backflow protection device.
- No piping or other connections shall exist in any part of the WWTP or collection system that might cause the contamination of a potable water supply.
- A sign shall be permanently posted at each hose bib, sill cock, or other fixture on the non-potable water system indicating that the water is not safe for drinking.
- Where break tanks are used for backflow prevention, water shall discharge to the break tank through an air-gap at least 6 inches above the maximum flood line or the spill line of the tank, whichever is higher.

REVIEW OF DESIGN CONSIDERATION & ALTERNATIVES

No alternatives were considered.

BASIS OF DESIGN

A new plant water system will supply on-demand non-potable plant water to the treatment plant for operations:

- yard hydrants
- hose stations
- flushing water for equipment (screening, dewatering, septage, etc.).
- carrier water for chemicals
- spray water for foam control
- seal water for pumps

Plant water needs for various processes and equipment throughout the facility were assessed to determine baseline and maximum demand flows. These demands are summarized in the attached calculations.

The new system will include pumps, variable frequency drives, a flow meter, pressure transducer, jockey pump, hydro-pneumatic tank (if necessary), and controls to provide variable flow rates at constant pressure. The system will include a new 6” duplex basket strainer on the plant water system suction side to remove particulate matter from the plant water influent with a new differential pressure switch.

Yard hydrants require the greatest plant water flow. The plant water system is designed to provide adequate flow and pressure through the yard hydrants to wash down equipment, including the Chlorine Contact Tanks and trickling filters, without having to connect to multiple hydrants.

Three pumps will be provided to meet the plant water flow requirements outlined above. Two of the pumps will be duty pumps, while the third pump will be a smaller jockey pump. This three pump configuration will allow the plant water system to meet capacity requirements when there is high demand (two yard hydrants operating simultaneously, etc.), while also allowing the system to achieve adequate turndown to provide plant water during low demand periods (overnight when few systems are online). During periods of intermittent demand from various sources throughout the facility, combinations of the duty pump(s) and jockey pump shall provide sufficient plant water to the facility.

PLANT WATER SYSTEM BASIS OF DESIGN		
Parameter	**Existing**	**Design**
Total Pumps	2	3
Main	2	2
Jockey	0	1
Future	na	1
Hydro-pneumatic Tank Size	1000 gal	1000 gal (1)
NPSHa	na	>30' @ 450 gpm
Type	Centrifugal	Centrifugal
Flow		
Minimum	Unknown	5 gpm
Continuous	Unknown	350 gpm
Maximum	200 gpm	450 gpm
Pressure	80 psi	110 psi
Power		460V/3 p/60 Hz
Lead		25 HP
Lag		25 HP
Jockey Pump		3 HP
Area Classification		Unclassified
Strainer, Suction	Unknown	Duplex Basket 5/64" opening
Redundancy		Process water connection in Solids Handling Building
NFPA 820 Classification		Unclassified

(1) Estimated, to be verified during final design.

BUILDING / STRUCTURE DESCRIPTION

The existing Chlorination Building will no longer be needed for the disinfection process and will be repurposed for the new plant water system. There is significant piping in the basement that will be demolished to create space for the new plant water system and new stairs. Due to the size of the basement (<250 sf), it is allowed by code to use a circular stair and leave it open to the first floor. A new 5'-4" square opening in the existing concrete slab is required for the spiral stair. Building improvements are summarized:

- New building name will be Plant Water Building.

- Demolish piping; fill pipe penetrations where piping is demolished.
- Add spiral stairs for access to basement.
- Add windows to increase natural lighting.
- New double door.
- Add new electrical room with door to outside.

PROCESS CONTROL DESCRIPTION

The plant water system will be controlled by the control panel provided by the manufacturer (OEM) as part of a package plant water system and mounted in the basement of the Plant Water Building.

The pump station provides water service to a closed distribution system at a relatively constant pressure. Two main pumps will operate together in lead/lag and are sized to meet the peak flow conditions. The pumps alternate at the end of each cycle. A third jockey pump is provided to operate during periods of low consumption. The small jockey pump will be controlled by pressure and will not operate when the consumption requires a larger pump. System pressure is controlled with VFDs by varying the pump speed in direct ratio to the discharge pressure.

A flow meter and pressure transducer will be installed on the common discharge header of the pumps to record plant water flow and system pressure via a PLC and SCADA.

PLUMBING

Demolish existing sump pump and provide new 5 HP sump pump in basement.

CONSTRUCTION SEQUENCING

The plant water pumping system cannot be installed in the lower level until the lagoons are taken offline due to the existing pipes running through the lower level. Process water will be provided temporarily until the plant water system is online. Some piping modifications in the lower level will be needed to make the connection to process water, and before the lagoons are offline.

FUTURE EXPANSION CONSIDERATIONS

Plan for future third pump to increase plant water capacity for future tertiary treatment system. There is also adequate space in the basement for larger pumps if needed in the future.

FILE LOCATION

\\wp\wp-fs\vol4\ENG\NH\Exeter\12883-WWTF\12883B-WW Design\Technical\Process\Major Unit Processes\Plant Water\A-X Plant Water.docx

ATTACHMENTS

A. Calculations
B. Vendor quote

WRIGHT-PIERCE
Engineering a Better Environment

75 Washington Avenue
Portland, ME 04101
www.wright-pierce.com
(207) 761-2991

CLIENT	Exeter, NH
PROJECT	WWTP Upgrade
PROJECT NO.	12883B
DESIGNED BY	KMC
DATE	7/6/2015
CHECKED BY	
DATE	

Purpose: Preliminary Design - Size package plant water system.

Assumptions:
1. Infrequent use is <1 hour/day
2. Frequent Long Term Flow is >8 hr/day
3. Foam spray discharge pressure at nozzle 60 psi.
4. Hydrant discharge pressure 100 psi.
5. Static assumed to be 5 psi.
6. Friction assumed to be 5 psi.
7. Seal water will be process water (not plant water).

Conclusions:

File Location
\\wp\wp-fs\vol4\ENG\NH\Exeter\12883-WWTF\12883B-WW Design\Technical\Process\Major Unit Processes\Plant Water\[Plant Water Usage rev3.xlsx]Plant Water

PLANT WATER SYSTEM SIZING

Location/ Service	# of Total Units	Flow per Unit, GPM	# of Concurrent Units Oper.	C -continuous F -frequent I -infrequent	Total Continuous Flow	Frequent Long-term Flow	Infrequent Use	Seal Water Only	Comments
INFLUENT SCREENING									
Mechanical Screen	1	25	1	F		25			
Screening Wash Press	1	30	1	F		30			
GRIT REMOVAL									
Grit Washer	1	10	1	F		10			
Grit Screw Conveyer	1	5	1	F		5			
Grit Pumps	2	0.5	1	S				0.5	seal water
Influent Equalization Pumps	3	0.5	2	S				1.0	seal water
AERATION TANK TRAINS									
Foam Spray	3	60	3	C	180				Don Song email 7/22/15
Sec Clarifiers	3	25	3	C	75				
SECONDARY SETTLING TANKS									
Return Activated Sludge Pumps	3	0.5	3	S				1.5	seal water
Waste Activated Sludge Pumps	3	0.5	3	S				1.5	seal water
SOLIDS HANDLING									
Dewatering Feed Pumps	3	0.5	2	S				1.0	seal water
Polymer Dilution Water	2	10	2	F		20			
Equipment Flushing	2	50	1	I			50		equipment TBD
SEPTAGE									
Septage Receiving Unit	1	40	1	I			40		
Rock Trap	1	25	1	I			25		
CHEM FEED									
Carrier water	2	3	2	C	6				
HOSE STATIONS									
Headworks	1	25	1	I			25		
Grit	1	25	1	I			25		
Septage	1	25	1	I			25		
YARD HYDRANTS									
UV Distinfection	1	50	1	I			50		
Secondary Clarifiers	1	50	1	I			50		
Splitter Structure 2	1			I					
IEQ1	1	100	1	I			100		
IEQ2	1	100		I					
IEQ Pump Station	1			I					
Grit Building	1			I					
Septage Area	1			I					
Junction Structure 3	1			I					
Yard Pump Station	1			I					
FIRE HYDRANTS	3	50	1	I			50		

PLANT WATER										
Plant Water Pumps	3	0.5	2	S					1.0	seal water
MIN. REQUIREMENT PER ELEMENT, GPM						6	5	25	0.5	
MAX. REQUIREMENT PER ELEMENT, GPM						180	30	100	1.5	
TOTAL, GPM						261	90	440	6.5	
TOTAL C & F							351	gpm		
TOTAL C, F, & I							791	gpm		
25% OF I							110	gpm		
DESIGN MIN 15 MINUTES					jocky pump	MIN	**5**	gpm		seal water only
DESIGN 8 HOURS/DAY					2 pumps	AVE	**351**	gpm		
DESIGN PEAK HOUR C, F, & 25% I					2 pumps	MAX	**461**	gpm		400 may be more realistic?

Work
250 gpm @ 70 psi
100 gpm @ 110 psi

SyncroFlo
Pumping System Solutions

TO:		**DATE:**	**July 8, 2015**
ATTN:		**QUOTE NUMBER:**	**150708JT-01**
QUOTED BY:	**FJT**		
PROJECT:	**Exeter PWS**	**LOCATION:**	**Exeter, NH**
ENGINEER:	**Wright Pierce**		

Schedule

Submittals: 6 weeks after acknowledgement of order. Include this proposal as part of the purchase order for this system. One copy in pdf is offered for representative and contractor. Contractor may print as many hard copies as he requires from the pdf.

Shipment: 16 weeks after receipt of approved submittals and release to production (release for fabrication consists of a signed submittal, signed general arrangement drawing and written release from the customer). Shipment date may change at release, depending on product availability from key vendors. Delivery date may be up to 10 days after shipment date, depending on carrier and distance from the factory.

Scope of Equipment

Factory built pumping system. Principal components are as listed below. Station shall be UL Listed as a complete unit under UL and ETL categories. Control panel shall be UL 508 listed.

System is quoted per RFQ dated **7/7/15**.
SyncroFlo is **ISO 9001:2008** certified, certificate number FM 555054.

System Particulars

- System Model Number: SFIMG3-3P438-VMS100
- System Design Flow Rate (GPM): 440 GPM
- System Rated Suction Pressure (PSI): Flooded
- System Rated Discharge Pressure (PSI): 100
- Power to Be Provided (Voltage/Phase/Hertz): 460/3/60
- System Approximate Dry Weight (lbs.): 5,700
- System Approximate Footprint: 6’ x 10’, not including controls

Mechanical

- Qty (1) Goulds 22eSV-5 pump with mechanical seal, rated at 100 GPM @ 246’ TDH including station losses.
- Qty (1) 15 hp 3600 RPM TEFC premium efficient motor, totally non overloaded, conforming to MG-1 Part 31 for use on inverter.
- Qty (1) 3" pump suction lug pattern butterfly valve, and grooved connector.
- Qty (1) 3" pump discharge grooved connector, check valve and lug pattern butterfly valve.

SyncroFlo, Inc. 2905 Pacific Drive, Norcross, GA 30071
Phone: 770.447.4443 Fax: 770.448.6120
www.syncroflo.com

- Qty (2) Goulds 46eSV-3/2 pumps with mechanical seals, each rated at 220 GPM @ 246' TDH including station losses.
- Qty (2) 25 hp 3600 RPM TEFC premium efficient motors, totally non overloaded, conforming to MG-1 Part 31 for use on inverter.
- Qty (2) 4" pump suction butterfly valves, and grooved connectors.
- Qty (2) 4" pump discharge grooved connectors, check valves and butterfly valves.
- Qty (3) thermal purge valves, mechanically operated.
- Qty (3) motor and pump ¼" neoprene pads as vibration isolators.
- Qty (1) 8" system inlet connection flange.
- Qty (1) 6" duplex basket strainer with 1/16" perforated SS screen.
- Qty (1) 6" 304 stainless steel suction manifold.
- Qty (1) set of 304 stainless steel branch piping.
- Qty (1) 6" 304 stainless steel discharge manifold.
- Qty (1) 2.5" pressure relief valve with butterfly valves at its inlet & outlet, discharging to suction.
- Qty (1) 4" Krohne electromagnetic flowmeter.
- Qty (1) 1/2" sample tap.
- Qty (1) 3/4" hose bibb with vacuum breaker.
- Qty (2) 1/2" manual air release valves.
- Qty (1) 6" system outlet connection flange.
- Qty (1) set of copper tubing for instrumentation connection.
- Qty (1) 185 gal 200 PSI ASME rated bladder tank, with 1" connection piping and full port ball valve.
- Qty (2) 4.5" and (3) 2.5" glycerin filled pressure gauges with isolation valves, pipe mounted.
- Qty (6) Skid anchor clips and stainless steel anchor bolts.
- Station skid, suitable for grouting on site.
- System to be blasted to SSPC-SP6.
- System to be primed and painted with an ISO 121944 C3 coating system, comprised of:
  - One coat of PPG Amerlock 2 series primer, 4.0-8.0 mils DFT
  - Two coats of PPG's Amercoat 450H Acrylic Aliphatic Polyurethane, 2.0-5.0 mils DFT per coat

<u>Controls:</u>

- Qty (1) UL listed NEMA 4X rated air conditioned control panel to house all logic and motor control for the pump system, shipped off skid for installation adjacent to the PWS, including:
  - Qty (1) Secondary surge & lightning arrestor.
  - Qty (1) Main disconnect circuit breaker, 25kAIC rated, with through door operator.
  - Qty (1) Phase monitor.
  - Qty (3) Motor circuit breakers, 25kAIC rated.
  - Qty (3) Dedicated VFDs, as manufactured by Mitsubishi, F740 series, with 5% line reactor.
  - Qty (3) Dedicated isolation contactors and full voltage bypass starters, IEC sized.
  - Qty (1) 110 volt control transformer.
  - Qty (1) Uninterruptable Power Supply
  - Qty (1) Set of 22 mm operator controls including:

SyncroFlo, Inc. 2905 Pacific Drive, Norcross, GA 30071
Phone: 770.447.4443   Fax: 770.448.6120
www.syncroflo.com

- Pump H-O-A switches
- Alarm reset push button
- Pump run lights - Green
- Alarm light - Red
- Control power light - White

- Qty (3) run time meters for pumps.
- Qty (1) 24VDC power supply.
- Qty (2) Pressure transmitters, one on suction header and one on discharge header.
- Qty (3) Pressure switches, one on each pump discharge to detect pump failure from any cause.
- Qty (3) Pressure switches on discharge manifold for pump operation in case of PLC failure.
- Qty (1) Pressure switch on suction manifold for low inlet pressure protection in case of PLC failure.
- Qty (1) Differential pressure switch across strainer for plugged strainer alarm.
- Qty (1) Four port unmanaged Ethernet switch.
- Qty (1) Allen Bradley MicroLogix 1400 programmable controller with successive and 24 hour pump alternation, sequence shifting, power failure restart sequence, pressure sequencing with staging delay, alarm systems, etc.
- Qty (1) Maple HMI5070NL color touch screen OIT (800 x 480 pixels). System can be used to access registers within the Microprocessor from the front of the control panel.
- Qty (1) Set of station OIT displayed items:
  - Selection of lead pump or selection of automatic alternation
  - Current suction pressure
  - Current discharge pressure
  - Current flow rate
  - Total accumulated flow
  - Pump run times
  - Pumping system diagnostics
  - Low inlet pressure alarm display
  - Low discharge pressure alarm display
  - High discharge pressure alarm display
  - Phase failure alarm display
  - Pump and/or VFD failure alarm display
- Qty (1) Terminal strip in control panel dedicated to SCADA interface.

Spare Parts:

- Qty (2) 1/16” perforated baskets for Hayward strainer
- Qty (3) Seal kits with gaskets, one per pump
- Qty (1) Set of control panel replacement fuses
- Qty (1) Set of pilot light replacement lamps

SCADA Ethernet Interface:

- Qty (3) auxiliary analog Ethernet signals including:
  - Suction Pressure (EAO)
  - Discharge Pressure E(AO)
  - Flow Rate (EAO)
- Qty (13) auxiliary Ethernet contacts including:
  - Each Pump Call (EDI x 3)
  - Each Pump Running (EDO x 3)
  - Each Pump Fault (EDO x 3)
  - Each System Alarm (EDO x 4):
    - Low inlet pressure
    - Low discharge pressure
    - High discharge pressure
    - Irregular power

Building:

- No building is offered.

Post Production:

- Hydrostatic test at 150 PSI for 20 minutes.
- Full factory functional and performance testing with X-Y plot.
  - Test rig is NIST traceable.
  - System test at 5 points from 0 to 125% of rated flow.
  - Flow rate at each point.
  - Suction pressure at each point.
  - Discharge pressure at each point.
- Freight to site via LTL carrier has been estimated and included.
- Installation is not included.
- Start-up, station calibration & operator training are included, 1 day on site allotted.
- Warranty is 1 Year from startup not to exceed 18 months from the date of shipment.
- Owner's Manual, SyncroFlo Standard format and information:
  - Based on approved submittal
  - Component manufacturers' manuals
  - Troubleshooting guide
  - As built mechanical drawings
  - As built electrical drawings
  - One copy in pdf is offered for representative and contractor. Contractor may print as many copies as he requires from the pdf.

Notes, Clarifications & Exceptions:

1. In reviewing the marked up drawing M-4 dated May 1988, the maximum space available for the plant water system appears to be 12' x 16', including the space directly below the hatch.

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Pumping System Solutions

2. Water supply to the pumps must have at least 2.5 feet of head at the suction manifold to be assured that the mechanical seals are adequately wetted at all times.
3. Request says voltage is 230/460/3/60. Offer is based on an available voltage of 460/3/60, and not on 230/3/60. Please advise if voltage is not 460/3/60.
4. Sample specification received required a backup control system in case the PLC failed. Backup control is pressure switch on and off for each pump and pressure switch for low inlet pressure, only actuated if PLC fails. Please advise if not required.
5. Isolation contactors and bypass starters are offered for operation of the pumps in case one or more VFD failure. Please advise if not required.

Budget Price: $PR,ICE.00

SyncroFlo terms and conditions:

> **Progress payment schedule – 30% due upon receipt of approved submittals and release to production, 65% Net 30 days at shipment from the Factory, 5% after start up, not to exceed 120 days from shipment**

Price is valid for 30 days from the above date and may be subject to change after that time. Tax is not included.

Submitted by:
John Santi
Municipal Sales Manager

Price does not include taxes, installation or crane.

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE

PROJECT NO.: 12883B

PRELIMINARY DESIGN PACKAGE

System/Subject:	Supplemental Alkalinity and Carbon Feed Systems		
Calculations By:	William Hankins	Date:	7/29/2015
Checked By:	Don Song	Date:	8/4/2015
Revised By:		Date:	
Checked By:		Date:	

Checklist (to be completed by Design Engineer prior to calculation checking):

X	Brief Process Description
	Graphs/Sketches of System Attached (Plans & Schematics)
	Design Calculations Attached
X	Design Guidelines/Standards Noted
	Equations Noted and Referenced
X	Electrical Loads Developed and Identified
X	Process Control Description Developed
	Preliminary Basis of Design (Support Divisions) Attached
	Construction Sequence Developed
X	Product Information Attached
	Manufacturer's Review of Specs and Drawings (If Applicable)
X	Electronic File Location Noted
X	Program(s) Used (Version) Noted
	Coordinated with Hydraulic Profile (If Applicable)

DESCRIPTION OF EXISTING FACILITIES

The Town of Exeter's wastewater treatment facility (WWTF) does not currently employ alkalinity and supplemental carbon feed.

FACILITY PLAN RECOMMENDATIONS

- Construct a supplemental alkalinity system to maintain pH for process control (nitrification/denitrification) and effluent pH compliance. This system will have a bulk liquid storage tank and two chemical feed pumps. This system will be housed in a dedicated building located near the Aeration Tanks.
- Construct a supplemental carbon storage and feed system to achieve 3-mg/l effluent TN. This system will have a bulk liquid storage tank and three chemical feed pumps suitable for use with methanol, MicroC® or similar products. This system will be an exterior installation.

CLIENT PREFERENCES

Client prefers the use of magnesium hydroxide over caustic for alkalinity.

The choice of supplemental carbon to be discussed.

DESIGN GUIDELINES (TR-16, EPA MANUAL, ETC.)

Section 7.4.2 Alkalinity and pH Adjustment

- It is good practice to provide the materials and equipment necessary to maintain the minimum level of alkalinity required in the effluent of biological treatment processes (preferably 75 mg/L of alkalinity).
- Liquid chemical storage tanks and tank fill connections should be located within a containment structure having a capacity of no less than 125 percent of the total volume of the storage vessel(s), excluding the volume of the storage vessel above the elevation of the containment wall. Valves on the discharge lines should be located adjacent to the

storage tank and within the containment structure. The containment area should slope to a sump area. No floor drains should be permitted in the containment area.

- Any auxiliary facilities, including pumps and pump controls located adjacent to the containment area, should be situated above the highest anticipated liquid level.
- Platforms, ladders, and railings should be provided as necessary for convenient and safe access to all connections, storage tank entries, and measuring devices.

Section 7.4.3 Chemical Feed

- Chemical feed facilities should supply peak demand with the largest unit out of service.
- Chemical feed equipment should continue to function properly in the event of a storage tank or pipe failure.
- Chemical overfeeding caused by induction siphoning must be prevented.
- Feed tanks should have drains for maintenance and above-bottom draw-offs to avoid the withdrawal of solids into chemical feed lines.
- Consider the accessibility of piping. Piping should be installed with plugged Ys, Ts, or crosses at changes in direction to facilitate cleaning.

Section 7.4.3.4 Protective Measures

- Chemical feed equipment and storage facilities should be constructed of materials resistant to chemical attack.
- Prevention of freezing or crystallization should be addressed in the design.
- Any structural shelter for equipment should have adequate ventilation for protection of personnel and equipment.

Section 6.3.11 Supplemental Carbon Addition

- Overdosing of supplemental carbon in a downstream anoxic zone will result in product breakthrough and a [potential] violation of the effluent BOD permit. Therefore, feed pumps should be calibrated so the supplemental carbon source is just sufficient to meet the stoichiometric requirement for denitrification. Consider varying the supplemental carbon feed rate by manual adjustment or flow pacing with on-line nitrate analyzers.

DESIGN GUIDELINES (NHDES Env-Wq)

The New Hampshire Code of Administrative Rules chapter Env-Wq 700 Standard of Design and Construction for Sewerage and Wastewater Treatment Facilities establishes minimum technical standards for the design of wastewater treatment facilities. However, the NH code does not include technical standards for supplemental alkalinity or carbon feed.

REVIEW OF DESIGN CONSIDERATION & ALTERNATIVES

Alkalinity Source

Alkalinity is commonly provided by various chemicals, including:

- Lime (quick or hydrated)
- Sodium hydroxide (caustic)
- Soda ash
- Magnesium hydroxide slurry

Of these chemicals, *magnesium hydroxide is selected* for the following advantages:

- No dust
- Safety in chemical handling
- Ease in storage and feed

As mag hydroxide is provided as a slurry, care must be provided in mixing of storage tanks and draining and cleaning of inactive piping.

Supplemental Carbon vs. Aeration Tank Volume

The third stage of the 4-stage Bardenpho process is a post-anoxic zone where residual nitrate levels are further reduced to achieve Total Nitrogen levels at the limit of technology (3-3.5 mg/L TN). Energy in the form of reduced carbon is required to drive the reaction, which could be provided by a supplemental carbon source or by endogenous bacterial metabolism. Kinetic rates of denitrification by methanol-utilizing bacteria can be up to 10 times faster than by endogenous metabolism (Tchobanaglous, 2002). Process modeling using BIOWIN 4.0 indicates that the total post-anoxic zone volume must be increased from 0.27 MG to 0.57 MG in order to provide sufficient endogenous metabolism reaction time to avoid supplemental carbon usage during average conditions. This translates into increasing the length of the tanks by 30 feet (or 15%).

Therefore, it is recommended to reduce aeration tank volume and add supplemental carbon for nitrate removal on a regular basis for the following reasons:

- Enlarging the aeration tanks would incur greater capital expense for construction. The debt retirement for the additional capital expenditure would be greater than the purchase of the chemical.
- Additional post-anoxic volume would require greater energy for anoxic mixing to offset chemical savings
- A supplemental carbon feed facility would be required at a minimum for peak nitrogen loading periods

Supplemental Carbon Source

Supplemental carbon is commonly provided using the following:

- Methanol
- Acetic Acid
- Micro C 1000 (formerly Micro C)
- Micro C 2000 (formerly Micro Cg)

The selection of supplemental carbon sources must consider safety and price variability. Methanol is extremely flammable and requires special storage and feed facilities that reduce risk of explosion. Micro C1000 and 2000 are proprietary products that are not hazardous, but are more expensive than methanol. Methanol is derived from petroleum, and as such is subject to greater price volatility than agricultural-based products such as acetic acid and the Micro C products. Acetic acid is generally used at smaller package plants with lower carbon requirements. Table 1 presents an evaluation of various carbon sources as provided by the EPA.

TABLE 1. SUPPLEMENTAL CARBON ALTERNATIVES

	Alcohols		Acetate		Carbohydrates			Co-products	EOSi Products	
Product Attribute	Methanol	Ethanol	Acetic Acid*	Sodium Acetate**	Corn Syrup	Molasses	Sucrose Solutuion	Crude Glycerin	MicroCg	MicroCglycerin
Safety / Flammability	1	1	2	4	4	4	4	4	4	4
Price Volatility	2	2	2	2	3	3	3	2	3	3
Rate of Denitrification	2	4	4	4	3	3	3	3	3	4
Viscosity / Handling	4	4	4	3	1	1	1	2	4	4
Freezing Point	4	4	4	1	2	2	2	3	3	4
Product Stability	4	4	4	4	2	2	1	3	4	4
Supply Availability	4	4	4	4	4	4	4	2	4	3
Quality Control	4	4	4	4	4	3	3	1	4	4
Cost	4	3	1	1	1	2	2	3	2	3
Large body of technical literature	4	4	4	4	2	2	2	2	3	3

*56% solution **30% solution. Requires mixing

4	Very Good
3	Good
2	Fair
1	Poor

An economic life cycle cost comparison between installation and utilization of methanol vs. Micro C 2000 is provided in Table 2.

TABLE 2. CARBON SOURCE LIFE CYCLE COST ANALYSIS

Alternative:	No.1 Methanol	No.2 Micro-C2000
CAPITAL AND CONSTRUCTION COST[1]	**$329,100**	**$178,447**
SRF Loan Rate	2.0%	2.0%
Loan Term, years	20	20
Capital Recover (A/P, i%, n)	0.061	0.061
Annual Debt Payment	$20,000	$11,000
OPERATION AND MAINTENANCE COSTS		
Operating Costs		
Annual Operating Cost ($/yr)	$14,700	$27,300
Net Present Worth ($) - O&M	$240,366	$446,394
Total Net Present Worth Over 20 Years	**$569,466**	**$624,841**

Notes:

1. Capital and Construction Cost represents construction cost (equipment and installation) and not project cost.
2. Assume methanol at $1.75/gallon, average demand 40 gallons/day for 210 days/yr.
3. Assume microC2000 at $2.50/gallon, average demand 52 gallons/day for 210 days/yr.

Table 2 shows that the estimated difference in life-cycle costs between the two options is 10 percent over 20 years, which indicates that the economic costs are essentially the same given the limits of the analysis. *Therefore, based on non-economic factors of safety and less exposure to risk due to petroleum price increases, utilization of Micro-C2000 is recommended.*

BASIS OF DESIGN

Supplemental Alkalinity

Process modeling indicates alkalinity demands of 90 gpd and 150 gpd 60% $Mg(OH)_2$ for average and maximum month current conditions. Demands of 120 gpd and 210 gpd for design annual average and maximum month conditions were projected. Bulk delivery of magnesium hydroxide is typically provided in 4,000 - 6,000 gallons. Therefore, a storage tank to hold 5,000 gallons will be installed in a separate building located at the aeration tanks. The magnesium hydroxide will be pumped to Junction Structure 2 ahead of the aeration tank distribution structure.

SUPPLEMENTAL ALKALINITY STORAGE TANK	
Application:	Chemical Feed
Type:	Cross-linked HDPE, double-wall, vertical
Capacity:	5,000 gallons
Nozzles:	Top frame-mounted mixer, suction, feed, level transmitter,
Mixer Motor HP:	7.5 HP
Acceptable Manufacturer(s):	Tanks: Polyprocessing, Snyder, Assmann Mixer: Flygt, Lightnin SPX
Accessories	Piping cleanouts/drains; Leak detection; Steel frame mixer mount unless mounted on structure; Chemical fill panel with alarms

SUPPLEMENTAL ALKALINITY FEED PUMPS	
Application:	Chemical Feed
Type:	Peristaltic Hose Pump
Capacity:	30 gph @ 50 psi
Number:	2 (1 duty/1 standby)
Mixer Motor HP:	0.75 HP
Acceptable Manufacturer(s):	Watson-Marlow APEX
Accessories	Suction Strainer, Calibration Columns, VFDs Chemical fill panel with alarms

Supplemental Carbon

Process modeling indicates carbon demands of 50 gpd and 160 gpd 60% Micro C 2000 for average and maximum month current conditions. Demands of 130 gpd and 230 gpd for design average and maximum month conditions were projected. A bulk storage tank of 3,000 gallons is recommended for supplemental carbon. The carbon is to be pumped directly to the post-anoxic zones (Zone F) near the anoxic mixer.

SUPPLEMENTAL CARBON STORAGE TANK	
Application:	Chemical Feed
Type:	Cross-linked HDPE, double-wall, vertical
Capacity:	3,000 gallons
Nozzles:	Suction, feed, level transmitter,
Acceptable Manufacturer(s):	Tanks: Polyprocessing, Snyder, Assmann
Accessories	Piping cleanouts/drains Leak detection

SUPPLEMENTAL CARBON FEED PUMPS	
Application:	Chemical Feed
Type:	Peristaltic Hose Pump
Capacity:	30 gph @ 50 psi
Number:	3 (2 duty/1 standby)
Mixer Motor HP:	0.75 HP
Acceptable Manufacturer(s):	Watson-Marlow APEX
Accessories	Suction Strainers, calibration columns, VFDs

BUILDING / STRUCTURE DESCRIPTION

The Supplemental Alkalinity system will be located in a separate building near the aeration tanks along with the Supplemental Carbon feed system. Total filled weight of tanks is estimated as:

Supplemental Alkalinity Tank (full tank) : 65,550 lb

Supplemental Carbon Tank (full tank): 34,050 lb

PROCESS CONTROL DESCRIPTION

Supplemental Alkalinity Storage and Mixing

A chemical fill panel will be provided for chemical suppliers at the exterior of the building. The panel will have a cam-lock fitting for fill pipe, and display % full of the tank and sound an alarm upon high level. Alarm for leak-detection will also be displayed. Tank level and leak-detection will also be transmitted to SCADA.

The mixer will have a local control station (LOR) and e-stop mounted near the pumps. In LOCAL, the mixer will run. In OFF, the mixer will not run. If REMOTE, the mixer will be controlled by the SCADA system. SCADA will allow for manual or repeat cycle timer mode of operation.

Supplemental Alkalinity Pumping

Each supplemental alkalinity pump will have a local control station and e-stop mounted near the pumps. The mixers will be manual start/stop from either the local control station or from the SCADA system. Alkalinity pumps will have VFDs installed in a separate electrical room. Alternatively, options for integral VFDs and controls are available from the manufacturer if desired. When in Remote mode (automatic mode in SCADA), pump speed shall be paced to match either an operator-adjustable feed rate or operator-adjustable pH setpoint. The feed rate shall be determined as a proportion of the feed rate measured at maximum speed. A PID algorithm will control speed as a function of pH measured by a pH meter at the effluent of the aeration tanks.

Supplemental Carbon Storage

A chemical fill panel will be provided for chemical suppliers at the exterior of the building. The panel will have a cam-lock fitting for fill pipe, and display % full of the tank and sound an alarm upon high level. Alarm for leak-detection will also be displayed. Tank level and leak-detection will also be transmitted to SCADA.

Supplemental Carbon Pumping

Each supplemental carbon pump will have a local control station and e-stop mounted near the pumps. The mixers will be manual start/stop from either the local control station or from the SCADA system. Carbon pumps will have VFDs installed in a separate electrical room. Alternatively, options for integral VFDs and controls are available from the manufacturer if desired.

When in Remote mode (automatic mode in SCADA), pump speed shall be paced to match either an operator-adjustable feed rate or operator-adjustable nitrate setpoint. The feed rate shall be determined as a proportion of the feed rate measured at maximum speed. A PID algorithm will control speed as a function of the nitrate concentration as measured by an online nitrate meter at the effluent of the aeration tanks.

The following instruments, control panels, and local control stations are anticipated:

Item	Local/Remote	NEMA	By Division	Range/Units
Local Control Station Supplemental Carbon Feed Pump 1 and 2 (MicroC)	local	4X	13	n/a
Local Control Station Supplemental Carbon Feed Pump 3 (FUTURE)	local	4X	13	n/a

Item	Local/Remote	NEMA	By Division	Range/Units
Local Control Station Supplemental Alkalinity Feed Pump 1 and 2	local	4X	13	n/a
Chemical Fill Panels (2)	local	4X	13	n/a
Supplemental Alkalinity Tank Level Element	local	4X	13	0 to XX feet
Supplemental Carbon Tank Level Element	local	4X	13	0 to XX feet
Supplemental Alkalinity Tank Leak Detection	local	4X	13	ON/OFF
Supplemental Carbon Tank Leak Detection	local	4X	13	ON/OFF

Electrical information:

Supplemental Alkalinity Mixer	
Power	7.5 HP
Speed	Constant
Enclosure	Unclassified
Volts, Phase/ Hz	460/ 3/ 60

Supplemental Alkalinity Feed Pumps	
Number	2 (1 duty, 1 standby)
Power	0.75 HP
Speed	Variable
Enclosure	Unclassified
Volts, Phase/ Hz	460/ 3/ 60

Supplemental Carbon Feed Pumps	
Number	3 (2 duty, 1 standby)
Power	0.75 HP
Speed	Variable
Enclosure	Unclassified
Volts, Phase/ Hz	460/ 3/ 60

X Coordinated with NFPA Memo

X Coordinated with Equipment List

CONSTRUCTION SEQUENCING

Not Applicable

FUTURE EXPANSION CONSIDERATIONS

Space shall be reserved for an additional supplemental carbon pump for a future third train.

FILE LOCATION

J:\ENG\NH\Exeter\12883-WWTF\12883B-WW Design\Technical\Process\Design Memos\A-15 Supplemental Alkalinity and Carbon.docx

ATTACHMENTS

Supplemental Carbon Storage

Cutsheet: Tank

Supplemental Carbon Storage

Cutsheet: Tank

Supplemental Carbon and Alkalinity Feed Pumps

Cutsheet: Watson-Marlow APEX 10

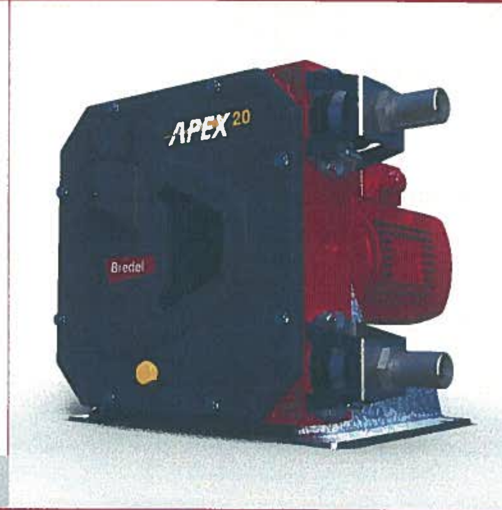
APEX10, APEX15 and APEX20 hose pumps

APEX SERIES

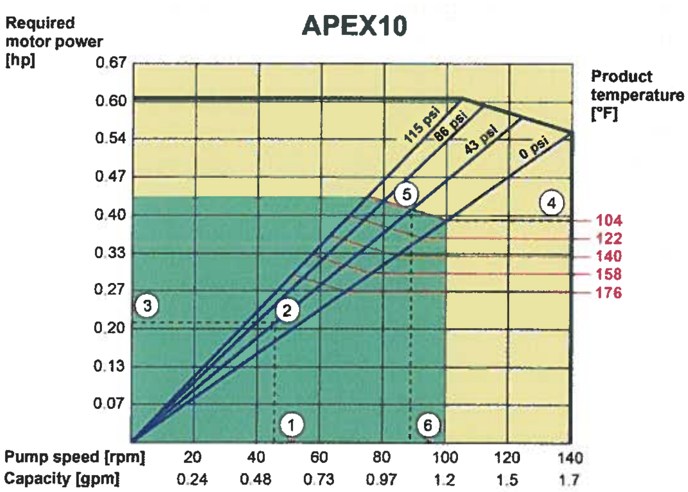
Bredel Hose Pumps

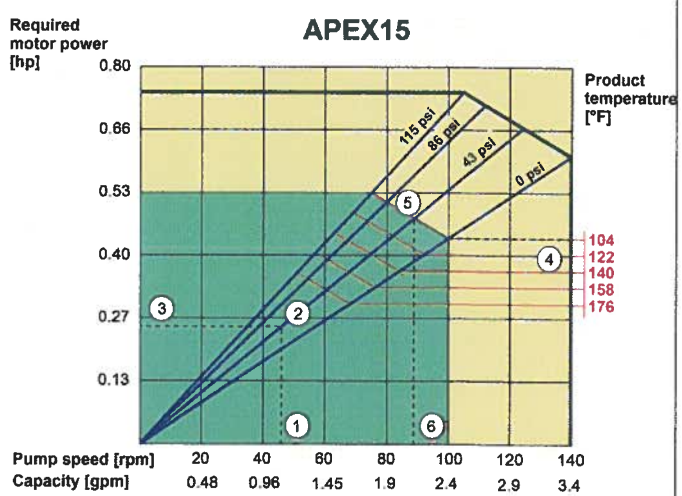
FEATURES

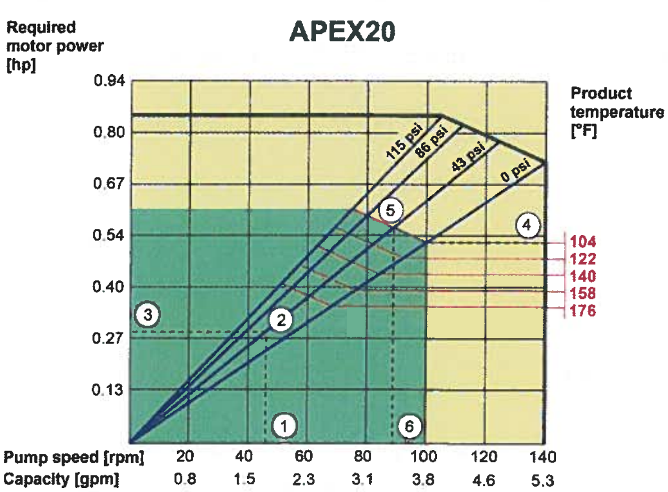
- Seal less, valveless pumping principle for reliable, low maintenance chemical metering
- Single compact pump is configurable to accept three hose element sizes to future-proof your process
- Compact direct coupled design minimizes loading on gear motor
- Flow rates from 0.74 to 371 GPH and pressure up to 116 psi
- Long life hose element provides significantly reduced maintenance
- Decreased cost of ownership due to single component change, low inventory stocking



PERFORMANCE







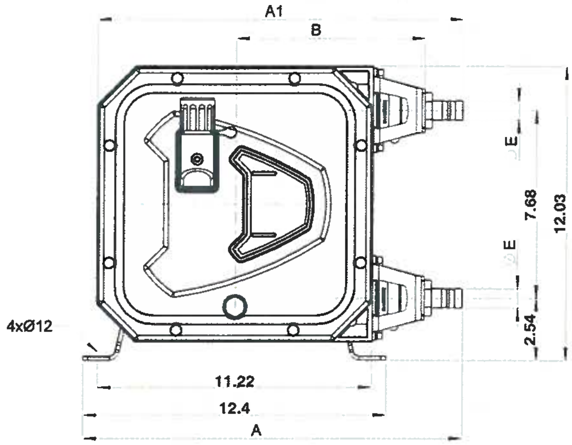
Continuous Duty

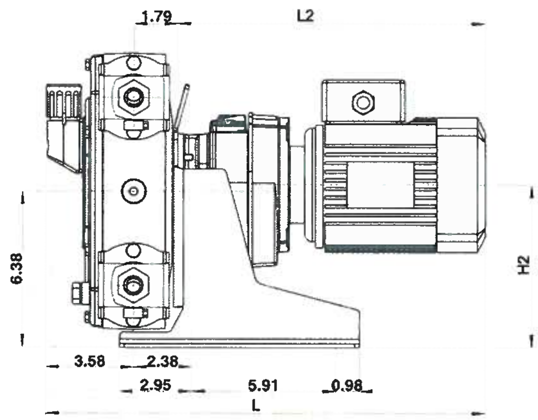
Intermittent Duty*

* Maximum 3 hours operation followed by minimum 1 hour stop

1 Flow required indicates pump speed
2 Calculated discharge pressure
3 Net motor power required
4 Product temperature
5 Calculated discharge pressure
6 Maximum recommended pump speed

DRAWINGS





	A	A1	B	E	H2max	Lmax	L2max
APEX10	15.3	17.7	7.8	1/2"NPT	6.7	18.7	14.5
APEX15/20	15.5	14.98	7.8	3/4" NPT	6.7	18.7	14.5

All dimensions in [inches]

SPECIFICATION

	APEX10	APEX15	APEX20
Flow range continuous	0.74 - 74 GPH	1.45 - 145.3 GPH	2.3 - 230 GPH
Flow range intermittent	0.74 - 103 GPH	1.45 - 203.4 GPH	2.3 - 317 GPH
Capacity	0.012 G/rev	0.024 G/rev	0.038 G/rev
Minimum starting torque	425 in lb	505 in lb	505 in lb
Inner diameter pump element	Ø 10 mm	Ø 15 mm	Ø 20 mm
Common features			
Maximum discharge pressure	116 psi		
Supply	230/460/3ph/60Hz, fixed speed or inverter duty		
Continuous operating speed	up to 100 rpm		
Intermittent operating speed	up to 140 rpm		
Product temperature range	14°F up to 176°F		
Ambient temperature range	4°F up to 113°F		
Hose lubricant required	0.26 G		
Weight of complete pumphead	35 lbs		
Typical weight of a complete pump	104 lbs (will vary on type of motor and gearbox used)		

MATERIALS OF CONSTRUCTION

	APEX10/15/20
Pump housing	Die cast aluminium (color RAL 3011)
Pump rotor with integral shoes	Cast iron
Cover	Copolyester
Brakets	AISI 316
Pump support	Galvanized steel
Fasteners	AISI 316
Hose clamps	AISI 316
Dynamic seal	NBR
Cover window	PMMA
Cover seal	EPDM
Hose connection sealing bush	EPDM

Options	APEX10/15/20
Available hose materials	NR, NBR, EPDM, CSM
Available rotors	Low pressure rotor (0-58 psi) Medium pressure rotor (0-116 psi)
Available port configurations	Ports left (position 1), right (postion 2), up (position 3) and down (position 4). Standard configuration position 2.
Available fitting materials	316SS, PVC, Polypropylene
Available fitting types	1/2" NPT or ANSI Flange (APEX10), 3/4" NPT or ANSI Flange (APEX 15/20), hose barb or tri-clamp style

wmpg.com
support@wmpg.us

Bredel
Hose Pumps

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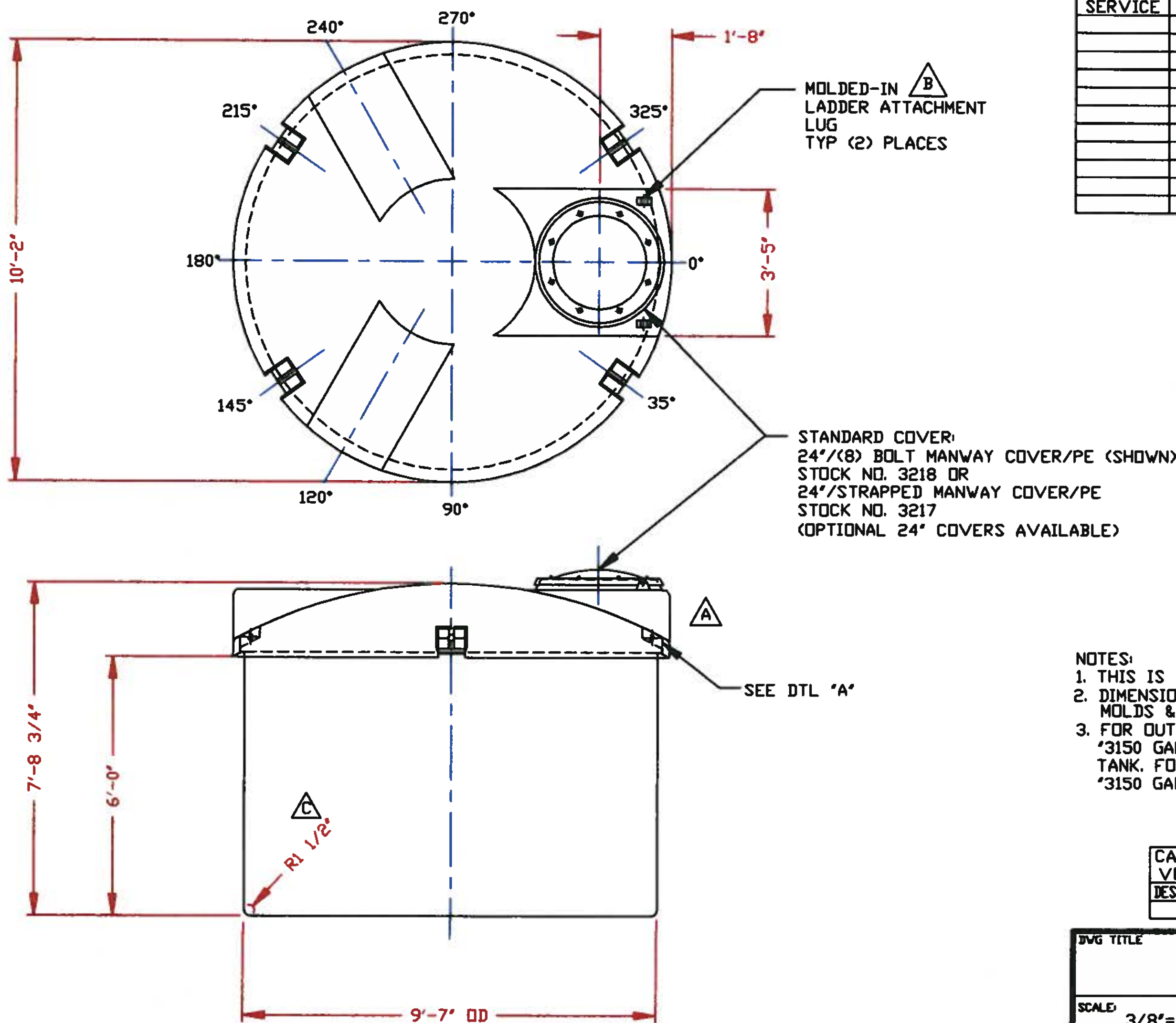
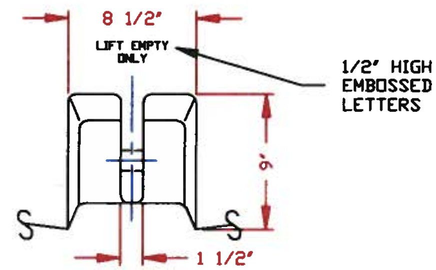


NOZZLE SCHEDULE & ACCESSORIES

SERVICE	MK	STOCK NO.	SIZE	FITTING	DEG	ELEV



DETAIL "A"
SCALE: 1 1/2"=1'-0"

NOTES:
1. THIS IS A COMPUTER GENERATED DWG. DO NOT REVISE BY HAND.
2. DIMENSIONS WILL VARY ±3% DUE TO VARIATIONS IN MULTIPLE MOLDS & CONDITIONS PREVALENT DURING MANUFACTURE & USAGE.
3. FOR OUTER TANK DTLS SEE COMPUTER FILE NO. 2103550, TITLE "3150 GALLON OUTER SAFE-TANK/3550 GALLON OPEN TOP TANK. FOR ASSEMBLY SEE COMPUTER FILE NO. 2003150A, TITLE "3150 GALLON SAFE-TANK ASSEMBLY".

CALCULATED CAPACITIES/ VOLUME IN U.S. GALLONS		
DESIGN CAP	DOME VOL	TOTAL VOL
3191	419	3610

DWG TITLE: 3150 GALLON INNER SAFE-TANK

SCALE: 3/8"=1'-0"	POLY PROCESSING COMPANY	DR: MB WILKERSON	
DATE: 12/6/99		CK: D. RECTOR	
SHEET: 1 OF 1	COMPUTER FILE: 2003150	REV: C	

REV "C" REVISED RADIUS BY:JB 3/2/10 CK:WM
REV "B" ADDED LADDER ATTACHMENT LUGS BY:JB 10/1/04 CK:WM
REV "A" MODIFICATION TO MOLD BY:MBW 9/10/02 CK:JB

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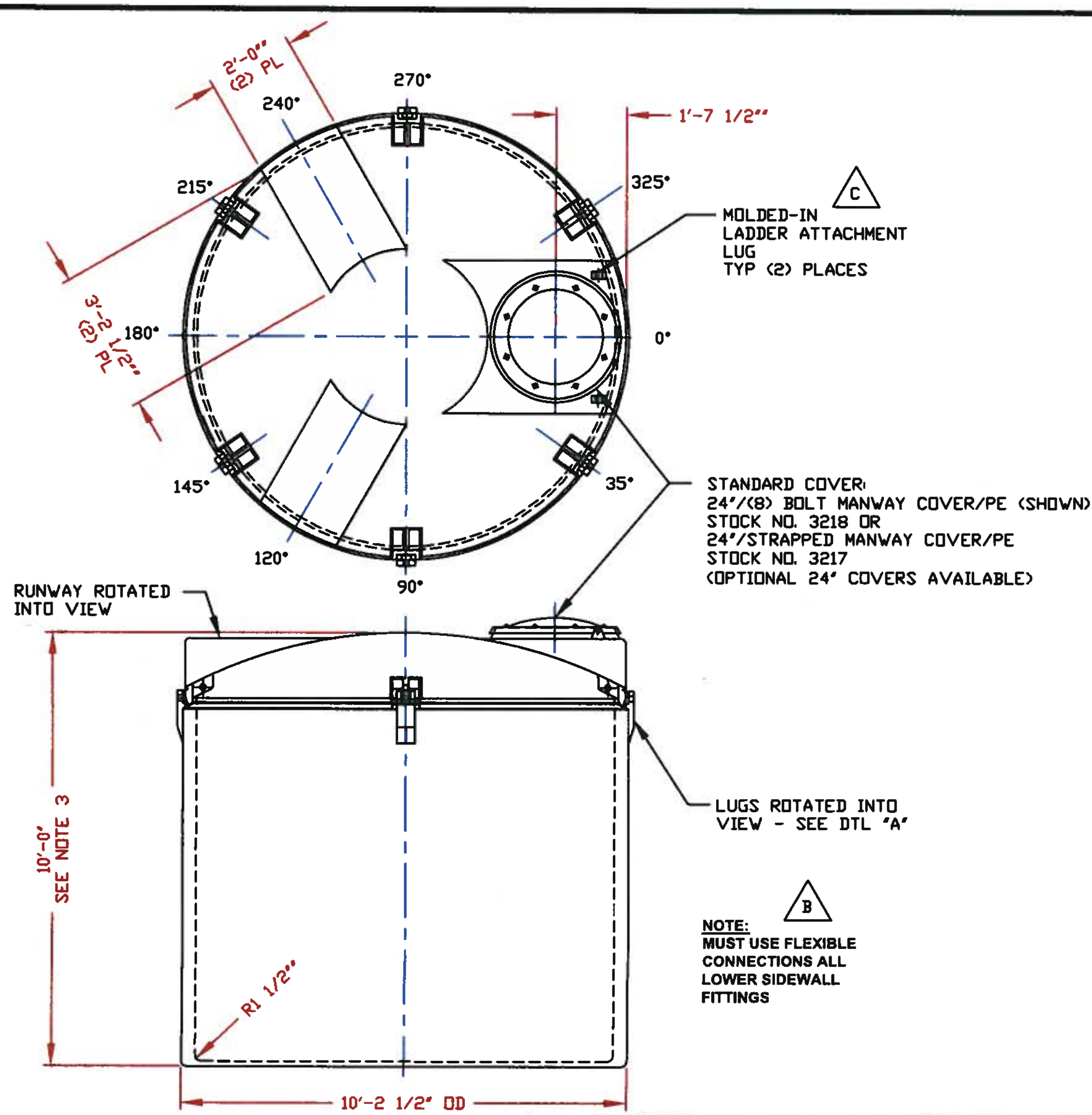
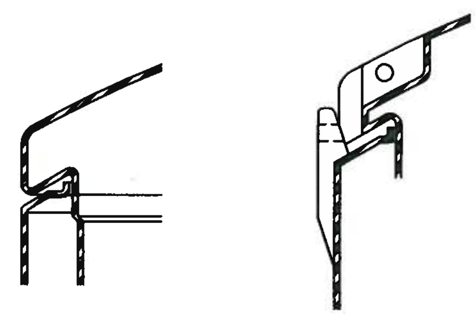


NOZZLE SCHEDULE & ACCESSORIES						
SERVICE	MK	STOCK NO.	SIZE	FITTING	DEG	ELEV



LIP DETAIL
SCALE: 1 1/2" = 1'-0"

LIP DETAIL AT LUG
SCALE: 1 1/2" = 1'-0"

NOTES:
1. THIS IS A COMPUTER GENERATED DWG. DO NOT REVISE BY HAND.
2. DIMENSIONS WILL VARY ±3% DUE TO VARIATIONS IN MULTIPLE MOLDS & CONDITIONS PREVALENT DURING MANUFACTURE & USAGE.
3. OVERALL HEIGHT DIMENSION WILL VARY WITH THE PENETRATION OF THE INNER TANK INTO THE OUTER TANK.
4. NO MOLDED IN GALLONAGE MARKERS THESE TANKS.
5. FOR INNER TANK DTLS SEE COMPUTER FILE NO. 2004400, TITLE "4400 GALLON INNER SAFE-TANK" FOR OUTER TANK DTLS SEE COMPUTER FILE NO. 2104950, TITLE "4400 GALLON OUTER SAFE-TANK/4950 GALLON OPEN TOP TANK."

CALCULATED CAPACITIES/ VOLUME IN U.S. GALLONS			
TANK	DESIGN CAP	DOME VOL	TOTAL VOL
INNER	4385	437	4822
OUTER	4994	N/A	4994

DWG TITLE: 4400 GALLON SAFE-TANK ASSEMBLY

SCALE: 3/8"=1'-0"
DATE: 12/7/99

POLY PROCESSING
SOLUTIONS. SIMPLIFIED.

Central Region

DR: MB WILKERSON
CK: D. RECTOR
SHEET: 1 OF 1
COMPUTER FILE: 2004400A
REV: C

REV "C" ADDED LADDER ATTACHMENT LUGS BY:JB 8/30/04 CK:WM
REV "B" ADDED FITTING NOTE BY:MBW 4/16/03 CK:JB
REV "A" REDRAWN SHOWING MOLD MODIFICATIONS BY:MBW 5/15/02 CK:JB

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE

PROJECT NO.: 12883B

PRELIMINARY DESIGN PACKAGE

System/Subject:	HYPOCHLORITE FOR RETURN SLUDGE LINE		
Calculations By:	JEFF MERCER	Date:	8/4/15
Checked By:	ED LEONARD	Date:	8/7/2015
Revised By:		Date:	
Checked By:		Date:	

Checklist (to be completed by Design Engineer prior to calculation checking):

- x Brief Process Description
- \- Graphs/Sketches of System Attached (Plans & Schematics)
- x Design Calculations Attached
- x Design Guidelines/Standards Noted
- \- Equations Noted and Referenced
- x Electrical Loads Developed and Identified
- x Process Control Description Developed
- x Preliminary Basis of Design (Support Divisions) Attached
- x Construction Sequence Developed
- \- Product Information Attached
- \- Manufacturer's Review of Specs and Drawings (If Applicable)
- x Electronic File Location Noted
- \- Program(s) Used (Version) Noted
- \- Coordinated with Hydraulic Profile (If Applicable)

DESCRIPTION OF EXISTING FACILITIES

The Exeter WWTF does not currently have a return activated sludge system.

FACILITY PLAN RECOMMENDATIONS

The Facility Plan did not cover details pertaining to the addition of hypochlorite to the return sludge line.

CLIENT PREFERENCES

The client has not stated any preferences for the addition of hypochlorite to the return sludge line at this time.

DESIGN GUIDELINES

The NHDES WQ-700 design standards do not have any requirements related to the addition of hypochlorite to the RSL.

TR-16 does not provide any recommendations.

References for RSL chlorine dosage includes:

1. D. Jenkins, M.G. Richard and G. Daigger, Lewis Publishers (1993). *Causes and Control of Activated Sludge Bulking and Foaming, Second Edition*. Boca Raton, FL: Lewis Publishers.

2. Black & Veatch. (2011). *White's Handbook of Chlorination and Alternative Disinfectants.* Overland Park, KS: John Wiley & Sons.

REVIEW OF DESIGN CONSIDERATION & ALTERNATIVES

The addition of hypochlorite to the return sludge line allows operators to chlorinate return sludge to control floc formation in the aeration tanks. Using the return sludge discharge main header as an application point provides hydraulic mixing and contact with microorganisms in the return sludge stream.

Typical dosages range from 2 to 8 lbs of chlorine per 1,000 pounds of mixed liquor volatile suspended solids per day. There are currently two secondary treatment options (Option 3 and Option 6) with slightly different MLVSS concentrations and aeration volumes. Chlorine will be fed from a 330 gallon tote with 12.5% chlorine concentration. The dosage/concentration will be controlled by the operators and the pumps will be paced based on the return sludge flow rate. The exact dosage will be based on operator experience and monitoring effects within the secondary treatment system. Approximate dosages are summarized in **Table 1** below. Using these preliminary calculations a peristaltic chemical feed pump can be sized for 0.9 to 16 gph of 12.5% chlorine solution which equates to a chlorine concentration of 1.5 to 6.0 mg/l of flow to the aeration tanks.

TABLE 1: CHLORINE DOSAGE

Option 3	MLVSS (mg/l)	Oxic Volume (MG)	MLVSS (lbs)	Chlorine (mg/l)	Chlorine (lbs/d)	Chlorine Solution (gpd)	Pump Rate (gph)
Min Day	1,052	1.24	10,880	2	22	21	0.9
Design Ave	2,057	1.86	31,909	6	191	184	7.7
Max Month	2,983	2.04	50,752	8	406	389	16
Option 6							
Min Day	956	1.38	11,003	2	22	21	0.9
Design Ave	1,883	2.07	32,507	6	195	187	7.8
Max Month	3,081	1.5	38,543	8	308	296	12

BASIS OF DESIGN

CHLORINE FEED PUMP	
Application	Inject RSL with Chlorine solution
Number/Type	1 / peristaltic tubing pump
Design Flow	Minimum of 0.5 to 20 gph
Discharge Pressure	30 psi
Discharge Piping	Marprene II tubing or equal
Pump Speed	220 rpm
Speed Control Ratio, min	2200:1
Power	120V/1ph/60hz
Acceptable Manufacturer(s)	Watson Marlow, Flowrox

BUILDING / STRUCTURE DESCRIPTION

The hypochlorite feed pump will be located in the Solids Handling Building lower floor adjacent to the return sludge pumps. Space will be retained for a second future pump and chemical drum. The pumps will be located on top of the drum and draw directly from them and discharge into the common RSL discharge header.

A containment area will be constructed with a minimum of 425 gallons of storage (two days of chemical at design average). The sump will be covered with FRP grating and the chemical contianer located over the sump.

Structural information:

Chemical Pumps	
Weight (approx.)	<50 lb
Containment Sump	
Volume	426 gal
Dimensions	6-ft by 9.5-ft by 1-ft

PROCESS CONTROL DESCRIPTION

The Solids Handling Building Lower Level pump room will be designated a NEMA 4X (Unclassified) space.

<u>Chemical Feed Pump</u>

The chemical feed pump will have local controls at the pump through a PLC/HMI with a MANUAL/AUTO selector. In manual, the operator will control the pump speed at the pump. In Auto, the operator sets the desired hypochlorite concentration and the pump speed will vary based on RSL feed rate and influent flow rate (total) to maintain the desired concentration. The pumps will be able to receive a 4-20ma signal from a nearby PLC to enable remote control through SCADA.

The following instruments, control stations, and control panels are anticipated:

Item	**Local/Remote**	**NEMA**	**By Division**	**Range**
Float Switch (containment)	Local	Unclassified/4X	13	-
Pump LCS (on pump)	Local	Unclassified/4X	11-OEM	-

Electrical information:

	Chemical Feed Pump
Number	1
Power	n/a
Speed	variable
Enclosure	4X
Volts, Phase/ Hz	120/ 1/ 60

x Coordinated with NFPA Memo

x Coordinated with Equipment List

CONSTRUCTION SEQUENCING

The Hypochlorite system for the RSL piping may be constructed at the same time as the return sludge pumps and piping.

FUTURE EXPANSION CONSIDERATIONS

Space will be retained for a second drum and pump for future needs. The containment area will be sized for two drums.

FILE LOCATION

12883B-WW Design\Technical\Process\Design Memos

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE

PROJECT NO.: 12883B

PRELIMINARY DESIGN PACKAGE

System/Subject:	Lagoon Decommissioning		
Calculations By:	ANDY MORRILL	Date:	08/07/2015
Checked By:	ED LEONARD	Date:	08/28/2015
Revised By:	ANDY MORRILL	Date:	08/28/2015
Checked By:	ED LEONARD	Date:	08/28/2015

Checklist (to be completed by Design Engineer prior to calculation checking):

X Description of Existing Facilities

X Facility Plan Recommendations

X Design Guidelines/Standards Noted

X Basis of Design

X Implementation Items

X Implementation Steps

X Construction Sequence

X Electronic File Location Noted

DESCRIPTION OF EXISTING FACILITIES

Three aerated lagoons are located behind the Control and Grit Buildings and were re-graded and re-configured during the 1988 upgrade. The Aerated Lagoon Data Table below summarizes key dimensional data associated with the aerated lagoons.

AERATED LAGOON DATA

<table>
<tr><th colspan="2">Dimensions</th><th>Lagoon No.1</th><th>Lagoon No.2</th><th>Lagoon No.3</th></tr>
<tr><td colspan="2">Volume at Average Design Flow (MG)</td><td>26.0</td><td>27.0</td><td>23.4</td></tr>
<tr><td colspan="2">Water Surface Area (acres)</td><td>9.01</td><td>9.30</td><td>8.22</td></tr>
<tr><td rowspan="2">Water Surface Elevation (ft)</td><td>Average Design Flow</td><td>25.40</td><td>16.27</td><td>15.28</td></tr>
<tr><td>Peak Design Flow</td><td>25.60</td><td>16.50</td><td>15.72</td></tr>
<tr><td colspan="2">Maximum Depth (ft)[1]</td><td>9.6</td><td>10.5</td><td>9.7</td></tr>
<tr><td colspan="2">Bottom Elevation (ft)</td><td>16.0</td><td>6.0</td><td>6.0</td></tr>
<tr><td colspan="2">Freeboard (ft)</td><td>2.4</td><td>1.5</td><td>2.3</td></tr>
</table>

Note: 1. Maximum depth calculated at Peak Design Flow.

The quantity of sludge in the lagoons has been estimated a few of times over the past 10 years. These reports have indicated potential range of sludge in the lagoons of between approximately 1,290 dry tons at 3% solids to 2,150 dry tons at 5% solids (Underwood, 2005) and approximately 1,800 dry tons at 4% solids (Wright-Pierce based on SolarBee service report, 2013).

In October 2014, Wright-Pierce conducted a sludge survey in order to provide a more current assessment of the quantity and quality of sludge in the lagoons. This survey consisted of taking “sludge judge” measurements on a 100-foot grid in each of the three lagoons. A composite sludge sample was collected from each lagoon and was submitted for laboratory analysis in order to compare to the Sludge Quality Certification (SQC) metals criteria specified in Env-Wq 807.03(c). This analysis indicated a potential range of sludge in the lagoons of between approximately 1,850 dry tons at 3% solids and 3,080 dry tons at 5% solids (See Sludge Survey Results and Volume Analysis Table below).

SLUDGE SURVEY RESULTS AND VOLUME ANALYSIS

Sludge Lagoon	Avg. Total Depth (ft)	Avg. Sludge Depth (ft)	Wet Sludge Volume (ft^3)	Wet Sludge Weight (tons)	Dry Sludge Weight (tons) based on Percent Solids		
					3%	4%	5%
No. 1	8.3	2.5	1,020,000	31,900	958	1,278	1,597
No. 2	7.7	1.3	490,000	15,200	457	609	762
No. 3	7.6	1.4	470,000	14,600	438	583	729
Total[1]	-	-	1,980,000	61,800	**1,853**	**2,471**	**3,088**

[1]Sludge Storage Lagoon not included in total.

The sludge storage lagoon was estimated to have approximately 500 dry tons based on discussions with the Town on its' use and by comparing the quantities found in lagoons No. 1, 2 and 3. A more detailed analysis is being scheduled and advice will be sought from Charley Hanson of Resource Management, Inc. and Paul Senesac of P.H. Senesac, Inc.

The laboratory analysis also indicated that some metals (molybdenum and zinc) may slightly exceed the SQC values. It is believed that the high zinc readings could be attributed to the use of a corrosion inhibitor by the water treatment plant and further investigation is needed to verify this assumption. Initial discussions with NHDES indicate that a waiver could potentially be pursued or that blending with wood ash may be needed. Ultimately, a more detailed assessment will be required by NHDES, at a point in time closer to the actual sludge removal, in order to obtain a SQC. The “Aerated Lagoon Sludge Survey” memorandum dated 02 February 2015 which summarizes this effort is included as Attachment A.

FACILITY PLAN RECOMMENDATIONS

1. A review of decommissioning alternatives was conducted in the Facilities Plan (See Section 5.7) and included the following methods.
    - Method No. 1 - Cap and Monitor Lagoon
    - Method No. 2 - Dewater and Dispose of Sludge
    - Method No. 3 - Dry and Dispose of Sludge
    - Method No. 4 - Keep Aerated Lagoons in Process
2. Once decommissioning is completed there are three options for end use of the land.
    - Option 1 - Fill the lagoons with clean water (i.e., not part of the treatment process)
    - Option 2 - Fill the lagoons with backfill and reuse the site for municipal purposes (e.g., recreational uses, public works uses; etc.)
    - Option 3 - Removing all/portions of the lagoon embankments and restoring the area to flood plains and brackish wetlands for the Squamscott River.
3. The following recommendations were made in the Facilities Plan.
    - Abandon the existing Aerated Lagoons. Abandon/remove structures and piping.
    - Conduct decommissioning of former Aerated Lagoon Nos. 1, 2, 3 and the former Sludge Storage Lagoon in accordance with a NHDES-approved Closure Plan. Decommissioning is assumed to consist of hydraulically dredging, dewatering and disposal of the sludge as an "unclassified waste" by a construction contractor.
    - Repurpose the former Sludge Storage Lagoon as the location for the majority of the new WWTF tankage and buildings.
    - Repurpose former Aerated Lagoon No. 1 to new influent equalization basins.
    - Restore brackish flood plains and tidal wetlands within former Aerated Lagoons No. 2 and No. 3 to brackish flood plains/tidal wetlands. Continue discussions with NHDES.
    - Pursue NHDES grants (e.g., the Aquatic Resource Mitigation (ARM) Fund) to offset restoration costs for design, demolition, construction, legal fees and/or plantings.

- Prior to deciding on the fate of the lagoons, consider whether diurnal (river), tidal (river) or seasonal (spray irrigation) discharge strategies help with the river water quality objectives.

DESIGN GUIDELINES (TR-16, EPA MANUAL, ETC.)

Federal standards 40 CFR Part 503 – Standards for the use or disposal of sewage sludge.

1. This part establishes standards, which consist of general requirements, pollutant limits, management practices, and operational standards, for the final use or disposal of sewage sludge generated during the treatment of domestic sewage in a treatment works. Standards are included in this part for sewage sludge applied to the land, placed on a surface disposal site, or fired in a sewage sludge incinerator. Also included in this part are pathogen and alternative vector attraction reduction requirements for sewage sludge applied to the land or placed on a surface disposal site.
2. In addition, the standards in this part include the frequency of monitoring and recordkeeping requirements when sewage sludge is applied to the land, placed on a surface disposal site, or fired in a sewage sludge incinerator. Also included in this part are reporting requirements for Class I sludge management facilities, publicly owned treatment works (POTWs) with a design flow rate equal to or greater than one million gallons per day, and POTWs that serve 10,000 people or more.

DESIGN GUIDELINES (NHDES Env-Wq)

The lagoon decommissioning will be in accordance with the following NHDES Code of Administrative Rules from Chapter ENV-Wq 800 Sludge Management.

- Env-Wq 804.03 Sludge Quality Certification Required
- Env-Wq 807 Sludge Quality Certification Requirements
- Env-Wq 808.09 Closure Plan

BASIS OF DESIGN

The lagoon decommissioning basis of design is Method No. 2 – Dewater and Dispose of sludge and the end use Option No. 3 – Flood Plain/Wetlands Restoration. The lagoon decommissioning basis of design is consistent with the facility plan and a bulleted summary is provided below.

- Will provide the fastest method of decommissioning.
- The former Sludge Storage Lagoon will be repurposed for the new WWTF tankage and buildings.
- The former Aerated Lagoon No. 1 will be repurposed for the new influent equalization basins
- The former Aerated Lagoons Nos. 2 and 3 will be repurposed to provide natural flood plains and brackish wetlands for the Squamscott River as well as a safe habitat for the numerous bird species present.

IMPLEMENTATION ITEMS

1. Prepare and obtain an approved NHDES Lagoon Closure Plan
    a. Apply for and obtain one or more Sludge Quality Certificate (SQC). Ideally contractor could be responsible for obtaining SQC
2. Submit Invasive Species Management Plan for the WWTF and for the regional pockets of invasive species upstream and downstream of the WWTF. Obtain NHDES approval for the plan as a part of project permitting.
3. Restore former Aerated Lagoons Nos. 2 and 3 to flood plains and wetlands.
4. Consider the following sources for funding restoration at the WWTF site.
    a. Wetland Compensation Bank (Would need to be created via NHDES/EPA guidelines)
    b. Aquatic Resource Mitigation Fund
    c. Other funding sources (e.g. Duck's Unlimited, Federal grants, State grants)
5. Consider the following sources for funding of off-site invasive species management.
    a. NHDOT
    b. NHDES
    c. National Resources Conservation Service
    d. Rockingham County Conservation Commission
    e. Town of Newfields
    f. Town of Stratham

CONSTRUCTION SEQUENCING

1. Continue treatment through Aerated Lagoon Nos. 1, 2 and 3.
2. If Aerated Lagoon No. 2 is nitrifying during the late summer months, provide a source of pH to the influent.
3. Decommission former Sludge Storage Lagoon.
4. Construct the new WWTF and access road.
5. Startup the new WWTF.
6. Use former Aerated Lagoon No. 2 as temporary influent equalization.
7. Decommission former Aerated Lagoon No. 1.
8. Construct the new Influent Equalization Basins within decommissioned Aerated Lagoon No. 1. Start up the new IEQ basins and pump station.

9. Decommission former Aerated Lagoon No. 2 and 3.
10. Restore former Aerated Lagoon Nos. 2 and 3 to flood plains and brackish wetlands for the Squamscott River.

FILE LOCATION
J:\Eng\NH\Exeter\12883-WWTF\12883B-WW Design\Technical\Process\Design Memos

ATTACHMENTS

A "Aerated Lagoon Sludge Survey" memorandum dated 02 February 2015

WRIGHT-PIERCE
Engineering a Better Environment

MEMORANDUM

TO:	Project Team	DATE:	02 February 2015
FROM:	Ed Leonard, PE Andy Morrill, PE Michael Curry	PROJECT NO.:	12883A
SUBJECT:	Exeter, NH – Wastewater Facilities Plan Aerated Lagoon Sludge Survey		

INTRODUCTION

The Exeter WWTF includes three aerated wastewater lagoons. As part of the Wastewater Facilities Plan, a sludge sampling survey was conducted by Wright-Pierce with the purpose of refining the lagoon decommissioning cost estimate. This memorandum summarizes the survey procedures, sludge volume analysis, sludge sample analysis, and regulatory impacts.

SLUDGE LAGOON SURVEY

The purpose of the sludge lagoon survey was to assess the quantity and quality of the sludge in each lagoon. The sludge survey procedure proposed the use of three different test methods at each location using a portable TSS/solids probe, "sludge judge" and fish/depth finder. Different sampling methods were initially used to determine the most accurate and efficient means of sampling. After initial trials, it was found that the TSS/solids probe and fish/depth finder was not able to provide reliable data. Therefore all survey data was collected using the "sludge judge".

The sludge survey was completed during the week of October 24, 2014. Sampling grids for each lagoon were created in 100-foot intervals and geo-referenced in a handheld GPS unit prior to the survey as shown on Figure 1. At each sample location, a 10-foot "sludge judge" was carefully lowered from the boat to the bottom of the lagoon. The sludge judge was then raised, and the sludge blanket thickness was measured and recorded.

One composite sludge sample was collected from each lagoon for laboratory analysis. The composite sample from each lagoon (1,500 mL) consisted of three randomly selected discrete samples (500 mL). The composite samples were thoroughly mixed and then split into duplicates (120 mL) and both duplicate samples were analyzed for selected metals and percent solids.

SLUDGE SAMPLE ANALYSIS

Both duplicate sludge samples for each lagoon were analyzed by a certified private laboratory for Sludge Quality Certification (SQC) metals specified in Env-Wq 807.03(c). The laboratory results are presented in the Analytical Report (Attachment A) and a summary of the laboratory results can be found in Table 1. Results indicate that two of the metals exceeded SQC Criteria in several of the samples. Molybdenum exceeded the SQC Criteria (35 mg/kg) in one of the samples in Lagoon 2 and both samples in Lagoon 3. Zinc exceeded the SQC Criteria (2,500 mg/kg) in both samples in Lagoon 1 and Lagoon 2.

Additional analyses are required to obtain a SQC, which are specified in Env-Wq 807.03(e) and are not included in this evaluation. These Interim Guidance Values (Attachment 2) for screening includes, but is not limited to: volatile organic compounds (VOCs); semi-volatile organic compounds (SVOCs); additional metals; pesticides; polychlorinated biphenyls (PCBs); dioxins; cyanides; and enteric virus. This screening analysis based on the Interim Guidance Values will determine the class sludge and site specific limitations.

Table 1: Sludge Metals Analysis

Analyte	*Lagoon 1*		*Lagoon 2*		*Lagoon 3*		Criteria for SQC Certification
	Dup. 1	Dup. 2	Dup. 1	Dup. 2	Dup. 1	Dup. 2	
Percent Solids (mg/kg)	4.62	4.86	3.69	4.42	2.65	2.56	-
Arsenic, Total (mg/kg)	24	24	20	18	16	21	32
Cadmium, Total (mg/kg)	<8.4	<8.0	<10	<8.6	<7.5	<7.5	14
Chromium, Total (mg/kg)	50	66	76	67	65	76	1,000
Copper, Total (mg/kg)	730	790	790	700	520	600	1,500
Lead, Total (mg/kg)	73	75	77	68	<74	<76	300
Mercury, Total (mg/kg)	4.3	2.8	2.3	2.3	<2.4	<2.5	10
Molybdenum, Total (mg/kg)	<21	26	**37**	33	**50**	**57**	35
Nickel, Total (mg/kg)	29	33	44	40	48	58	200
Selenium, Total (mg/kg)	<17	<16	<20	<17	<15	<15	28
Zinc, Total (mg/kg)	**3,300**	**3,500**	**2,900**	**2,600**	1900	2200	2,500

Note:

1. **Bold** font indicates a result above SQC Criteria (Env-Wq 807.03(c))

SLUDGE VOLUME ANALYSIS

The recorded sludge survey data points were used to develop GIS surface models of the lagoon sludge blankets for each lagoon. From these models, a wet sludge volume was calculated for each lagoon. The 3% to 5% range of solids concentrations for lagoon sludge was estimated based on sludge sampling laboratory results which ranged from 2.5% to 4.8% and from previous telephone communications with Paul Senesac of P.H. Senesac. Using the wet sludge volume, the dry weight of sludge was calculated over a 3% to 5% range of percent solids as shown in Table 2.

Table 2: Sludge Survey Results and Volume Analysis

Sludge Lagoon	Avg. Total Depth (ft)	Avg. Sludge Depth (ft)	Wet Sludge Volume (ft^3)	Wet Sludge Weight (tons)	Dry Sludge Weight (tons) based on Percent Solids		
					3%	4%	5%
No. 1	8.3	2.5	1,020,000	31,900	958	1,278	1,597
No. 2	7.7	1.3	490,000	15,200	457	609	762
No. 3	7.6	1.4	470,000	14,600	438	583	729
Total[1]	-	-	1,980,000	61,800	**1,853**	**2,471**	**3,088**

[1]Sludge Storage Lagoon not included in total.

REGULATORY IMPACTS

The data indicates that a SQC for the lagoon sludge could not be obtained in its current state due to molybdenum and zinc concentrations being marginally above the criteria value. Based on email correspondence with Mike Rainey (NHDES Residuals Management) on December 12, 2014, the lagoon sludge would require either 1) further treatment (i.e., blending) to lower the metals concentrations; or 2) a waiver to receive a SQC. Mr. Rainey indicated that waivers are not commonly granted and should not be considered a primary approach.

As a result, Wright-Pierce contacted Charley Hanson of Resource Management, Inc. by telephone on December 17, 2014, to discuss blending options to lower the metals concentrations in the sludge. Mr. Hanson indicated that wood ash could be blended with the dewatered sludge to effectively lower metals concentrations to below SQC criteria.

COST IMPACTS

Costs presented in Wastewater Facilities Plan were updated to reflect the findings of the initial aerated lagoon sludge survey. Based on telephone communications on December 17, 2014 with Paul Senesac of P.H. Senesac, the sludge dewatering and disposal unit cost of $1,000 per dry ton would be sufficient to include the added cost of wood ash blending. Estimated sludge dewatering and disposal costs are shown in Table 3.

Table 3: Estimated Sludge Dewatering and Disposal Costs

Sludge Lagoon	Total Cost Based on Percent Solids ($1,000/dry ton[1])		
	3%	4%	5%
No. 1	$960,000	$1,280,000	$1,600,000
No. 2	$460,000	$610,000	$770,000
No. 3	$440,000	$590,000	$730,000
Total	**$1,860,000**	**$2,480,000**	**$3,100,000**

[1]Sludge dewatering and disposal unit cost based on Town of Peterborough Lagoon Closure bid results (July 10, 2014, ENR CCI 9835) and discussions with P. H. Senesac

RECOMMENDATIONS

We offer the following recommendations.

- In the design phase, perform additional sampling and laboratory analysis in all three aerated lagoons to obtain an SQC based on the criteria listed in the NHDES Interim Guidance Values (Attachment 2).

- In the design phase, perform a sludge survey for the sludge storage lagoon to quantify the sludge volume and analyze samples for the metals specified in Env-Wq 807.03(c).

- Update the costs carried in the Wastewater Facilities Plan (Preliminary Draft, October 2014)

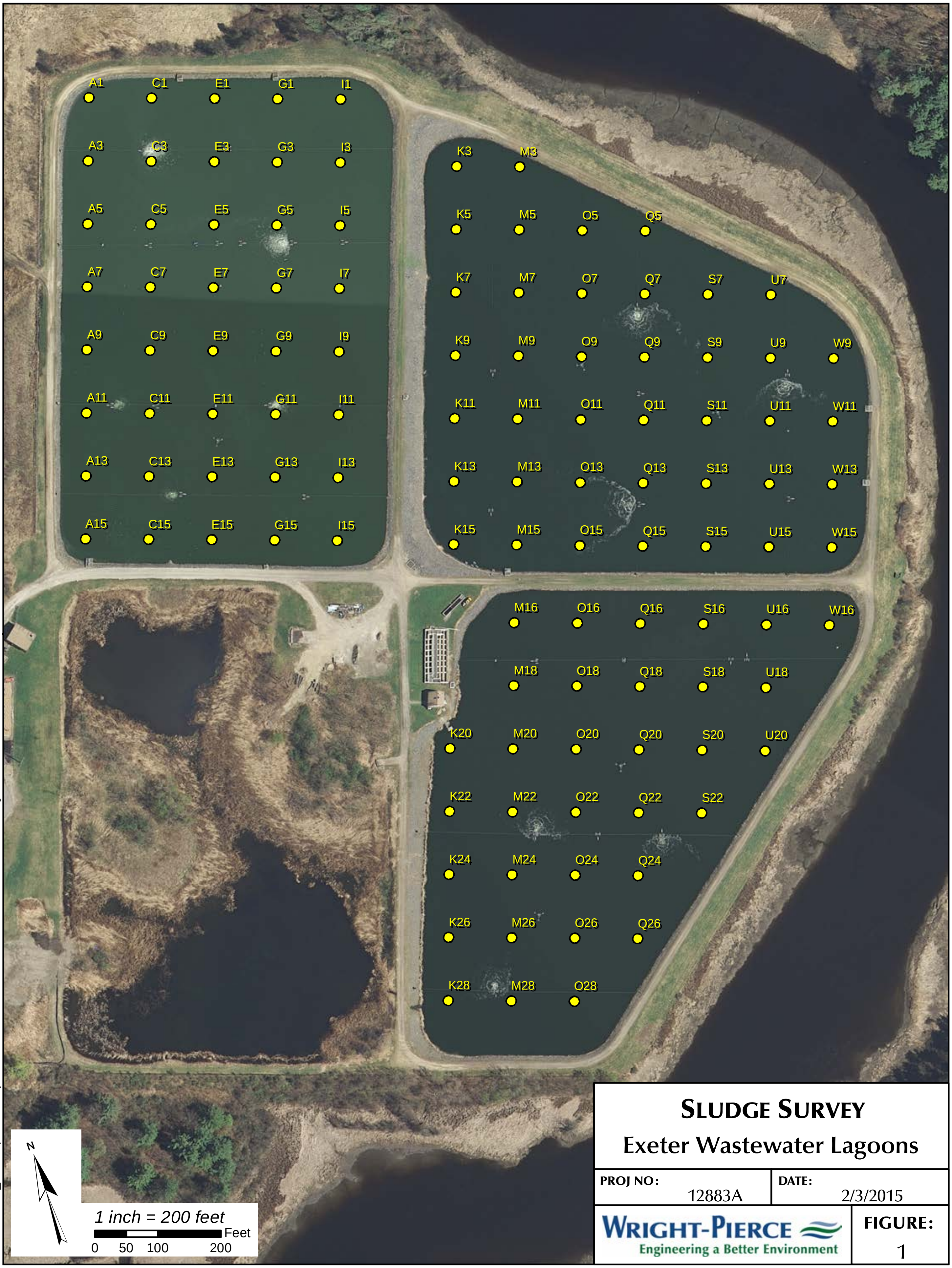
Figure

- Figure 1 – Sludge Survey Grid

Attachments

- Attachment A – Laboratory Analytical Report – Sludge Samples (January 8, 2015)

- Attachment B – Interim Guidelines (March 30, 2001)



SLUDGE SURVEY

Exeter Wastewater Lagoons

PROJ NO: 12883A	DATE: 2/3/2015
WRIGHT-PIERCE Engineering a Better Environment	FIGURE: 1

JMN W:\GIS_Development\Projects\NH\Exeter\12883A-WWFacilitiesPlan\MXDs\LagoonsGrid.mxd

ANALYTICAL REPORT

Lab Number:	L1425833
Client:	Wright-Pierce 230 Commerce Way Suite 302 Portsmouth, NH 03801
ATTN:	Michael Curry
Phone:	(603) 430-6094
Project Name:	EXETER WWTF LAGOONS
Project Number:	12883A
Report Date:	01/08/15

Certifications & Approvals: MA (M-MA086), NY (11148), CT (PH-0574), NH (2003), NJ NELAP (MA935), RI (LAO00065), ME (MA00086), PA (68-03671), USDA (Permit #P-330-11-00240), NC (666), TX (T104704476), DOD (L2217), US Army Corps of Engineers.

Eight Walkup Drive, Westborough, MA 01581-1019
508-898-9220 (Fax) 508-898-9193 800-624-9220 - www.alphalab.com

Project Name: EXETER WWTF LAGOONS
Project Number: 12883A

Lab Number: L1425833
Report Date: 01/08/15

Alpha Sample ID	Client ID	Matrix	Sample Location	Collection Date/Time	Receive Date
L1425833-01	LAGOON 1 SAMPLE 1	SOIL	EXETER, NH	10/27/14 12:00	10/29/14
L1425833-02	LAGOON 1 SAMPLE 2	SOIL	EXETER, NH	10/27/14 12:00	10/29/14
L1425833-03	LAGOON 2 SAMPLE 1	SOIL	EXETER, NH	10/29/14 09:30	10/29/14
L1425833-04	LAGOON 2 SAMPLE 2	SOIL	EXETER, NH	10/29/14 09:30	10/29/14
L1425833-05	LAGOON 3 SAMPLE 1	SOIL	EXETER, NH	10/29/14 11:00	10/29/14
L1425833-06	LAGOON 3 SAMPLE 2	SOIL	EXETER, NH	10/29/14 11:00	10/29/14

Case Narrative

The samples were received in accordance with the Chain of Custody and no significant deviations were encountered during the preparation or analysis unless otherwise noted. Sample Receipt, Container Information, and the Chain of Custody are located at the back of the report.

Results contained within this report relate only to the samples submitted under this Alpha Lab Number and meet all of the requirements of NELAC, for all NELAC accredited parameters. The data presented in this report is organized by parameter (i.e. VOC, SVOC, etc.). Sample specific Quality Control data (i.e. Surrogate Spike Recovery) is reported at the end of the target analyte list for each individual sample, followed by the Laboratory Batch Quality Control at the end of each parameter. If a sample was re-analyzed or re-extracted due to a required quality control corrective action and if both sets of data are reported, the Laboratory ID of the re-analysis or re-extraction is designated with an "R" or "RE", respectively. When multiple Batch Quality Control elements are reported (e.g. more than one LCS), the associated samples for each element are noted in the grey shaded header line of each data table. Any Laboratory Batch, Sample Specific % recovery or RPD value that is outside the listed Acceptance Criteria is bolded in the report. All specific QC information is also incorporated in the Data Usability format of our Data Merger tool where it can be reviewed along with any associated usability implications. Soil/sediments, solids and tissues are reported on a dry weight basis unless otherwise noted. Definitions of all data qualifiers and acronyms used in this report are provided in the Glossary located at the back of the report.

In reference to questions H (CAM) or 4 (RCP) when "NO" is checked, the performance criteria for CAM and RCP methods allow for some quality control failures to occur and still be within method compliance. In these instances the specific failure is not narrated but noted in the associated QC table. The information is also incorporated in the Data Usability format of our Data Merger tool where it can be reviewed along with any associated usability implications.

Please see the associated ADEx data file for a comparison of laboratory reporting limits that were achieved with the regulatory Numerical Standards requested on the Chain of Custody.

HOLD POLICY
For samples submitted on hold, Alpha's policy is to hold samples (with the exception of Air canisters) free of charge for 21 calendar days from the date the project is completed. After 21 calendar days, we will dispose of all samples submitted including those put on hold unless you have contacted your Client Service Representative and made arrangements for Alpha to continue to hold the samples. Air canisters will be disposed after 3 business days from the date the project is completed.

Please contact Client Services at 800-624-9220 with any questions.

Project Name: EXETER WWTF LAGOONS **Lab Number:** L1425833
Project Number: 12883A **Report Date:** 01/08/15

Case Narrative (continued)

Report Submission

This report replaces the report issued November 05, 2014. The reporting limits for Molybdenum were lowered on all samples, and for Selenium and Cadmium on samples L1425833-05 and -06.

At the client's request, the samples were also analyzed for Copper.

I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete. This certificate of analysis is not complete unless this page accompanies any and all pages of this report.

Authorized Signature: Lisa Westerlind

Title: Technical Director/Representative Date: 01/08/15

METALS

Project Name:	EXETER WWTF LAGOONS	**Lab Number:**	L1425833
Project Number:	12883A	**Report Date:**	01/08/15

SAMPLE RESULTS

Lab ID:	L1425833-01	Date Collected:	10/27/14 12:00
Client ID:	LAGOON 1 SAMPLE 1	Date Received:	10/29/14
Sample Location:	EXETER, NH	Field Prep:	Not Specified
Matrix:	Soil		
Percent Solids:	5%		

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
Total Metals - Westborough Lab											
Antimony, Total	ND		mg/kg	42	--	1	10/30/14 21:02	11/04/14 20:33	EPA 3050B	1,6010C	MG
Arsenic, Total	24		mg/kg	8.4	--	1	10/30/14 21:02	11/04/14 20:33	EPA 3050B	1,6010C	MG
Beryllium, Total	ND		mg/kg	4.2	--	1	10/30/14 21:02	11/04/14 20:33	EPA 3050B	1,6010C	MG
Cadmium, Total	ND		mg/kg	8.4	--	1	10/30/14 21:02	11/04/14 20:33	EPA 3050B	1,6010C	MG
Chromium, Total	50		mg/kg	8.4	--	1	10/30/14 21:02	11/04/14 20:33	EPA 3050B	1,6010C	MG
Copper, Total	730		mg/kg	8.4	--	1	10/30/14 21:02	11/04/14 20:33	EPA 3050B	1,6010C	MG
Lead, Total	73		mg/kg	42	--	1	10/30/14 21:02	11/04/14 20:33	EPA 3050B	1,6010C	MG
Mercury, Total	4.3		mg/kg	1.5	--	1	10/31/14 09:01	10/31/14 14:52	EPA 7471B	1,7471B	MC
Molybdenum, Total	ND		mg/kg	21	--	1	10/30/14 21:02	11/04/14 20:33	EPA 3050B	1,6010C	MG
Nickel, Total	29		mg/kg	21	--	1	10/30/14 21:02	11/04/14 20:33	EPA 3050B	1,6010C	MG
Selenium, Total	ND		mg/kg	17	--	1	10/30/14 21:02	11/04/14 20:33	EPA 3050B	1,6010C	MG
Silver, Total	15		mg/kg	8.4	--	1	10/30/14 21:02	11/04/14 20:33	EPA 3050B	1,6010C	MG
Thallium, Total	ND		mg/kg	17	--	1	10/30/14 21:02	11/04/14 20:33	EPA 3050B	1,6010C	MG
Zinc, Total	3300		mg/kg	42	--	1	10/30/14 21:02	11/04/14 20:33	EPA 3050B	1,6010C	MG

Project Name:	EXETER WWTF LAGOONS	**Lab Number:**	L1425833
Project Number:	12883A	**Report Date:**	01/08/15

SAMPLE RESULTS

Lab ID:	L1425833-02	Date Collected:	10/27/14 12:00
Client ID:	LAGOON 1 SAMPLE 2	Date Received:	10/29/14
Sample Location:	EXETER, NH	Field Prep:	Not Specified
Matrix:	Soil		
Percent Solids:	5%		

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
Total Metals - Westborough Lab											
Antimony, Total	ND		mg/kg	40	--	1	10/30/14 21:02	11/04/14 20:36	EPA 3050B	1,6010C	MG
Arsenic, Total	24		mg/kg	8.0	--	1	10/30/14 21:02	11/04/14 20:36	EPA 3050B	1,6010C	MG
Beryllium, Total	ND		mg/kg	4.0	--	1	10/30/14 21:02	11/04/14 20:36	EPA 3050B	1,6010C	MG
Cadmium, Total	ND		mg/kg	8.0	--	1	10/30/14 21:02	11/04/14 20:36	EPA 3050B	1,6010C	MG
Chromium, Total	66		mg/kg	8.0	--	1	10/30/14 21:02	11/04/14 20:36	EPA 3050B	1,6010C	MG
Copper, Total	790		mg/kg	8.0	--	1	10/30/14 21:02	11/04/14 20:36	EPA 3050B	1,6010C	MG
Lead, Total	75		mg/kg	40	--	1	10/30/14 21:02	11/04/14 20:36	EPA 3050B	1,6010C	MG
Mercury, Total	2.8		mg/kg	1.3	--	1	10/31/14 09:01	10/31/14 14:54	EPA 7471B	1,7471B	MC
Molybdenum, Total	26		mg/kg	20	--	1	10/30/14 21:02	11/04/14 20:36	EPA 3050B	1,6010C	MG
Nickel, Total	33		mg/kg	20	--	1	10/30/14 21:02	11/04/14 20:36	EPA 3050B	1,6010C	MG
Selenium, Total	ND		mg/kg	16	--	1	10/30/14 21:02	11/04/14 20:36	EPA 3050B	1,6010C	MG
Silver, Total	17		mg/kg	8.0	--	1	10/30/14 21:02	11/04/14 20:36	EPA 3050B	1,6010C	MG
Thallium, Total	ND		mg/kg	16	--	1	10/30/14 21:02	11/04/14 20:36	EPA 3050B	1,6010C	MG
Zinc, Total	3500		mg/kg	40	--	1	10/30/14 21:02	11/04/14 20:36	EPA 3050B	1,6010C	MG

Project Name: EXETER WWTF LAGOONS **Lab Number:** L1425833
Project Number: 12883A **Report Date:** 01/08/15

SAMPLE RESULTS

Lab ID: L1425833-03
Client ID: LAGOON 2 SAMPLE 1
Sample Location: EXETER, NH
Matrix: Soil
Percent Solids: 4%
Date Collected: 10/29/14 09:30
Date Received: 10/29/14
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
Total Metals - Westborough Lab											
Antimony, Total	ND		mg/kg	51	--	1	10/30/14 21:02	11/04/14 20:40	EPA 3050B	1,6010C	MG
Arsenic, Total	20		mg/kg	10	--	1	10/30/14 21:02	11/04/14 20:40	EPA 3050B	1,6010C	MG
Beryllium, Total	ND		mg/kg	5.1	--	1	10/30/14 21:02	11/04/14 20:40	EPA 3050B	1,6010C	MG
Cadmium, Total	ND		mg/kg	10	--	1	10/30/14 21:02	11/04/14 20:40	EPA 3050B	1,6010C	MG
Chromium, Total	76		mg/kg	10	--	1	10/30/14 21:02	11/04/14 20:40	EPA 3050B	1,6010C	MG
Copper, Total	790		mg/kg	10	--	1	10/30/14 21:02	11/04/14 20:40	EPA 3050B	1,6010C	MG
Lead, Total	77		mg/kg	51	--	1	10/30/14 21:02	11/04/14 20:40	EPA 3050B	1,6010C	MG
Mercury, Total	2.3		mg/kg	1.8	--	1	10/31/14 09:01	10/31/14 14:56	EPA 7471B	1,7471B	MC
Molybdenum, Total	37		mg/kg	26	--	1	10/30/14 21:02	11/04/14 20:40	EPA 3050B	1,6010C	MG
Nickel, Total	44		mg/kg	25	--	1	10/30/14 21:02	11/04/14 20:40	EPA 3050B	1,6010C	MG
Selenium, Total	ND		mg/kg	20	--	1	10/30/14 21:02	11/04/14 20:40	EPA 3050B	1,6010C	MG
Silver, Total	23		mg/kg	10	--	1	10/30/14 21:02	11/04/14 20:40	EPA 3050B	1,6010C	MG
Thallium, Total	ND		mg/kg	20	--	1	10/30/14 21:02	11/04/14 20:40	EPA 3050B	1,6010C	MG
Zinc, Total	2900		mg/kg	51	--	1	10/30/14 21:02	11/04/14 20:40	EPA 3050B	1,6010C	MG

Project Name:	EXETER WWTF LAGOONS	**Lab Number:**	L1425833
Project Number:	12883A	**Report Date:**	01/08/15

SAMPLE RESULTS

Lab ID:	L1425833-04	Date Collected:	10/29/14 09:30
Client ID:	LAGOON 2 SAMPLE 2	Date Received:	10/29/14
Sample Location:	EXETER, NH	Field Prep:	Not Specified
Matrix:	Soil		
Percent Solids:	4%		

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
Total Metals - Westborough Lab											
Antimony, Total	ND		mg/kg	43	--	1	10/30/14 21:02	11/04/14 20:44	EPA 3050B	1,6010C	MG
Arsenic, Total	18		mg/kg	8.6	--	1	10/30/14 21:02	11/04/14 20:44	EPA 3050B	1,6010C	MG
Beryllium, Total	ND		mg/kg	4.3	--	1	10/30/14 21:02	11/04/14 20:44	EPA 3050B	1,6010C	MG
Cadmium, Total	ND		mg/kg	8.6	--	1	10/30/14 21:02	11/04/14 20:44	EPA 3050B	1,6010C	MG
Chromium, Total	67		mg/kg	8.6	--	1	10/30/14 21:02	11/04/14 20:44	EPA 3050B	1,6010C	MG
Copper, Total	700		mg/kg	8.6	--	1	10/30/14 21:02	11/04/14 20:44	EPA 3050B	1,6010C	MG
Lead, Total	68		mg/kg	43	--	1	10/30/14 21:02	11/04/14 20:44	EPA 3050B	1,6010C	MG
Mercury, Total	2.3		mg/kg	1.5	--	1	10/31/14 09:01	10/31/14 14:58	EPA 7471B	1,7471B	MC
Molybdenum, Total	33		mg/kg	22	--	1	10/30/14 21:02	11/04/14 20:44	EPA 3050B	1,6010C	MG
Nickel, Total	40		mg/kg	22	--	1	10/30/14 21:02	11/04/14 20:44	EPA 3050B	1,6010C	MG
Selenium, Total	ND		mg/kg	17	--	1	10/30/14 21:02	11/04/14 20:44	EPA 3050B	1,6010C	MG
Silver, Total	23		mg/kg	8.6	--	1	10/30/14 21:02	11/04/14 20:44	EPA 3050B	1,6010C	MG
Thallium, Total	ND		mg/kg	17	--	1	10/30/14 21:02	11/04/14 20:44	EPA 3050B	1,6010C	MG
Zinc, Total	2600		mg/kg	43	--	1	10/30/14 21:02	11/04/14 20:44	EPA 3050B	1,6010C	MG

Project Name:	EXETER WWTF LAGOONS	**Lab Number:**	L1425833
Project Number:	12883A	**Report Date:**	01/08/15

SAMPLE RESULTS

Lab ID:	L1425833-05	Date Collected:	10/29/14 11:00
Client ID:	LAGOON 3 SAMPLE 1	Date Received:	10/29/14
Sample Location:	EXETER, NH	Field Prep:	Not Specified
Matrix:	Soil		
Percent Solids:	3%		

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
Total Metals - Westborough Lab											
Antimony, Total	ND		mg/kg	74	--	1	10/30/14 21:02	11/04/14 21:08	EPA 3050B	1,6010C	MG
Arsenic, Total	16		mg/kg	15	--	1	10/30/14 21:02	11/04/14 21:08	EPA 3050B	1,6010C	MG
Beryllium, Total	ND		mg/kg	7.4	--	1	10/30/14 21:02	11/04/14 21:08	EPA 3050B	1,6010C	MG
Cadmium, Total	ND		mg/kg	7.5	--	1	10/30/14 21:02	11/04/14 21:08	EPA 3050B	1,6010C	MG
Chromium, Total	65		mg/kg	15	--	1	10/30/14 21:02	11/04/14 21:08	EPA 3050B	1,6010C	MG
Copper, Total	520		mg/kg	15	--	1	10/30/14 21:02	11/04/14 21:08	EPA 3050B	1,6010C	MG
Lead, Total	ND		mg/kg	74	--	1	10/30/14 21:02	11/04/14 21:08	EPA 3050B	1,6010C	MG
Mercury, Total	ND		mg/kg	2.4	--	1	10/31/14 09:01	10/31/14 14:59	EPA 7471B	1,7471B	MC
Molybdenum, Total	50		mg/kg	37	--	1	10/30/14 21:02	11/04/14 21:08	EPA 3050B	1,6010C	MG
Nickel, Total	48		mg/kg	37	--	1	10/30/14 21:02	11/04/14 21:08	EPA 3050B	1,6010C	MG
Selenium, Total	ND		mg/kg	15	--	1	10/30/14 21:02	11/04/14 21:08	EPA 3050B	1,6010C	MG
Silver, Total	19		mg/kg	15	--	1	10/30/14 21:02	11/04/14 21:08	EPA 3050B	1,6010C	MG
Thallium, Total	ND		mg/kg	30	--	1	10/30/14 21:02	11/04/14 21:08	EPA 3050B	1,6010C	MG
Zinc, Total	1900		mg/kg	74	--	1	10/30/14 21:02	11/04/14 21:08	EPA 3050B	1,6010C	MG

Project Name:	EXETER WWTF LAGOONS	**Lab Number:**	L1425833
Project Number:	12883A	**Report Date:**	01/08/15

SAMPLE RESULTS

Lab ID:	L1425833-06	Date Collected:	10/29/14 11:00
Client ID:	LAGOON 3 SAMPLE 2	Date Received:	10/29/14
Sample Location:	EXETER, NH	Field Prep:	Not Specified
Matrix:	Soil		
Percent Solids:	3%		

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Prep Method	Analytical Method	Analyst
Total Metals - Westborough Lab											
Antimony, Total	ND		mg/kg	76	--	1	10/30/14 21:02	11/04/14 21:11	EPA 3050B	1,6010C	MG
Arsenic, Total	21		mg/kg	15	--	1	10/30/14 21:02	11/04/14 21:11	EPA 3050B	1,6010C	MG
Beryllium, Total	ND		mg/kg	7.6	--	1	10/30/14 21:02	11/04/14 21:11	EPA 3050B	1,6010C	MG
Cadmium, Total	ND		mg/kg	7.5	--	1	10/30/14 21:02	11/04/14 21:11	EPA 3050B	1,6010C	MG
Chromium, Total	76		mg/kg	15	--	1	10/30/14 21:02	11/04/14 21:11	EPA 3050B	1,6010C	MG
Copper, Total	600		mg/kg	15	--	1	10/30/14 21:02	11/04/14 21:11	EPA 3050B	1,6010C	MG
Lead, Total	ND		mg/kg	76	--	1	10/30/14 21:02	11/04/14 21:11	EPA 3050B	1,6010C	MG
Mercury, Total	ND		mg/kg	2.5	--	1	10/31/14 09:01	10/31/14 15:01	EPA 7471B	1,7471B	MC
Molybdenum, Total	57		mg/kg	38	--	1	10/30/14 21:02	11/04/14 21:11	EPA 3050B	1,6010C	MG
Nickel, Total	58		mg/kg	38	--	1	10/30/14 21:02	11/04/14 21:11	EPA 3050B	1,6010C	MG
Selenium, Total	ND		mg/kg	15	--	1	10/30/14 21:02	11/04/14 21:11	EPA 3050B	1,6010C	MG
Silver, Total	16		mg/kg	15	--	1	10/30/14 21:02	11/04/14 21:11	EPA 3050B	1,6010C	MG
Thallium, Total	ND		mg/kg	30	--	1	10/30/14 21:02	11/04/14 21:11	EPA 3050B	1,6010C	MG
Zinc, Total	2200		mg/kg	76	--	1	10/30/14 21:02	11/04/14 21:11	EPA 3050B	1,6010C	MG

Project Name: EXETER WWTF LAGOONS **Lab Number:** L1425833
Project Number: 12883A **Report Date:** 01/08/15

Method Blank Analysis
Batch Quality Control

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Metals - Westborough Lab for sample(s): 01-06 Batch: WG736184-1										
Antimony, Total	ND		mg/kg	2.0	--	1	10/30/14 21:02	11/04/14 16:31	1,6010C	MG
Arsenic, Total	ND		mg/kg	0.40	--	1	10/30/14 21:02	11/04/14 16:31	1,6010C	MG
Beryllium, Total	ND		mg/kg	0.20	--	1	10/30/14 21:02	11/04/14 16:31	1,6010C	MG
Cadmium, Total	ND		mg/kg	0.20	--	1	10/30/14 21:02	11/04/14 16:31	1,6010C	MG
Chromium, Total	ND		mg/kg	0.40	--	1	10/30/14 21:02	11/04/14 16:31	1,6010C	MG
Copper, Total	ND		mg/kg	0.40	--	1	10/30/14 21:02	11/04/14 16:31	1,6010C	MG
Lead, Total	ND		mg/kg	2.0	--	1	10/30/14 21:02	11/04/14 16:31	1,6010C	MG
Molybdenum, Total	ND		mg/kg	1.0	--	1	10/30/14 21:02	11/04/14 16:31	1,6010C	MG
Nickel, Total	ND		mg/kg	1.0	--	1	10/30/14 21:02	11/04/14 16:31	1,6010C	MG
Selenium, Total	ND		mg/kg	0.40	--	1	10/30/14 21:02	11/04/14 16:31	1,6010C	MG
Silver, Total	ND		mg/kg	0.40	--	1	10/30/14 21:02	11/04/14 16:31	1,6010C	MG
Thallium, Total	ND		mg/kg	0.80	--	1	10/30/14 21:02	11/04/14 16:31	1,6010C	MG
Zinc, Total	ND		mg/kg	2.0	--	1	10/30/14 21:02	11/04/14 16:31	1,6010C	MG

Prep Information

Digestion Method: EPA 3050B

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
Total Metals - Westborough Lab for sample(s): 01-06 Batch: WG736266-1										
Mercury, Total	ND		mg/kg	0.08	--	1	10/31/14 09:01	10/31/14 13:15	1,7471B	MC

Prep Information

Digestion Method: EPA 7471B

Lab Control Sample Analysis
Batch Quality Control

Project Name: EXETER WWTF LAGOONS
Project Number: 12883A
Lab Number: L1425833
Report Date: 01/08/15

Parameter	LCS %Recovery	Qual	LCSD %Recovery	Qual	%Recovery Limits	RPD	Qual	RPD Limits
Total Metals - Westborough Lab Associated sample(s): 01-06 Batch: WG736184-2 SRM Lot Number: D083-540								
Antimony, Total	146		-		1-210	-		
Arsenic, Total	90		-		78-122	-		
Beryllium, Total	94		-		82-118	-		
Cadmium, Total	91		-		82-118	-		
Chromium, Total	92		-		79-121	-		
Copper, Total	95		-		80-120	-		
Lead, Total	89		-		81-119	-		
Molybdenum, Total	92		-		77-123	-		
Nickel, Total	89		-		82-118	-		
Selenium, Total	96		-		78-123	-		
Silver, Total	94		-		74-125	-		
Thallium, Total	86		-		78-122	-		
Zinc, Total	92		-		80-121	-		
Total Metals - Westborough Lab Associated sample(s): 01-06 Batch: WG736266-2 SRM Lot Number: D083-540								
Mercury, Total	100		-		75-126	-		

Matrix Spike Analysis
Batch Quality Control

Project Name: EXETER WWTF LAGOONS
Project Number: 12883A
Lab Number: L1425833
Report Date: 01/08/15

Parameter	Native Sample	MS Added	MS Found	MS %Recovery	Qual	MSD Found	MSD %Recovery	Qual	Recovery Limits	RPD	Qual	RPD Limits
Total Metals - Westborough Lab Associated sample(s): 01-06 QC Batch ID: WG736184-3 WG736184-4 QC Sample: L1425901-06 Client ID: MS Sample												
Antimony, Total	ND	47.2	42	89		34	75		75-125	**21**	Q	20
Arsenic, Total	3.6	11.3	14	92		12	77		75-125	15		20
Beryllium, Total	ND	4.72	4.6	97		4.4	97		75-125	4		20
Cadmium, Total	ND	4.82	4.7	98		4.4	95		75-125	7		20
Chromium, Total	14	18.9	31	90		30	88		75-125	3		20
Copper, Total	28	23.6	68	**169**	Q	46	79		75-125	**39**	Q	20
Lead, Total	120	48.2	310	**394**	Q	140	**43**	Q	75-125	**76**	Q	20
Molybdenum, Total	ND	94.5	84	89		81	89		75-125	4		20
Nickel, Total	15	47.2	56	87		54	86		75-125	4		20
Selenium, Total	ND	11.3	11	97		10	92		75-125	10		20
Silver, Total	ND	28.3	27	95		26	96		75-125	4		20
Thallium, Total	ND	11.3	9.6	85		9.3	85		75-125	3		20
Zinc, Total	93	47.2	310	**459**	Q	130	82		75-125	**82**	Q	20
Total Metals - Westborough Lab Associated sample(s): 01-06 QC Batch ID: WG736266-4 QC Sample: L1425818-01 Client ID: MS Sample												
Mercury, Total	ND	0.14	0.16	114		-	-		80-120	-		20

Lab Duplicate Analysis
Batch Quality Control

Project Name: EXETER WWTF LAGOONS
Project Number: 12883A

Lab Number: L1425833
Report Date: 01/08/15

Parameter	Native Sample	Duplicate Sample	Units	RPD	Qual	RPD Limits
Total Metals - Westborough Lab Associated sample(s): 01-06 QC Batch ID: WG736266-3 QC Sample: L1425818-01 Client ID: DUP Sample						
Mercury, Total	ND	ND	mg/kg	NC		20

INORGANICS
&
MISCELLANEOUS

Project Name: EXETER WWTF LAGOONS **Lab Number:** L1425833
Project Number: 12883A **Report Date:** 01/08/15

SAMPLE RESULTS

Lab ID: L1425833-01
Client ID: LAGOON 1 SAMPLE 1
Sample Location: EXETER, NH
Matrix: Soil

Date Collected: 10/27/14 12:00
Date Received: 10/29/14
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	4.62		%	0.100	NA	1	-	10/29/14 23:37	30,2540G	RT

Project Name: EXETER WWTF LAGOONS | **Lab Number:** L1425833
Project Number: 12883A | **Report Date:** 01/08/15

SAMPLE RESULTS

Lab ID: L1425833-02
Client ID: LAGOON 1 SAMPLE 2
Sample Location: EXETER, NH
Matrix: Soil

Date Collected: 10/27/14 12:00
Date Received: 10/29/14
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	4.86		%	0.100	NA	1	-	10/29/14 23:37	30,2540G	RT

Project Name: EXETER WWTF LAGOONS **Lab Number:** L1425833
Project Number: 12883A **Report Date:** 01/08/15

SAMPLE RESULTS

Lab ID: L1425833-03
Client ID: LAGOON 2 SAMPLE 1
Sample Location: EXETER, NH
Matrix: Soil

Date Collected: 10/29/14 09:30
Date Received: 10/29/14
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	3.69		%	0.100	NA	1	-	10/29/14 23:37	30,2540G	RT

Project Name:	EXETER WWTF LAGOONS	**Lab Number:**	L1425833
Project Number:	12883A	**Report Date:**	01/08/15

SAMPLE RESULTS

Lab ID:	L1425833-04	Date Collected:	10/29/14 09:30
Client ID:	LAGOON 2 SAMPLE 2	Date Received:	10/29/14
Sample Location:	EXETER, NH	Field Prep:	Not Specified
Matrix:	Soil		

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	4.42		%	0.100	NA	1	-	10/29/14 23:37	30,2540G	RT

Project Name: EXETER WWTF LAGOONS
Project Number: 12883A
Lab Number: L1425833
Report Date: 01/08/15

SAMPLE RESULTS

Lab ID: L1425833-05
Client ID: LAGOON 3 SAMPLE 1
Sample Location: EXETER, NH
Matrix: Soil
Date Collected: 10/29/14 11:00
Date Received: 10/29/14
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	2.65		%	0.100	NA	1	-	10/29/14 23:37	30,2540G	RT

Project Name: EXETER WWTF LAGOONS **Lab Number:** L1425833
Project Number: 12883A **Report Date:** 01/08/15

SAMPLE RESULTS

Lab ID: L1425833-06
Client ID: LAGOON 3 SAMPLE 2
Sample Location: EXETER, NH
Matrix: Soil

Date Collected: 10/29/14 11:00
Date Received: 10/29/14
Field Prep: Not Specified

Parameter	Result	Qualifier	Units	RL	MDL	Dilution Factor	Date Prepared	Date Analyzed	Analytical Method	Analyst
General Chemistry - Westborough Lab										
Solids, Total	2.56		%	0.100	NA	1	-	10/29/14 23:37	30,2540G	RT

Lab Duplicate Analysis
Batch Quality Control

Project Name: EXETER WWTF LAGOONS
Project Number: 12883A

Lab Number: L1425833
Report Date: 01/08/15

Parameter	Native Sample	Duplicate Sample	Units	RPD	Qual	RPD Limits
General Chemistry - Westborough Lab Associated sample(s): 01-06 QC Batch ID: WG735788-1 QC Sample: L1425833-01 Client ID: LAGOON 1 SAMPLE 1						
Solids, Total	4.62	4.64	%	0		20

Project Name: EXETER WWTF LAGOONS
Project Number: 12883A

Lab Number: L1425833
Report Date: 01/08/15

Sample Receipt and Container Information

Were project specific reporting limits specified? YES

Reagent H2O Preserved Vials Frozen on: NA

Cooler Information **Cooler**	**Custody Seal**
A	Absent

Container Information

Container ID	Container Type	Cooler	pH	Temp deg C	Pres	Seal	Analysis(*)
L1425833-01A	Amber 120ml unpreserved	A	N/A	2.9	Y	Absent	BE-TI(180),AS-TI(180),AG-TI(180),CR-TI(180),MO-TI(180),NI-TI(180),TL-TI(180),TS(7),PB-TI(180),SB-TI(180),SE-TI(180),ZN-TI(180),HG-T(28),CD-TI(180)
L1425833-02A	Amber 120ml unpreserved	A	N/A	2.9	Y	Absent	BE-TI(180),AS-TI(180),AG-TI(180),CR-TI(180),MO-TI(180),NI-TI(180),TL-TI(180),TS(7),PB-TI(180),SB-TI(180),SE-TI(180),ZN-TI(180),HG-T(28),CD-TI(180)
L1425833-03A	Amber 120ml unpreserved	A	N/A	2.9	Y	Absent	BE-TI(180),AS-TI(180),AG-TI(180),CR-TI(180),MO-TI(180),NI-TI(180),TL-TI(180),TS(7),PB-TI(180),SB-TI(180),SE-TI(180),ZN-TI(180),HG-T(28),CD-TI(180)
L1425833-04A	Amber 120ml unpreserved	A	N/A	2.9	Y	Absent	BE-TI(180),AS-TI(180),AG-TI(180),CR-TI(180),MO-TI(180),NI-TI(180),TL-TI(180),TS(7),PB-TI(180),SB-TI(180),SE-TI(180),ZN-TI(180),HG-T(28),CD-TI(180)
L1425833-05A	Amber 120ml unpreserved	A	N/A	2.9	Y	Absent	BE-TI(180),AS-TI(180),AG-TI(180),CR-TI(180),MO-TI(180),NI-TI(180),TL-TI(180),TS(7),PB-TI(180),SB-TI(180),SE-TI(180),ZN-TI(180),HG-T(28),CD-TI(180)
L1425833-06A	Amber 120ml unpreserved	A	N/A	2.9	Y	Absent	BE-TI(180),AS-TI(180),AG-TI(180),CR-TI(180),MO-TI(180),NI-TI(180),TL-TI(180),TS(7),PB-TI(180),SB-TI(180),SE-TI(180),ZN-TI(180),HG-T(28),CD-TI(180)

*Values in parentheses indicate holding time in days

GLOSSARY

Acronyms

EDL - Estimated Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The EDL includes any adjustments from dilutions, concentrations or moisture content, where applicable. The use of EDLs is specific to the analysis of PAHs using Solid-Phase Microextraction (SPME).

EPA - Environmental Protection Agency.

LCS - Laboratory Control Sample: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

LCSD - Laboratory Control Sample Duplicate: Refer to LCS.

LFB - Laboratory Fortified Blank: A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes.

MDL - Method Detection Limit: This value represents the level to which target analyte concentrations are reported as estimated values, when those target analyte concentrations are quantified below the reporting limit (RL). The MDL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

MS - Matrix Spike Sample: A sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available.

MSD - Matrix Spike Sample Duplicate: Refer to MS.

NA - Not Applicable.

NC - Not Calculated: Term is utilized when one or more of the results utilized in the calculation are non-detect at the parameter's reporting unit.

NI - Not Ignitable.

RL - Reporting Limit: The value at which an instrument can accurately measure an analyte at a specific concentration. The RL includes any adjustments from dilutions, concentrations or moisture content, where applicable.

RPD - Relative Percent Difference: The results from matrix and/or matrix spike duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD). Values which are less than five times the reporting limit for any individual parameter are evaluated by utilizing the absolute difference between the values; although the RPD value will be provided in the report.

SRM - Standard Reference Material: A reference sample of a known or certified value that is of the same or similar matrix as the associated field samples.

Footnotes

1 - The reference for this analyte should be considered modified since this analyte is absent from the target analyte list of the original method.

Terms

Total: With respect to Organic analyses, a 'Total' result is defined as the summation of results for individual isomers or Aroclors. If a 'Total' result is requested, the results of its individual components will also be reported. This is applicable to 'Total' results for methods 8260, 8081 and 8082.

Analytical Method: Both the document from which the method originates and the analytical reference method. (Example: EPA 8260B is shown as 1,8260B.) The codes for the reference method documents are provided in the References section of the Addendum.

Data Qualifiers

A - Spectra identified as "Aldol Condensation Product".

B - The analyte was detected above the reporting limit in the associated method blank. Flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For MCP-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank. For DOD-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte at less than ten times (10x) the concentration found in the blank AND the analyte was detected above one-half the reporting limit (or above the reporting limit for common lab contaminants) in the associated method blank. For NJ-Air-related projects, flag only applies to associated field samples that have detectable concentrations of the analyte above the reporting limit. For NJ-related projects (excluding Air), flag only applies to associated field samples that have detectable concentrations of the analyte, which was detected above the reporting limit in the associated method blank or above five times the reporting limit for common lab contaminants (Phthalates, Acetone, Methylene Chloride, 2-Butanone).

C - Co-elution: The target analyte co-elutes with a known lab standard (i.e. surrogate, internal standards, etc.) for co-extracted analyses.

D - Concentration of analyte was quantified from diluted analysis. Flag only applies to field samples that have detectable concentrations of the analyte.

E - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.

Project Name: EXETER WWTF LAGOONS **Lab Number:** L1425833

Project Number: 12883A **Report Date:** 01/08/15

Data Qualifiers

G - The concentration may be biased high due to matrix interferences (i.e, co-elution) with non-target compound(s). The result should be considered estimated.

H - The analysis of pH was performed beyond the regulatory-required holding time of 15 minutes from the time of sample collection.

I - The lower value for the two columns has been reported due to obvious interference.

M - Reporting Limit (RL) exceeds the MCP CAM Reporting Limit for this analyte.

NJ - Presumptive evidence of compound. This represents an estimated concentration for Tentatively Identified Compounds (TICs), where the identification is based on a mass spectral library search.

P - The RPD between the results for the two columns exceeds the method-specified criteria.

Q - The quality control sample exceeds the associated acceptance criteria. For DOD-related projects, LCS and/or Continuing Calibration Standard exceedences are also qualified on all associated sample results. Note: This flag is not applicable for matrix spike recoveries when the sample concentration is greater than 4x the spike added or for batch duplicate RPD when the sample concentrations are less than 5x the RL. (Metals only.)

R - Analytical results are from sample re-analysis.

RE - Analytical results are from sample re-extraction.

S - Analytical results are from modified screening analysis.

J - Estimated value. This represents an estimated concentration for Tentatively Identified Compounds (TICs).

ND - Not detected at the reporting limit (RL) for the sample.

REFERENCES

1 Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. EPA SW-846. Third Edition. Updates I - IV, 2007.

30 Standard Methods for the Examination of Water and Wastewater. APHA-AWWA-WPCF. 18th Edition. 1992.

LIMITATION OF LIABILITIES

Certification Information

Last revised December 16, 2014

The following analytes are not included in our NELAP Scope of Accreditation:

Westborough Facility
EPA 524.2: Acetone, 2-Butanone (Methyl ethyl ketone (MEK)), Tert-butyl alcohol, 2-Hexanone, Tetrahydrofuran, 1,3,5-Trichlorobenzene, 4-Methyl-2-pentanone (MIBK), Carbon disulfide, Diethyl ether.
EPA 8260C: 1,2,4,5-Tetramethylbenzene, 4-Ethyltoluene, Iodomethane (methyl iodide), Methyl methacrylate, Azobenzene.
EPA 8270D: 1-Methylnaphthalene, Dimethylnaphthalene,1,4-Diphenylhydrazine.
EPA 625: 4-Chloroaniline, 4-Methylphenol.
SM4500: Soil: Total Phosphorus, TKN, NO2, NO3.
EPA 9071: Total Petroleum Hydrocarbons, Oil & Grease.

Mansfield Facility
EPA 8270D: Biphenyl.
EPA 2540D: TSS
EPA TO-15: Halothane, 2,4,4-Trimethyl-2-pentene, 2,4,4-Trimethyl-1-pentene, Thiophene, 2-Methylthiophene, 3-Methylthiophene, 2-Ethylthiophene, 1,2,3-Trimethylbenzene, Indan, Indene, 1,2,4,5-Tetramethylbenzene, Benzothiophene, 1-Methylnaphthalene.

The following analytes are included in our Massachusetts DEP Scope of Accreditation, Westborough Facility:

Drinking Water
EPA 200.8: Sb,As,Ba,Be,Cd,Cr,Cu,Pb,Ni,Se,Tl; **EPA 200.7**: Ba,Be,Ca,Cd,Cr,Cu,Na; **EPA 245.1:** Mercury;
EPA 300.0: Nitrate-N, Fluoride, Sulfate; **EPA 353.2**: Nitrate-N, Nitrite-N; **SM4500NO3-F**: Nitrate-N, Nitrite-N; **SM4500F-C, SM4500CN-CE, EPA 180.1, SM2130B, SM4500Cl-D, SM2320B, SM2540C, SM4500H-B**
EPA 332: Perchlorate.
Microbiology: **SM9215B; SM9223-P/A, SM9223B-Colilert-QT, Enterolert-QT.**

Non-Potable Water
EPA 200.8: Al,Sb,As,Be,Cd,Cr,Cu,Pb,Mn,Ni,Se,Ag,Tl,Zn;
EPA 200.7: Al,Sb,As,Be,Cd,Ca,Cr,Co,Cu,Fe,Pb,Mg,Mn,Mo,Ni,K,Se,Ag,Na,Sr,Ti,Tl,V,Zn;
EPA 245.1, SM4500H,B, EPA 120.1, SM2510B, SM2540C, SM2340B, SM2320B, SM4500CL-E, SM4500F-BC, SM426C, SM4500NH3-BH, **EPA 350.1**: Ammonia-N, **LACHAT 10-107-06-1-B**: Ammonia-N, **SM4500NO3-F, EPA 353.2**: Nitrate-N**, SM4500NH3-BC-NES, EPA 351.1, SM4500P-E, SM4500P-B, E, SM5220D, EPA 410.4, SM5210B, SM5310C, SM4500CL-D, EPA 1664, SM14 510AC, EPA 420.1, SM4500-CN-CE, SM2540D.**
EPA 624: Volatile Halocarbons & Aromatics,
EPA 608: Chlordane, Toxaphene, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, delta-BHC, Dieldrin, DDD, DDE, DDT, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Endrin Aldehyde, Heptachlor, Heptachlor Epoxide, PCBs
EPA 625: SVOC (Acid/Base/Neutral Extractables), **EPA 600/4-81-045**: PCB-Oil.
Microbiology: **SM9223B-Colilert-QT; Enterolert-QT, SM9222D-MF**.

For a complete listing of analytes and methods, please contact your Alpha Project Manager.

Serial_No:01081514:41

CHAIN OF CUSTODY

PAGE 1 OF 1

ALPHA ANALYTICAL — World Class Chemistry

8 Walkup Drive, Westboro, MA 01581, Tel: 508-898-9220
320 Forbes Blvd, Mansfield, MA 02048, Tel: 508-822-9300

Date Rec'd in Lab: 10/29/14

ALPHA Job #: L1425833

Project Information

Project Name: Exeter WWTF Lagoons
Project Location: Exeter, NH
Project #: 12883A
Project Manager: Ed Leonard
ALPHA Quote #:

Report Information - Data Deliverables

☐ ADEx ☒ EMAIL

Billing Information

☒ Same as Client info PO #:

Client Information

Client: Wright - Pierce
Address: 230 Commerce Way, Suite 302 Portsmouth, NH
Phone: 603 570 7118
Email: michael.curry@wright-pierce.com

Regulatory Requirements & Project Information Requirements

- ☐ Yes ☒ No MA MCP Analytical Methods ☐ Yes ☒ No CT RCP Analytical Methods
- ☐ Yes ☒ No Matrix Spike Required on this SDG? (Required for MCP Inorganics)
- ☐ Yes ☒ No GW1 Standards (Info Required for Metals & EPH with Targets)
- ☐ Yes ☒ No NPDES RGP
- ☐ Other State /Fed Program ____ Criteria ____

Turn-Around Time

☒ Standard ☐ RUSH (only confirmed if pre-approved!)

Date Due: 11/5/14

Additional Project Information:

Please invoice to the attention of: Michael Curry
** metals list: As, Cd, Cr, Pb, Hg, Mo, Ni, Se, Zn, Sb, Be, Ag, Tl

ANALYSIS: VOC: ☐ 8260 ☐ 624 ☐ 524.2; SVOC: ☐ ABN ☐ PAH; METALS: ☐ MCP 13 ☐ MCP 14 ☐ RCP 15; METALS: ☐ RCRA5 ☐ RCRA8 ☐ PP13; EPH: ☐ Ranges & Targets ☐ Ranges Only; VPH: ☐ Ranges & Targets ☐ Ranges Only; ☐ PCB ☐ PEST; TPH: ☐ Quant Only ☐ Fingerprint; Metals **

SAMPLE INFO — Filtration: ☐ Field ☐ Lab to do; Preservation: ☐ Lab to do

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler Initials	Metals **	Sample Comments	Total # Bottles
25833-01	Lagoon 1 Sample 1	10/27/14	1200	SG	MC	X		
02	Lagoon 1 Sample 2	↓	↓	SG	MC	X		
03	Lagoon 2 Sample 1	10/29/14	0930	↓	↓	X		
04	Lagoon 2 Sample 2		0930			X		
05	Lagoon 3 Sample 1		1100			X		
06	Lagoon 3 Sample 2	↓	1100	↓	↓	X		
Container Type						A		
Preservative						A		

Container Type: P= Plastic, A= Amber glass, V= Vial, G= Glass, B= Bacteria cup, C= Cube, O= Other, E= Encore, D= BOD Bottle

Preservative: A= None, B= HCl, C= HNO_3, D= H_2SO_4, E= NaOH, F= MeOH, G= $NaHSO_4$, H = $Na_2S_2O_3$, I= Ascorbic Acid, J = NH_4Cl, K= Zn Acetate, O= Other

Relinquished By:	Date/Time	Received By:	Date/Time
[signature]	10/29/14 1430	[signature]	10/29/14 1430
[signature]	10/29/14	[signature] AAL	10-29-14 1620
[signature] AAL	10-29-14 1800	[signature]	10/29/14 1800

All samples submitted are subject to Alpha's Terms and Conditions. See reverse side.

FORM NO: 01-01 (rev. 12-Mar-2012)

Attachment B. Interim Guidance Values for Assessing Sludge Quality

March 30, 2001

Compound	CAS	Class A Guidance Values	Class B and SPF Guidance Values		Detection Limit (mg/kg)
			Direct Contact	Leaching	
Section A. Volatile Organic Compounds					
Dichlorodifluoromethane	75-71-8	1,000 (a)	2,500 (a)	NCM	2 (1.0)
Chloromethane	74-87-3	2 (c)	170	2 (c)	2 (0.7)
Vinyl chloride	75-01-4	2 (c)	2 (c)	2	2 (0.4)
Bromomethane	74-83-9	2 (c)	60	2 (c)	2 (0.3)
Chloroethane	75-00-3	1,000 (a)	2,500 (a)	2,500 (a)	2 (1.0)
Trichlorofluoromethane	75-69-4	1,000 (a)	2,500 (a)	NCM	2 (1.0)
Diethyl ether	60-29-7	1,000 (a)	2,500 (a)	2,500 (a)	5.0
Acetone	67-64-1	200 (b)	2,500 (a)	200 (b)	5.0
1,1-Dichloroethene	75-35-4	3	2.500 (a)	3	2 (0.5)
Methylene chloride	75-09-2	2.2 (b)	290	2.2 (b)	2 (0.1)
Carbon disulfide	75-15-0	12 (b)	2,500 (a)	12 (b)	2 (0.2)
Methyl-tert-butylether (MTBE)	1634-04-4	2	1,200	2	2.0
trans-1,2-Dichloroethene	156-60-5	9	2,500 (a)	9	2 (1.0)
1,1-Dichloroethane	75-34-3	3	1,600	3	2 (1.0)
2-Butanone (MEK)	78-93-3	18 (b)	2,500 (a)	18 (b)	2 (1.0)
2,2-Dichloropropane	590-20-7	1,000 (a)	2,500 (a)	2,500 (a)	2 (1.0)
cis-1,2-Dichloroethene	156-59-2	2	1,600	2	2 (1.0)
Chloroform	67-66-3	6 (b)	360	6 (b)	2 (0.1)
Bromochloromethane	74-97-5	1,000 (a)	2,500 (a)	2,500 (a)	2 (1.0)
Tetrahydrofuran (THF)	109-99-9	7	2,500 (a)	7	2 (1.0)
1,1,1-Trichloroethane	71-55-6	42	2,500 (a)	42	2 (1.0)
1,1-Dichloropropene	563-58-6	1,000 (a)	2,500 (a)	2,500 (a)	2 (1.0)
Carbon tetrachloride	56-23-5	6	17	12	2 (1.0)
1,2-Dichloroethane	107-06-2	2.6 (b)	21	2.6 (b)	2 (0.08)
Benzene	71-43-2	2 (c)	75	2 (c)	2 (0.3)
Trichloroethene	79-01-6	2 (c)	200	2 (c)	2 (0.8)
1,2 Dichloropropane	78-87-5	2 (c)	32	2 (c)	2 (0.1)
Dichlorobromomethane	75-27-4	2 (c)	17	2 (c)	2 (0.02)
Dibromomethane	74-95-3	1,000 (a)	2,500 (a)	2,500 (a)	2 (1.0)
4-Methyl-2-pentanone (MIBK)	108-10-1	10	1,300	10	2 (1.0)
cis-1,3-Dichloropropene	10061-01-5	2 (c)	12	2 (c)	2 (0.5)
Toluene	108-88-3	100	2,500 (a)	100	2 (1.0)
trans-1,3-Dichloropropene	10061-02-6	2 (c)	12	2 (c)	2 (0.5)
1,1,2-Trichloroethane	79-00-5	2 (c)	20	2 (c)	2 (0.1)
2-Hexanone	591-78-6	1,000 (a)	2,500 (a)	2,500 (a)	5.0
1,3-Dichloropropane	142-28-9	1,000 (a)	2,500 (a)	2,500 (a)	2 (1.0)
Tetrachloroethene	127-18-4	2	42	2	2 (1.0)
Dibromochloromethane	128-48-1	2 (c)	8	2 (c)	2 (0.01)
1,2-Dibromoethane	106-93-4	2 (c)	2,500 (a)	2 (c)	2 (0.09)
Chlorobenzene	108-90-7	6	1,200	6	2 (1.0)
1,1,1,2-Tetrachloroethane	630-20-6	2	30	2	2 (1.0)
Ethylbenzene	100-41-4	140	2,500 (a)	140	2 (1.0)
m&p-Xylene	108-38-3 106-42-3	1,000 (a)	2,500 (a)	1,100	10
o-Xylene	95-47-6	1,000 (a)	2,500 (a)	1,100	5.0
Styrene	100-42-5	14	770	14	2 (1.0)

Compound	CAS	Class A Guidance Values	Class B and SPF Guidance Values		Detection Limit (mg/kg)
			Direct Contact	Leaching	
Bromoform	75-25-2	2 (c)	60	2 (c)	2 (0.1)
Isopropylbenzene	98-82-8	123	2,500 (a)	123	5.0
1,1,2,2-Tetrachloroethane	79-34-5	2 (c)	2	2 (c)	2 (0.02)
1,2,3-Trichloropropane	96-18-4	2 (c)	220	2 (c)	2 (1.0)
n-Propylbenzene	98-06-6	10	250	10	5.0
Bromobenzene	108-86-1	1000 (a)	2,500 (b)	2,500 (b)	2 (1.0)
1,3,5-Trimethylbenzene	108-67-8	27	250	27	5.0
2-Chlorotoluene	95-49-8	30	1,100	30	2 (1.0)
4-Chlorotoluene	106-43-4	21	800	21	2 (1.0)
tert-Butylbenzene	104-51-8	6	250	6	5.0
1,2,4-Trimethylbenzene	95-63-6	59	250	69	5.0
sec-Butylbenzene	135-98-8	7	250	7	5.0
p-Isopropyltoluene	99-87-6	59	250	250	5.0
1,3-Dichlorobenzene	541-73-1	45	1,900	45	5.0
1,4-Dichlorobenzene	106-46-7	6	17	9	5.0
n-Butylbenzene	104-51-8	18	250	18	5.0
1,2-Dichlorobenzene	95-50-1	66	2,000	66	5.0
1,2-Dibromo-3-chloropropane	96-12-8	2 (c)	2 (c)	2 (c)	2 (0.02)
1,2,4-Trichlorobenzene	120-82-1	15	210	15	2.0
Hexachlorobutadiene	87-68-3	2 (c)	2 (c)	2 (c)	2 (0.2)
Naphthalene	91-20-3	5	1,400	5	5.0
1,2,3-Trichlorobenzene	87-61-6	1,000 (a)	2,500 (a)	2,500 (a)	2.0
Section B. Semi-Volatile Organic Compounds					
1,2-Diphenylhydrazine (as Azobenzene)	122-66-7	2.5 (c)	2.5 (c)	2.5 (c)	2.5 (1.7)
2,4,5-Trichlorophenol	95-95-4	120	2,500 (a)	120	5.0
2,4,6-Trichlorophenol	88-06-2	2.5 (c)	94	2.5 (c)	2.5 (1.7)
2,4-Dichlorophenol	120-83-2	2.5 (c)	220	2.5 (c)	2.5 (1.7)
2,4-Dimethylphenol	105-67-9	4	1,500	4	2.5 (2.0)
2,4-Dinitrophenol	51-28-5	2.5 (c)	150	2.5 (c)	12
2,4-Dinitrotoluene	121-14-2	2.5 (c)	2.5 (c)	2.5 (c)	2.5 (1.7)
2,6-Dinitrotoluene	606-20-2	2.5 (c)	2.5 (c)	2.5 (c)	2.5 (1.7)
2-Chloronaphthalene	91-59-7	1,000 (a)	2,500 (a)	2,500 (a)	10
2-Chlorophenol	95-97-8	2.5 (c)	370	2.5 (c)	2.5 (2.0)
2-Methylnaphthalene	91-57-6	150	1400	150	5.0
2-Methylphenol (o-Cresol)	95-48-7	18	370	18	5.0
2-Nitroaniline	88-74-4	5.9	5.9	5.9	5.0
2-Nitrophenol	88-75-5	788	788	788	5.0
3,3'-Dichlorobenzidine	91-94-1	2.5 (c)	2.5 (c)	2.5 (c)	4.0
3-Nitroaniline	99-09-2	287	287	287	5.0
3&4-Methylphenol (m&p-Cresol)	106-44-5	130	410	410	5.0
4,6-Dinitro-2-methylphenol	534-52-1	9.8	9.8	9.8	12
4-Bromophenyl phenylether	85-68-7	1,000 (a)	2,500 (a)	2,500 (a)	10
4-Chloro-3-methylphenol	59-50-7	1,000 (a)	2,500 (a)	2,500 (a)	10
4-Chloroaniline	106-47-8	45 (b)	400	45 (b)	2.5 (1.3)
4-Chlorophenyl phenylether	7005-72-3	1,000 (a)	2,500 (a)	2,500 (a)	10
4-Nitroaniline	100-01-6	2.5 (c)	2.5 (c)	2.5 (c)	5.0
4-Nitrophenol	100-02-7	788	788	788	12
Acenaphthene	83-32-9	270	2,500 (a)	270	5.0
Acenaphthylene	208-96-8	300	2,500 (a)	300	5.0
Anthracene	120-12-7	1,000 (a)	2,500 (a)	2,500 (a)	5.0

Compound	CAS	Class A Guidance Values	Class B and SPF Guidance Values		Detection Limit (mg/kg)
			Direct Contact	Leaching	
Benzidine	92-87-5	2.5 (c)	2.5 (c)	2.5 (c)	12
Benzo (a) anthracene	56-55-3	2.5 (c)	2.5 (c)	NCM	2.5 (1.7)
Benzo (a) pyrene	50-32-8	2.5 (c)	2.5 (c)	2.5 (c)	2.5 (1.7)
Benzo (b) fluoranthene	205-99-2	7	20	NCM	5.0
Benzo (g,h,i) perylene	191-24-2	160	800	NCM	5.0
Benzo (k) fluoranthene	207-08-9	7	20	NCM	5.0
Bis (2-chloroethoxy) methane	111-91-1	1,000 (a)	2,500 (a)	2,500 (a)	5.0
Bis (2-chloroethyl) ether	111-44-4	2.5 (c)	2.5 (c)	2.5 (c)	2.5 (1.7)
Bis (2-chloroisopropyl) ether	39638-32-9	2.5 (c)	4	4	2.5 (2.0)
Bis (2-ethylhexyl) phthalate	117-81-7	39	110	NCM	5.0
Butyl Benzyl phthalate	85-68-7	810	930	810	5.0
Carbazole	86-74-8	2.5 (c)	32	2.5 (c)	2.5 (1.7)
Chrysene	218-01-9	70	200	NCM	5.0
Di-n-butyl phthalate	84-74-2	1,000 (a)	2,500 (a)	NCM	5.0
Di-n-octyl phthalate	117-84-0	1,000 (a)	1,600	1,600	5.0
Dibenzo (a,h) anthracene	53-70-3	2.5 (c)	2.5 (c)	NCM	2.5 (1.7)
Dibenzofuran	132-64-9	380	380	380	5.0
Diethyl phthalate	84-66-2	1,000 (a)	2,500 (a)	2,500 (a)	5.0
Dimethyl phthalate	131-11-3	1,000 (a)	2,500 (a)	1,500	5.0
Fluoranthene	206-44-0	270	1400	NCM	5.0
Fluorene	86-73-7	270	1400	510	5.0
Hexachlorobenzene	118-74-1	2.5 (c)	2.5 (c)	NCM	2.5 (1.7)
Hexachlorocyclopentadiene	77-47-4	36	150	NCM	5.0
Hexachloroethane	67-72-1	2.5 (c)	2.5 (c)	2.5 (c)	2.5 (1.7)
Indeno (1,2,3-cd) pyrene	193-39-5	2.5 (c)	2.5 (c)	NCM	2.5 (1.7)
Isophorone	78-59-1	2.5 (c)	1,100	2.5 (c)	2.5 (1.7)
N-Nitroso-di-n-propylamine	621-64-7	2.5 (c)	2.5 (c)	2.5 (c)	2.5 (1.7)
N-Nitrosodimethylamine	62-75-9	2.5 (c)	2.5 (c)	2.5 (c)	4.0
N-Nitrosodiphenylamine	86-30-6	2.5 (c)	130	2.5 (c)	2.5 (1.7)
Nitrobenzene	98-95-3	2.5 (c)	39	2.5 (c)	2.5 (1.7)
Pentachlorophenol	87-86-5	2.5 (c)	9	2.5 (c)	4.0
Phenanthrene	85-01-8	160	800	NCM	5.0
Phenol	108-95-2	56	2,500 (a)	56	5.0
Pyrene	129-00-0	160	800	NCM	5.0
Section C. Metals					
Total Arsenic	7440-38-2	STD	STD		10
Total Cadmium	7440-43-9	STD	STD		1.0
Total Chromium	16065-83-1	STD	STD		10
Total Copper	7440-50-8	STD	STD		10
Total Lead	7439-92-1	STD	STD		11
Total Mercury	7439-97-6	STD	STD		0.05
Total Molybdenum	7439-98-7	STD	STD		18
Total Nickel	7440-02-0	STD	STD		10
Total Selenium	7782-49-2	STD	STD		18
Total Zinc	7440-66-6	STD	STD		10
Total Antimony	7440-36-0	5	26	26	8
Total Beryllium	7440-41-7	0.95	0.95	0.95	0.1
Total Silver	7440-22-4	45	200	200	4.0
Total Thallium	7440-28-0	10 (c)	21	21	10
Section D. Pesticides					

Compound	CAS	Class A Guidance Values	Class B and SPF Guidance Values		Detection Limit (mg/kg)
			Direct Contact	Leaching	
Aldrin	309-00-2	0.3 (c)	0.3 (c)	NCM	0.3 (0.09)
Gamma-BHC (Lindane)	58-89-9	0.3 (c)	0.8	0.3 (c)	0.3 (0.09)
Alpha-BHC	319-84-6	0.3 (c)	0.3 (c)	0.3 (c)	0.3 (0.06)
Delta-BHC	319-86-8	4.4	4.4	4.4	0.3 (0.09)
Beta-BHC	319-85-7	0.3 (c)	0.6	0.3 (c)	0.3 (0.06)
Chlordane	57-74-9	0.8	2	NCM	0.8
4,4'-DDT	50-29-3	0.9	3	NCM	0.3 (0.09)
4,4'-DDE	72-55-9	0.7	2	NCM	0.3 (0.07)
4,4'-DDD	72-54-9	0.7	2	NCM	0.3 (0.07)
Alpha-Endosulfan	959-98-8	45	1,300	45	0.3 (0.07)
Beta-Endosulfan	33213-65-9	45	1,300	45	0.3 (0.07)
Endosulfan Sulfate	1031-07-8	1,000 (a)	2,500 (a)	2,500 (a)	0.3 (0.07)
Endrin	72-20-8	8	54	NCM	0.3 (0.07)
Endrin Aldehyde	7421-93-4	1,000 (a)	2,500 (a)	2,500 (a)	0.3 (0.07)
Heptachlor	76-44-8	0.3 (c)	0.7	NCM	0.3 (0.2)
Heptachlor Epoxide	1024-57-3	0.3 (c)	0.3	NCM	0.3 (0.07)
Toxaphene	8001-35-2	0.8 (c)	0.8 (c)	NCM	0.8
Section E. Polychlorinated Biphenyls					
PCB-1242	53469-21-9	STD	STD		1 (0.7)
PCB-1254	11097-69-1	STD	STD		1 (0.7)
PCB-1221	11104-28-2	STD	STD		1 (0.7)
PCB-1232	11141-16-5	STD	STD		1 (0.7)
PCB-1248	12672-29-6	STD	STD		1 (0.7)
PCB-1260	11096-82-5	STD	STD		1 (0.7)
PCB-1016	12674-11-2	STD	STD		1 (0.7)
Section F. Additional Analyses					
pH	na	na	na		na
Percent solids	na	na	na		na
nitrate-nitrite	14797-55-8 14797-65-0	na	na		30
Total Kjeldahl nitrogen	na	na	na		300
ammonia nitrogen	na	na	na		30
Total organic nitrogen	na	na	na		na
potassium	na	na	na		15
phosphorus	na	na	na		15
Section G. Dioxins					
2,3,7,8 TCDD & 2,3,7,8 TCDF	1746-01-6	STD	STD		5ppt TEQ
Remaining congeners of 2,3,7,8 TCDD	1746-01-6	STD	STD		5ppt TEQ
Section H. Cyanides					
Total cyanides	na	510	2,500 (a)	2,500 (a)	10
Section I. Enteric Virus					
Enteric Virus	na	STD	STD		1 PFU/ 4g

Notes:

(a) – For Class A, any risk value over 1,000 mg/kg was reduced to 1,000 mg/kg. For Class B, any risk value over 2,500 mg/kg was reduced to 2,500 mg/kg.

(b) – This value is the guidance value developed by SESOIL modeling for the stockpile scenario. See Table B for the reclamation and agriculture values.

(c) – Value based on the method detection limit

.

na - not applicable

NCM – Negligible contaminant movement

STD – Standard already established in the Env-Ws 800

(#) – number in parentheses indicates the detection limit currently required by the Env-Ws 800

H:\SEPTAGE& SLUDGE\SLUDGE\DATA\S-1CAL\GUIDANCE VALUES.DOC

TOWN OF EXETER, NH

WWTF & MAIN PUMP STATION UPGRADE

PROJECT NO.: 12883B

PRELIMINARY DESIGN PACKAGE

System/Subject:	ODOR CONTROL SYSTEMS		
Calculations By:	KYLE COOLIDGE CHELSEA DEAN	Date:	7/21/2015
Checked By:		Date:	
Revised By:	KYLE COOLIDGE	Date:	9/1/2015
Checked By:		Date:	

Checklist (to be completed by Design Engineer prior to calculation checking):

X	Brief Process Description
X	Graphs/Sketches of System Attached (Plans & Schematics)
X	Design Calculations Attached
X	Design Guidelines/Standards Noted
	Equations Noted and Referenced
X	Electrical Loads Developed and Identified
X	Process Control Description Developed
X	Preliminary Basis of Design (Support Divisions) Attached
X	Construction Sequence Developed
X	Product Information Attached
	Manufacturer's Review of Specs and Drawings (If Applicable)
X	Electronic File Location Noted
	Program(s) Used (Version) Noted
	Coordinated with Hydraulic Profile (If Applicable)

DESCRIPTION OF EXISTING FACILITIES

The existing WWTF does not have an odor control system.

FACILITY PLAN RECOMMENDATIONS

Provide odor control for the sludge dewatering room, the dewatering equipment, the truck loading bay, and the main pump station only via a single activated carbon system.

CLIENT PREFERENCES

None.

DESIGN GUIDELINES

TR-16:

- Activated carbon adsorption is effective for removing low levels of odorous compounds such as hydrogen sulfide, reduced sulfur compounds, and VOCs from air emissions at municipal wastewater treatment facilities.
- The carbon bed should be sized to have a 2.0 to 8.0 second residence time.
- The cross-sectional area of the vessel should allow a linear gas velocity through the carbon bed of 30 to 60 feet per minute (fpm).
- The gas inlet and outlet should be sized to allow an exaust air velocity of 2,000 to 3,000 fpm.
- For carbon media designed for H_2S removal, humidity of the inlet air is less critical.
- The blower should be centrifugal, belt-driven type constructed of high-quality, corrosion-resistant FRP.
- The fan motor should be TEFC, energy-efficient, 1.15 service factor, and 230-460 V/3 Phase/60 Hz.
- The dampers should withstand 10 inches of water column (w.c.) pressure.
- Dampers should be equipped with a full circumference blade seal to limit leaks to less than 3 cfm/sq. ft. at 10 inches w.c.

- A demister/grease eliminator should be considered upstream of the carbon vessel to remove excess water vapor and condense semi-volatiles such as grease aerosols that might otherwise foul the carbon.

NHDES Env-Wq:

- Odor control technology and practices shall be provided to control odors generated from the solids handling processes to minimize the impact of odors outside the facility property boundaries.
- Sludge storage facilities shall be designed to control odors so that odors do not create a nuisance at the property boundary.
- With regards to sewage pumping stations: ventilation exhaust from wet wells shall not cause an odor nuisance to the public or surrounding occupied buildings.

Additional Information:

- Receptor detection threshold for H2S is 0.00047 ppm (M&E 4^{th} Ed.).

REVIEW OF DESIGN CONSIDERATION

Potential Odor Receptors

The WWTF is bounded by the Squamscott River to the east, Route 101 to the north, railroad tracks and Route 85 to the west and by a residential property to the south. There are five residential parcels within 500 feet of the WWTF.

BASIS OF DESIGN

The sources of odors at the WWTF are grouped into four areas:

System 1 – Solids Handling Building

System 2 - Headworks Building

System 3 - Septage Receiving Building

System 4 – Main Pump Station

Each area will have a separate skid mounted odor control system sized appropriately for that area. Each skid generally consists of:

- FRP Exhaust Fan with High Efficiency TEFC Motor
- FRP Ducting between Fan Discharge and Adsorber Inlet
- FRP Adsorber Inlet Flow Control Damper

- FRP Carbon Adsorber Vessel
- Carbon Sample Probes
- Exhaust Stack
- Vapor Phase Activated Carbon Odor Control Media
- Control Panel

The following parameters will form the basis of design for the odor control systems:

1. There is no site-specific odor characterization data and H2S concentrations were estimated based on past project experience.
2. Fan enclosure rated for outside use with sound attenuation (<60 dB @ 3’).
3. Carbon bed layout (deep or radial) based on least cost.
4. Assume vacuum in duct at tie-in point 3” WC.
5. Assume H2S removal 99% at peak.
6. Odor control flow rates and estimated H2S concentrations attached.
7. Ports for sampling carbon included with each vessel.
8. Ductwork will be FRP pipe, above ground, and sloped toward condensate drains.
9. Size carbon canisters for minimum 2-years between media replacement.
10. Stack discharge height minimum 3 feet above adjacent roof.
11. Condensate drain lines will be heat traced for outdoor applications.

STRUCTURE DESCRIPTION

All odor control systems at the WWTF will be located outside on concrete pad adjacent to the building it serves. The Main Pump Station odor control system will be located inside the building.

PROCESS CONTROL DESCRIPTION

Instrumentation:

1. Differential pressure gauges located at the following:
   a. Grease/Mist Eliminator
   b. Fan
   c. Carbon Vessel inlet to outlet
2. E-stop for each Fan

3. Local Control Panel with the following:
    a. Fan On / Off
    b. Run Light for each Fan
    c. General Fault Light
4. Signals to SCADA: General fault

For the Main Pump Station only, the odor control system (and ventilation system) will have a LOR switch, and when in remote shall be activated upon entry to the wet well (via light switch) or activated by process control.

OEM Controls information:

The system fan shall be factory wired to a locally mounted control panel of NEMA 4X construction. The control panel shall have a Local-Off-Remote (LOR) switch with a pilot light to indicate the fan running status. The panel shall be provided with a power disconnect switch, motor starter and control transformer. Electrical information:

Tags	OCF-1	OCF-2	OCF-3	OCF-4
Area	Solids Handling	Headworks	Septage Receiving	Main Pump Station
Power (HP)	10	3	2	5
Area Classification	C1D2 Group D	C1D2 Group D	C1D2 Group D	C1D1 Group D

X Coordinated with NFPA Memo
X Coordinated with Equipment List

NFPA 820 Compliance:

All motors, instruments and equipment within three feet of the odorous air stream shall be rated for Class I, Division 2, Group D (except Main Pump Station shall be Division 1). The local control panel will be mounted remotely from the scrubber system and shipped separately. The installation and wiring of the remote-mounted control panel to the fan will be the responsibility of the Contractor.

CONSTRUCTION & SEQUENCING

The odor control system will be operational before the sources of odor (equipment) are commissioned.

FUTURE EXPANSION CONSIDERATIONS

No plans for future expansion. If additional areas (additional air flow) must be treated for odor, or an additional/different odor profile must be treated, the system could be modified or upgraded as needed, or systems could be added.

FILE LOCATION

\\wp\wp-fs\vol4\eng\nh\exeter\12883-wwtf\12883b-ww design\technical\process\design memos\a-19 odor control.docx

ATTACHMENTS

A. Odor Control System Needs Memorandum, June 16, 2015
B. Design Calculations
C. Equipment Brochure

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MEMORANDUM

TO:	Chris Dwinal, Jeff Pinnette	DATE:	16 June 2015
FROM:	Ed Leonard	PROJECT NO.:	12883B-3015
SUBJECT:	Exeter, NH – WWTF Phase 1 Upgrade Odor Control System Needs		

We are in the preliminary design phase of the WWTF Upgrade for the Town of Exeter, NH. This project consists of a comprehensive upgrade to convert an aerated lagoon plant to an activated sludge plant designed to remove nitrogen (Bardenpho process). We would like to get your initial thoughts on odor control system needs and suggestions for the project. This memo presents information on the following items:

- Existing and Proposed Odor Sources. A summary of the existing and proposed odor sources is summarized below. There is no odor characterization data. Existing and proposed site figures from the Wastewater Facility Study (March 2015, WP) are attached.

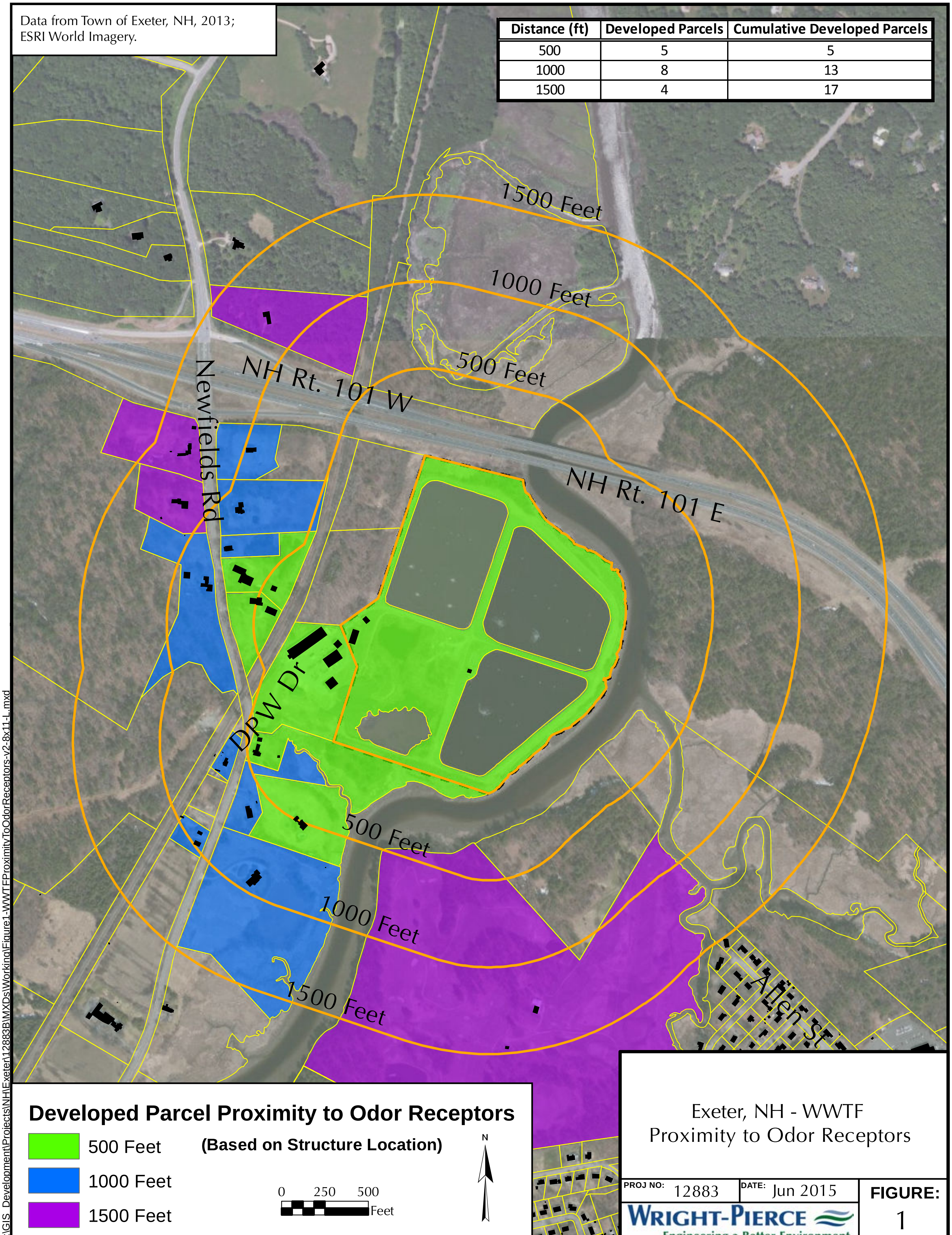
Unit Process	Existing WWTF	Proposed WWTF
Screening	Yes	Yes, similar location
Grit Removal	Yes	Yes, similar location
Influent Equalization	No	New, portion of Lagoon 1
Aerated Lagoon	Yes	No
Activated Sludge (Bardenpho)	No	Yes
Tertiary Filtration (Future)	No	Yes
Disinfection	Yes	Yes
Septage Receiving	Yes (but not used)	Yes
Sludge Storage (Aerated WSL)	No	Yes
Sludge Dewatering	No	Yes
Sludge Hauling for Off-Site Disposal	No	Yes

- Proximity of Sensitive Receptors. The WWTF is bounded by the Squamscott River to the east, Route 101 to the north, railroad tracks and Route 85 to the west and by a residential property to the south. There are a number of residential parcels in the vicinity of the WWTF. See attached figure.

- Odor Control Provisions at Other Seacoast NH Area WWTFs. A summary of the type and number of odor control system at other local Seacoast NH area WWTFs is below.

Location	Headworks/ Septage	Solids Handling	Primary	Activated Sludge
Conventional WWTFs				
Dover	No	Permanganate of sludge feed. Sludge tanks (carbon). Roll-off bay (carbon).	Yes (covered tanks with biofilter)	Yes (covered tanks with biofilter)
Durham	Yes (carbon)	Permanganate of sludge feed.	No	No
Epping	No	No	No	No
Farmington	No	Dewatering Room and roll-off bay (carbon)	N/A	No
Hampton	No	Permanganate of sludge feed.	No	No
Newington	No	No	N/A	No
Newmarket	No	No	No	No
Portsmouth Pease	Yes (wet scrubber)	Solids handling (wet scrubber)	No	No
Converted Lagoon WWTFs				
Rochester	No	N/A	N/A	No
Peterborough	Yes (wet scrubber)	Yes (wet scrubber)	N/A	No
Pittsfield	No	No	N/A	No
Sanford Maine	No	No	N/A	No

The existing WWTF does not have any odor control systems. We are looking to minimize the number and complexity of any new system(s). Initial thoughts are to provide odor control for the sludge dewatering room, the dewatering equipment and the truck loading bay only via a single activated carbon system. We would like to set up a review meeting to discuss this topic as soon as possible.



Distance (ft)	Developed Parcels	Cumulative Developed Parcels
500	5	5
1000	8	13
1500	4	17

Exeter, NH - WWTF
Proximity to Odor Receptors

PROJ NO: 12883 DATE: Jun 2015

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FIGURE:
1

W:\GIS_Development\Projects\NH\Exeter\12883B\MXDs\Working\Figure1-WWTFProximityToOdorReceptors-v2-8x11-L.mxd

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CLIENT	Exeter, NH
PROJECT	Contract 1
PROJECT NO.	12883
DESIGNED BY	Kyle Coolidge
DATE	7/21/2015
CHECKED BY	Ed Leonard
DATE	7/22/2015

Purpose: Preliminary design, size odor control systems for vendor.

Assumptions:
1. H2S concentrations assumed. (no data for Exeter)
2. No need for headworks channel/grit head space to be ventilated 12 ACH because is separate system from rest of odor control.

Conclusions:

System	Area	Make-up Air	Design Flow (CFM)	Design Flow (ACH)	H2S Peak (ppm)	H2S Ave. (ppm)	Basis	Comments
System #1 Dewatering	Container (Truck) Bay	room air	1,275	6	50	7.5	Unclassified - 6 ACH. C1/D2 - <6 ACH.	Container/Truck Bay (17x50x15=12750cf) (650 cfm at 3ACH or 1300cfm at 6ACH)
	Centrifuge 1	room air	150	na	50	7.5		
	Centrifuge 2	room air	150	na	50	7.5		
	Drain/Filtrate Pipe	room air	15	na	50	7.5		
	Conveyors	room air	250	na	50	7.5		
		TOTAL:	1,840					
System #2 Headworks	Channel Head Space	room/outside	200	na	10	2	maintain negative pressure for odor control	recent jobs used 200-300
	Wash Press	room air	50	na	10	2		
	Grit Washer	room air	50	na	10	2		
	Vortex Grit Chamber	room/outside	100	na	10	2	maintain negative pressure for odor control	
		TOTAL:	400					
System #3 Septage Receiving	Septage Tank	Outside Air	75	12	25	5	maintain negative pressure for odor control	150% of mixing air from PDR memo
	Septage Receiving Unit	truck/outside	67	na	100	5	125% of max capacity into unit	Unit designed to accept 400 gpm (54 cfm) septage; air out of tank and SRU should be greater than this.

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OFFERING A COMPLETE LINE OF ODOR CONTROL PRODUCTS AND ACCESSORIES

V1-TM

The V1-TM is a low cost, simple odor control system that utilizes activated carbon – sometimes in conjunction with a secondary polishing media to remove odor.

- Simple and easy to install and operate
- High efficiencies of H_2S and organic odor removal
- Perfect for applications between 50 and 1500 CFM
- High quality FRP construction manufactured to exceed industry standards

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V1-TM

SIMPLE, EASY, COST EFFECTIVE SOLUTION UP TO 3000 CFM

FEATURES	BENEFIT
Low Cost	V1-TM systems can economically treat up to 1500 cfm. Capital costs are reduced because of unit simplicity.
No Chemicals	Uses carbon media to treat odor compounds, no chemicals or additives are required.
High-Quality Construction	Manufactured using high-quality FRP components. Full 100-mil corrosion barriers on all surfaces exposed to the corrosive environment
Industry Standard Design Basis	Systems are sized to keep bed velocities between 50 and 60 f/m. Standard contact time for all V1 units is 3 seconds.
High Quality Media	The ECS V1 is available with a wide variety of media including Calgon Minotaur, one of only two A-Grade carbons with a .3 H_2S capacity and Calgon Centaur, a water regenerable carbon with ultimate H_2S capacity of .69
High Reliability	ECS carbon units require no acclimation time and can operate intermittently.
Options Available	V1-TM deep beds are available in a number of options • Custom colors available • Sound attenuation packages (enclosure and silencer) • Single or three phase operation

ECS Offers the Following Complete Line of Odor Control Products

- V1 Single Bed
- V2 Dual-Bed
- VX Radial Flow
- X-Pac Chemical Scrubber
- BioPure Biofilter Media
- FRP Ductwork Systems
- AMCA Certified Dampers
- Grease Filter / Mist Eliminators
- Control Panels
- FRP Fans
- Activated Carbon Media
- FRP Chemical Storage Tanks
- FRP Hoods / Covers
- Sound Enclosures and Silencers
- Field Services

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ECS is based out of a 100,000 sq/ft manufacturing / design facility located in central Texas.

We offer a complete line of odor control equipment and services including carbon adsorbers, wet scrubbers, biofilters with the unique capability to manufacture and supply system components.

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CLIENT Exeter, NH
PROJECT **Contract No. 1 WWTF Upgrades**
PROJECT NO. 12883
DESIGNED BY mdb/cjd
DATE 8/17/2015
CHECKED BY
DATE

Purpose:

Assumptions:
1.
2.

Conclusions:

SELF CONTAINED SLIDE GATE SCHEDULE

Enginee	Rev Date	LOCATION	GATE No.	Masonry Opening (WxH)	Type Mounting	EL. A	EL. B	EL. C	TYPE CLOSURE	TYPE OF OPERATOR	REMARKS
CJD	4-Aug-2015	INFLUENT CHANNEL IN HEADWORKS BUILDING UPSTREAM OF MECHANICAL SCREEN	SLD-1	36" x XX"							
CJD	4-Aug-2015	INFLUENT CHANNEL IN HEADWORKS BUILDING DOWNSTREAM OF MECHANICAL SCREEN	SLD-2	36" x XX"							
CJD	4-Aug-2015	INFLUENT CHANNEL IN HEADWORKS BUILDING UPSTREAM OF MANUAL BAR RACK IN BYPASS CHANNEL	SLD-3	36" x XX"							
CJD	4-Aug-2015	INFLUENT CHANNEL IN HEADWORKS BUILDING DOWNSTREAM OF MANUAL BAR RACK IN BYPASS CHANNEL	SLD-4	30" x XX"							
CJD	4-Aug-2015	INFLUENT CHANNEL IN HEADWORKS BUILDING TO FLOW DIVERSION OUTLET BOX	SCWG-1	60" x XX"							
CJD	4-Aug-2015	INFLUENT CHANNEL IN HEADWORKS BUILDING TO GRIT CHAMBER, UPSTREAM	SLD-5	30" x XX"							
CJD	4-Aug-2015	INFLUENT CHANNEL IN HEADWORKS BUILDING TO GRIT CHAMBER, BYPASS CHANNEL	SLD-6	30" x XX"							
CJD	4-Aug-2015	INFLUENT CHANNEL IN HEADWORKS BUILDING TO GRIT CHAMBER, DOWNSTREAM	SLD-7	30" x XX"							
CJD	4-Aug-2015	INFLUENT FLOW EQUALIZATION STRUCTURE 105 TO STRUCTURE 102	SLD-XXX								**Existing to remain**
CJD	4-Aug-2015	INFLUENT FLOW EQUALIZATION STRUCTURE 105 TO STRUCTURE 101	SLD-XXX								**Existing to remain**
CJD	4-Aug-2015	INFLUENT FLOW EQUALIZATION STRUCTURE 101 TO IEQ2	SLD-XXX								**Existing to remain**
CJD	4-Aug-2015	INFLUENT FLOW EQUALIZATION STRUCTURE 101 TO STRUCTURE 401	SLD-XXX								**Existing to remain**
CJD	4-Aug-2015	FLOW FROM IEQ 2 TO IEQ PS	SLD-XXX	16" x 16"							
CJD	4-Aug-2015	FLOW FROM IEQ 1 TO IEQ PS	SLD-XXX	16" x 16"							
CJD	4-Aug-2015	STRUCTURE 401 TO LAGOON 2	SLD-XXX								**Existing to remain**
CJD	4-Aug-2015	STRUCTURE 401 TO LAGOON 3	SLD-XXX								**Existing to remain**
CJD	4-Aug-2015	AERATION TANK NO. 1 ANOXIC ZONE 1A TO SWING ZONE 1D	SLD-XXX								
CJD	4-Aug-2015	AERATION TANK NO. 1 ANOXIC ZONE 1B TO SWING ZONE 1D	SLD-XXX								
CJD	4-Aug-2015	AERATION TANK NO. 1 ANOXIC ZONE 1C TO SWING ZONE 1D	SLD-XXX								
CJD	4-Aug-2015	AERATION TANK NO. 2 ANOXIC ZONE 2A TO SWING ZONE 2D	SLD-XXX								
CJD	4-Aug-2015	AERATION TANK NO. 2 ANOXIC ZONE 2B TO SWING ZONE 2D	SLD-XXX								
CJD	4-Aug-2015	AERATION TANK NO. 2 ANOXIC ZONE 2C TO SWING ZONE 2D	SLD-XXX								
CJD	4-Aug-2015	FUTURE AERATION TANK NO. 3 ANOXIC ZONE 3A TO SWING ZONE 3D	SLD-XXX								
CJD	4-Aug-2015	FUTURE AERATION TANK NO. 3 ANOXIC ZONE 3B TO SWING ZONE 3D	SLD-XXX								
CJD	4-Aug-2015	FUTURE AERATION TANK NO. 3 ANOXIC ZONE 3C TO SWING ZONE 3D	SLD-XXX								
CJD	4-Aug-2015	SPLITTER STRUCTURE #2 (TO AERATION TANK NO. 1)	SCWG-2	60" x XX"							
CJD	4-Aug-2015	SPLITTER STRUCTURE #2 (TO AERATION TANK NO. 2)	SCWG-3	60" x XX"							
CJD	4-Aug-2015	SPLITTER STRUCTURE #2 (TO FUTURE AERATION TANK NO. 3)	SCWG-4	60" x XX"							
CJD	4-Aug-2015	SPLITTER STRUCTURE #3 (TO SECONDARY CLARIFIER #1)	SCWG-5	60" x XX"							
CJD	4-Aug-2015	SPLITTER STRUCTURE #3 (TO SECONDARY CLARIFIER #2)	SCWG-6	60" x XX"							
CJD	4-Aug-2015	SPLITTER STRUCTURE #3 (TO SECONDARY CLARIFIER #3)	SCWG-7	60" x XX"							
CJD	4-Aug-2015	SPLITTER STRUCTURE #3 (TO FUTURE SECONDARY CLARIFIER #4)	SCWG-8	60" x XX"							

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PROJECT Contract No. 1 WWTF Upgrades
PROJECT NO. 12883
DESIGNED BY mdb/cjd
DATE 8/17/2015
CHECKED BY 0
DATE 1/0/1900

Purpose:
Assumptions:
1.
2.

Conclusions:

SLUICE GATE SCHEDULE

Engineer	Rev Date	LOCATION	GATE No.	SIZE WxH	GATE TYPE	TYPE MOUNTING	EL. "A"	EL. "B"	OPER. HD. FT. OF WTR.	TYPE CLOSURE	TYPE OPERATOR
CJD	4-Aug-2015	JUNCTURE STRUCTURE 4 TO JUNCTION STRUCTURE 5	SLG-XX								
CJD	17-Aug-2015	AERATION TANK 1 Drain	SLG-XX								
CJD	17-Aug-2015	AERATION TANK 2 Drain	SLG-XX								
CJD	17-Aug-2015	AERATION TANK 3 Drain	SLG-XX								

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PROJECT	Contract No. 1 WWTF Upgrades
PROJECT NO.	12883
DESIGNED BY	mdb/cjd
DATE	8/17/2015
CHECKED BY	0
DATE	1/0/1900

Purpose:

Assumptions:
1.
2.

Conclusions:

FIXED WEIR PLATE SCHEDULE

Engineer	Rev Date	LOCATION	FIXED WEIR No.	Crest of Weir Plate	Width of Weir Plate	REMARKS
CJD	4-Aug-2015	INFLUENT EQUALIZATION STRUCTURE 401 FIRST COMPARTMENT TO SECOND COMPARTMENT	FW-XXX			Existing to remain
CJD	4-Aug-2015	SPLITTER STRUCTURE #2 VORTEX BREAKER CHAMBER TO AERATION TANK NO. 1	FW-1		6'	
CJD	4-Aug-2015	SPLITTER STRUCTURE #2 VORTEX BREAKER CHAMBER TO AERATION TANK NO. 2	FW-2		6'	
CJD	4-Aug-2015	SPLITTER STRUCTURE #2 VORTEX BREAKER CHAMBER TO FUTURE AERATION TANK NO. 3	FW-3		6'	
CJD	4-Aug-2015	AERATION TANK NO. 1 (AEROBIC ZONE 1G TO EFFLUENT CHANNEL)	ATW-1		35'	Width if the weir spans the whole width of the channel
CJD	4-Aug-2015	AERATION TANK NO. 2 (AEROBIC ZONE 2G TO EFFLUENT CHANNEL)	ATW-2		35'	Width if the weir spans the whole width of the channel
CJD	4-Aug-2015	SPLITTER STRUCTURE #3 VORTEX BREAKER CHAMBER TO SECONDARY CLARIFIER #1	FW-4		6'	
CJD	4-Aug-2015	SPLITTER STRUCTURE #3 VORTEX BREAKER CHAMBER TO SECONDARY CLARIFIER #2	FW-5		6'	
CJD	4-Aug-2015	SPLITTER STRUCTURE #3 VORTEX BREAKER CHAMBER TO SECONDARY CLARIFIER #3	FW-6		6'	
CJD	4-Aug-2015	SPLITTER STRUCTURE #3 VORTEX BREAKER CHAMBER TO FUTURE SECONDARY CLARIFIER #4	FW-7		6'	
CJD	4-Aug-2015	CHLORINE CONTACT TANK TO PARSHALL FLUME	FW-8		TBD	By UV Manufacturer

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MEMORANDUM

TO:	Andy Morrill	DATE:	08/21/2015
FROM:	Chris Berg	PROJECT NO.:	12883B
SUBJECT:	Exeter WWTP Route 85 Water Main Sizing		

The Exeter distribution system hydraulic model was used to size the water main extension along Route 85 required for the WWTP upgrade. Boundary conditions used for the hydraulic modeling analysis include:

- The storage tank water levels are set in the model as follows:
  - Cross Road tank at 209’
  - Hampton Road tank at 190’
  - Epping Road tank at 225’
  - Proposed Bunker Hill Tank in Stratham (when applicable) at 225’
- Both the Lary Lane WTP and Surface WTP are modeled as offline
- The water main on Lincoln St has been replaced as 12-inch ductile iron

As part of this project, an approximately 5200 lf water main extension on Route 85 is required as indicated in Figure 1. Assuming a FFE elevation of the WWTP buildings of 35 ft, normal static pressure will be ~87 psi at the facility. Available fire flows for 8-inch and 12-inch water main are included in Table 1. Replacement of the existing 6-inch water main in Route 85 from Main St to the Summer St intersection will increase available flows at the WWTP.

Figure 1
Water Extension Overview

Table 2
Scenario 1 - Estimated Available Pressures and Fire Flows at the WWTP

Nominal Water Main Size	Water main extension from Summer St to WWTP Est. Available Fire Flow and Pressure*	Water main extension from Summer St to WWTP with replacement from Summer St to Main St Est. Available Fire Flow and Pressure*
8-inch	550 gpm @ 20 psi	850 gpm @ 20 psi
12-inch	650 gpm @ 20 psi	1,800 gpm @ 20 psi

*Assumes an elevation of 37 ft. Modeled available fire flows do not reduce pressure at the hydrant below 20 psi or pressure elsewhere within the main service zone below 20 psi.

We recommend installation of 12-inch water main along Route 85 from Water Street to the WWTP in order to have available fire flows greater than 1,000 gpm as this water main will serve both the Public Works Facility and the WWTP.

There is a concern about encountering contaminated soil in Route 85 in the recommended water main replacement area between Main St and Summer St. An alternative route that will allow fire flows to the WWTP is water main replacement on Cass St and Summer St from Main St to Route 85 as indicated in Figure 1.

Appendix B

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APPENDIX B

DESIGN MEMORANDA

B-1: NFPA 820/Project Nomenclature

B-2: Civil

B-3: Architectural

B-4: Structural/Geotechnical

B-5: Mechanical HVAC/Plumbing

B-6: Instrumentation & Controls

B-7: Electrical

B-8: Invasive Species Management Consideration/Wetlands Restoration

B-9: Invasive Species Management Plan

B-10: Geotechnical Data Report

B-11: Hazardous Materials Survey Report

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CLIENT	Exeter, NH
PROJECT	Contract 1
PROJECT NO.	12883
DESIGNED BY	KMC, MAC, JRM, EJL, DLS, MDB
DATE	7/22/2015
CHECKED BY	
DATE	

Purpose:
To identify the following:
-Summary of nomenclature for buildings/structures and spaces, space classifications and NEMA ratings, and references to applicable sections of NFPA 820

These names, classifications, abbreviations and terminology shall be used where work is performed as a part of this project.

Reference: NFPA 820, 2012 Edition.

LEGEND	
Italics	Existing structures/buildings and spaces
Bold	New structures/buildings and spaces
~~Strikethrough~~	Buildings or spaces that are to be eliminated or changed

Building / Level	Space Name	Classification	NEMA Rating	NFPA 820 Reference	Notes
Control Building / Lower Level	*~~Pump Room~~ Utility Room*	*Unclassified*	*1/12*	*N/A*	*1*
	~~Blower Room~~ Storage Room	*Unclassified*	*1/12*	*N/A*	*1*
Control Building / Upper Level	*All spaces reconfigured. Refer to Architectural XREF*	*Unclassified*	*1/12*	*N/A*	*1*
		Unclassified	*1/12*	*N/A*	*1*
~~Grit Building~~ Septage Building	Electrical and Blower Room	Unclassified	*1/12*	*N/A*	*1*
	Process Room	Class 1/Division 1	*7*	*-*	*14*
Headworks Building / Lower Level	Container Room	Class 1/Division 1	7	Table 5.2, 1a, 4a	2
	Grit Pump Room	Unclassified	4X	Table 6.2a,2	-
	Storage Room	Unclassified	4X	N/A	1
Headworks Building / First Floor	Grit/Screening Room	Class 1/Division 1	7	Table 5.2, 1a, 4a	2
	Electrical Room	Unclassified	1/12	N/A	1
	Flow Diversion Outlet Box	Class 1/Division 1	7	Table 5.2.3.a	-
Solids Handling Building / Lower Floor	Stair	Unclassified	1	N/A	1
	Blower Room	Unclassified	1/12	N/A	1
	Mechanical Room	Unclassified	1/12	N/A	1
	RSL/WSL Area	Unclassified	4X	Table 6.2a,9b	10
	DSL Area	Unclassified	4X	Table 6.2a,9b	10
Solids Handling Building / First Floor	Electrical Room	Unclassified	1/12	N/A	1
	Generator Room	Unclassified	1/12	N/A	1
	Container Bay	Unclassified	4X	Table 6.2a.12-13	10
	Dewatering Area	Unclassified	4X	Table 6.2a.12-13	10
	Polymer Area	Unclassified	4X	Table 6.2a.12-13	10
	Control Room	Unclassified	1/12	N/A	1
	Electrical Room	Unclassified	1/12	N/A	1
	Stair	Unclassified	1/12	N/A	1
	Toilet (Unisex)	Unclassified	1/12	N/A	1
~~Chemical Building~~ Plant Water Building	Equipment Room	Unclassified	4X	N/A	1
	Electrical Room	Unclassified	1/12	N/A	1
Chlorine Contact Tank	UV Building	Unclassified	4X	Table 5.2, 17/24	7
	Chlorine Contact Tank 2	*Unclassified*	*4X*	*Table 5.2,17/24*	*7*
Site, General	Odor Control Systems 1, 2, 3	Class 1/Div 2 (w/in 3 feet)	7	Table 5.2, 26b	3
		[Unclassified (beyond 3 feet)]	[4X]	[Table 5.2, 26b, 26 c]	
	Sludge Storage Tanks 1, 2	Class 1/Division 1	7	Table 6.2(a), 10a	2
	Influent Structure	Class 1/Division 1 (interior)	7	Table 5.2a, 1a	-
	Influent Equalization Tanks 1,2	Class 1/Div 2 (interior & envelope)	4X	Table 5.2.3.c	13
	Junction Structure 1	Class 1/Div 2 (interior & envelope)	7/4X	upstream of secondary	-
	Junction Structure 2	Class 1/Div 2 (interior & envelope)	7/4X	upstream of secondary	-
	Splitter Structure 2	Class 1/Div 2 (interior & envelope)	7/4X	upstream of secondary	-
	Supplemental Chemical Building	Unclassified	4X	N/A	1,15
	Aeration Tanks	Class 1/Div 2 (interior & envelope)	7/4X	upstream of secondary	-
	Juction Structure 3	Class 1/Div 2 (interior & envelope)	7/4X	upstream of secondary	-
	Splitter Structure 3	Class 1/Div 2 (interior & envelope)	7/4X	upstream of secondary	-
	Secondary Clarifiers Nos. 1, 2, 3	Class 1/Div 2 (interior & envelope)	7/4X	Table 5.2, 14	7
	Scum Pump Station	Class 1/Division 1 (interior)	7	Table 6.2a, 5a	-
	Junction Structure 4	Unclassified	4X	dwnstm of secondary	-
	Yard Pump Station (building, physically sep)	Unclassified	4X	Table 4.2, 18	-
	Yard Pump Station (wetwell	Class 1/Division 1	7	Table 4.2, 16	-
	~~Chlorine Contact Tank 1~~	*Unclassified*	*4X*	-	-
	Effluent Parshall Flume	*Unclassified*	*4X*	*Table 5.2, 25*	-

Notes:
1. NFPA 820 does not establish ventilation criteria for spaces devoted to administrative areas, laboratories and other ancillary spaces (Paragraph 9.1.1.3).
2. Combustible gas detection, hydrant(s) and fire extinguisher(s) are required.
3. Combustible gas detection, fire extinguisher(s) and a fire detection system are required.
4. A fire alarm system, fire extinguisher(s) and hydrant(s) are required.
5. Combustible gas detection and hydrant(s) are required.
6. Fire extinguisher(s) and hydrant(s) are required.
7. Hydrant(s) is(are) required.
8. Fire extinguisher(s) are required.
9. The requirements for combustible gas detection and/or fire extinguisher are not applicable as the enclosed space is a tank and not intended for occupancy.
10. Ventilation equipment is already or will be installed to provide a minimum of 6 air changes per hour (AC/hr.) when the outside temperature is 50°F or above and 3/1.5 AC/hr. when the outside temperature is below 50°F to allow de-rating of the space from Class I, Division 2 to unclassified.
11. As Stair No. 5 opens into the below-grade Pump Room, it will have the same space classification and NEMA rating as the Pump Room. The Pump Room will be ventilated out of a Class I, Division 2 rating to unclassified (see Note 10), so Stair No. 5 will also be unclassified.
12. As the Primary Effluent Pump Room is connected to the Pump and Compressor Room, it will have the same space classification and NEMA rating as the Pump and Compressor Room. The Pump and Compressor Room will be ventilated out of a Class 1, Division 2 rating to unclassified (see Note 10), so the Primary Effluent Pump Room will also be unclassified.
13. For Class1/Division2 spaces the local control stations can be hermetically sealed NEMA 4X enclosures.
14. NFPA 820 does not establish criteria for septage receiving. This space is treated as a Class 1/Division 1 space.
15. Supplemental carbon will be based on glycerin and NOT methanol.

WRIGHT-PIERCE
Engineering a Better Environment

MEMORANDUM

TO:	Design Team	DATE:	September 15, 2015
FROM:	Jeff Preble, PE Chris Cronin	PROJECT NO.:	12883B
SUBJECT:	Exeter, NH –WWTF & Main Pump Station Upgrade Preliminary Design Report Civil/Site Design Considerations		

The Town of Exeter is proposing a comprehensive upgrade to the WWTF and Main Pump Station. The improvements slated for the WWTF Upgrade project will have a variety of impacts on the site with respect to new impervious surfaces, realignment of the site access drive, grading modifications adjacent to new and existing structures, modifications to the existing site drainage, work within the Shoreland Protection Zone (300-feet for Town of Exeter and 250-feet for NHDES), modifications to the existing lagoons, and impacts to nearby wetlands. Improvements are also slated for many of the building/structure access areas throughout the site to improve traffic flow and operator access.

The project creates a unique opportunity through the decommissioning of the lagoons to restore coastal wetlands along the Squamscott River. Because of this unique opportunity, the regulatory approval needs for the proposed improvements will need to be explored prior to proceeding with permitting applications.

The Federal Emergency Management Agency (FEMA) flood map for the Town of Exeter shows that the existing treatment facility site is located adjacent to the Squamscott River and to the 100-year flood plain (Zone AE) at Elev 8.0 (NGVD 29). No existing or proposed structures are within this zone. The Main Station is located in the 100-year flood plain (Zone AE) at elevation 8 as well.

Wetlands are located along the perimeter of the site. The access into the proposed WWTF is located to avoid the wetland area adjacent to the entrance to the public works lot. We do not expect any direct impacts to wetlands as a result of the project. Wetland impacts associated with the decommissioning of the lagoons is discussed separately. Wetland setbacks at the site include a 100-foot setback from Prime Wetland Buffers as defined in the 2005 Prime Wetland Report and registered with the NH Wetlands Bureau, as well as a 50-foot setback for Exemplary Wetlands as defined by the NH Heritage Bureau. These wetland setbacks are shown on the plans.

Federal, State and local permitting for the project will be completed by Wright-Pierce as part of the Final Design effort. Review of the survey plan provided by Doucet Survey, Inc. indicates that a large portion of the project work will take place within the Shoreland Protection Zone adjacent to the Squamscott River, requiring permit approval under the Shoreland Water Quality

Protection Act (SWQPA). The Main Pump Station site is also located within the Shoreland zone. There is an area of isolated wetlands located adjacent to the existing site access drive on the southwest side of the site. This area will likely be impacted by the proposed improvements to the site access drive and will require permit approval from the NHDES Wetlands Bureau. These areas will need to be properly protected with erosion and sedimentation controls during construction.

The addition of new impervious surfaces (pavement, buildings, tank structures), which will impact surface water runoff, and alter the existing drainage pattern onsite may require permit approval from the NHDES Alteration of Terrain (AOT) Bureau. The need for an AOT permit depends on the total square footage of land disturbances onsite, and if the proposed work is greater than or equal to 50,000 square feet (in aggregate) then an AOT permit will be required. The current site plan will be located within the existing footprint of the current lagoons with the exception of the access drive into the proposed plant. Wright-Pierce will discuss the proposed site work with the NHDES Land Resources Management Division prior to submitting the AOT Permit.

Local permitting through the Exeter Planning Board is also needed for the project through Site Plan Review. Where work is taking place within the Shoreland Protection District, a Conditional Use permit will be needed. A Conditional Use permit will also be required for the wetland disturbances associated with the proposed improvements. The local approval process will be undertaken concurrently with the State permitting efforts through the NHDES. Pre-application meetings with both the Town of Exeter and the NHDES will be conducted prior to the development of the needed permit applications during the final design phase.

Federal permitting through the Army Corps of Engineers may be required for the lagoon decommissioning work. The Programmatic General Permit may not be required for a non-controversial project approved by the NHDES. Where coastal wetlands are being restored through the lagoon work, a discussion will be needed with the ACOE to determine the permitting needs associated with the work. Further information regarding the Invasive Species Management Plan (ISMP) is discussed separately in the ISMP Technical Memorandum.

Each area slated for improvements, site modifications and the associated impacts are discussed in detail below.

General Site Modifications

Several new structures are proposed for the wastewater treatment facility. The new structures are listed below followed by discussions of site impacts associated with each of the buildings.

- Headworks Building
- Maintenance Building
- Aeration Tanks

- Supplemental Chemical Building
- Secondary Clarifiers
- Solids Handling Building
- Sludge Storage Tanks
- Miscellaneous site structures, splitter boxes, and junction structures.
- Relocation of material stockpiles

In addition, a portion of existing lagoon #1 will be redeveloped into an equalization lagoon.

Extensive site preparation is needed in the area of the proposed treatment facilities prior to construction. Much of the fill and sludge in the footprint of the facility will need to excavated and disposed of. Some of the fill will be suitable for reuse on site, while the sludge will require off site disposal. It is also noted that much of the treatment facility site is covered with invasive species. A separate memo has been developed for handling of the invasive species present on the site.

Headworks Building

The Headworks Building will be located on the northern corner of the new treatment facility site. This building will be accessed by the existing gravel road between the lagoons (with new pavement added) and by the new treatment plant drives. The building will require access for roll-off containers for collection of the grit and screenings materials. A concrete pad will be provided outside the building for the loading and unloading of roll off containers.

Supplemental Chemical Building

The Supplemental Chemical Building will require access by tanker trucks for delivery of the supplemental carbon materials. This building will be located adjacent to the Aeration Tanks.

Aeration Tanks

The improvements project will include the construction of two new Aeration Tanks. Space is provided at this location for an additional Aeration Tank in the future. The proposed Aeration Tank structure (including both Tank No.1 and Tank No.2) is approximately 80 feet x 175 feet.

Secondary Clarifiers

Three 70-foot diameter Secondary Clarifiers will be constructed as part of the project. A new splitter structure will divide flows between the new structures.

Solids Handling Building

The Solids Handling Building will be located in the center of the site. Roll-off containers are proposed for loading bio-solids generated at the facility for disposal. A concrete pad will be provided adjacent to the building for swapping containers. A drive through truck bay is provided for sludge container loading.

Maintenance Building

The Maintenance Building proposed for the site will be used for storage/maintenance of equipment. The Town's vactor truck will be stored in this building. The second bay of the proposed garage will store other Sewer Department equipment. Other spaces in the building will include a shop/maintenance area, electric room, and a bathroom.

Site Driveways

A new 24-foot wide access drive will be constructed from the entrance at the public works facility, through the existing snow dump area, and into the new site near the Maintenance Building and the Headworks Building. The main perimeter road through the site will be 24-feet wide. New pavement will be installed for vehicle parking and access to various new structures. The perimeter road will also extend from the Influent Equalization Pump Station to the UV disinfection and aeration tank area to minimize traffic utilizing the Public Works Facility. Approximately 105,000 square feet of new pavement is proposed to be installed as part of this project. Impacts to the snow dump area will be discussed with Public Works personnel in an attempt to provide suitable areas on site for future snow storage operations.

Site Grading and Drainage

Site grading will be required for the construction of these new building and tank structures. Based on soil borings conducted at the site, ledge excavation will likely be required for the construction of several of these structures, as well as within some of the areas adjacent to the structures. Much of the existing fill materials, and the sludge layer will need to be excavated from the WWTF site. Some of the excavated materials can be re-used on site to achieve the desired subgrades. The sludge layer will need to excavated from the site and disposed of at a licensed receiving facility. The lagoon decommissioning grading is shown on the drawings and is described in a separate memo regarding invasive species management.

These site modifications will require new stormdrain infrastructure to collect runoff in the southeast area of the WWTF site. This new infrastructure will include a network of catch basin structures and piping, as well as vegetated rain gardens, sediment forebay and detention basin proposed along the southern edge of the site in the area of the former Sludge Storage Lagoon. The outlet of the detention basin will discharge to the restored wetlands to be constructed as part of the ISMP. This new infrastructure will be designed in accordance with NHDES stormwater requirements and regulations. The new stormwater infrastructure and associated lagoon modifications will be permitted under the same environmental permits noted above, as required for the proposed work on the WWTF site. The Draft NH Small Municipal Separate Storm Sewer Systems (MS4) permit requirements and the Town's non-point source nitrogen management measures will be considered during the final design of proposed stormwater elements of the WWTF Upgrade project. Space will be retained for maintaining the snow dump area in the southwest corner of the site. Modifications to the existing stormwater treatment swale will be required due to impacts on this swale from the new access road construction.

The existing treatment facility and DPW Complex is now serviced by a private well. The expanded treatment operations will require connection to the public water supply. A 12-inch main is proposed to serve the site to provide water service and fire protection. The Town is considering whether potable water will also be extended to the existing DPW Complex buildings.

The proposed site work will also include: installation of access gates, and installation of guardrail along a portion of the re-aligned access drive.

Control Building & Septage Receiving Station

Work at the existing Control Building and Septage Receiving area will involve mostly interior work. However, some exterior piping, and new electrical duct banks will be installed requiring removal and replacement of pavement.

Relocation of Material Stockpiles

The Town of Exeter currently has various material stockpiles within the footprint of the proposed WWTF. These materials are located in the area of the aeration tanks and will need to be relocated to another portion of the site. An area will be established to the south and east of the Solids Handling Building on the southerly side of the perimeter road. This area will be located away from the main traffic flow of the new facility and provide space for loading vehicles and delivery of stockpiled materials.

Main Pump Station

The Main Pump Station site is level and grade will not be significantly changed. A new valve vault and screenings channel is proposed for the site. New fencing and site driveway access from Swasey Parkway is also proposed for the site. A new odor control system is also being considered for the site. All site work at this location is within the Shoreland Zone and the 100-year flood plain. The existing pump station building has a finish floor elevation of 11.0-feet, which is nearly 3-feet above the 100-year flood elevation for this site and 1-foot above the recommendation from the Climate Adaption Plan for Exeter (CAPE). Landscape screening of the pump station should be maintained and perhaps enhanced between the pump station and the adjacent housing development to the west of the site. An existing privacy fence separates these two properties currently and the addition of evergreen trees would enhance the screening. On the riverside (east) of the pump station there is an alley of mature trees immediately adjacent to the pump station and along Swasey Parkway. Many of these trees are estimated to be between 100 to 200 years of age and careful coordination of site staging and laydown areas to reconstruction the pump station, as well as replacement of the force main will need to take place to best retain these existing trees where feasible, minimizing visual impact to the Town's waterfront.

Erosion and Sedimentation Controls

All work on the project will be required to meet the guidelines established by the New Hampshire Stormwater Manual prepared by Comprehensive Environmental, Inc. and the New Hampshire Department of Environmental Services, dated December 2008 (or latest version). Erosion control measures proposed for the site will include use of silt fence, silt logs, catch basin inlet protection, wood waste berms, stone check dams, erosion control matting, and other devices as needed for the proper control of soil erosion during construction. All of the measures implemented will require maintenance throughout the construction period. Special emphasis will be required during design development to further define the measures to be utilized for work taking place within the Shoreland Protection Zone and/or adjacent to jurisdictional wetlands. As noted above, several of the improvements encroach on these areas of the site.

Civil Drawings

See Final Design Drawing List, as part of this PDR, for Preliminary Site Drawings.

WWTF and Main Pump Station Upgrade
Exeter, NH

8/2015
12883B

ARCHITECTURAL PRELIMINARY DESIGN REPORT

General Description

The Exeter Wastewater Treatment Facility site is currently a lagoon site with a Control/Chemical Building, a Grit Building and a Chemical Building. The upgrade project will also provide improvements to the Main Pump Station. To add nitrogen removal to the facility a major upgrade is proposed including several new buildings and improvements to the existing buildings. The buildings at the WWTF were constructed in 1988 and the Main Street Pump Station was constructed in 1964.

General Comments

The buildings at the WWTF are constructed of masonry walls with a split-faced masonry veneer and have wood truss roofs. The buildings are mainly in great shape however the windows, doors and louvers are at the end of their life span and seeing signs of degradation. Exterior doors and windows will be replaced with aluminum storefront style doors and windows. All openings will be replaced. The existing asphalt shingle roofing is near the end of its useful life and will be replaced also. The masonry veneer is mainly in good shape with some efflorescence. The caulking is past its life span and will be replaced. The veneer should also be resealed.

The main new buildings will use a similar construction style. Several small secondary buildings will use a pre-engineered, metal building style.

The Main Pump Station structure consists of an aluminum frame with thin precast concrete wall panels and precast concrete roof panels. This is a difficult construction style to renovate and because of this, modifications to the exterior shell will be limited. The building is in fair condition however all openings should be replaced when equipment is upgraded.

Governing Codes

Currently the New Hampshire Building Code includes:

- 2009 International Building Code as Amended
- 2009 International Existing Building Code as Amended
- 2009 International Energy Conservation Code as Amended
- 2009 International Plumbing Code
- 2003 ANSI A117.1 (Accessibility)

Most of the buildings at the Exeter Wastewater Treatment Facility are normally unoccupied spaces and designed solely for housing equipment necessary for the treatment of wastewater. This equipment is automated and normally runs without human interaction. These buildings are an F-1 occupancy where the equipment performs the processing with personnel only visiting the building for short periods of time to check this equipment. Per the description at No. 4 in IPC Table 403.1, plumbing fixtures are not required. For convenience, one single user bathroom will be provided in the Solids Handling Building.

Currently, New Hampshire is in the process of updating to the 2015 I-codes. If these codes are adopted before building permits will be required, the design may need to meet the 2015 I-codes.

Existing Building Code Implications

Work in existing buildings is governed by the Existing Building Code. The existing building code classifies work in existing buildings in 6 categories; Repairs, Alteration – Level 1, Alteration – Level 2, Alteration – Level 3, Change of Occupancy and Additions. Following is a summary of how these classifications are defined and basic implications of each classification to the project:

Repairs: Fixing or replacing damaged materials. Replacement materials must comply with the building code.

Alteration – Level 1: Replacement of existing materials and equipment with new that serves the same purpose. New materials and equipment must comply with the building and energy codes.

Alteration – Level 2: Reconfiguration of space (where the Work Area is under 50%), addition/elimination of doors and windows, extension of existing systems or installing additional equipment. Modifications must comply with the building, energy and accessibility codes and cannot worsen means of egress. Other items required include:

- Providing automatic sprinkler systems in windowless stories greater than 1500 sf.
- Providing guards at openings in work areas.

Alteration – Level 3: Where the Work Area is greater than 50%. Work Area is defined as the portion of the building where space is reconfigured. If other sections of the Existing Building Code requires reconfiguration of space, this reconfiguration does not count towards the Work Area. Modifications must comply with requirements for Level 2 Alterations plus additional items including:

- Enclosing stairs.
- Enclosing shafts and floor openings.
- Providing the number of exits required per current code.

- Providing doors that swing in the direction of travel for areas with an occupant load over 50.

Change of Use: Where the use or occupancy classification of a building is changed modifications must comply with requirements for Level 2 and 3 Alterations. The building must also be made accessible.

Generally, the energy code does not require updating existing buildings to current energy codes. New work and items must meet current energy codes if possible. If a building currently has a vestibule, the vestibule must remain or a new one provided. If any space changes from an unconditioned space to a conditioned space, the envelope of the space must be updated to meet the envelop requirements of the energy code.

GRIT/SEPTAGE RECEIVING BUILDING

General Description

The existing Grit Building intercepts the influent at the WWTF and removes screenings and grit. A new headworks building will be created for this purpose and the existing Grit Building will be renovated into a Septage Receiving Building. The building is approximately 27 feet wide and 37 feet long with 12 foot high walls. The building is a masonry veneer building with a wood framed pitched roof.

Existing Materials/Conditions/Modifications/Repairs

Exterior:

Foundation: The foundation consists of concrete frost walls, slabs on grade and channels/tankage. Some of the channels will be **filled** in to facilitate the new function of the building.

Structure: The structural system consists of load bearing CMU walls with a pitched wood truss roof system.

Walls: The exterior walls consist of CMU backup block with insulation, air space and split-faced CMU veneer. **Clean and reseal** the veneer and **re-caulk** all joints.

Doors: The existing doors are hollow metal doors and frames and are showing signs of degradation. Along with any new door openings, the existing doors will be **replaced** with aluminum storefront doors with a baked on finish.

Windows: The existing windows are aluminum double hung windows and have seen their useful lifespan. If not used for mechanical openings, these existing window openings will be **replaced** with aluminum storefront windows with a baked on finish.

Louvers: Any **new** louvers will be aluminum with a baked on finish.

Roofing — The roofing is asphalt, 3-tab shingles and near the end of its serviceable life. As part of the upgrade the roofing will be **replaced** with architectural asphalt shingles.

Gable Ends — The gable end walls have vinyl siding and are in fair condition however with changes to equipment mounted in the gables, the vinyl siding will be **replaced** with a flush profile metal siding.

Edge Trim — The fascia and rake trim is metal with a baked on, dark brown finish and is in good condition however will be replaced when the roofing and gable siding is **replaced**.

Interior:

Floors — The floors are painted concrete floors with lots of missing paint. As part of the upgrade, existing openings in the floor will be infilled. The floor will be **painted** as part of the upgrade.

Walls — The inside of the exterior walls are painted CMU and shows some pealing. The walls will be **repainted** as part of the upgrade.

Ceilings — The ceiling is painted GWB and shows a lot of mildew. Due to the proposed use of the existing Grit Building as a Septage Receiving Building, we propose **cleaning** the existing GWB and **installing** FRP faced plywood panels over the GWB.

Space Modifications/Additions

To repurpose this building as a Septage Receiving Building, the existing equipment will be removed and existing openings in the floor will be infilled. A new interior partition will be provided to divide the building into an Electrical/Blower Room and a Process Room. One existing door will be replaced with a double door for equipment access.

HEADWORKS BUILDING

General Description

The Headworks Building will be a new building to receive the influent and remove grit and screenings. It will be approximately 41 feet wide by 56 feet long and 2 stories high. Half of the length of the lower floor will be wastewater channels and grit removal units and the other half storage, pump and container rooms. The entire upper level will be an electrical room and a grit/screenings room.

Building Materials

Exterior:

Foundation — The foundation consists of concrete frost walls, slabs on grade and channels/tankage.

Structure — Load bearing CMU walls with a pitched wood truss roof system.

Walls — CMU backup block with insulation, air space and split-faced CMU veneer.

Doors	Aluminum storefront doors with a baked on finish.
	Roll-up doors with a baked on finish.
Windows	Aluminum storefront windows with a baked on finish.
Louvers	Aluminum with a baked on finish.
Roofing	Architectural asphalt shingles.
Gable Ends	Flush profile metal siding.
Edge Trim	The fascia, rake trim and soffits will be metal with a baked on finish.

Interior:

Floors	Sealed concrete.
Walls	CMU walls will be painted and concrete walls will be covered with rigid insulation and FRP faced plywood.
Ceilings	Unfinished concrete on the lower floor and FRP faced plywood panels on the first floor.
Doors	Painted hollow metal doors and frames.
Stairs	The stairs will be grated aluminum stairs.

Code Concerns

The first floor will only have at grade access on the northeast side. Two doors from the grit/screenings room will be required from this space and must be located at least one half of the greatest diagonal dimension of that room to meet egress criteria.

CHLORINATION/PLANT WATER BUILDING

General Description

The existing Chlorination Building houses equipment and pumps to introduce chlorine into the adjacent chlorine contact channels. This process will not be required in the upgraded facility and this building will be repurposed as a Plant Water Building. The first floor will house electrical equipment and the lower floor a plant water system. The building is approximately 22 feet wide and 22 feet long with 10 foot high walls. The building is a masonry veneer building with a wood framed pitched roof.

Existing Materials/Conditions/Modifications/Repairs

Exterior:

Foundation	The foundation consists of concrete frost walls, slabs on grade and concrete foundation walls around the lower floor.
Structure	The structural system consists of load bearing CMU walls with a pitched wood truss roof system.

Walls	The exterior walls consist of CMU backup block with insulation, air space and split-faced CMU veneer. **Clean and reseal** the veneer and **re-caulk** all joints.
Doors	The existing door is a hollow metal door and frame, shows signs of degradation and is not wide enough to meet current egress codes. This door will be **replaced** with an aluminum storefront door with a baked on finish.
Roofing	The roofing is asphalt, 3-tab shingles and near the end of its serviceable life. As part of the upgrade the roofing will be **replaced** with architectural asphalt shingles.
Gable Ends	The gable end walls have vinyl siding and are in fair condition however with changes to equipment mounted in the gables, the vinyl siding will be **replaced** with a flush panel metal siding.
Edge Trim	The fascia and rake trim is metal with a baked on, dark brown finish and is in good condition however will be replaced when the roofing and gable siding is **replaced**.

Interior:

Floors	The floors are painted concrete floors with lots of missing paint. As part of the upgrade, some existing curbs will be removed and a new opening in the floor will be created for spiral stair access to the lower floor. The floor will be **painted** as part of the upgrade.
Walls	The inside of the exterior walls are painted CMU and fair condition. As part of the upgrade the equipment on the walls will be removed and to provide a uniform, serviceable finish, the walls will be **repainted** as part of the upgrade. The lower level walls are unfinished concrete and will remain as is.
Ceilings	The ceiling is painted GWB and good condition. Lighting and ceiling mounted equipment will likely be replaced during the upgrade and to provide a uniform, serviceable finish, the ceilings will be **repainted** as part of the upgrade. The lower level ceiling is unfinished concrete and will remain as is.

Space Modifications/Additions

The lower floor is currently a pipe and valve vault and access is via a hatch. To repurpose this room as a plant water equipment room, an opening will be added to the first floor slab and a spiral metal stair will be added.

DISINFECTION BUILDING

General Description

The Disinfection Building will be a new building built on top of the chlorine contact channels. Some of the chlorine contact channels will be reused for a UV treatment system and the building will provide an enclosure for this system. The building will be a pre-engineered metal framed building. It will be approximately 19 feet wide by 84 feet long and 1 story high.

Building Materials

Exterior:

Foundation	The foundation consists of the existing concrete channel walls. Two openings in the exterior walls will need to be infilled and an existing interior wall will need to be raised to match the height of the exterior walls.
Structure	Pre-engineered galvanized metal frame.
Walls	Metal panels with a baked on finish on the steel frame.
Doors	Aluminum storefront doors with a baked on finish.
Louvers	Aluminum with a baked on finish.
Roofing	Metal panels with a baked on finish on the steel frame.
Trim	Metal with a baked on finish.

Interior:

Floors	Aluminum grating and/or plating.
Walls	Metal panels and exposed galvanized metal building structure.
Ceilings	Metal panels and exposed glavanized metal building structure.
Stairs	The stairs will be grated aluminum stairs.

SOLIDS HANDLING BUILDING

General Description

The Solids Handling Building will be a new building with one floor at grade and one floor below grade. It is approximately 50 feet wide and 86 feet long with an extra 20 feet in length on the first floor for a container bay.

Building Materials

Exterior:

Foundation	The foundation consists of concrete frost walls, slabs on grade and concrete foundations around the below grade space.
Structure	Load bearing CMU walls with a pitched wood truss roof system.
Walls	CMU backup block with insulation, air space and split-faced CMU veneer.
Doors	Aluminum storefront doors with a baked on finish.
	Roll-up doors with a baked on finish.

Windows	Aluminum storefront windows with a baked on finish.
Louvers	Aluminum with a baked on finish.
Roofing	Architectural asphalt shingles.
Gable Ends	Flush profile metal siding.
Edge Trim	The fascia, rake trim and soffits will be metal with a baked on finish.

Interior:

Floors	Sealed concrete.
Walls	FRP faced plywood over rigid insulation at the lower floor and painted CMU at the first floor.
Ceilings	Unfinished concrete on the lower floor and FRP faced plywood panels on the first floor.
Doors	Painted hollow metal doors and frames.
Vision Panels	Glazed hollow metal frames.
Stairs	The stairs will be grated aluminum stairs.

Code Concerns

As a large windowless story, the lower floor is required to have an automatic sprinkler system. With an automatic sprinkler system, this level is allowed to have one centrally located exit.

CONTROL BUILDING

General Description

The existing Control Building houses operations spaces and chemical storage on the first floor and a pump room and blower room on the lower floor. Chemical storage and the pump and blower processes will be located in new buildings at the facility. Existing space used for these purposes will be repurposed into additional operations space. The building is approximately 36 feet wide and 82 feet long on the first floor and 26 feet long on the lower floor. The building is a masonry veneer building with a wood framed pitched roof.

Existing Materials/Conditions/Modifications/Repairs

Exterior:

Foundation	The foundation consists of concrete frost walls, slabs on grade and concrete foundations around the below grade space.
Structure	The structural system consists of load bearing CMU walls with a pitched wood truss roof system.

Walls	The exterior walls consist of CMU backup block with insulation, air space and split-faced CMU veneer. **Clean and reseal** the veneer and **re-caulk** all joints.
Doors	The existing doors are hollow metal doors and frames and are showing signs of degradation. Along with any new door openings, the existing doors will be **replaced** with aluminum storefront doors with a baked on finish.
Windows	The existing windows are aluminum double hung windows and have seen their useful lifespan. If not used for mechanical openings, these existing window openings will be **replaced** with aluminum storefront windows with a baked on finish.
Louvers	Any **new** louvers will be aluminum with a baked on finish.
Roofing	The roofing is asphalt, 3-tab shingles and near the end of its serviceable life. As part of the upgrade the roofing will be **replaced** with architectural asphalt shingles.
Gable Ends	The gable end walls have vinyl siding and are in fair condition however with changes to equipment mounted in the gables, the vinyl siding will be **replaced** with a flush profile metal siding.
Edge Trim	The fascia and rake trim is metal with a baked on, dark brown finish and is in good condition however will be replaced when the roofing and gable siding is **replaced**.

Interior:

Floors	The floors are a combination of painted concrete and VCT floors. All existing flooring will be removed and replaced. A medium-build epoxy flooring will be used in the locker rooms, painted concrete in the lower floor and VCT in the other areas.
Walls	The inside of the exterior walls are painted CMU and shows some pealing in the chemical areas and in fair condition in the other areas. The basement walls are painted concrete and show some pealing. The walls will be **repainted** as part of the upgrade.
Ceilings	The ceiling is painted GWB in the chemical areas, painted concrete in the lower floor and ACT in the other areas. With the exception of the electrical room, all first floor spaces and the lower floor plan room will **receive** new ACT ceilings. The existing painted concrete ceilings at the other lower floor areas will remain as is.
Doors	The doors are hollow metal doors and frames and are in fair condition however do exhibit some surface rust on the bottom of the doors and frames. **Prep and repaint** any existing doors to remain.
Hardware	The door hardware is knob style hardware and will be **replaced** with lever style hardware.

Wood Trim	There is a wood sill and apron at the base of the exterior windows and is in fair condition. This trim should be **prepped and re-varnished** when the walls are repainted.

Space Modifications/Additions

The east end of the building current houses chemical storage tanks. The smallest room in this area will be repurposed into a break room and the remaining 'L' shaped area will be corridor, locker rooms and an open office area. The existing office and lab will continue their current uses. The existing locker room will become a PPE room and the existing boiler room will become a conference room. In the basement, the blower room and water service entrance area will become a utility room. In the existing pump room, the stair will be enclosed, a corridor will be created from the exit to the stair and down to the utility room. On one side of the corridor will be a plan room storage area on the other.

Code Concerns

The existing stair serving the Lower Floor will need to be enclosed to meet the code criteria for a Level 3 Alteration.

MAINTENANCE BUILDING

General Description

The Maintenance Building will be a new building with one vehicular bay for the vac truck, one bay for the plow and service trucks and additional space to the side for maintenance, an electrical room and a single user bathroom. The building will be a pre-engineered metal framed building. It will be approximately 46 feet wide by 46 feet long and 1 story high.

Building Materials

Exterior:

Foundation	The foundation consists of frost walls and a slab on grade.
Structure	Pre-engineered metal frame, insulated with thermal breaks.
Walls	Metal panels with a baked on finish on the steel frame.
Doors	Aluminum storefront doors with a baked on finish.
	Roll-up doors with a baked on finish.
Louvers	Aluminum with a baked on finish.
Roofing	Metal panels with a baked on finish on the steel frame.
Trim	Metal with a baked on finish.

Interior:

Floors	Sealed concrete.
Walls	Painted plywood panels to 8 feet high and the metal building system fabric vapor retarder above.

Ceilings	The metal building system fabric vapor retarder.
Doors	Painted hollow metal doors and frames.

SUPPLEMENTAL CARBON BUILDING

General Description

The Supplemental Carbon Building will be a new building for storing chemicals necessary for the treatment of the wastewater effluent. It is approximately 32 feet wide and 34 feet long.

Building Materials

Exterior:

Foundation	The foundation consists of concrete frost walls and a slab on grade.
Structure	Load bearing CMU walls with a pitched wood truss roof system.
Walls	CMU backup block with insulation, air space and split-faced CMU veneer.
Doors	Aluminum storefront doors with a baked on finish.
Windows	Aluminum curtainwall windows with a baked on finish (sized for tank installation and removal).
Louvers	Aluminum with a baked on finish.
Roofing	Architectural asphalt shingles.
Gable Ends	Flush profile metal siding.
Edge Trim	The fascia, rake trim and soffits will be metal with a baked on finish.

Interior:

Floors	Sealed concrete.
Walls	Painted CMU.
Ceilings	FRP faced plywood panels.

Code Concerns

The chemicals to be stored are not classified as hazardous per the Building Code so the building will be classified as a Factory Industrial Use and does not need to be sprinklered.

MAIN PUMP BUILDING

General Description

The Main Pump Building is an existing building used to collect wastewater in the towns system and pump it to the Wastewater Treatment Facility. It consists of two below grade levels with a wet side and a dry side. The first floor is approximately three feet above grade. On top of the first floor slab is a pre-engineered building consisting of an aluminum frame, 2½" thick precast concrete wall panels and precast concrete roof panels.

Existing Materials/Conditions/Modifications/Repairs

Exterior:

Foundation	The foundation consists of concrete foundation walls enclosing two below grade levels.
Structure	The structural system consists of an aluminum frame of 'I' shaped columns at about 4 feet on center around the exterior and a ring of angle to support the roof planks. The wall panels are fastened to the frame as an integrated structural system.
Walls	The exterior walls consist of precast concrete panels with a pebbled exterior finish.
Doors	The existing doors are hollow metal doors and frames and are showing signs of degradation. Along with any new door openings, the existing doors will be **replaced** with aluminum storefront doors with a baked on finish.
Windows	The existing windows are aluminum windows with a mill finish and have seen their useful lifespan. If not used for mechanical openings, these existing window openings will be **replaced** with aluminum storefront windows with a baked on finish.
Louvers	The existing louvers are aluminum with a mill finish and will be **replaced** with aluminum louvers with a with a baked on finish.
Roofing	The roofing was not observed however according to town personnel the roofing was replaced with a built-up roof approximately 10 years ago and is leaking. As part of the upgrade, the roofing will be **replaced** with an insulated EPDM roofing system.
Skylights	The skylights are aluminum framed skylights and past their expected lifespan. These will be removed and the openings **reused** for mechanical ductwork or **replaced** with new skylights.
Edge Trim	The fascia and rake trim is metal with a baked on, dark brown finish and is in good condition however will be **replaced** when the roofing is replaced.

Interior:

Floors	The floors are painted concrete and show some pealing. Due to equipment removal and cutting in a new hatch, the control room floor will be **repainted**.

Walls	The inside of the exterior walls are painted concrete and are in fair condition. The interior walls are painted CMU and in fair condition. In areas where a lot of equipment is removed, the walls will be **repainted** as part of the upgrade.
Ceilings	The ceilings are painted concrete.
Doors	The doors are hollow metal doors and frames and are in fair condition however do exhibit some surface rust on the bottom of the doors and frames. **Prep and repaint** the existing doors.
Hatch	A new hatch will be an aluminum hatch will be **provided**.
Hardware	The door hardware is knob style hardware and will be **replaced** with lever style hardware.

Space Modifications/Additions

Lower level pumps will be replaced, necessitating the installation of a larger hatch. One of the aluminum columns and two of the precast concrete wall panels will be removed to allow the installation of a monorail door. A new exterior door will also be added to the electrical room to provide direct egress to the exterior.

WRIGHT-PIERCE
Engineering a Better Environment

TECHNICAL MEMORANDUM

TO:	EJL	DATE:	August 27, 2015
FROM:	DCS	PROJECT No.:	12883B
SUBJECT:	Town of Exeter, New Hampshire Wastewater Treatment Facility and Main Pump Station Upgrade Structural PDR		

The purpose of this memo is to identify the structural components, governing Codes and Standards, anticipated materials and Geotechnical issues for the Subject Project.

STRUCTURAL SCOPE OF WORK

Existing Structures:

Buildings:

- Conversion of the Grit Building to the Septage Building
- Modifications to Control Building
- Conversion of the Chlorination Building to the Plant Water Building
- Modifications to Main Pump Station
- Other incidental structural work

Tanks:

- Conversion of Chlorine Contact Tank to a Disinfection Tank and Building
- Modifications to Parshall Flume

New Structures:

Buildings:

- Headworks Building
- Solids Handling Building
- Maintenance Building
- Supplemental Carbon Building

Tanks:

- Aeration Tanks (2)
- Secondary Clarifiers (3)

- Sludge Storage Tanks (2)
- Flow Diversion Structure/Channels/Vortex Structure (Headwork Building)
- Flow Splitter Structure #2
- Flow Splitter Structure #3
- Influent Flow Equalization Pump Station
- Other incidental structural work

GOVERNING CODES AND STANDARDS

- International Building Code (IBC) - 2015 Edition
- ASCE 7-10 – Minimum Design Loads for Buildings and other Structures
- ACI 318-11 - Building Code Requirements for Reinforced Concrete
- ACI 350-06 - Code Requirements for Environmental Engineering Concrete Structures
- ACI 530/530.1-13 - Building Code Requirements and Specification for Masonry Structures
- AISC Manual Of Steel Construction - 13th Edition
- Aluminum Association - Specifications for Aluminum Structures
- Occupational Safety and Health Administration

MATERIALS OF CONSTRUCTION

- Reinforced Concrete
  - f'_c - 4,500 psi
  - f_y - 60,000 psi (Reinforcing steel)
  - Max W/C ratio - 0.42
  - Air Content - 6 +/- 1.5%
- Structural Steel
  - Structural Shapes
    - ASTM A992 Grade 50 (wide flange beams)
    - ASTM A36 Grade 36 ("S" type beams, channels and angles)
  - Anchor Rods - ASTM F1554
  - Bolts - ASTM A325
  - Finish - Hot-dipped galvanized or painted
  - Welding - E70XX electrodes
- Structural Aluminum
  - Shapes/Plates - ASTM B308 Alloy 6061-T6
  - Bolts - Stainless Steel Type 316
  - Finish - Mill or clear anodized
- Reinforced Concrete Masonry
  - f'_m - 1,500 psi
  - CMU Block - ASTM C90 Type N-1 - 2,000 psi
  - Mortar - ASTM C270 Type S - 1,800 psi
  - Grout - ASTM C476 - 2,000 psi

LIVE LOADS

In accordance with ASCE 7

Basic live loads:

- Ground Snow Load – 50 psf
- Basic Wind Speed = 130 mph
- Earthquake:
  - Ss (0.2 second Spectral Response Acceleration coefficient) = 0.363
  - S_1 (1.0 second Spectral Response Acceleration coefficient) = 0.080
  - Site Class C (areas where the sludge fill subgrade is removed)
  - Site Class D (areas where the sludge fill subgrade will remain)

Tanks and foundations:

- Lateral earth pressures:
  - Above groundwater table - 65 psf / ft
  - Below groundwater table - 95 psf / ft
- Lateral surcharge pressures:
  - Lateral surcharge resulting from adjacent live loads
- Hydrostatic lateral pressures:
  - Hydrostatic leak test - 63 psf / ft
  - General wastewater - 70 psf / ft
- Hydrostatic uplift pressure - 62.4 pcf x height of groundwater
- Flotation resistance - Dead weight of structure as required

STRUCTURES

***Modifications to Existing Structures*:**

- Grit Building:
  - Remove existing grating and guards
  - Infill open areas with a reinforced concrete slab, aluminum hatch and concrete fill

- Chlorine Contact Tank/Disinfection Building:
  - Raise one channel with new reinforced concrete slab to accommodate UV units
  - New Pre-Engineered Metal Building with monorail over UV channel
  - Cover one full length channel with aluminum grating
  - Cover one full length channel with aluminum floor plate

- Control Building:
    - Remove existing hatch and infill opening with reinforced concrete
    - Infill depressed slab in Dechlorination Room with reinforced concrete

- Main Pump Station:
    - Remove existing hatch and concrete slab and install a larger hatch
    - Remove precast concrete wall panels and support columns to facilitate installation of double door. Provide structural modifications to support door.
    - Install structural steel monorail beam and hoist
    - Install reinforced concrete loading dock
    - Install reinforced concrete Influent Channel Structure and precast concrete Valve Vault
    - Install reinforced concrete Generator Pad

- Plant Water Building:
    - Cut and reinforce hole in reinforced concrete slab for circular slab
    - Infill depressed slab in Dechlorination Room with reinforced concrete

- Effluent Parshall Flume:
    - Repair concrete around Parshall Flume insert
    - Provide a metal roof structure

***New Structures*:**

Tanks:

- Aeration Tanks:
    - Base slab - Reinforced concrete mat slab
    - Walls – Reinforced concrete walls
- Secondary Clarifiers:
    - Base slab - Reinforced concrete mat slab
    - Walls – Reinforced concrete walls
- Sludge Storage Tanks:
    - Base slab - Reinforced concrete mat slab
    - Walls – Reinforced concrete walls with coating
    - Roof – Reinforced concrete slab
- Flow Diversion Structure/Channels/Vortex Structure (Headwork Building)
    - Base slab - Reinforced concrete mat slab
    - Walls – Reinforced concrete walls
    - Covers – Aluminum grating or plate
- Flow Splitter Structure #1
    - Base slab - Reinforced concrete mat slab
    - Walls – Reinforced concrete walls

- Cover – Aluminum grating
- Flow Splitter Structure #2
  - Base slab - Reinforced concrete mat slab
  - Walls – Reinforced concrete walls
  - Cover – Aluminum grating
- Influent Equalization Pump Station (cast-in-place or precast concrete):
  - Base slab - Reinforced concrete mat slab
  - Walls – Reinforced concrete walls
  - Cover – Reinforced concrete slab
- Yard Pump Station (precast concrete):
  - Foundation - precast concrete
  - Superstructure – reinforced concrete

Buildings:

- Solids Handling Building:
  - Foundation:
    - Process Area (Full basement area):
      - Base slab: Reinforced concrete mat slab
      - Walls: Reinforced concrete wall
      - Floor slab: Reinforced concrete structural slab
    - Container Bay:
      - Frost Walls: Reinforced concrete footings and frost walls
      - Floor slab: Reinforced concrete slab-on-grade
  - Superstructure:
    - Walls: Reinforced concrete masonry
    - Roof: Wood trusses

- Headworks Building:
  - Foundation:
    - Lower Floor:
      - Base slab: Reinforced concrete mat slab
      - Walls: Reinforced concrete wall
    - First Floor:
      - Tanks and channels: See Tank section
      - Floor slab: Reinforced concrete structural slab slab-on-grade
  - Superstructure
    - Walls: Reinforced concrete masonry
    - Roof: Wood trusses

- Supplemental Carbon Building:
  - Foundation:

    - Frost walls: Reinforced concrete footings and frost walls
    - Floor slab: Reinforced concrete slab-on-grade
  - Superstructure:
    - Walls: Reinforced concrete masonry
    - Roof: Wood trusses

- Maintenance Building:
  - Foundation:
    - Frost walls: Reinforced concrete footings and frost walls
    - Floor slab: Reinforced concrete slab-on-grade
  - Superstructure – Pre-Engineered Metal building

GEOTECHNICAL

All of the new structures will be constructed within former Lagoon No. 4 (Sludge Storage Lagoon). During June and July of 2015 New England Boring Contractors (under the direction of Haley & Aldrich) drilled 26 test borings at the proposed Project site (11) and along the proposed force main (15). In addition, numerous boring have been drilled in the past by others for previous Projects.

Strata

In general the soil strata encountered consists of the following:

- Fill (silt, sand gravel and/or sludge fills)
- Marine deposits (stiff silt)
- Glacial till (dense sand, stiff silt and gravel)
- Bedrock

The presence and depth of each layer varies at each of the boring locations.

Groundwater

Monitoring wells were installed at four of the boring locations. Results indicate groundwater levels as low as Elevation 3.0 and as high as Elevation 20.0. It is anticipated that groundwater levels will fluctuate throughout the year.

MEMORANDUM

TO:	Ed Leonard	DATE:	August 27, 2015
FROM:	Nat Balch	PROJECT NO.:	12883B
SUBJECT:	Town of Exeter, New Hampshire WWTF and Main Pump Station Upgrades PDR – Mechanical Design Approach		

The purpose of this technical memo is to document the Preliminary Mechanical Engineering and Design Approach for the Contract No. 1 Facility Upgrades, at the Exeter Waste Water Treatment Plant.

Waste Water Treatment Facility Mechanical Improvements – Contract 1

Existing Conditions

Control Bldg

- Electric Room

  HVAC: Electrical gear in the electrical room rejects significant heat. This electrical equipment will be replaced in its entirety. The new installed system should reject significantly less heat.

  A 16" x 16" outside air louver is located near an egress door, approximately 6 inches above grade. This is subject to becoming obstructed by snow during the winter.

  A 12" x 12" eggcrate ceiling exhaust grille is very dirty.

  HVAC equipment in the electrical room is controlled by a manual thermostat.

- Toilet Room

  Plumbing

  The Toilet Room is equipped with the following plumbing fixtures: (1) Shower, (1) Lavatory, (1) Water Closet, and (1) Floor Drain. All fixtures are in good condition. An exhaust register in the Toilet Room is dirty.

- Office

  HVAC: Fin-tube radiation in the office is in good condition. It is controlled by a Honeywell manual thermostat.

  A Sanyo ductless split air conditioning unit appears to be old, and operates quietly.

- Laboratory

  HVAC: The lab hood appears to be in good to very good condition. The lab casework also is generally in very good condition.
  An 8" diameter lab hood outlet is in good condition.
  A Sanyo ductless split air conditioning unit operates quietly.
  Fin-tube radiation in the laboratory is in good condition. It is controlled by a programmable thermostat.
  Plumbing: The lab sinks and faucets appear to be in good condition. These are somewhat dirty. These fixtures discharge directly into the building sanitary waste system, without acid resistant piping or acid neutralizing sump.
  An emergency shower/eyewash unit appears to be in very good condition, but is not equipped with a flow alarm switch.

- Chemical Storage 1

  HVAC: Fin-tube radiation in Chemical Room 1 is in good condition. It is controlled by a Honeywell manual thermostat.
  Ductwork in the room is in good condition.
  Plumbing: A wall-mounted stand-alone eyewash unit is located on the west wall. This unit is in good condition.

- Chemical Storage 2

  HVAC: Fin-tube radiation in Chemical Room 2 is rusty. It is controlled by a Honeywell manual thermostat.
  Galvanized ductwork in the room is in good condition. Paint on the ductwork is peeling, as is paint on the ceiling.
  Plumbing: A wall-mounted stand-alone eyewash unit is located on the west wall. The eyewash bottle is missing from the wall unit.

- Bisulfite Room

  HVAC: A hydronic unit heater is in good condition.
  Plumbing: A freestanding plastic service sink is in good condition.

- Boiler Room

  HVAC: A Weil McLain Model #B-388-WS boiler provides heating hot water to the Control Building and the Headworks. The boiler has a net I=B=R rated heating output of 943,000 British Thermal Units per hour (BTUh). This boiler was converted to fire on natural gas in the 1990's, and operates using a Powerflame Model CR1-G-12 burner.

The boiler is approximately 25 years old; it appears to be in good condition, but is old and relatively inefficient when compared with boilers currently manufactured. Plumbing: A duplex centrifugal pump set consisting of two Grundfos pumps circulates hot water through the hydronic system. The expansion tank is a horizontal compression-type tank. A 36-gallon tank type electric water heater manufactured by Reliance is in very good condition.

- Attic

  HVAC: An oil-fired makeup air unit manufactured by National Manufacturing is located in the attic truss framing. This unit can provide 3,500 cfm at 0.5" w.c., has a 350,000 BTUh output capacity, and is rated at 80 percent efficient, firing on #2 oil. The unit is rarely used, and is in good condition. This unit is probably not regularly maintained, due to its location in the extremely cramped attic crawl space. This unit provides heat and ventilation to first floor rooms and basement storage rooms.

- Basement Storage

  HVAC: Hydronic piping and insulation is in good condition. A portion of this piping extends to the Grit Building. A hydronic unit heater manufactured by the Trane Corporation is in good condition.

Grit Building

HVAC: A hydronic makeup air unit receives heated hot water from the control building. This unit has failed. An intake Air Louver mounted on the West wall is equipped with a bug screen, which is completely clogged with dust. A roof exhaust fan appears to be in good condition. Its actual performance is unknown.

Chlorination Building

HVAC: This building is to be retrofitted to include an ultraviolet clarification system. A roof exhaust fan appears to be in good condition. Heat is provided to the space using a propane-fired makeup air unit. This unit does operate. The fan motor was replaced last winter. Ductwork in the chlorination building is in good condition, as is a supply air diffuser. A Honeywell programmable thermostat provides room temperature control.
Plumbing: A stand-alone wall-mounted emergency eyewash unit (squeeze bottle type) is in good condition.

Recommendations

Design Standards

Design criteria for areas subject to renovation will be designed according to the following design standards:

HVAC

A. Codes and Standards
   1. 2009 International Energy Conservation Code
   2. ASHRAE Ventilation for Acceptable Indoor Air Quality
   3. International Fuel Gas Code

B. Design Conditions
   1. Outdoor Design Temperature
      Summer: 89.6°F DB, 72.8°F WB, ASHRAE 0.4%

      Winter: 2.8°F DB, ASHRAE 99.6%

   2. Indoor Design Temperature

LOCATION	SUMMER	WINTER
Office, Laboratory, Break Room, Conference Room, Shower Rooms, Corridor	73°F, 50% RH	70°F
Electrical Room	80 °F	50°F
PPE Room, Stairs	75°F, 50% RH	65°F

   3. Ventilation Rates:

Office Areas, etc.	5 cfm/person or 0.06 cfm/sqft.
Garage	N/A
Workshop	0.75 cfm/sqft.

PLUMBING

A. Codes and Standards
   1. International Plumbing Code, as amended by the State of New Hampshire
   2. NFPA 10 Standard for Portable Fire Extinguishers.

Control Bldg

Control Bldg-General Overview of Mechanical Renovations

- Hydronic Heating System: The existing boiler room containing the gas-fired cast iron sectional boiler, pumps, expansion tank, air separator and boiler room accessories will be renovated to accommodate the future Conference Room. A new boiler room will be established in the basement, and will include a high-efficiency direct-fire gas boiler, pumps, and necessary boiler room accessories. The new hydronic system will circulate a 30 percent propylene glycol/water solution, to protect against freezing. Combustion air and flue gas venting will be piped directly outdoors. Automatic temperature control panels will be located in this room. The 36-gallon tank type electric water heater will be replaced by an indirect tank-type water heater heated by the boiler, with sufficient capacity to accommodate two showers, lavatories, sinks and tempered water to the emergency shower/eyewash unit in the Laboratory. Hydronic piping from the Control Building to the Grit Building will be disconnected and capped.

- Air Distribution System: The oil-fired makeup air unit located in the attic truss framing will be removed. Roof penetrations (flue gas vent, combustion air vent) will be removed and roof openings patched. Ventilation air to the building will be provided by a split-system air handling unit with Dx cooling coil and a hydronic heating coil. The aim is to install this unit in the basement, with outside air, return air and supply air ductwork risers and heating pipe risers between the first floor and basement. The new unit will provide heat and ventilation to first floor rooms and basement storage rooms. The preferred approach toward air distribution is to provide a variable air volume (VAV) system. An air-cooled condensing unit will be mounted on an existing concrete pad. Roof-mounted exhaust fans currently serving chemical areas will be removed and the roof curbs will be capped.

- First Floor
  The first floor of the control building will be reconfigured, with the exception of the electrical room, the laboratory and the office. Existing HVAC and plumbing systems will be demolished prior to renovations. After renovations, the following proposed areas are anticipated, with mechanical systems as listed:
  - Conference Room
    - HVAC system
    - Perimeter heating
    - Temperature controls
  - Personal Protective Equipment (PPE) Room
    - HVAC system
    - Mop receptor
    - Duct/pipe chase behind lockers

Hall
- Bi-level water cooler
- Portable fire extinguishers (one at each main entry door)

Open Office
- HVAC system
- Perimeter heating
- Temperature controls

Break Room
- HVAC system
- Perimeter heating
- Temperature controls
- General purpose sink

Men's Toilet/Shower Room
- HVAC system
- Perimeter heating
- Temperature controls
- Bathroom fixtures: shower, water closet, urinal, two lavatories and floor drain.

Women's Toilet/Shower Room
- HVAC system
- Perimeter heating
- Temperature controls
- Bathroom fixtures: shower, water closet, one lavatory and a floor drain.

Areas where significant mechanical demolition and reconfiguration will occur include the Boiler Room (future Conference Room), Toilet Room (future PPE Room), and the attic space above the Toilet Room, where an oil-fired split system AHU is currently located.

- Electric Room
  HVAC: Provide a direct expansion (Dx) ductless heat pump system to keep the electric room cool in summer and to provide some heat in the winter. The unit will be sized to provide adequate cooling to offset the heat load and provide some heat during the heating system. The 16" x 16" outside air louver interior face will be infilled with rigid fiberglass insulation, 2" thick.

- Laboratory
  HVAC: The laboratory and HVAC equipment is in good condition and will be retained. No significant work is anticipated in this area. The hydronic fin-tube radiation in the laboratory will be vacuum-cleaned, and the cover restored in place.
  Plumbing: The existing sanitary waste piping serving the lab sink will be replaced with acid-resistant polypropylene piping. An acid neutralizing sump will be provided. The sink will be cleaned. Tepid (60oF) water will be provided to the emergency shower/eyewash unit, and a flow alarm switch will be installed in the water line supplying the unit.

- Basement
  HVAC: A portion of the piping extending to the Grit Building will be removed and pipe ends capped. The hydronic system serving the building will be provided, including a boiler, pumps, expansion tank, air separator, glycol fill station and accessories. A new mixed air air handling unit with hydronic heating coil and Dx cooling coil will be suspended from the underside of the ceiling. Air distribution ductwork will extend up to the ceiling level above the first floor. Ventilation will be provided to areas in the basement.
  Plumbing: The water service to the building will remain in the basement. Automatic temperature control panels will be installed in this area. An electric water heater will be installed at this location.

<u>Septage Receiving Building (Currently Grit Building)</u>
HVAC: The hydronic unit heater, associated hydronic piping and the intake air louver mounted on the West wall will be demolished. An indirect gas-fired heating and ventilating unit will be installed on a concrete pad on the north side of the building. An explosion proof electric unit heater will be provided. Roof exhaust fan EF-7 will be replaced with a new unit. Ventilation to the process room will be in compliance with NFPA 820 for Class 1, Division 1 hazard ratings. A combustible gas detector will be provided. A ductless split heat pump-type air conditioning unit with pad-mounted heat pump will be provided in the electrical room.
Plumbing: A natural gas line will extend to this building, to serve the makeup air unit.

<u>Plant Water Building (Currently Chlorination Building)</u>
HVAC: Existing HVAC equipment will be re-used. Where possible, the units will be re-balanced to conform to current code requirements. An exhaust duct will extend to the future crawl space, and a new exhaust fan will be installed on the roof. A unit heater will be provided in the crawl space.

<u>Proposed Supplemental Chemical Building</u>
HVAC: NEMA 4X rated equipment will be provided at this building. A stainless steel washdown-type unit heater, a propeller-type exhaust fan and intake louver/damper assembly will be installed. A makeup air unit firing on natural gas will be provided.
Plumbing: A corrosion-resistant emergency shower/eyewash unit will be installed at this location. A 1-1/4" diameter domestic water line and a gas line will extend over to this area. Tepid (70^{o}F) water will be generated using a direct-fired instantaneous water heater firing on natural gas.

<u>Proposed Headworks Building</u>

HVAC: Ventilation to the grit/screenings room and roll-off container bay will be in compliance with NFPA 820 for Class 1/Division 1 hazard ratings. The storage room, grit pump room and electrical room will be ventilated to conform to NFPA 820 unclassified rating. An indirect-fired type gas makeup air unit will provide ventilation. Electric unit heaters will be provided, rated for the spaces they serve. Two exhaust fans will be provided. Combustible gas detectors will be provided in each enclosed Class 1/Division 1 room. A ductless split heat pump-type air conditioning unit with pad-mounted heat pump will be provided in the electrical room.
Plumbing: A buried ¾" diameter domestic water line and a gas line will extend to the Headworks Building. A hose washdown station with manual shutoff valve and hose rack and a wall-mounted stainless steel wash sink with an instantaneous water heater will be provided.

Proposed Solids Handling Building

HVAC: Ventilation to the RSL/WSL area, DSL area, Dewatering Room and container bay will be in compliance with NFPA 820 for Unclassified hazard rating. Six air changes per hour of continuous ventilation will be provided to each space using an indirect gas-fired makeup air unit. The ventilation system will provide 100 percent outside air to the building when it is occupied. When the building is unoccupied, the ventilation system shall recirculate up to 75 percent of the air. Air-to-air energy recovery and toilet room exhaust will be provided. An automatic temperature control panel will be located in the electrical room. A ductless split heat pump-type air conditioning unit with pad-mounted heat pump will be provided for cooling in the electrical room. NEMA 4X equipment will be provided in areas exposed to corrosive atmosphere. In the blower room, ventilation air for the blowers, insulation on blower piping and temperature exhaust relief will be provided for the blower room. Heat reclaim may be considered where feasible. Makeup air for the polymer area will be provided.
Plumbing: A buried 1-1/2" diameter domestic water line will extend to the Solids Handing Building. A tank-type water closet, a wall-hung lavatory with an instantaneous water heater and a hose washdown station with manual shutoff valve and hose rack will be provided. Emergency eyewash stations for the polymer and hypochlorite areas served by tepid water will be provided.

Proposed Maintenance Building

HVAC: Ventilation to the maintenance building will be in compliance with the International Mechanical Code (IMC). A standard makeup air/exhaust ventilation system will be provided for the truck maintenance area using an indirect gas-fired makeup air unit; a carbon monoxide sensor and CO exhaust ventilation control will also be provided. Toilet room exhaust will be provided. An automatic temperature control panel will be located in the electrical room. A ductless split heat pump-type air conditioning unit with pad-mounted heat pump will be provided for cooling in the electrical room.

Plumbing: A buried 1-1/2" diameter domestic water line will extend to the Maintenance Building. A tank-type water closet, a wall-hung lavatory with an instantaneous water heater, a bi-level water cooler and a hose washdown station with manual shutoff valve and hose rack will be provided. Additional water services will be provided for vehicle washdown. An oil/water separator will be provided in the sanitary drainage system serving trench drains in the vehicle area.

Gas Service to the Site

Natural gas is used at the DPW Building, at the Garage/Storage Building, the Maintenance Building and at the Control Building. A 725 kW emergency standby generator using natural gas is proposed. A 6" diameter natural gas main extends north and south on Newfields Road near the Exeter Wastewater Treatment Plant, with a 2" diameter branch main serving the facility located near the south end of the property. The existing and proposed gas consumption is tabulated below. The existing service plus a new service for the WWTF will be needed. It is anticipated that the new line would need to be connected to the gas main on Newfields Road. It may be advisable to consolidate the two gas services into a single service tap. This will need to be coordinated with Unitil.

Building	Gas Consumption - Existing	Gas Consumption - Proposed
DPW Building	1,050 cfh	1,050 cfh
Garage Building	1,200 cfh	1,200 cfh
Storage Building	800 cfh	800 cfh
Control Building/Grit Building	1,360 cfh	1,360 cfh
Headworks Building	n/a	160 cfh
Generator (60kW)	814 cfh	814 cfh
Total – Existing 2" Service	4650 cfh	4650 cfh
Solids Handling Building	n/a	175 cfh
Supp. Chemical Building	n/a	200 cfh
Generator (725kW)	n/a	10,000 cfh
Total – New Natural Gas" Service	n/a	20,409 cfh

Main Pump Station Mechanical Improvements – Contract 2

Existing Conditions

Boiler Room

A Trianco gas-fired "Heatmaker Mark 11" boiler provides heating hot water to the building. This was installed in the later part of 1998. This unit is in average to good condition.

Control Room

A wall-mounted hydronic convector is in average condition. A 2-bin stainless steel sink is in acceptable condition, although it is very old.

Equipment Storage

A wall-mounted hydronic convector and an exhaust vent are in average condition.

Bathroom

The toilet and shower room contains a hydronic convector which is old and rusty and a wall-mounted propeller exhaust fan. The bathroom also contains a water closet, urinal, lavatory, and shower. These fixtures are original construction; they are old, not water saver type fixtures, and at the end of their service lives.

Dry Well

Ductwork in the drywell is acceptable condition. Fin-tube radiation is in fair condition. A Simplex sump pump appears to be several years old, and is in good condition. A 20 pound wall mounted portable fire extinguisher is in acceptable condition. A 1" diameter domestic cold water service with a reduced pressure zone backflow preventer provides potable water to the building.

Wet Well

Upper Level

A wall mounted convector is very corroded, and is in poor condition. A propeller-type exhaust fan is corroded and is in poor condition.

Lower Level

Hydronic hot water supply and return piping is very corroded. The sanitary drain piping, serving the toilet and shower room plumbing fixtures are in acceptable condition; paint on the piping has peeled. A propeller –type exhaust fan is very corroded and does not operate.

Recommendations

Boiler Room

HVAC: The existing boiler room containing the gas-fired high-efficiency boiler, pumps, expansion tank, air separator and boiler room accessories continue to be used. Severely rusted piping and heating terminal units will be replaced. A glycol fill station will be added to circulate a 30 percent propylene glycol/water solution throughout the hydronic system, to protect against freezing. Automatic temperature control panels will be located in this room.

Control Room

HVAC: Replace the wall-mounted hydronic convector with a new unit, with stainless steel enclosure if economically feasible. The space will be ventilated using an air handling unit with indirect-fired gas heating. Replace the electronic thermostat with a 7-day programmable thermostat.

Plumbing: Refurbish (clean, rebuild faucet) the 2-bin stainless steel sink.

Equipment Storage

HVAC: Replace the wall-mounted hydronic convector with a new unit, with stainless steel enclosure if economically feasible. Replace the electronic thermostat with a 7-day programmable thermostat.

Bathroom

HVAC: Replace the wall-mounted hydronic convector with a new unit, with stainless steel enclosure if economically feasible. Replace the electronic thermostat with a 7-day programmable thermostat. Replace the wall-mounted propeller exhaust fan.

Plumbing: Replace the bathroom fixtures (water closet, urinal, lavatory, and shower).

Dry Well

HVAC: Replace the fin-tube radiation with equipment with stainless steel enclosure if economically feasible. Ventilation will be provided to the space at six air changes per hour using an air handling unit with indirect-fired gas heating. The ventilation system will provide 100 percent outside air to the dry well when it is occupied. When the dry well is unoccupied, the ventilation system shall recirculate up to 75 percent of the air. Provide a NEMA 4X programmable thermostat. Air-to-air energy recovery may be considered.

Plumbing: Replace the simplex sump pump and the 20 pound wall mounted portable fire extinguisher. The 1” reduced pressure zone backflow preventer should be refurbished to ensure smooth operation.

Wet Well

Upper Level/Lower Level

HVAC: Replace the wall-mounted hydronic convector with a new unit, with stainless steel enclosure if economically feasible. Replace the electronic thermostat with a 7-day programmable thermostat. The wet well will be ventilated in accordance with NFPA 820 for Class 1/Division 1 requirements at six air changes per hour using an air handling unit with indirect-fired gas heating. Provide a combustion gas detector. The propeller-type exhaust fan will be removed and the wall opening infilled. Provide explosion-proof controls. Replace the existing hydronic piping with new piping. Prime and paint the piping with epoxy paint. Exhaust air will be ventilated to an odor control system.

Plumbing: Sandblast, prime and paint the sanitary drainage piping serving the bathroom fixtures.

WRIGHT-PIERCE
Engineering a Better Environment

MEMORANDUM

TO:	File	DATE:	08/19/2015
FROM:	AJM	PROJECT NO.:	12883
SUBJECT:	Town of Exeter, NH WWTF and MPS Upgrades - **INSTRUMENTATION**		

DESCRIPTION OF EXISTING FACILITIES

The Town of Exeter, NH WWTF is currently operating through the SCADA system (iFIX version 4.0, roughly 2007 vintage) in the Control Building Laboratory. The SCADA communicates with a "Local Control Panel MTU" which has two radio systems. The first being a FCC licensed VHF system (Calamp Viper SC-200, license is ~218MHz) to communicate to 10 remote pump stations via the repeater station at the Epping Water Tank. The second is an unlicensed 900 MHz (GE MDS 9810) used to communicate with the the lagoon pumps, chlor/dechlor and effluent functions in the Lagoon Building. Alarms are dialed out to the operations personnel via Win911 software on the SCADA, a Mission RTU device functions as a backup for alarm notification if the Win911 system is not working. Reports are entered and submitted through NetDMR.

FACILITY PLAN RECOMMENDATIONS

Upgrade the existing SCADA system to incorporate the WWTF upgrade instrumentation, monitoring, control and alarming systems. The new SCADA system will include three workstations – two in the Control Building and one in the Solids Process Building. (This has been further defined through Client Preferences and the Design Guidelines).

CLIENT PREFERENCES

Based on the existing setup the client has indicated that the SCADA system should include an additional SCADA node in the Control Building Office with productivity software (MS Office suite, maintenance software, etc.).

DESIGN GUIDELINES

1. Programmable Logic Controllers (PLCs): Based on discussions with the client new PLCs will be by manufacturer Allen-Bradley to match the existing Pump Stations. Building Control Panels (CPs) shall be CompactLogix 5370 L3 series for the I/O count and Ethernet addressing capacity. The Main Pump Station Control panel shall be a A-B Micrologix 1400.

2. OIT: Based on discussions with the client, OITs shall be Allen Bradley PanelView Plus 6 and shall support communication with multiple PLCs and each shall be configured for access to all OIT screens designed for the site.

3. Communications:
    a. Ethernet - The network shall be setup as a redundant fiber optic ring with star connections as necessary to pick up additional systems. Interior CPs shall connect with CAT 6, exterior panels shall be fiber optic.
    b. Radio –
        i. The licensed radio system shall remain as installed with new installations for the Master Radio at the WWTF and the Remote at the Main Pump Station.
        ii. The unlicensed 900 MHz connection to the Lagoon Building shall be removed and disconnected. Communications shall make use of site Ethernet (copper and fiber as necessary).

4. Alarm Dialer: SCADA shall call out to operations staff through integrated redundant Alarm Server, or Win911 Software and backup Alarm Dialer system.

5. Local Control Stations (LCSs): Major mechanical equipment without integral controls shall be specified with Division 16 provided LCSs. LCS design shall be process and client driven and shall typically include:
    a. Run Indication
    b. Local-Off-Remote Selector Hand Switch
    c. Speed Potentiometer Hand Switch (VFD equipment only)
    d. Emergency Stop (E-Stop) Pushbutton Hand Switch

6. Local Control Panels (LCPs): Equipment with protection interlocks for High Suction Pressure, High Discharge Pressure, and High Motor Temperature shall have an LCP with:
    a. Integral LCS components listed above (i.e. one LCP, not an LCS and an LCP)
    b. Alarm Indication
        i. High Suction Pressure
        ii. High Discharge Pressure
        iii. High Motor Temperature
    c. Reset Pushbutton Hand Switch.

7. Indicator Light Color:
    a. Run — Red (Danger equipment energized)
    b. Stop — Green (Equipment de-energized)
    c. Warning — Amber
    d. Alarm — Red
    e. Power — White

8. SCADA Hardware: The SCADA computers will consist of two redundant servers located in the Control Building (one in the Laboratory, one in the office) along with two view node clients located one each in the office and in the Solids Handling Building Control Room. Two (2) cellular connected web licensed SCADA tablets will be provided for both regular duty and on-call use.

9. SCADA Software: Due to the complexity of upgrading a SCADA application several generations old and the minimal cost savings of upgrading an existing license, the existing screens (e.g. Pump Stations) shall be built fresh along with the new screens on new SCADA software.

10. Firewall: The SCADA network shall connect to its own firewall device for a secure internet connection that is SCADA dedicated and isolated from the town's administration network. Remote connections shall be added to the firewall as whitelisted devices. The firewall ports shall be default closed with exceptions for the required connections.

11. Existing Centralized Control Equipment – "Local Control Panel MTU": Prior to disconnecting and removing the existing control panel, Local Control Panel MTU, from service the existing program shall be backed up. The backed up program shall be used only to provide the system integrator with the required information for communicating with the remote pump stations. The actual communication messaging shall be programmed using current standards for radio communications with correction of asynchronous reading/writing of blocks of data by using a sequential counter incremented for each communication (read and write) and reset upon completion of the poll sequence.

REVIEW OF DESIGN CONSIDERATION & ALTERNATIVES

Two options were identified for Aeration Tank Instruments:

1. Multi-parameter (2+) Analyzer with Ethernet
2. Two (2) Channel 4-20 mA Analog Output Analyzer Transmitters

The second option was eliminated from consideration for several reasons:

1. While each transmitter has two channels, many times there is no need for an additional probe at that transmitter's location. Longer probe cable runs can be labor intensive with securing and/or removing the entire length of the cable for maintenance issues.
2. Each transmitter requires a separate power, signal, and control wiring conduit (total of three) run back to the associated control panel.
3. Each transmitter signal wire requires an analog surge device installed at the associated control panel for lightning protection.

The first option provides flexibility and lower installation cost (materials and labor). In addition some models feature:

1. Low-cost extension and interface modules can be added to extend the network and provide connections for probes where needed.
2. Communication and power are supplied with a single networked connection.
3. Integrated lightning protection.
4. Analog Input and Output modules for pickup of 3rd party instruments and devices.

These features allow for integration of the Aeration and Plant instruments while minimizing the requirements of the associated controller panel in I/O modules, panel space, and miscellaneous components. In cases where only a probe or two is needed and it is impractical to extend the Multi-parameter network or where the max count of the network will be exceeded, the second option is still a viable one.

PROCESS CONTROL DESCRIPTION

Basic Automated Control Options:

A number of systems shall be programmed with basic automation with remote control available at the OIT/SCADA, including one or more of the following modes:

1. TIMER (REPEAT CYCLE TIMER) mode: The PLC will control the selected equipment using a repeat cycle timer function. The repeat cycle timer shall allow the operator to input equipment ON and equipment OFF times, each with a range of 0 to 999 minutes. Setting the OFF time to 0 will cause the equipment to operate continuously. The control function shall also allow the operator to input equipment START TIME (real time from 0:00 to 24:00) and RUN TIME period (0.0 to 24.0 hours). The equipment will start automatically at the START time and continue to run for the set RUN TIME. The speed of the equipment will be controlled by the manual hand speed controller function through the OIT/SCADA.

2. LEVEL mode: The system will run based on operator adjustable setpoints used to start/stop the system.

3. CONTINUOUS FLOW mode: The equipment shall operate to maintain operator adjustable flow setpoints from their associated flow meter. This shall be done through a PID or equal algorithm.

4. FLOW TOTAL mode: The system will run until the daily totalized flow reaches the operator adjustable setpoint.

5. INFLUENT (OR EFFLUENT) FLOW mode: The Influent (or Effluent) flow meters shall be used to set the pump speed as an operator adjustable percentage (0-300%) of the Influent (Or Effluent) Flow signal, with setpoints for min and max flow rates.

This functionality shall be included for the following systems:

1. Mechanical Screen and Wash Press

2. Grit Removal System

3. Influent Equalization Pumps and Mixers

4. Pre-Anoxic Zone Mixers

5. Swing Zone Mixers

6. Post-Anoxic Zone Mixers

7. Internal Recycle Pumps

8. Return Activated Sludge Pumps

9. Waste Activated Sludge Pumps

10. Secondary Scum Pump

11. Sludge Storage Tank Blowers

12. Septage Receiving Unit

13. Septage Storage Blower

14. Septage Pump

15. Alkalinity System Mixer

16. Alkalinity Feed Pumps

17. Carbon Feed Pumps (INFLUENT FLOW mode with a NITRATE TRIM)

18. Plant Water System

19. Air Compressors

20. Yard Pump Station

21. Main Pump Station

Advanced Automated Control Options:

A number of systems shall be programmed with advanced automation with remote control available at the OIT/SCADA, the controls of each of these are further detailed below.

22. Air Header Pressure and Air Control Valves

    a. Manual local control of the valves shall be provided for operating separately from the PLC/SCADA.

    b. In Auto mode, the Aeration Blowers shall be controlled to maintain a pressure setpoint. The Air Control Valves shall be controlled to maintain a Dissolved Oxygen (DO) setpoint from its associated DO probe. The Air Control Valves' positions shall be monitored to determine if:
        i. They are not open enough, and therefore the pressure setpoint is too high
        ii. They are too open (opening to the point where no additional air flow is provided) and therefore the pressure setpoint is too low.

    c. The pressure setpoint shall be adjusted automatically by an adjustable setpoint after an adjustable time delay based on the current position of the Air Control Valves and High and Low % Position Setpoints.

d. If the current position is less than the Low % Position value, then the Header Pressure Setpoint will be lowered by a Header Pressure Trim Value.
e. If the current position is greater than a High % Position value, then the Header Pressure Setpoint will be raised by the Header Pressure Trim Value.

f. The PLC, after each time delay, shall determine which valve is the best to compare to by selecting the valve that is currently in the Most Open Position.

23. Aeration Blower Control System

a. The Aeration Blower staging and operation shall be performed by the manufacturer's control panels to maintain the required Aeration Header Pressure setpoints.

24. Dewatering System

a. The Sludge Dewatering System will control sludge feed pumps, sludge grinders, polymer and permanganate feed units, centrifuges and conveying screws by a programmable logic controller (PLC) based control system.

b. The Dewatering System will be initiated manually. If all equipment is in Remote and not in alarm and Sludge Storage Tanks Levels are not in alarm, all associated equipment shall start and stop automatically, staging as required.

c. Centrifuge feed pumps will pump waste activated sludge from the Sludge Storage Tanks to one of two Centrifuges. Cake dryness is controlled and monitored by a centrifuge torque PID control loop.

d. Conveyors shall operate with the system and the truck container shall be filled through Conveyor Slide Gates. The level under each gate shall be monitored and opened/closed for an operator adjustable duration. Each section of the container shall be filled until all the levels are at the high setpoint.

e. When the container is full the Dewatering System will pause, alert the operations personnel to inspect/manually rake the container and resume operation or acknowledge the container is full and begin the shutdown procedure.

f. The Dewatering System will be connected to the SCADA Network and provisions shall be made for the Operators to have the same control available locally to the Dewatering Control Panel at the Division 13 provided OIT/SCADA.

g. A local control station will be provided for each pump, centrifuge, and conveyor with hand switches for Local-Off-Remote and Estop. In the Local position, the pumps will be controlled from the Local Control Station. In the Remote mode, initiation of the pump start sequence will be automatically initiated from the Dewatering System Control Panel.

h. The Dewatering System includes the following:

i. Sludge Storage Tanks

ii. Sludge Grinders

iii. Dewatering Feed Pumps

iv. Polymer Blending System

v. Polymer Ageing Tanks

vi. Dilute Polymer Pump

vii. Centrifuge - Main Drive

viii. Centrifuge - Back Drive

ix. Potassium Permanganate System

x. Sludge Screw Conveyors (from machine)

xi. Sludge Screw Conveyors (to truck bay)

xii. Sludge Screw Conveyors (in truck bay)

xiii. Conveyor Slide Gates and Container Levels

<u>Basic Monitoring and Status Options:</u>

A number of systems shall be programmed with mainly monitoring and status (or Alarms) at the OIT/SCADA. This functionality shall be included for the following systems:

25. Secondary Clarifier (in addition to Start/Stop from PLC)

26. Autosamplers (Flow Signal from PLC)

27. Basement Flood Switches and Sump Pumps

    a. Headworks Building

    b. Control Building

    c. Plant Water Building

    d. Solids Handling Building

    e. Influent Equalization Meter Vault

28. Gas Detectors

29. Heating, Ventilation, and Air Conditioning (HVAC) Equipment

30. Odor Control Systems

    a. Odor Control System - Main Pump Station

    b. Odor Control System - Headworks

    c. Odor Control System – Septage

    d. Odor Control System – Dewatering

31. Building Temperature

    a. Main Pump Station

    b. Control Building

    c. Grit/Septage Building

    d. Headworks Building

    e. Disinfection Building

    f. Plant Water Building

    g. Solids Handling Building

    h. Maintenance Building

32. Generator / ATS

33. Fire Alarm Control Panels

34. Emergency Showers and Eyewashes

35. UV Disinfection

CONSTRUCTION & SEQUENCING

Instrumentation and Controls systems shall follow the construction and sequencing of the related equipment and buildings. Equipment startup and testing shall not be considered complete until all local and OIT/SCADA functions are working as expected.

FUTURE EXPANSION CONSIDERATIONS

The majority of future I&C equipment considerations corresponds with those for the associated equipment. Aeration Instrumentation system shall allow for the flexibility to upgrade as needed.

FILE LOCATION

C:\Users\alex.misiaszek\Downloads\Open Work\NH-Exeter---WWTF & Main PS\12883 Instrumentation PDR Memo.docx

ATTACHMENTS

None

TAG	TYPE/ SIZE	DESCRIPTION	LOCATION	RANGE	UNITS	SERVICE	POWER	P&ID	SPEC. SECTION
MPS-LE/LT-10A	SUB	Main Pump Station Wet Well No. 1 Level	Main Pump Station Wet Well No. 1	0-11.0	feet	Transducer: NEMA 7 Junction Box: NEMA 4X	24 VDC Loop		13440 2.1 C #
MPS-LSLL-10A	FLT	Main Pump Station Wet Well No. 1 Low Low Level Float Switch	Main Pump Station Wet Well No. 1	-	-	Submersible	--		13440 2.1 C #
MPS-LSHH-10A	FLT	Main Pump Station Wet Well No. 1 High High Level Float Switch	Main Pump Station Wet Well No. 1	-	-	Submersible	24 VDC Loop		13440 2.1 C #
MPS-LE/LT-10B	SUB	Main Pump Station Wet Well No. 2 Level	Main Pump Station Wet Well No. 2	0-11.0	feet	Transducer: NEMA 7 Junction Box: NEMA 4X	24 VDC Loop		13440 2.1 C #
MPS-LSLL-10B	FLT	Main Pump Station Wet Well No. 2 Low Low Level Float Switch	Main Pump Station Wet Well No. 2	-	-	Submersible	--		13440 2.1 C #
MPS-LSHH-10B	FLT	Main Pump Station Wet Well No. 2 High High Level Float Switch	Main Pump Station Wet Well No. 2	-	-	Submersible	--		13440 2.1 C #
MPS-FE/FIT-15	MAG/ 16"	Main Pump Station Wastewater Flow	Wastewater Flow Meter Vault	0-600	gpm	NEMA 4X	120VAC		13440 2.1 C #
MPS-LSH-15	FLT	Wastewater Flow Meter Vault High Level Float Switch	Wastewater Flow Meter Vault	-	-	Submersible	--		13440 2.1 C #
MPS-FE/FIT-16	MAG/ 16"	Main Pump Station Combined Sewer Overflow (CSO)	CSO Meter Vault	0-600	gpm	NEMA 4X	120VAC		13440 2.1 C #
MPS-LSH-16	FLT	CSO Meter Vault High Level Float Switch	CSO Meter Vault	-	-	Submersible	--		13440 2.1 C #
MPS-AE/AIT-20A MPS-AE/AIT-20B MPS-AE/AIT-20C	-	Main Pump Station Hazardous Gas Analyzing Transmitters and Sensors	HGRP-20 at the Main Pump Station	0.0-50.0 0.0-100% 0.00-25.0	ppm % %	Sensors: Class I Div II Transmitter: NEMA 4X	120VAC		13440 2.1 C #
MPS-AL-20A MPS-AL-20B	-	Hazardous Gas Alarm Strobe	Main Pump Station	-	-	NEMA 3R/4X	120VAC		13440 2.1 C #
MPS-Horn	-	Hazardous Gas Alarm Horn	Main Pump Station	78-103	dB	NEMA 7	120VAC		13440 2.1 C #
AE/AIT-21A AE/AIT-21B AE/AIT-21C	-	Headworks Hazardous Gas Analyzing Transmitters and Sensors	HGRP-21 at the Headworks	0.0-50.0 0.0-100% 0.00-25.0	ppm % %	Sensors: Class I Div II Transmitter: NEMA 4X	120VAC		13440 2.1 C #
AL-21A AL-21B	-	Hazardous Gas Alarm Strobe	Headworks	-	-	NEMA 3R/4X	120VAC		13440 2.1 C #
FE/FIT-100	MAG/ 4"	Septage Receiving Flow	Septage Receiving	0-600	gpm	NEMA 4X	120VAC		Division 11
LE/LIT-113	ULT	Septage Tank Level Indicating Transmitter	Septage Tank	TBD	feet	NEMA 4X	120VAC		13440 2.1 C #
LSH-113	FLT	Septage Tank High Level Float Switch	Septage Tank	-	-	Submersible	--		13440 2.1 C #
LSL-113	FLT	Septage Tank Low Float Switch	Septage Tank	-	-	Submersible	--		13440 2.1 C #
LSHH-121	FLT	SCR-1, Upstream Channel High High Level Float	Upstream Channel from SCR-1	-	-	Submersible	--		13440 2.1 C #

TAG	TYPE/ SIZE	DESCRIPTION	LOCATION	RANGE	UNITS	SERVICE	POWER	P&ID	SPEC. SECTION
LE-121A LE-121B LIT-121	ULT	SCR-1, Upstream and Downstream Water Levels Transmitter	Sensors: Above the Upstream and Downstream Channels Transmitter: Pump Gallery	0-10.0 0-100%	feet %	Sensors: C1D1 Transmitter: NEMA 4X	120VAC		13440 2.1 C #
LSHH-122	FLT	Headworks Channel No. 2 High High Level Float	Upstream Channel No. 2 from MSCR-1	-	-	Submersible	--		13440 2.1 C #
LE/LT-140A	SUB	IEQ Wet Well No. 1 Level	IEQ Wet Well No. 1	0-11.0	feet	Transducer: NEMA 7 Junction Box: NEMA 4X	24 VDC Loop		13440 2.1 C #
LSLL-140A	FLT	IEQ Wet Well No. 1 Low Low Level Float Switch	IEQ Wet Well No. 1	-	-	Submersible	--		13440 2.1 C #
LSHH-140A	FLT	IEQ Wet Well No. 1 High High Level Float Switch	IEQ Wet Well No. 1	-	-	Submersible	--		13440 2.1 C #
LE/LT-140B	SUB	IEQ Wet Well No. 2 Level	IEQ Wet Well No. 2	0-11.0	feet	Transducer: NEMA 7 Junction Box: NEMA 4X	24 VDC Loop		13440 2.1 C #
LSLL-140B	FLT	IEQ Wet Well No. 2 Low Low Level Float Switch	IEQ Wet Well No. 2	-	-	Submersible	--		13440 2.1 C #
LSHH-140B	FLT	IEQ Wet Well No. 2 High High Level Float Switch	IEQ Wet Well No. 2	-	-	Submersible	--		13440 2.1 C #
FE/FIT-145	MAG/ 8"	IEQ Return Flow	IEQ Meter Vault	0-1800	gpm	Sensors: Class I Div II Transmitter: NEMA 4X	120VAC		13440 2.1 C #
LSH-145	FLT	IEQ Meter Vault High Level Float Switch	IEQ Meter Vault	-	-	Submersible	--		13440 2.1 C #
FE/FIT-155	ULT	WWTF Influent Parshall Flume Flow	Influent Flow Diversion Structure	0-3000	gpm	Sensors: Class I Div I Transmitter: NEMA 4X	120VAC		13440 2.1 C #
LE/LT-170	SUB	Yard Pump Station Wet Well Level	Yard Pump Station Wet Well	0-11.0	feet	Transducer: NEMA 7 Junction Box: NEMA 4X	24 VDC Loop		Division 11
LSLL-170	FLT	Yard Pump Station Wet Well Low Low Level Float Switch	Yard Pump Station Wet Well	-	-	Submersible	--		Division 11
LSHH-170	FLT	Yard Pump Station Wet Well High High Level Float Switch	Yard Pump Station Wet Well	-	-	Submersible	--		Division 11
LSH-175	FLT	Yard Pump Station Valve Vault High Level Float Switch	Yard Pump Station Valve Vault	-	-	Submersible	--		Division 11
FE/FIT-176	MAG/ 4"	Yard Pump Station Flow	Yard Pump Station Valve Vault	0-300	gpm	Sensor: Class I Div II X-mitter: NEMA 4X	120VAC		Division 11
PE/PIT-306	PSI	Aeration Discharge Header Pressure	Solids Building Chemical Room	0-25	psi	NEMA 4X	24 VDC Loop		13440 2.1 C #
AIT-310	MULTI	Aeration Tank No. 1 Multi-parameter Analyzer Transmitter	Aeration Tank No. 1	-	-	NEMA 4X	120VAC		13440 2.1 C #
AE-311	ORP	Aeration Tank No. 1 Zone A ORP	Aeration Tank No. 1 Zone A	-1000 to +1000	mV	Class I Div II	120VAC		13440 2.1 C #

TAG	TYPE/ SIZE	DESCRIPTION	LOCATION	RANGE	UNITS	SERVICE	POWER	P&ID	SPEC. SECTION
AE-314	DO	Aeration Tank No. 1 Zone D Dissolved Oxygen	Aeration Tank No. 1 Zone D	0-20.0	mg/L	Class I Div II	120VAC		13440 2.1 C #
AE-315	DO	Aeration Tank No. 1 Zone E Grid 1 Dissolved Oxygen	Aeration Tank No. 1 Zone E Grid 1	0-20.0	mg/L	Class I Div II	120VAC		13440 2.1 C #
AE-316	DO	Aeration Tank No. 1 Zone E Grid 2 Dissolved Oxygen	Aeration Tank No. 1 Zone E Grid 2	0-20.0	mg/L	Class I Div II	120VAC		13440 2.1 C #
AE-317	DO	Aeration Tank No. 1 Zone E Grid 3 Dissolved Oxygen	Aeration Tank No. 1 Zone E Grid 3	0-20.0	mg/L	Class I Div II	120VAC		13440 2.1 C #
AE-318	DO	Aeration Tank No. 1 Zone F Dissolved Oxygen	Aeration Tank No. 1 Zone F	0-20.0	mg/L	Class I Div II	120VAC		13440 2.1 C #
AE-319	ORP	Aeration Tank No. 1 Zone G ORP	Aeration Tank No. 1 Zone G	-1000 to +1000	mV	Class I Div II	120VAC		13440 2.1 C #
FE/FIT-314	THERM / 4"	Aeration Tank No. 1 Zone D Air Flow	Aeration Tank No. 1 Zone D	0-400	SCFM	NEMA 4X	120VAC		13440 2.1 C #
FE/FIT-315	THERM / 4"	Aeration Tank No. 1 Zone E Grid 1 Air Flow	Aeration Tank No. 1 Zone E Grid 1	0-400	SCFM	NEMA 4X	120VAC		13440 2.1 C #
FE/FIT-316	THERM / 4"	Aeration Tank No. 1 Zone E Grid 2 Air Flow	Aeration Tank No. 1 Zone E Grid 2	0-400	SCFM	NEMA 4X	120VAC		13440 2.1 C #
FE/FIT-317	THERM / 4"	Aeration Tank No. 1 Zone E Grid 3 Air Flow	Aeration Tank No. 1 Zone E Grid 3	0-400	SCFM	NEMA 4X	120VAC		13440 2.1 C #
FE/FIT-318	THERM / 4"	Aeration Tank No. 1 Zone F Air Flow	Aeration Tank No. 1 Zone F	0-400	SCFM	NEMA 4X	120VAC		13440 2.1 C #
FE/FIT-319	THERM / 4"	Aeration Tank No. 1 Zone G Air Flow	Aeration Tank No. 1 Zone G	0-400	SCFM	NEMA 4X	120VAC		13440 2.1 C #
AIT-320	MULTI	Aeration Tank No. 2 Multi-parameter Analyzer Transmitter	Aeration Tank No. 2	-	-	NEMA 4X	120VAC		13440 2.1 C #
AE-321	ORP	Aeration Tank No. 2 Zone A ORP	Aeration Tank No. 2 Zone A	-1000 to +1000	mV	Class I Div II	120VAC		13440 2.1 C #
AE-324	DO	Aeration Tank No. 2 Zone D Dissolved Oxygen	Aeration Tank No. 2 Zone D	0-20.0	mg/L	Class I Div II	120VAC		13440 2.1 C #
AE-325	DO	Aeration Tank No. 2 Zone E Grid 1 Dissolved Oxygen	Aeration Tank No. 2 Zone E Grid 1	0-20.0	mg/L	Class I Div II	120VAC		13440 2.1 C #
AE-326	DO	Aeration Tank No. 2 Zone E Grid 2 Dissolved Oxygen	Aeration Tank No. 2 Zone E Grid 2	0-20.0	mg/L	Class I Div II	120VAC		13440 2.1 C #
AE-327	DO	Aeration Tank No. 2 Zone E Grid 3 Dissolved Oxygen	Aeration Tank No. 2 Zone E Grid 3	0-20.0	mg/L	Class I Div II	120VAC		13440 2.1 C #
AE-328	DO	Aeration Tank No. 2 Zone F Dissolved Oxygen	Aeration Tank No. 2 Zone F	0-20.0	mg/L	Class I Div II	120VAC		13440 2.1 C #
AE-329	ORP	Aeration Tank No. 2 Zone G ORP	Aeration Tank No. 2 Zone G	-1000 to +1000	mV	Class I Div II	120VAC		13440 2.1 C #
FE/FIT-324	THERM / 4"	Aeration Tank No. 2 Zone D Air Flow	Aeration Tank No. 2 Zone D	0-400	SCFM	NEMA 4X	120VAC		13440 2.1 C #

Exeter, NH - WWTF and Main Pump Station Upgrade
Preliminary Design Phase (Aug 2015)

TAG	TYPE/ SIZE	DESCRIPTION	LOCATION	RANGE	UNITS	SERVICE	POWER	P&ID	SPEC. SECTION
FE/FIT-325	THERM / 4"	Aeration Tank No. 2 Zone E Grid 1 Air Flow	Aeration Tank No. 2 Zone E Grid 1	0-400	SCFM	NEMA 4X	120VAC		13440 2.1 C #
FE/FIT-326	THERM / 4"	Aeration Tank No. 2 Zone E Grid 2 Air Flow	Aeration Tank No. 2 Zone E Grid 2	0-400	SCFM	NEMA 4X	120VAC		13440 2.1 C #
FE/FIT-327	THERM / 4"	Aeration Tank No. 2 Zone E Grid 3 Air Flow	Aeration Tank No. 2 Zone E Grid 3	0-400	SCFM	NEMA 4X	120VAC		13440 2.1 C #
FE/FIT-328	THERM / 4"	Aeration Tank No. 2 Zone F Air Flow	Aeration Tank No. 2 Zone F	0-400	SCFM	NEMA 4X	120VAC		13440 2.1 C #
FE/FIT-329	THERM / 4"	Aeration Tank No. 2 Zone G Air Flow	Aeration Tank No. 2 Zone G	0-400	SCFM	NEMA 4X	120VAC		13440 2.1 C #
AIT-375	MULTI	Effluent Channel Multi-parameter Analyzer Transmitter	Effluent Channel	-	-	NEMA 4X	120VAC		13440 2.1 C #
AE-375A	NO3	Aeration Tank No. 1 Effluent NO3 Probe	Effluent Channel	0-1000	mg/L	Class I Div II	120VAC		13440 2.1 C #
AE-375B	pH	Aeration Tank No. 1 Effluent pH Probe	Effluent Channel	0-14	pH	Class I Div II	120VAC		13440 2.1 C #
LSH-380	FLT	Supplemental Carbon Containment Leak	Solids Building Chemical Room	-	-	Submersible suitable for use in Supplemental Carbon	--		13440 2.1 C #
LE/LT-381	ULT	Supplemental Carbon Storage Tank #1 Level	Solids Building Chemical Room	0-5.5 0-755 0-100%	feet gallons %	NEMA 4X	24 VDC Loop		13440 2.1 C #
LSH-390	FLT	Magnesium Hydroxide Containment Leak	Solids Building Chemical Room	-	-	Submersible suitable for use in xxx% Magnesium Hydroxide	--		13440 2.1 C #
LE/LT-391	ULT	Magnesium Hydroxide Storage Tank #1 Level	Solids Building Chemical Room	0-5.5 0-755 0-100%	feet gallons %	NEMA 4X	24 VDC Loop		13440 2.1 C #
FE/FIT-411	MAG/ 6"	Return Activated Sludge Pump No. 1 Flow	Solids Handling Building Basement	0-800	gpm	NEMA 4X	120VAC		13440 2.1 C #
FE/FIT-412	MAG/ 6"	Return Activated Sludge Pump No. 2 Flow	Solids Handling Building Basement	0-800	gpm	NEMA 4X	120VAC		13440 2.1 C #
FE/FIT-413	MAG/ 6"	Return Activated Sludge Pump No. 3 Flow	Solids Handling Building Basement	0-800	gpm	NEMA 4X	120VAC		13440 2.1 C #
FE/FIT-414	MAG/ 6"	Return Activated Sludge Pump No. 4 Flow	Solids Handling Building Basement	0-800	gpm	NEMA 4X	120VAC		13440 2.1 C #
PSL	PSI	Plant Water Low Suction Pressure Switch	Plant Water Building	TBD	psi	NEMA 4X	--		Division 11
FE/FIT-535	MAG/ 4"	Plant Water Flow	Plant Water Building	0-100	gpm	NEMA 4X	120VAC		Division 11
PE/PIT-535	PSI	Plant Water Pressure	Plant Water Building	TBD	psi	NEMA 4X	24 VDC Loop		Division 11

TAG	TYPE/ SIZE	DESCRIPTION	LOCATION	RANGE	UNITS	SERVICE	POWER	P&ID	SPEC. SECTION
FE/FIT-545	ULT	WWTF Effluent Parshall Flume Flow	Effluent Parshall Flume	0-3000	gpm	Sensor: Submersible X-mitter: NEMA 4X	120VAC		13440 2.1 C #
LSH-707	FLT	Secondary Scum Well High Level Float Switch	Secondary Scum Well	-	-	Submersible	--		13440 2.1 C #
LE/LT-707	SUB	Secondary Scum Well Level	Secondary Scum Well	TBD	feet	Transducer: NEMA 7 Junction Box: NEMA 4X	24 VDC Loop		13440 2.1 C #
FE/FIT-710	MAG/ 4"	Waste Activated Sludge Flow	Solids Handling Building Basement	0-100	gpm	NEMA 4X	120VAC		13440 2.1 C #
AE/AIT-710	TSS	Waste Activated Sludge Total Suspended Solids	Solids Handling Building Basement	0-10,000	mg/L	NEMA 4X	120VAC		13440 2.1 C #
LE/LIT-711	RAD	Sludge Storage Tank No. 1 Radar Level Indicating Transmitter	Sludge Storage Tank No. 1	0-12.0	feet	NEMA 4X	120VAC		13440 2.1 C #
LSL-711	FLT	Sludge Storage Tank No. 1 Low Level Float Switch	Sludge Storage Tank No. 1	-	-	Submersible	--		13440 2.1 C #
LSH-711	FLT	Sludge Storage Tank No. 1 High Level Float Switch	Sludge Storage Tank No. 1	-	-	Submersible	--		13440 2.1 C #
LE/LIT-712	RAD	Sludge Storage Tank No. 2 Radar Level Indicating Transmitter	Sludge Storage Tank No. 2	0-12.0	feet	NEMA 4X	120VAC		13440 2.1 C #
LSL-712	FLT	Sludge Storage Tank No. 2 Low Level Float Switch	Sludge Storage Tank No. 2	-	-	Submersible	--		13440 2.1 C #
LSH-712	FLT	Sludge Storage Tank No. 2 High Level Float Switch	Sludge Storage Tank No. 2	-	-	Submersible	--		13440 2.1 C #
FE/FIT-725	MAG/ 4"	Dewatering Sludge Pump No. 1 Flow	Maintenance Building Basement	0-100	gpm	NEMA 4X	120VAC		13440 2.1 C #
FE/FIT-726	MAG/ 4"	Dewatering Sludge Pump No. 2 Flow	Maintenance Building Basement	0-100	gpm	NEMA 4X	120VAC		13440 2.1 C #
LE/LT-761	ULT	Conveyor No. 2 Slide Gate No. 1 Container Level	Container Bay	0-10.0 0-100%	feet %	NEMA 4X	120VAC		13440 2.1 C #
LE/LT-762	ULT	Conveyor No. 2 Slide Gate No. 2 Container Level	Container Bay	0-10.0 0-100%	feet %	NEMA 4X	120VAC		13440 2.1 C #
LE/LT-763	ULT	Conveyor No. 2 Slide Gate No. 3 Container Level	Container Bay	0-10.0 0-100%	feet %	NEMA 4X	120VAC		13440 2.1 C #

MAG - Electromagnetic	SUB - Submersible	RAD- Radar	DPI- Differential Pressure
RTD - Resistance Thermal Diode	ORP-Oxygen Reduction Potential	TURB- Turbity	DO- Disolved Oxygen
FLT - Float	CL- Chlorine Residual	CAP- Capacitance	ULT-Ultrasonic
THER - Thermal Mass	NO3 - Nitrate	COD - Chemical Oxygen Demand	

WRIGHT-PIERCE
Engineering a Better Environment

MEMORANDUM

TO:	Ed Leonard	DATE:	August 13, 2015
FROM:	Steve LaPrise	PROJECT NO.:	12883B
SUBJECT:	Town of Exeter, New Hampshire Wastewater Treatment Facility ─ Contract No.1 Upgrade **PDR – Electrical Design Approach**		

The purpose of this technical memo is to document the Preliminary Electrical Engineering and Design Approach for the Contract No. 1 Facility Upgrades, at the Exeter Waste Water Treatment Plant.

Waste Water Treatment Facility Electrical Improvements – Contract 1

Existing Conditions:

The Facility Plan has detailed information regarding the existing conditions of the current Service and Distribution systems within the plant. For purposes of the Preliminary Design Report, we have focused on various options and recommendations of the Contract No. 1 Facility Upgrade.

Governing Codes

The electrical design shall adhere to the electrical codes listed below:

- NFPA-70 National Electrical Code 2014 Edition
- NFPA-70E Standard for Electrical Safety in the Workplace, latest edition
- NFPA-72 National Fire Alarm and Signal Code 2013 Edition
- NFPA-820 Standard for Fire Protection in Wastewater Treatment and Collection Systems 2012 Edition

Contract No. 1 Facility Improvements

Electrical Power will be required for the new facilities planned as part of the upgrade. These facilities include conversion of the existing control building into an office/operations building, conversion of the Grit Building into a Septage Handling Building, conversion of the Chlorination Building into a UV system Plant Water building as well as the additional buildings and processes listed below:

- Head Works Building (Head works and Grit processes)
- Solids Handling Building (Dewatering and Aeration Processes)
- Aeration Tanks
- Secondary Clarifiers
- Sludge Storage Tanks
- Maintenance Building

- Supplemental Chemical Building
- Disinfection Building

Proposed Electrical Service and Distribution.

As the existing service at the Control Building is inadequate to serve the new process equipment and planned additional buildings, a new electrical service will be installed and brought into the new Solids Building. Based on the equipment list and other proposed loads, the main service requirements is 2500 amps at 480/277VAC 3phase, 4 wire, 60 Hz. The utility company shall require a pad mounted transformer with primary feeder connections from a nearby utility pole. The new power service proposed installation and routing shall be coordinated with the local utility company “Unitil” during design.

The Main Service disconnect shall be housed in a switchgear, complete with distribution feeder breakers and automatic transfer switch to provide back-up power to all of the respective loads listed in the Master Equipment List. The Main Switchgear shall be named SWGR-SB-1, and shall be located in the Electrical Room of the Solids Building. The switchgear shall also have a dedicated breaker for each of the planned and future MCC’s located throughout the plant. Each MCC will be labelled for the building they are located in (i.e. Solids Handling Building is SB). Some MCC Feeder Breakers in the switchgear shall have a load shed feature that will prevent these loads from connecting to the emergency standby generator upon a power loss. See MCC/ Feeder listing on next page, and refer to the Single Line Diagram for further information.

MCC Name	Location	Load Shed	Respective Loads
MCC-SB-1A	Solids Handling Building Electrical Room	No	Aeration Tank, Secondary Clarifiers, Supp. Chemical Building
MCC-SB-1B	Solids Handling Building Electrical Room	No	Aeration Tank
MCC-SB-2	Solids Handling Building Electrical Room	Yes	Dewatering
MCC-SEP-1	Septage Building Electrical Room	Yes	Septage Receiving
MCC-HW-1	Head Works Building Electrical Room	No	Headworks, Grit Removal
MCC-PW-1A,1B	Plant Water Building Electrical Room	No	Disinfection Building, Plant Water
MCC-CB-1	Control Building Electrical Room	No	Influent Equalization Pumps, Mixers, Office, Maintenance Building
MCC-TB-1	Tertiary Building (Future)	No	Tertiary Process
MCC-PG-1(Future)	Primary Gallery (Future)	No	Primary Clarifier, Primary Sludge

<u>Emergency Standby Power</u>

An automatic Transfer Switch (ATS) shall be provided to monitor for a power failure and to start an emergency standby generator. Once the generator has reached voltage, the ATS shall transfer all required loads to the generator. As the ATS is a critical point in the distribution system, the transfer switch shall be installed with a manual bypass feature that will allow the ATS to be removed and racked out for maintenance or repair and still keep the plant operational. The bypass switch can operate with either the utility or generator power source. The ATS will include a programmed neutral transition feature to allow the load transients and motor loads to settle prior to switching from generator power back to utility.

The proposed emergency standby generator is a natural gas driven, 725 kW, 480/277VAC, 3 phase, four wire unit. The unit shall be located outdoors in a walk in steel enclosure complete with intake and exhaust louvers. The enclosure shall be a level 2 sound attenuated to limit the noise to 73dBa, at 23 feet (7 meters). The enclosure shall be located near the solids building. The generator will be specified with a complete control panel, battery charger, regulators, exhaust muffler, and block heaters for quick starts. The walk in enclosure shall contain a low voltage distribution panel, necessary lighting, motorized dampers, and heating. The existing gas service shall be reviewed during design with the local gas utility to ensure the generator and other HVAC gas flow requirements can be met.

Distribution Redundancy

For redundancy the Aeration Tank(s) distribution shall be split into two MCC's, MCC-SB-1A, and MCC-SB-1B. This redundancy will allow maintenance to be performed on one MCC, and yet still keep at least on aeration tank operational. Should one MCC fail, the remaining MCC shall be able to run at least one aeration tank.

For redundancy at the Disinfection building two feeders will be run into a split buss MCC-DIS-1A/B with a Tie Breaker. The Main/Tie/Main will utilize a Kirk key arrangement to prevent all of the breakers from being closed at the same time. One feeder or both feeders could be connected to the MCC depending on the position of the Tie breaker. This arrangement will allow better flexibility if one feeder should fail, or if one MCC side is down for maintenance purposes.

Building Electrical Distribution and Lighting

Each new and existing building will be designed with a new electrical room dedicated for the proposed MCC and other distribution panels. The proposed MCC shall provide power to all respective process loads, HVAC equipment, and a local step down transformer. The transformer will be used to power a local 208/120VAC panel to power all lighting, instrumentation, and small loads. Similar to the MCC's, each distribution panel will be tagged based on the building they are located in.

Each building will be designed with energy efficient fluorescent or LED lighting. Emergency and exit lighting shall be included in the design to meet compliance with the local building codes. Available light fixture rebates will be investigated with the utility company during design. Interior lighting illumination levels will meet IESNA standards for the designated areas.

Foot candle Levels –	Electrical Room/Control Room	35 - 40
	Pump Room	25
	Process Areas	25
	Office	30
	Stairwells	10
	General Maintenance Areas	20

Exterior Lighting will be provided above any egress doors as well as emergency egress lighting. Site lighting shall be provided along entrance roadways and near exterior process equipment such as the clarifiers.

Fire Alarm System Needs

The design shall include a facility wide addressable fire alarm system with the main panel located at the Solids Building. Each building will have fire alarm initiation and alarming devices. The specific requirements for the plant will be reviewed with the Fire and Building Departments during final design.

Site Work Conduit Requirements:

Power Feeder, site lighting, instrumentation, and communication conduits will be run within new concrete enclosed duct banks and coordinated so that all power, site lighting, instrumentation and communications are distributed from the Solids Building electrical room. Spare conduits for power instrumentation and communications will be included within the duct banks.

Basic Materials

1) Power Wiring - XHHW insulated copper, 600 volt.
2) Control Wiring - THHN/THWN insulated copper, 600 volt.
3) Instrumentation Wiring - 2 or 3 conductor twisted pair shielded copper, 600 volt.
4) Data Wiring - Fiber optic cable network to be installed underground in duct bank between buildings as required. Ethernet CAT 6 network cabling within each location between PLC's (Programmable Logic Controllers) and SCADA computers, as required.
5) Conduit:
    - Underground - PVC Schedule 40 or 80, concrete encased in duct bank.
    - Electrical and Mechanical Rooms – Aluminum Conduit
    - Pump or Process Rooms – Aluminum Conduit
    - Wet Well, and Chemical Feed Areas – PVC Coated rigid steel
    - Hazardous Areas – PVC Coated rigid steel
    - Office Wiring – Rigid Conduit in exposed areas, EMT in non-exposed areas
6) Enclosures:
    - General use (Electrical Room and Control Room) NEMA-12.
    - Damp/Wet or Corrosive Areas - NEMA 4X (Fiberglass or Stainless Steel).
    - Hazardous Areas NEMA 7, cast aluminum explosion proof enclosures
    - MCC's, Switchgear NEMA 12
    - VFD enclosures, NEMA 12, and NEMA 4X is corrosive or wet areas.
    - Panel boards NEMA 12, and NEMA 4 in outdoor areas.

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Engineering a Better Environment

MEMORANDUM

TO:	Ed Leonard	DATE:	August 13, 2015
FROM:	Chris Abell, Steve LaPrise	PROJECT NO.:	12883B
SUBJECT:	Town of Exeter, New Hampshire Main Pump Station – Contract No. 2 Upgrade **PDR - Electrical Design Approach**		

Existing Conditions

The Facility Plan has detailed information regarding the existing conditions of the current Service and Distribution systems within the plant. For purposes of the Preliminary Design Report, we have focused on various options and recommendations of the Contract No. 1 Pump Station Upgrade.

Governing Codes

The electrical design shall adhere to the electrical codes listed below:

- NFPA-70 National Electrical Code 2014 Edition
- NFPA-70E Standard for Electrical Safety in the Workplace, latest edition
- NFPA-72 National Fire Alarm and Signal Code 2013 Edition
- NFPA-820 Standard for Fire Protection in Wastewater Treatment and Collection Systems 2012 Edition

Basic Materials

1) Power Wiring - XHHW insulated copper, 600 volt.
2) Control Wiring - THHN/THWN insulated copper, 600 volt.
3) Instrumentation Wiring - 2 or 3 conductor twisted pair shielded copper, 600 volt.
4) Data Wiring - Fiber optic cable network to be installed underground in duct bank between buildings as required. Ethernet CAT 6 network cabling within each location between PLC's (Programmable Logic Controllers) and SCADA computers, as required.
5) Conduit:
   - Underground - PVC Schedule 40 or 80, concrete encased in duct bank.
   - Electrical and Mechanical Room – Aluminum Conduit
   - Pump Room – Aluminum Conduit
   - Wet Well – PVC Coated rigid steel.
6) Enclosures:
   - General use (Electrical Room and Control Room) NEMA-1.
   - Damp/Wet or Corrosive Areas - NEMA 4X (Fiberglass or Stainless Steel).
   - Hazardous Areas NEMA 7, cast aluminum explosion proof enclosures

Electrical Service

The electrical service will be upgraded to a new 480/277 Volt, 3 phase 4 wire service sized at 600 Amperes. The new service will be routed underground from the existing service riser pole located on the site. The existing electrical service and pole mounted transformer will be removed and the service will be upgraded to a new 480/277 Volt, 4 wire service with a new kilowatt hour meter. Power service locations and conduit routing shall be coordinated with Unitil during design.

Power Distribution Equipment

The existing storage room will be converted to a new Electrical Room to house all of the electrical distribution equipment. The electrical service will upgraded to 1000 Amperes at 480 Volts and will allow for all four pumps and two grinders to run. The main circuit breaker will be located within the entrance of the door to make the main disconnect readily accessible as required by the National Electric Code. The distribution equipment will consist of the following:

- Distribution Equipment - 480/277 volt, 3 phase, 4 wire, 1000 amp Main Circuit Breaker, Main Distribution Panel.
- Variable Frequency Drives- 75 HP Constant Torque Variable frequency drives with harmonic matric filters to operate each pump.
- Motors/Large Process Loads - 480 volt, 3 phase, 3 wire supply to each motor, with local disconnecting means within sight from each motor.
- Miscellaneous Power and Lighting Loads - 120/208 volt, 3 phase 4 wire lighting panelboard and dry-type transformer.

Emergency Stand-By Power

The existing generator is currently under sized in order to operate three pumps and two grinders. The existing generator will be removed and a new outdoor 350 KW natural gas generator housed with a sound attenuated enclosure will be installed. The pump station will transfer between normal and emergency automatically through a programmed transition automatic transfer switch.

Conduit Runs

Interior – Surface mounted.

Exterior – underground in concrete encased duct banks.

Illumination

Interior:

Scope - New lighting throughout the building.

Type – Fluorescent with energy-saving ballasts and lamps in office and electrical room. Either LED or Metal Halide HID fixtures in high-bay areas. High bay fixtures will be suitable for unheated, wet and dirty environment.

Foot candle Levels –	Electrical Room/Control Room	35 - 40
	Pump Room	25
	Process Areas	25
	Office	30
	Stairwells	10
	General Maintenance Areas	20

Exterior

Type –LED fixtures, ceiling mounted, wall mounted, and/or pole mounted with photocell and/or time controls as required.

Emergency and Exit Lights

Provided in building as required: Emergency Lights (battery packs and remote heads, for building egress) and Exit Signs (self-powered with battery back-up, LED type).

Fire Alarm System

The design shall include an addressable fire alarm system with the fire alarm panel located within the new electrical room. During final design, the fire alarm system needs will be reviewed with the Fire and Building Departments.

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MEMORANDUM

TO:	Design Team	DATE:	September 15, 2015
FROM:	Travis Pryor, RLA	PROJECT NO.:	12883B
SUBJECT:	Exeter, NH – Wastewater Treatment Facility Upgrade Preliminary Design Report Invasive Species Management Plan Considerations		

The Town of Exeter owns and operates the Wastewater Treatment Facility (WWTF) located at 13 Newfields Road. The Town is proposing to upgrade the WWTF with various improvements slated for several areas throughout the site. The improvements slated for the WWTF Upgrade project will have a variety of impacts on the site with respect to new impervious surfaces, realignment of the site access drive, grading modifications adjacent to new and existing structures, modifications to the existing site drainage, work within the 250-foot shoreland protection zone, modification to the existing lagoons, and impacts to nearby wetlands. Improvements are also slated for many of the building/structure access areas throughout the site to improve traffic flow and operator access.

As part of the environmental site assessment several existing invasive plant species have been mapped in detail within the Town's 55 acre parcel, and phragmites colonies have been identified by aerial survey at a regional scale along the Squamscott River to the north and south of the Town's parcel. (*See Invasive Species Management Plan*, by Gove Environmental Services, Inc. and dated September 2015). Further information regarding the Site Development is discussed separately in the Civil/Site Design Considerations Technical Memorandum.

Preliminary design consideration has been given to management of the invasive species (ISMP) in relation to:

- ISMP Requirements Related to WWTF Construction Activities
- ISMP Requirements Related to Continued Monitoring / Management After WWTF Construction Activities
- Future Snow Storage Operations
- ISMP Related to Options for Decommissioning the Lower Lagoons
- Regional Considerations for Control of Phragmites

<u>ISMP Requirements Related to WWTF Construction Activities</u>

A variety of invasive vegetative species have been identified throughout the Town parcel. The recommendations for management of these invasive plant materials are generally described as follows:

- Minimize site disturbance related to all construction activities and stabilize disturbed areas as soon as possible.
- Make sure all new material brought to the site is free of invasive species.
- Cleaning of construction equipment operating in invasive species areas prior to leaving the site
- Avoidance of staging of construction materials in invasive species areas.
- Manage of disturbed invasive species areas by disposal of invasive plant materials (including excavated soil materials to a depth of 4 feet) in accordance with NH DOT's *Best Management Practices for Roadside Invasive Plans, 2008 edition*.
- Management of non-disturbed invasive species areas by herbicides and disposal of above ground plant material in accordance with NH DOT's *Best Management Practices for Roadside Invasive Plans, 2008 edition*. We estimate that approximately 6 acres current non-disturbed invasive species areas will need to be managed.

The predominant invasive species on-site is Common Reed (*Phragmites australis*). This species is particularly prevalent throughout the majority of the sludge lagoon where the majority of the new WWTF construction is anticipated to take place. We have estimated that approximately 35,800 cubic yards of excavated material in these disturbed areas will need to be either buried on-site in areas where finish grade will be 4 feet or greater above the material, or removed and disposed off-site in accordance with NH DOT BMPs. Based on the preliminary design, there is approximately 22,700 cubic yards of available storage area within the existing sludge lagoons where the excavated material could be disposed of on-site (primarily in the area where the future snow dump and stormwater detention ponds are located). That leaves approximately 13,100 cubic yards of excavated material that will either need to be located elsewhere on site or disposed of off-site if no additional suitable areas are available. This excavated material where invasive species have been disturbed is not suitable as fill material under or immediately adjacent to building structures.

Timing for removal of invasive species materials will need to be coordinated with WWTF Construction activities. Disposal of invasive species materials and herbicide treatments are recommended to be performed during late summer / early fall if possible.

Given the variety of BMP's available to address disposal of invasive species materials, it is recommended that the contractor propose a project-specific ISMP utilizing the GES, Inc. report as well as any combination of NH DOT's *Best Management Practices for Roadside Invasive Plans, 2008 edition,* for review and approval by the Owner prior to construction.

<u>ISMP Requirements Related to Continued Monitoring / Management After WWTF Construction Activities</u>

Monitoring of invasive species should also involve post construction elements. The completed project should be formally monitored for at least 2 years and it is recommended that this be part of the Contractor's ISMP responsibilities.

After that, the Town should continue indefinitely to monitor and control invasive plant species should the attempt to re-vegetate on the Town parcel. Early detection and eradication of any re-vegetated areas is the best defense to prevent large populations of invasive species from returning to the site. On-site maintenance staff should receive training on identifying, removing and, and disposing of invasive vegetation or the Town should be prepared to hire outside expert consultants to monitor and perform ongoing invasive species management on-site. Specific post construction practices should consider:

- Invasive species prefer disturbed soils so post construction control methods should create as little disturbance as possible.
- Carefully executed cutting and herbicide application is the preferred post construction control method for phragmites and japanese knotweed.
- Phragmites and japanese knotweed should NOT be mowed, whether on purpose or unintentionally, as this generally increases stand density and spreads viable plant material further.
- Maximize site access for ISMP maintenance. The creation of inaccessible areas should be avoided to the greatest extent possible. Fence lines, extreme slopes, and long term stockpiles, for instance are notorious locations for invasive species infestation. In addition to the disturbance factor, access for maintenance is impeded or impossible which allows the populations to become entrenched.
- Minimize maintained lawn areas. Consider the use of native wildflower species and tall grasses to cover areas where maintained lawn would typically be used. This inhibits the invasive species growth, reduces maintenance costs, and provides better wildlife habitat. In areas where less openness and access is acceptable, native shrubs can also be incorporated to reduce annual invasive species maintenance.

<u>Future Snow Storage Operations</u>

Another on-site practice not directly associated with the WWTF project is the current operation of the site for snow storage. Ideally the Town should consider discontinuing winter snow storage at this site given its proximity to the adjacent ecologically sensitive shoreline of the Squamscott River. Snow storage provides an opportunity to re-introduce invasive plant material to the site, as well as to promote the additional growth of phragmites on-site by placing stress on desirable species unable to tolerate the road salt and other potential contaminants.

ISMP Related to Options for Decommissioning the Lower Lagoons

Options for decommissioning of the lower lagoons include a unique opportunity to restore coastal wetlands along the Squamscott River, and the potential to provide public access to the river for hand carry boaters and birding enthusiasts. While such an effort will require significant construction costs associated with earthwork, installation of native low marsh vegetation and native shrub growth to stabilize the adjacent shoreline embankments, this option is likely to be of interest to state and federal environmental agencies, as well as potential non-profit environmental groups such as the Nature Conservancy and Ducks Unlimited who are interested in restoring native habitat, benefiting the local ecosystem along the Squamscott River, as well as to provide regional benefit to the Great Bay Estuary. These potential partners may be interested in providing funding in support of such an effort and a next step would be to initiate such stakeholder conversations.

Specific design recommendations for the option to decommission the lower lagoons as low marsh coastal wetlands and to provide public access to the Squamscott River are as follows:

- After sludge is removed from the lagoons to an elevation of 6 feet, further excavation of native materials below the sludge will be necessary to an elevation of 0.5 feet at the upland edge of the restored low marsh area and continuing past the existing lagoon outer embankments to the shoreline at an elevation of -0.5 feet. Excavating to these depths will create a low marsh intertidal zone that will allow for longer tidal inundation and increased salinity within the restored low marsh areas at elevations where phragmites is currently observed to be less dominant then native marsh plant species near the site. This native material is anticipated to be unsuitable as backfill under and adjacent to building structures on site. We estimate that 166,800 cubic yards of material will be excavated below the existing sludge levels to create low marsh areas in the lower lagoons and extending to the Squamscott River shoreline.
- Removal of the outer lagoon embankments. We anticipate that this material may be suitable as common borrow for WWTF construction activities as needed. We estimate that approximately 228,400 cubic yards of material will be available for such use and that the available material will exceed the needs of the WWTF construction activities, and it will be necessary to transport some of this material off-site. It is recommended that the outer lagoon embankments be removed in their entirety along the shoreline, with the exception of the area immediately adjacent to the WWTF outfall.
- If desired, construction of a public access road along the easterly Lagoon 3 embankment for hand carry boat access and for birding enthusiasts to visit the shoreline. If so, it is recommended to be constructed at a 7% average grade down to elevation -1.5 feet. This excavation of the embankment will create approximately 8,200 cubic yards of material that is anticipated to be suitable for common borrow associated with WWTF construction

activities as needed, however it is again anticipated that this material will be in excess of what is needed on-site and will need to be disposed of off-site.

- Planting of perennial native marsh grasses at 18 inch maximum spacing in the low marsh areas is recommended immediately after excavation to stabilize the site and minimize the ability for invasive species to re-vegetate this disturbed area.
- Continuing the 3:1 maximum lagoon embankment side slopes to the bottom of the low marsh areas and revegetating these embankments with native shrub materials is recommend to minimize revegetation of disturbed areas by invasive plant species, as well as to minimize ongoing invasive species re-population management needs.
- The Outfall pipe is currently located within and beneath Lagoon 3 and excavation associated with creation of low marsh areas will reduce the ground cover over this pipe. It is recommended that 6 feet of cover be maintained over the pipe and then a uniform embankment slope continuing to the top of the lagoon. We estimate that 13,400 cubic yards of fill will be needed to maintain cover over the pipe and the excavated outer embankment material would be suitable to use for this effort.
- Manage of disturbed invasive species during construction of low marsh areas and a potential public access drive by disposal of invasive plant materials (including excavated soil materials to a depth of 4 feet) in accordance with NH DOT's *Best Management Practices for Roadside Invasive Plans, 2008 edition*. We estimate that approximately 3,800 cubic yards of material will need to be disposed of.
- Management of non-disturbed invasive species areas by herbicides and disposal of above ground plant material in accordance with NH DOT's *Best Management Practices for Roadside Invasive Plans, 2008 edition.*
- Long term post construction monitoring and maintenance of Phragmites be plant growth removal and herbicide treatment on an annual basis will be required should phragmites re-establish in the low marsh areas.

Ultimately, this decommissioning option could take place after the WWTF construction activities, however the opportunity to reuse some suitable excavated materials for the WWTF construction activities, as well as to potentially take credit during environmental permitting efforts for the creation of new coastal wetlands as a means to offset impacted wetlands due to WWTF construction activities would be lost.

Should restoration of coastal wetlands become unattainable, the decommissioning of the lagoons by removal of sludge only and retaining the freshwater pond areas, invasive species management in these areas would be by removal of invasive species non-disturbed areas and on-going monitoring and maintenance of re-invested areas as generally described above for ISMP requirements related to WWTF construction activities.

Permitting

Permitting requirements for disposal of invasive species materials are fairly minimal would likely be as follows:

- A burn permit from the Town may be required should the contractor propose to dispose of harvested invasive species by that method.
- A permit from the NH Division of Pesticide Control will be required and a certified applicator will need to be used for herbicide treatments, both during construction and for post construction monitoring and management activities.

Permitting associated with the option to decommissioning of the lagoons as low marsh coastal wetlands will require local, state and federal efforts. See Civil/Site Design Considerations technical memorandum for further description.

Regional Considerations for Control of Phragmites

Ideally, the ISMP would also be developed in conjunction with a regional control effort along the Squamscott River. This would, be beneficial to the ecology of the entire river corridor, in addition to being of importance to the Town to discourage re-colonization of phragmites on the Town parcel. The presence of other populations of phragmites along the river, particularly those that are nearby, would greatly increase likelihood phragmites will be introduced into the along the parcel shoreline and in restoration low marsh areas should that option for decommissioning the lower lagoon move forward. (See ISMP p*hragmites Regional View* map, Appendix D, GEI, Inc report). The lack of large extensive monocultures in this area, with perhaps the exception of the Route 101 bridge population, suggests that implementing a control plan in this area is feasible and likely to yield good results if carried out in the near term. Advancing control efforts within the populations closest to the facility, such as the Route 101bridge, so as to preempt the restoration work will likely yield the best results. This effort will require coordination with other land owners, interested stakeholders, the Towns of Stratham and Newfields, and state and federal agencies in terms of permitting, and for coordinated partnering of funding this additional ISMP measure. Regional control of phragmites is anticipated to need an ongoing annual herbicide and plant growth removal program over a minimum of 10 years.

Civil Drawings

See Final Design Drawing List, as part of this PDR, for Preliminary Site Drawings.

GOVE ENVIRONMENTAL SERVICES, INC.

Invasive Species Management Plan

for

Exeter Wastewater Treatment Facility Project

September, 2015

Prepared For:
Wright-Pierce
&
The Town of Exeter, NH

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1.0 Introduction

The Exeter Wastewater Treatment Facility (EWWTF) is located on approximately 55 acres of land directly adjacent to the tidal Squamscott River. The site consists of several public works garages, facility buildings, and four treatment lagoons, only three of which appear active. Invasive vegetation is prevalent at the site and includes several aggressive species that are considered to be most problematic in New Hampshire. Most notably is common reed (*Phragmites australis*), which is of particular concern given the proximity to the exemplary habitat along the tidal Squamscott River. The brackish marshes along the river are ideal habitats for Phragmites and are very vulnerable to infestation.

As the Town of Exeter considers options for reconfiguring and upgrading the facility, a comprehensive Invasive Species Management Plan (ISMP) will be critical to prevent the spread of invasive species within the facility and into the surrounding sensitive riverine environment. A project such as this one where significant disturbance will occur also presents an opportunity to eradicate these populations if done carefully. The primary goals of this ISMP are:

1) to prevent the spread of invasive species during construction disturbance,

2) to eradicate large areas of invasive plants where possible during construction, and

3) to monitor completed areas post construction and address areas of resurgence before they become extensive and harder to deal with.

The following sections characterize the populations of invasive vegetation on the site, provide a set of best management practices (BMPs) for dealing with invasive species in general, and offer detailed site-specific procedures for the project. Recommendations are also provided relative to the potential removal of the lower lagoons and restoration of marsh in these areas. The appendices to this report include an aerial photo plan of the invasive vegetation on the site and identification guides to the species, and invasive species maps.

2.0 Invasive Species Population

2.1 Mapping

The location of invasive species was mapped using GPS equipment, and GIS software was used to create the enclosed plan (see Appendix C). This information is also available for use in CAD software for inclusion on design plans. The invasive species population on the site does not fall neatly into discrete polygons so it was not possible, nor did it make sense, to map all occurrences using polygons. Instead, both linear features and point features were used in conjunction with polygons to provide the most practical picture of the invasive vegetation on the property considering the likely project impacts. A complete list of species mapped and other summary information is provided in Table 1.

Table 1—List of Mapped Invasive Species

COMMON NAME	SCIENTIFIC NAME	Type	COMMENTS
Common Reed	*Phragmites australis*	Type II	Primary target species. Greatest threat to marsh areas
Purple Loosestrife	*Lythrum salicaria*	Type II	Not widespread on site. Galerucella biological control is active on site.
Japanese Knotweed	*Polygonum cuspidatum*	Type II	Only one area exists. This species is a threat to up and downstream areas if transported by river.
Oriental Bittersweet	*Celastrus orbiculata*	Type I	Some individual occurrences but mostly these species occur together along the southern fence line, the upland areas of the SW lagoon and the northern forest line.
Autumn Olive	*Elaeagnus umbellata*	Type I	
Glossy Buckthorn	*Rhamnus frangula*	Type I	
Common Buckthorn	*Rhamnus cathartica*	Type I	
Multiflora Rose	*Rosa multiflora*	Type I	
Bush Honeysuckle	*Lonicera sp.*	Type I	

The character of invasive vegetation on the site is complex. Most mapped features contain more than one and often several different species. Generally, mixed populations of invasive vegetation exist along all edges of the site. Shrub species such as buckthorns, multiflora rose, and bush honeysuckle occupy the forested edges along the southern fence line and the forested area near Route 101. Patches of invasive shrub species also exist at the upper edge of the marsh at the base of lagoon berms along the river side of the facility. In addition, there exists in that area a nearly continuous narrow band of Purple Loosestrife.

Within the interior of the Site, the most significant population of invasive vegetation lies within and adjacent to the southwest lagoon where the largest population of Phragmites exists. Phragmites also extends from this lagoon out toward the parking area for the administration building and along the gas easement to the entrance of the site. There is a separate small stand near the resident salt shed along with small spot occurrences in the south east lagoon.

The invasive species mapped on the site have been grouped into two categories depending on how they propagate, their aggressiveness, and the relative difficulty of control measures once populations reach infestation levels. Type I species include the woody shrubs which propagate primarily or exclusively through fruit and seed. Recommended BMPs for these species are relatively less intense, particularly if accomplished prior to fruit production. The Type II species reproduce vegetatively through plant fragments as well as seed, making removal and control much more challenging particularly in a construction scenario when extensive disturbance is proposed. Phragmites, the primary target species of this ISMP, is within this group along with two other priority species: Japanese Knotweed and Purple Loosestrife.

2.2 Habitat Characterization

Relatively few distinctions can be made between the areas occupied by invasive vegetation on the site. The nature of invasive vegetation is such that they typically flourish in a wide range of conditions with a preference for disturbed areas. All populations are in some way or another related to disturbance, either from the WWTF, gas main, highway or even past use of the areas as agricultural field.

The most obvious habitat difference is between wetland areas and non-wetland areas though even this distinction can be fuzzy. Phragmites is much more prevalent in wetland areas such as the southwest lagoon but has also colonized the adjacent upland areas of maintained lawn. It is clear that this has been exacerbated by mowing operations and by the stressors imposed on more desirable vegetation by snow storage in this area. The effects of disturbance along the gas main easement is also clear as a dense monoculture of Phragmites extends along the corridor.

In a tidal system, differences in the distribution and vigor of Phragmites populations is often evident within different salinity zones. This is not the case, however, in the brackish marshes along this portion of the Squamscott. Here, some stands of Phragmites extend all the way out to the upper edge of the mud flat, though they are evidently stressed by the longer inundation at the edge of this zone. The edge of the intertidal mudflat, which is only exposed for a brief time during low tide, corresponds to the limit of all marsh vegetation. The salinity of the river was measured during all tidal stages and appears to be between 10 and 15 ppt. Since Phragmites is tolerant of salinities approaching 20ppt, salinity does not appear to exert an influence on the species at this site. It should be assumed that all vegetated areas of the brackish marsh are suitable habitat for Phragmites with the exception of intertidal mud flat.

Woody species tend to occupy more upland environments as is generally the case on this site. Regular maintenance, and conversely, lack of maintenance, has tended to concentrate the invasive shrub species to areas at the northern and southern property lines and the interior of southwest lagoon.

3.0 BMPs for All Species

The following BMPs apply to the handling of all invasive species on the property. These have been adapted from the invasive species manual produced by NH DOT for working in infested areas[1] and are largely applicable to this site.

[1] Best Management Practices for Roadside Invasive Plants, New Hampshire Department of Transportation, 2008air.

3.1 Soil Disturbance and Stabilization

- Minimize soil disturbance as much as possible since invasive species quickly colonize disturbed areas.

- Stabilize disturbed areas as soon as possible with vegetation, rock, gravel, or impervious surfaces if proposed.

- All material bought into the site should be verified free of invasive species. Fill brought from infested sites is often the origin of invasive species problems, particularly species such as Japanese Knotweed.

- Monitor areas where invasive vegetation was removed or disturbed for a minimum of two years.

3.2 Movement and Maintenance of Equipment

- Staging areas and stockpiles should not be located in areas of invasive vegetation to avoid spreading seeds and plant material with movement of equipment and materials.

- Equipment that operates within areas of invasive vegetation must be cleaned of all plant material and soil at the site of infestation before moving to another work area. This is especially important for Type II species, which are able to reproduce from plant fragments. Cleaning methods may include high pressure air, brush broom, or water. However, if water is used, runoff needs to be contained in accordance with discharge regulations.

- If equipment must be used in areas containing Japanese knotweed, Phragmites, or purple loosestrife, aboveground plant material should be cut and properly disposed of prior to excavation to prevent maceration of the plant which can then be more easily spread.

3.3 Removal of Invasive vegetation

- Phragmites, Japanese Knotweed, and Purple Loosestrife should not be mowed. Mowing results in spreading these species and stimulates denser growth of Phragmites stands.

- Phragmites, Japanese Knotweed, and Purple Loosestrife should be cut with minimal disturbance (preferably by hand), removed from the affected area and disposed of in accordance with the methods outlined in Section 3.1.4. Removal of these species should follow the timing and sequence specified in the site specific methods outlined in Section 4.0 since cutting at the wrong time may increase densities.

- Woody invasive species may be cut by conventional means and removed from the affected area prior to fruit production in late summer.

3.4 Disposal of Invasive Vegetation Removed From Work Areas

- Brush Piles: Woody invasive species can be piled on site to dry out if cut prior to fruit production in late summer. Japanese knotweed, purple loosestrife, Phragmites should not be brush piled.

- Drying/Liquefying: Place plant material on impervious surface such as asphalt, tarps, or heavy plastic, and cover with tarps or heavy plastic to prevent the material from blowing away. Smaller amounts of plant material or plants with non-woody stems may be placed in heavy-duty (3-mil or thicker) garbage bags. Keep plant material covered or bagged for at least one month until rendered inert by either liquefying or drying until brittle. Plant material can then be disposed of in a landfill or brush piled. This method is best used for Japanese knotweed, purple loosestrife and Phragmites.

- Burying: Plant material can be buried a minimum of three (3) feet below grade. Japanese knotweed must be buried at least at least five (5) feet below grade but *burial of viable plant material from this species is not recommended*.

- Burning: Plant material from all invasive species may be burned in piles or at a biomass generation facility. A burn permit may be required.

- Herbicide: Herbicide is a valuable tool for managing invasive species. It can may be used alone but is normally most effective if used in conjunction with other techniques which reduce the viability of the plant. Multiple applications may be required, making it impractical for pre-construction removal and best suited for long term management or in areas where no soil disturbance is required. This method is best used for Japanese knotweed, purple loosestrife and Phragmites.

- Invasive plant material must be covered if transported.

3.5 Excavated Material from Infested Areas

- Soil excavated from infested areas contains viable plant material and seeds. This is particularly problematic for Japanese knotweed, purple loosestrife and Phragmites that can spread through plant fragments. Soil from these areas must not be used in other areas of the site. If excavation and removal is necessary soil must be buried at least three (3) feet below grade. Japanese knotweed must be buried at least at least five (5) feet below grade.

- Stockpiles of soil contaminated with invasive species must be on an impervious surface and covered.

- Soil containing invasive plant material must be covered if transported.

4.0 Site Specific Construction Term Procedures

The following site specific procedures are the recommended methods for dealing with the different populations of invasive vegetation at the site. These procedures build on the BMPs outlined in section 3.1 and take into consideration: the likely proposed work (minimal detail is currently available); setting of the site adjacent a sensitive tidal resource area; and the nature of the invasive species population. These methods are intended for use only for when disturbance of invasive vegetation is necessary for construction. They are fundamentally different than non-construction related management efforts, which generally try to minimize disturbance because most invasive vegetation flourishes in disturbed areas. The procedures proposed here also rely on the availability of sufficiently deep excavations for the disposal of material and can make use of other consecution term techniques such as large scale clearing and chipping operations. These normally generate large amounts of material directly into covered trucks for incineration at a regional biomass generation facility.

There are a number of factors that can influence the implementation and effectiveness of these measures such as timing of work, phasing, availability of excavations, and other construction specifications. It is recommended that the contractor be required to submit an invasive species management plan detailing its methods such as burial locations, stockpile locations, and timing. Such plans should also include alternatives for the priority species should the construction schedule need to be altered.

4.1 Phragmites (construction areas)

Where soil disturbance is going to be required for construction, the recommended method of dealing with Phragmites is removal of the above ground portion of the plant, complete excavation of the contaminated soil, and burial. The primary areas on the site where this technique is expected to be used are the southwest lagoon and the proposed entrance drive which contain the most extensive populations on the site. The recommended procedure requires several steps:

1) Dense or tall stands of Phragmites should be removed to facilitate equipment operation and reduce the spread of plant fragments. These should be cut by hand using a gas operated brush saw or hedge trimmer blades and gathered for proper disposal (see #2). Ideally, cutting should be conducted in late summer when the plant is just beginning to tassel and most of the plant's energy is above ground. If timing does not allow this, cutting should be done immediately before excavation since cutting at other times of the year may increase stand density.

2) Populations of Phragmites intermixed with other woody species (trees or shrubs, invasive or native) can be cleared together as long as disposal methods adhere to those outlined for Phragmites

3) Preferred disposal options include incineration or immediate burial in an onsite location a minimum of three (3) feet below the surface, preferably deeper.

Desiccation or liquefaction is not recommended due to the open nature of the site, the volume of material, and the possibility it may spread to marsh areas via wind.

4) Excavation within areas infested with Phragmites must extend a minimum of three (3) feet beyond the limit of the infestation and three (3) feet down. The absence of rhizomes or stolons at the limit of excavation should be confirmed as these can extend a great deal further than 3 feet. Special attention must be paid to remove all soil containing rhizomes or stolons in areas that are currently mowed as this has likely increased the density of these structures below ground. Soil excavated from these areas must be disposed of by burial at least three (3) feet below the surface.

5) Clean all equipment prior to moving from the burial site.

6) Monitor original site of infestation and disposal area and treat all regrowth with the procedures outlined in section 3.2.2 for Phragmites outside construction areas.

4.2 Phragmites (outside construction)

It is also likely that Phragmites will need to be removed from areas without the widespread disturbance employed for construction areas. Such areas may include the smaller populations in sensitive areas such those extending from the base of the lagoon impoundments out into the marsh or areas at the edge of the site where disturbance is not necessary or desirable. The recommended procedure for these areas is a combination of treatment with herbicide and post treatment cutting.

1) Treat Phragmites in the late summer (August) with a formulation of glyphosate herbicide approved for use in wetlands. A permit will need to be obtained from the NH Division of Pesticide Control and a certified applicator will need to be used. For marsh areas the recommended application method is wiping to absolutely minimize collateral damage to other marsh vegetation. In non-marsh areas a backpack sprayer may be used.

2) Cut and remove dead stems following treatment to reduce standing dead cover and facilitate follow up treatments.

3) Monitor treated areas and treat all regrowth in the same manner.

4.3 Japanese Knotweed

This is a very aggressive colonizer that is also able to spread through stem and root fragments. There is only a single relatively small occurrence of this species on the site located on the outer lagoon berm. It is unclear whether this area will be disturbed by construction or how much but since the occurrence is near the water there is additional risk of plant fragments being transported in the river if the plant is disturbed. Treatment should begin as soon as possible, prior to construction, so that the stand may be diminished, if not eradicated, prior to disturbance. The recommended procedure is a combination of cutting and treatment with herbicide followed up by total excavation and burial if necessary.

1) The single area of knotweed should be carefully cut in the early part of the summer (June) using hand tools, placed in heavy black plastic bags and allowed to decompose before being disposed of at the landfill

2) Treat all re-growth with a glyphosate herbicide in the fall following die off of the flowers (September-October). Late fall treatment avoids impacting bees which are actively gathering pollen during flowering.

3) Monitor and follow up with the same treatment for as long as necessary to eradicate the stand or until disturbance for construction is necessary.

4) When/if the area is to be disturbed by construction all stems should be cut prior to disturbance to minimize spreading

5) The entire area should be excavated five (5) feet beyond the limit of infestation and five (5) feet down and all soil and plant material from this area should be buried at least 5 feet below grade (preferably deeper) in an area prepared in advance of the work.

6) Clean all equipment prior to moving from the burial site

7) Monitor the area as well as the disposal area for re-sprouts and treat with herbicide.

4.4 Purple Loosestrife

There are no dense monocultures of this species although it is prevalent on the site, being present in all the wetland areas except the marsh along the river. There it only occupies a narrow band at the bottom of the lagoon berm. There is currently some level of biological control of this species on the site. Numerous signs of feeding by the Galerucella beetle were noted on many plants and larvae were also directly observed. This is the best long term control option for purple loosestrife. The plant is also generally present along with Phragmites so in most cases the measures described for that species will also apply to purple loosestrife. If purple loosestrife is to be disturbed on its own the flowing procedure is recommended.

1) No pre-disturbance cutting of the plant is needed due to its low stature and sparse occurrence on the site.

2) Excavate a minimum of three (3) feet beyond the limit of the infestation and three (3) feet down.

3) Bury soil and plant material at least three (3) feet below grade ion a location prepared in advance of the work.

4.5 Woody Species

This category includes Oriental Bittersweet, Autumn Olive, Glossy Buckthorn, Common Buckthorn, Multiflora Rose, and Bush Honeysuckle. It should be noted that these shrub species often occur in close proximity to other Type II species (Phragmites, Purple Loosestrife, or Japanese Knotweed). The recommended methods for dealing with these shrub species in the absence of any Type II species is:

1) Cut shrubs and chip into a covered truck for transport to biomass generation facility for incineration.

2) The topsoil from these areas may contain viable seeds. It may be used in the exact limits of the infestation or buried at least three (3) feet below grade in a location prepared in advance of the work. Topsoil from these areas should NOT be stockpiled for and used on any other portion of the site.

4.6 Mixed Populations

The majority of the invasive vegetation on the site is comprised of a mix of species and often a mix of Type I and II species. The procedure for all such areas should be based on the most restrictive species which in most cases will be Phragmites since only one area of Japanese Knotweed is present. The primary difference will be pre-disturbance clearing which will have to be adjusted according to the species present, particularly shrubs and trees. The preferred method of clearing large areas of invasive vegetation mixed with woody species is complete removal, chipping, and incineration. The most significant such area on the site is the interior of the southwest lagoon.

5.0 Monitoring

Monitoring of invasive species should involve both construction term and post construction elements. During construction, all completed areas, particularly those where invasive species were removed, stockpiled, or disposed should be monitored for re-growth. Any emerging invasive species should be immediately removed and disposed of in accordance with the BMPs in section 3.0 to prevent establishment of new populations. This is particularly important in stockpile areas from which material may be used across the site.

The completed project should be formally monitored for at least 2 years. Ideally, a vigilant monitoring and control effort should be sustained indefinitely at the facility. Early detection and eradication is the best defense against establishment of difficult to eradicate populations. Onsite maintenance staff should receive training on identifying, removing and disposing of invasive vegetation. The BMPs outlined in Section 3.0 should serve as a guide to managing invasive species post construction with a few additional important considerations.

1) Invasive species prefer disturbed soils so post construction control methods should create as little disturbance as possible.

2) Carefully executed cutting and application of herbicide is the preferred post construction control method for Phragmites and Japanese Knotweed.

3) Phragmites and Japanese Knotweed should NOT be mowed, whether on purpose or unintentionally, as this generally increases stand density and spreads viable plant Phragmites.

6.0 Recommendations

The principal factors in controlling invasive species are prevention, vigilant monitoring, and early action. A few general design recommendations are provided in this section which should aid in these efforts. The decommissioning of the lower lagoons as it relates to invasive species control is also discussed.

6.1 General Recommendations

Maximize Access. The creation of inaccessible areas should be avoided to the greatest extent possible. For example, fence lines, extreme slopes, and long term stockpiles are notorious locations for invasive species infestation. In addition to the disturbance factor, access for maintenance is impeded or impossible which allows the populations to become entrenched.

Minimize Maintained Lawn Area. Consider the use of native wildflower species and tall grasses to cover areas where maintained lawn would typically be used. This inhibits the invasive species growth, reduces maintenance costs, and provides better wildlife habitat. In areas where less openness and access is acceptable, native shrubs can also be incorporated and maintenance can be reduced to less than annually.

Snow Storage. Consider discontinuing winter snow storage at this site given its ecologically sensitive location. Snow storage likely brings in invasive plant material as well as promoting the growth of Phragmites at the site by placing stress on desirable species unable to tolerate the road salt and other potential contaminants.

6.2 Lagoon Decommissioning

The possible decommissioning of the two lower (eastern) wastewater lagoons as post of the proposed project presents a significant restoration opportunity on this site. When the facility was constructed in 1965 these two lagoons were constructed inside an existing meander in the river, roughly corresponding to the current outer edge of the lagoons. The area appears to have consisted of brackish marsh, possible fresh water wetland, and floodplain grading up to agricultural field. Setting aside the details of the proposed facility and decommissioning requirements, there are several general options for the future of these lagoons. These range from restoration of tidal wetland to being filled in and made into athletic fields. A scenario that includes wetland restoration, particularly the *Lower* and *Upper Brackish Riverbank Marsh* systems[2], would be a significant project for the region and would likely be viewed very favorably by regulators and environmental interests.

Invasive species management, principally of Phragmites, will be one of the greatest challenges of such a restoration effort. The restored areas will be ideal habitat for Phragmites because they will be disturbed by restoration construction activities. If Phragmites is allowed to become established in the restored wetlands, the ecological integrity of the restoration area be compromised and a significant vector will have been created for spread of the invasive species to other areas of the river. Management of Phragmites will require a long term commitment (10 years or more) during which funds must be available for monitoring and interventions.

The spread of Phragmites is not likely to be totally avoidable under any option, particularly if wetland or open water is incorporated into the decommissioned lagoon area. If an attempt was made to naturalize the existing lagoons it is likely they would develop Phragmites populations at their margins. Even completely filled in they are not totally immune to development of Phragmites as is clear from the existing state of the site. Given the significance of the restoration opportunity, the overall recommendation is that some form of tidal wetland restoration be included in the lagoon decommissioning plan.

Any restoration efforts will, of course, require detailed restoration plans specifying grades, stabilization measures, sequencing, planting plans, and monitoring. Some general recommendations are provided here for consideration in developing a plan:

Habitat Zones

The restoration plan should include several different wetland and upland zones, generally mimicking the surrounding marsh, though tailored for greatest success at controlling Phragmites. Due to the low salinity in this brackish marsh system (approximately 10-15 ppt), salinities within the lower marsh zones cannot be relied upon to control Phragmites as it might in a more coastal tidal environment. For this reason, the zonation should include broader areas of intertidal flat and *Lower Brackish Riverbank Marsh* which experience the longest inundation times. Observation of the surrounding area reveals that Phragmites is entirely absent from intertidal flat areas and significantly stressed in the lowest marsh areas. These zones are generally very narrow in the vicinity of the facility but broader areas do exist nearby in this system.

[2] Sperduto, D.D. and William F. Nichols. 2011. Natural Communities of New Hampshire. 2nd Ed. NH Natural Heritage Bureau, Concord, NH. Pub. UNH Cooperative Extension, Durham, NH

Grades will have to be very precisely established in order to accomplish this zonation. A survey of the current marsh at the site suggests that the low marsh vegetation begins at Elv. -0.5 feet, with intertidal flat extending below that elevation down to mean low water and low marsh, dominated by Smooth Cordgrass, extending approximately 1-foot above. A generalized profile for the restored areas should follow these elevations from Elv. -1.5 at the river side to Elv.0.5 at the upper limit of the restored marsh. A relatively sharp transition should be made from the low marsh elevation in order to minimize higher marsh elevations that are ideal Phragmites habitat.

Planting

Restored marsh areas should be aggressively planted to establish desirable vegetation as soon as possible. Live plugs of smooth cord-grass (*Spartina alterniflora*) will be the principal species for vegetating the low marsh area (Elv -0.5 to 0.5). Other species that may be included in the upper area of the low mash may include Stout Bulrush (*Scirpus robustus*), three-square rush (*Scirpus pungens*), and Salt marsh rush (*Juncus gerardii*). The recommended density for planting is 1-1.5 foot-on-center and should not exceed 3 foot-on-center. Narrow-leaved cattail (*Typha angustifolia*) is the dominant species in the marsh and should also be expected to colonize restored areas.

The side slopes of the restored marsh should be rather steep so as to maximize restoration area while preserving existing infrastructure and land needed for the new facility. Quickly established dense growth is generally desirable on these slopes for habitat, buffering, and stability. Shrubs should be planted no farther apart than 8 feet-on-center and may include species such as Blackberry and Raspberry, Northern Bayberry (*Myrica pensylvanica*), eastern shadbush (*Amelanchier canadensis*), and Virginia Rose (*Rosa virginiana*). The slopes should also be seeded with a conservation/wildflower seed mix including native grasses and forbs.

Post Restoration Invasive Species Management Plan

As stated previously, the greatest challenge in successfully reestablishing a brackish marsh in this location is controlling Phragmites. The restoration project will require a detailed post construction invasive species management plan such as is outlined earlier in this report for the construction phase. This will be a long term effort. The plan will have to be adequately funded for 10 years or more and will have to identify the party/parties responsible for implementing it and enforcing it.

6.3 Regional Considerations

Ideally, such a plan would also be developed in conjunction with a regional control effort along the Squamscott. This would, of course, be beneficial to the ecology of the entire river corridor but is also important to provide additional protection to the newly restored marsh areas. The presence of other populations of Phragmites along the river, particularly those that are nearby, would greatly increase likelihood Phragmites will be introduced into the restoration areas and be problematic long term. The close proximity of the large population of Phragmites associated with the Route 101 bridge makes this especially important.

To assess the status of Phragmites near the facility, populations were mapped using growing season aerial photography with limited ground-truthing. This was not intended to be an exhaustive survey of Phragmites in the marsh but rather to gauge the level of effort necessary for, and expected efficacy of potential management efforts. The results are depicted on the *Phragmites: Regional View* plan included in Appendix D. Within a mile of the facility there is a total of approximately 6 acres of Phragmites along the river and in the marsh. The majority of this (about 4 acres) is associated with the footprint of the Route 101 bridge. All other occurrences are relatively small, discrete populations ranging in size from about 800 to 11,000 square feet. Acting on these small newly established populations before they become entrenched is a fundamental concept of invasive species management.

The lack of large extensive monocultures in this area, with perhaps the exception of the 101 bridge population, suggests that implementing a control plan in this area is feasible and likely to yield good results if carried out in the near term. Advancing control efforts within the populations closest to the facility, such as the Route 101bridge, so as to preempt the restoration work will likely yield the best results.

Appendix A

Photographs

Outer edge of lagoon impoundment berm. Purple Loosestrife is generally at the edge of cattail

Typical feeding damage to Purple Loosestrife from Galerucella Beetle

Typical occurrence of invasive shrub species along outer impoundment berm

The non ponded areas of the southwest lagoon contain a mix of invasive shrubs and phragmites

Most significant areas of Phragmites exist around the ponded areas in the SW lagoon

Narrow mowed areas between Phragmites should be considered to be infested as well

The southern fence line is dominated by invasive shrub species, close proximity to Phragmites as well

Appendix B

Invasive Species Identification Guide

CONTACT INFORMATION

TERRESTRIAL PLANTS

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Website: www.agriculture.nh.gov

AQUATIC PLANTS

Amy Smagula, Clean Lakes and Exotic Species Coordinator, NH Department of Environmental Services, 29 Hazen Drive, PO Box 95, Concord, NH 03302
(603) 271-2248, asmagula@des.state.nh.us.

RESOURCES

NH Coastal Watershed Invasive Plant Partnership (CWIPP)
www.des.nh.gov/organization/divisions/water/wmb/coastal/cwipp/index.htm
Invasive Plant Atlas of New England (IPANE)
http://invasives.eeb.uconn.edu/ipane
Natural Resource Conservation Service (NRCS)
http://plants.usda.gov
New England Wildflower Society (NEWS)
www.newfs.org
New Hampshire Department of Agriculture, Markets & Food (DAMF)
www.agriculture.nh.gov
New Hampshire Department of Resources & Economic Development, Natural Heritage Bureau (DRED)
http://www.naturalheritage.org
New Hampshire Department of Resources & Economic Development, Division of Forests and Lands (DRED)
http://www.nhdfl.org/organization/div_nhnhi.htm
New Hampshire Department of Environmental Services (DES)
www.des.state.nh.us/wmb/exoticspecies
New Hampshire Fish & Game Department
www.wildlife.state.nh.us
The Nature Conservancy (TNC)
www.nature.org
U.S. Department of Agriculture's Animal Plant Health Inspection Service (USDA APHIS)
www.aphis.usda.gov
University of New Hampshire Cooperative Extension (UNHCE)
www.ceinfo.unh.edu

Funding for the printing of this booklet provided by:
U.S. Department of Agriculture's Animal Plant Health Inspection Service

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New Hampshire Guide to Upland Invasive Species

New Hampshire
Department of Agriculture
Markets and Food, Plant Industry Division

3rd Edition
2011

Douglas Cygan

Introduction

Throughout the world, non-native invasive species have become an overwhelming problem resulting in impacts to the natural environment and managed landscapes. Invasive species typically possess certain traits that give them an advantage over most native species. The most common traits include the production of many offspring, early and rapid development, and adaptability and high tolerance to many environmental conditions. These traits allow invasive species to be highly competitive and, in many cases, suppress native species. Studies show that invasives can reduce natural diversity, impact endangered or threatened species, reduce wildlife habitat, create water quality impacts, stress and reduce forest and agricultural crop production, damage personal property, and cause health problems.

Invasive species began arriving in North America in the mid-to-late 1700s by various means. Many were brought here for ornamental uses, erosion control, or to provide for wildlife habitat. Others arrived inadvertently through international travel and commerce.

Impacts and Actions

Biologists have found that invasive species cover more than 100 million acres of land in the U.S. and their population numbers continue to spread. The repeated process of spread has become so extreme that invasive species cost the United States billions of dollars per year. This is a result of lost agricultural and forest crops, impacts to natural resources and the environment, and the control efforts required to eradicate them.

On February 3, 1999, President Clinton signed Executive Order 13112, which established the National Invasive Species Council. The Council is responsible for assessing the impacts of invasive species, providing the nation with guidance and leadership on invasive species issues, and seeing that federal programs are coordinated and compatible with state and local initiatives.

Each state is also required to participate by evaluating and responding to their invasive species concerns. In the summer of 2000, the State of New Hampshire passed House Bill 1258-FN, which created the Invasive Species Act (ISA) and the New Hampshire Invasive Species Committee.

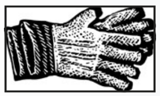
GLOSSARY OF PLANT TERMS

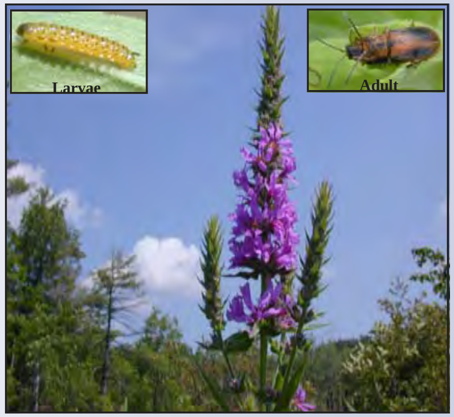
Alternate: Arranged singly at each node, as leaves or buds on different sides of a stem.
Annual: Living or growing for only one year or season.
Aril: A fleshy, usually brightly colored cover of a seed that develops from the ovule stalk and partially or entirely envelops the seed.
Axis: The point at which the leaf is attached to the main stem or branch.
Berry: A small, juicy, fleshy fruit.
Biennial: Having a life cycle that normally takes two growing seasons to complete.
Capsule: A dry dehiscent fruit that develops from two or more united capsules.
Compound: Composed of more than one part.
Deciduous: Shedding or losing foliage at the end of the growing season.
Dehiscent: The spontaneous opening of a fruit at maturity.
Drupe: A fleshy fruit usually having a single hard stone enclosing a seed.
Entire: Referring to a leaf not having an indented margin.
Filiform: Having the form resembling a thread or filament.
Furrowed: A rut groove or narrow depression.
Glabrous: Having no hairs or projections; smooth.
Imbricate: To be arranged with regular overlapping edges.
Inflorescence: A cluster of small flowers arranged on a flower stalk.
Lanceolate: A leaf tapering from a rounded base toward an apex, lance-shaped
Lenticels: The small, corky pores or narrow lines on the surface of the stems of woody plants that allow the interchange of gases between the interior tissue and the surrounding air.
Lustrous: Having a sheen or glow.
Native: A species that originated in a certain place or region; indigenous.
Naturalized: Adapted or acclimated to a new environment without cultivation.
Opposite: Growing in pairs on either side of a stem.
Ovate: Broad or rounded at the base and tapering toward the end.
Panicle: A branched cluster of flowers in which the branches are racemes
Peduncle: The stalk of a solitary flower of an inflorescence.
Peltate: Leaf being round with the stem attached near its center.
Perennial: Living three or more years.
Perfect: Having both stamens and pistals in the same flower.
Pod: A dry, several-sealed, dehiscent fruit.
Pubescent: Covered in fine short hairs.
Raceme: Elongated cluster of flowers along the main stem in which the flowers at the base open first.
Rhizome: A horizontal, usually underground stem that often sends out roots and shoots from its nodes.
Samara: A winged, often one-seed indehiscent fruit as of the ash, elm or maple.
Simple: Having no divisions or branches; not compound.
Umbel: A flat-topped or rounded inflorescence.

Lythrum salicaria - Purple Loosestrife

Family: Lythraceae
Native to: Eurasia

Description: Perennial growing 30-80" tall by $^{2}/_{3}$'s as wide. **Stems:** 4-6 sided, turning woody in summer. **Leaves:** Opposite to whorled, lanceolate, 2-4" long. **Flowers:** Spiked raceme, purple to magenta, June to October. **Fruit:** Capsule. **Habitat:** Mostly found in wetlands and aquatic systems, full to partial sun. **Spread:** Each plant can produce approximately 2.5-4.5 million seeds. Seeds dispersed by water, wildlife and humans. **Comments:** Invades wetlands suppressing native species and destroying wildlife habitat. **Controls:** Hand pull, use a spade to dig larger plants or use biocontrols (*Galerucella Spp*., top left is a larvae & top right is an adult).





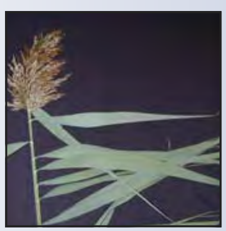
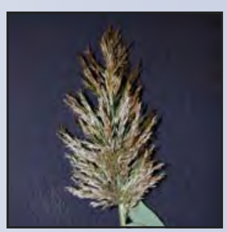

Photos by Douglas Cygan

Phragmites australis - Common Reed

Family: Poaceae
Native to: Eurasia

Description: Perennial rhizomatous grass growing 14' tall. **Stems:** Called 'culms' are large, hollow and grow up to 1" dia. **Leaves:** Lanceolate, up to 24" long, bluish-green in color. **Flowers:** Panicles with many spikelets having seven small reddish flowers. **Habitat:** Mostly found in marshlands, but also grows in freshwater wetlands and aquatic systems, full to partial sun. **Spread:** Spreads primarily by rhizomes. **Comments:** Forms dense colonies that suppress native species and alter wildlife habitat. **Controls:** Hand pull small plants. Use a spade to dig larger plants or apply herbicides.



Photos by Douglas Cygan

New Hampshire Invasive Species Committee

The New Hampshire Invasive Species Committee (ISC) is an advisory group for the Commissioner of the NH Department of Agriculture, Markets & Food (DAMF) on matters concerning invasive species in the state. The ISC consists of 11 appointed members representing the following: the NH Department of Agriculture, the NH Department of Environmental Services, the NH Department of Resources & Economic Development, the NH Department of Transportation, the NH Department of Fish & Game, The College of Life Science & Agriculture of the University of NH, the UNH Cooperative Extension, environmental interests, horticultural interests, general public interests, and livestock owners & feed growers interests. The ISC meets regularly to conduct the following efforts:

- Review information;
- Evaluate and discuss potentially invasive plant, insect and fungi species of concern;
- Host guest presentations on related topics;
- Develop outreach and educational materials;
- Formulate management practices as guidance for the control of invasive species; and
- Prepare lists of proposed prohibited and restricted species.

(*Note: This committee is not charged with the evaluation or listing of aquatic plant species, which is conducted by the Department of Environmental Services under RSA-487:16-a. However, a brief description of the program and four of the aquatic species are described on pages 29 & 30 of this book*).

New Hampshire Rules

In accordance with the Invasive Species Act (ISA), HB 1258-FN, the DAMF is the lead state agency for terrestrial invasive plants, insects and fungi species. The DAMF has the responsibility for the evaluation, publication and development of rules on invasive plant species. This is for the purpose of protecting the health of native species, the environment, commercial agriculture, forest crop production, and human health. Therefore, the rule, Agr 3800, states "**<u>No person shall collect, transport, import, export, move, buy, sell, distribute, propagate or transplant any living or viable portion of any listed prohibited invasive plant species, which includes all of their cultivars and varieties, listed"</u>** (see the New Hampshire Department of Agriculture's website at www.agriculture.nh.gov to review the complete set of rules).

Invasive Upland Plant Species (Agr 3800)

Invasive Insect Species

(To see the complete list of all 16 invasive insects refer to rules Agr 3800)

Invasive Aquatic Plant Species

To see the complete list of invasive aquatic plants refer to DES's Env-Wq 1300 rules

New Hampshire Department of Environmental Services
Aquatic Invasive Plant Species

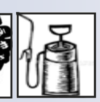
"Exotic aquatic species" are plants or animals that are not part of New Hampshire's native aquatic flora and fauna. Since the first exotic aquatic plant infestation in New Hampshire was discovered in 1965 in Lake Winnipesaukee, exotic aquatic plant infestations have increased to a total of 83 infestations in 72 waterbodies in 2008. Species present include variable milfoil (63 waterbodies), Eurasian milfoil (3 waterbodies), fanwort (9 waterbodies), water chestnut (1 waterbody) and Brazilian elodea (1 waterbody), Curly Leaf Pondweed (3 waterbodies), and European Naiad (3 waterbodies), and Didymo (1 waterbody). Most of these exotic plants can propagate by fragmentation as well as by seed.

Exotic aquatic plant fragments can easily become attached to aquatic recreational equipment, such as boats, motors, and trailers, and can spread from waterbody to waterbody through transient boating activities. Infestations can have detrimental effects on the ecological, recreational, aesthetic, and economic values of the state's precious surface waters, limiting use of the waterbodies and decreasing shorefront property values by as much as 1020 percent according to a UNH study (Halstead, et al., 2001).

Myriophyllum heterophyllum - Variable Milfoil

Family: Haloragaceae
Native to: Eurasia

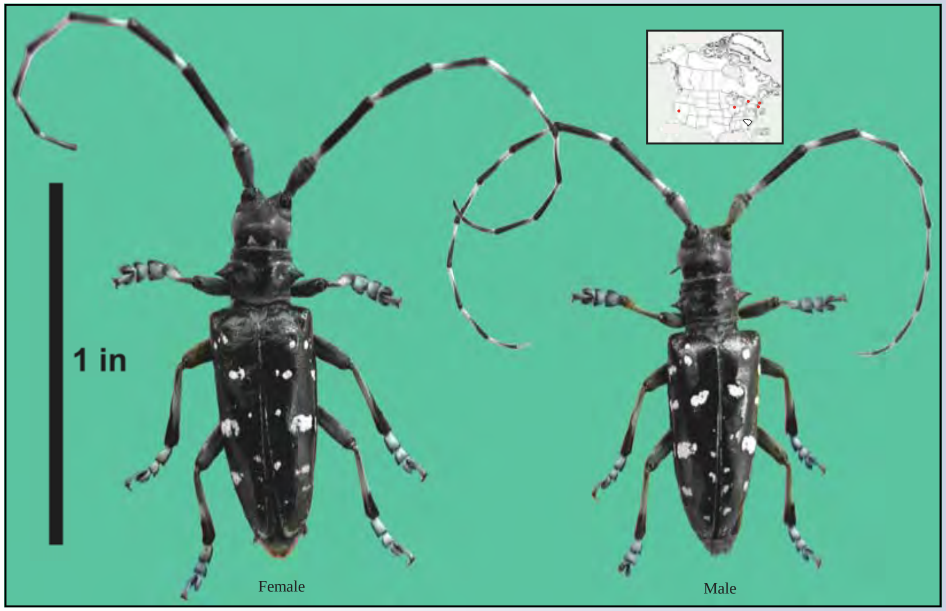
Description: Submerged aquatic perennial growing 20' tall. **Stems:** Round, thick and reddish. **Leaves:** Feathery leaflets surrounding the stem. **Flowers:** Stalks that emerge above the water with green leaves, June to August. **Habitat:** Lakes, ponds, calm streams, and other similar aquatic systems with full to partial sun. **Spread:** It reproduces primarily by vegetative propagules when individual plant segments break off, and dispersed by water movement, humans, and boats. **Comments:**Invades water bodies, suppresses native species and destroys fish habitat. **Controls:** Prevention, hand pulling, bottom screening, and aquatic herbicide use.



Photos by Amy Smagula

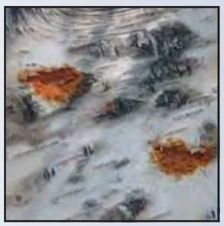
Anoplophora glabripennis - Asian Longhorned Beetle

Family: Cerambycidae
Native to: Europe



Asian Longhorned Beetle—*Anoplophora glabripennis* (Photo by Chris Rallis)

The Asian longhorned beetle (ALB) is a serious threat to a large variety of deciduous hardwoods in North America. ALB is a large glossy black insect with white spots dotting its elytra. Adults grow to 1-1.5" long and have whitish bandings on their antennae. Females are typically bigger than males. Tree injury occurs when larvae tunnel through the xylem (heartwood) of the host, thus weakening the tree. Hosts trees include, but aren't limited to: Maple, Chestnut, Poplar, Willow, Birch, Elm, and Mountain ash. Adult females chew a crater in the bark and lay 1-egg per site. Upon hatching the larvae feed on the wood and emerge as adults in 1-2 years through perfect $^{3}/_{8}$" diameter exit holes. Other signs include coarse wood shavings called frass, oozing sap, oviposition sites, leaf-feeding damage, and mature beetles. **If found, please call the NH Dept. of Agriculture at (603) 271-2561**.

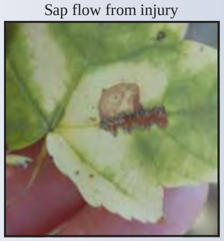


Oviposition Site

Egg (Rutgers University)

Sap flow from injury

Larval damage (Rutgers Univ.)



Adult feeding damage on leaf

3/8" diameter exit hole

Photos by Douglas Cygan, Chris Rallis & Rutgers University

DO NOT MOVE FIREWOOD

WHAT YOU CAN DO

There are many things that you, as an individual, can do to help control the spread of invasive species and preserve native flora and fauna:

- Minimize impacts to natural vegetation, soils, and drainage.
- Learn how to identify invasive plants and know how to tell them apart from native species.
- Control invasives on your property by following recommended practices.
- When landscaping, ask your local garden center or contact your County Extension Service about alternative plantings.
- Become active in local or regional initiatives to control invasives.
- After working in an area with invasive species remove any soil, or propagules that may have adhered to clothing, shoes, vehicle tires, etc.

CONTROL METHODS

Mechanical: Mechanical control involves hand pulling, digging, cultivation, mowing, cutting or utilizing some type of physical barrier such as a tarpaulin, mulch, wood chips, etc. This method is most effective when populations of unwanted species are low.

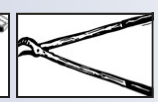
Cultural: Cultural control is the manipulation of a plant community to prevent the introduction or spread of an unwanted species. This can be accomplished by modifying the growing environment such as the soil, available light or moisture, or planting trees or shrubs that can outcompete the invasive species.

Chemical: Chemical control involves the use of an approved herbicide to manage a targeted species. The application method must be chosen to avoid damage to beneficial or native species. The applicator must adhere to all State and Federal pesticide regulations and in many cases be licensed by the state. For more information, contact the NH Department of Agriculture's Pesticide Control Division at 603-271-3550 or www.agriculture.nh.gov.

Biological: Biological control is the use of native or introduced beneficial organisms to naturally reduce populations of unwanted species. Most biological controls are found to be self-sustaining and host specific.

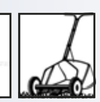
Pulling

Digging

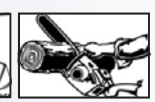


Cutting-Hand tools

Herbiciding



Mowing



Cutting-Saws

Biocontrols

Acer platanoides - Norway Maple

Family: Aceraceae
Native to: Europe


Norway Maple—*Acer platanoides*

Norway Maple (in yellow) Invasion in Franklin, NH

Description: Large deciduous tree 60' high by 40' wide. **Bark:** Grayish and somewhat furrowed. **Twigs:** Smooth, olive-brown. **Buds:** Terminal, imbricate, rounded, smooth, greenish-red. **Leaves:** Opposite, 4-7" wide, 5-lobed, dark green to dark red above, lustrous below. **Flowers:** Greenish-yellow, April. **Fruit:** Horizontal samara. **Zone:** 3-7. **Habitat:** Moist, well drained soils, full sun to partial shade. **Spread:** Seeds spread by wind and water. **Comments:** Leaf stalks exude milky white sap. Fast growing, buds break earlier than most native species. Naturalizes in woodlands where it can outcompete native species. **Controls:** Pull or dig seedlings/saplings. Cut large trees and prune suckers when they sprout. Herbicide: foliar spray, cut-stem, bark banding, or slash bark with ax and apply to wounds.

Milky white sap-leaf petiole

Leaf with winged seed

Terminal buds rounded

Flowers greenish-yellow

Bark is grayish & furrowed

Leaves turn yellow in Fall

Photos by Douglas Cygan

Agrilus planipennis - Emerald Ash Borer

Family: Buprestidae
Native to: Asia

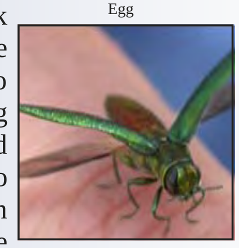
Emerald Ash Borer—*Agrilus planipennis*

Dead standing Ash trees (Canadian Forest Service)

Emerald Ash Borers (EAB) are small invasive wood boring beetles that attack all species of ash trees (*Fraxinus spp.*). Native to East Asia, it is suspected that they were accidentally introduced to North America in infested wood packing material. The adults are 3/8" to ½" in length by 1/16" in width. Their bodies have a dark metallic green appearance. Adults emerge from a D-shaped exit hole from late May to mid-July and live for 3-6 weeks, during which time they feed on ash foliage, and fly 1-mile or so in search of a mate and to lay eggs. Females will lay 60-90 eggs in the crevices of ash tree bark. Larvae emerging from the eggs create distinctive S-shaped feeding galleries within the cambium which is directly beneath the bark. These feeding galleries can girdle the tree and result in tree death. <u>Movement of EAB into new uninfested areas is principally through transportation of firewood.</u> **If found, please contact the NH Dept. of Agriculture at (603) 271-2561.**

Egg

Larvae in feeding galleries



Adult with wings spread

Feeding galleries in cambium

D-shaped exit hole

EAB Purple prism trap

Photos by Douglas Cygan & Chris Rallis

DO NOT MOVE FIREWOOD

Adelges tsugae - Hemlock Wooly Adelgid

Family: Adelgidae
Native to: Asia


Hemlock Wooly Adelgid—*Adelges tsugae* Nests

Hemlock trees dead from Adelgid (www.earthportal.org)

Hemlock Wooly Adelgid (*Adelges tsugae*) (HWA) is a serious pest to all North American hemlock trees (*Tsuga spp.*). It is native to Japan & China and was first found in the Pacific Northwest in the 1920's. By the 1950's it had reached the east coast and now infects hemlock trees from Georgia to Maine. It spreads by movement of nursery stock, wind and animals. These insects are extremely small averaging about 1/8" in length with piercing-sucking mouth parts similar in appearance to aphids. All adults are females with each producing 50-300 eggs. To protect themselves & their eggs they produce a white-waxy covering. Adults insert their piercing mouth parts into the stem at the base of the needles. Trees die from needle loss & lack of nutrition. **If found, please call the NH Dept. of Agriculture at (603) 271-2561**.

Adult female laying eggs

Egg mass in protective nest

Eggs & crawlers (Chris Rallis)

Heavily infested branch

Crawlers (Chris Rallis)

Crawler leaving nest (Chris Rallis)

Photos by Douglas Cygan & Chris Rallis

DO NOT MOVE FIREWOOD

Ailanthus altissima - Tree of Heaven

Family: Simaroubaceae
Native to: China


Tree of Heaven—*Ailanthus altissima*

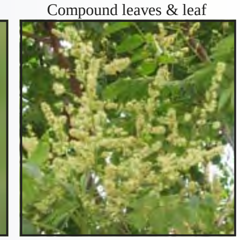
Tree of Heaven invasion

Description: Deciduous tree up to 60' tall by 40' wide. **Bark:** Grayish, slightly furrowed. **Twigs:** Reddish-brown. **Leaves:** Compound, 18-24" long with 13-25 leaflets arranged alternately on stem, lanceolate, 3-5" long with 2-4 teeth near base. **Flowers:** Panicles, 8-16" long, yellowish-green, mid-June. **Fruit:** Samara. **Zone:** 4-8. **Habitat:** Highly adaptable and pollution tolerant, full sun to partial shade. **Spread:** Seeds are wind dispersed. **Comments:** Very fast growing, dense canopy shades out native species. **Controls:** Remove seedlings and saplings by hand. Larger trees can be mechanically removed or cut. To prevent suckering, if trees are cut, apply herbicide to cut portion of stump.

Leaf scar on stem

Compound leaves & leaf

Leaf bud



Flowers yellowish-green

Bark grayish & furrowed

Winged seed cluster

Photos by Douglas Cygan

Alliaria petiolata - Garlic Mustard

Family: Cruciferae
Native to: Europe

Garlic Mustard—*Alliaria petiolata*

Woodland invasion (photo by Cornell University)

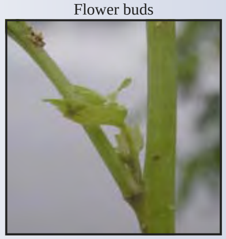
Description: Cool season biennial, 2nd year plants flower and reach 2-$3^{1}/_{2}$' tall. **Leaves:** Triangular, coarsely toothed, heart-shaped. **Flowers:** Umbel, small, 4-petals, white, April-May. **Fruit:** Pods, seeds turn black when mature. **Zone:** 4-8. **Habitat:** Prefers moist shaded flood-plains, forests and roadsides, adaptable to most soil and light conditions. **Spread:** Seeds spread by water and wildlife. **Comments:** Plants spread quickly into natural areas leading to competition and displacement of native species. **Controls:** Small populations can be hand pulled while large populations can be continuously cut back to prevent flowering and seed production. Herbicide treatments are also effective.

Basal rosette

Leaf

Flower buds

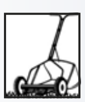
Flowers 4-petaled, white



Stems

Seed pods

Photos by Douglas Cygan



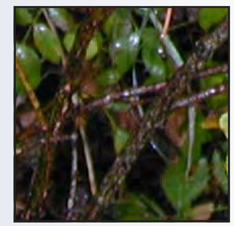
Rosa multiflora - Multiflora Rose

Family: Rosaceae
Native to: Japan & Korea

Multiflora Rose-*Rosa multiflora*

Multiflora Rose invasion, Canterbury, NH

Description: Hardy shrub / climber reaching up to 15' or more in height and 10’ in width. **Stems:** Long and arching, forming dense clumps, thorns may or may not be present. **Leaves:** Alternately arranged, compound with 7-9 leaflets and having feather margins at base. **Flowers:** Clusters of white or pink, June to July. **Fruit:** Rose hips turn red in fall. **Zone:** 3-8. **Habitat:** Prefers moist, well drained soils, full sun. **Spread**: Fruits with seeds are dispersed by birds. **Comments:** Very aggressive, leading to competition and displacement of native species. **Controls:** Hand or mechanical removal, cutting, or herbicide application.



Twig/stem bark

Leaves

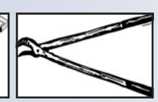
Feathery margin at base of leaf

Flowers white

Fall color

Fruit is called a hip

Photos by Douglas Cygan



Rhamnus cathartica - Common Buckthorn

Family: Rhamnaceae
Native to: Eurasia

Description: Deciduous shrub or small tree measuring 20' by 15'. **Bark:** Grayish to brown with raised lenticels. **Stems:** Cinnamon colored with terminal spine. **Leaves:** Opposite, simple and broadly ovate with toothed margins. **Flowers:** Inconspicuous, 4-petaled, greenish-yellow, mid-June. **Fruit:** Fleshy, 1/4" diameter turning black in the fall. **Zone:** 3-7. **Habitat:** Adapts to most conditions including pH, heavy shade to full sun. **Spread:** Seeds are bird dispersed. **Comments: Highly:** Aggressive, fast growing, outcompetes native species. **Controls:** Remove seedlings and saplings by hand. Larger trees can be cut or plants can be treated with an herbicide.

Photos courtesy of John M. Randall/The Nature Conservancy

Rhamnus frangula - Glossy Buckthorn

Family: Rhamnaceae
Native to: Japan

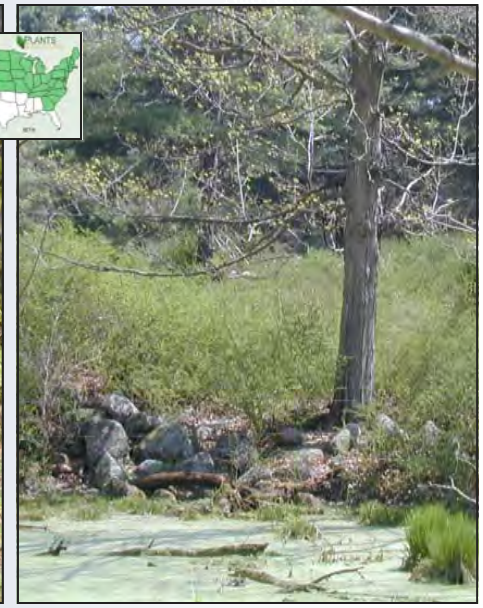
Description: Tall deciduous shrub up to 20' in height by 15' wide, **Bark:** Grayish with whitish lenticels. **Twigs:** Reddish-brown. **Leaves:** Ovate, 4-5" long by 3-4" wide, arranged oppositely or whorled on stem. **Flowers:** Small, greenish-white, mid-June. **Fruit:** Fleshy, turning black in the fall. **Zone:** 2-7. **Habitat:** Highly adaptable and pollution tolerant, full sun to partial shade. **Spread:** Seeds are bird dispersed. **Comments:** Very fast growing, dense canopy shades out native species. **Controls:** Remove seedlings and saplings by hand. Larger trees can be cut or herbicide may be used.

Photos by Douglas Cygan

Berberis thunbergii - Japanese Barberry

Family: Berberidaceae
Native to: Japan

Japanese Barberry-*Berberis thunbergii*

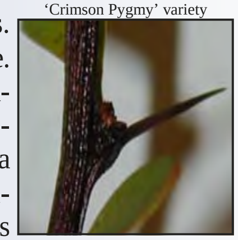


Japanese Barberry invasion, Antrim, NH

Description: Deciduous shrub, 2-4$^1/_2$' tall. **Leaves:** Ovate, simple, entire. Color varies depending on variety. **Flowers:** Small yellowish, bloom in May in clusters of 2-4. **Fruit:** Drupe, turning red in summer. **Zone:** 4-8. **Habitat:** Prefers well drained soils in semi shade and often occurring in forests, roadsides, and open fields. **Spread:** Seeds are dispersed by wildlife. **Comments:** Forms dense thickets in natural environments where it becomes established, resulting in impacts to native flora and fauna. **Controls:** Remove small immature plants by hand. Dig larger plants with a garden spade or remove mechanically. Cut stems at base or control with herbicide treatment.

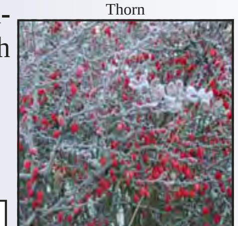
'Crimson Pygmy' variety

Leaves



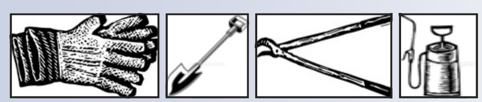
Thorn

Flowers yellowish



Frost covered Barberry

Fruit is a fleshy drupe



Photos by Douglas Cygan

Berberis vulgaris - European Barberry

Family: Berberidaceae
Native to: China

European Barberry-*Berberis vulgaris*

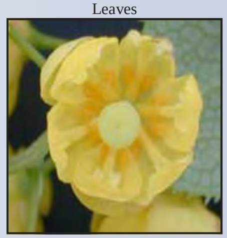
Woodland invasion, Claremont, NH

Description: Shrub 3-8' in height by 3-6' in width. **Stems:** Tan bark with 3 long spines at each leaf axis. **Leaves:** Alternate, simple, $\frac{1}{2}$"-1$\frac{1}{2}$" long, bright green above, dull below. **Flowers:** Perfect, yellow, $\frac{1}{2}$" long, mid-April to May. **Fruit:** Oblong drupe turning pale red in fall. **Zone:** 4-8. **Habitat:** Prefers full sun to partial shade and open spaces to wooded areas. **Spread:** Seeds are dispersed by birds and wildlife. **Comments:** Highly adaptable to most environments and is pollution tolerant. **Controls:** Hand pull young plants. Cut or mechanically remove older larger plants or apply approved herbicides for large populations.

Thorns

Leaves

Flowers



Flowers whitish-yellow

Stems

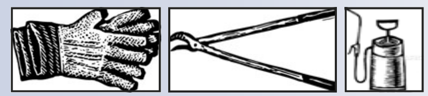
Seed pods

Photos by Douglas Cygan

Polygonum cuspidatum - Japanese Knotweed

Family: Polygonaceae
Native to: Japan

Description: Perennial reaching 10' in height and width. Bohemian Knotweed (*Reynoutria x bohemica*) is similar. **Stems:** Greenish, hollow and jointed, similar to bamboo. **Leaves:** Alternate, broadly ovate, 3-7" long. **Flowers:** Small, whitish, forming panicles, August-September. **Seeds: C**alyx, brown, triangular. **Habitat:** Found in woodland sites, open spaces, ditches, roadsides, riverbanks. Prefers moist, well-drained soils. **Spread:** Stem & root fragments, and by seed. **Comments:** Aggressive, spreads quickly along surface waters and in right-of-ways. **Controls: Do <u>not</u> mow**, cut stems at base then smother by covering area with heavy-duty fabric/plastic, herbicides also recommended.



Photos by Douglas Cygan

Polygonum perfoliatum - Mile-a-Minute Vine

Family: Polygonaceae
Native to: Asia

Description: Very fast growing herbaceous perennial vine growing to 25' in height. **Stems:** Greenish with stiff barbs used for support. **Leaves:** Alternate, triangular in shape with clasping bract at the base, 1-3" long. **Flowers:** Racemes, inconspicuous and white forming at the bract, August - October. **Seeds:** An achene within a greenish, berry-like fruit. **Habitat:** Grows in partial shade to full sun, fields, roadsides & forests. Prefers moist, well-drained soils. **Spread:** Seed spread by birds & wildlife. **Comments:** Fast growing, aggressive. **Controls:** Mowing, hand cutting or herbicide use is recommended.

Photos by Leslie J. Mehrhoff

Microstegium vimineum - Japanese Stilt Grass

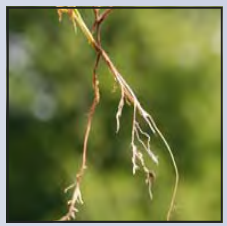
Family: Poaceae
Native to: Asia

Japanese Stilt Grass—*Microstegium vimineum*

Japanese Stilt Grass woodland invasion

Description: Weak-stemmed annual grass, reaching 2-4' tall. **Leaves:** Lanceolate, tapered at both ends, 2-3" long with silvery stripe of reflective hairs down the midrib. **Flowers:** Racemes occur at the ends of the stalk itself, late August. **Fruit:** Achenes develop in late fall. **Zone:** 5-11. **Habitat:** Occurs along riverbanks, floodplains, forests and roadsides, adaptable to most soil and light conditions. **Spread:** Seeds spread by water, wildlife & humans. **Comments:** Plants spread quickly into natural areas leading to competition and displacement of native species. **Controls:** Small populations can be hand pulled while large populations can be continuously cut back to prevent flowering and seed production. Herbicide treatments are also effective.

Early development



Root (UMASS Extension)

Leaf with silvery reflective hairs along midrib

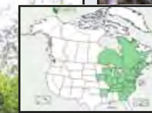
Fall-leaves turn purplish

Seed-Achene

Photos courtesy of Leslie J. Mehrhoff/UCONN-IPANE and UMASS Extension

Celastrus orbiculatus - Oriental Bittersweet

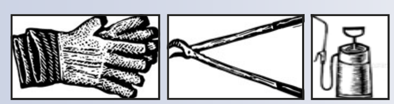
Family: Celastraceae
Native to: Japan, China



Oriental Bittersweet-*Celastrus orbiculatus*

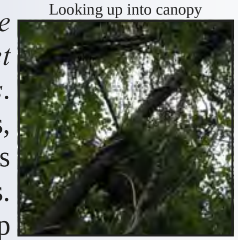
Oriental Bittersweet invasion, Concord, NH

Description: Deciduous vine reaching heights of 40-60'. **Bark:** Tannish, furrowed. **Leaves:** Alternate, ovate, bluntly toothed, 3-4" long by 2/3's as wide, tapered at the base. **Flowers:** Small, greenish, blooming in spring. **Fruit:** Yellow dehiscent capsule surrounding an orange-red aril. *Fruits occur in the axils of the stems whereas native bittersweet (Celastrus scandens) fruits at the ends*. **Zone:** 4-8. **Habitat:** Disturbed edges, roadsides, fields, forests and along rivers and streams. **Spread:** Birds and humans. **Comments:** Very aggressive, climbs up and over trees and smothers them. Do not buy wreaths made of these vines. **Controls:** Difficult to manage. Cutting, pulling, or recommended herbicide use applied to foliage, bark, or cut-stump.

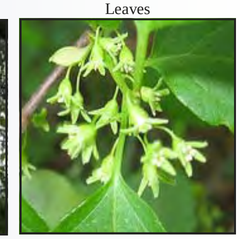


Looking up into canopy

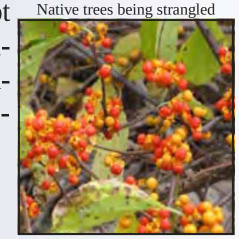
Leaves



Native trees being strangled



Flowers yellowish-white



Mature Orange-yellow fruit

Fruit is a fleshy capsule

Photos by Douglas Cygan

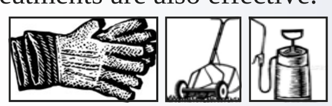
Centaurea maculosa - Spotted Knapweed

Family: Compositae
Native to: Eurasia

Spotted Knapweed—*Centaurea maculosa*

Invasion (photo by Leslie Mehrhoff)

Description: Tall erect herbaceous perennial living 3-5 years. **Leaves:** Alternate, divided, Pale green, 1-3" long. **Flowers:** Aster-like, terminal, purple, July-August. **Fruit:** Each plant produces thousands of brownish seeds per year. **Zone:** 3-10. **Habitat:** Invades dry sunny roadsides, fields and waste places. Its large taproot allows it to survive harsh winters and draught **Spread:** Seeds spread by wind and wildlife. **Comments:** Plants spread quickly into natural meadows and fields leading to competition and displacement of native species. Roots excrete a toxin killing off other plants. **Controls:** Small populations can be hand pulled while large populations can be continuously cut back to prevent flowering and seed production. Herbicide treatments are also effective.

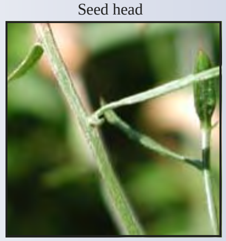


Basal rosette

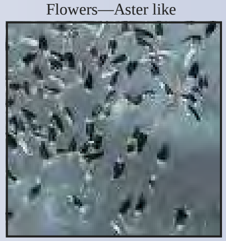
Leaf

Seed head

Flowers—Aster like



Stems



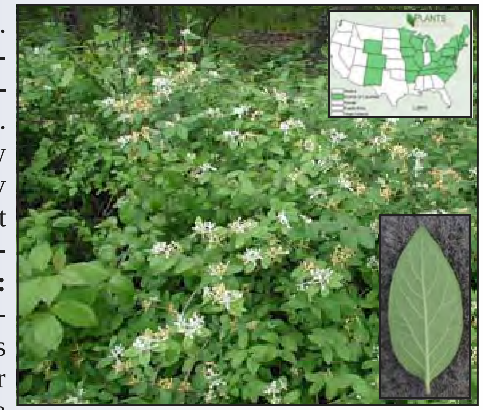
Seeds

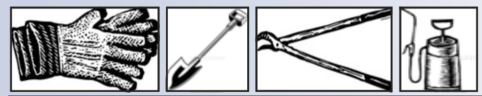
Photos by Leslie Mehrhoff & Douglas Cygan

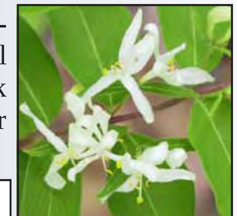
Lonicera morrowii - Morrow's Honeysuckle

Family: Caprifoliaceae
Native to: Japan

Description: Shrub reaching 6-8' tall. **Stems:** Smooth, glabrous, Tannish, hollow. **Leaves:** Ovate, simple, entire, opposite, pubescent beneath, 1-2 1/2" long. **Flowers:** Tubular, white, turning yellow with age, May to June. **Fruits:** Berry turning red. **Zone:** 3 . **Habitat:** Moist to wet shaded floodplains, forests, roadsides, fields, waste places. **Spread:** Seeds are dispersed by wildlife and humans. **Comments:** Rapidly invades sites, forming a dense vegetative layer that outcompetes native flora and fauna species. **Controls:** Hand control is effective for small plants, while mechanical removal and repetitive cutting also work well. Herbicide treatment is better for areas with greater infestations.







Photos by Douglas Cygan & Leaf Photo by Leslie J. Mehrhoff

Lonicera tatarica - Tatarian Honeysuckle

Family: Caprifoliaceae
Native to: Eurasia

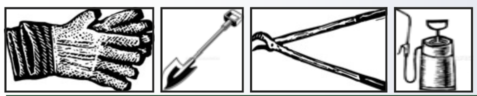
Description: Upright deciduous shrub reaching 6-15' tall. **Stems:** Smooth, glabrous, tan, hollow. **Leaves:** Ovate, smooth, bluish-green, opposite, 1-2 1/2" long. **Flowers:** Tubular, pink or white, April to May. **Fruit:** Berry with two seeds, turning red in fall. **Zone:** 3. **Habitat:** Under story species in woodland sites, also invades open spaces. Thrives in moist soils. **Spread:** Seeds dispersed by wildlife and humans. **Comments:** Rapidly invades forests, fields, roadsides and floodplains. Outcompetes native species. **Controls:** Hand control is effective for small plants while mechanical removal, cutting and chemical applications are better for larger stands.

Photos by Leslie J. Mehrhoff & Berry Photo by Douglas Cygan

Lonicera x bella - Showy Bush Honeysuckle

Family: Caprifoliaceae
Native to: Eurasia

Description: Shrub reaching 20' in height and width. **Stems:** Greenish to tan with corky wings. **Leaves:** Oppositely arranged, simple and elliptic, 1-3" long by half as wide, light green. **Flowers:** Yellow, white or pink, May to early June. **Fruit:** Fleshy red, forming in pairs in leaf axis. **Zone:** 4. **Habitat:** Prefers dry upland soils, full sun to heavy shade, pH adaptable. **Spread:** Seeds are dispersed by birds. **Comments:** *L. x bella* is a cross between *L. tatarica* & *L. morrowii*. Spreads into natural areas forming dense stands, which displace native species. **Controls**: Hand or mechanical removal, continuous cutting, girdling, and herbicide treatment.

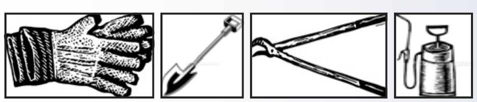


Photos courtesy of Leslie J. Mehrhoff/UCONN-IPANE

Lonicera japonica - Japanese Honeysuckle

Family: Caprifoliaceae
Native to: Eurasia

Description: Climbing vine. **Stems:** Reddish-brown, pubescent. **Leaves:** Opposite and not clasping the stem as opposed to the three native honeysuckle vines that do clasp the stem, oblong, $1^{1}/_{2}$-2" long, rounded at base. **Flowers:** Tubular, white or yellow, fragrant, May to mid-July. **Fruit:** Berry, smooth, blackish to slightly purplish. **Zone:** 4-8. **Habitat:** Prefers moist soils and full sun to partial shade. **Spread:** Seeds spread by wildlife. **Comments:** Vines grow quickly, covering native vegetation, resulting in loss of habitat. **Controls:** hand or mechanical removal, cutting, girdling, chemical.



Photos courtesy of John M. Randall/The Nature Conservancy
& Leaf Photo by Leslie J. Mehrhoff

Cynanchum nigrum - Black Swallow-Wort

Family: Asclepiadaceae
Native to: Eurasia

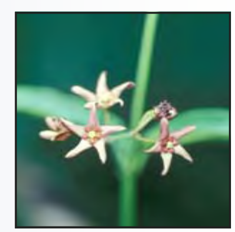
Description: Perennial herbaceous vine that grows to 6'. **Leaves:** Opposite, lanceolate, dark glossy green, simple with a smooth edge, 2-4" long. **Flowers:** Small $^{1}/_{4}$", 5-petaled, purplish, from June to September. **Seed:** Seeds are similar to those of milkweed. **Zone:** 4 to 8. **Habitat:** It prefers full to partial sun. **Spread:** Seeds dispersed by wind. **Comments:** Invades roadsides, fields, disturbed sites, meadows, and woodlands, outcompeting native species. **Controls:** Hand pull young plants. Remove and destroy seed pods before they open. Apply herbicides as a foliar spray during the growing season. If plants are to be dug, use a spade and make sure that all root fragments are removed.

Photos by Douglas Cygan

Cynanchum rossicum - Pale Swallow-Wort

Family: Asclepiadaceae
Native to: China

Description: Perennial vine growing to 3-6'. Very similar to black swallow-wort with the exception of the flowers. **Leaves:** Opposite, lanceolate, 2-4" long. **Flowers:** Magenta, $^{3}/_{8}$", flowering from June to September. **Seed:** Seeds are similar to milkweed. **Zone:** 4 to 8. **Habitat:** It prefers full to partial sun. **Spread:** Seeds dispersed by wind. **Comments:** Invades roadsides, fields, disturbed sites, meadows and woodlands. **Controls:** Hand pull young plants. Remove and destroy seed pods before they open. Apply herbicides as a foliar spray. Dig using a spade to ensure all root fragments are removed.



Photos courtesy of John M. Randall/The Nature Conservancy

*Elaeagnus umbellata - A*utumn Olive

Family: Elaeagnaceae
Native to: Asia

Autumn Olive—Elaeagnus umbellata

Autumn Olive invasion in Concord, NH

Description: Weedy deciduous shrub measuring 20' by 20'. **Bark:** Silvery-gray and smooth with whitish lenticels. **Stems:** Cinnamon-brown. **Leaves:** Elliptical, 2-3" long, glossy, green above and silverish below. **Flowers:** Solitary, whitish, 4-petaled, mid-June. **Fruit:** Drupe. **Zone:** 3-8. **Habitat:** Naturalizes in open spaces exposed to full sun. **Spread:** Seeds dispersed by birds and wildlife. **Comments:** Very aggressive. Outcompetes and displaces native species. **Controls:** Remove seedlings and saplings by hand. Larger shrubs can be mechanically removed, or cut and apply herbicide to stump.

Silvery-gray Bark

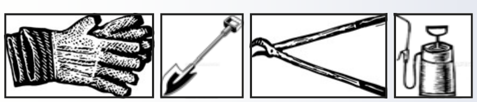
Leaves

Terminal bud

Flowers whitish

Fall Color

Fruit is a fleshy drupe



Photos by Douglas Cygan

Ligustrum obtusifolium - Blunt-leaved Privet

Family: Oleaceae
Native to: Europe

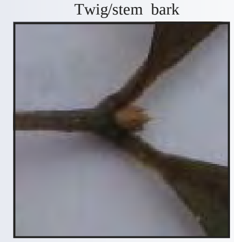
Blunt-leaved Privet-*Ligustrum obtusifolium*

Blunt-leaved Privet (Photo: Leslie J. Mehrhoff)

Description: Shrub reaching 12' tall by 10-12' wide. **Stems:** Greenish, smooth. **Leaves:** Opposite, simple and elliptic, 1-3" long by half as wide, blunt tipped, light green. **Flowers:** Small white panicles, May to early June. **Fruit:** Small blackish drupe. **Zone:** 4-7. **Habitat:** Prefers dry upland soils, full sun to heavy shade, pH adaptable. **Spread:** Seeds dispersed by birds. **Comments**: Becomes established in natural areas leading to competition and displacement of native species. **Controls:** Hand or mechanical removal, cutting, herbicide applications such as foliar or cut-stem.

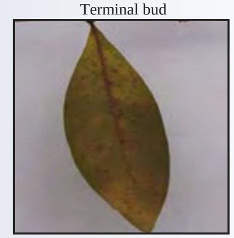
Twig/stem bark

Leaves

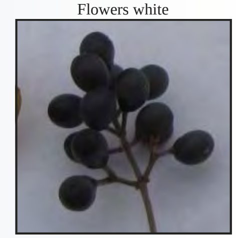


Terminal bud

Flowers white



Fall color

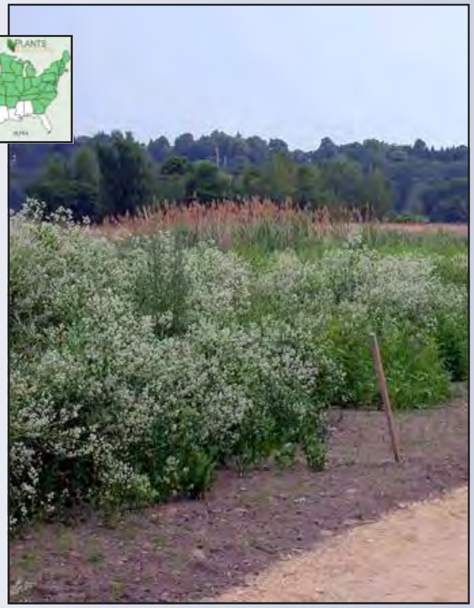


Fruit is a dark drupe

Photos by Douglas Cygan & Leslie Mehrhoff

Lepidium latifolium - Perennial Pepperweed

Family: Cruciferae
Native to: Eurasia



Perennial Pepperweed—*Lepidium latifolium*

Perennial Pepperweed invasion Seacoast area, NH

Description: Long lived perennial growing 2-4' tall. **Leaves:** Alternate, lanceolate with serrated edge. **Flowers:** Terminal, tightly clustered, white, July. **Fruit:** Silicle, rounded, flattish, hairy $^{1}/_{16}$" long. **Zone:** 4-8. **Habitat:** Prefers wet, brackish soils such as coastal tidal marshes and ditches, wetlands, and floodplains. **Spread:** Seeds and creeping rhizome fragments spread by water, wildlife and humans. **Comments:** Plants spread quickly into natural areas leading to competition and displacement of native coastal wetland species. **Controls:** Small populations can be hand pulled while large populations can be continuously cut back to prevent flowering and seed production. Herbicide treatments are also effective.

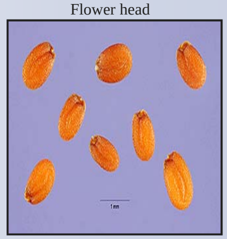
Basal rosette

Leaf

Rhizome root with shoot

Flower head

Persistent stems



Seeds (photo—USDA)

Photos by Kevin Lucey & Jennifer Forman

Euonymus alatus - Burning Bush

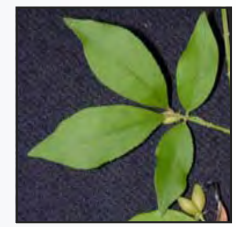
Family: Celastraceae
Native to: Asia

Burning Bush-*Euonymus alatus*

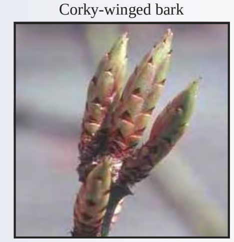
Burning Bush invasion, Boscawen, NH

Description: Deciduous shrub reaching 20' in height and width. **Stems:** Greenish with corky wings. **Leaves:** Oppositely arranged, simple and elliptic, 1-3" long by half as wide, light green. **Flowers:** Inconspicuous greenish-yellow, May to June. **Fruit:** Fleshy green capsule turning red in fall. **Zone:** 3 to 8. **Habitat:** Prefers dry upland soils, full sun to heavy shade, pH adaptable. **Spread**: Seeds are dispersed by birds and wildlife. **Comments:** Outcompetes and displaces native species. **Controls:** Hand remove seedlings and saplings. Use a spade or shovel to dig out larger plants. Large populations may be controlled with herbicide use.

Corky-winged bark

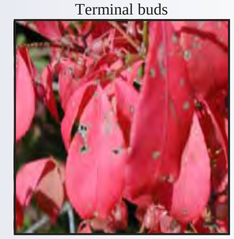


Leaves



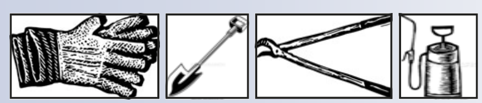
Terminal buds

Flowers yellowish-white



Fall color

Fruit is a fleshy capsule



Photos by Douglas Cygan

Heracleum mantegazzianum - Giant Hogweed

Family: Apiaceae
Native to: China



Giant Hogweed-*Heracleum mantegazzianum*

Open field invasion (Photo-Bugwood.org)

Description: Biennial growing to 15' tall. **Stems:** Greenish with purple splotches, 2-4" diameter with coarse hairs, hollow. **Leaves:** Large, compound, deeply incised, 3-5' wide, hairy on underside. **Flowers:** White inflorescence, 1-2' in diameter, May-June. **Seeds:** Flattened, $^{3}/_{8}$" long, ovate with 4 brown resin canals. **Zone:** 3-8. **Habitat:** Found in wet areas, roadsides, gardens, open spaces, full sun to partial shade. **Spread:** Seeds dispersed by water, wildlife and humans. **Comments:** The clear, watery sap is phototoxic to human skin, causing severe blistering and burns. Spreads readily and displaces native species. **Controls:** Remove plants by digging up tap root. Herbicide can also be used as a foliar treatment.

Purple spotted, hairy stem

Leaf

130-150 Floral rays

Flowers whitish umbel

Persistent dead stalks

Seeds with resinous veins

Photos by Douglas Cygan

Hesperis matronalis - Dame's Rocket

Family: Brassicaceae
Native to: Eurasia



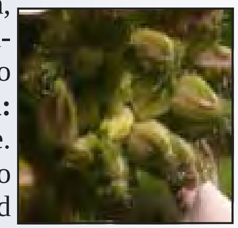
Dame's Rocket—*Hesperis matronalis*

Dame's Rocket invasion

Description: Cool season biennial, 2nd year plants flower and reach 30" tall. **Leaves:** Alternately arranged and lanceolate in shape with toothed margins. **Flowers:** Terminal racemes, 4-petals, purplish, early to mid spring. **Fruit:** Pods, seeds turn brown when mature. **Zone:** 4-8. **Habitat:** Prefers partial sun, moist to mesic conditions such as floodplains, forests and roadsides, adaptable to full sun with adequate moisture. **Spread:** Seeds spread by water and wildlife. **Comments:** Plants spread quickly into natural areas leading to competition and displacement of native species. **Controls:** Small populations can be hand pulled while large populations can be continuously cut back to prevent flowering and seed production. Herbicide treatments are also effective.

Basal rosette

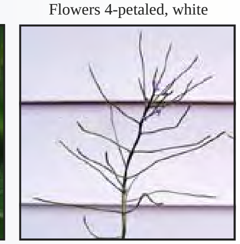
Leaf



Flower buds

Flowers 4-petaled, white

Stems



Seed pods

Photos by Leslie Mehroff

Appendix C

Invasive Species Location Plan

Invasive Species Mapping
Exeter Wastewater Treatment Facility
Exeter, New Hampshire

Spot Locations of Invasive Vegetation

Areas of Invasive Vegetation

Edge of Linear Invasive Species

Approximate Property Lines (Exeter Assesors Data)

KEY TO INVASIVE SPECIES ABREVIATIONS:

TYPE I SPECIES	TYPE II SPECIES
PHRAG-- Phragmites	GB--Glossy Buckthorn
PL--Purrple Loosestrife	MR--Multiflora Rose
JK--Japanese Knotweed	AO--Autum Olive
	RC--Reed-Canary-Grass
	BH--Bush Honeysuckle
	OB--Oriental Bittersweet

Prepared for: Wright-Pierce

Prepared by: Gove Environmental Services, Inc.

Date: 9/3/15

Appendix D

Phragmites Regional View Plan

Phragmites: Regional View
Exeter Wastewater Treatment Facility
Exeter, New Hampshire

Regional Phragmites (Aerial Mapping)

Facility Invasive Vegetation Mapping (GPS)

Prepared for: Wright-Pierce

Prepared by: Gove Environmental Services, Inc.
8 Continental Drive, Bldg 2 Unit H, Exeter NH 03833 603.778.0644

Date: 9/3/15

www.haleyaldrich.com

GEOTECHNICAL DATA REPORT
PROPOSED IMPROVEMENTS
EXETER WASTEWATER TREATMENT FACILITY
EXETER, NEW HAMPSHIRE

by
Haley & Aldrich, Inc.
Portland, Maine

for
Wright-Pierce
Portland, Maine

File No. 42149-000
August 2015

Haley & Aldrich, Inc.
75 Washington Avenue
Suite 1A
Portland, ME 04101
207.482.4600

21 August 2015
File No. 42149-000

Wright-Pierce
75 Washington Avenue, Suite 202
Portland, Maine 04101

Attention: Edward Leonard

Subject: Geotechnical Data Report
Proposed Improvements
Exeter Wastewater Treatment Facility
Exeter, New Hampshire

Ladies and Gentlemen:

Haley & Aldrich, Inc. (Haley & Aldrich) is pleased to submit this geotechnical data report, which presents the results of subsurface explorations and laboratory testing conducted in connection with planned improvements to the existing Exeter Wastewater Treatment Facility (WWTF) in Exeter, New Hampshire. The purpose of this report is to provide geotechnical information to the project team that will be needed to develop design requirements for proposed improvements. The report should also be included in the contract document package to provide "basis of bid" information for prospective contractors. This work has been completed in accordance with our proposal dated 21 May 2015 and your subsequent authorization.

Elevation Datum

Elevations reported herein are in feet and reference the National Geodetic Vertical Datum of 1929 (NGVD29).

Existing Site Conditions

The Exeter Wastewater Treatment Facility (WWTF) is located just east of Newfields Road (Route 85) in Exeter, New Hampshire. The site is generally bordered by Interstate NH-101 to the northeast and the Squamscott River to the east and south. Refer to Figure 1, Project Locus.

The existing facility is generally comprised of several buildings and structures including a public works department building, a storage building, a control building, a grit building, and four lagoons for sludge storage. Site grades vary from about El. 30 to El. 35 in the area of the existing WWTF and DPW buildings. The bottom of Lagoons 1, 2 and 3 are generally at about El. 15 to El. 16; the earth berms between the lagoons rise to about El. 24 to El. 28. Site grades within Lagoon 4, which was previously decommissioned and partially backfilled, vary from about El. 13 to El. 29. Refer to Figure 2, Site and

Subsurface Exploration Location Plan, for a general layout of the existing WWTF and Public Works Department.

An existing 16-in. diameter force main runs from the existing WWTF, along Newfield Road and Swasey Parkway to an existing Main Pump Station located approximately 400 ft north of the intersection of Swasey parkway and Main Street. Ground surface elevations along Newfields Road and Swasey Parkway vary from about El. 27 at the WWTF to about El. 7 at the existing Main Pump Station. Refer to Figure 3.

Review of available historic Sanborn Maps from 1924, 1943 and 1964 in the vicinity of the Main Pump Station, and in the general area of Water Street, Dewey Street and Green Street, indicate the presence of a former manufactured gas plant near the intersection of Green Street and Water Street. Copies of the Sanborn maps with the former manufactured gas plant highlighted are provided in Appendix A for reference.

Proposed Improvements

At this time, we understand the proposed improvements at the existing WWTF site will include a new solids handling building, biofilter area, secondary clarifiers, BNR tanks, stormwater detention/treatment basin, headworks building, sludge storage tanks, influent equalization basins, an addition to the existing chlorination building, and supporting piping infrastructure and access roadways. It is our understanding that two of the remaining three lagoons may be decommissioned and filled to facilitate construction of new improvements; Lagoon 1 will be modified to accommodate new equalization basins. Proposed improvements at the WWTF are shown on Figure 2.

Off-site improvements are planned to include a new 5,000-ft long, 16-in. diameter force main that will extend from the existing Main Pump Station (located approximately 400 ft north of the intersection of Swasey Parkway and Main Street) to the WWTF. The force main will generally run parallel to Swasey Parkway and Newfields Road. A new 12-in. diameter water main (estimated length of 4,000-ft) is also planned to be installed from the intersection of Summer Street and Water Street to the existing WWTF. We estimate approximately 1,000 ft of the water main will be installed within its own trench along Water Street. Based on discussions with you, we understand the remaining length of the water main (approximately 3,000 ft) will be installed nearby and parallel to the new force main along Newfields Road. The general limits of the force main and water main along Newfields Road, Swasey Parkway and Water Street are shown on Figure 3.

Regional Geology

The project site and vicinity lies within the Coastal Lowlands of the New England Physiographic Province. This coastal plain area generally has little topographic relief. The Squamscott River which is tidally influenced flanks the entire site to the east. According to mapped publications, surficial geologic units mapped at the site and surrounding vicinity consist of artificial fill, marine deposits and glacial till.

Artificial Fill was encountered in all recent explorations at the site and typically consisted of well graded to poorly graded sand with silt and gravel as well as reworked native soil consisting of silt and clay.

Marine Deposits were encountered in most of the recent explorations and typically consisted of a thin layer of shallow marine organic silt to silty sand overlying brown to gray marine clay and sand deposits.

Marine deposits typically overlie glacial till sediment comprised of a heterogeneous mix of sand, silt, clay and gravel. Glacial till deposits encountered in recent test borings primarily ranged from brown to gray silty sand with gravel to silt with gravel and occasional cobbles. Glacial till is deposited directly by glacial ice and overlies bedrock.

Bedrock at the site is mapped as Silurian to Ordovician age rocks of the Kittery Formation. This formation is part of the Merrimack Group which consists of metamorphic rocks of sedimentary origin. Phyllite of the Kittery Formation was encountered in recent explorations at the site.

Subsurface Exploration Program

PREVIOUS SUBSURFACE EXPLORATIONS BY OTHERS

Available historic plans and drawings indicate several phases of exploratory explorations were conducted at the WWTF by others. Drawings SP-17 and SP-18, prepared by Environmental Engineers, Inc., dated February 1980, include logs for select test borings and auger probes. The locations of the test borings and auger probes summarized on sheets SP-17 and SP-18 are shown on Drawing G-2, prepared by Hoyle, Tanner & Associates, Inc. dated May 1988. Additional test boring and test probe explorations conducted by GZA Drilling, Inc. of Londonderry, New Hampshire in 1987 are also shown on Drawing G-2. A plan labeled Figure 2, prepared by Underwood Engineers and dated January 2013 shows the location of three monitoring wells. Copies of Drawings G-2, SP-17, SP-18 and Underwood Engineers Figure 2 and logs are included in Appendix B for reference.

RECENT SUBSURFACE EXPLORATIONS

Test Borings – During the period 22 June to 6 July 2015, a project-specific subsurface exploration program consisting of twenty-six (26) test borings was undertaken by Haley & Aldrich at the subject site. Drilling of each test boring was completed by New England Boring Contractors of Derry, New Hampshire, as described below. A Haley & Aldrich geologist was on-site to provide technical monitoring during drilling and to document the soil, rock and groundwater conditions encountered in the explorations.

Borings were generally advanced through the overburden soils using 4-in. (HW-size) or 2.25-in. (HAS-size) inside diameter (ID) steel casing and cased-washed boring drilling techniques. Test borings HA15-4 through HA15-7, and HA15-9, were advanced into the bedrock underlying the site with the use of 2 in. ID (NQ-size) casing. Geotechnical soil samples were collected at 2-ft to 5-ft intervals by driving a 1-3/8 in. ID split-spoon sampler with a 140-lb hammer dropped from a height of 30 in., as indicated on the test boring logs. The number of hammer blows required to advance the sampler through each 6-in. interval was recorded and is provided on the logs. The uncorrected SPT N-value (N-uncorrected) is defined as the total number of blows required to advance the sampler through the middle 12 in. of the 24-in. sampling interval. Geotechnical soil samples collected were preserved in glass jars. Soil samples not submitted for laboratory testing are available for review upon request. Available soil samples are currently being housed at the Haley & Aldrich storage facility in Portland, Maine.

Test boring reports and core boring reports from the recent subsurface exploration program are included in Appendix C. “As-drilled” test boring locations were determined by Haley & Aldrich in the field using a hand-held Trimble GeoExplorer 2008 Series, Geo XT GPS system. Ground surface elevations at “as-drilled” test boring locations were estimated based on topographic information on plans and drawings provided by Wright-Pierce (W-P).

<u>WWTF Borings</u> - Eleven (11) test borings (designated HA15-1 through HA15-11) were completed at the WWTF site to depths ranging from 14.0 to 70.1 ft below existing site grades with the use of an ATV-mounted drill rig (Mobile B-53 Bombardier):

Proposed Access Roadway – Three test borings, designated HA15-1, HA15-2 and HA15-3 were completed to depths ranging from 14.0 to 17.0 ft along the proposed alignment of a new access road for the WWTF.

Proposed Facility Upgrades and New Structures – Six test borings, designated HA15-4 through HA15-9, were drilled within the limits of existing sewerage Lagoon 4 in the general location of proposed WWTF buildings and structures. We understand Lagoon 4 had been decommissioned and partially filled at the time of drilling. The depth of borings completed in the area of the proposed upgrades and new structures ranged from 15.0 ft to 41.0 ft below ground surface.

Lagoon Embankments – An additional two test borings, HA15-10 and HA15-11, were drilled within the soil embankments along the perimeter of two existing sewerage lagoons to depths of 32.0 and 70.1 ft, respectively. Two, undisturbed samples of marine clay were obtained from test boring HA15-11(OW). The samples were obtained by advancing a 3-in. OD thin-wall Shelby Tube into the clay using a piston sampler.

<u>Proposed Force Main and Water Main</u> –Fifteen (15) test borings (designated HA15-12 through HA15-26) were conducted along the alignments of the proposed force main (Newfields Road and Swasey Parkway) and water main (Newfields Road and Water Street). Each test boring was drilled 10 to 11 ft with the use of a truck-mounted drill rig (Diedrich D50).

Observation Well Installation – Observation wells (open standpipe piezometers) were installed in four of the completed test borings (HA15-4, HA15-7, HA15-9 and HA15-11) to provide information on static groundwater levels at the site. In general, each well is comprised of a 10-ft length of 2-in. ID, machine-slotted PVC well screen and solid PVC riser pipe. Each well was screened within the fill and into the underlying naturally deposited soils; wells installed in borings HA15-4 and HA15-9 were screened into the bedrock underlying the site. Each observation well was protected with either a locking guardpipe or roadway box installed at ground surface. Groundwater observation well installation reports are included in Appendix D.

Water Level Monitoring – Levelogger downhole transducers (automated data collectors) were installed by Haley & Aldrich in each of the four new wells on 2 July 2015 (HA15-7, HA15-9 and HA15-11) and on 6 July 2015 (HA15-4) to provide daily monitoring of groundwater levels. The level logger data was downloaded on 22 July 2015 and the dataloggers were reinstalled back into the observation wells to collect future data.

In addition to the levelogger data, manual water level readings have been collected by Haley & Aldrich at each well location during periodic site visits to install the levelogger equipment and periodically download levelogger data for review.

The results of groundwater level monitoring at the site are provided in Appendix E and are summarized in a subsequent section of this report.

In-situ Vane Shear Testing - In-situ vane shear tests were conducted within the marine clay deposits in test boring HA15-11(OW). Vane shear tests were conducted using a 65 mm by 130 mm rectangular Geonor vane attached to a 2-ft long, 12-mm diameter rod extension, attached to a string of 5/8-in. outside diameter (OD) hollow chrome-moly rods. At each in-situ vane shear test location, the vane was pushed (by hand) until the bottom of the vane was approximately 1 to 2 ft below the bottom of the borehole. The vane was then rotated at a rate of about 90 degrees per minute using a calibrated torque wrench. Results of the vane shear testing are shown on Figure G1 and are also provided on the test boring log in Appendix C.

Environmental Field Screening - A photoionization detector (PID) was used in the field to screen for the presence of volatile organic compounds (VOCs) in soil samples collected along the alignment of the proposed force and water mains. Significantly elevated PID readings (greater than 5 ppm) were not observed in any soil samples obtained from the test borings with the exception of test borings HA15-17, HA15-18, HA15-19, HA15-25 and HA15-26. Each of the test borings where elevated PID readings were detected are generally located in the vicinity of the intersection of Water Street and Swasey Parkway/Newfields Road as shown on Figure 3. Elevated PID readings at these test boring locations generally ranged from 5 to 94 ppm and occurred both in the near surface fill soils and the underlying naturally deposited marine and glacial soils to depths up to 10 ft (at which point the explorations were terminated).

An asphalt-like odor was noted during drilling in the fill soils just below the bituminous concrete at ground surface in borings HA15-18, HA15-19 and HA15-25. A diesel-like odor and petroleum-like odor were also noted in the fill soils just below ground surface in test borings HA15-18 and HA15-26, respectively. No other visual/olfactory evidence of contamination was noted during drilling, specifically within the naturally deposited marine and glacial soils. Based on field observations and our experience, it is our opinion that the measured PID readings are not accurate, especially within the naturally deposited soils, and are a result of a faulty PID monitor. However, based on our observation of conditions in the field, and the olfactory evidence noted above, it is our opinion that there is the potential for the near surface soils in the vicinity of test borings HA15-18, HA15-19, HA15-25 and HA15-26 to be impacted and require special handling and management during construction.

Subsurface Conditions

SOIL AND BEDROCK CONDITIONS

Subsurface conditions encountered at the site generally consist of the following geologic units presented in order of increasing depth below ground surface: fill, marine deposits, glacial till, weathered bedrock and bedrock. Refer to Table I for a summary of the soil units and thicknesses encountered at each test boring location. A general description of each soil unit identified at the site is provided below. Detailed soil descriptions are provided on the Haley & Aldrich test boring logs included in Appendix C.

Please note that soil descriptions provided on the test boring logs and summarized below do not represent field conditions other than at the specific test boring locations. The conditions between boring locations may vary from those described herein.

Bituminous Concrete

Bituminous concrete, varying in thickness from 0.3 to 0.8 ft, was encountered at several test boring locations drilled along Newfields Road and Water Street (HA15-12 through HA15-19, HA15-25 and HA15-26).

Topsoil

Topsoil, generally consisting of SILT with organics to sandy SILT with gravel and varying in thickness from 0.3 to 1.8 ft, was encountered at boring locations HA15-3 through HA15-6 at the WWTF and borings HA15-20 through HA15-24 completed along Swasey Parkway.

Fill

Where encountered the total thickness of fill soils varied from 1.6 to 23 ft. The nature of the fill soils encountered at each test boring location varied as described further below. Refer to the test boring logs included in Appendix C for additional details on the nature of the fill soils encountered during the recent test borings.

Reworked Native Soils - Fill consisting of reworked native soils generally described as SILT to SILT with sand to SAND with gravel was encountered at many of the test borings (i.e. HA15-4, HA15-12 through HA15-17, HA15-19 through HA15-21 and HA15-23). Where encountered the thickness of the reworked native soils varied from 0.7 ft to 4 ft and was generally identified just above the naturally deposited soils encountered at each test boring location.

Sludge Fill - Sludge fill was encountered from 3.7 to 7.7 ft, from 5.5 to 6.0 ft, and from 1.0 to 12.0 ft in borings HA15-4, HA15-5 and HA15-8, respectively. The sludge fill can generally be described as SILT to SILT with gravel or organics to GRAVEL with silt and sand. Naturally deposited glacial till soils were encountered below the sludge fill at each of the three test boring locations.

Gravel Fill – A 4 ft thick layer of gravel fill was encountered at ground surface in test boring HA15-9; a 2-ft thick layer of gravel fill was encountered from 6 to 8 ft at HA15-16. A possible cobble/boulder was encountered within the Fill soils at HA15-1 at a depth of 12.7 to 14.0 ft below ground surface.

Miscellaneous Fill - Miscellaneous fill soils generally consisting of SAND with varying amounts of silt and gravel to lean CLAY to SILT with varying amounts of sand and gravel were encountered at many of the test boring locations. Miscellaneous debris such as brick, wood, ash, glass, ceramic and plastic was encountered within the Fill soils.

An asphalt-like odor was noted within the fill soils just below the bituminous concrete in test borings HA15-12, HA15-18, HA15-19 and HA15-25. It is not unusual to have this occur immediately below bituminous concrete. A petroleum-like odor was noted in test borings HA15-14 and HA15-26, and a diesel-like odor was noted in test boring HA15-18. No visual signs of petroleum or diesel product were observed.

Marine Deposits

Marine deposits generally described as very stiff to hard SILT with varying amounts of sand, gravel, clay and organics to medium dense SAND with organics were encountered at many of the test borings; refer to Table I. At HA15-11 and HA15-15, marine deposits described as very soft to stiff lean clay were noted. Where encountered, the thickness of the deposit varied from 0.7 to 44.5 ft.

Shallow Marine Deposit – A shallow marine deposit consisting of marine deposits (as described above) with a higher organic content were encountered in several test borings, including HA15-2, HA15-6, HA15-7, HA15-22 and HA15-24, as noted on the test boring logs.

Based on the results of in-situ vane shear and laboratory strength testing the marine clay encountered in test boring HA15-11 is typically medium stiff to stiff (undrained shear strengths ranging from approximately 500 to 1,000 psf) with some localized zones or areas that may be very soft to soft (undrained shear strengths less than approximately 500 psf). A graphical representation of the in-situ vane shear test results within the marine clay deposit is provided as Figure G1 in Appendix G.

Glacial Till

Glacial till generally consisting of dense to very dense SAND to hard to very stiff SILT to loose to very dense GRAVEL, all with varying amounts of silt, sand and gravel was encountered at several of the test boring locations, as summarized on Table I. Where encountered, the thickness of the deposit varied from about 1.1 to 12.5 ft. Cobbles were noted within the glacial till from 12.0 to 13.5 ft in boring HA15-3. A zone of highly weathered rock was encountered within the glacial till deposit from 7.8 to 9.5 ft in test boring HA15-17.

Weathered Bedrock

A thin zone of weathered bedrock was encountered above the more competent bedrock in borings HA15-5 and HA15-6. Where encountered, the thickness of the weathered bedrock zone ranged from 0.5 to 1.0 ft.

Bedrock

Bedrock generally consisting of moderately hard, fresh to moderately weathered fine-grained Phyllite, was encountered at test borings HA15-4 through HA15-10 at depths ranging from 8.5 to 35.5 ft below ground surface, corresponding to about El. 20.0 to El. -12.0.

Of the recovered length of rock core, the Rock Quality Designation (RQD), or the percent of rock pieces recovered greater than 4 in. in length, generally varied from 17 to 97 percent except at HA15-4 where RQD was 0 percent. Photos of the rock core are included in Appendix F.

WATER LEVELS

As discussed in previous sections of this report, observation wells were installed in four of the completed boreholes (i.e., HA15-4, HA15-7, HA15-9 and HA15-11). Beginning on 3 and 6 July 2015, downhole pressure transducers were installed in the completed observation wells and were programmed to record the groundwater levels daily. The transducers were temporarily removed and data downloaded on 21 July 2015. The transducers were reinstalled back into the observation wells to collect future data. Additionally, water level measurements were taken manually at each of the wells during periodic site visits. A plot of measured water levels versus time at each observation well is included in Appendix E as Figure E1. Groundwater monitoring reports summarizing manual water level readings collected by Haley & Aldrich at each well location are also included in Appendix E. A summary of the recorded water level readings collected between 3 July and 21 July 2015 is provided below.

Observation Well Designation	Subsurface Conditions in Well Screen Section	Estimated Ground Surface Elevation (ft, NGVD29)	Approximate Range in Water Level Elevation (ft, NGVD29)
HA15-4	fill/glacial till/rock	24.5	El. 2.0 to El. 3.4
HA15-7	fill/marine/glacial till	24.5	El. 11.8 to El. 12.9
HA15-9	fill/rock	28.5	El. 1.5 to El. 2.8
HA15-11	fill/marine	27.5	El. 17.9 to El. 19.8

Water levels may fluctuate with season, precipitation and local soil/bedrock conditions. Therefore, water levels may vary from those reported herein.

Geotechnical Laboratory Testing

A geotechnical laboratory testing program was undertaken on representative soil samples collected during the recent subsurface exploration program to assist in soil classification, evaluating soil reuse potential and to determine engineering soil properties needed for geotechnical design and construction. In general, laboratory testing was performed on disturbed and undisturbed soil samples collected during SPT and Shelby tube sampling, respectively. All laboratory testing was performed in accordance with applicable American Society for Testing Materials (ASTM) testing procedures by GeoTesting Express of Acton, Massachusetts. The assigned geotechnical laboratory testing is summarized below.

- 10 grain size analyses
- 6 natural water content tests
- 6 Atterberg limits tests
- 2 isotropically consolidated, undrained triaxial shear strength tests

All recent geotechnical laboratory test results are provided in Appendix G. A graphic summary of results is provided as Figure G1. We will use the results of the laboratory testing to complete our technical evaluations and ultimately develop geotechnical design recommendations for the project.

Closure

In accordance with our proposal, we will be starting our geotechnical evaluations for the proposed site improvements shortly. We will be reaching out to you to better understand the specific details of the proposed improvements as we will need this information to conduct our evaluations. We will summarize the results of our evaluations along with the geotechnical and foundation design recommendations for the proposed improvements under separate cover.

We appreciate the opportunity to provide geotechnical engineering services on this phase of the project. Please do not hesitate to call if you have any questions or comments.

Sincerely yours,
HALEY & ALDRICH, INC.

Jessica Lefkowitz
Geotechnical Engineer

Erin A. Force, P.E.
Project Manager

Wayne A. Chadbourne, P.E.
Vice President

Enclosures:

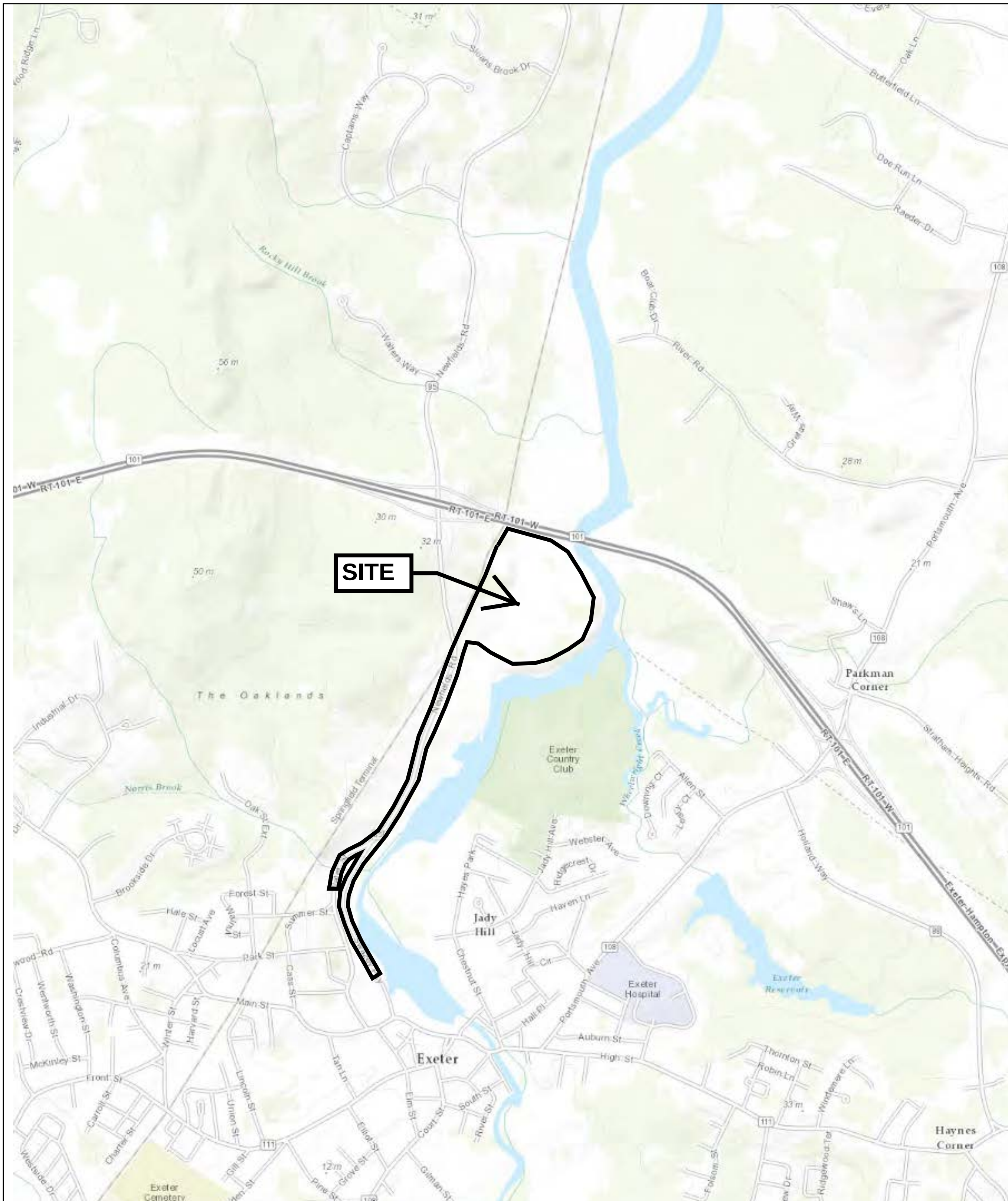
Table I – Summary of Subsurface Explorations – Subsurface Data
Figure 1 – Project Locus
Figure 2 – Site and Subsurface Exploration Location Plan (WWTF Borings)
Figure 3 – Site and Subsurface Exploration Location Plan (Force Main and Water Main Borings)
Appendix A – Sanborn Maps
Appendix B – Plans of Previous Explorations by Others - Drawings SP-17 and G-2
Appendix C – Recent Test Boring Logs and Core Boring Reports
Appendix D – Groundwater Observation Well Installation Reports
Appendix E –Groundwater Level Data
Appendix F – Rock Core Photographs
Appendix G – Geotechnical Laboratory Test Results

TABLE I
Summary of Subsurface Explorations - Subsurface Data
June / July 2015 Test Borings
Proposed Improvements
Exeter Wastewater Treatment Facility
Exeter, New Hampshire

Test Boring Designation[1]	Approximate Ground Surface Elevation[2,3]	Approximate Strata Thickness[4,5,6] (ft)							Bedrock Thickness Drilled/Cored (ft)	Approximate Top of Bedrock Elevation[2,3]	Approximate Elevation of Bottom of Exploration[2,3]	Observation Well (OW) Installed?[7]
		Bituminous Concrete	Topsoil	Total Fill	Sludge Fill	Marine Deposits	Glacial Till	Weathered Bedrock				
WWTF												
HA15-1	23.0	NE	NE	> 14.0	NE	-	-	-	-	-	9.0	N
HA15-2	22.5	NE	NE	5.0	NE	7.0	> 5.0	-	-	-	5.5	N
HA15-3	25.5	NE	0.4	1.6	NE	1.9	10.8	-	-	10.8	10.8	N
HA15-4	24.5	NE	1.8	5.9	4.0	NE	1.1	NE	6.2	15.7	9.5	Y
HA15-5	27.5	NE	0.5	5.5	0.5	NE	12.5	0.5	6.0	8.5	2.5	N
HA15-6	23.5	NE	0.3	11.5	NE	11.7	11.0	1.0	5.5	-12.0	-17.5	N
HA15-7	24.5	NE	NE	14.5	NE	2.0	7.0	NE	7.0	1.0	-6.0	Y
HA15-8	28.5	NE	NE	12.0	11.0	NE	11.0	NE	1.0	5.5	4.5	N
HA15-9	28.5	NE	NE	8.5	NE	NE	NE	NE	5.5	20.0	14.5	Y
HA15-10	28.0	NE	NE	15.2	NE	12.3	2.0	NE	2.5	-1.5	-4.0	N
HA15-11	27.5	NE	NE	23.0	NE	44.5	2.6	-	-	-42.6	-42.6	Y
Force and Water Mains												
HA15-12	26.6	0.8	NE	3.2	NE	5.8	> 0.3	-	-	-	16.5	N
HA15-13	23.7	0.5	NE	4.2	NE	> 5.3	-	-	-	-	13.7	N
HA15-14	21.9	0.5	NE	4.5	NE	> 5.0	-	-	-	-	11.9	N
HA15-15	20.9	0.5	NE	4.5	NE	> 5.0	-	-	-	-	10.9	N
HA15-16	19.0	0.6	NE	7.4	NE	NE	> 2.0	-	-	-	9.0	N
HA15-17	12.6	0.6	NE	3.1	NE	3.8	> 2.5	-	-	-	2.6	N
HA15-18	13.4	0.6	NE	2.9	NE	> 6.5	-	-	-	-	3.4	N
HA15-19	9.5	0.7	NE	3.8	NE	> 6.5	-	-	-	-	-1.5	N
HA15-20	7.8	NE	1.4	1.9	NE	0.7	> 6.0	-	-	-	-2.2	N
HA15-21	7.9	NE	0.5	2.5	NE	6.5	> 0.5	-	-	-	-2.1	N
HA15-22	7.8	NE	0.4	2.7	NE	> 6.9	-	-	-	-	-2.2	N
HA15-23	7.2	NE	0.6	> 9.4	NE	-	-	-	-	-	-2.8	N
HA15-24	7.5	NE	0.9	7.1	NE	> 2.0	-	-	-	-	-2.5	N
HA15-25	11.0	0.4	NE	> 9.6	NE	-	-	-	-	-	1.0	N
HA15-26	31.0	0.3	NE	1.7	NE	> 8.0	-	-	-	-	21.0	N

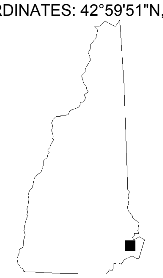
Notes:
[1] Test boring locations are shown on Figure 2 - Subsurface Exploration Location Plan, Proposed Facility Improvements (HA15-1 to HA15-11) and Figure 3 - Subsurface Exploration Location Plan, Proposed Force Main and Water (HA15-12 to HA15-26).
[2] Ground surface elevations at as-drilled test boring locations are approximate and were estimated based on topographic information provided by Wright-Pierce.
[3] Elevations are measured in feet and reference the National Geodetic Vertical Datum of 1929 (NGVD29).
[4] "NE" indicates stratum was not encountered in test boring.
[5] "-" indicates not determined; boring terminated before presence of deposit/material verified.
[6] ">" indicates total thickness not determined; boring terminated at elevation indicated within material/deposit.
[7] "(OW)" indicates observation well (open standpipe piezometer) installed in completed borehole.

	Individual	Date
Prepared By:	JMT	7/28/2015
Checked By:	JLL	7/30/2015
Reviewed By:	WAC	8/3/2015



MAP SOURCE: ESRI

SITE COORDINATES: 42°59'51"N, 70°56'35"W



HALEY ALDRICH

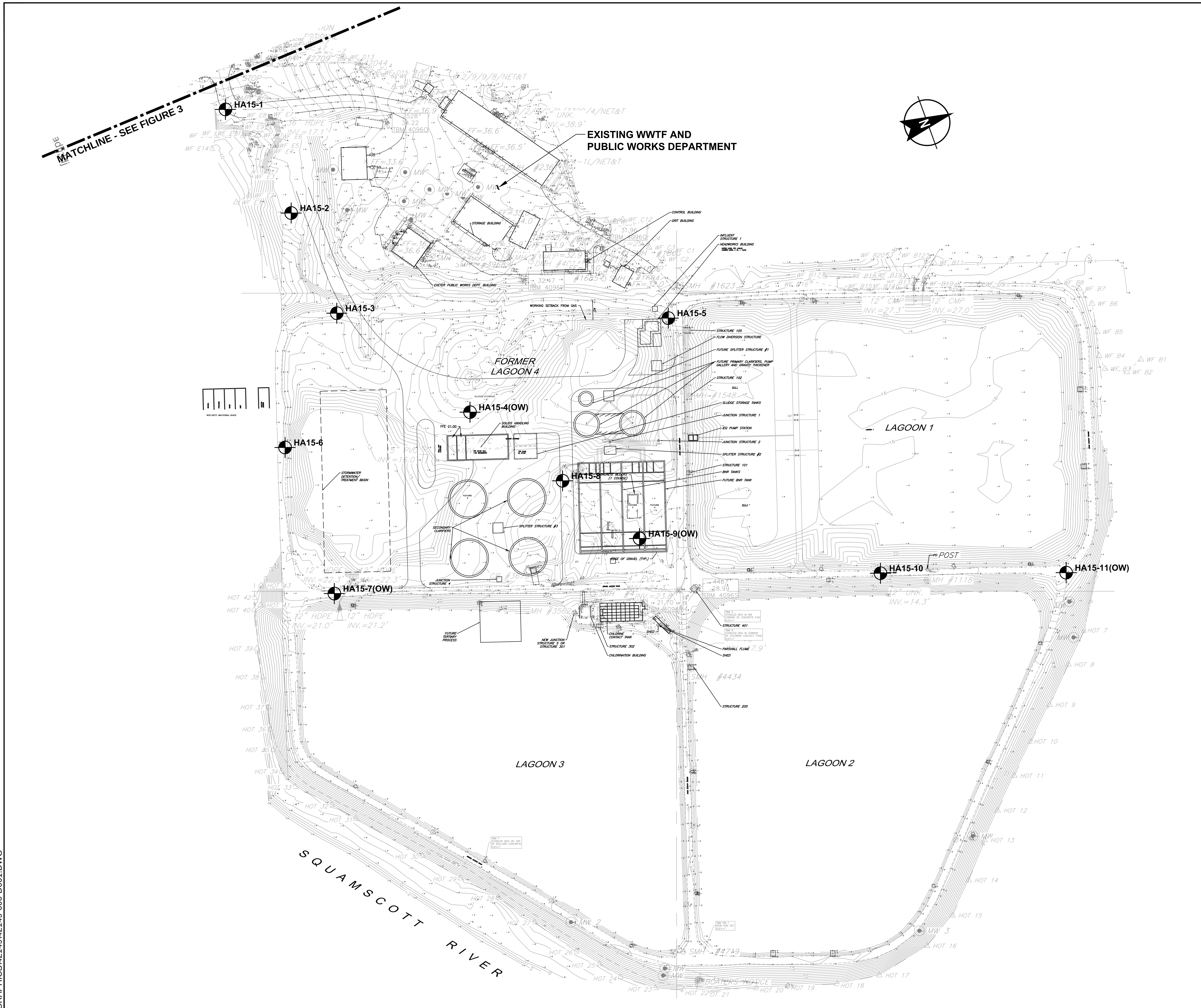
EXETER WASTEWATER TREATMENT FACILITY
EXETER, NEW HAMPSHIRE

PROJECT LOCUS

APPROXIMATE SCALE: 1 IN = 2000 FT
AUGUST 2015

FIGURE 1

42149-000_1_LOCUS.PDF



LEGEND

HA15-11 — DESIGNATION AND APPROXIMATE LOCATION OF TEST BORING DRILLED BY NEW ENGLAND BORING CONTRACTORS OF DERRY, NEW HAMPSHIRE DURING THE PERIOD 22 JUNE TO 6 JULY 2015

(OW) — INDICATES GROUNDWATER OBSERVATION WELL INSTALLED IN COMPLETED BOREHOLE

NOTES

1. BASE PLAN PREPARED FROM A ELECTRONIC DRAWING FILE NAMED ñ12883-PRELIMDESIGN.dwgò UNTITLED, UNDATED PROVIDED TO HALEY & ALDRICH, INC. BY WRIGHT-PIERCE ON 9 JULY 2015.

2. TECHNICAL MONITORING OF THE TEST BORINGS WAS PERFORMED BY HALEY & ALDRICH, INC.

3. ELEVATIONS ARE IN FEET AND REFERENCE THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29).

4. THE AS-DRILLED LOCATION OF EACH TEST BORING WAS DETERMINED IN THE FIELD BY HALEY & ALDRICH, INC. USING A HAND-HELD TRIMBLE GEOEXPLORER 2008 SERIES GEO XT GPS SYSTEM.

0 100 200 300 400
SCALE IN FEET

HALEY ALDRICH

EXETER WASTEWATER TREATMENT FACILITY
EXETER, NEW HAMPSHIRE

SUBSURFACE EXPLORATION
LOCATION PLAN
PROPOSED FACILITY IMPROVEMENTS
(HA15-1 TO HA15-11)

SCALE: AS SHOWN
AUGUST 2015

FIGURE 2

MCELENEY, TERRI Printed: 8/3/2015 1:57 PM Layout: D001
J:\GRAPHICS\42149\42149-000-D001.DWG

LEGEND

HA15-26 — DESIGNATION AND APPROXIMATE LOCATION OF TEST BORING DRILLED BY NEW ENGLAND BORING CONTRACTORS OF DERRY, NEW HAMPSHIRE DURING THE PERIOD 22 JUNE TO 6 JULY 2015

NOTES

1. BASE PLAN PREPARED FROM A ELECTRONIC DRAWING FILE NAMED ñ12883-PRELIMDESIGN.dwgò UNTITLED, UNDATED PROVIDED TO HALEY & ALDRICH, INC. BY WRIGHT-PIERCE ON 9 JULY 2015.
2. TECHNICAL MONITORING OF THE TEST BORINGS WAS PERFORMED BY HALEY & ALDRICH, INC.
3. ELEVATIONS ARE IN FEET AND REFERENCE THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29).
4. THE AS-DRILLED LOCATION OF EACH TEST BORING WAS DETERMINED IN THE FIELD BY HALEY & ALDRICH, INC. USING A HAND-HELD TRIMBLE GEOEXPLORER 2008 SERIES GEO XT GPS SYSTEM.

HALEY ALDRICH

EXETER WASTEWATER TREATMENT FACILITY
EXETER, NEW HAMPSHIRE

SUBSURFACE EXPLORATION
LOCATION PLAN
PROPOSED FORCE MAIN AND
WATER MAIN (HA15-12 TO HA15-26)

SCALE: AS SHOWN
AUGUST 2015

FIGURE 3

MCELENEY, TERRI Printed: 8/3/2015 1:57 PM Layout: D002
J:\GRAPHICS\42149\42149-000-D001.DWG

APPENDIX A

Sanborn Maps

Exeter WWTF

Former MGP Facility, Water Street

Exeter, NH 03833

Inquiry Number: 4365485.1

July 27, 2015

Certified Sanborn® Map Report

EDR®

6 Armstrong Road, 4th Floor
Shelton, Connecticut 06484
Toll Free: 800.352.0050
www.edrnet.com

Certified Sanborn® Map Report

7/27/15

Site Name:	**Client Name:**
Exeter WWTF Former MGP Facility, Water Exeter, NH 03833	Haley & Aldrich, Inc. 75 Washington Ave. Portland, ME 04101-2617
EDR Inquiry # 4365485.1	Contact: Dave Dearden

The Sanborn Library has been searched by EDR and maps covering the target property location as provided by Haley & Aldrich, Inc. were identified for the years listed below. The Sanborn Library is the largest, most complete collection of fire insurance maps. The collection includes maps from Sanborn, Bromley, Perris & Browne, Hopkins, Barlow, and others. Only Environmental Data Resources Inc. (EDR) is authorized to grant rights for commercial reproduction of maps by the Sanborn Library LLC, the copyright holder for the collection. Results can be authenticated by visiting www.edrnet.com/sanborn.

The Sanborn Library is continually enhanced with newly identified map archives. This report accesses all maps in the collection as of the day this report was generated.

Certified Sanborn Results:

Site Name:	Exeter WWTF
Address:	Former MGP Facility, Water Street
City, State, Zip:	Exeter, NH 03833
Cross Street:	
P.O. #	42149-000
Project:	Exeter WWTF Site
Certification #	AFDD-4F8D-B0FB

Sanborn® Library search results
Certification # AFDD-4F8D-B0FB

Maps Provided:

1964

1943

1924

The Sanborn Library includes more than 1.2 million fire insurance maps from Sanborn, Bromley, Perris & Browne, Hopkins, Barlow and others which track historical property usage in approximately 12,000 American cities and towns. Collections searched:

- ✔ Library of Congress
- ✔ University Publications of America
- ✔ EDR Private Collection

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Sanborn Sheet Thumbnails

This Certified Sanborn Map Report is based upon the following Sanborn Fire Insurance map sheets.

1964 Source Sheets

Volume 1, Sheet 2

Volume 1, Sheet 4

Volume 1, Sheet 14

1943 Source Sheets

Volume 1, Sheet 2

Volume 1, Sheet 4

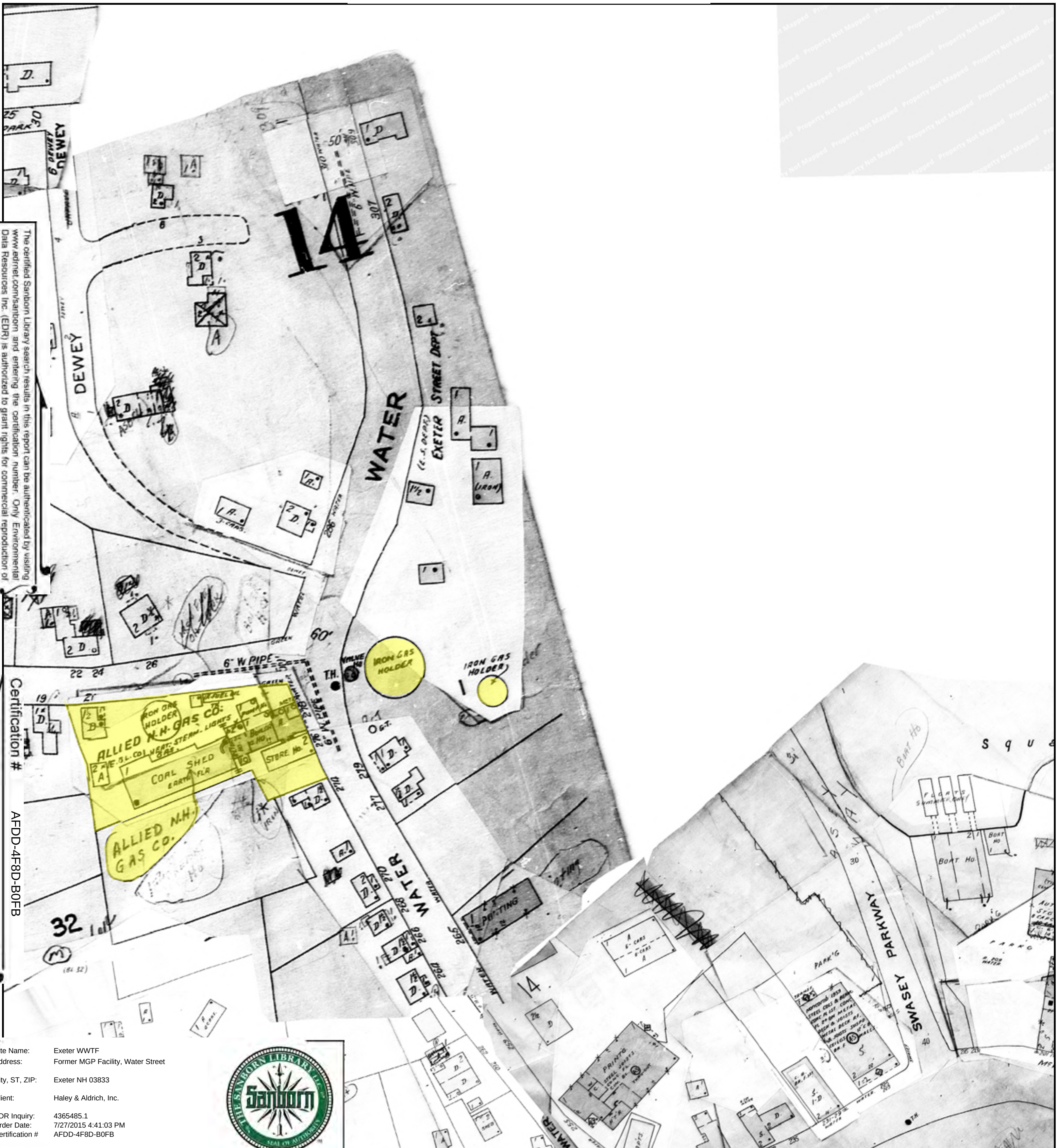
Volume 1, Sheet 14

1924 Source Sheets

Volume 1, Sheet 2

Volume 1, Sheet 14

1964 Certified Sanborn Map



Certification # AFDD-4F8D-B0FB

Site Name: Exeter WWTF
Address: Former MGP Facility, Water Street
City, ST, ZIP: Exeter NH 03833
Client: Haley & Aldrich, Inc.
EDR Inquiry: 4365485.1
Order Date: 7/27/2015 4:41:03 PM
Certification # AFDD-4F8D-B0FB
Copyright: 1964

This Certified Sanborn Map combines the following sheets.
Outlined areas indicate map sheets within the collection.

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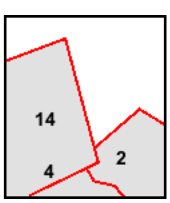
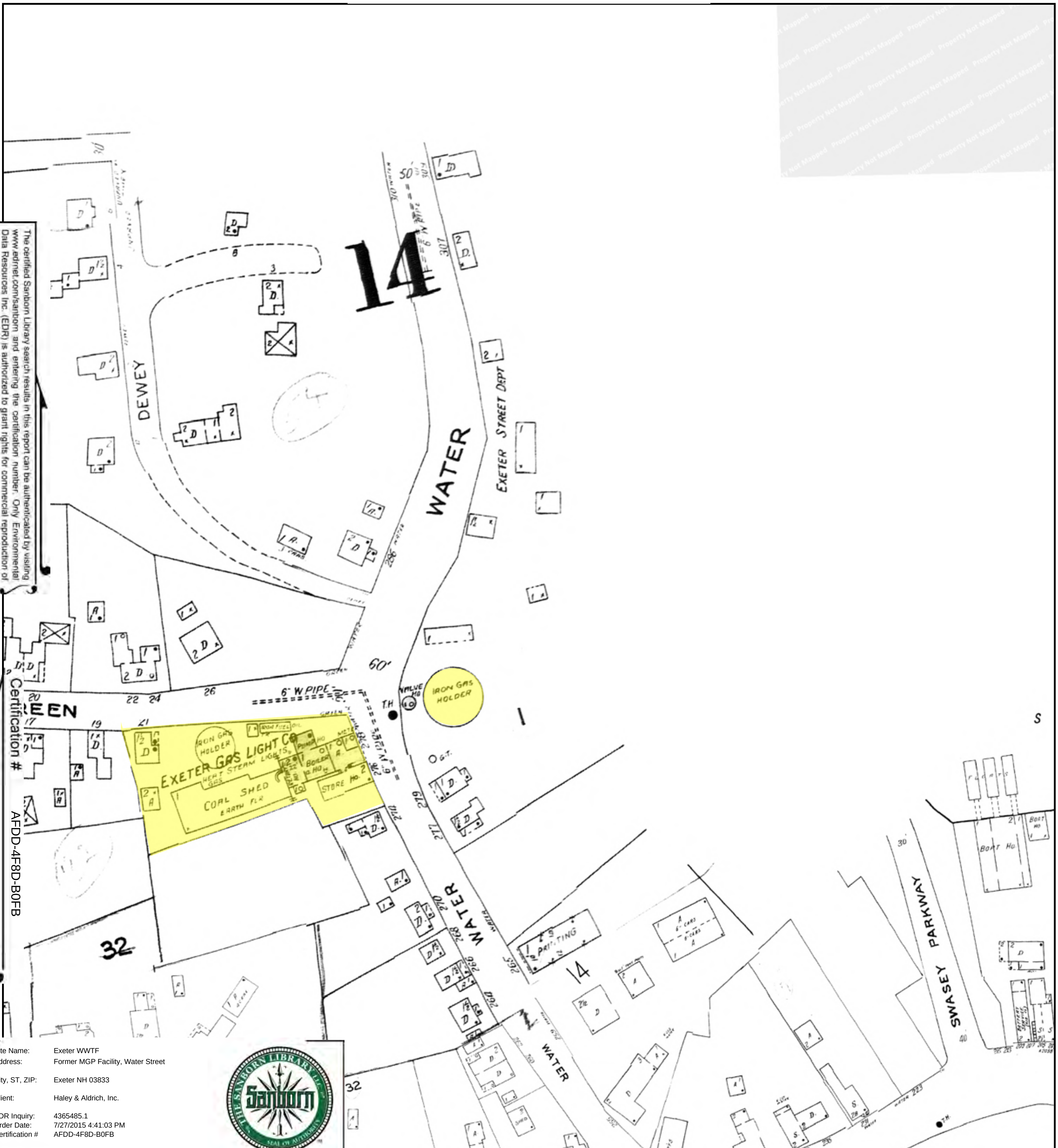


Volume 1, Sheet 2
Volume 1, Sheet 4
Volume 1, Sheet 14

N

1943 Certified Sanborn Map



Certification # AFDD-4F8D-B0FB

Site Name: Exeter WWTF
Address: Former MGP Facility, Water Street
City, ST, ZIP: Exeter NH 03833
Client: Haley & Aldrich, Inc.
EDR Inquiry: 4365485.1
Order Date: 7/27/2015 4:41:03 PM
Certification # AFDD-4F8D-B0FB
Copyright: 1943

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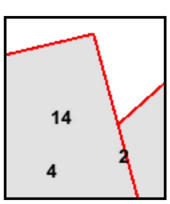
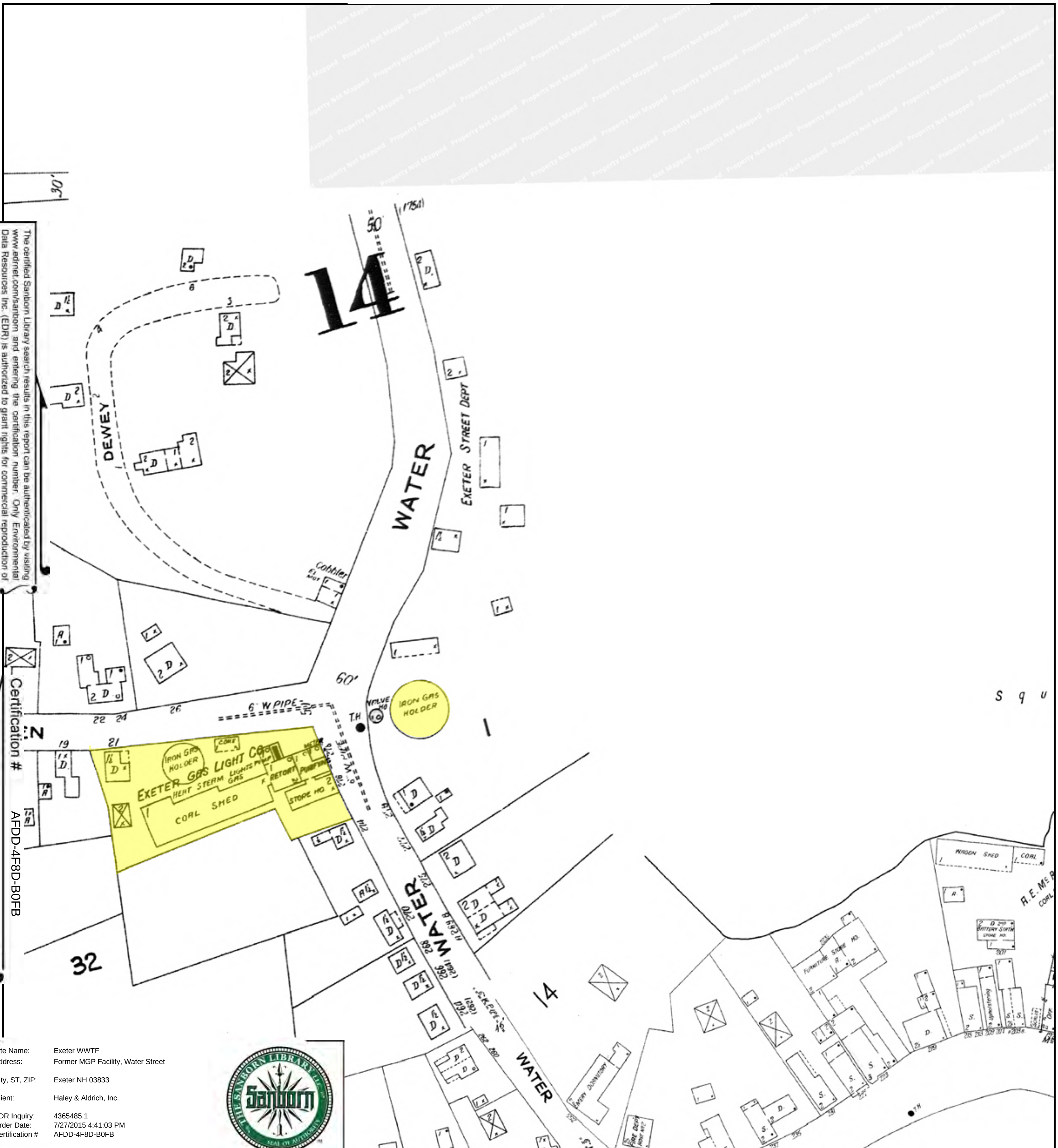


Volume 1, Sheet 2
Volume 1, Sheet 4
Volume 1, Sheet 14

N

1924 Certified Sanborn Map



Site Name:	Exeter WWTF
Address:	Former MGP Facility, Water Street
City, ST, ZIP:	Exeter NH 03833
Client:	Haley & Aldrich, Inc.
EDR Inquiry:	4365485.1
Order Date:	7/27/2015 4:41:03 PM
Certification #	AFDD-4F8D-B0FB
Copyright:	1924

This Certified Sanborn Map combines the following sheets.
Outlined areas indicate map sheets within the collection.

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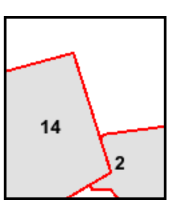
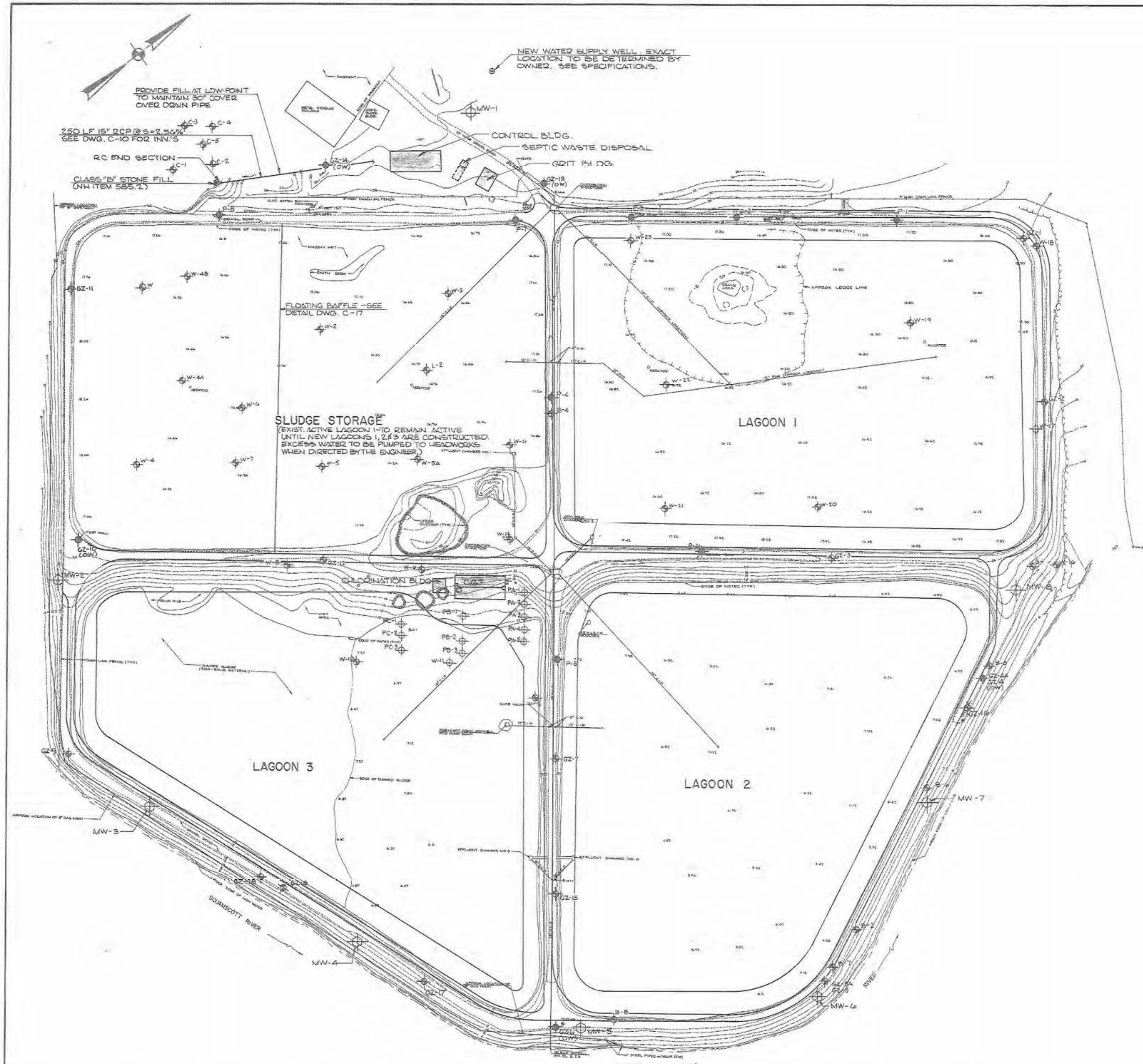


Volume 1, Sheet 2
Volume 1, Sheet 14

N

APPENDIX B

Plans of Previous Explorations by Others



NOTES:

1). BASE MAP WAS DRAWN FROM A PLAN ENTITLED, "GEOPHYSICAL DATA, WASTEWATER TREATMENT FACILITIES, TOWN OF EXETER, EXETER, NEW HAMPSHIRE," SHEET NO. SP-16, PREPARED BY ENVIRONMENTAL ENGINEERS, INC. OF CONCORD, NEW HAMPSHIRE AND PROVIDED BY HOYLE, TANNER AND ASSOCIATES, INC., DATED FEBRUARY, 1980.

2). TEST BORINGS GZ-1 THROUGH GZ-15 AND TEST PROBES P-1 THROUGH P-8 WERE DRILLED BY GZA DRILLING, INC. OF LONDONDERRY, NEW HAMPSHIRE ON 12/20/87 THROUGH 03/05/87 AND WERE OBSERVED AND LOGGED BY GZA PERSONNEL.

3). TEST BORINGS GZ-16 THROUGH GZ-18 WERE DRILLED BY GZA DRILLING, INC. OF LONDONDERRY, NEW HAMPSHIRE ON 12/21/87 AND 12/22/87 AND WERE OBSERVED AND LOGGED BY GZA PERSONNEL.

4). GZA TEST BORING AND TEST PROBE LOCATIONS WERE DETERMINED BY TAPE MEASUREMENTS FROM PROMINENT EXISTING FEATURES. THE LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.

5). TEST BORINGS B-1 THROUGH B-7, C-1 THROUGH C-5; AUGER PROBES PA-1 THROUGH PA-5, PB-1 THROUGH PB-3 AND PC-1 THROUGH PC-3, TEST HOLES W-1 THROUGH W-2 WERE PERFORMED PRIOR TO 1981 BY OTHERS. REFER TO SHEET NO.S' SP-17 AND SP-18 OF PLANS PREPARED BY ENVIRONMENTAL ENGINEERS, INC., DATED FEBRUARY, 1980.

LEGEND:

GZ-1 TEST BORING LOCATION AND NUMBER.

P-1 TEST PROBE LOCATION AND NUMBER.

(OW) INDICATES INSTALLED OBSERVATION WELL.

PREVIOUS SUBSURFACE EXPLORATIONS BY OTHERS:

B-1
W-1
C-1

PA-1
PB-1
PC-1 LOCATION AND NUMBER.

MW-1 PROPOSED MONITORING WELL - SEE GRADING & DRAINAGE DWGS FOR ACTUAL LOCATIONS. SEE DETAIL DWG. C-17

PROPOSED STRUCTURES - SEE YARD PIPING PLANS FOR ADDITIONAL STRUCTURES NOT SHOWN.

ENGINEER/ARCHITECT

REV.	DESCRIPTION	DR. BY	CHKD. BY	APPD. BY	DATE

PROJECT NO. 24106

Hoyle, Tanner & Associates, Inc.
Five Commerce Park North Bedford, NH 03102 (603) 669-5555
HTA Companies

SCALE: 1" = 80'	DATE: MAY, 1988	DES. BY W.R.H.	DR. BY TED	CHKD. BY W.R.H.

DO NOT SCALE DRAWING

WASTEWATER TREATMENT FACILITY
EXETER, NEW HAMPSHIRE

GENERAL

GENERAL PLAN
BORING LOCATIONS

DRAWING NO.

G-2

SHEET 2 OF 59

Boring No. D-1 (EL. 24.0)

Depth	Strata	Blows
0'-0"	Silty Gravel Fill	27, 47
5'-0"	Silt & Broken Rock	44, 45, 40, 43
14'-0"	Fine Sand Silt & Trace of Fine Sand; W.T.	23, 38, 14, 16, 12, 15
23'-0"		
25'-0"	Clay	3, 4, 2
31'-0"	Soft Clay	0, 0, 0, 0, 0, 0
60'-0"	Silty Sand & Stones	51, 76, 128
64'-0"	Ref. on Bed Rock or Bldr.	

Boring No. D-2 (EL. 14.4)

Depth	Strata	Blows
0'-0"	Silty Gravel	
3'-0"	Silt & Stones	85, 168, 26
9'-0" W.T.	Silt & Small Stones	15, 13
14'-0"	Muck	12
16'-0"	Silt	18, 13
19'-0"	Fine Sand Silt	38, 18, 16, 21, 22
28'-0"	Soft Clay	1, 1, 0, 0, 0, 0
51'-0"	Silty Sand & Stones	54, 50, 43, 46, 41, 158
60'-0"	Ref. on Bed Rock	

Boring No. D-3 (EL. 13.5)

Depth	Strata	Blows
0'-0"	Silt, Sand & Stones	85, 159
7'-0"	W.T.	38, 59
13'-0"	Organic Silt	13, 19
18'-0"	Organic Silt Trace of Sand	20, 34, 19, 32, 16
29'-0"	Soft Clay	4, 1, 0, 0, 0, 0
43'-0"	Silty Sand & Stones	40, 86, 115
46'-0"	Ref. on Bed Rock or Bldr.	

Boring No. B-4 (EL. 24.5)

Depth	Strata	Blows
0'-0"	Silt & Small Stones	10, 16, 19
5'-0"	Silt	17, 18, 18, 14, 17
15'-0"	Ref. on Bed Rock or Bldr.	

Boring No. B-5 (EL. 15.0)

Depth	Strata	Blows
0'-0"	Silty Gravel	80, 52
5'-0"	Silt & Small Stones	18, 32
13'-0"	Muck	6, 12
15'-0"	Fine Sand & Silt; Silt	19, 30
19'-0"	W.T.	52, 20, 29
25'-0"	Bottom of Hole	

Boring No. B-6 (EL. 14.2)

Depth	Strata	Blows
0'-0"	Silty Gravel (Rock)	73, 92, 116, 45, 23, 47
10'-0"	Silty Small Stones	19, 19
13'-0"	Muck	10, 15
15'-0"	Fine Sand & Silt; W.T.	17, 28, 19, 31, 27, 25
25'-0"	Bottom of Hole	

Boring No. B-7 (EL. 14.2)

Depth	Strata	Blows
0'-0"	Silty Gravel	51, 66, 37, 58
8'-0"	Silty & Small Stones	27, 29, 14, 21
15'-0"	Muck	11
16'-0" W.T.	Silty Fine Sand	14, 16, 21, 23, 28, 31
25'-0"	Bottom of Hole	

Boring No. B-8 (EL. 14.0)

Depth	Strata	Blows
0'-0"	Silt, Sand & Stones; Water	31, 43, 37
8'-0"		62, 41, 33
15'-0"	Silty Fine Sand Trace of Organic	22, 27, 29, 23, 20, 25
25'-0"	Bottom of Hole	

Auger Probe PA-1 (EL. 11.8)

Depth	Strata
0'-0"	Water
2'-0"	Silt & Stones
4'-0"	Refusal

Auger Probe PA-2 (EL. 11.8)

Depth	Strata
0'-0"	Water
4'-0"	Silt
5'-0"	Refusal

Auger Probe PA-3 (EL. 11.8)

Depth	Strata
0'-0"	Water
4'-0"	Silt & Stones
7'-0"	Refusal

Auger Probe PA-4 (EL. 11.8)

Depth	Strata
0'-0"	Water
4'-0"	Silt & Stones
8'-0"	Refusal

Auger Probe PA-5 (EL. 11.8)

Depth	Strata
0'-0"	Water
4'-0"	Silt & Stones
6'-0"	Refusal

Auger Probe PB-1 (EL. 11.8)

Depth	Strata
0'-0"	Water & Muck
3'-0"	Refusal

Boring No. C-1 (EL. [illegible])

Depth	Strata	Blows
0'-0"	Fill Loam & Sand	1, 1, 3, 7
9'-0"	Silty Till; W.T.	28, 56
12'-0"		47, 218
15'-0"	Ref. on Bed Rock or Bldr.	

Boring No. C-2 (EL. [illegible])

Depth	Strata	Blows
0'-0"	Fill	
2'-0"	Silty Till; W.T.	29, 64
6'-0"		46, 56
9'-0"	Ref. on Bed Rock or Bldr.	

Boring No. C-3 (EL. [illegible])

Depth	Strata	Blows
0'-0"	Fill Can Tar Sand	10, 5, 3
8'-0"	Silty Till	31, 68
11'-0"	W.T.	45, 72
15'-0"	Ref. on Bed Rock	

Boring No. C-4 (EL. [illegible])

Depth	Strata	Blows
0'-0"	Fill	
2'-0"	Loam & Sand	5, 6, 3
7'-0"	Silty Till; W.T.	19, 33, 47
13'-0"		58, 86, 210
17'-0"	Ref. on Bed Rock or Bldr.	

Boring C-5 (EL. [illegible])

Depth	Strata	Blows
0'-0"	Fill	
2'-0"	Silty Till	14, 12, 31, 52, 71
10'-6"	Ref. on Bed Rock or Bldr.	

Auger Probe PB-2 (EL. 11.8)

Depth	Strata
3'-0"	Refusal

Auger Probe PB-3 (EL. 11.8)

Depth	Strata
0'-0"	Water
3'-0"	Silt & Stones
5'-0"	Refusal

Auger Probe PC-1 (EL. 11.8)

Depth	Strata
0'-0"	Water
2'-0"	Silt & Stones
4'-0"	Refusal

Auger Probe PC-2 (EL. 11.8)

Depth	Strata
0'-0"	Water
3'-0"	Silt & Stones
5'-0"	Refusal

Auger Probe PC-3 (EL. 11.8)

Depth	Strata
0'-0"	Water
4'-0"	Silt & Stones
6'-0"	Refusal

JONES & BEACH ENGINEERS, INC.
85 PORTSMOUTH AVENUE
STRATHAM, NEW HAMPSHIRE 03885

environmental engineers, inc.
affiliate of the WESTON group
concord, n.h.

Date	FEB. 1980
Scale	N.T.S.
Drawn By	
Checked By	

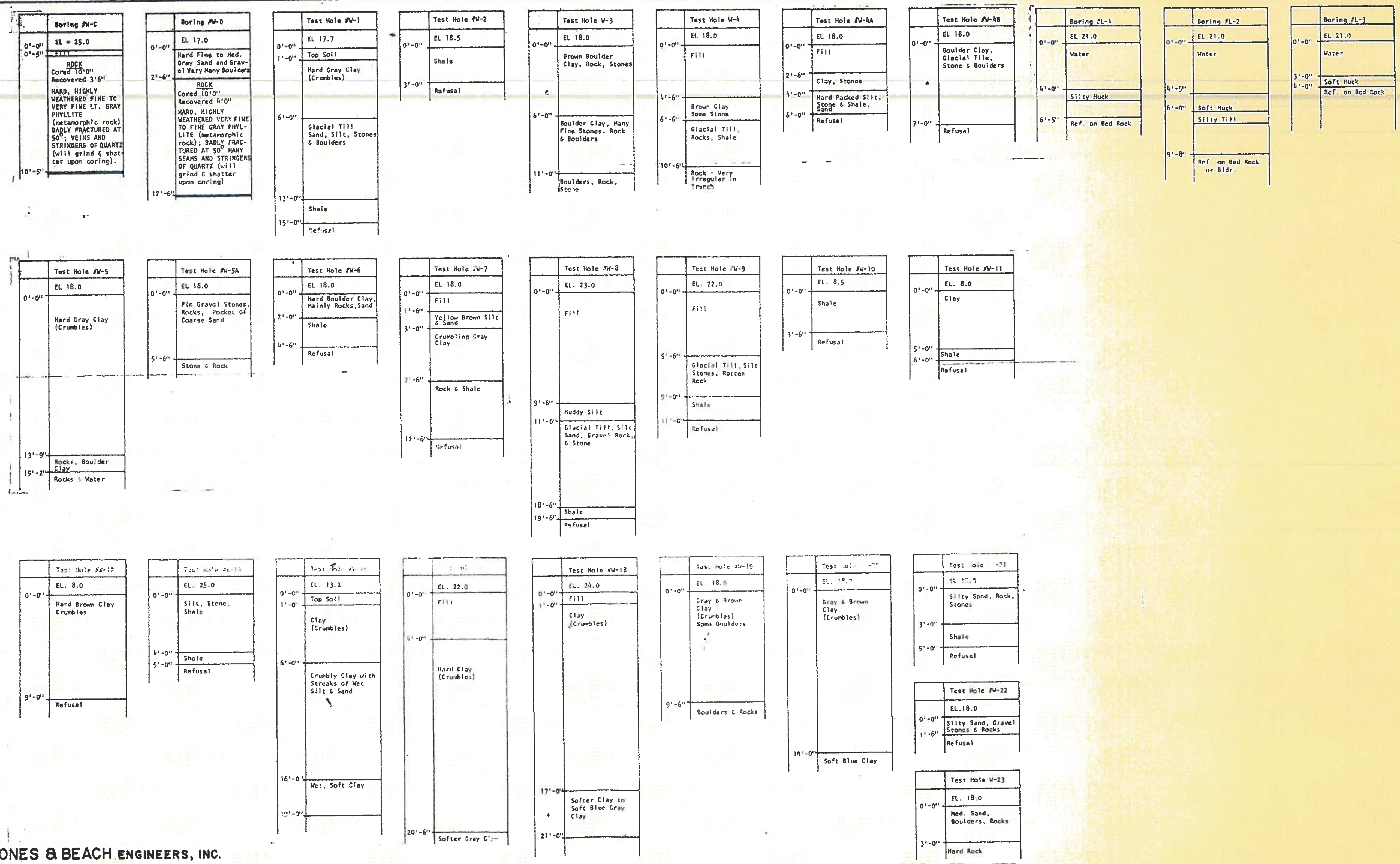
No. | Date | Revision

Project Title: WASTEWATER TREATMENT FACILITIES
TOWN OF EXETER
NEW HAMPSHIRE

Sheet Title: BORING LOGS

Sheet No. SP-17

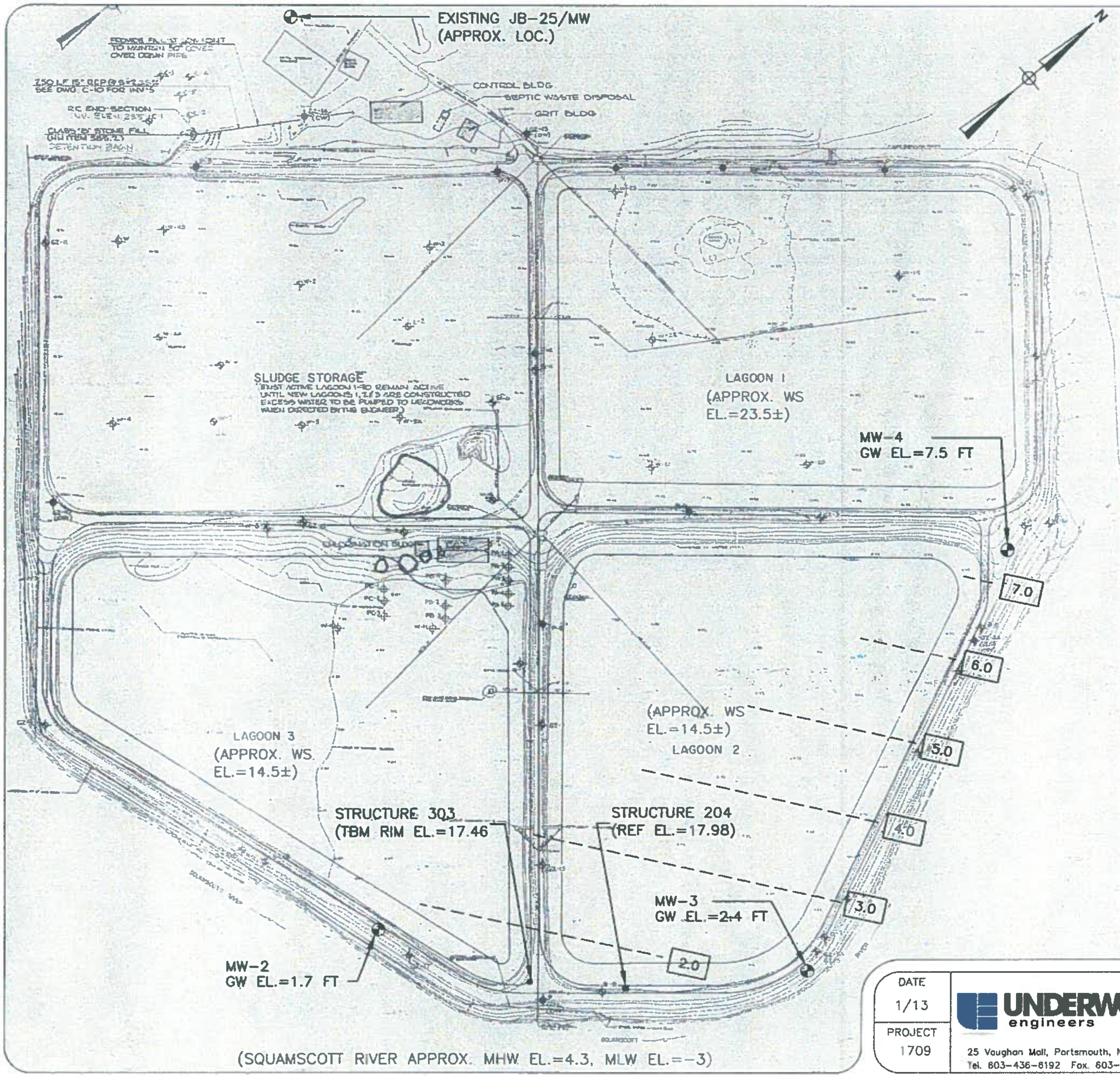
Project No. J&B-7710
EEI-1692



JONES & BEACH ENGINEERS, INC.
85 PORTSMOUTH AVENUE
STRATHAM, NEW HAMPSHIRE 03885

environmental engineers, inc.
affiliate of the WESTON group
concord, n.h.

Date FEB. 1980	No.	Date	Revision	Project Title: WASTEWATER TREATMENT FACILITIES — TOWN OF EXETER NEW HAMPSHIRE	Sheet Title: BORING LOGS
Scale N.T.S.					Sheet No. SP-18
Drawn By					Project No. JBB-7710 EEI-1692
Checked By					



LEGEND:

APPROXIMATE LOCATION OF MONITORING WELLS

7.0 — APPROXIMATE GROUNDWATER CONTOUR BASED ON 11/12/12 MONITORING WELL SAMPLING SEE TABLE 2.

NOTES:

1. BASE MAP FROM PLAN ENTITLED "GENERAL PLAN BORING LOCATIONS, WASTEWATER TREATMENT FACILITY, EXETER, NEW HAMPSHIRE, SHEET NO. G-2, AS-BUILT", PREPARED BY HOYLE, TANNER & ASSOCIATES, INC. DATED MAY 1988.
2. MONITORING WELLS MW-2, MW-3, AND MW-4 WERE INSTALLED BY EASTERN ANALYTICAL, INC. ON APRIL 19, 2012. THE LOCATION OF MONITORING WELLS WAS BASED ON SWING TIES PERFORMED BY UNDERWOOD ENGINEERS PERSONNEL.
3. MONITORING WELL REFERENCE POINT ELEVATIONS WERE BASED ON A LEVEL SURVEY PERFORMED BY UNDERWOOD ENGINEERS, INC. ON MAY 24, 2012. THE RIM OF STRUCTURE 303 WAS USED AS A REFERENCE FOR THE ELEVATION SURVEY (EL.=17.46 NGVD29) BASED ON THE PLAN ENTITLED "SITE PLAN, WWTP OUTFALL IMPROVEMENTS, RECORD DRAWINGS", PREPARED BY UNDERWOOD ENGINEERS, INC., DATED 2/12/02.
4. THE LOCATION OF MONITORING WELL JB-25/MW IS APPROXIMATE BASED ON "EXHIBIT A-4, GROUNDWATER CONTOUR PLAN, JUNE 2011" DATED SEPTEMBER 2011, BY TERRACON.
5. GROUNDWATER CONTOURS ARE APPROXIMATE AND BASED ON LIMITED MONITORING POINTS AND VARY BETWEEN MONITORING POINTS.

160 0 160 320

SCALE: 1 INCH = 160 FT.

DATE			FIG.
1/13	UNDERWOOD engineers	NOVEMBER 2012 GROUNDWATER CONTOURS 2012 ANNUAL GDP REPORT EXETER WWTF EXETER, NEW HAMPSHIRE	2
PROJECT 1709	25 Vaughan Mall, Portsmouth, N.H. 03801 Tel. 603-436-6192 Fax. 603-431-4733		

H:\Real Numbers\Exeter\1709 - WWTF GDP\1709 GW Contours.dwg, 1/25/2013 3:18:22 PM, RICOH MP C6000 COLOR MERGE.pc3

UNDERWOOD engineers

SOIL BORING and MONITORING WELL INSTALLATION LOG

BORING NO.:	MW-2
DOCUMENT NO.:	
SHEET	1 OF 1

BORING CO.:	Eastern Analytical	JOB	1709
ADDRESS:		PROJECT NAME:	Exeter WWTF Groundwater Discharge Permit
FOREMAN:		PROJECT ADDRESS:	Exeter WWTF, Newfields Road, Exeter, NH 03833
		CLIENT NAME:	Town of Exeter

LOCATION: *See Site Plan*

GROUNDWATER OBSERVATIONS				CASING	SAMPLER	CORE BARREL
Date	Depth	Time	TYPE	Auger	Geoprobe	
4/19/2012	15.5'	13:00	INSIDE DIAMETER	4"		
4/19/2012	15.2'	13:45	HAMMER WEIGHT	N/A		
4/19/2012	15.2'	15:00	HAMMER FALL	N/A		
4/19/2012	15.3'	16:00	NOTES:			

Casing Elevation (ft.)	20.21
PVC Elevation (ft.)	20.05
Surface Elevation (ft.)	17.93
Date Started	4/19/2012
Date Completed	4/19/2012

Depth	Sample Number	Sample Depths (feet)	Penetration/ Recovery (inches)		Blows per 6" penetration	Strata Changes	Soil Descriptions	Well As Built	Depth	Notes
	S1		60"	47"		Fill	**S1** (0-8") TOPSOIL **S1** (8"-47") SILTY SAND WITH GRAVEL Mostly fine to medium sand, reddish brown ~30% nonplastic fines ~15% subangular gravel to 1"			
5									5'	
	S2		60"	42"		Fill	**S2** (0"-37") SILTY SAND WITH GRAVEL - Similar to 8"-47" of S1 **S2** (37"-42") SILT WITH CLAY Mostly nonplastic gray silt Clay layers to 1" thick ~10% Fine to coarse sand, <5% angular gravel to 1", moist		7' 8'	
10										
	S3		60"	44"		Fill / Organic Peat	**S3** (0"-38") SILT WITH CLAY - Similar to 37"-42" of S2, lower 6" more clay **S3** (38"-44") ORGANIC PEAT AND SILT Roots, organics, and silt, brown			
15										
	S4		60"	59"		Silty Sand	**S4** (15"-59") SILTY SAND Mostly fine sand, ~15% nonplastic fines, more silt in upper 29" of sample			
20										
	S5		60"	59"		Silty Sand / Clay w/Silt	**S5** (0"-42") SILTY SAND - Similar to 15"-59" of S4 **S5** (42"-59") CLAY WITH SILT Mostly medium plastic clay, ~30% silt, <5% fine sand		23'	
25										
30										
35										
40										

1. Well reference point elevations based on level survey performed by UE on 5/24/12 referenced to NGVD 1929 Mean Sea Level (MSL)

2. Structure 303 manhole rim elevation (el. = 17.46') used as benchmark for level survey based on Underwood Engineers, Inc. *WWTP Outfall Improvements* record drawings dated 2/12/02

▼ Depth of Groundwater
Natural Fill.
Well screen.
Well sand.
Bentonite seal.

UNDERWOOD engineers

SOIL BORING and MONITORING WELL INSTALLATION LOG

BORING NO.:	MW-3
DOCUMENT NO.:	
SHEET	1 OF 1
LOCATION	See Site Plan

BORING CO.:	Eastern Analytical	JOB	1709
ADDRESS:		PROJECT NAME:	Exeter WWTF Groundwater Discharge Permit
FOREMAN:		PROJECT ADDRESS:	Exeter WWTF, Newfields Road, Exeter, NH 03833
		CLIENT NAME:	Town of Exeter

GROUNDWATER OBSERVATIONS

Date	Depth	Time
4/19/2012	13.6'	14:30
4/19/2012	13.4	15:00
4/19/2012	14.1	15:45

	CASING	SAMPLER	CORE BARREL
TYPE	Auger	Geoprobe	
INSIDE DIAMETER	4"		
HAMMER WEIGHT	N/A		
HAMMER FALL	N/A		
NOTES:			

Casing Elevation (ft.)	18.6
PVC Elevation (ft.)	18.34
Surface Elevation (ft.)	18.66
Date Started	4/19/2012
Date Completed	4/19/2012

Depth	Sample Number	Sample Depths (feet)	Penetration/Recovery (inches)	Blows per 6" penetration	Strata Changes	Soil Descriptions	Well As Built	Depth	Notes
	S1		60" / 46"		Fill	S1 (0-8") TOPSOIL S1 (8"-46") SILTY SAND WITH GRAVEL Mostly fine to medium sand, reddish brown ~30% nonplastic fines ~15% subangular gravel to 1"			
5	S2		60" / 43"		Fill	S2 SILTY SAND WITH GRAVEL - Similar to 8"-46" of S1			
10	S3		60" / 45"		Fill	S3 SILTY SAND WITH GRAVEL - Similar to 8"-46" of S1 clay in tip of sample		10' 12' 13'	
15	S4		60" / 48"		Silt w/Clay Fill Organic Peat Silt w/Sand	S4 (0"-23") SILT WITH CLAY Mostly nonplastic gray silt Clay layers to 1" thick ~10% Fine to coarse sand, ~10% angular gravel to 1", moist S4 (23"-30") ORGANIC PEAT AND SILT Roots, organics, and silt, brown S4 (30"-48") SILT WITH SAND AND ORGANICS Mostly brown non-plastic silt, ~30% fine sand, organic/plant matter throughout			
20	S5		60" / 59"		Silt w/Sand	S5 SILT WITH SAND AND ORGANICS - Similar to 30"-48" of S4			
25	S6		60" / 59"		Sand w/Silt Silt w/Sand	S6 (0"-18") SAND WITH SILT Mostly fine to medium sand, ~10% nonplastic fines S6 (18"-59") SILT WITH SAND AND ORGANICS Similar to 30"-48" of S4		28'	
30									
35									
40									

1. Well reference point elevations based on level survey performed by UE on 5/24/12 referenced to NGVD 1929 Mean Sea Level (MSL)

2. Structure 303 manhole rim elevation (el. = 17.46') used as benchmark for level survey based on Underwood Engineers, Inc. *WWTP Outfall Improvements* record drawings dated 2/12/02

Legend: ▼ Depth of Groundwater; Natural Fill.; Well screen.; Well sand.; Bentonite seal.

UNDERWOOD engineers

SOIL BORING and MONITORING WELL INSTALLATION LOG

BORING NO.:	MW-4
DOCUMENT NO.:	
SHEET	1 OF 1

BORING CO.:	Eastern Analytical	JOB	1709
ADDRESS:		PROJECT NAME:	Exeter WWTF Groundwater Discharge Permit
FOREMAN:		PROJECT ADDRESS:	Exeter WWTF, Newfields Road, Exeter, NH 03833
		CLIENT NAME:	Town of Exeter

LOCATION: ***See Site Plan***

GROUNDWATER OBSERVATIONS				CASING	SAMPLER	CORE BARREL
Date	Depth	Time	TYPE	Auger	Geoprobe	
4/19/2012	17.3	17:00	INSIDE DIAMETER	4"		
			HAMMER WEIGHT	N/A		
			HAMMER FALL	N/A		
			NOTES:			

Casing Elevation (ft.)	24.09
PVC Elevation (ft.)	23.8
Surface Elevation (ft.)	21.83
Date Started	4/19/2012
Date Completed	4/19/2012

Depth	Sample Number	Sample Depths (feet)	Penetration/ Recovery (inches)		Blows per 6" penetration	Strata Changes	Soil Descriptions	Well As Built	Depth	Notes
0–5	S1		60"	43"		Fill	S1 (0-8") TOPSOIL S1 (8"-43") SILTY SAND WITH GRAVEL Mostly fine to medium sand, reddish brown ~30% nonplastic fines ~20% angular gravel to >1.25"			
5–10	S2		60"	45"		Clayey Silt	S2 (0"-12") SILTY SAND WITH GRAVEL Similar to 8'-43" of S1 S2 (12"-45") CLAYEY SILT Mostly gray to brown silt, ~30-40% clay ~10% fine sand lenses		6' 8' 10'	
10–15	S3		60"	50"			~5% angular gravel to 1", mottled gray/brown S3 Clayey Silt - Similar to 12"-45" of S2			
15–20	S4		60"	60"			S4 CLAYEY SILT - Similar to 12'-45" of S2 Siltly sand layers (~20% silt) @ 6"-18" and 42"-50"			
20–25	S5		60"	60"			S5 CLAYEY SILT - Similar to S4 Siltly sand layer (~20% silt) @ 10"-18"		25'	
30										
35										
40										

1. Well reference point elevations based on level survey performed by UE on 5/24/12 referenced to NGVD 1929 Mean Sea Level (MSL)

2. Structure 303 manhole rim elevation (el. = 17.46') used as benchmark for level survey based on Underwood Engineers, Inc. *WWTP Outfall Improvements* record drawings dated 2/12/02

▼ Depth of Groundwater
Natural Fill. — Well sand.
Well screen. — Bentonite seal.

APPENDIX C

Recent Test Boring Logs and Core Boring Reports

WWTF Test Borings
(HA15-1 through HA15-11)

Proposed Access Road
(HA15-1 through HA15-3)

HALEY ALDRICH

TEST BORING REPORT

Boring No. HA15-1

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire	File No.	42149-000
Client	Wright-Pierce	Sheet No.	1 of 2
Contractor	New England Boring Contractors	Start	25 June 2015
		Finish	25 June 2015
		Driller	B. Cross
		H&A Rep.	K. Russ/M. Snow
		Elevation	23.0 (Est.)
		Datum	NGVD 29
		Location	See Plan

	Casing	Sampler	Barrel
Type	HW	S	--
Inside Diameter (in.)	4.0	1.375	--
Hammer Weight (lb)	300	140	-
Hammer Fall (in.)	24	30	-

Drilling Equipment and Procedures

Rig Make & Model: Mobile B-53 Bombardier
Bit Type: Roller Bit
Drill Mud: None
Casing: HW Drive to 10'
Hoist/Hammer: Winch Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	13 20 18 14	S1 12	0.0 2.0	NO WELL INSTALLED		SW-SM	Dense dark brown to brown well graded SAND with silt and gravel (SW-SM), mps 2.0 in., no odor, dry	5	10	10	40	25	10				
	9 10 11 8	S2 10	2.0 4.0			SM	Medium dense silty SAND (SM), mps 0.5 in., no odor, dry		10	15	40	20	15				
							-FILL-										
					3.8												
	5 2 4 7	S3 5	4.0 6.0			ML	Medium stiff gray-brown sandy SILT (ML), mps 0.5 in., no odor, moist		5	15	10	10	60				
5						ML	Medium stiff gray-brown sandy SILT with gravel (ML), mps 1.5 in., no odor, wet	20	5	5	10	10	50				
							-FILL-										
					6.0												
	7 4 2 2	S4 0	6.0 8.0				No Recovery Note: Water encountered at approximately 6.0 ft.										
	7 2 2 2	S5 2	8.0 10.0			SP	Very loose gray-brown silty SAND (SP), mps 1.0 in., slight organic odor, wet, contains 1.0 in. brick piece			5	30	40	25				
10	7 4 5 3	S6 5	10.0 12.0			SM	Loose gray-brown silty SAND with gravel (SM), mps 1.0 in., slight organic odor, wet	5	10	5	25	30	25				
							-FILL-										
	18 120/3"	S7 8	12.0 12.7			SM	Very dense dark gray silty SAND with gravel (SM), mps 0.75 in., no odor, wet, contains 4.0 in. wood piece, plastic pieces	5	10	5	25	30	25				
					12.7		Note: Coal, brick and plastic pieces in wash water. Advanced roller bit into obstruction (possible cobble/boulder) to a depth of 14.0 ft; did not break through. -POSSIBLE COBBLE/BOULDER-										
					14.0		BOTTOM OF EXPLORATION 14.0 FT REFUSAL AT 14.0 FT										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
6/25/15	10:30	0	10.0	14.0	6.0

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	14.0
Rock Cored (ft)	0.0
Samples	7S

Boring No. HA15-1

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. HA15-1
File No. 42149-000
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	**VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION** (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand				Field Test			
								% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
				NO WELL INSTALLED			Note: 1. No significantly elevated PID readings detected during drilling and sampling operations.										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. HA15-1

TEST BORING REPORT

Boring No. HA15-2

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire	File No.	42149-000
Client	Wright-Pierce	Sheet No.	1 of 1
Contractor	New England Boring Contractors	Start	24 June 2015
		Finish	24 June 2015
		Driller	B. Cross
		H&A Rep.	K. Russ/M. Snow
		Elevation	22.5 (Est.)
		Datum	NGVD 29
		Location	See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HW	S	--	Rig Make & Model: Mobile B-53 Bombardier
Inside Diameter (in.)	4.0	1.375	--	Bit Type: Roller Bit; Drill Mud: None
Hammer Weight (lb)	300	140	-	Casing: HSA Spun to 10'
Hammer Fall (in.)	24	30	-	Hoist/Hammer: Winch Safety Hammer; PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	2 40 31 11	S1 S1A 18	0.0 2.0		NO WELL INSTALLED		SP	Very dense brown poorly graded SAND with gravel (SP), mps 1.5 in., no odor, dry -FILL-	20	10	10	30	25	5				
						1.0	ML	Very stiff dark gray SILT with sand (ML), mps 0.25 in., no odor, moist -FILL-			10	10	10	70				
	15 12 15 17	S2 8	2.0 4.0															
	10 10 10 12	S3 13	4.0 6.0					Note: Water encountered at approximately 5.0 ft.										
5						5.0	ML	Very stiff dark gray-brown sandy SILT with organics (ML), mps 0.25 in., slight organic odor, wet		10	10	10	15	55				
	8 8 5 8	S4 0	6.0 8.0					S4: No Recovery -SHALLOW MARINE DEPOSIT-										
	6 8 10 16	S5 10	8.0 10.0				ML	Very stiff gray-brown SILT with sand (ML), mps 0.25 in., no odor, moist to wet			5	5	10	80				
10	10 14 35 48	S6 16	10.0 12.0			10.0	ML	Hard olive-brown-gray SILT (ML), trace gray fine sand and organics, mps 1.5 in., contains rock fragment in spoon tip, no odor, wet -MARINE DEPOSIT-					5	95				
						12.0		-GLACIAL TILL-										
15	26 28 36 50	S7 11	15.0 17.0				SM	Very dense brown silty SAND with gravel (SM), mps 1.5 in., no odor, wet	15	10	15	15	30	15				
						17.0		BOTTOM OF EXPLORATION 17.0 FT - NO REFUSAL										

Note:
1. No significantly elevated PID readings detected during drilling and sampling operations.

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
6/25/15	12:45	0.25	10.0	17.0	4.0

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	17.0
Rock Cored (ft)	0.0
Samples	7S

Boring No. HA15-2

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. HA15-3

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors

File No.	42149-000
Sheet No.	1 of 2
Start	25 June 2015
Finish	25 June 2015
Driller	B. Cross
H&A Rep.	K. Russ/M. Snow
Elevation	25.5 (Est.)
Datum	NGVD 29
Location	See Plan

	Casing	Sampler	Barrel
Type	HW	S	--
Inside Diameter (in.)	4.0	1.375	--
Hammer Weight (lb)	300	140	-
Hammer Fall (in.)	24	30	-

Drilling Equipment and Procedures

Rig Make & Model: Mobile B-53 Bombardier
Bit Type: Roller Bit
Drill Mud: None
Casing: HW Drive to 10'
Hoist/Hammer: Winch Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	3 7 10 9	S1 15	0.0 2.0		NO WELL INSTALLED		ML	Medium dense dark brown SILT with organics (ML), mps 0.25 in., no odor, dry -TOPSOIL-					10	90				
						0.4	SW	Medium dense brown well graded SAND with gravel (SW), mps 1.5 in., no odor, dry -FILL-	5	25	10	25	30	5				
	5 7 9 31	S2 15	2.0 4.0			2.0	ML	Very stiff olive-brown SILT with sand (ML), mps 0.75 in., no odor, moist -MARINE DEPOSIT-		5	5	5	5	80				
5	14 10 27 41	S3 11	4.0 6.0			3.9	SM	Dense brown silty SAND with gravel (SM), mps 1.0 in., no odor, wet, moderately bonded -GLACIAL TILL-	20	10	15	20	20	15				
	43 7 4 11	S4 9	6.0 8.0															
						7.0	ML	Stiff dark gray sandy SILT with gravel (ML), mps 1.0 in., no odor, wet, well bonded		20	10	5	5	60				
	11 12 14 15	S5 8	8.0 10.0				ML	Very stiff gray to dark gray SILT with gravel (ML), mps 1.0 in., no odor, wet	10	5	5			80				
10	81 17 29 46	S6 10	10.0 12.0				ML	Hard gray to olive-brown SILT (ML), mps 4.0 in., no odor, wet, layer of silty sand with gravel from approximately 10.8 to 12.0 ft. -GLACIAL TILL (Basal)- Note: Advanced roller bit through cobble from 12.0 to 13.5 ft. From 13.5 to 14.0 ft drill action and wash water indicate gravel.	5	5	5	5		80				
	76 60/3"	S7 8	14.0 14.7				SM	Very dense gray-brown silty SAND with gravel (SM), mps 1.5 in., no odor, wet Note: Refusal on probable bedrock at 14.7 ft.	20	10	10	10	30	20				
15						14.7		-TOP OF PROBABLE BEDROCK 14.7 FT- BOTTOM OF EXPLORATION 14.7 FT REFUSAL AT 14.7 FT										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
6/25/15	?	?	10.0	14.7	3.8

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	14.7
Rock Cored (ft)	0.0
Samples	7S

Boring No. HA15-3

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. HA15-3
File No. 42149-000
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
					NO WELL INSTALLED			Note: 1. No significantly elevated PID readings detected during drilling and sampling operations.										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. HA15-3

WWTF Upgrades and Proposed Structures
(HA15-4 through HA15-9)

TEST BORING REPORT

Boring No. HA15-4

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire	File No.	42149-000
Client	Wright-Pierce	Sheet No.	1 of 2
Contractor	New England Boring Contractors	Start	06 July 2015
		Finish	06 July 2015
		Driller	B. Cross
		H&A Rep.	K. Russ
		Elevation	24.5 (Est.)
		Datum	NGVD 29
		Location	See Plan

	Casing	Sampler	Barrel
Type	HW	S	NQ
Inside Diameter (in.)	4.0	1.375	2.0
Hammer Weight (lb)	300	140	-
Hammer Fall (in.)	24	30	-

Drilling Equipment and Procedures
Rig Make & Model: Mobile B-53
Bit Type: Roller Bit
Drill Mud: None
Casing: HW Drive to 8.8'
Hoist/Hammer: Winch Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	2 3 3 4	S1 S1A 4	0.0 2.0				ML	Loose brown sandy SILT with gravel (ML), mps 1.0 in., no odor, dry, trace roots	10	15	5		20	50				
								-TOPSOIL-										
						1.8	ML	Medium stiff SILT (ML), mps 4.75 mm, no odor, dry			5	5		90				
	60 21 7 3	S2 10	2.0 4.0				ML	Medium stiff SILT (ML), mps 4.75 mm, no odor, wet										
								-FILL (Reworked Native)-										
						3.7	ML	Very stiff gray SILT (ML), mps 0.75 in., septic-like odor, wet	10	10				80				
5	3 2 1 1	S3 12	4.0 6.0				ML	Soft gray SILT (ML), mps 1.25 in., septic-like odor, wet	5	5				90				
	1 3 2 100	S4 S4A 10	6.0 8.0					-FILL (Sludge)-										
						7.7	GM	Loose olive-gray silty GRAVEL with sand (SM), mps 2.0 in., slight septic-like odor, wet	30	20	5	5	15	25				
	90 100/3"	S5	8.0 8.8					-GLACIAL TILL-										
						8.8	SP-SM	Very dense olive-gray poorly graded SAND with silt and gravel (SP-SM), mps 2.0 in., slight septic-like odor, wet	10	30	35	10	5	10				
								-TOP OF BEDROCK 8.8 FT-										
10								SEE CORE BORING REPORT FOR ROCK DETAILS										

Note:
1. No significantly elevated PID readings detected during drilling and sampling operations.

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
7/6/15	12:00	1	15.0	15.0	3.37

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	8.8
Rock Cored (ft)	5.0
Samples	5S, 2C

Boring No. HA15-4

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

CORE BORING REPORT

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weathering	Well Diagram	Elev./Depth (ft)	Visual Description and Remarks
									SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
									Note: Advanced roller bit through bedrock from 8.8 to 10.0 ft. Begin NQ rock core at 10.0 ft.
10	6 5 7 6	C1	10.0 14.0	48 0	100 0	Slight to Fresh		10.0	Moderately hard, slightly weathered to fresh, light gray fine-grained PHYLLITE with calcite stringers. Joints dipping at high angles, extremely close to very close, planar to undulating, open. Slightly weathered joint surfaces at 13.4 and 13.7 ft.
	6	C2	14.0 15.0	12 0	100 0	Slight to Fresh			Moderately hard, slightly weathered to fresh, light gray fine-grained PHYLLITE with calcite stringers. Joints dipping at high angles, extremely close to very close, planar to undulating, open. Slightly weathered joint surface at 14.5 ft.
15								15.0	BOTTOM OF EXPLORATION 15.0 FT
									Note: Installed observation well in completed borehole. See Groundwater Observation Well Installation Report HA15-4(OW) for details.
20									
25									
30									

TEST BORING REPORT

Boring No. HA15-5

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors

File No.	42149-000
Sheet No.	1 of 3
Start	30 June 2015
Finish	01 July 2015
Driller	B. Cross
H&A Rep.	M. Snow
Elevation	27.5 (Est.)
Datum	NGVD 29
Location	See Plan

	Casing	Sampler	Barrel
Type	HW	S	NQ
Inside Diameter (in.)	4.0	1.375	2.0
Hammer Weight (lb)	300	140	-
Hammer Fall (in.)	24	30	-

Drilling Equipment and Procedures

Rig Make & Model: Mobile B-53 Bombardier
Bit Type: Roller Bit
Drill Mud: None
Casing: HW Drive to 19'
Hoist/Hammer: Winch Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	2 9 13 24	S1 S1A 18	0.0 2.0		NO WELL INSTALLED	0.5	ML	Medium dense dark brown SILT with organics (ML) -TOPSOIL-					10	90				
							SM	Medium dense brown silty SAND with gravel (SM), mps 1.25 in., no odor, dry to moist	-	15	5	14	30	36				
	32 36 39 24	S2 12	2.0 4.0				SM	Very dense brown silty SAND with gravel (SM), mps 1.0 in., no odor, moist -FILL-	-	27	6	11	31	25				
5	9 6 13 16	S3 12	4.0 6.0			4.0	ML	Very stiff gray-brown sandy SILT with gravel (ML), mps 1.5 in., no odor, moist -FILL-	10	5	5	5	25	50				
						5.5	ML	Very stiff brown SILT with organics (ML), mps 1.5 in., no odor, moist -FILL (Sludge)-	5	5			10	80				
	19 17 20 23	S4 16	6.0 8.0			6.0	SP-SM	Dense brown poorly graded SAND with silt and gravel (SP-SM), mps 1.25 in., no odor, wet, well bonded	15	5	10	10	50	10				
	34 40 40 33	S5 9	8.0 10.0				SW-SM	Very dense well graded SAND with silt and gravel (SW-SM), mps 1.5 in., no odor, wet	15	10	25	15	25	10				
10								-GLACIAL TILL-										
15	70 30/3"	S6 3	14.0 14.7				SM	Very dense brown silty SAND with gravel (SM), mps 2.0 in., no odor, wet	15	10	10		45	20				
						18.5		Note: Drill action indicates top of weathered bedrock at 18.5 ft. -WEATHERED BEDROCK-										
20						19.0		Note: Drill action indicates top of bedrock at 19.0 ft. -TOP OF BEDROCK 19.0 FT- SEE CORE BORING REPORT FOR ROCK DETAILS										

Water level symbol shown at approximately 4.0 ft.

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
6/30/15	?	5	14.0	17.0	4.0

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	20.0
Rock Cored (ft)	5.0
Samples	6S, 1C

Boring No. HA15-5

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
					NO WELL INSTALLED			Note: 1. No significantly elevated PID readings detected during drilling and sampling operations.										
25																		

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

CORE BORING REPORT

Boring No. HA15-5
File No. 42149-000

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weathering	Elev./ Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
								Note: Advanced roller bit through bedrock from 19.0 to 20.0 ft. Begin NQ rock core at 20.0 ft.
20	3 5 5 5 5	C1	20.0 25.0	60 10	100 17	Fresh to Slight		Moderately hard, fresh to slightly weathered, gray aphanitic PHYLLITE. Joints dipping at moderate to high angles, secondary near vertical joints, extremely close to close, planar, smooth to rough, tight to open. Quartz veins (1.0 to 3.0 in. diameter) at approximately 21.5 ft and 24.5 ft, frequent calcite stringers, slight oxidation on some joint surfaces.
25							25.0	BOTTOM OF EXPLORATION 25.0 FT
30								
35								
40								

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA15-6

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors

File No.	42149-000
Sheet No.	1 of 3
Start	24 June 2015
Finish	26 June 2015
Driller	B. Cross
H&A Rep.	M. Snow
Elevation	23.5 (Est.)
Datum	NGVD 29
Location	See Plan

	Casing	Sampler	Barrel
Type	HW	S	NQ
Inside Diameter (in.)	4.0	1.375	2.0
Hammer Weight (lb)	300	140	-
Hammer Fall (in.)	24	30	-

Drilling Equipment and Procedures

Rig Make & Model: Mobile B-53 Bombardier
Bit Type: Roller Bit
Drill Mud: None
Casing: HW Drive to 36'
Hoist/Hammer: Winch Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	8 22 26 23	S1 10	0.0 2.0		NO WELL INSTALLED		ML	Dense dark brown to brown SILT with organics (ML) -TOPSOIL-					10	90				
						0.3	SW-SM	Dense brown well graded SAND with silt and gravel (SW-SM), mps 1.0 in., no odor, dry -FILL-	10	10	10	25	35	10				
	24 26 31 61	S2 1	2.0 4.0					Note: S2 recovered 1 in. rock piece - sampler pushed on gravel.										
5	77 54 26 19	S3 4	4.0 6.0			4.0	GP-GM	Very dense dark gray poorly graded GRAVEL with silt and sand (GP-GM), mps 1.0 in., no odor, wet, moderately bonded	5	45	20	10	10	10				
	11 15 9 9	S4 12	6.0 8.0				SM	Medium dense gray-brown silty SAND with gravel (SM), mps 1.0 in., no odor, wet, well bonded	15	10	15	10	25	25				
	12 14 19 9	S5 14	8.0 10.0				SM	Dense gray-brown silty SAND with gravel (SM), mps 1.0 in., no odor, wet, well bonded -FILL (Reworked Glacial Till)-	15	10	15	10	25	25				
10	2 3 11 12	S6 16	10.0 12.0				SM	Medium dense gray-brown silty SAND with gravel (SM), mps 1.0 in., no odor, wet, well bonded	15	10	15	10	25	25				
						11.8	SM	Medium dense dark brown silty SAND with organics (SM), roots, mps 0.42 mm, organic odor, wet, stratified -SHALLOW MARINE DEPOSIT-					85	15				
15	11 15 19 20	S7 16	14.0 16.0			14.0	ML	Hard olive-brown SILT with gravel (ML), mps 1.25 in., no odor, wet -MARINE DEPOSIT-	10	5	5			80				
20	8 10	S8 20	19.0 21.0				ML	Very stiff olive-brown SILT (ML), mps 0.075 mm, no odor, wet						100				

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	35.5
Rock Cored (ft)	5.0
Samples	11S, 1C

Boring No. HA15-6

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA15-6
File No. 42149-000
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	12 15							-MARINE DEPOSIT-										
						23.5	GW-GM	Very dense brown-gray well graded GRAVEL with silt and sand (GW-GM), mps 1.5 in., no odor, wet	30	20	15	5	20	10				
25	33 53 45 40	S9 10	24.0 26.0															
								-GLACIAL TILL-										
30	39 39 48 75/3"	S10 13	29.0 30.7		NO WELL INSTALLED		GW-GM	Very dense brown-gray well graded GRAVEL with silt and sand (GW-GM), mps 1.5 in., no odor, wet	25	25	15	5	20	10				
	125	S11 5	34.0 34.5				SM	Very dense gray-brown silty SAND with gravel (SM), mps 1.25 in., no odor, wet, contains weathered rock pieces	25	10	10	10	30	15				
35						34.5		Note: Weathered rock chips in wash water from 34.5 to 35.5 ft.										
						35.5		-WEATHERED BEDROCK-										
								Note: Drill action indicates top of bedrock at 35.5 ft.										
								-TOP OF BEDROCK 35.5 FT-										
								SEE CORE BORING REPORT FOR ROCK DETAILS										
								Note: 1. No significantly elevated PID readings detected during drilling and sampling operations.										
40																		

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. HA15-6

CORE BORING REPORT

HALEY ALDRICH

Boring No. HA15-6
File No. 42149-000

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weathering	Elev./ Depth (ft)	Visual Description and Remarks
								SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
	3	C1	36.0 41.0	60 58	100 97	Fresh		Note: Advanced roller bit through bedrock from 35.5 to 36.0 ft. Begin NQ rock core at 36.0 ft. Moderately hard, gray, fine-grained to aphanitic PHYLLITE. Joints wide, dipping at moderate angles, planar, smooth, right to open. Frequent calcite stringers.
	3							
	3							
	4							
40	4							
							41.0	BOTTOM OF EXPLORATION 41.0 FT
45								
50								
55								

TEST BORING REPORT

Boring No. HA15-7

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire	File No.	42149-000
Client	Wright-Pierce	Sheet No.	1 of 3
Contractor	New England Boring Contractors	Start	26 June 2015
		Finish	29 June 2015
		Driller	B. Cross
		H&A Rep.	M. Snow
		Elevation	24.5 (Est.)
		Datum	NGVD 29
		Location	See Plan

	Casing	Sampler	Barrel
Type	HW	S	NQ
Inside Diameter (in.)	4.0	1.375	2.0
Hammer Weight (lb)	300	140	-
Hammer Fall (in.)	24	30	-

Drilling Equipment and Procedures

Rig Make & Model: Mobile B-53 Bombardier
Bit Type: Roller Bit
Drill Mud: None
Casing: HW Drive to 25.5'
Hoist/Hammer: Winch Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0	11 15 16 18	S1 11	0.0 2.0				SW	Dense brown well graded SAND with gravel (SW), mps 1.5 in., no odor, dry	20	10	25	20	20	5				
	26 14 11 27	S2 12	2.0 4.0				ML	Very stiff dark gray-brown SILT with sand and gravel (ML), mps 1.0 in., no odor, dry to moist, bonded -FILL-	5	15	5	10	15	50				
5	18 18 17 32	S3 10	4.0 6.0				SM	Dense gray-brown silty SAND with gravel (SM), mps 1.0 in., no odor, wet Note: Water encountered at approximately 5.0 ft.	10	10	5	10	35	30				
	17 12 13 16	S4 11	6.0 8.0			6.0	ML	Very stiff dark gray-brown SILT with sand and gravel (ML), mps 0.75 in., no odor, wet (appears water worked) -FILL-	5	10	10	10	5	60				
	20 28 13 8	S5 12	8.0 10.0				ML	Hard dark gray-brown sandy SILT with gravel (ML), mps 1.25 in., no odor, wet	10	5	10	10	10	55				
10	5 3 2 2	S6 10	10.0 12.0			10.0	CL/ML	Medium stiff dark gray-brown lean CLAY to SILT (CL/ML), trace fine gravel, mps 0.25 in., no odor, wet		5				95				
	3 5 6 6	S7 16	12.0 14.0				CL/ML	Stiff dark gray-brown lean CLAY to SILT (CL/ML), trace fine gravel, mps 0.25 in., no odor, wet -FILL-		5				95				
						14.5	ML	Hard dark brown SILT with organics (ML), roots, mps 0.075 mm, organic odor, wet -SHALLOW MARINE DEPOSIT-						100				
15	4 8 23 29	S8 S8A 18	15.0 17.0															
						16.5	SM	Dense dark brown silty SAND with gravel (SM), mps 1.5 in., no odor, wet	20	5	10	15	25	25				
	14 130 125	S9 14	17.0 18.5				GM	Very dense dark gray-brown silty GRAVEL with sand (GM), mps 1.5 in., no odor, wet -GLACIAL TILL-	35	20	5	5	10	25				
	19 17	S10 8	19.0 21.0				GM	Very dense dark gray-brown silty GRAVEL with sand (GM), mps 1.5 in., no odor, wet	25	25	10	5	10	25				
20																		

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	25.5
Rock Cored (ft)	5.0
Samples	11S, 1C

Boring No. HA15-7

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	25 33							-GLACIAL TILL-										
						23.5		Note: Drill action indicates top of bedrock at 23.0 ft. Advance roller bit to 24.0 ft.										
	105/1"	S11 0	24.0 24.1			24.1		S11: No Recovery										
25								-TOP OF BEDROCK 23.5 FT-										
								SEE CORE BORING REPORT FOR ROCK DETAILS										
30																		

HALEY ALDRICH

CORE BORING REPORT

Boring No. **HA15-7**
File No. 42149-000
Sheet No. 3 of 3

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weathering	Well Diagram	Elev./ Depth (ft)	Visual Description and Remarks
									SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
									Note: Advanced roller bit through bedrock from 24.1 to 25.5 ft. Begin NQ rock core at 25.5 ft.
25	2 5 7 8 9	C1	25.5 30.5	60 25	100 42	Fresh to Moderate			Moderately hard, fresh to moderately weathered, gray aphanitic to fine-grained PHYLLITE. Joints extremely close to close, dipping at low to moderate angles, planar to undulating, smooth to rough, tight to open.
30								30.5	BOTTOM OF EXPLORATION 30.5 FT
									Note: 1. Installed observation well in completed borehole. See Groundwater Observation Well Installation Report HA15-7(OW) for details. 2. No significantly elevated PID readings detected during drilling and sampling operations.
35									
40									
45									

TEST BORING REPORT

Boring No. HA15-8

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors

File No.	42149-000
Sheet No.	1 of 2
Start	30 June 2015
Finish	30 June 2015
Driller	B. Cross
H&A Rep.	M. Snow
Elevation	28.5 (Est.)
Datum	NGVD 29
Location	See Plan

	Casing	Sampler	Barrel
Type	HW	S	--
Inside Diameter (in.)	4.0	1.375	--
Hammer Weight (lb)	300	140	-
Hammer Fall (in.)	24	30	-

Drilling Equipment and Procedures

Rig Make & Model: Mobile B-53 Bombardier
Bit Type: Roller Bit
Drill Mud: None
Casing: HW Drive to 19'
Hoist/Hammer: Winch Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	4 4 1 1	S1 2	0.0 2.0		NO WELL INSTALLED		SP	Loose brown poorly graded SAND (SP), mps 0.25 in., no odor, dry		5	20	30	40	5				
						1.0		-FILL-										
	2 2 6 8	S2 1	2.0 4.0				ML	Medium stiff dark brown SILT (ML), mps 0.42 mm, no odor, moist					5	95				
5	11 2 2 2	S3 1	4.0 6.0				GW-GM	Loose gray GRAVEL with silt and sand (GW-GM), mps 1.25 in., no odor, wet. Note: S3 recovery appears to be wash sample.	20	30	25	10	5	10				
	3 3 3 4	S4 16	6.0 8.0				ML	Medium stiff dark brown SILT with gravel (ML), mps 1.5 in., no odor, moist -FILL (Sludge)-	5	5		5	5	80				
10	1 2 2 2	S5 S5A 20	9.0 11.0				ML	Medium stiff dark brown SILT with gravel (ML), mps 1.5 in., no odor, wet	5	5		5	5	80				
						10.5	ML	Soft black SILT with organics and rootlets (ML), mps 0.075 mm, strong organic odor, wet						100				
	WOH 15 39 45	S6 S6A 18	11.0 13.0					-FILL (Sludge)-										
						12.0	GM	Very dense gray-brown silty GRAVEL with sand (GM), mps 1.75 in., no odor, wet, well bonded	25	24	15	13	9	14				
15	23 37 40 29	S7 16	14.0 16.0				GM	Very dense gray silty GRAVEL with sand (GM), mps 1.5 in., no odor, wet, moderately bonded	29	24	14	13	8	12				
								-GLACIAL TILL-										
20	12 19	S8 6	19.0 21.0				GM	Dense brown-gray silty GRAVEL with sand (GM), mps 1.0 in., no odor, wet, moderately bonded	30	20	10	10	10	20				

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
6/30/15	13:30	0	-	24.0	6.6

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	23.0
Rock Cored (ft)	0.0
Samples	8S

Boring No. HA15-8

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA15-8
File No. 42149-000
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	12 22				NO WELL INSTALLED			-GLACIAL TILL-										
						23.0		Note: Drill action indicates top of probable bedrock at 23.0 ft. Note: Advanced roller bit into probable bedrock from 23.0 to 24.0 ft. -TOP OF PROBABLE BEDROCK 23.0 FT-										
						24.0		-PROBABLE BEDROCK- BOTTOM OF EXPLORATION 24.0 FT Note: 1. No significantly elevated PID readings detected during drilling and sampling operations.										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. HA15-8

TEST BORING REPORT

Boring No. HA15-9

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors

File No.	42149-000
Sheet No.	1 of 2
Start	29 June 2015
Finish	29 June 2015
Driller	B. Cross
H&A Rep.	M. Snow
Elevation	28.5 (Est.)
Datum	NGVD 29
Location	See Plan

	Casing	Sampler	Barrel
Type	HW	S	NQ
Inside Diameter (in.)	4.0	1.375	2.0
Hammer Weight (lb)	300	140	-
Hammer Fall (in.)	24	30	-

Drilling Equipment and Procedures

Rig Make & Model: Mobile B-53 Bombardier
Bit Type: Roller Bit
Drill Mud: None
Casing: HW Drive to 9'
Hoist/Hammer: Winch Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	29 30 38 29	S1 14	0.0 2.0				GW-GM	Very dense gray well graded GRAVEL with silt and sand (GW-GM), mps 1.75 in., no odor, dry -GRAVEL FILL-	11	38	15	16	10	10				
	45 100/3"	S2 4	2.0 2.7				GW	Very dense gray well graded GRAVEL with sand (GW), mps 1.5 in., no odor, dry Note: Obstruction encountered at 2.7 ft. Moved 3.0 ft west; advanced roller bit through cobbles to a depth of 4.0 ft and resumed sampling.	40	25	10	10	10	5				
5	17 10 10 18	S3 4	4.0 6.0			4.0	GM	Medium dense dark gray silty GRAVEL with sand (GM), mps 1.5 in., no odor, wet -FILL-	25	16	12	14	9	24				
	7 10 13 37	S4 14	6.0 8.0			6.2	ML	Dark brown SILT with sand (ML), mps 0.25 in., no odor, wet -FILL- Note: Drill action indicates top of bedrock at 8.5 ft. -TOP OF BEDROCK 8.5 FT-			5	5	5	85				
						8.5		SEE CORE BORING REPORT FOR ROCK DETAILS										
10																		

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	8.5
Rock Cored (ft)	5.0
Samples	4S, 1C

Boring No. HA15-9

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

CORE BORING REPORT

Boring No. HA15-9
File No. 42149-000
Sheet No. 2 of 2

Depth (ft)	Drilling Rate (min./ft)	Run No.	Run Depth (ft)	Recovery/RQD in.	Recovery/RQD %	Weathering	Well Diagram	Elev./Depth (ft)	Visual Description and Remarks
									SEE TEST BORING REPORT FOR OVERBURDEN DETAILS
									Note: Advanced roller bit through bedrock from 8.5 to 9.0 ft. Begin NQ rock core at 9.0 ft.
	2	C1	9.0 14.0	60 46	100 77	Fresh to Slight			Moderately hard, fresh to slightly weathered, gray aphanitic PHYLLITE. Joints dipping at low to moderate angles, very close to close, planar to undulating, smooth to rough, two secondary high angle joints. Slight oxidation on some joint surfaces, frequent calcite stringers, occasional 0.5 in. wide veins.
10	2								
	5								
	5								
	5							14.0	BOTTOM OF EXPLORATION 14.0 FT
15									Note: 1. Installed observation well in completed borehole. See Groundwater Observation Well Installation Report HA15-9(OW) for details. 2. No significantly elevated PID readings detected during drilling and sampling operations.
20									
25									
30									

H+A_CORE+WELL07-1 (20 FT SCALE) HA-LIB09.GLB HA-TB+CORE+WELL-07-1.GDT G:\PROJECTS\42149 - EXETER WWTF\000\FIELD\GINT DATABASE\42149-000_TB_MW.GPJ Aug 21, 15

Existing Lagoon Embankment
(HA15-10 and HA15-11)

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA15-10

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors

File No.	42149-000
Sheet No.	1 of 2
Start	01 July 2015
Finish	01 July 2015
Driller	B. Cross
H&A Rep.	M. Snow
Elevation	28.0 (Est.)
Datum	NGVD 29
Location	See Plan

	Casing	Sampler	Barrel
Type	HW	S	--
Inside Diameter (in.)	4.0	1.375	--
Hammer Weight (lb)	300	140	-
Hammer Fall (in.)	24	30	-

Drilling Equipment and Procedures

Rig Make & Model: Mobile B-53 Bombardier
Bit Type: Roller Bit
Drill Mud: None
Casing: HW Drive to 24'
Hoist/Hammer: Winch Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	1 5 7 22	S1 12	0.0 2.0	NO WELL INSTALLED		SP-SM	Medium dense brown poorly graded SAND with silt (SP-SM), mps 1.0 in., no odor, moist	5		10	20	55	10				
5	18 26 26 23	S2 12	4.0 6.0			SM	Very dense brown-gray silty SAND with gravel (SM), mps 1.0 in., no odor, wet	5	10	15	20	30	20				
							-FILL-										
10	71 20 63 56	S3 14	9.0 11.0			SM	Very dense brown-gray silty SAND with gravel (SM), mps 1.0 in., no odor, wet	5	20	10	20	20	25				
					13.0	ML/CL	Hard brown-gray SILT to lean CLAY (ML/CL), mps 0.42 mm, no odor, wet					10	90				
							-FILL-										
15	8 13 22 24	S4 S4A 17	14.0 16.0		15.2	ML	Hard brown-gray mottled SILT (ML), trace organics, mps 0.075 mm, no odor, wet						100				
							-MARINE DEPOSIT-										
20	7 11	S5 20	19.0 21.0			ML/CL	Very stiff brown SILT to lean CLAY (ML/CL), mps 0.075 mm, no odor, wet						100				

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	32.0
Rock Cored (ft)	0.0
Samples	7S

Boring No. HA15-10

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. HA15-10
File No. 42149-000
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
20	14 20			NO WELL INSTALLED													
							-MARINE DEPOSIT-										
25	3 5 5 6	S6 24	24.0 26.0			CL	Medium stiff brown lean CLAY (CL), mps 0.075 mm, no odor, wet						100	S	L	H	H
							Note: Drill action indicates strata change at 27.5 ft.										
					27.5	GW	Very dense gray well graded GRAVEL (GW), mps 1.25 in., no odor, wet	40	55				5				
							-GLACIAL TILL-										
	66 100/0"	S7 4	29.0 29.5				-TOP OF PROBABLE BEDROCK 29.5 FT-										
30					29.5		Note: Advanced roller bit into probable bedrock from 29.5 to 32.0 ft.										
							-PROBABLE BEDROCK-										
					32.0		BOTTOM OF EXPLORATION 32.0 FT										
							Note: 1. No significantly elevated PID readings detected during drilling and sampling operations.										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. HA15-11

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire	File No.	42149-000
Client	Wright-Pierce	Sheet No.	1 of 4
Contractor	New England Boring Contractors	Start	01 July 2015
		Finish	02 July 2015
		Driller	B. Cross
		H&A Rep.	K. Russ/M. Snow

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HW	S	--	Rig Make & Model: Mobile B-53 Bombardier
Inside Diameter (in.)	4.0	1.375	--	Bit Type: Roller Bit Drill Mud: None
Hammer Weight (lb)	300	140	-	Casing: HW Drive to 23'
Hammer Fall (in.)	24	30	-	Hoist/Hammer: Winch Safety Hammer PID Make & Model: MiniRAE 2000

Elevation	27.5 (Est.)
Datum	NGVD 29
Location	See Plan

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0	7 14 18 17	S1 14	0.0 2.0			SM	Dense brown silty SAND (SM), mps 1.0 in., no odor, wet	3	9	6	13	26	43				
							-FILL-										
	12 16 15 11	S2 S2A 14	4.0 6.0			SM	Dense brown silty SAND (SM), mps 1.5 in., no odor, wet	3	9	6	13	26	43				
5					5.8	CL	Hard dark gray lean CLAY with sand and gravel (CL), mps 1.0 in., no odor, wet		15	5	5	5	70				
							-FILL-										
	6 8 6 8	S3 0	9.0 11.0		9.0		S3: No Recovery										
10																	
	2 4 3 15	S4 15	11.0 13.0			CL	Medium stiff brown-gray sandy CLAY with gravel (CL), mps 1.0 in., no odor, wet		15	10	10	10	55				
	15 10 51	S5 16	14.0 16.0			CL	Hard brown-gray lean CLAY (CL), mps 4.75 mm, no odor, wet			5			95				
15																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	70.1
Rock Cored (ft)	0.0
Samples	13S, 2U

Boring No. HA15-11

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA15-11
File No. 42149-000
Sheet No. 2 of 4

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
15	41																
							-FILL-										
	9 7 5 6	S6 18	19.0 21.0		19.0	SM	Medium dense brown-gray silty SAND (SM), mps 0.25 in., no odor, wet			10	5	70	15				
20																	
							-FILL-										
					23.0		Note: Drill action indicates strata change at 23.0 ft.										
	6 8 8 8	S7 24	24.0 26.0			CL	Stiff brown lean CLAY (CL), with frequent 0.25 to 0.5 in. silty fine sand seams					10	90	S	L	H	H
25																	
							-MARINE DEPOSIT-										
	WOR WOH WOH WOH	S8 24	29.0 31.0			CL	Very soft gray-brown lean CLAY (CL), mps 0.075 mm, no odor, wet						100				
30																	
		U1 27	34.0 36.0			CL	Note: Gray lean CLAY (CL) observed in top and bottom of tube sample.										
35																	
							FV1 (36.5-37.0 ft): 150/28 in. lbs; Su=580/107 psf										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
							FV2 (37.5-38.0 ft): 150/30 in. lbs; Su=580/115 psf										
40							-MARINE DEPOSIT-										
45	WOR WOR WOR WOR	S9 24	44.0 46.0			CL	Soft to medium stiff gray lean CLAY with black organics (CL), mps 0.075 mm, no odor, wet FV3 (44.5-45.0 ft): 114/23 in. lbs; Su=441/89 psf FV4 (45.5-46.0 ft): 173/21 in. lbs; Su=672/83 psf						100				
50		U2 24	49.0 51.0			CL	Note: Gray lean CLAY (CL) observed in top and bottom of tube sample.										
							FV5 (51.5-52.0 ft): 117/80 in. lbs; Su=450/310 psf FV6 (52.5-53.0 ft): 138/25 in. lbs; Su=540/95 psf										
55							-MARINE DEPOSIT-										
	WOR WOR WOM WOM	S10 24	57.0 59.0			CL	Medium stiff gray lean CLAY (CL), mps 0.075 mm, no odor, wet FV7 (57.5-58.0 ft): 170/35 in. lbs; Su=660/135 psf FV8 (58.5-59.0 ft): 190/47 in. lbs; Su=735/180 psf						100				

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA15-11
File No. 42149-000
Sheet No. 4 of 4

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
60							Note: Drill action indicates probable gravel at 63.0 ft.										
	18 4 6 7	S11 24	63.0 65.0		63.0	CL	Stiff gray lean CLAY (CL), mps 0.5 in., no odor, wet, gravel fragments intermittently throughout sample		5				95				
65							-MARINE DEPOSIT-										
							Note: Drill action indicates strata change at 67.5 ft.										
	15 41 51 100/5"	S12 22	68.0 69.9		67.5	GM	Very dense gray silty GRAVEL with sand (GM), mps 1.5 in., no odor, wet -GLACIAL TILL- Note: Recovered wash sample (glacial till/gravel). Refusal on probable bedrock at 70.1 ft. -TOP OF PROBABLE BEDROCK 70.1 FT-	20	35	15	10	5	15				
70	100/1"	S13 1	70.0 70.1		70.1		BOTTOM OF EXPLORATION 70.1 FT REFUSAL AT 70.1 FT										

Note:
1. Installed observation well in completed borehole. See Groundwater Observation Well Installation Report HA15-11(OW) for details.
2. WOR = Weight of Rods; WOH = Weight of Hammer; WOM = Weight of Man.
3. FV1 (36.5-37.0 ft) indicates in-situ vane shear test performed at depth interval indicated with corrected peak/residual undrained shear strengths shown.
4. No significantly elevated PID readings detected during drilling and sampling operations.

Proposed Force and Water Mains
(HA15-12 through HA15-26)

TEST BORING REPORT

Boring No. HA15-12

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors

File No.	42149-000
Sheet No.	1 of 1
Start	24 June 2015
Finish	24 June 2015
Driller	B. Cross
H&A Rep.	K. Russ/M. Snow
Elevation	26.6 (Est.)
Datum	NGVD 29
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	2.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures

Rig Make & Model: Diedrich D50
Bit Type: Cutting Head
Drill Mud: None
Casing: HSA Spun to 9.8'
Hoist/Hammer: Cat-Head Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0					NO WELL INSTALLED			-BITUMINOUS CONCRETE-										
	14 13 8 8	S1 S1A 14	0.8 2.8			0.8	SW	Medium dense brown well graded SAND with gravel (SW), mps 1.0 in., slight asphalt-like odor, dry -FILL-	15	10	15	20	35	5				
						2.3	ML	Very stiff brown SILT (ML), mps 0.075 mm, no odor, dry -FILL (Reworked Native)-						100				
	4 8 11 13	S2 20	3.0 5.0															
						4.0	ML	Very stiff olive-brown SILT (ML), mps 0.42 mm, no odor, dry, single fine sand lens 10 in. from bottom of sample					5	95				
5	6 13 16 17	S3 22	5.0 7.0					-MARINE DEPOSIT-										
	5 100/4"	S4 18	7.0 7.8				ML	Very stiff olive-brown SILT, mps 0.25 in., no odor, dry, weathered silt zone at bottom 2.0 in. of sample Note: Augered through probable cobble/boulder from 7.8 to 9.0 ft.					5	95				
	7 47 100/1"	S5 S5A 13	9.0 10.1			9.0	SM	Very dense light brown silty SAND (SM), mps 0.42 mm, no odor, wet, one silt layer -MARINE DEPOSIT-					70	30				
10						9.8 10.1	SP-SM	Very dense brown poorly graded SAND with silt (SP-SM), mps 4.75 mm, no odor, wet, weathered material -GLACIAL TILL-			10	40	40	10				

BOTTOM OF EXPLORATION 10.1 FT
REFUSAL AT 10.1 FT

Note:
1. No significantly elevated PID readings detected during drilling and sampling operations.

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	10.1
Rock Cored (ft)	0.0
Samples	5S

Boring No. HA15-12

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. HA15-13

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire	File No.	42149-000
Client	Wright-Pierce	Sheet No.	1 of 1
Contractor	New England Boring Contractors	Start	24 June 2015
		Finish	24 June 2015
		Driller	B. Cross
		H&A Rep.	K. Russ/M. Snow

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	--	Rig Make & Model: Diedrich D50
Inside Diameter (in.)	2.25	1.375	--	Bit Type: Cutting Head; Drill Mud: None
Hammer Weight (lb)	--	140	-	Casing: HSA Spun to 8'; Hoist/Hammer: Cat-Head Safety Hammer
Hammer Fall (in.)	--	30	-	PID Make & Model: MiniRAE 2000

Elevation 23.7 (Est.)
Datum NGVD 29
Location See Plan

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0					NO WELL INSTALLED			-BITUMINOUS CONCRETE-										
	20 24 20	S1 13	0.5 2.0			0.5	SW	Dense brown well graded SAND with gravel (SW), mps 1.0 in., no odor, dry -FILL-	15	10	10	25	35	5				
	5 10 7 10	S2	2.0 4.0			1.8	ML	Very stiff light brown SILT (ML), mps 0.075 mm, no odor, dry -FILL-					5	95				
		S2A 17				2.0	SM	Medium dense olive-gray silty SAND (SM), mps 0.5 in., no odor, dry to moist -FILL-		5	5	30	25	35				
						3.2	ML	Very stiff light brown SILT (ML), mps 0.075 mm, no odor, dry -FILL-					5	95				
	6 14 16 20	S3	4.0 6.0			4.0	ML	Very stiff olive-brown SILT with sand (ML), mps 0.25 in., no odor, dry -FILL (Reworked Native)-				10	40	50				
5		S3A 21				4.7	ML	Very stiff olive-brown SILT (ML), mps 0.075 mm, no odor, dry						100				
	6 10 16 19	S4 24	6.0 8.0				ML	Very stiff olive-brown SILT (ML), mps 0.075 mm, no odor, wet Note: Water observed at approximately 6.0 ft.						100				
	6 9 11 15	S5 21	8.0 10.0				ML	Very stiff olive-brown SILT (ML), trace clay, silt grading to clay with depth, mps 0.075 mm, no odor, wet -MARINE DEPOSIT-						100				
10						10.0		BOTTOM OF EXPLORATION 10.0 FT - NO REFUSAL										
								Note: 1. No significantly elevated PID readings detected during drilling and sampling operations.										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	10.0
Rock Cored (ft)	0.0
Samples	5S

Boring No. HA15-13

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-07-1 PID (NO WELL) HA-LIB09.GLB HA-TB+CORE+WELL-07-1.GDT G:\PROJECTS\42149 - EXETER WWTF\000\FIELD\GINT DATABASE\42149-000_TB_MW.GPJ Aug 21, 15

HALEY ALDRICH — TEST BORING REPORT

Boring No. HA15-14

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire	File No.	42149-000
Client	Wright-Pierce	Sheet No.	1 of 1
Contractor	New England Boring Contractors	Start	23 June 2015
		Finish	23 June 2015
		Driller	B. Cross
		H&A Rep.	K. Russ
		Elevation	21.9 (Est.)
		Datum	NGVD 29
		Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	2.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures

Rig Make & Model: Diedrich D50
Bit Type: Cutting Head
Drill Mud: None
Casing: HSA Spun to 8'
Hoist/Hammer: Cat-Head Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0					NO WELL INSTALLED			-BITUMINOUS CONCRETE-										
	25 27 29	S1 12	0.5 2.0			0.5	GW	Very dense brown well graded GRAVEL with sand (GW), mps 1.375 in., slight petroleum-like odor, dry -FILL-	25	20	10	20	20	5				
	7 12 4 4	S2 18	2.0 4.0			2.5	ML	Very stiff olive-brown SILT with sand (ML), mps 2.0 mm, no odor, wet -FILL (Reworked Native)-				5	20	75				
	4 7 10 14	S3 22	4.0 6.0				ML	Very stiff olive-brown SILT with sand (ML), mps 0.42 mm, no odor, dry					15	85				
5						5.0	ML	Very stiff olive-brown SILT (ML), trace sand, mps 0.12.0 in., no odor, dry, trace organics					5	95				
	5 11 15 19	S4 24	6.0 8.0				ML	Very stiff olive-brown SILT (ML), mps 0.075 mm, no odor, dry, trace organics -MARINE DEPOSIT-						100				
	5 7 14 18	S5 24	8.0 10.0				ML	Very stiff olive-brown SILT (ML), mps 0.075 mm, no odor, dry, trace organics						100				
10						10.0		BOTTOM OF EXPLORATION 10.0 FT - NO REFUSAL Note: 1. No significantly elevated PID readings detected during drilling and sampling operations.										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	10.0
Rock Cored (ft)	0.0
Samples	5S

Boring No. HA15-14

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA15-15

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors

File No.	42149-000
Sheet No.	1 of 1
Start	23 June 2015
Finish	23 June 2015
Driller	B. Cross
H&A Rep.	K. Russ
Elevation	20.9 (Est.)
Datum	NGVD 29
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	2.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures

- Rig Make & Model: Diedrich D50
- Bit Type: Cutting Head
- Drill Mud: None
- Casing: HSA Spun to 8'
- Hoist/Hammer: Cat-Head Safety Hammer
- PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0					NO WELL INSTALLED			-BITUMINOUS CONCRETE-										
	17 26 17	S1 13	0.5 2.0			0.5	SP-SM	Dense brown poorly graded SAND with silt and gravel (SP-SM), mps 1.5 in., no odor, dry -FILL-	10	10	10	20	40	10				
	6 6 4 6	S2 S2A 22	2.0 4.0			2.0	SP-SM	Loose olive-gray poorly graded SAND with silt (SP-SM), mps 2.0 mm, no odor, dry -FILL-				15	75	10				
						3.3	ML	Stiff olive-brown SILT (ML), mps 0.42 mm, no odor, dry					5	95				
	5 7 13 19	S3 24	4.0 6.0				ML	Very stiff olive-brown SILT (ML), mps 0.42 mm, no odor, dry -FILL (Reworked Native)-										
5						5.0	ML	Very stiff olive-brown SILT (ML), mps 0.075 mm, no odor, dry						100				
	6 11 14 16	S4 24	6.0 8.0				ML	Very stiff olive-brown SILT (ML), mps 0.075 mm, no odor, wet, trace organics (roots) -MARINE DEPOSIT- Note: Water encountered at approximately 7.5 ft.						100				
	5 9 10 13	S5 24	8.0 10.0				ML	Very stiff olive-brown SILT (ML), mps 0.075 mm, no odor, wet, trace organics (roots)						100				
10						10.0		BOTTOM OF EXPLORATION 10.0 FT - NO REFUSAL Note: 1. No significantly elevated PID readings detected during drilling and sampling operations.										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID

- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	10.0
Rock Cored (ft)	0.0
Samples	5S

Boring No. HA15-15

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-07-1 PID (NO WELL) HA-LIB09.GLB HA-TB+CORE+WELL-07-1.GDT G:\PROJECTS\42149 - EXETER WWTF\000\FIELD\GINT DATABASE\42149-000_TB_MW.GPJ Aug 21, 15

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA15-16

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors

File No.	42149-000
Sheet No.	1 of 1
Start	24 June 2015
Finish	24 June 2015
Driller	B. Cross
H&A Rep.	K. Russ
Elevation	19.0 (Est.)
Datum	NGVD 29
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	2.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures

Rig Make & Model: Diedrich D50
Bit Type: Cutting Head
Drill Mud: None
Casing: HSA Spun to 8'
Hoist/Hammer: Cat-Head Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0					NO WELL INSTALLED			-BITUMINOUS CONCRETE-										
	19 13 13	S1 12	0.6 2.0			0.6	SW-SM	Medium dense brown well graded SAND with silt and gravel (SW-SM), mps 1.25 in., no odor, dry	20	10	10	15	35	10				
	13 22 25 32	S2 16	2.0 4.0				ML	Dense brown sandy SILT with gravel (ML), mps 1.12.0 in., no odor, dry -FILL-	15	5	5	10	25	40				
	25 100/5"	S3 3	4.0 4.9			4.0	GM	Very dense brown silty GRAVEL (GM), mps 1.25 in., no odor, dry Note: Cobble encountered at 4.9 ft; augered through to approximately 6.0 ft. -FILL-	75	5			5	15				
5																		
	20 42 100/4"	S4 14	6.0 7.3			6.0	SM	Very dense brown silty SAND with gravel (SM), mps 1.0 in., no odor, moist -FILL (Reworked Native)- Note: Encountered water at approximately 8.0 ft.	15	15	10	15	30	15				
	25 40 26 23	S5 18	8.0 10.0			8.0	SW-SM	Very dense brown well graded SAND with silt and gravel (SW-SM), mps 1.0 in., no odor, wet, moderately to well bonded -GLACIAL TILL-	10	20	10	15	35	10				
10						10.0		BOTTOM OF EXPLORATION 10.0 FT - NO REFUSAL Note: 1. No significantly elevated PID readings detected during drilling and sampling operations.										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	10.0
Rock Cored (ft)	0.0
Samples	5S

Boring No. HA15-16

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. HA15-17

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors

File No.	42149-000
Sheet No.	1 of 1
Start	22 June 2015
Finish	22 June 2015
Driller	B. Cross
H&A Rep.	K. Russ
Elevation	12.6 (Est.)
Datum	NGVD 29
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	2.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures

Rig Make & Model: Diedrich D50
Bit Type: Cutting Head
Drill Mud: None
Casing: HSA Spun to 9.5'
Hoist/Hammer: Cat-Head Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0					NO WELL INSTALLED			-BITUMINOUS CONCRETE-										
	14 18 15	S1 13	0.6 2.0			0.6	SM	Dense brown silty SAND with gravel (SM), mps 1.5 in., no odor, dry -FILL-	3	21	12	26	25	13				
	5 5 6 8	S2 22	2.0 4.0			2.0	ML	Stiff gray SILT (ML), mps 0.25 in., no odor, dry, trace brick, occasional 0.25 to 0.5 in. sand pockets -FILL (Reworked Native)-			5	5		90				
	4 8 9 11	S3 24	4.0 6.0			3.7	ML	Very stiff olive-brown SILT (ML), mps 0.075 mm, no odor, dry -MARINE DEPOSIT-						100				
5	4 6 7 20	S4 S4A 23	6.0 8.0				ML	Stiff olive-brown SILT (ML), mps 0.075 mm, no odor, dry, trace organics						100				
	20 19 13 21	S5 S5A 15	8.0 10.0			7.5 7.8	SP-SM	Medium dense yellow-brown poorly graded SAND with silt and gravel (SP-SM), mps 1.25 in., no odor, moist, bottom 2.0 in. contains weathered rock (Probable decomposed cobble/boulder) -GLACIAL TILL-	5	10	5	20	50	10				
								-WEATHERED ROCK- (Probable decomposed cobble/boulder)										
10						9.5 10.0	SM	Dense light brown silty SAND with gravel (SM), mps 1.25 in., no odor, moist -GLACIAL TILL-	15	10	10	5	40	20				

BOTTOM OF EXPLORATION 10.0 FT - NO REFUSAL

Note:
1. No significantly elevated PID readings detected during drilling and sampling operations.

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	10.0
Rock Cored (ft)	0.0
Samples	5S

Boring No. HA15-17

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. HA15-18

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors

File No.	42149-000
Sheet No.	1 of 1
Start	22 June 2015
Finish	22 June 2015
Driller	B. Cross
H&A Rep.	K. Russ
Elevation	13.4 (Est.)
Datum	NGVD 29
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	2.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures

- Rig Make & Model: Diedrich D50
- Bit Type: Cutting Head
- Drill Mud: None
- Casing: HSA Spun to 8'
- Hoist/Hammer: Cat-Head Safety Hammer
- PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0				1.0	NO WELL INSTALLED			-BITUMINOUS CONCRETE-										
	12 19 21	S1 14	0.6 2.0			0.6	SW	Dense brown well graded SAND with gravel (SW), mps 1.25 in., asphalt-like odor, dry -FILL-	25	15	10	20	25	5				
	8 5 7 8	S2 S2A 13	2.0 4.0	13.7			SP-SM	Loose brown poorly graded SAND with silt and gravel (SP-SM), mps 1.0 in., diesel-like odor, wet	5	15	10	20	40	10				
						3.5	ML	Stiff olive-gray SILT (ML), mps 0.075 mm, no odor, wet						100				
5	2 5 7 7	S3 24	4.0 6.0				ML	Stiff olive-brown SILT (ML), trace clay, mps 0.075 mm, no odor, moist						100				
	3 7 7 8	S4 23	6.0 8.0				ML	Stiff olive-brown SILT (ML), trace clay, mps 0.075 mm, no odor, moist, one brown fine sand lens at approximately 6.4 ft -MARINE DEPOSIT-						100				
	2 5 6 6	S5 24	8.0 10.0				ML	Stiff olive-brown SILT (ML), trace clay, mps 0.075 mm, no odor, moist, increasing clay content with depth, trace organics, roots						100				
10						10.0		BOTTOM OF EXPLORATION 10.0 FT - NO REFUSAL										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID

- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	10.0
Rock Cored (ft)	0.0
Samples	5S

Boring No. HA15-18

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA15-19

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors

File No.	42149-000
Sheet No.	1 of 1
Start	22 June 2015
Finish	22 June 2015
Driller	B. Cross
H&A Rep.	K. Russ
Elevation	9.5 (Est.)
Datum	NGVD 29
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	2.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures

- Rig Make & Model: Diedrich D50
- Bit Type: Cutting Head
- Drill Mud: None
- Casing: HSA Spun to 9'
- Hoist/Hammer: Cat-Head Safety Hammer
- PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0				3.4	NO WELL INSTALLED			-BITUMINOUS CONCRETE-										
	10 13 11 8	S1 14	0.7 2.7			0.7	SW	Medium dense dark brown to yellow-brown well graded SAND with fine gravel (SW), mps 0.5 in., asphalt-like odor, dry		15	15	25	40	5				
				25.2				-FILL-										
						2.5	ML	Very stiff olive-brown SILT (ML), mps 0.75 in., no odor, dry		5			5	90				
	4 6 8 11	S2 20	3.0 5.0				ML	Stiff olive-brown SILT (ML), mps 0.075 mm, no odor, dry		5			5	90				
								-FILL (Reworked Native)-										
						4.5	ML	Stiff brown SILT (ML), mps 0.42 mm, no odor, dry					5	95				
5	5 9 11 12	S3 24	5.0 7.0				ML	Very stiff olive-brown SILT (ML), mps 0.25 in., no odor, dry, trace organics, roots						100				
	5 9 10 14	S4 24	7.0 9.0				ML	Very stiff olive SILT (ML), mps 0.42 mm, no odor, dry, trace organics, roots					5	95				
								-MARINE DEPOSIT-										
10	5 7 10 11	S5 24	9.0 11.0				ML	Very stiff olive SILT (ML), mps 0.075 mm, no odor, dry, trace organics, roots						100				
						11.0		BOTTOM OF EXPLORATION 11.0 FT - NO REFUSAL										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID

- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	11.0
Rock Cored (ft)	0.0
Samples	5S

Boring No. HA15-19

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. HA15-20

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors

File No.	42149-000
Sheet No.	1 of 1
Start	24 June 2015
Finish	24 June 2015
Driller	B. Cross
H&A Rep.	K. Russ
Elevation	7.8 (Est.)
Datum	NGVD 29
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	2.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures

Rig Make & Model: Diedrich D50
Bit Type: Cutting Head
Drill Mud: None
Casing: HSA Spun to 8'
Hoist/Hammer: Cat-Head Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	2 3 5 5	S1 S1A 20	0.0 2.0		NO WELL INSTALLED		ML	Medium stiff dark brown SILT with organics (ML), mps 0.42 mm, organic odor, wet, roots from 0 to 0.6 ft -TOPSOIL-					5	95				
						1.4	ML	Medium stiff dark brown SILT (ML), mps 1.0 in., organic odor, dry, contains trace brick fragments, contains 1.0 in. diameter coal piece				5		95				
	4 7 8 15	S2 S2A 17	2.0 4.0				ML	Stiff olive-brown SILT (ML), mps 2.0 mm, no odor, dry -FILL (Reworked Native)-				5		95				
						3.3	ML	Stiff olive-brown SILT (ML), mps 1.0 in. as gravel, no odor, dry -MARINE DEPOSIT-						100				
5	18 64 45 27	S3 15	4.0 6.0			4.0	GW-GM	Very dense yellow-brown well graded GRAVEL with silt and sand (GW-GM), mps 1.0 in., no odor, dry, well bonded, color change to light brown from 5.4 to 6.0 ft -GLACIAL TILL-	25	25	15	10	15	10				
	11 15 37 32	S4 12	6.0 8.0				GW-GM	Very dense light brown well graded GRAVEL with silt and sand (GW-GM), mps 1.0 in., no odor, wet, well bonded Note: Water observed at approximately 6.0 ft.	25	25	15	10	15	10				
						7.2	GM	Very dense olive-gray silty GRAVEL with sand (GM), mps 1.0 in., no odor, wet, weakly to moderately bonded	30	20	5	5	10	30				
	13 23 18 16	S5 13	8.0 10.0				GM	Dense gray to rust-brown silty GRAVEL with sand (GM), mps 1.25 in., no odor, moist, moderately to well bonded -GLACIAL TILL-	15	30	15	15	10	15				
10						10.0		BOTTOM OF EXPLORATION 10.0 FT - NO REFUSAL Note: 1. No significantly elevated PID readings detected during drilling and sampling operations.										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	10.0
Rock Cored (ft)	0.0
Samples	5S

Boring No. HA15-20

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA15-21

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors

File No.	42149-000
Sheet No.	1 of 1
Start	24 June 2015
Finish	24 June 2015
Driller	B. Cross
H&A Rep.	K. Russ
Elevation	7.9 (Est.)
Datum	NGVD 29
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	2.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures

Rig Make & Model: Diedrich D50
Bit Type: Cutting Head
Drill Mud: None
Casing: HSA Spun to 8'
Hoist/Hammer: Cat-Head Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0	1 4 4 5	S1 S1A 19	0.0 2.0		NO WELL INSTALLED		ML	Medium stiff dark brown SILT with organics (ML), roots from 0 to 0.3 ft, wood chunk at 0.2 ft -TOPSOIL-						100				
						0.5	ML	Medium stiff light brown SILT (ML), mps 0.42 mm, no odor, dry					5	95				
	5 6 7 7	S2 19	2.0 4.0				ML	Stiff light brown SILT (ML), mps 0.075 mm, no odor, dry -FILL (Reworked Native)-						100				
						3.0	ML	Stiff light brown SILT (ML), mps 0.075 mm, no odor, dry, trace organics at 3.9 ft						100				
	5 4 3 3	S3 S3A 24	4.0 6.0				ML	Stiff light brown SILT (ML), mps 0.075 mm, no odor, wet, one fine sand lens -MARINE DEPOSIT-						100				
5						5.1	CL	Medium stiff gray-brown lean CLAY (CL), mps 0.075 mm, no odor, wet						100				
	4 3 3 8	S4 24	6.0 8.0				CL	Medium stiff gray-brown lean CLAY (CL), mps 0.075 mm, no odor, wet -MARINE DEPOSIT-						100				
	9 9 8 9	S5 8	8.0 10.0				CL	Medium stiff gray-brown lean CLAY (CL), mps 0.075 mm, no odor, wet						100				
						9.5	SM	Medium dense olive-gray silty SAND with gravel (SM), mps 1.5 in., no odor, wet, moderately to well bonded -GLACIAL TILL-	15	10	10	15	25	25				
10						10.0		BOTTOM OF EXPLORATION 10.0 FT - NO REFUSAL										

Note:
1. No significantly elevated PID readings detected during drilling and sampling operations.

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	10.0
Rock Cored (ft)	0.0
Samples	5S

Boring No. HA15-21

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA15-22

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire	File No.	42149-000
Client	Wright-Pierce	Sheet No.	1 of 1
Contractor	New England Boring Contractors	Start	24 June 2015
		Finish	24 June 2015
		Driller	B. Cross
		H&A Rep.	K. Russ
		Elevation	7.8 (Est.)
		Datum	NGVD 29
		Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	2.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures

Rig Make & Model: Diedrich D50
Bit Type: Cutting Head
Drill Mud: None
Casing: HSA Spun to 8'
Hoist/Hammer: Cat-Head Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	1 5 7 10	S1 S1A 22	0.0 2.0		NO WELL INSTALLED	0.4	ML	Stiff dark brown SILT with organics (ML), roots to 0.4 ft -TOPSOIL-					5	95				
							SM	Medium dense brown silty SAND with gravel (SM), mps 1.25 in., no odor, moist -FILL-	10	17	6	22	21	24				
	3 5 6 5	S2 S2A 16	2.0 4.0			1.7	ML	Stiff olive-gray SILT (ML), mps 2.0 mm, no odor, moist, silt content increasing with depth -FILL-					10	90				
						3.1	SM	Loose dark brown to gray-brown (with depth) silty SAND (SM), mps 0.42 mm, organic odor, wet -SHALLOW MARINE DEPOSIT-					85	15				
5	3 3 3 5	S3 S3A 19	4.0 6.0			4.0	ML	Medium stiff olive-gray SILT (ML), mps 0.25 in., no odor, wet -SHALLOW MARINE DEPOSIT-					10	90				
	7 8 7 9	S4 24	6.0 8.0			5.7 6.0	ML ML	Loose dark brown interlayered ORGANIC SILT (top) and gray-brown fine SAND with silt (middle) and olive-gray sandy SILT (bottom) (ML), mps 0.42 mm, organic odor, moist -SHALLOW MARINE DEPOSIT-					30 40	70 60				
						6.8	ML	Stiff olive-gray sandy SILT (ML), mps 0.42 mm, organic odor, moist -SHALLOW MARINE DEPOSIT-						100				
								Stiff olive-gray SILT (ML), mps 0.075 mm, no odor, moist, trace organics -SHALLOW MARINE DEPOSIT-										
	3 5 8 8	S5 21	8.0 10.0			8.4	ML	Stiff light olive-brown SILT (ML), mps 0.42 mm, no odor, moist, frequent fine sand lenses -MARINE DEPOSIT-					5	95				
10						10.0		BOTTOM OF EXPLORATION 10.0 FT - NO REFUSAL Note: 1. No significantly elevated PID readings detected during drilling and sampling operations.										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	10.0
Rock Cored (ft)	0.0
Samples	5S

Boring No. HA15-22

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. HA15-23

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire	File No.	42149-000
Client	Wright-Pierce	Sheet No.	1 of 1
Contractor	New England Boring Contractors	Start	24 June 2015
		Finish	24 June 2015
		Driller	B. Cross
		H&A Rep.	K. Russ
		Elevation	7.2 (Est.)
		Datum	NGVD 29
		Location	See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	--	Rig Make & Model: Diedrich D50
Inside Diameter (in.)	2.25	1.375	--	Bit Type: Cutting Head; Drill Mud: None
Hammer Weight (lb)	--	140	-	Casing: HSA Spun to 8'; Hoist/Hammer: Cat-Head Safety Hammer
Hammer Fall (in.)	--	30	-	PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	2 5 9 7	S1 S1A 19	0.0 2.0		NO WELL INSTALLED		ML	Stiff dark brown SILT with roots (ML) -TOPSOIL-					10	90				
						0.6	SP-SM	Medium dense brown to dark brown poorly graded SAND with silt and gravel (SP-SM), mps 1.0 in., no odor, dry, contains trace brick fragments -FILL-	5	10	5	30	40	10				
	6 4 5 4	S2 12	2.0 4.0			2.2	SP-SM	Loose black poorly graded SAND with silt (SP-SM), mps 0.25 in., no odor, moist -FILL-				10	80	10				
							SW-SM	Loose brown well graded SAND with silt and gravel (SW-SM), mps 0.5 in., no odor, wet (3.5 ft), contains ash, ceramic pieces, miscellaneous fill (trash) -FILL-		30	25	20	15	10				
	1 2 3 2	S3 3	4.0 6.0			4.0	ML	Medium stiff brown SILT with sand and gravel (ML), mps 0.75 in., septic-like odor, wet Note: Water encountered at 5.0 ft. -FILL-		25		5	10	60				
5																		
	2 3 2 3	S4 12	6.0 8.0			6.0	OL/OH	Medium stiff black ORGANIC SOIL with wood (OL/OH), mps 0.42 mm, organic odor, wet, contains ceramic piece, trace ash					5	95				
	1 3 3 4	S5 6	8.0 10.0				ML	Medium stiff dark brown SILT with sand and organics (ML), mps 1.5 in. as brick piece, organic odor, wet -FILL (Reworked Shallow Marine Deposit)-					40	60				
10						10.0		BOTTOM OF EXPLORATION 10.0 FT - NO REFUSAL Note: 1. No significantly elevated PID readings detected during drilling and sampling operations.										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	10.0
Rock Cored (ft)	0.0
Samples	5S

Boring No. HA15-23

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. HA15-24

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors

File No.	42149-000
Sheet No.	1 of 1
Start	24 June 2015
Finish	24 June 2015
Driller	B. Cross
H&A Rep.	K. Russ
Elevation	7.5 (Est.)
Datum	NGVD 29
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	2.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures

Rig Make & Model: Diedrich D50
Bit Type: Cutting Head
Drill Mud: None
Casing: HSA Spun to 8'
Hoist/Hammer: Cat-Head Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	1 2 2 4	S1 17	0.0 2.0		NO WELL INSTALLED		ML	Soft dark brown SILT (ML), with roots to 0.5 ft -TOPSOIL-					10	90				
						0.9	ML	Soft gray-brown SILT with sand (ML), mps 0.25 in., slight organic odor, wet, organics -FILL-					20	80				
	11 8 4 4	S2 18	2.0 4.0			2.0	SW	Medium dense brown to rust-brown well graded SAND with gravel (SW), mps 1.0 in., no odor, moist -FILL-	5	10	25	35	20	5				
						3.5	ML	Stiff gray-brown SILT (ML), mps 0.42 mm, no odor, moist					15	85				
5	1 1 2 3	S3 17	4.0 6.0				ML	Soft gray-brown sandy SILT with organics (ML), mps 0.42 mm, organic odor, wet Note: Water encountered at 5.0 ft.					30	70				
	4 4 3 1	S4 9	6.0 8.0				ML	Medium stiff dark gray to black sandy SILT with organics (ML), mps 0.25 in., organic odor, wet, contains glass -FILL-					30	70				
	1 2 2 3	S5 18	8.0 10.0			8.0	ML	Soft gray-brown sandy SILT with organics (ML), mps 0.42 mm, organic odor, wet -SHALLOW MARINE DEPOSIT-					30	70				
						9.3	SM	Gray-brown silty SAND (SM), mps 0.42 mm, no odor, wet -MARINE DEPOSIT-					70	30				
10						10.0		BOTTOM OF EXPLORATION 10.0 FT - NO REFUSAL Note: 1. No significantly elevated PID readings detected during drilling and sampling operations.										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	10.0
Rock Cored (ft)	0.0
Samples	5S

Boring No. HA15-24

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. HA15-25

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire	File No.	42149-000
Client	Wright-Pierce	Sheet No.	1 of 1
Contractor	New England Boring Contractors	Start	22 June 2015
		Finish	22 June 2015
		Driller	B. Cross
		H&A Rep.	K. Russ
		Elevation	11.0 (Est.)
		Datum	NGVD 29
		Location	See Plan

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S	--	Rig Make & Model: Diedrich D50
Inside Diameter (in.)	2.25	1.375	--	Bit Type: Cutting Head
Hammer Weight (lb)	--	140	-	Drill Mud: None
Hammer Fall (in.)	--	30	-	Casing: HSA Spun to 8'
				Hoist/Hammer: Cat-Head Safety Hammer
				PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0					NO WELL INSTALLED			-BITUMINOUS CONCRETE-										
	16 38 26 22	S1 16	0.0 2.0	9.8		0.4	SW	Very dense dark brown well graded SAND with gravel (SW), mps 1.0 in., asphalt-like odor, dry	10	15	10	20	40	5				
	15 16 11 2	S2 12	2.0 4.0	6.0			SW-SM	Medium dense dark brown to brown (color change at 3.5 ft) well graded SAND with silt and gravel (SW-SM), mps 1.0 in., no odor, dry -FILL-	5	15	15	15	35	15				
5	4 5 5 6	S3 1	4.0 6.0	0.6			SM	Loose dark brown silty SAND (SM), mps 0.75 in., no odor, wet Note: Water encountered at 4.0 ft.	5	5	10	10	50	20				
	1 2 3 3	S4 4	6.0 8.0			6.0	ML	Medium stiff gray-brown SILT (ML), mps 0.12 in., no odor, wet -FILL-				5	5	90				
	1 3 3 3	S5 19	8.0 10.0				ML	Medium stiff olive-brown SILT (ML), with 1.0 in. silty fine sand layer, mps 0.5 mm, slight organic odor, wet, trace wood and organics					10	90				
10						10.0		BOTTOM OF EXPLORATION 10.0 FT - NO REFUSAL										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	10.0
Rock Cored (ft)	0.0
Samples	5S

Boring No. HA15-25

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

Boring No. HA15-26

HALEY ALDRICH

Project	Proposed Improvements, Exeter Wastewater Facility, Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors

File No.	42149-000
Sheet No.	1 of 1
Start	22 June 2015
Finish	22 June 2015
Driller	B. Cross
H&A Rep.	K. Russ
Elevation	31.0 (Est.)
Datum	NGVD 29
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	--
Inside Diameter (in.)	2.25	1.375	--
Hammer Weight (lb)	--	140	-
Hammer Fall (in.)	--	30	-

Drilling Equipment and Procedures

Rig Make & Model: Diedrich D50
Bit Type: Cutting Head
Drill Mud: None
Casing: HSA Spun to 8'
Hoist/Hammer: Cat-Head Safety Hammer
PID Make & Model: MiniRAE 2000

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	PID Readings (ppm) (sample/bkgd)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0					NO WELL INSTALLED			-BITUMINOUS CONCRETE-										
	6 5 7 7	S1 16	0.0 2.0	27.0		0.3	SP	Medium dense dark brown poorly graded SAND with silt (SP), mps 1.25 in., slight petroleum-like odor -FILL-		5	10	25	50	10				
						0.7	ML	Stiff olive-brown to gray-brown SILT with clay (ML), mps 0.075 mm -FILL-						100				
	8 11 18 22	S2 20	2.0 4.0			2.0	ML	Very stiff olive-brown to brown SILT (ML), with brown silty fine sand lenses to layers, mps 0.42 mm, no odor, moist					30	70				
5	5 8 11 11	S3 22	4.0 6.0				ML	Very stiff olive-brown to brown SILT (ML), with brown silty fine sand lenses to layers, mps 0.42 mm, no odor, wet Note: Water encountered at approximately 4.0 ft.					30	70				
	6 9 11 14	S4 24	6.0 8.0				ML	Very stiff olive-brown SILT with clay (ML), no sand lenses, mps 0.075 mm, no odor -MARINE DEPOSIT-						100				
	5 7 9 12	S5 24	8.0 10.0				ML	Very stiff olive-brown SILT with clay (ML), mps 0.075 mm, no odor, single 0.5 in. diameter rock fragment						100				
10						10.0		BOTTOM OF EXPLORATION 10.0 FT - NO REFUSAL										

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	10.0
Rock Cored (ft)	0.0
Samples	5S

Boring No. HA15-26

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

APPENDIX D

Groundwater Observation Well Installation Logs

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. HA15-4 (OW)
Boring No. HA15-4 (OW)

Project	Proposed Improvements, Exeter Wastewater Facility
Location	Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors
Driller	B. Cross
Initial Water Level (depth bgs)	3.37 ft

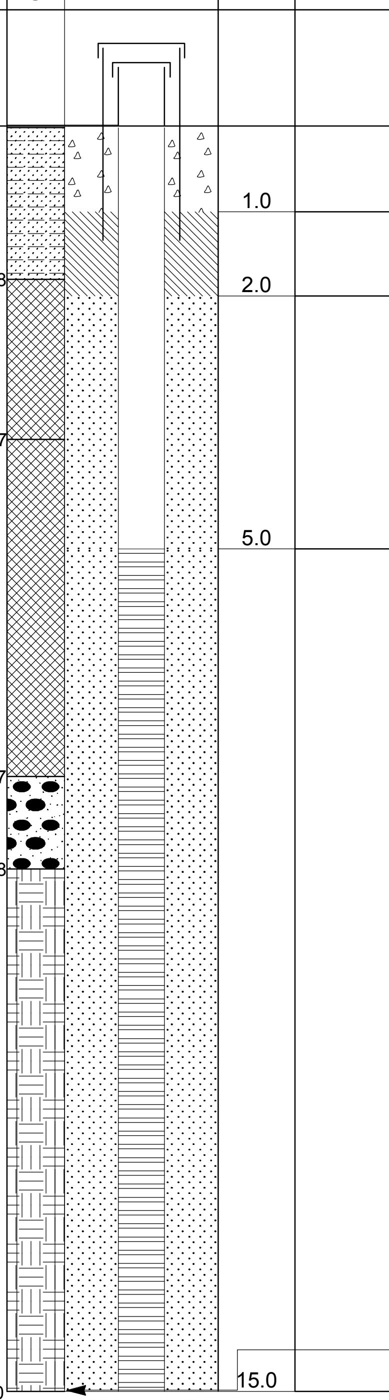
Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No.	42149-000
Date Installed	06 Jul 2015
H&A Rep.	K. Russ
Location	See Plan
Ground El.	24.5 (Est.)
Datum	NGVD 29

SOIL/ROCK CONDITIONS	DEPTH (ft.)
-TOPSOIL-	0 – 1.8
-FILL (Reworked Native)-	1.8 – 3.7
-FILL (Sludge)-	3.7 – 7.7
-GLACIAL TILL-	7.7 – 8.8
-BEDROCK-	8.8 – 15.0

GRAPHIC / WELL DETAILS / DEPTH (ft.) / ELEVATION (ft.)



WELL CONSTRUCTION DETAILS

Type of protective cover	Guardpipe with locking cap
Height of Guard Pipe above ground surface	3.3 ft
Height of top of riser above ground surface	3.1 ft
Type of protective casing	Guard Pipe
Length	5.0 ft
Inside diameter	4.0 in.
Depth of bottom of Guard Pipe	1.7 ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	5.0 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	1.0
Bentonite Seal	1.0	1.0
	-	-
	-	-

Diameter of borehole	4.0 in.
Depth to top of well screen	5.0 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Filter Sand
Depth to bottom of well screen	15.0 ft
Bottom of silt trap	15.0 ft
Depth of bottom of borehole	15.0 ft

COMMENTS:

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. HA15-7(OW)
Boring No. HA15-7 (OW)

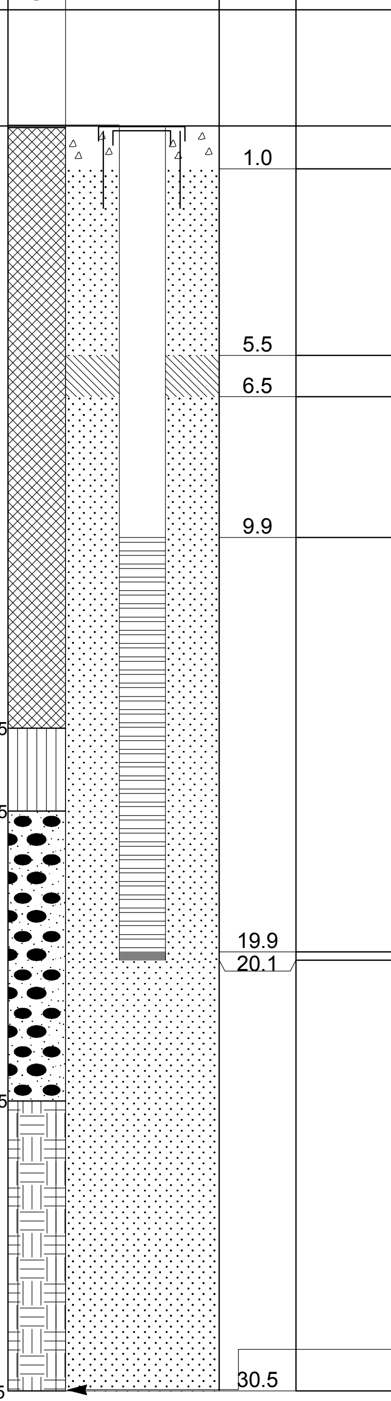
Project	Proposed Improvements, Exeter Wastewater Facility
Location	Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors
Driller	B. Cross
Initial Water Level (depth bgs)	13.05 ft

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No. 42149-000
Date Installed 29 Jun 2015
H&A Rep. M. Snow
Location See Plan

Ground El. 24.5 (Est.)
Datum NGVD 29

SOIL/ROCK CONDITIONS	DEPTH (ft.)
-FILL-	0 – 14.5
-SHALLOW MARINE DEPOSIT-	14.5 – 16.5
-GLACIAL TILL-	16.5 – 23.5
-BEDROCK-	23.5 – 30.5



WELL CONSTRUCTION DETAILS

Type of protective cover	Hex. bolt
Depth of Roadway Box below ground surface	0.0 ft
Depth of top of riser below ground surface	0.3 ft
Type of protective casing	Roadway Box
Length	0.8 ft
Inside diameter	6.0 in.
Depth of bottom of Roadway Box	0.8 ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	9.9 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	1.0
Bentonite Seal	6.5	1.0
	-	-
	-	-

Diameter of borehole	4.0 in.
Depth to top of well screen	9.9 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Filter Sand
Depth to bottom of well screen	19.9 ft
Bottom of silt trap	20.1 ft
Depth of bottom of borehole	30.5 ft

COMMENTS:

HALEY ALDRICH

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

Well No. HA15-9(OW)
Boring No. HA15-9 (OW)

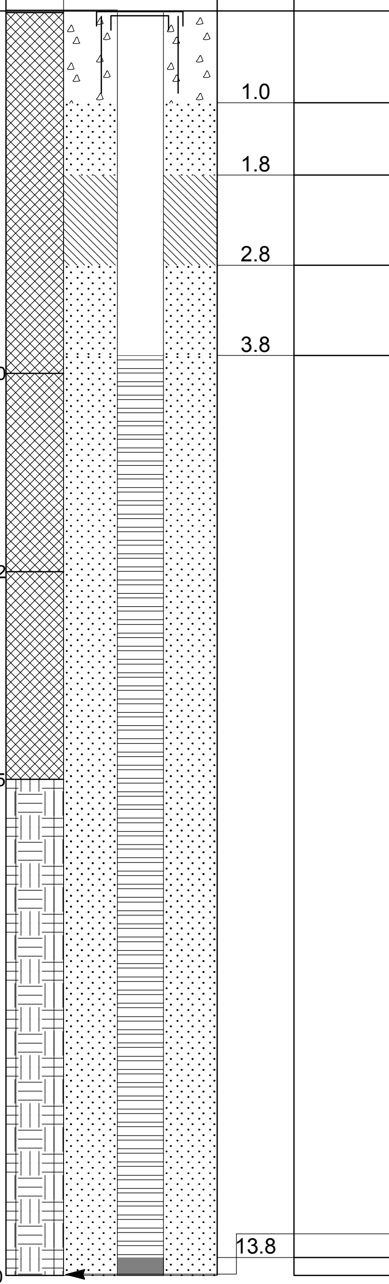
Project	Proposed Improvements, Exeter Wastewater Facility
Location	Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors
Driller	B. Cross
Initial Water Level (depth bgs)	2.66 ft

Well Diagram: Riser Pipe, Screen, Filter Sand, Cuttings, Grout, Concrete, Bentonite Seal

File No. 42149-000
Date Installed 29 Jun 2015
H&A Rep. M. Snow
Location See Plan

Ground El. 28.5 (Est.)
Datum NGVD 29

SOIL/ROCK CONDITIONS	DEPTH (ft.)
-GRAVEL FILL-	0 – 4.0
-FILL-	4.0 – 6.2
-FILL-	6.2 – 8.5
-BEDROCK-	8.5 – 14.0



WELL CONSTRUCTION DETAILS

Type of protective cover	Hex. bolt
Depth of Roadway Box below ground surface	0.0 ft
Depth of top of riser below ground surface	0.3 ft
Type of protective casing	Roadway Box
Length	0.8 ft
Inside diameter	6.0 in.
Depth of bottom of Roadway Box	0.8 ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	3.8 ft

Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	1.0
Bentonite Seal	2.0	1.0
	-	-
	-	-

Diameter of borehole	4.0 in.
Depth to top of well screen	3.8 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Filter Sand
Depth to bottom of well screen	13.8 ft
Bottom of silt trap	14.0 ft
Depth of bottom of borehole	14.0 ft

COMMENTS:

HA-LIB09.GLB GW INSTALLATION REPORT-07-1 G:\PROJECTS\42149 - EXETER WWTF\000\FIELD\GINT DATABASE\42149-000_TB_MW.GPJ Aug 21, 15

GROUNDWATER OBSERVATION WELL INSTALLATION REPORT

HALEY ALDRICH

Well No. HA15-11(OW)
Boring No. HA15-11 (OW)

Project	Proposed Improvements, Exeter Wastewater Facility
Location	Exeter, New Hampshire
Client	Wright-Pierce
Contractor	New England Boring Contractors
Driller	B. Cross
Initial Water Level (depth bgs)	19.82 ft

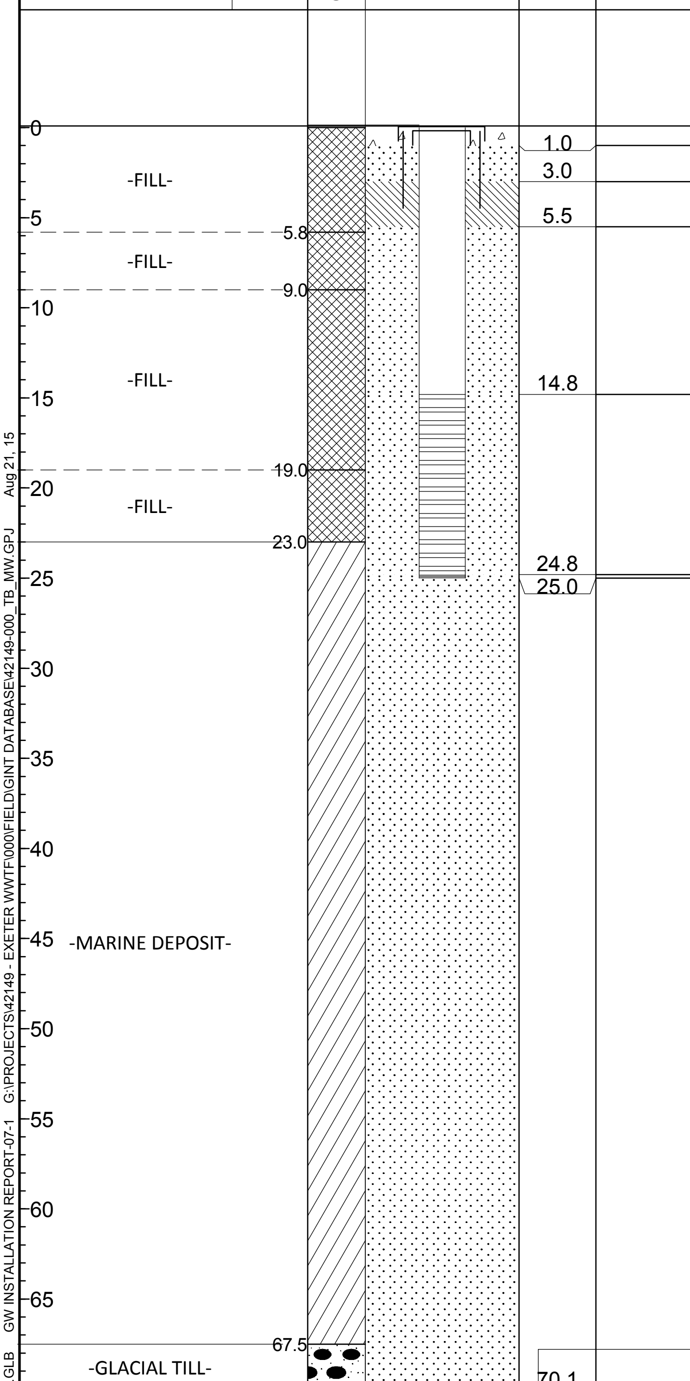
Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

File No. 42149-000
Date Installed 02 Jul 2015
H&A Rep. K. Russ/M. Snow
Location See Plan

Ground El. 27.5 (Est.)
Datum NGVD 29

SOIL/ROCK CONDITIONS	DEPTH (ft.)	GRAPHIC	WELL DETAILS	DEPTH (ft.)	ELEVATION (ft.)



WELL CONSTRUCTION DETAILS

Type of protective cover	Hex. bolt
Depth of Roadway Box below ground surface	0.0 ft
Depth of top of riser below ground surface	0.4 ft
Type of protective casing	Roadway Box
Length	0.8 ft
Inside diameter	6.0 in.
Depth of bottom of Roadway Box	0.8 ft
Type of riser pipe	Schedule 40 PVC
Inside diameter of riser pipe	2.0 in.
Depth of bottom of riser pipe	14.8 ft

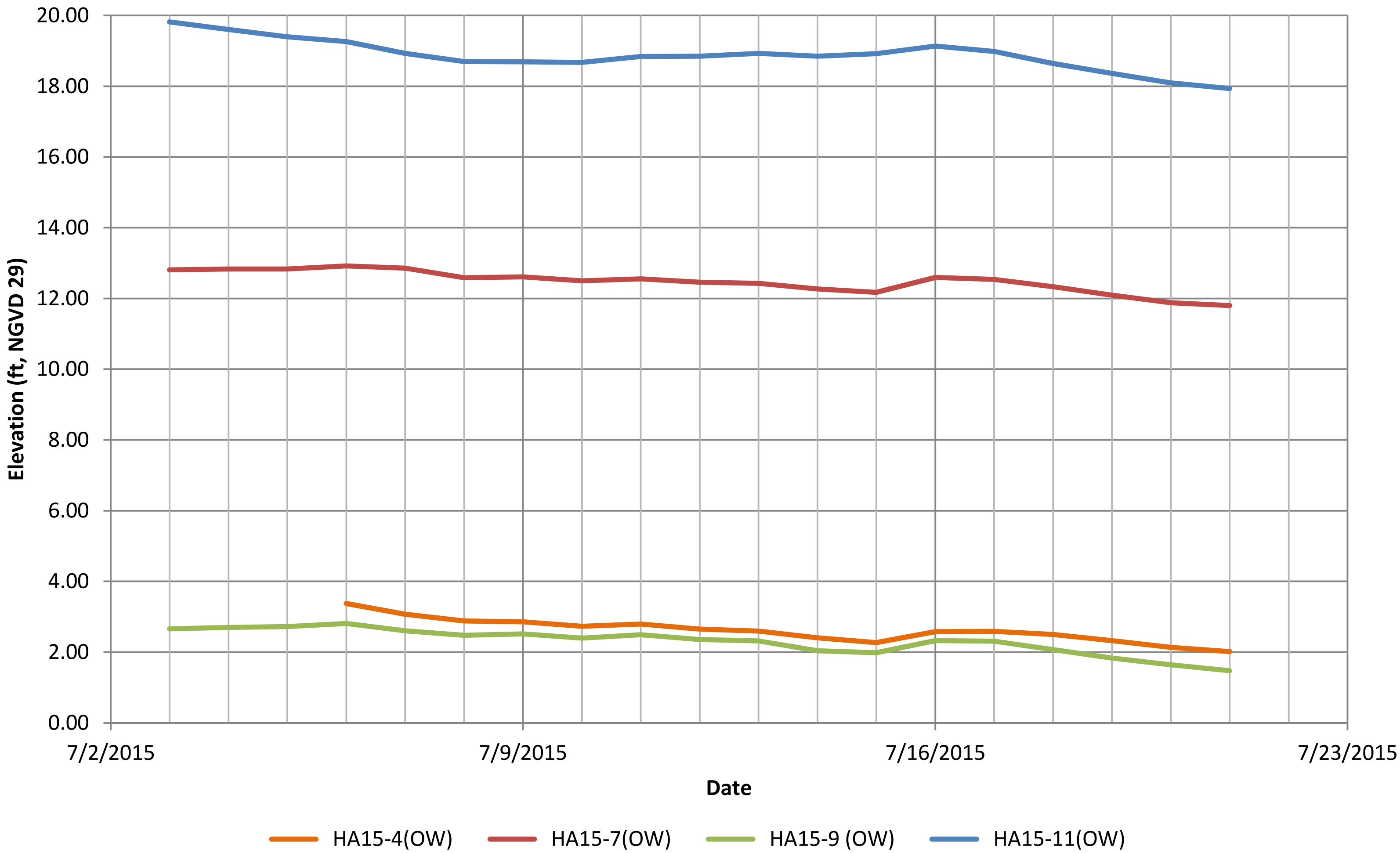
Type of Seals	Top of Seal (ft)	Thickness (ft)
Concrete	0.0	1.0
Bentonite Seal	3.0	2.5
	-	-
	-	-

Diameter of borehole	4.0 in.
Depth to top of well screen	14.8 ft
Type of screen	Machine slotted Sch 40 PVC
Screen gauge or size of openings	0.010 in.
Diameter of screen	2.0 in.
Type of Backfill around Screen	Filter Sand
Depth to bottom of well screen	24.8 ft
Bottom of silt trap	25.0 ft
Depth of bottom of borehole	70.1 ft

COMMENTS:

APPENDIX E

Plot of Water/Groundwater Level Data vs. Time and Groundwater Monitoring Reports



Notes:

1. Elevations are in feet and reference the National Geodetic Vertical Datum of 1929 (NGVD29).

HALEY ALDRICH

PROPOSED IMPROVEMENTS
EXETER WASTEWATER TREATMENT FACILITY
EXETER, NEW HAMPSHIRE

WATER LEVEL VS. TIME
3 JULY TO 21 JULY 2015

FILE NO.: 42149-000

FIGURE E1

HALEY ALDRICH

GROUNDWATER MONITORING REPORT

OW/PZ NUMBER
HA15-4(OW)

PROJECT	Proposed Improvements, Exeter Wastewater Treatment Facility,	**H&A FILE NO.**	42149-000
LOCATION	Exeter, New Hampshire	**PROJECT MGR.**	E. Force
CLIENT	Wright-Pierce	**FIELD REP.**	K. Russ
CONTRACTOR	New England Boring Contractors	**DATE**	7/6/2015

ELEVATION OF REFERENCE POINT 24.5 (est.) **REFERENCE POINT:** Ground Surface ☑ PVC ☐ Other ☐

Date	Time	Elapsed Time (days)	Depth of Water from Reference Point	Elevation of Water	Remarks	Read By
7/6/2015	11:30	0	3.37	21.13	Initial Reading	KAR
7/22/2015	11:15	16	4.25	20.25		MLS

GROUNDWATER MONITORING REPORT

HALEY ALDRICH

OW/PZ NUMBER: HA15-7(OW)

PROJECT	Proposed Improvements, Exeter Wastewater Facility,	**H&A FILE NO.**	42149-000
LOCATION	Exeter, New Hampshire	**PROJECT MGR.**	E. Force
CLIENT	Wright-Pierce	**FIELD REP.**	M. Snow
CONTRACTOR	New England Boring Contractors	**DATE**	6/30/2015

ELEVATION OF REFERENCE POINT 24.5 (est.) **REFERENCE POINT:** Ground Surface ☑ PVC ☐ Other ☐

Date	Time	Elapsed Time (days)	Depth of Water from Reference Point	Elevation of Water	Remarks	Read By
6/30/2015	07:15	1	13.05	11.45		MLS
7/2/2015	16:21	3	12.81	11.69		MLS
7/22/2015	10:40	23	13.79	10.71		MLS

GROUNDWATER MONITORING REPORT

OW/PZ NUMBER: HA15-9(OW)

Page 1 of 1

PROJECT	Proposed Improvements, Exeter Wastewater Facility,	H&A FILE NO.	42149-000
LOCATION	Exeter, New Hampshire	PROJECT MGR.	E. Force
CLIENT	Wright-Pierce	FIELD REP.	M. Snow
CONTRACTOR	New England Boring Contractors	DATE	7/2/2015

ELEVATION OF REFERENCE POINT 28.5 (est.) REFERENCE POINT: Ground Surface ☑ PVC ☐ Other ☐

Date	Time	Elapsed Time (days)	Depth of Water from Reference Point	Elevation of Water	Remarks	Read By
7/2/2015	15:45	3	2.66	25.84		MLS
7/22/2015	9:15	23	5.43	23.07		MLS

GROUNDWATER MONITORING REPORT

OW/PZ NUMBER
HA15-11(OW)
Page 1 of 1

PROJECT	Proposed Improvements, Exeter Wastewater Facility,	H&A FILE NO.	42149-000
LOCATION	Exeter, New Hampshire	PROJECT MGR.	E. Force
CLIENT	Wright-Pierce	FIELD REP.	M. Snow
CONTRACTOR	New England Boring Contractors	DATE	7/2/2015

ELEVATION OF REFERENCE POINT 27.5 (est.) **REFERENCE POINT:** Ground Surface ☑ PVC ☐ Other ☐

Date	Time	Elapsed Time (days)	Depth of Water from Reference Point	Elevation of Water	Remarks	Read By
7/2/2015	16:07	0	19.82	7.68	Initial Reading	MLS
7/22/2015	10:23	20	21.50	6		MLS

APPENDIX F

Rock Core Photographs

BORING ID	CORE ID	CORE RUN DEPTH (FT)	CORE RUN EL.[NOTE 1]	RECOVERY		RQD[NOTE 2]	
				IN.	%	IN.	%
HA15-4	C1	10.0 to 14.0	14.5 to 10.5	48	100	0	0
HA15-4	C2	14.0 to 15.0	10.5 to 9.5	12	100	0	0

NOTES:

1. ELEVATIONS ARE MEASURED IN FEET AND REFERENCE THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NVGD29).
2. "RQD" INDICATES ROCK QUALITY DESIGNATION (PERCENT OF ROCK PIECES RECOVERED EQUAL TO OR GREATER THAN 4 IN. IN LENGTH).

HALEY ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

EXETER WASTEWATER TREATMENT FACILITY
EXETER, NEW HAMPSHIRE

PHOTOGRAPH OF BEDROCK CORE BORING: HA15-4

FILE NO. 42149-000

July 2015

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BORING ID	CORE ID	CORE RUN DEPTH (FT)	CORE RUN EL.[NOTE 1]	RECOVERY		RQD[NOTE 2]	
				IN.	%	IN.	%
HA15-6	C1	36.0 to 41.0	-12.5 to -17.5	60	100	58	97
HA15-7	C1	25.5 to 30.5	-1.0 to -6.0	60	100	25	42
HA15-9	C1	9.0 to 14.0	19.5 to 14.5	60	100	46	77
HA15-5	C1	20.0 to 25.0	7.5 to 2.5	60	100	10	17

NOTES:

1. ELEVATIONS ARE MEASURED IN FEET AND REFERENCE THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NVGD29).
2. "RQD" INDICATES ROCK QUALITY DESIGNATION (PERCENT OF ROCK PIECES RECOVERED EQUAL TO OR GREATER THAN 4 IN. IN LENGTH).

HALEY ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

EXETER WASTEWATER TREATMENT FACILITY
EXETER, NEW HAMPSHIRE

PHOTOGRAPH OF BEDROCK CORE BORINGS: HA15-5, HA15-6, HA15-7 AND HA15-9

FILE NO. 42149-000 July 2015

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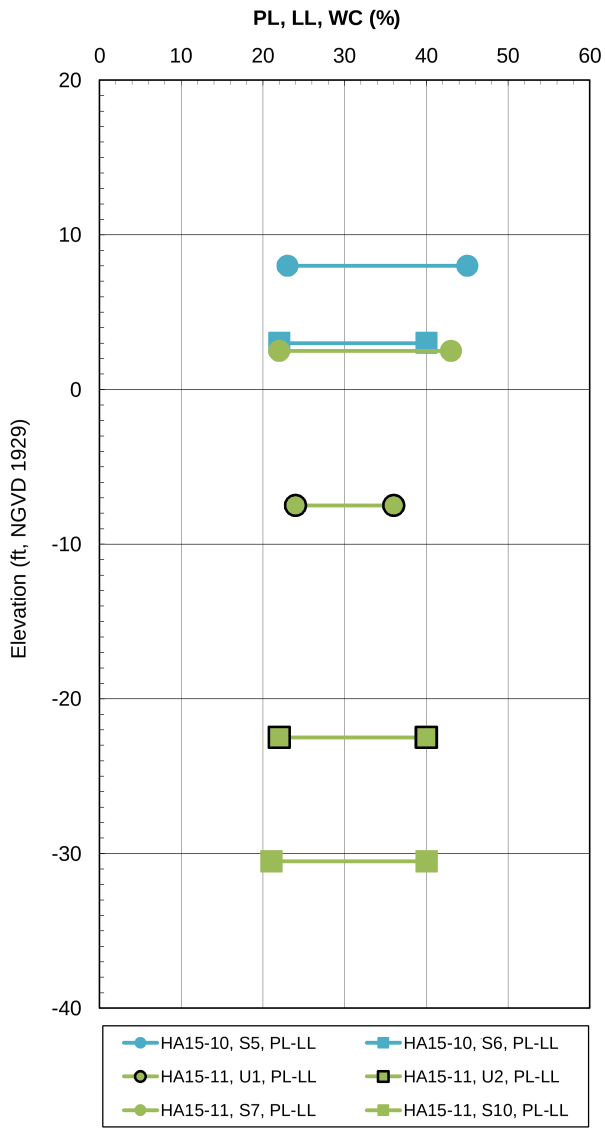
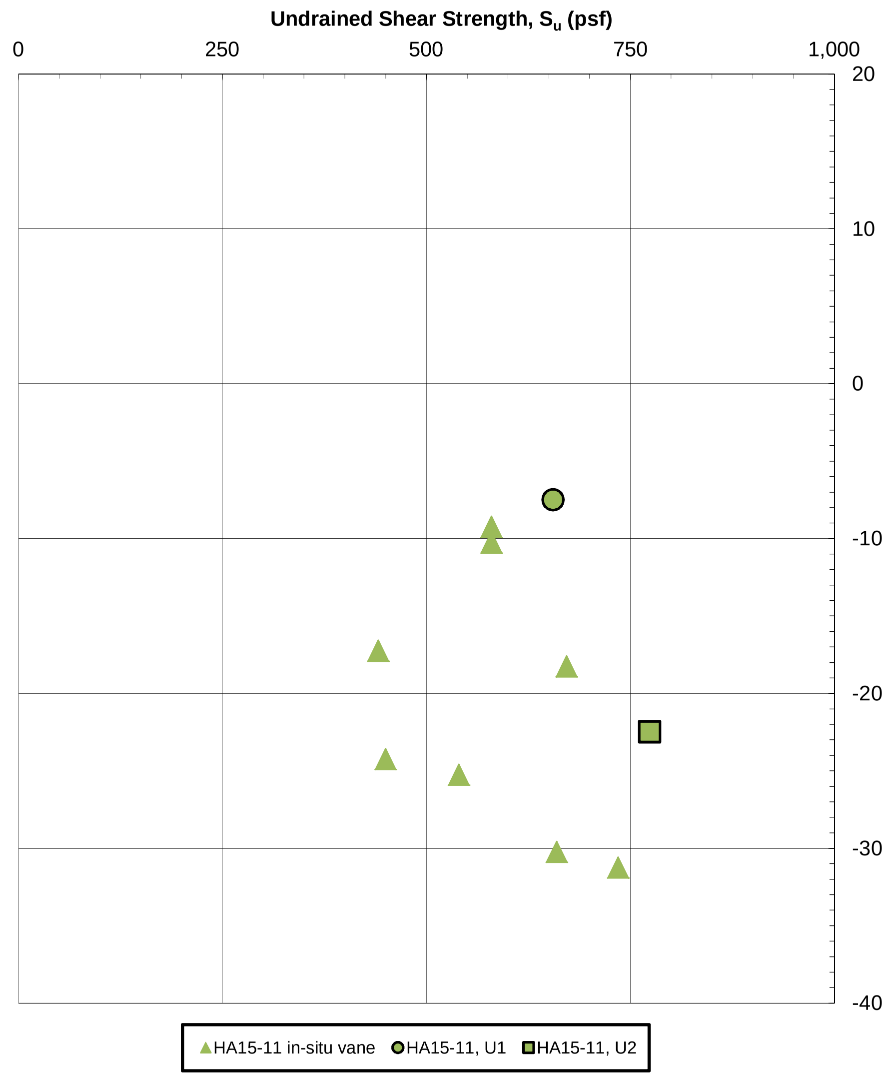
APPENDIX G

Geotechnical Laboratory Testing Results





Notes:

1. Index property and undrained shear strength data shown taken from the 2015 subsurface exploration and laboratory testing program completed by Haley & Aldrich.
2. Index properties shown for samples of naturally deposited marine clay.
3. Undrained shear strength data shown for naturally deposited marine clay (HA15-11).
4. Undrained shear strength data shown based on in-situ vane shear testing and isotropically consolidated undrained triaxial shear testing.

HALEY ALDRICH

UNDERGROUND ENGINEERING & ENVIRONMENTAL SOLUTIONS

EXETER WASTEWATER TREATMENT FACILITY
EXETER, NEW HAMPSHIRE

INDEX PROPERTIES AND UNDRAINED SHEAR STRENGTH DATA MARINE CLAY DEPOSIT HA15-10 AND HA15-11

FILE NO. 42149-000

August 2015

G:\PROJECTS\42149 - exeter wwtf\000\Subsurface Data Report\Appendix G - Geotechnical Laboratory Testing Results\[2015_0804_HAI_Shear Strength Data_Exeter WWTF-jll.xlsx]Compressibility Figure

Grain Size Analyses

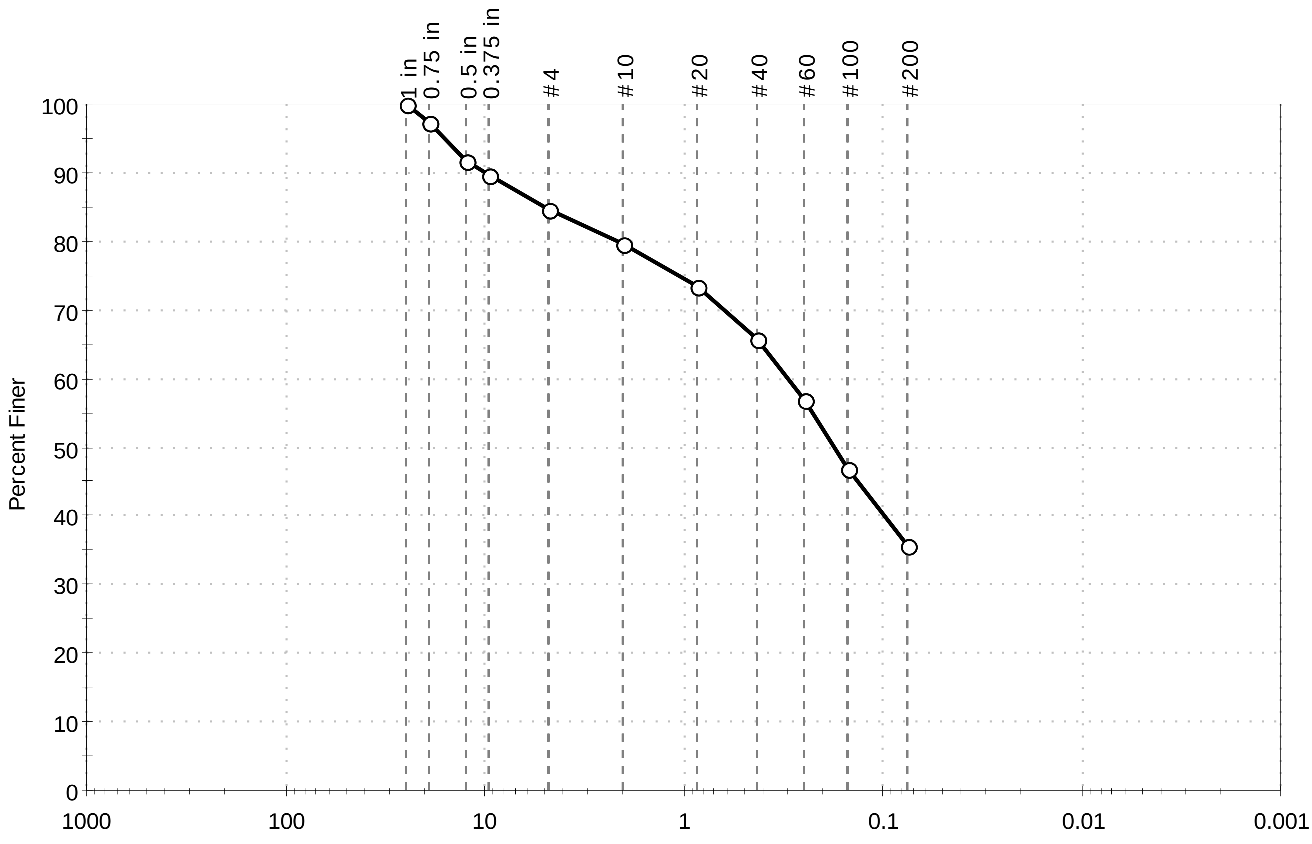
Client:	Haley & Aldrich, Inc.				
Project:	Wastewater Treatment Facility Upgrades				
Location:	Exeter, NH			Project No:	GTX-303499
Boring ID:	HA15-5	Sample Type:	jar	Tested By:	jbr
Sample ID:	S1A	Test Date:	07/30/15	Checked By:	jdt
Depth :	0.5-2	Test Id:	339884		

Test Comment: ---

Visual Description: Moist, light olive brown silty sand with gravel

Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	15.3	49.1	35.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	97		
0.5 in	12.50	92		
0.375 in	9.50	90		
#4	4.75	85		
#10	2.00	80		
#20	0.85	74		
#40	0.42	66		
#60	0.25	57		
#100	0.15	47		
#200	0.075	36		

Coefficients

D_{85} = 4.9362 mm	D_{30} = N/A
D_{60} = 0.2983 mm	D_{15} = N/A
D_{50} = 0.1746 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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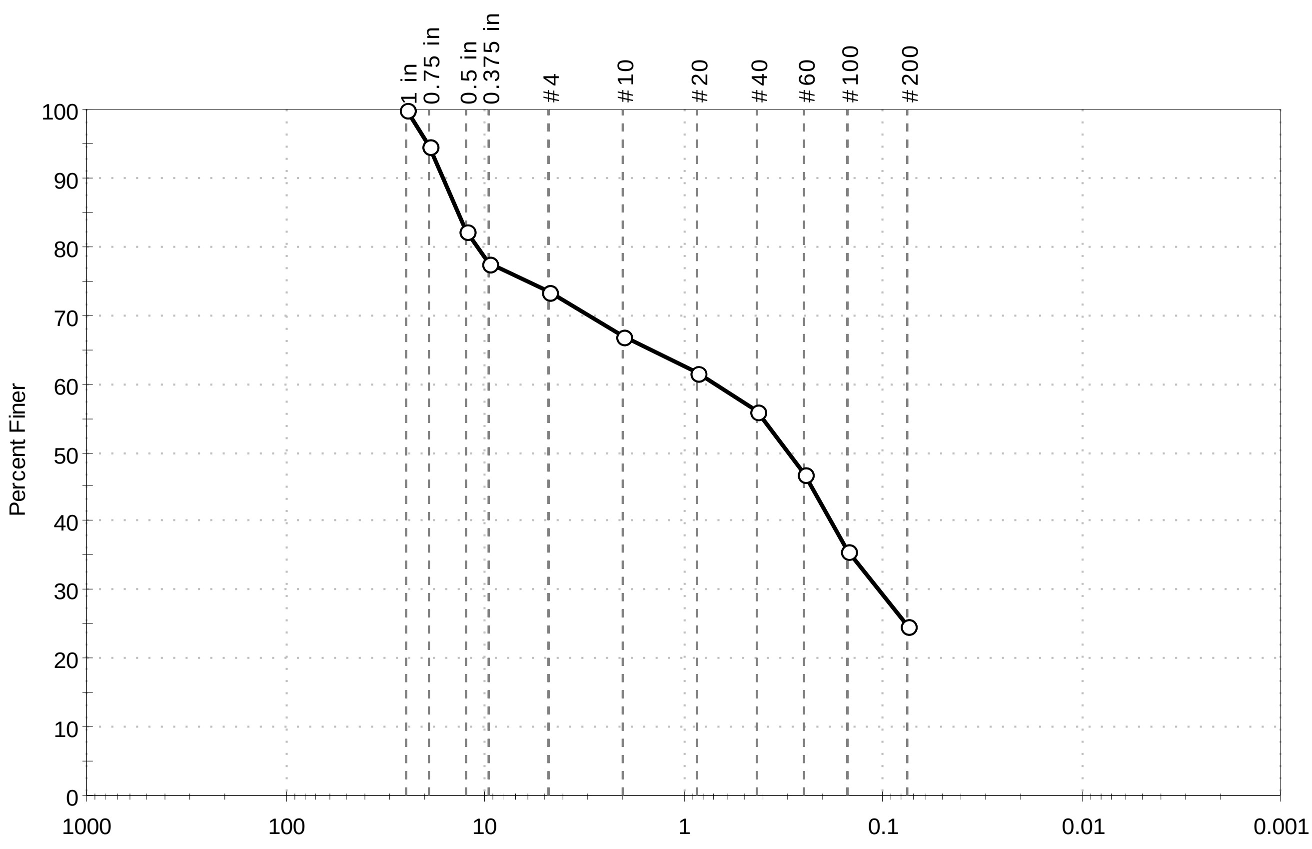
Client:	Haley & Aldrich, Inc.			
Project:	Wastewater Treatment Facility Upgrades			
Location:	Exeter, NH		Project No:	GTX-303499
Boring ID:	HA15-5	Sample Type: jar	Tested By:	jbr
Sample ID:	S2	Test Date: 07/30/15	Checked By:	jdt
Depth :	2-4	Test Id: 339885		
Test Comment:	---			
Visual Description:	Moist, olive silty sand with gravel			
Sample Comment:	---			

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	26.6	48.8	24.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	95		
0.5 in	12.50	82		
0.375 in	9.50	78		
#4	4.75	73		
#10	2.00	67		
#20	0.85	62		
#40	0.42	56		
#60	0.25	47		
#100	0.15	36		
#200	0.075	25		

Coefficients

D_{85} = 13.6567 mm
D_{30} = 0.1049 mm
D_{60} = 0.7044 mm
D_{15} = N/A
D_{50} = 0.2998 mm
D_{10} = N/A
C_u = N/A
C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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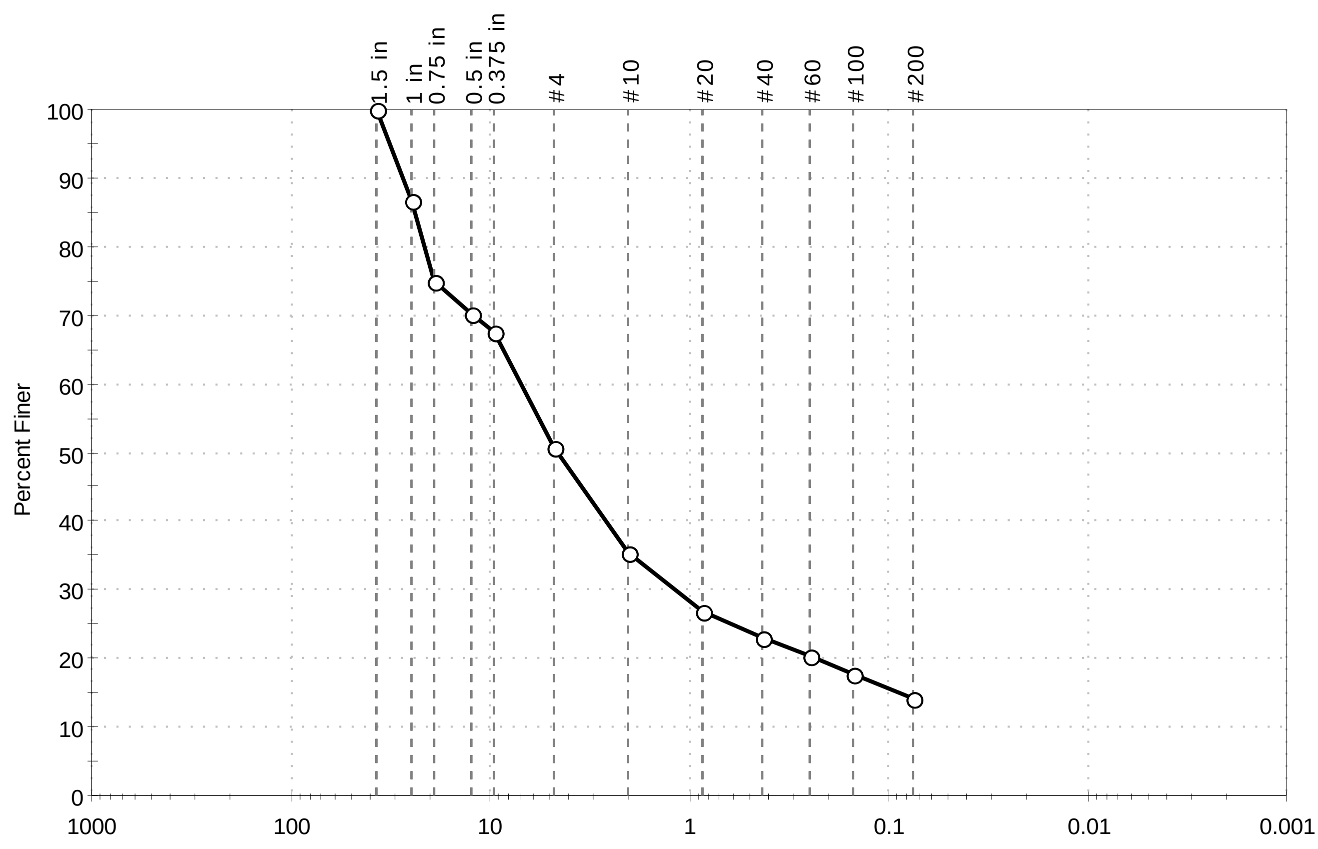
Client:	Haley & Aldrich, Inc.		
Project:	Wastewater Treatment Facility Upgrades		
Location:	Exeter, NH	Project No:	GTX-303499
Boring ID: HA15-8	Sample Type: jar	Tested By:	jbr
Sample ID: S6A	Test Date: 07/30/15	Checked By:	jdt
Depth : 12-13	Test Id: 339886		
Test Comment:	---		
Visual Description:	Moist, olive gray silt gravel with sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	49.3	36.5	14.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	87		
0.75 in	19.00	75		
0.5 in	12.50	70		
0.375 in	9.50	68		
#4	4.75	51		
#10	2.00	36		
#20	0.85	27		
#40	0.42	23		
#60	0.25	20		
#100	0.15	18		
#200	0.075	14		

Coefficients

D_{85} = 23.9859 mm — D_{30} = 1.1613 mm

D_{60} = 6.9526 mm — D_{15} = 0.0883 mm

D_{50} = 4.5689 mm — D_{10} = N/A

C_u = N/A — C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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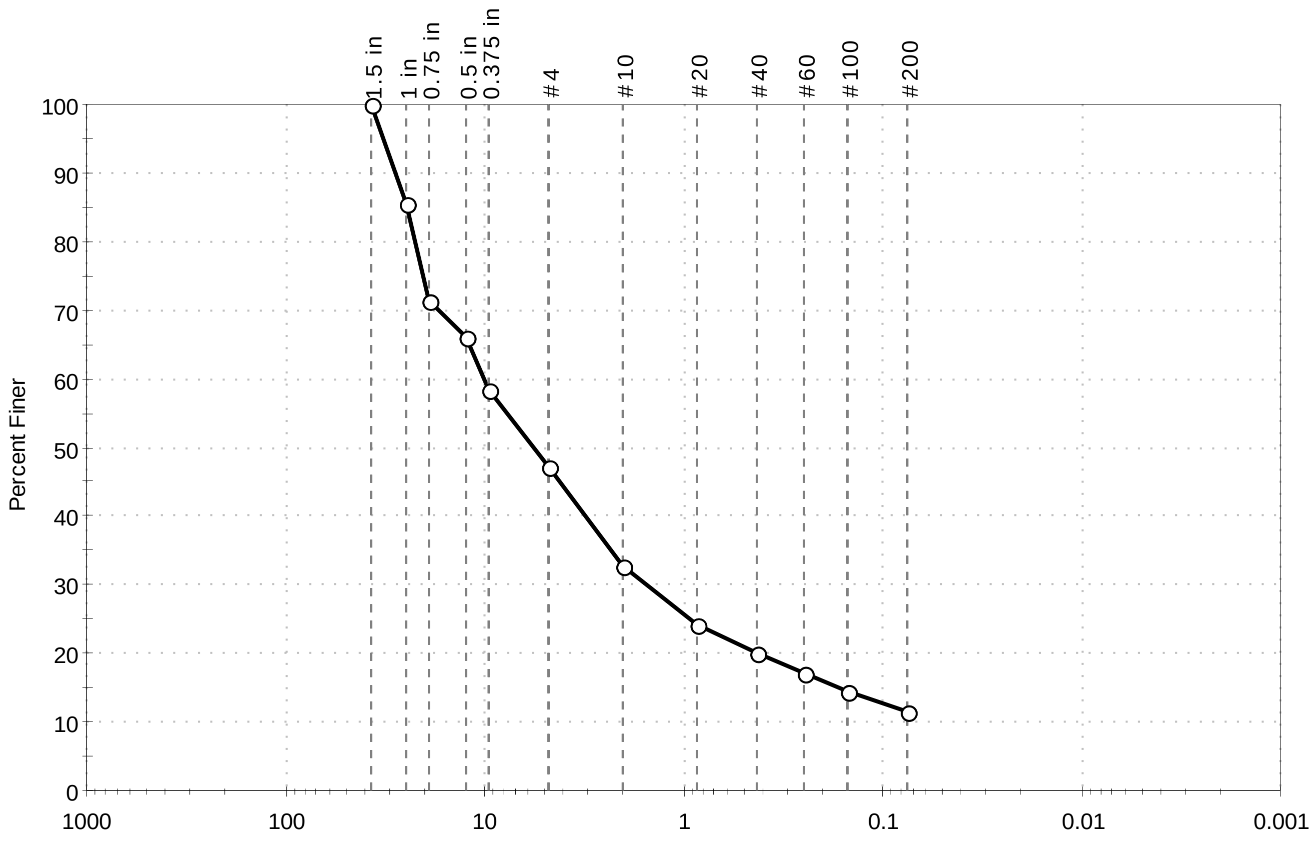
GeoTesting EXPRESS

Client:	Haley & Aldrich, Inc.				
Project:	Wastewater Treatment Facility Upgrades				
Location:	Exeter, NH			Project No:	GTX-303499
Boring ID:	HA15-8	Sample Type:	jar	Tested By:	jbr
Sample ID:	S7	Test Date:	07/30/15	Checked By:	jdt
Depth :	14-16	Test Id:	339887		

Test Comment: ---
Visual Description: Moist, olive gray gravel with silt and sand
Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	52.7	35.7	11.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	86		
0.75 in	19.00	71		
0.5 in	12.50	66		
0.375 in	9.50	58		
#4	4.75	47		
#10	2.00	33		
#20	0.85	24		
#40	0.42	20		
#60	0.25	17		
#100	0.15	15		
#200	0.075	12		

Coefficients

D_{85} = 24.6734 mm | D_{30} = 1.5161 mm
D_{60} = 10.0917 mm | D_{15} = 0.1631 mm
D_{50} = 5.6342 mm | D_{10} = N/A
C_u = N/A | C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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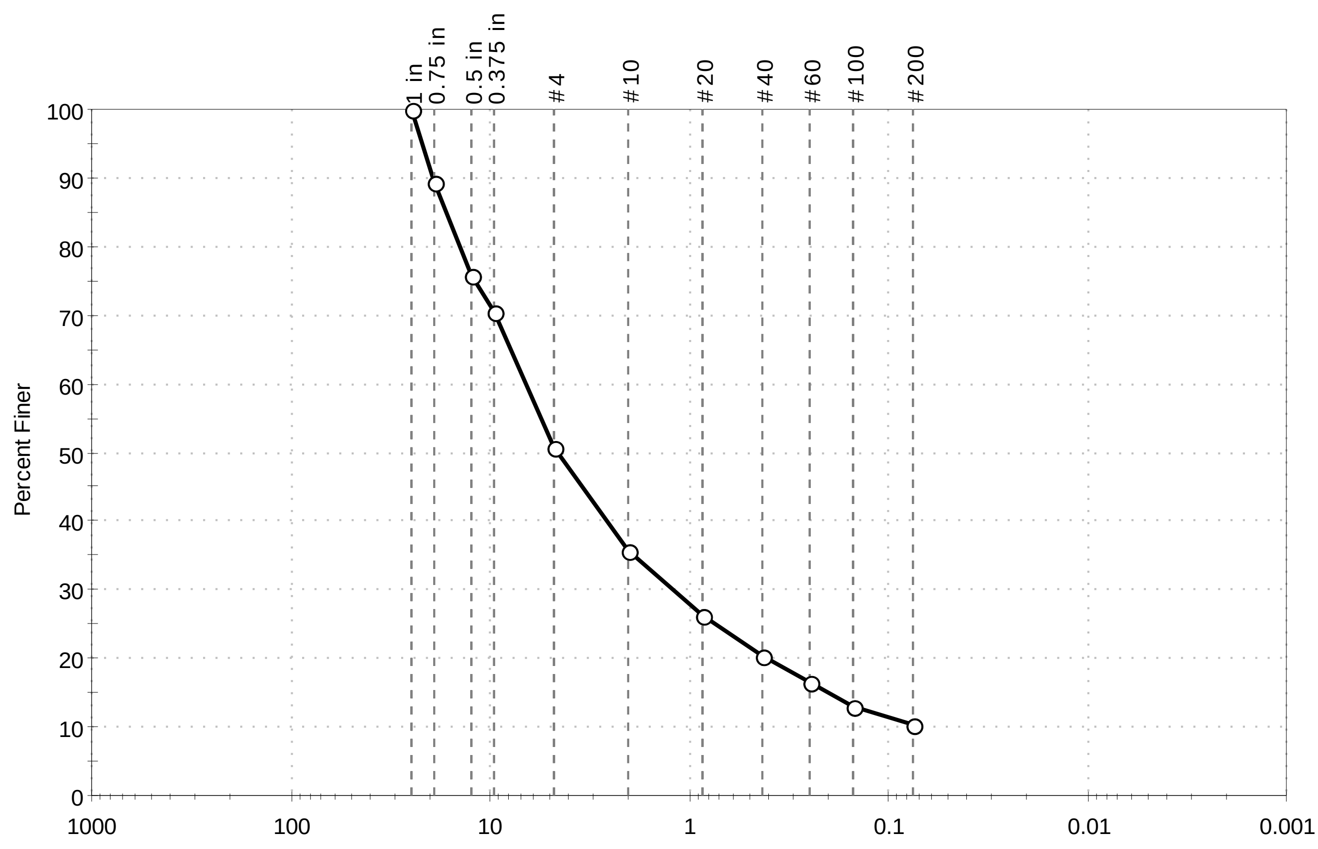
Client:	Haley & Aldrich, Inc.		
Project:	Wastewater Treatment Facility Upgrades		
Location:	Exeter, NH	Project No:	GTX-303499
Boring ID: HA15-9	Sample Type: jar	Tested By:	jbr
Sample ID: S1	Test Date: 07/31/15	Checked By:	jdt
Depth : 0-2	Test Id: 339888		
Test Comment:	---		
Visual Description:	Moist, olive brown gravel with silt and sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	49.3	40.5	10.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	89		
0.5 in	12.50	76		
0.375 in	9.50	70		
#4	4.75	51		
#10	2.00	36		
#20	0.85	26		
#40	0.42	20		
#60	0.25	17		
#100	0.15	13		
#200	0.075	10		

Coefficients

D_{85} = 16.6667 mm
D_{30} = 1.1935 mm
D_{60} = 6.5808 mm
D_{15} = 0.1988 mm
D_{50} = 4.5543 mm
D_{10} = N/A
C_u = N/A
C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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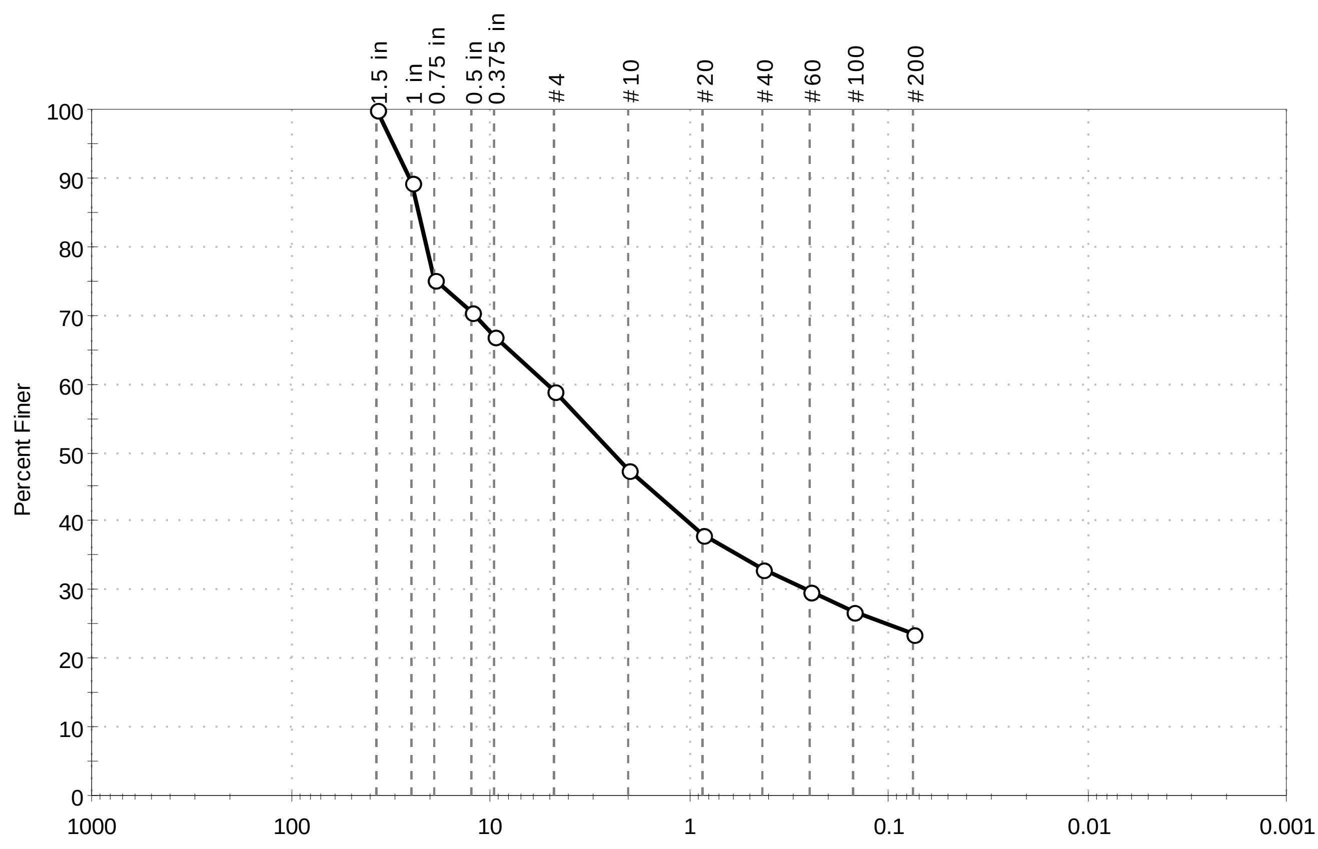
Client:	Haley & Aldrich, Inc.		
Project:	Wastewater Treatment Facility Upgrades		
Location:	Exeter, NH	Project No:	GTX-303499
Boring ID: HA15-9	Sample Type: jar	Tested By:	jbr
Sample ID: S3	Test Date: 07/30/15	Checked By:	jdt
Depth : 4-6	Test Id: 339889		
Test Comment:	---		
Visual Description:	Moist, olive gray silty gravel with sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	40.9	35.4	23.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	89		
0.75 in	19.00	75		
0.5 in	12.50	71		
0.375 in	9.50	67		
#4	4.75	59		
#10	2.00	47		
#20	0.85	38		
#40	0.42	33		
#60	0.25	30		
#100	0.15	27		
#200	0.075	24		

Coefficients

D_{85} = 22.9478 mm	D_{30} = 0.2631 mm
D_{60} = 5.1245 mm	D_{15} = N/A
D_{50} = 2.4206 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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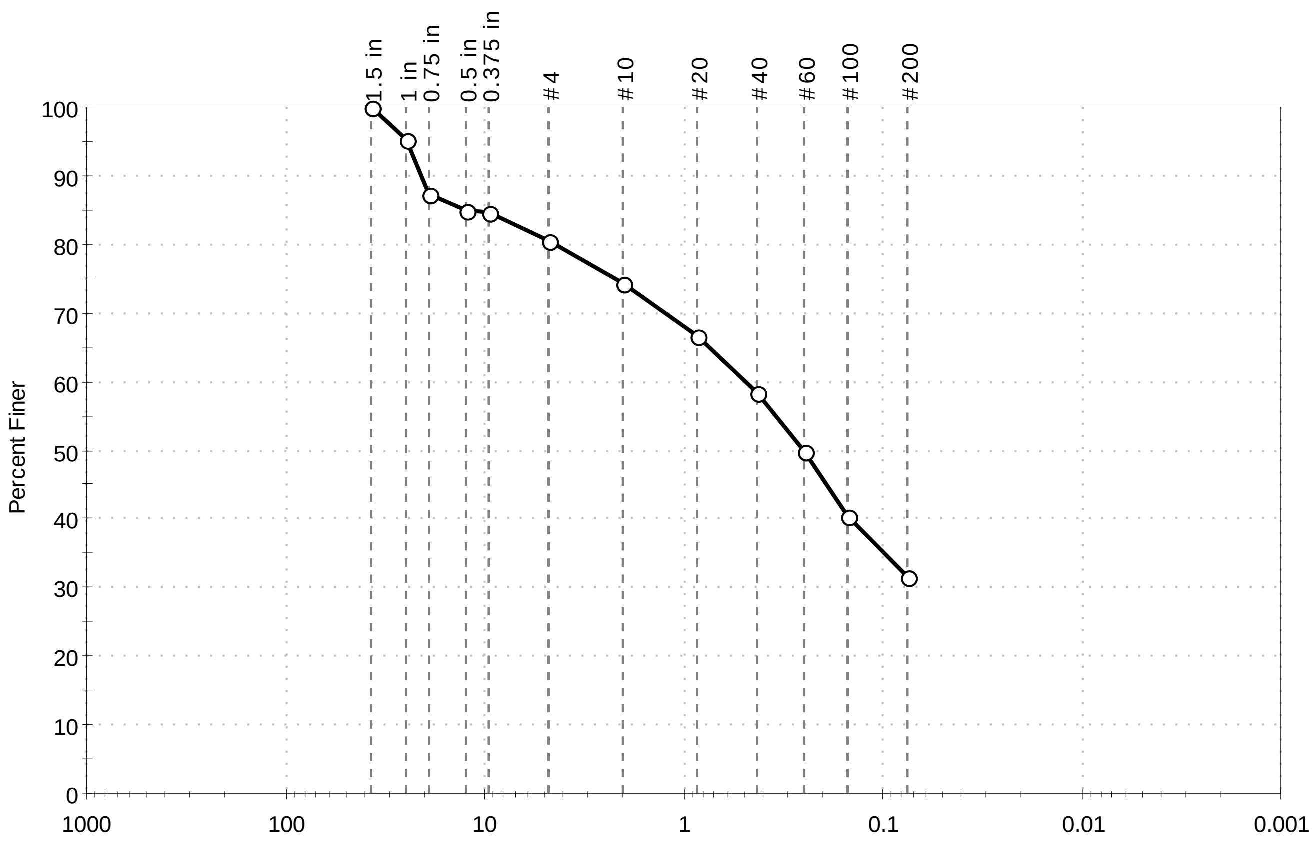
Client:	Haley & Aldrich, Inc.		
Project:	Wastewater Treatment Facility Upgrades		
Location:	Exeter, NH	Project No:	GTX-303499
Boring ID:	HA15-10	Sample Type: jar	Tested By: jbr
Sample ID:	S1/S2	Test Date: 07/30/15	Checked By: jdt
Depth :	0-6	Test Id: 339890	
Test Comment:	---		
Visual Description:	Moist, olive silty sand with gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	19.3	49.2	31.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 in	37.50	100		
1 in	25.00	95		
0.75 in	19.00	87		
0.5 in	12.50	85		
0.375 in	9.50	85		
#4	4.75	81		
#10	2.00	74		
#20	0.85	67		
#40	0.42	59		
#60	0.25	50		
#100	0.15	40		
#200	0.075	32		

Coefficients

D_{85} = 12.6564 mm	D_{30} = N/A
D_{60} = 0.4814 mm	D_{15} = N/A
D_{50} = 0.2533 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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Client:	Haley & Aldrich, Inc.		
Project:	Wastewater Treatment Facility Upgrades		
Location:	Exeter, NH	Project No:	GTX-303499

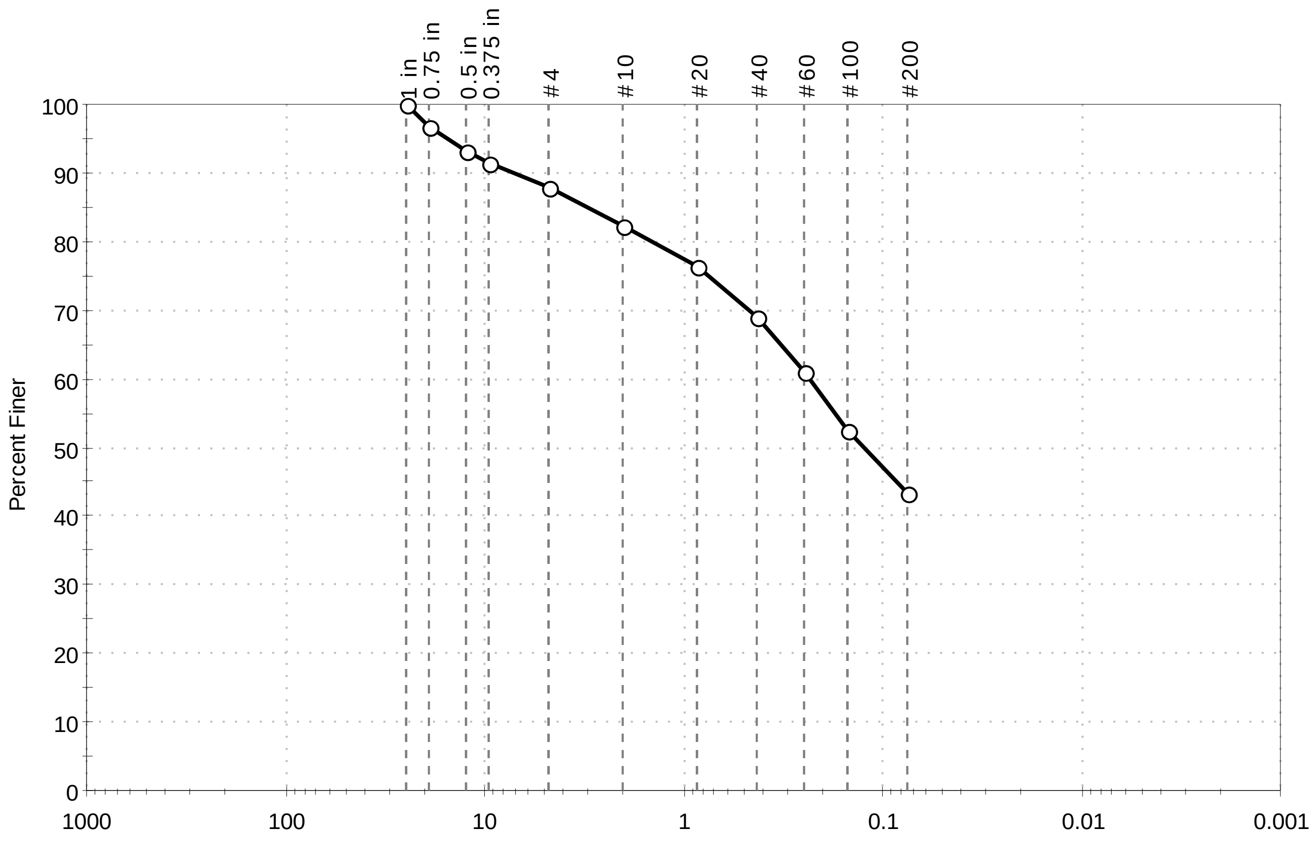
Boring ID:	HA15-11	Sample Type:	jar	Tested By:	jbr
Sample ID:	S1/S2	Test Date:	07/30/15	Checked By:	jdt
Depth :	0-5.8	Test Id:	339891		

Test Comment: ---

Visual Description: Moist, olive silty sand

Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	12.2	44.5	43.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	97		
0.5 in	12.50	93		
0.375 in	9.50	91		
#4	4.75	88		
#10	2.00	82		
#20	0.85	77		
#40	0.42	69		
#60	0.25	61		
#100	0.15	52		
#200	0.075	43		

Coefficients

D_{85} = 3.0483 mm D_{30} = N/A

D_{60} = 0.2350 mm D_{15} = N/A

D_{50} = 0.1252 mm D_{10} = N/A

C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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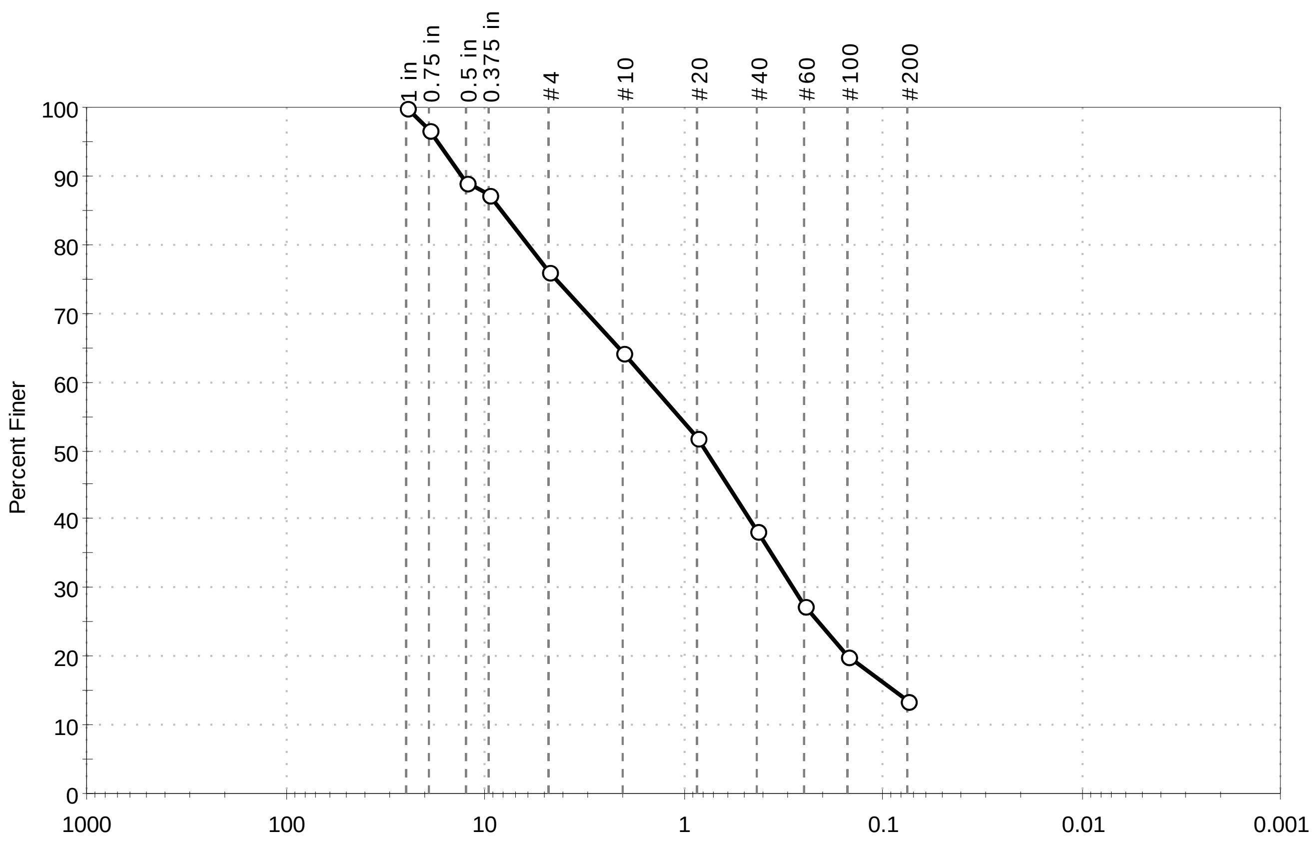
Client:	Haley & Aldrich, Inc.				
Project:	Wastewater Treatment Facility Upgrades				
Location:	Exeter, NH			Project No:	GTX-303499
Boring ID:	HA15-17	Sample Type:	jar	Tested By:	jbr
Sample ID:	S1	Test Date:	07/30/15	Checked By:	jdt
Depth :	0-6.2	Test Id:	339892		

Test Comment: ---

Visual Description: Moist, light olive brown silty sand with gravel

Sample Comment: ---

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	23.9	62.6	13.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	97		
0.5 in	12.50	89		
0.375 in	9.50	87		
#4	4.75	76		
#10	2.00	64		
#20	0.85	52		
#40	0.42	38		
#60	0.25	28		
#100	0.15	20		
#200	0.075	13		

Coefficients

D_{85} = 8.1993 mm	D_{30} = 0.2822 mm
D_{60} = 1.4777 mm	D_{15} = 0.0879 mm
D_{50} = 0.7678 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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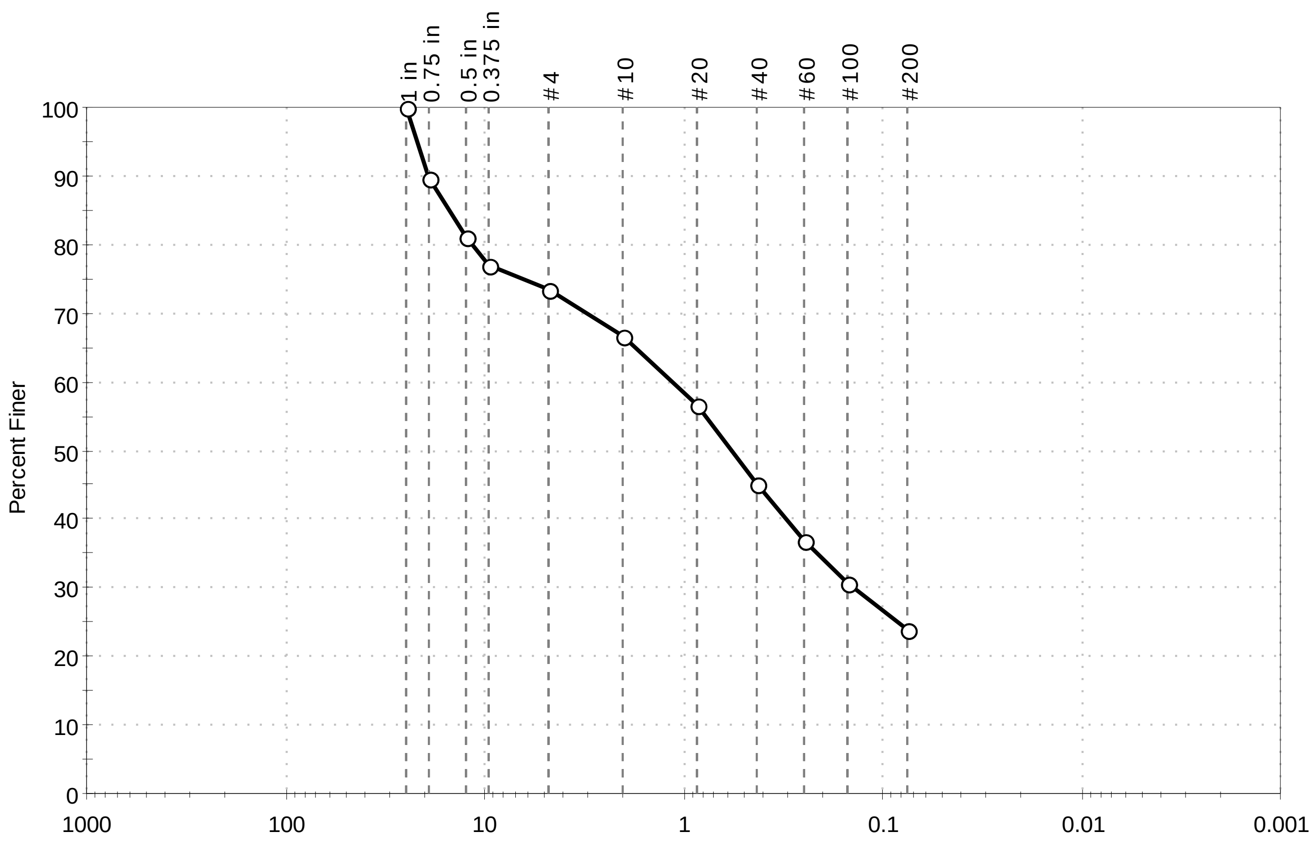
Client:	Haley & Aldrich, Inc.		
Project:	Wastewater Treatment Facility Upgrades		
Location:	Exeter, NH	Project No:	GTX-303499
Boring ID: HA15-22	Sample Type: jar	Tested By:	jbr
Sample ID: S1A	Test Date: 07/30/15	Checked By:	jdt
Depth : 0.4-2.1	Test Id: 339893		
Test Comment:	---		
Visual Description:	Moist, dark olive brown silty sand with gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	26.5	49.5	24.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	90		
0.5 in	12.50	81		
0.375 in	9.50	77		
#4	4.75	73		
#10	2.00	67		
#20	0.85	57		
#40	0.42	45		
#60	0.25	37		
#100	0.15	31		
#200	0.075	24		

Coefficients

D_{85} = 15.1084 mm
D_{30} = 0.1392 mm
D_{60} = 1.1354 mm
D_{15} = N/A
D_{50} = 0.5735 mm
D_{10} = N/A
C_u = N/A
C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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Water Content, Atterberg Limits and Shear Strength

Client:	Haley & Aldrich, Inc.				
Project:	Wastewater Treatment Facility Upgrades				
Location:	Exeter, NH			Project No:	GTX-303499
Boring ID:	---	Sample Type:	---	Tested By:	jbr
Sample ID:	---	Test Date:	07/30/15	Checked By:	jdt
Depth :	---	Test Id:	339906		

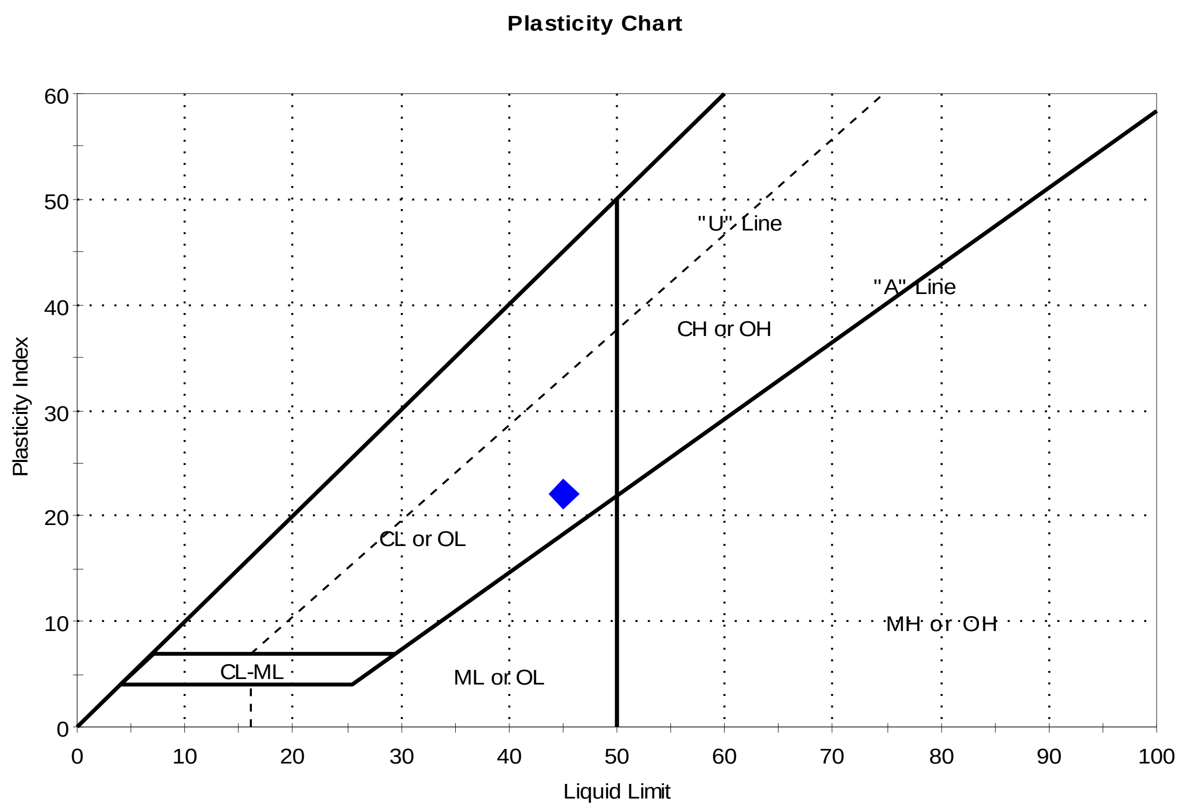
Moisture Content of Soil and Rock - ASTM D2216

Boring ID	Sample ID	Depth	Description	Moisture Content, %
HA15-10	S5	19-21	Moist, olive clay	28.7
HA15-10	S6	24-26	Moist, olive gray clay	37.7
HA15-11	U1	34-36	Moist, olive gray clay	37.9
HA15-11	U2	49-51	Moist, olive gray clay	43.3
HA15-11	S7	24-26	Moist, olive clay	31.5
HA15-11	S10	57-59	Moist, dark greenish gray clay	39.8

Notes: Temperature of Drying : 110º Celsius

Client:	Haley & Aldrich, Inc.				
Project:	Wastewater Treatment Facility Upgrades				
Location:	Exeter, NH			Project No:	GTX-303499
Boring ID:	HA15-10	Sample Type:	jar	Tested By:	cam
Sample ID:	S5	Test Date:	08/04/15	Checked By:	jdt
Depth :	19-21	Test Id:	339896		
Test Comment:	---				
Visual Description:	Moist, olive clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	S5	HA15-10	19-21	29	45	23	22	0.3	

Sample Prepared using the WET method

Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

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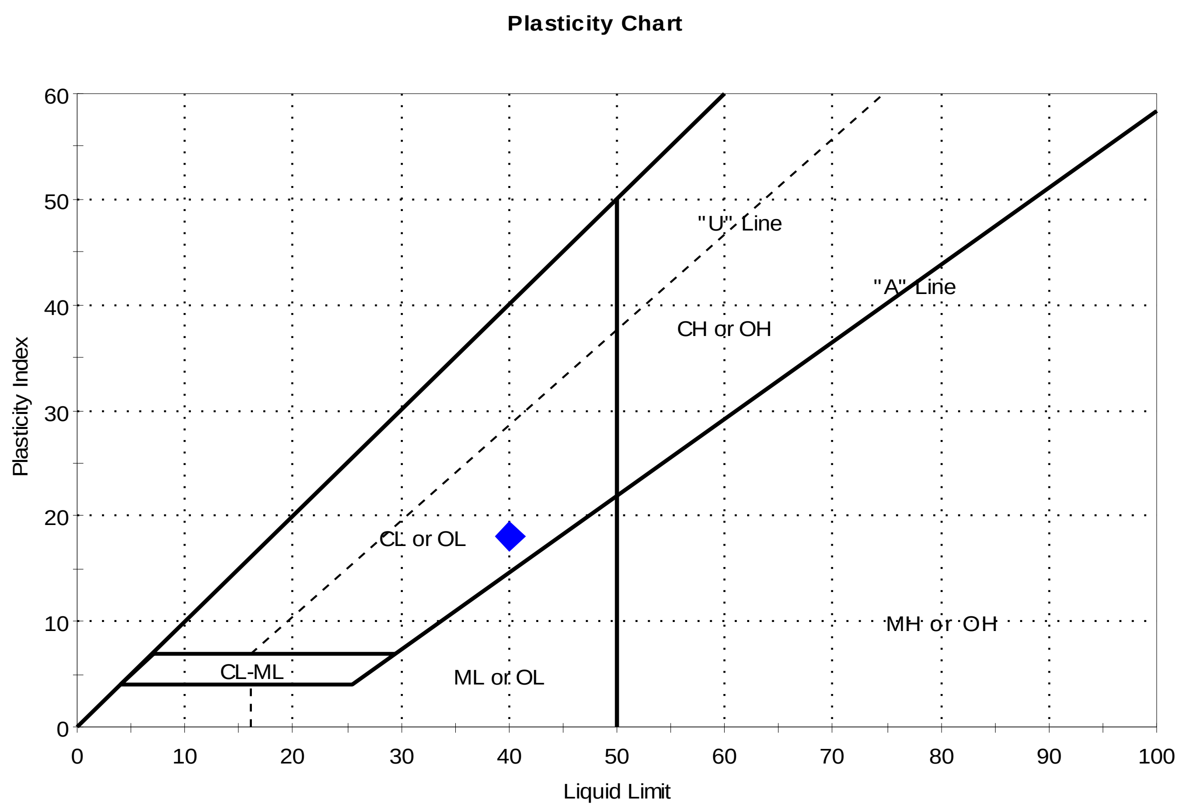
Client:	Haley & Aldrich, Inc.		
Project:	Wastewater Treatment Facility Upgrades		
Location:	Exeter, NH	Project No:	GTX-303499
Boring ID: HA15-10	Sample Type: jar	Tested By:	cam
Sample ID: S6	Test Date: 08/04/15	Checked By:	jdt
Depth : 24-26	Test Id: 339897		
Test Comment:	---		
Visual Description:	Moist, olive gray clay		
Sample Comment:	---		

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	S6	HA15-10	24-26	38	40	22	18	0.9	

Sample Prepared using the WET method

Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

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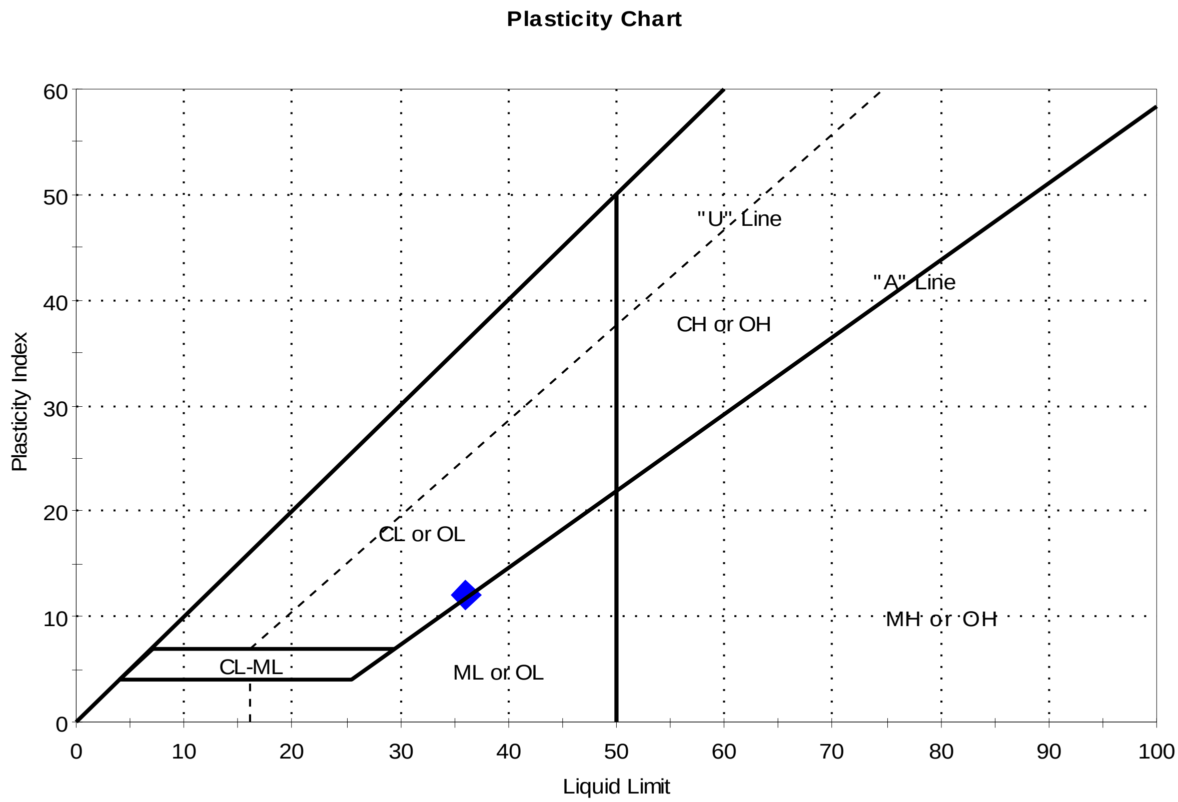
Client:	Haley & Aldrich, Inc.				
Project:	Wastewater Treatment Facility Upgrades				
Location:	Exeter, NH			Project No:	GTX-303499
Boring ID:	HA15-11	Sample Type:	tube	Tested By:	cam
Sample ID:	U1	Test Date:	08/04/15	Checked By:	jdt
Depth :	34-36	Test Id:	339894		
Test Comment:	---				
Visual Description:	Moist, olive gray clay				
Sample Comment:	---				

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	U1	HA15-11	34-36	38	36	24	12	1.2	

Sample Prepared using the WET method

Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

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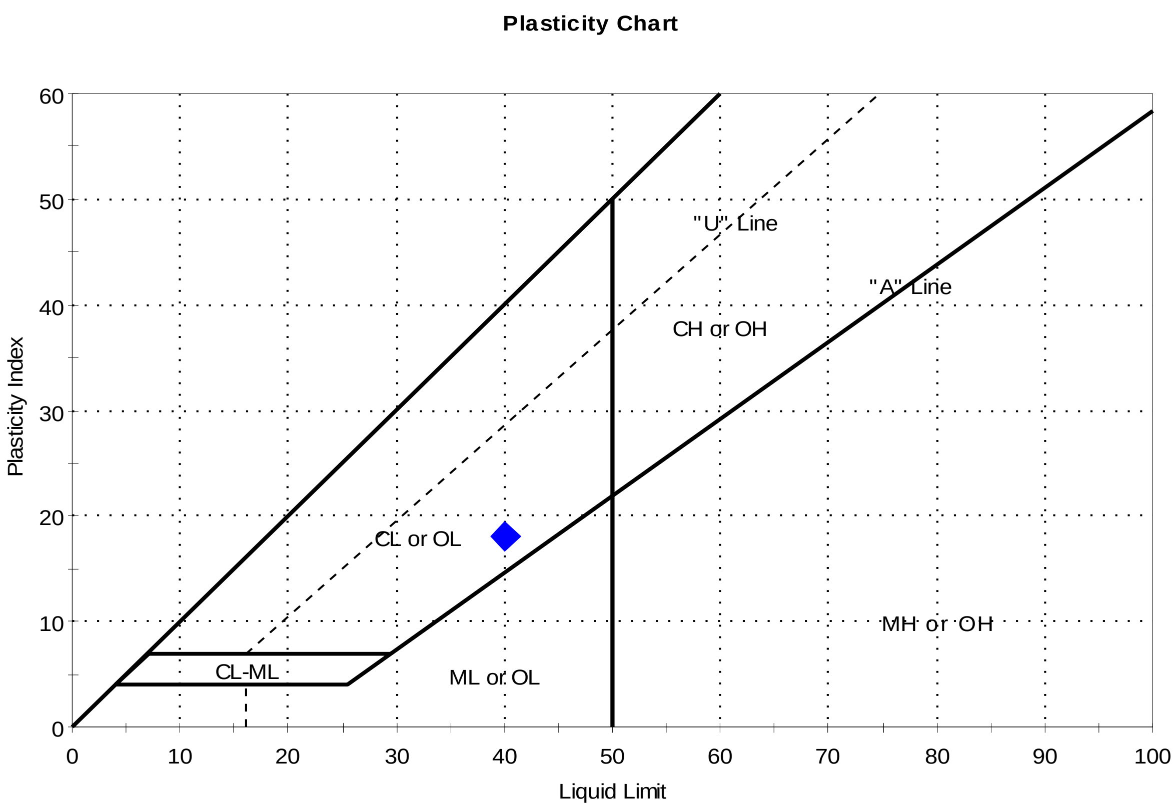
Client: Haley & Aldrich, Inc.			
Project: Wastewater Treatment Facility Upgrades			
Location: Exeter, NH		Project No:	GTX-303499
Boring ID: HA15-11	Sample Type: tube	Tested By:	cam
Sample ID: U2	Test Date: 08/04/15	Checked By:	jdt
Depth : 49-51	Test Id: 339895		
Test Comment: ---			
Visual Description: Moist, olive gray clay			
Sample Comment: ---			

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	U2	HA15-11	49-51	43	40	22	18	1.2	

Sample Prepared using the WET method

Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

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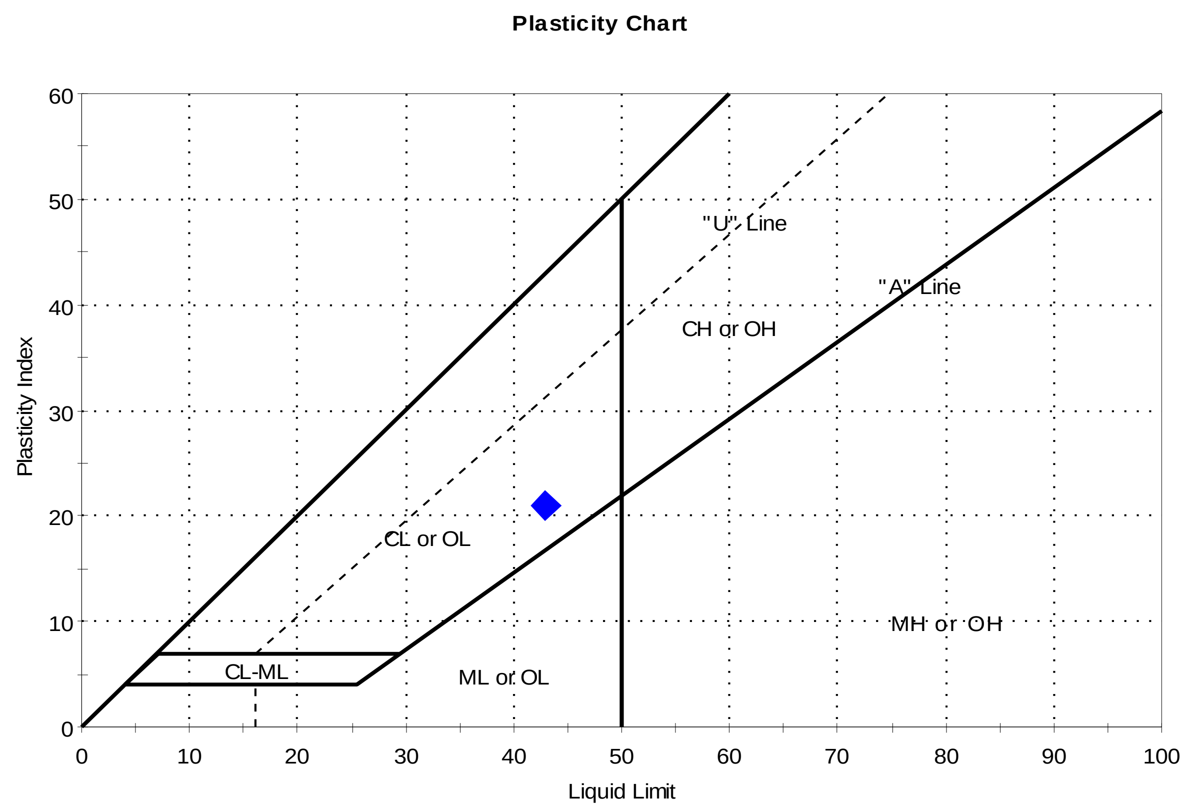
Client:	Haley & Aldrich, Inc.		
Project:	Wastewater Treatment Facility Upgrades		
Location:	Exeter, NH	Project No:	GTX-303499

Boring ID:	HA15-11	Sample Type:	jar	Tested By:	cam
Sample ID:	S7	Test Date:	08/04/15	Checked By:	jdt
Depth :	24-26	Test Id:	339898		

Test Comment: ---
Visual Description: Moist, olive clay
Sample Comment: ---

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	S7	HA15-11	24-26	32	43	22	21	0.5	

Sample Prepared using the WET method

Dry Strength: VERY HIGH
Dilatancy: SLOW
Toughness: LOW

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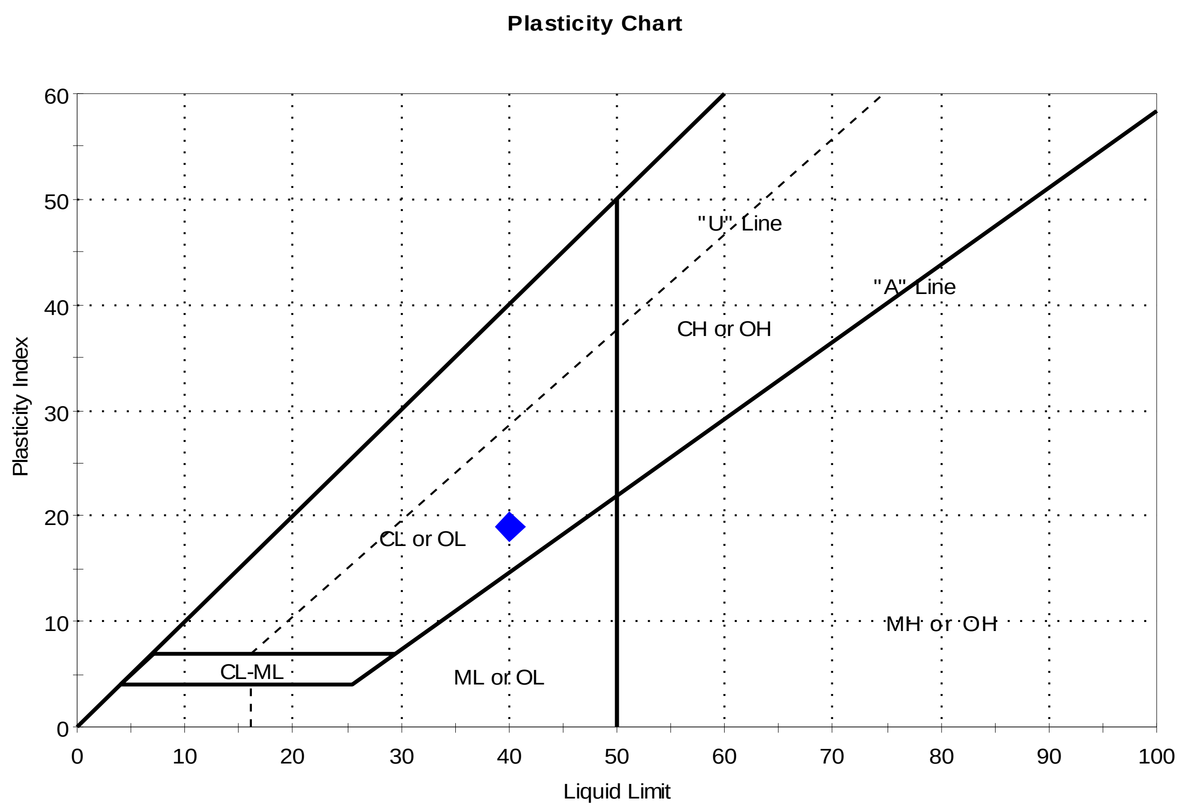
Client:	Haley & Aldrich, Inc.		
Project:	Wastewater Treatment Facility Upgrades		
Location:	Exeter, NH	Project No:	GTX-303499
Boring ID: HA15-11	Sample Type: jar	Tested By:	cam
Sample ID: S10	Test Date: 08/04/15	Checked By:	jdt
Depth : 57-59	Test Id: 339899		
Test Comment:	---		
Visual Description:	Moist, dark greenish gray clay		
Sample Comment:	---		

Atterberg Limits - ASTM D4318



Symbol	Sample ID	Boring	Depth	Natural Moisture Content,%	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
◆	S10	HA15-11	57-59	40	40	21	19	1	

Sample Prepared using the WET method

Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

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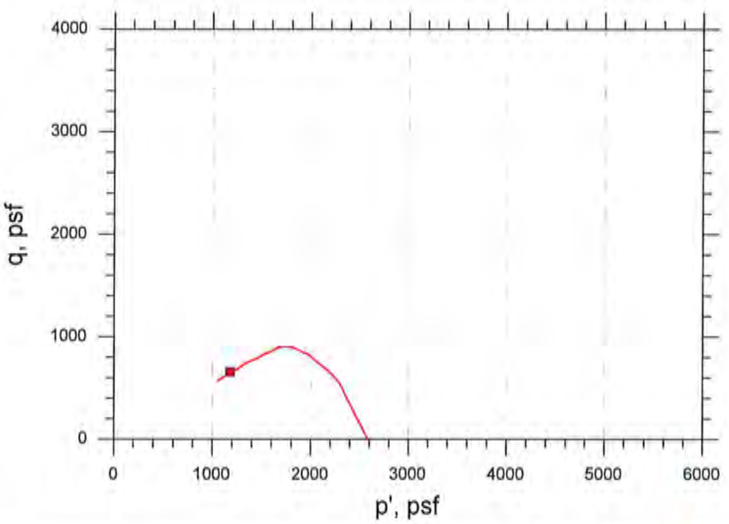
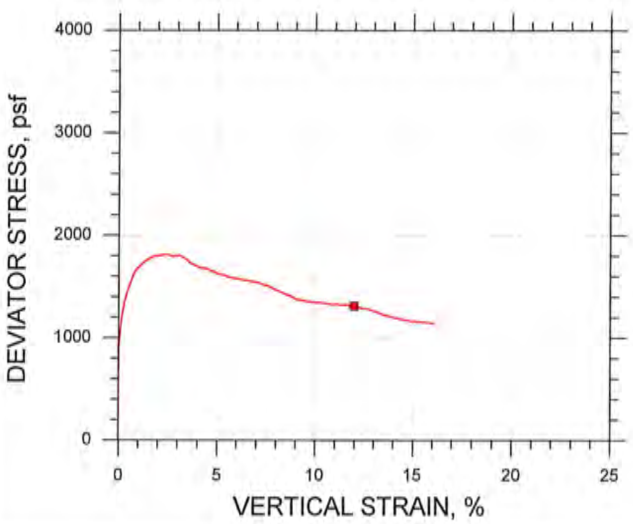
Client: Haley & Aldrich, Inc.	
Project Name: Wastewater Treatment	
Project Location: Exeter, NH	
Project Number: GTX-303499	
Tested By: md	Checked By: jdt
Boring ID: HA15-11	
Preparation: intact	
Description: Moist, olive gray clay	
Classification: ---	
Group Symbol: ---	
Liquid Limit: 40	Plastic Limit: 22
Plasticity Index: 18	Estimated Specific Gravity: 2.7

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





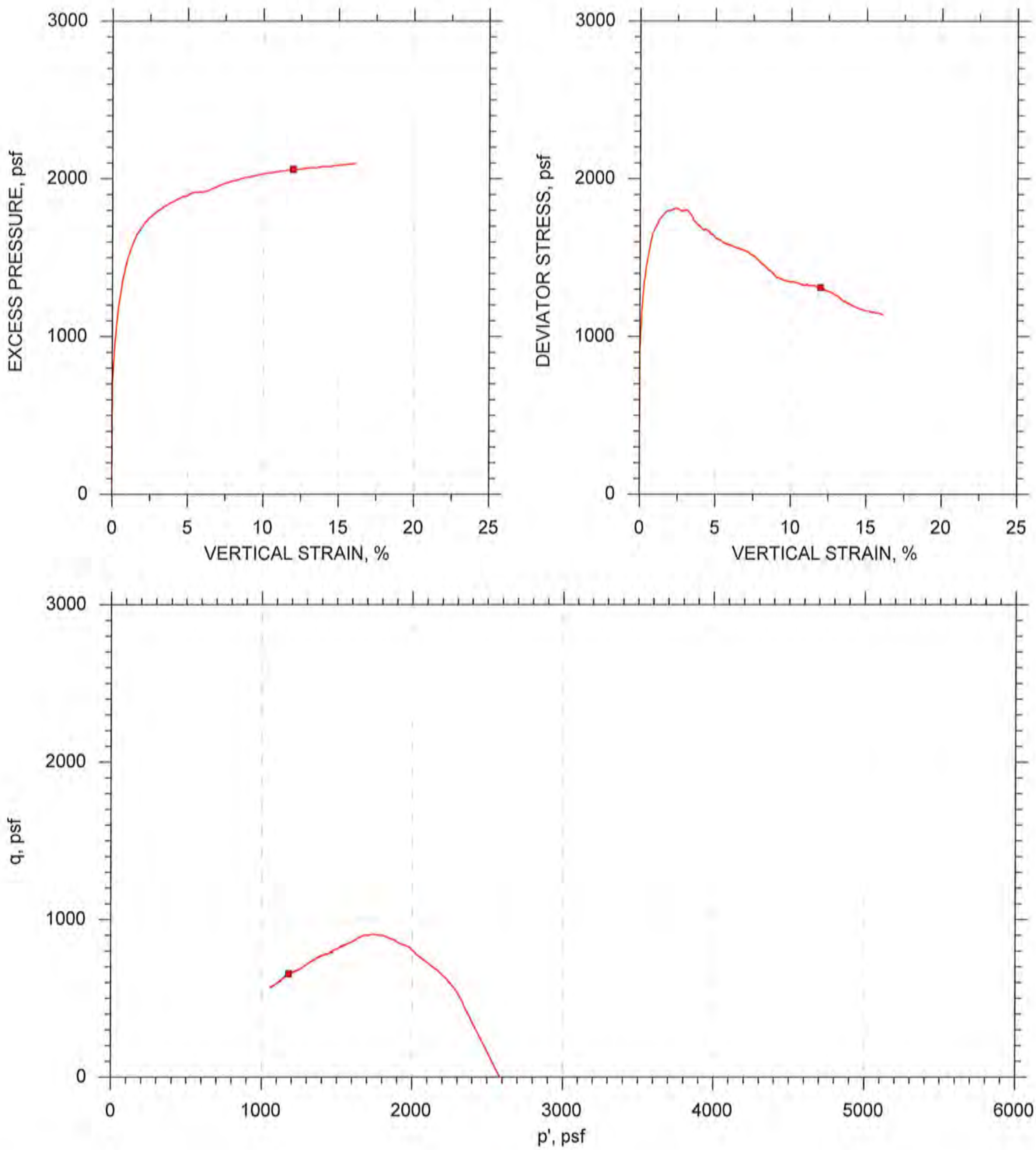
Symbol		■			
Sample ID		U2			
Depth, ft		49-51 ft			
Test Number		CU-1-1			
Initial	Height, in	4.550			
	Diameter, in	2.030			
	Moisture Content (from Cuttings), %	44.1			
	Dry Density, pcf	75.5			
	Saturation (Wet Method), %	96.7			
	Void Ratio	1.23			
Before Shear	Moisture Content, %	41.5			
	Dry Density, pcf	79.5			
	Cross-sectional Area (Method A), in²	3.106			
	Saturation, %	100.0			
	Void Ratio	1.12			
	Back Pressure, psf	2.027e+004			
Vertical Effective Consolidation Stress, psf		2576.			
Horizontal Effective Consolidation Stress, psf		2586.			
Vertical Strain after Consolidation, %		0.8451			
Volumetric Strain after Consolidation, %		4.409			
Time to 50% Consolidation, min		108.0			
Shear Strength, psf		655.5			
Strain at Failure, %		12.0			
Strain Rate, %/min		0.01600			
Deviator Stress at Failure, psf		1311.			
Effective Minor Principal Stress at Failure, psf		525.3			
Effective Major Principal Stress at Failure, psf		1836.			
B-Value		0.95			

Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Atterberg Limits determined by ASTM D4318.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

Remarks:

System T

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



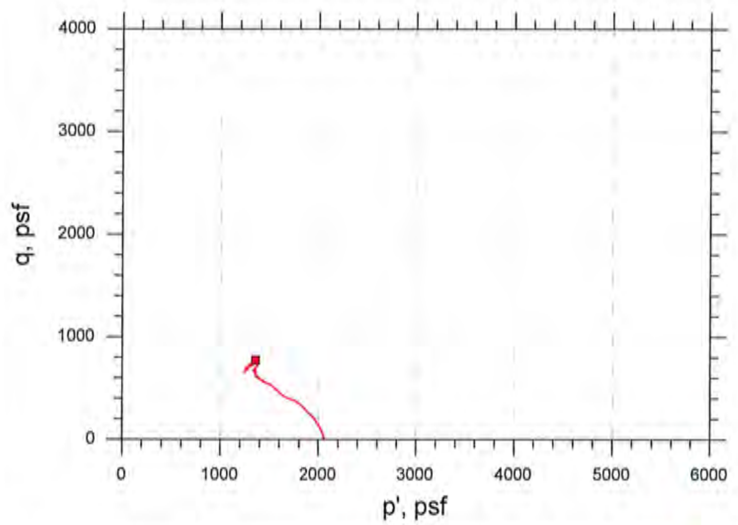
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	U2	CU-1-1	49-51 ft	md	7/27/15	jdt	---	303499-CU-1-1n.dat

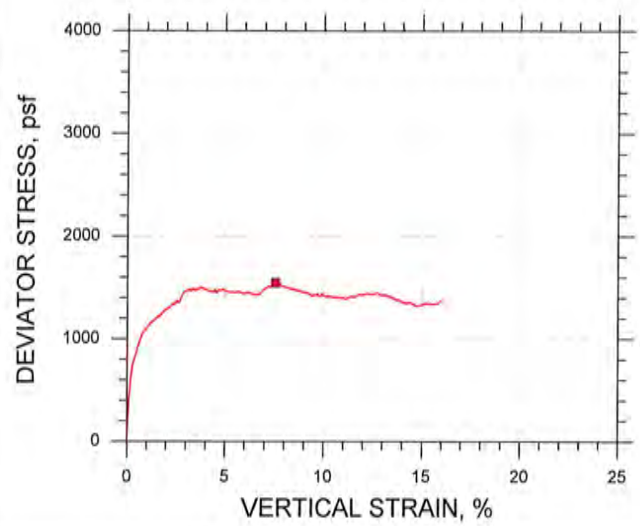
GeoTesting EXPRESS

Project: Wastewater Treatment	Location: Exeter, NH	Project No.: GTX-303499
Boring No.: HA15-11	Sample Type: intact	
Description: Moist, olive gray clay		
Remarks: System T		

Client: Haley & Aldrich, Inc.	
Project Name: Wastewater Treatment	
Project Location: Exeter, NH	
Project Number: GTX-303499	
Tested By: md	Checked By: jdt
Boring ID: HA15-11	
Preparation: intact	
Description: Moist, olive gray clay	
Classification: ---	
Group Symbol: ---	
Liquid Limit: 38	Plastic Limit: 24
Plasticity Index: 14	Estimated Specific Gravity: 2.7

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





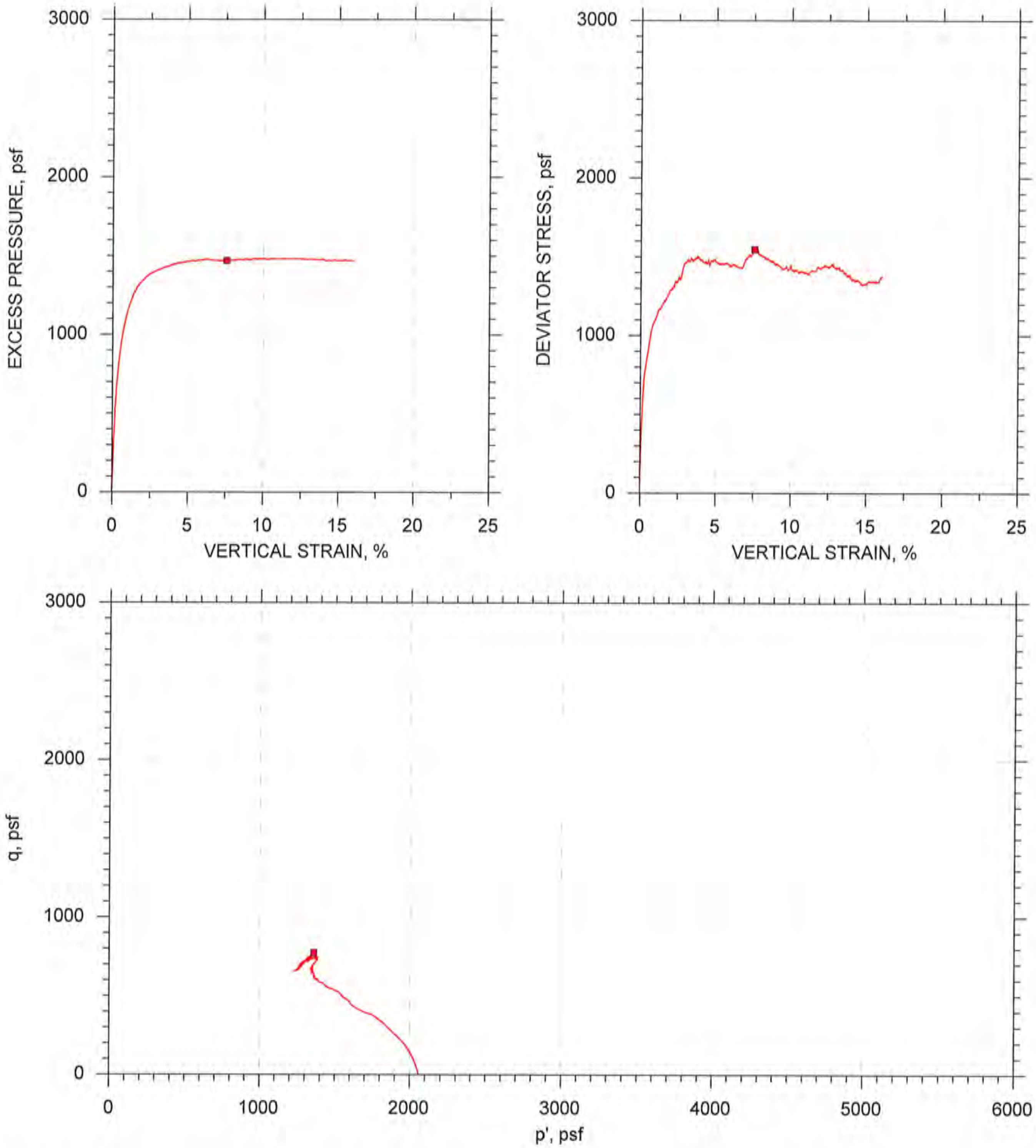
Symbol		■			
Sample ID		U1			
Depth, ft		34-36 ft			
Test Number		CU-2-1			
Initial	Height, in	4.600			
	Diameter, in	2.020			
	Moisture Content (from Cuttings), %	39.4			
	Dry Density, pcf	81.5			
	Saturation (Wet Method), %	99.7			
	Void Ratio	1.07			
Before Shear	Moisture Content, %	35.2			
	Dry Density, pcf	86.5			
	Cross-sectional Area (Method A), in²	3.079			
	Saturation, %	100.0			
	Void Ratio	0.949			
	Back Pressure, psf	2.025e+004			
Vertical Effective Consolidation Stress, psf		2046.			
Horizontal Effective Consolidation Stress, psf		2059.			
Vertical Strain after Consolidation, %		1.174			
Volumetric Strain after Consolidation, %		3.786			
Time to 50% Consolidation, min		96.00			
Shear Strength, psf		773.7			
Strain at Failure, %		7.55			
Strain Rate, %/min		0.01600			
Deviator Stress at Failure, psf		1547.			
Effective Minor Principal Stress at Failure, psf		585.9			
Effective Major Principal Stress at Failure, psf		2133.			
B-Value		0.95			

Notes:
- Before Shear Saturation set to 100% for phase calculation.
- Moisture Content determined by ASTM D2216.
- Atterberg Limits determined by ASTM D4318.
- Deviator Stress includes membrane correction.
- Values for c and φ determined from best-fit straight line for the specific test conditions. Actual strength parameters may vary and should be determined by an engineer for site conditions.

Remarks:

System W

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767



	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
■	U1	CU-2-1	34-36 ft	md	7/27/15	jdt	8/4/15	303499-CU-2-1n.dat

GeoTesting EXPRESS

Project: Wastewater Treatment	Location: Exeter, NH	Project No.: GTX-303499
Boring No.: HA15-11	Sample Type: intact	
Description: Moist, olive gray clay		
Remarks: System W		

HAZARDOUS MATERIALS ASSESSMENT for ASBESTOS, LEAD-BASED PAINT, PCB's & UNIVERSAL WASTE

at

WASTEWATER PUMP STATION
WATER STREET
EXETER, NEW HAMPSHIRE

NTC JOB #14816-2015

Prepared by:

NORTHEAST TEST CONSULTANTS
587 SPRING STREET
WESTBROOK, ME 04092

Prepared for:

Mr. Edward J. Leonard
Senior Project Engineer
Wright-Pierce
75 Washington Avenue, Suite 202
Portland, ME 04101

June 24, 2015

NORTHEAST TEST CONSULTANTS

June 24, 2015

Mr. Edward J. Leonard
Senior Project Engineer
Wright-Pierce
75 Washington Avenue, Suite 202
Portland, ME 04101

RE: **Asbestos, Lead Based-Paint,**
Polychlorinated Biphenyls (PCB's) and Universal Waste Assessment
Wastewater Pump Station, Water Street, Exeter, New Hampshire
NTC Job #14816-2015

Mr. Leonard:

Northeast Test Consultants has completed the **Asbestos, Lead-Based Paint, Polychlorinated Biphenyls (PCB's) and Universal Waste Assessment** at the Wastewater Pump Station located on Water Street in Exeter, New Hampshire.

PURPOSE

The purpose of this assessment was to characterize current environmental conditions at the site for the presence of Asbestos Containing Materials, Lead-Based Paint, Polychlorinated Biphenyls (PCB's) and Universal Wastes for demolition/renovation considerations.

PROCEDURES

On June 8, 2015 representatives of *Northeast Test Consultants* were on-site at the property to perform survey and inspection work.

No formal analytical testing for other specific items or chemicals was requested nor part of the scope of services provided.

Any conclusions contained herein are limited by the scope of work performed; no warranty, expressed or implied, is indicated as to any subsurface conditions not specifically noted within this report. All reasonable and customary assessment procedures and explorations for determination of the potential for multiple floor layering and possible hidden materials were performed during the course of this assessment activity, short of performing minor demolition.

Asbestos in Building Materials

The asbestos materials assessment consisted of visual evaluation and sample collection of suspect asbestos materials encountered by accredited US EPA Asbestos Inspectors and certified ME DEP asbestos inspectors, Brian Cohen, ME DEP #AI-0557 and Stacy Towne, ME DEP #AI-0642.

The collection of suspect asbestos containing building materials was in accordance with the *US EPA Asbestos Regulations*, *OSHA Regulations*, and the *State of New Hampshire* Asbestos Management Rules, He-P 5000, Inspection Requirements and Env-A 1804.01, Inspections Required Prior to Commencing Demolition or Renovation. Analysis of collected samples was performed as follows:

A. Surfacing materials and thermal system insulation and cementitious materials shall be analyzed using the PLM–EPA 600/R-93/116 visual estimation method (1993).

B. Non-friable Organically Bound materials (NOB's), including but not limited to floor tiles, asphalt shingles, caulking, glazing, mastics, coatings, sealants, adhesives and glues shall be analyzed using PLM NOB–EPA 600/R-93/116 with gravimetric preparation method.

Point counting of any samples with asbestos content less than 10% was automatically performed. Bulk sample groups were analyzed until a positive result was obtained or all samples in the group had been analyzed.

Lead-Based Paint

Lead-based paint determination was performed to identify if general painted components contained lead on interior and exterior painted surfaces of the structure.

The determination was performed by the collection of paint scrape samples followed by analysis for "Total Lead" content utilizing sample preparation according to ASTM D33335-85A and US EPA Method SW846- 3050B/7000B utilizing Atomic Absorption Spectrometry (AAS) to determine lead levels for OSHA compliance considerations.

The information compiled during this testing is not intended to be substituted for a comprehensive lead-based paint survey, or to be used to express potential exposure to airborne lead. The testing provides the client with information on the lead-based paint content on the materials tested.

Polychlorinated Bi-phenyls (PCB's)

The collection of suspect caulking materials for determination of polychlorinated bi-phenyls (PCB's) was performed in accordance with *US Environmental Protection Agency's* Method EPA 608 / SW-846 3550B (PCB) Preparation Method with Soxhlet Extraction and SW-846 8082 Analytical Method by Gas Chromatography.

Universal Waste

This assessment was performed to identify components and materials containing mercury such as light bulbs and thermostats, and containing PCB's/DEHP as in lighting system ballast components as well as other general universal waste materials. Items such as refrigerators and portable air conditioners, etc., were not quantified as they are considered items to be re-used at other facility locations.

Assessment was performed to identify and quantify materials/items for remediation and control considerations prior to demolition/renovation activities in accordance with the requirements of the *State of New Hampshire* Universal Waste Management Rules, CHAPTER Env-Hw 1100.

ASBESTOS INSPECTION & SAMPLING

A walkthrough was performed in all accessible areas of the structure and sampling was performed for all suspect asbestos containing materials excluding roof areas.

This inspection was performed in accordance with all reasonable and customary assessment procedures and explorations for the determination of the potential for multiple floor layering and possible hidden materials, short of performing minor demolition to dismantle/ deconstruct building components/systems.

The structure was found to have no suspect thermal systems insulation, flooring or wall/ceiling finishes.

The exterior elevations of all four (4) sides of the building were comprised of a transite sandwich panel system with the panel exterior having a mortar and pea stone finish.

Bulk samples of suspect materials collected during this assessment consisted of the following materials:

Sink Undercoating
Exterior Caulking
Cementitious Panels (transite)

The following number of samples were collected and analyzed during this assessment:

Analysis Type	Collected	Analyzed
PLM-Visual	5	5
PLM-NOB	4	4

<u>Asbestos</u> was detected in the following sampled materials:

Exterior

Transite Wall Panels	**B-6, 7 & 8**	**25 % Chrysotile Asbestos**

Refer to the attached analytical data sheets for descriptions and analysis data for collected samples, asbestos materials listing and marked drawings for sampling locations and regulated asbestos containing materials requiring abatement for renovation/demolition impact.

Limitations

Any conclusions contained herein are limited by the scope of work performed; no warranty, expressed or implied, is indicated as to any subsurface conditions not specifically noted within this report.

Explanation of Analysis Methods

The collected samples were analyzed utilizing Polarized Light Microscopy (PLM) as PLM–EPA 600/R-93/116 Visual Estimation Method (1993) and PLM NOB–EPA 600/R-93/116 with Gravimetric Preparation Method.

PLM is a US EPA accepted screening method for asbestos in bulks. This analytical method readily identifies asbestos content quantitatively. However, it can fail in samples where asbestos fibers are very fine or obscured by a tightly binding matrix system, for this reason PLM NOB methods is utilized for these types of materials.

PLM methods are compiled from standard techniques used in mineralogy and standard laboratory procedures used for asbestos bulk sample analysis. These techniques have been successfully applied to the analysis of US EPA Bulk Sample Analysis Quality Assurance Program since 1982.

Recommendations (Asbestos)

The asbestos containing material found at the site consists of a ***non-friable*** material in its present state, but can be rendered friable when impacted.

Friable materials can be crumbled by hand pressure and readily release asbestos fibers when impacted. Comparatively, *non-friable* materials do not crumble under hand pressure and do not readily release asbestos fibers to the surrounding atmosphere.

Materials containing equal to or greater than 1% of asbestos are a regulated material under the requirements of OSHA 29 CFR 1910.1001 and 29 CFR 1926.1101, US EPA, and ME DEP.

All work operations which would impact asbestos containing materials would need to be in compliance with the asbestos regulations as set forth in *OSHA* 29 CFR Part 1926.1101; US EPA Title 40 – CFR, Part 61 NESHAP, Subparts A and M (General Provisions and Asbestos Standards, respectively); & *State of New Hampshire* Asbestos Management Rules, He-P 5000.

Asbestos containing **Transite Wall Panels** identified at the structure need to be removed **prior to any demolition/renovation** activities that will cause damage to the material. Any removal and/or cleanup of the identified asbestos containing materials would need to be performed by properly trained and/or licensed companies and workers. Generated waste materials must be properly packaged and disposed of as asbestos waste in accordance with US EPA and NHDES regulatory requirements for Regulated Asbestos Containing Materials (RACM).

LEAD-BASED PAINT INSPECTION

A total of fourteen (14) painted surface bulk samples were collected and tested for "Total Lead" content.

A general listing of painted components tested for the presence of lead are as follows:

Foundation	Gray Paint
Concrete Platform	Gray Paint
Walls	White, Green, Light Blue, Dark Blue Paint
Floors	Gray Paint
Ceiling	White Paint
Door Frames	Gray Paint
Pipes/Valves	Gray Paint

The Consumer Products Safety Commission (CPSC) has established that paints containing lead values 0.06% and below to be non-lead containing (16 CFR 1303).

OSHA has recognized, that for certain workplace conditions, application of objective data to certain tasks listed in paragraph 1926.62(d)(2)(i)(A) may be warranted (specifically, power tool cleaning with dust collection systems, manual demolition of structures, manual scraping, and manual sanding). For these applications only, they have adopted the CPSC threshold under a very limited set of conditions. [1]

When a paint contains trace amounts of lead (e.g., 0.06% and below, as defined by the Consumer Products Safety Commission as non-lead containing, 16 CFR 1303), the employer may determine the concentration of lead in the air (i.e., employee exposure) by multiplying the total airborne concentration of dust times the percentage of lead in the paint. For example, if the concentration of total dust is 15 mg/m^3 and the concentration of lead in paint is 0.06%, the airborne lead level will be (0.06%) x (15 mg/m^3) x (1000 µg/mg) = 9 $\mu g/m^3$. [1]

Consequently, the airborne concentration of dust would have to be 50 mg/m^3 before the action level of 30 $\mu g/m^3$ would be reached. Arithmetically, this would read, (50 mg/m^3 total dust) x (0.06% lead) x (1000 $\mu g/mg$) = 30 $\mu g/m^3$ airborne lead. [1]

OSHA stresses that it does not set 0.06% as a lower threshold for the concentration of lead in paint which would exempt the employer from the requirements of the standard. The employer must still follow all requirements of the standard and conduct an exposure assessment for the tasks involving lead. Additionally, we are not stating that the Consumer Products Safety Commission level is a "safe" concentration of lead in paint, since all tasks listed under 1926.62(d)(2) frequently entail exposures above the action level, even at extremely low concentrations of lead. We are simply stating that the application of objective data may be applied to the above-specified tasks in paragraph 1926.62(d)(2)(i)(A), under the conditions stated herein. As these are less aggressive dust-generating methods of removal, this type of objective data may reasonably be applied. [1]

Analysis indicated that 5 samples were less than 0.06 percent by weight (<0.06%), and 9 samples were greater than 0.06 percent by weight (>0.06%) but less than 0.5% percent by weight (<0.5%).

Based on analysis data review, some lead content is present in paints tested, however no paints tested are at hazardous waste levels.

Refer to the attached "Analytical Results for Lead Based Paint" document and marked drawings for reference.

Limitations

In certain circumstances, leaded components may be covered by other building components, such as paneling/sheetrock, metal panels or transite sheeting enclosing or covering another painted surface, etc. It should be understood that this lead determination process was comprised of the collection of scrape samples for current surfaces. The Owner can either assume that inaccessible components contain lead-based paints or have them tested when renovation work may disturb them.

Recommendations (Lead Containing Paint)

Based on review of the analytical data for the collected paint samples, disturbance of painted surfaces does not appear to have the potential to create a significant risk for employees or the environment when performing general demolition actions and that the painted materials would not require any special handling or disposal requirements for any generated waste.

If significant dust is generated during renovation/demolition or any direct aggressive mechanical methods or flame torching of painted surfaces is conducted, then

contractors may be at risk for exposure to airborne lead levels. It is not the content of lead present for the painted surfaces but the method of impact that would determine what level of personal protective equipment would be required by affected personnel. Without conducting personal breathing zone monitoring, or without the benefit of historical or objective exposure data, an employer has no assurance of the employee's potential exposure.

The objective of this inspection/determination was to determine the presence of lead-based paint for overall renovation impact considerations and not to identify each and every surface of the structure containing lead-based paint. The information compiled during this testing is not intended to be substituted for a comprehensive lead-based paint survey, or to be used to express potential exposure to airborne lead for the purposes of regulation compliance. All scraping, sanding, cutting, welding, grinding, or demolition of any painted surface should not be performed under dry conditions in which airborne dust can be generated.

Similarly, renovation/demolition activities that may impact lead-containing components are a concern with respect to the generation of airborne lead dust; therefore, safety measures such as the use of engineering controls are essential in order to protect human health and the environment.

Contractors performing renovation/demolition activities in which excessive amounts of lead dust may potentially be generated shall be trained in the hazards of lead-containing materials and the subsequent control of the impacted environment, removal, cleaning, packaging, and handling of these materials as well as the wearing of NIOSH approved respirators, use of disposable clothing, and other requirements of the of the OSHA Standard.

Workers should not be exposed to airborne lead levels greater than 50 $\mu g/m^3$ as an eight-hour time weighted average (TWA) as outlined in OSHA *29 CFR Part 1926.62,* Lead Standard. Personal breathing zone sampling would be required to determine exposure.

All work operations impacting lead containing paints should be performed in accordance with the following regulations:

OSHA 29 CFR Part 1926.62, Lead Standard.
US EPA Renovation, Repair, & Repainting Rule (RRP), effective April 22, 2010

PCB INSPECTION

Polychlorinated biphenyls (PCBs) are a class of organic compounds with 1 to 10 chlorine atoms attached to biphenyl, which is a molecule composed of two benzene rings.

There are no known natural sources of PCBs. PCBs are either oily liquids or solids that are colorless to light yellow. Some PCBs can exist as a vapor in air. PCBs have no known smell or taste. Many commercial PCB mixtures are known in the U.S. by the trade name Aroclor.

Aroclor PCB mixtures were produced from approximately 1930 to 1979.

The specific Aroclor products screened for were Aroclor 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262 and 1268.

The first two digits generally refer to the number of carbon atoms in the phenyl rings and the last two digits in the name indicate the percentage of chlorine present in the material, for example, Aroclor 1016 means the product contains 10 carbon atoms and approximately 16% chlorine by weight.

US EPA regulatory guidelines classify materials with levels equal to or greater than 50 ppm ($\geq$ 50 ppm) of PCB content to be a controlled hazardous waste material under the Toxic Substance Control Act (TSCA).

A total of one (1) sample was collected for PCB content evaluation, representative of the type of exterior window caulking (Gray) present.

Review of sample results indicates that **no PCB's at regulatory levels are present in the exterior caulking materials sampled**.

Refer to the attached analytical data sheets for reference.

Recommendations (PCB's)

No recommendations required at this time.

UNIVERSAL WASTE ASSESSMENT

The areas were assessed for the presence of potential Universal Waste Items that may need to be addressed prior to demolition/renovation activities.

Universal Waste assessment was performed for compliance with the requirements of the *State of New Hampshire* Universal Waste Management Rules, CHAPTER Env-Hw 1100.

General comments regarding Universal Waste items:

Mercury:
Effective as of July 15, 2002, businesses and agencies can no longer dispose of mercury-added products in solid waste facilities (landfills or incinerators).

Thermostats
Mercury Thermostats may be recycled under the Thermostat Recycling Program. This program utilizes the existing wholesaler network by providing a collection container at participating locations. Return any out-of-service mercury thermostats to any participating HVAC wholesaler. Any name-brand mercury switch thermostat will be accepted.

Fluorescent Lamps
No fluorescent lamps are mercury-free.

This includes the new compact type light bulbs (CFL's) and lamps marketed as "low mercury" containing (green ends).

US EPA recommends that any mercury containing light bulb be recycled or properly handled and disposed properly, whether it is an older type bulb or a newer "low" mercury type bulb.

The State of New Hampshire law requires businesses and consumers to recycle *all mercury added lamps, including "low" mercury type bulbs* (green ends) under the CHAPTER Env-Hw 1100 rules.

PCB Ballasts
Non-leaking PCB ballasts are classified as a special hazardous waste and may be managed under the reduced requirements.

Waste from leaking ballasts is regulated by the Toxic Substances Control Act (TSCA).

Regulations require the use of DOT-approved 55-gallon drums for disposal of PCB capacitors once they are removed. Drums should contain absorbent material (speedi-dry or kitty litter) at the bottom in case some of the capacitors are damaged or leaking. There should be a PCB M_L label placed on each drum that contains PCB capacitors. Drums should be sealed and stored in a secure area that would minimize inadvertent damage or vandalism. Two drums are recommended, one to contain intact capacitors and one to contain any capacitors found to be leaking. This is beneficial because leaking capacitors must be disposed of within 30 days, however, intact capacitors can be stored until the drum is full.

NOTE: If one pound or more of PCBs (the amount in 12-16 ballasts) is released within 24 hours, notify the National Response Center.

Leaking Ballasts
TSCA Hotline .... (202) 554-1404

Releases of one pound or more
National Response Center............. (800) 424-8802

NON-PCB Ballasts:
Cannot be disposed of in conventional waste streams. Beginning in 1979 manufacturers began using **di (2-ethylhexyl) phthalate (DEHP)** as a replacement to polychlorinated biphenyl's (PCBs). DEHP is listed as a hazardous substance under the EPA's Superfund regulations. Generators discarding light ballasts should take the same precautions with their DEHP ballasts as they do with their PCB ballasts to avoid any future liabilities.

Miscellaneous Waste Items
No miscellaneous universal waste items consisting of ***Special and Hazardous Wastes*** were found to exist at the structures assessed.

Items such as any portable air conditioners and refrigerators (*Freon containing*), etc., were not included in any listing as they are assumed for re-use.

Refer to the attached Universal Waste Listing and marked drawing for locations, quantities, and types of items identified during this assessment.

Please review the attached analytical results for the collected bulk samples for asbestos, asbestos materials listing, analytical results for "Total Lead" in paints by AAS, PCB analytical analysis data, universal waste listing and marked drawings for all sampling parameters.

Should you have any questions regarding this assessment, please feel free to give me a call.

Sincerely,

John M. Boilard, RIHT
Operations Manager

Attachments

[1] OSHA's *Letters of Interpretation* regarding the concentration of lead in paint which triggers the Lead-in-Construction Standard 29 CFR 1926.62; 03/01/1999 & 09/10/2008.

ASBESTOS BULK RESULTS

Sample Date: 06/08/2015
NTC Job # 14816-2015

Client: Wright-Pierce
230 Commerce Way, Suite 302
Portsmouth, New Hampshire

Location: Pump Station
Water Street
Exeter, New Hampshire

Sample #	Lab #	Location / Description	% & Type of Asbestos	% & Type Fibrous Material	% Non-Fibrous Material
B-1	B- 5159022	Exterior, South Elevation **Caulking** around Aluminum Framing, White	None Detected	None Detected	40.0%
B-2	B- 5159023	Exterior, East Elevation **Caulking** around Aluminum Framing, White	None Detected	None Detected	35.8%
B-3	B- 5159024	Exterior, North Elevation **Caulking** around Aluminum Framing, White	None Detected	None Detected	34.9%
B-4	B- 5159025	Exterior, East Elevation **Remnant Caulk** around Windows, Gray	None Detected	None Detected	41.1%
B-5	B- 5159026	Exterior, North Elevation **Remnant Caulk** around Windows, Gray	None Detected	None Detected	39.0%
B-6	B- 5159027	Main Floor, Perimeter Walls, **Transite Panels**	**25% Chrysotile**	None Detected	75.0%
B-7	B- 5159028	Main Floor, Perimeter Walls, **Transite Panels**	*Sample Not Analyzed, Same as B-6*		
B-8	B- 5159029	Main Floor, Perimeter Walls, **Transite Panels**	*Sample Not Analyzed, Same as B-6*		
B-9	B- 5159030	Office & Control Room, Sink **Undercoating**, Gray	None Detected	2% Cellulose	98.0%

Sampled by: B. Cohen
Approved by: Stephen R. Broadhead
Initial

Lab: IATL (NVLAP# 101165-0) Analysis Method: PLM-EPA600/R-93/116 and/or PLM NOB-EPA600/R-93/116w/Gravimetric Prep

NTC

NORTHEAST TEST CONSULTANTS

ASBESTOS MATERIALS LISTING

CLIENT: Wright-Pierce
NTC Job #: 14816-2015
PROJECT: Pump Station
Water Street; Exeter, New Hampshire

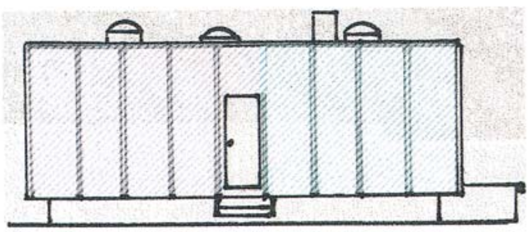
LINEAR AND SQARE FOOTAGE OF ASBESTOS CONTAINING MATERIAL

Homogeneous Area Sampling Location	Functional Space	Associated Field Sample	Elbows & Tees	Square Feet	Linear Feet	Remarks
Transite Sandwich Panels	Exterior Shell	**B6 B7 B8**		**Approx. 800**		Transite wall system consisting of inner and outer transite panels with approximately 1" of cellulose insulation filler. Transite wall system is used on the building's exterior shell which has a mortar and pea stone coating.

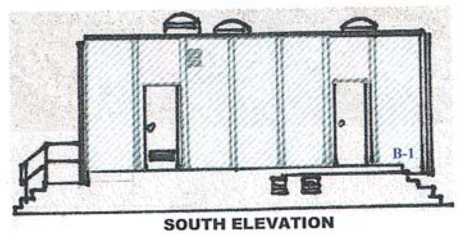
587 Spring Street • Westbrook • Maine 04092 (207) 854-3939 FAX (207) 854-3658

ASBESTOS MATERIALS SURVEY

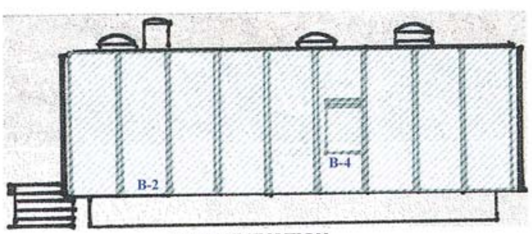
Water Street Pump Station
Exeter, New Hampshire



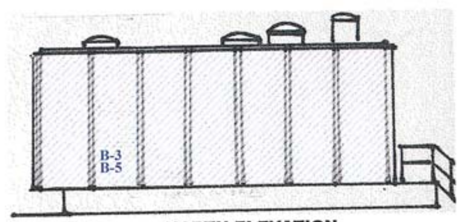
WEST ELEVATION



SOUTH ELEVATION



EAST ELEVATION



NORTH ELEVATION

KEY:

B-# BULK SAMPLES POSITIVE for ASBESTOS

B-# BULK SAMPLES NEGATIVE for ASBESTOS

ASBESTOS TRANSITE PANEL WALL SYSTEM (Approx. 850 square feet)

NTC

NORTHEAST TEST CONSULTANTS

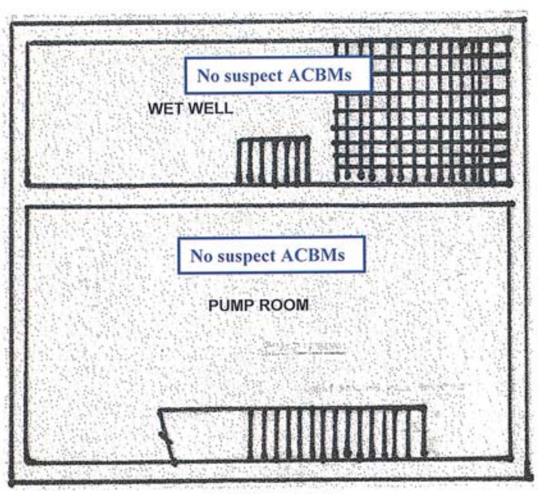
NTC JOB #14816-2015

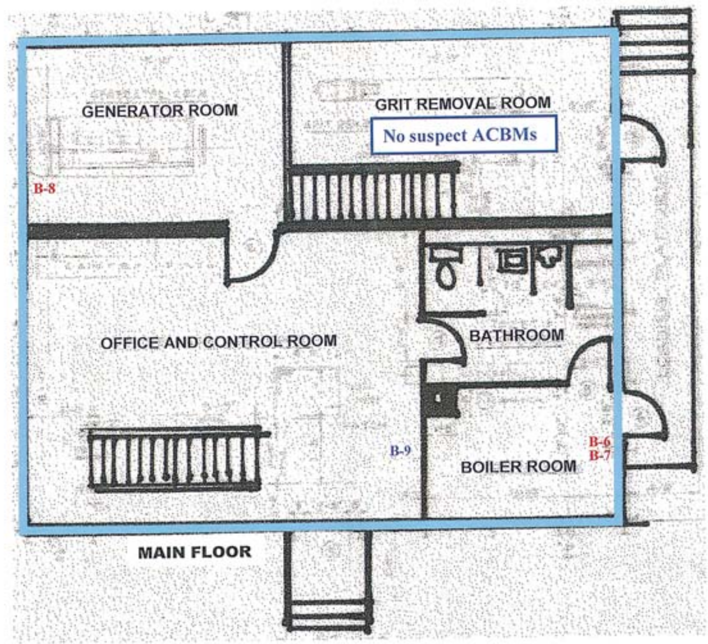
DRAWING DATE: 6-24-2015

BFC

DRAWING NOT TO SCALE

ASBESTOS MATERIALS SURVEY
Water Street Pump Station
Exeter, New Hampshire





KEY:

B-# BULK SAMPLES POSITIVE for ASBESTOS

B-# BULK SAMPLES NEGATIVE for ASBESTOS

ASBESTOS TRANSITE PANEL WALL SYSTEM (Approx. 850 square feet)

NTC — NORTHEAST TEST CONSULTANTS

NTC JOB #14816-2015

DRAWING DATE: 6-24-2015

BFC

DRAWING NOT TO SCALE

CLIENT: Wright-Pierce
230 Commerce Way, Suite 302
Portsmouth, New Hampshire

NTC JOB #: 14816-2015
SAMPLE DATE: 6/8/2015
ANALYZED DATE: 6/12/2015

TOTAL LEAD SAMPLE RESULTS

Pump Station, Water Street, Exeter, New Hampshire

Analytical Method: ASTM D3335-85A EPA SW846 3050B/7000B
by Atomic Absorption Spectrophotometry (AAS)

SAMPLE #	LAB ID #	SAMPLE DESCRIPTION	COLOR	TOTAL LEAD BY WEIGHT %
L-1	IHB5159008	Exterior, West Elevation, Foundation	Gray	0.14
L-2	IHB5159009	Exterior, South Elevation, Concrete Platform	Gray	0.12
L-3	IHB5159010	Grit Removal Room, Walls	White/ Green	0.084
L-4	IHB5159011	Grit Removal Room, Door Frame	Gray	0.024
L-5	IHB5159012	Main Floor, Floor	Gray	0.14
L-6	IHB5159013	"Wet Well", Walls	White/ Green	<0.0054
L-7	IHB5159014	Main Floor, Upper Walls	Light Blue	0.05
L-8	IHB5159015	Main Floor, Lower Walls	Dark Blue	<0.0052
L-9	IHB5159016	Main Floor, Ceiling	White	<0.0086
L-10	IHB5159017	Main Floor, Door Frame	Gray	0.33
L-11	IHB5159018	Pump Room, Upper Walls	Light Blue	0.22
L-12	IHB5159019	Pump Room, Lower Walls	Dark Blue	0.22
L-13	IHB5159020	Pump Room, Pipes, Valves	Gray	0.26
L-14	IHB5159021	Pump Room, Floor	Gray	0.6

Exceeds HUD/EPA Definition of Lead-Based Paint by AAS Analysis: 0.5% by weight

Exceeds Consumer Product Safety Commission Definition of Non-Lead-Based Paint by AAS Analysis: ≤ 0.06% by weight

* *Insufficient sample provided to perform QC reanalysis (<200 mg)*
** *Not enough sample provided to analyze (<50 mg)*
*** *Matrix/substrate interference possible.*

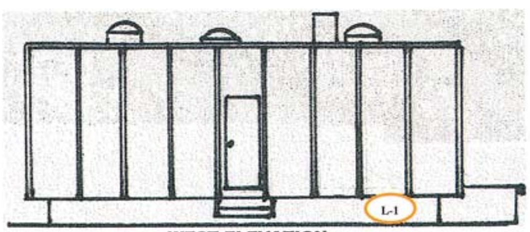
Analytical Laboratory: IATL

Sampled By: Brian Cohen

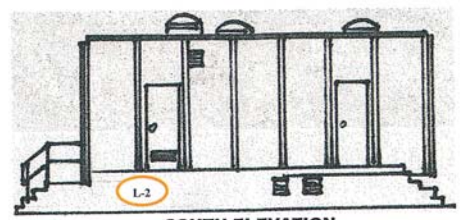
LEAD-BASED PAINT DETERMINATION SURVEY

Water Street Pump Station

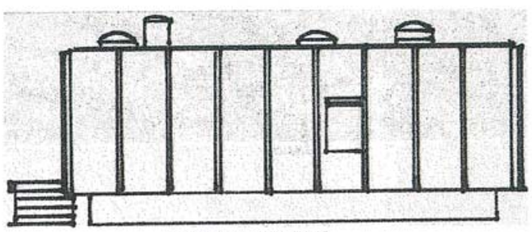
Exeter, New Hampshire



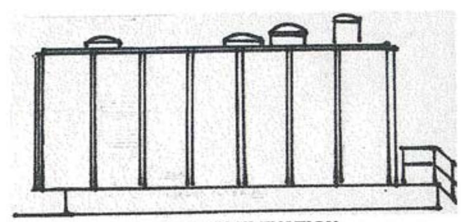
WEST ELEVATION



SOUTH ELEVATION



EAST ELEVATION



NORTH ELEVATION

KEY:

- L- BULK SAMPLE with TOTAL LEAD < 0.06% (CPSC Value)
- L- BULK SAMPLE with TOTAL LEAD > 0.06% (CPSC Value)
- L- BULK SAMPLE with TOTAL LEAD > 0.5% (US EPA Level)

NTC

NORTHEAST TEST CONSULTANTS

NTC JOB #14816-2015

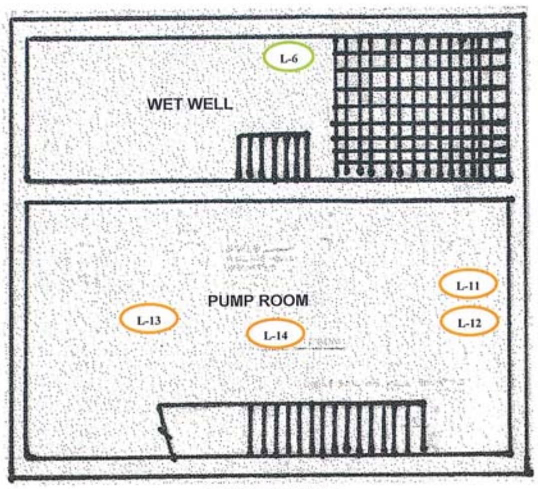
DRAWING DATE: 6-24-2015
BFC

DRAWING NOT TO SCALE

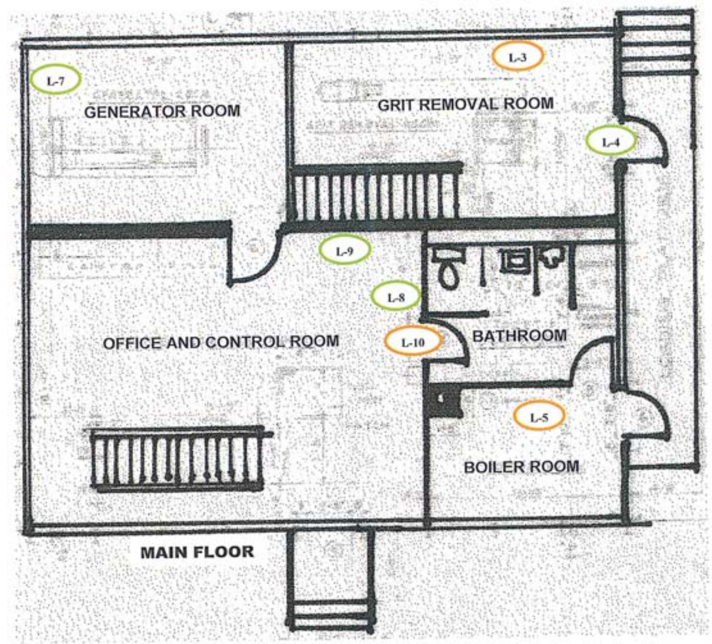
LEAD-BASED PAINT DETERMINATION SURVEY

Water Street Pump Station

Exeter, New Hampshire



LOWER FLOOR



MAIN FLOOR

KEY:

- (green circle) L- BULK SAMPLE with TOTAL LEAD < 0.06% (CPSC Value)
- (orange circle) L- BULK SAMPLE with TOTAL LEAD > 0.06% (CPSC Value)
- (blue circle) L- BULK SAMPLE with TOTAL LEAD > 0.5% (US EPA Level)

NTC

NORTHEAST TEST CONSULTANTS

NTC JOB #14816-2015

DRAWING DATE: 6-24-2015
BFC

DRAWING NOT TO SCALE

POLYCHLORINATED BIPHENYLS (PCB) ANALYSIS RESULTS

Pump Station
Water Street, Exeter, New Hampshire

Date Sampled: June 8, 2015
Sample Type: Caulking
Analytical Method: EPA 608/SW 846 8082 & Soxhlet Extraction (3540)
Sample /Lab#: **PCB-1 / IHB5159001**
Sample Location: **Pump Station, Water Street, Exeter, New Hampshire**
Sample Description: **Window Caulking, Gray**

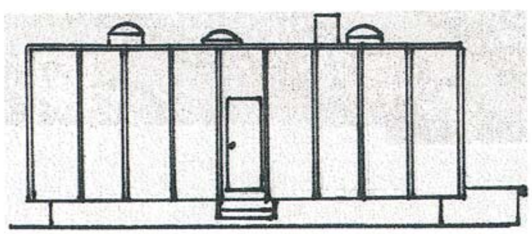
Polychlorinated Biphenyls (PCB)	Report Limit, ppm (mg/kg)	Result, ppm* (mg/kg)
Aroclor 1016	0.77	**ND**
Aroclor 1221	0.77	**ND**
Aroclor 1232	0.77	**ND**
Aroclor 1242	0.77	**ND**
Aroclor 1248	0.77	**ND**
Aroclor 1254	0.77	**ND**
Aroclor 1260	0.77	**0.82**
Aroclor 1262	0.77	**ND**
Aroclor 1268	0.77	**ND**

***Material containing PCB's ≥ 50 ppm designates material as Hazardous Waste under TSCA.**

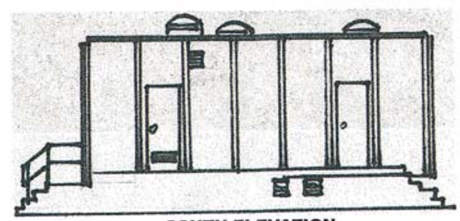
Laboratory: *Con-Test Analytical Laboratory*

PCB MATERIALS SURVEY

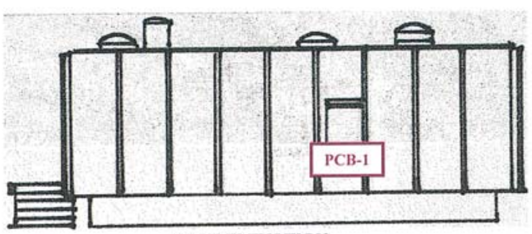
Water Street Pump Station
Exeter, New Hampshire



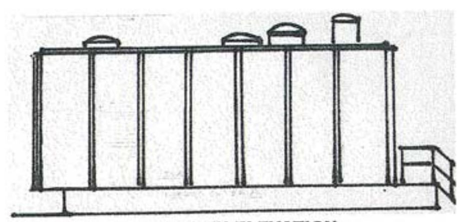
WEST ELEVATION



SOUTH ELEVATION



EAST ELEVATION



NORTH ELEVATION

KEY:

PCB-# SAMPLE LOCATION FOR PCB CAULKING

NTC

NORTHEAST TEST CONSULTANTS

NTC JOB #14816-2015

DRAWING DATE: 6-24-2015
BFC

DRAWING NOT TO SCALE

NTC

NORTHEAST TEST CONSULTANTS

UNIVERSAL WASTE LISTING

CLIENT: Wright-Pierce
NTC Job #: 14816-2015
PROJECT: Pump Station
Water Street
Exeter, New Hampshire

Exterior:

Mercury Containing Items

2	HID Bulbs

Main Floor:

Mercury Containing Items

4	Compact Fluorescent Bulbs
2	2' Bulbs
28	4' Bulbs
1	HID Bulb
1	Mercury Thermostat

PCB/DEHP Containing Items

14	Ballasts

Lower Floor:

Mercury Containing Items

2	Compact Fluorescent Bulbs
5	HID Bulb

Appendix C

Wright-Pierce
Engineering a Better Environment

APPENDIX C

PRELIMINARY DRAWINGS

BID SET No. ____________

TOWN OF EXETER, NEW HAMPSHIRE

CONTRACT DRAWINGS FOR

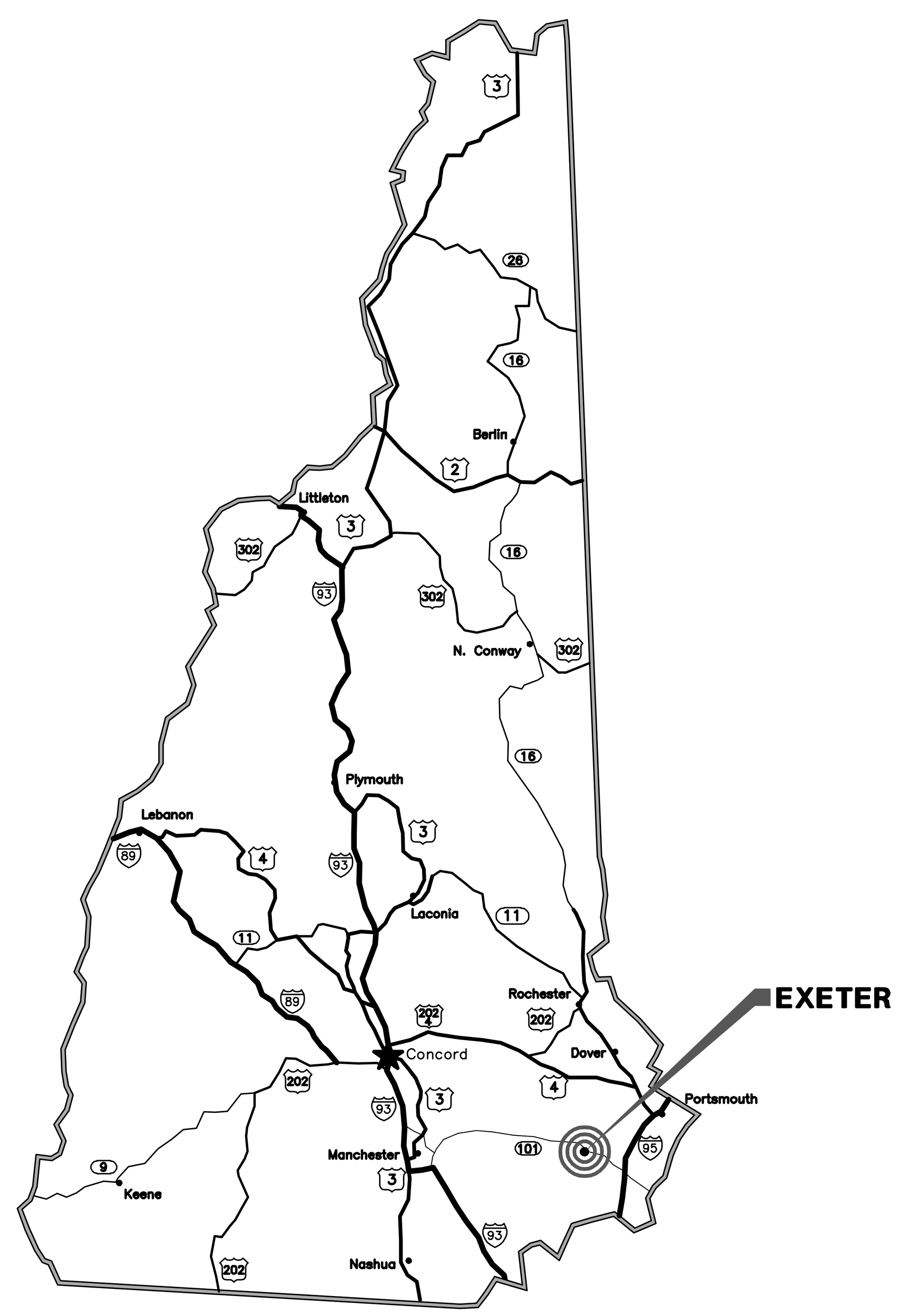
CONTRACT NO. 1

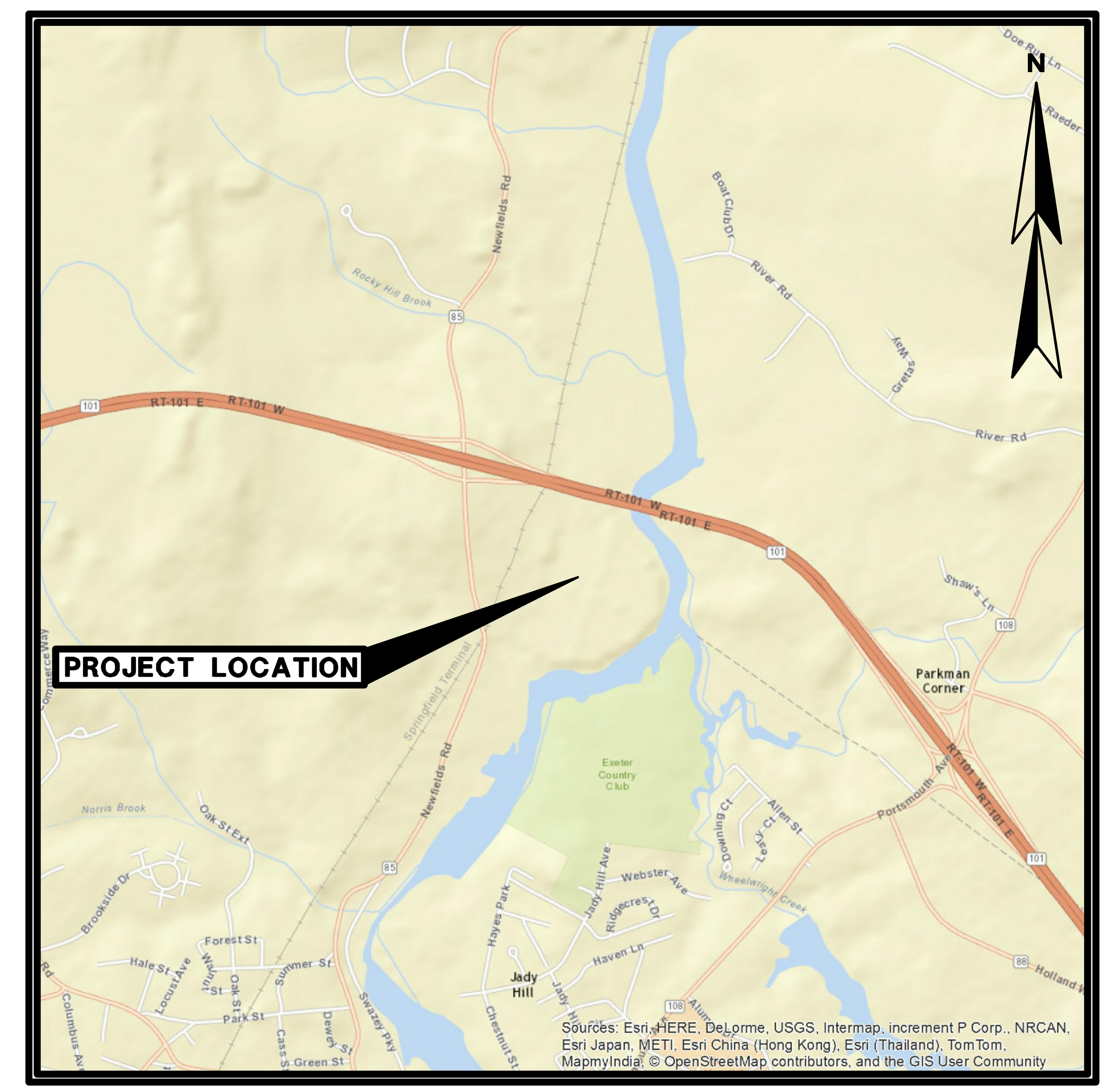
WASTEWATER TREATMENT FACILITY UPGRADES

SRF NO. XX-XXXXXX-XX

SEPTEMBER 2015

PDR SUBMITTAL





LOCATION PLAN

SCALE: 1" = 2000'

WRIGHT-PIERCE

Engineering a Better Environment

Offices Throughout New England

888.621.8156 | www.wright-pierce.com

FOR REVIEW SEPTEMBER 2015

FOR BIDDING ____________

WP PROJECT NO. 12883B

DRAWING INDEX

GENERAL

DRAWING NO.	TITLE
--	COVER
G-1	DRAWING INDEX

CIVIL

DRAWING NO.	TITLE
C-1	CIVIL NOTES, LEGEND AND ABBREVIATIONS
C-2	SITE KEY PLANS
C-3	EXISTING SITE CONDITIONS AND DEMOLITION PLAN I
C-2	EXISTING SITE CONDITIONS AND DEMOLITION PLAN II
C-5	EXISTING SITE CONDITIONS AND DEMOLITION PLAN III
C-6	EXISTING SITE CONDITIONS AND DEMOLITION PLAN IV
C-7	EXISTING SITE CONDITIONS AND DEMOLITION PLAN V
C-8	EXISTING SITE CONDITIONS AND DEMOLITION PLAN VI
C-9	EXISTING SITE CONDITIONS AND DEMOLITION PLAN VII
C-10	EXISTING SITE CONDITIONS AND DEMOLITION PLAN VIII
C-10A	FOCUS SITE PLAN
C-10B	SITE PROFILE – PROFILE A
C-10C	SITE PROFILE – PROFILE B
C-10D	SITE PROFILE – PROFILE C & PROFILE D
C-11	SITE LAYOUT PLAN I
C-12	SITE LAYOUT PLAN II
C-13	SITE LAYOUT PLAN III
C-14	SITE LAYOUT PLAN IV
C-15	SITE LAYOUT PLAN V
C-16	SITE LAYOUT PLAN VI
C-17	SITE GRADING PLAN I
C-18	SITE GRADING PLAN II
C-19	SITE GRADING PLAN III
C-20	SITE GRADING PLAN IV
C-21	SITE GRADING PLAN V
C-22	SITE GRADING PLAN VI
C-23	SITE PIPING PLAN I
C-24	SITE PIPING PLAN II
C-25	SITE PIPING PLAN III
C-26	SITE PIPING PLAN IV
C-27	SITE PIPING PLAN V
C-28	SITE PIPING PLAN VI
C-29	ROAD SECTIONS AND PROFILES
C-30	PIPING SECTIONS AND PROFILES
C-31	EROSION CONTROL NOTES & DETAILS
C-32	DETAILS I
C-33	DETAILS II
C-34	DETAILS III
C-35	DETAILS IV
C-100A	PLAN & PROFILE: ACCESS ROAD STA 1+00 TO STA 7+20

ARCHITECTURAL

DRAWING NO.	TITLE
A-1	ARCHITECTURAL NOTES, LEGEND AND ABBREVIATIONS
A-2	ARCHITECTURAL NOTES, LEGEND AND ABBREVIATIONS
A-3	GRIT/SEPTAGE BUILDING – FLOOR PLANS
A-4	SEPTAGE BUILDING – EXTERIOR ELEVATIONS, SECTIONS AND DETAILS
A-5	HEADWORKS BUILDING – FLOOR PLANS
A-6	HEADWORKS BUILDING – EXTERIOR ELEVATIONS
A-7	HEADWORKS BUILDING – SECTIONS
A-8	HEADWORKS BUILDING – DETAILS
A-9	CHLORINATION/PLANT WATER BUILDING – FLOOR PLANS
A-10	PLANT WATER BUILDING – EXTERIOR ELEVATIONS, SECTIONS AND DETAILS
A-11	DISINFECTION TANK/BUILDING – FLOOR PLAN
A-12	DISINFECTION TANK/BUILDING – EXTERIOR ELEVATIONS
A-13	DISINFECTION TANK/BUILDING – SECTIONS
A-14	DISINFECTION TANK/BUILDING – DETAILS
A-15	SOLIDS HANDLING BUILDING – LOWER FLOOR PLAN
A-16	SOLIDS HANDLING BUILDING – FIRST FLOOR PLAN
A-17	SOLIDS HANDLING BUILDING – EXTERIOR ELEVATIONS I
A-18	SOLIDS HANDLING BUILDING – EXTERIOR ELEVATIONS II
A-19	SOLIDS HANDLING BUILDING – SECTIONS I
A-20	SOLIDS HANDLING BUILDING – SECTIONS II
A-21	SOLIDS HANDLING BUILDING – DETAILS
A-22	CONTROL BUILDING – DEMO PLANS AND LOWER FLOOR MODIFICATION PLAN
A-23	CONTROL BUILDING – FIRST FLOOR MODIFICATION PLAN
A-24	CONTROL BUILDING – ELEVATIONS
A-25	CONTROL BUILDING – SECTIONS
A-26	CONTROL BUILDING – INTERIOR ELEVATIONS
A-27	CONTROL BUILDING – DETAILS
A-28	MAINTENANCE BUILDING – FLOOR PLAN AND ELEVATIONS
A-29	MAINTENANCE BUILDING – SECTIONS AND DETAILS
A-30	SUPPLEMENTAL CHEMICAL BUILDING – FLOOR PLAN AND ELEVATIONS
A-31	SUPPLEMENTAL CHEMICAL BUILDING – SECTIONS AND DETAILS
A-32	ROOM FINISH SCHEDULES
A-33	DOOR SCHEDULES
A-34	WINDOW ELEVATIONS
A-35	DOOR AND WINDOW DETAILS I
A-36	DOOR AND WINDOW DETAILS II
A-37	STAIR DETAILS
A-38	DETAILS I
A-39	DETAILS II
A-40	DETAILS III

STRUCTURAL

DRAWING NO.	TITLE
S-1	STRUCTURAL NOTES, LEGEND AND ABBREVIATIONS
S-2	GRIT BUILDING DEMOLITION AND MODIFICATION PLAN
S-3	GRIT BUILDING SECTIONS AND DETAILS
S-4	HEADWORKS FOUNDATION PLAN
S-5	HEADWORKS FIRST FLOOR PLAN
S-6	HEADWORKS ROOF PLAN
S-7	HEADWORKS SECTIONS AND DETAILS I
S-8	HEADWORKS SECTIONS AND DETAILS II
S-9	DISINFECTION BUILDING I DEMOLITION AND MODIFICATION PLAN
S-10	DISINFECTION BUILDING I SECTIONS AND DETAILS
S-11	DISINFECTION BUILDING II DEMOLITION PLAN
S-12	DISINFECTION BUILDING II PLAN
S-13	DISINFECTION BUILDING II ROOF PLAN
S-14	DISINFECTION BUILDING II SECTIONS AND DETAILS I
S-15	DISINFECTION BUILDING II SECTIONS AND DETAILS II
S-16	SOLIDS HANDLING BUILDING FOUNDATION PLAN
S-17	SOLIDS HANDLING BUILDING FIRST FLOOR PLAN
S-18	SOLIDS HANDLING BUILDING ROOF PLAN
S-19	SOLIDS HANDLING BUILDING SECTIONS AND DETAILS I
S-20	SOLIDS HANDLING BUILDING SECTIONS AND DETAILS II
S-21	SOLIDS HANDLING BUILDING SECTIONS AND DETAILS III
S-22	CONTROL BUILDING DEMOLITION PLAN
S-23	CONTROL BUILDING BASEMENT PLAN
S-24	CONTROL BUILDING FIRST FLOOR PLAN
S-25	CONTROL BUILDING SECTIONS AND DETAILS I
S-26	SEPTAGE RECEIVING TANK DEMOLITION AND MODIFICATION PLAN, DETAILS
S-27	SEPTAGE RECEIVING SECTIONS AND DETAILS
S-28	AERATION TANKS PLANS
S-29	AERATION TANKS PLANS AND SECTIONS
S-30	AERATION TANKS AERATION PIPE SUPPORT PLAN
S-31	AERATION TANKS DETAILS I
S-32	AERATION TANKS DETAILS II
S-33	SECONDARY CLARIFIERS PLANS
S-34	SECONDARY CLARIFIERS PLANS AND SECTIONS
S-35	SECONDARY CLARIFIERS PLANS AND SECTIONS
S-36	SECONDARY CLARIFIERS DETAILS I
S-37	SECONDARY CLARIFIERS DETAILS II

STRUCTURAL (cont.)

DRAWING NO.	TITLE
S-38	SLUDGE STORAGE TANKS PLANS
S-39	SLUDGE STORAGE TANKS PLANS AND SECTIONS
S-40	SLUDGE STORAGE TANKS AERATION PIPE SUPPORT PLAN
S-41	SLUDGE STORAGE TANKS DETAILS I
S-42	SLUDGE STORAGE TANKS DETAILS II
S-43	MISCELLANEOUS STRUCTURES I
S-44	MISCELLANEOUS STRUCTURES II
S-45	DETAILS I
S-46	DETAILS II
S-47	DETAILS III

PROCESS

DRAWING NO.	TITLE
PR-1	PROCESS NOTES
PR-2	PROCESS LEGEND AND ABBREVIATIONS
PR-3	HYDRAULIC PROFILE I
PR-4	HYDRAULIC PROFILE II
PR-5	PROCESS FLOW SCHEMATIC – HEADWORKS
PR-6	PROCESS FLOW SCHEMATIC – INFLUENT EQUALIZATION
PR-7	PROCESS FLOW SCHEMATIC – BNR/SECONDARY TREATMENT
PR-8	PROCESS FLOW SCHEMATIC – DISINFECTION
PR-9	PROCESS FLOW SCHEMATIC – SLUDGE HANDLING
PR-10	PROCESS FLOW SCHEMATIC – DEWATERING
PR-11	PROCESS FLOW SCHEMATIC – ODOR CONTROL
PR-12	PROCESS FLOW SCHEMATIC – CHEMICAL FEED SYSTEMS
PR-13	SEPTAGE RECEIVING TANK DEMOLITION AND MODIFICATION PLANS AND SECTIONS
PR-14	GRIT BUILDING DEMOLITION PLAN AND SECTIONS
PR-15	SEPTAGE BUILDING MODIFICATION PLAN AND SECTIONS
PR-16	HEADWORKS UPPER AND LOWER LEVEL PLANS
PR-17	HEADWORKS SECTIONS AND DETAILS
PR-18	AERATION TANKS LOWER LEVEL PLAN
PR-19	AERATION TANKS UPPER LEVEL PLAN
PR-20	AERATION TANKS SECTIONS AND DETAILS
PR-21	SECONDARY CLARIFIERS PLAN, SECTION AND DETAILS
PR-22	SECONDARY CLARIFIERS DETAILS
PR-23	CHLORINE CONTACT TANK DEMOLITION PLAN AND SECTION
PR-24	DISINFECTION TANK/BUILDING MODIFICATION PLAN AND SECTION
PR-25	CHLORINE CONTACT TANK / DISINFECTION TANK/BUILDING DEMOLITION AND MODIFICATION SECTIONS
PR-26	PARSHALL FLUME DEMOLITION AND MODIFICATION PLANS AND SECTIONS
PR-27	CHEMICAL/PLANT WATER BUILDING DEMOLITION AND MODIFICATION PLANS AND SECTIONS
PR-28	CONTROL BUILDING DEMOLITION PLAN AND SECTIONS
PR-29	SOLIDS HANDLING BUILDING LOWER FLOOR PLAN
PR-30	SOLIDS HANDLING BUILDING FIRST FLOOR PLAN
PR-31	SOLIDS HANDLING BUILDING SECTIONS I
PR-32	SOLIDS HANDLING BUILDING SECTIONS II
PR-33	SLUDGE STORAGE TANK PLAN
PR-34	SLUDGE STORAGE TANK SECTIONS
PR-35	SUPPLEMENTAL CHEMICAL BUILDING PLAN AND SECTIONS
PR-36	INFLUENT FLOW EQUALIZATION AND YARD PUMP STATIONS PLANS AND SECTIONS
PR-37	MISCELLANEOUS STRUCTURES I
PR-38	MISCELLANEOUS STRUCTURES II
PR-39	GATE DETAILS
PR-40	DETAILS I
PR-41	DETAILS II
PR-42	DETAILS III

MECHANICAL

DRAWING NO.	TITLE
M-1	MECHANICAL NOTES, LEGEND, ABBREVIATIONS AND DESIGN DATA
M-2	GRIT BUILDING DEMOLITION PLAN AND SECTIONS
M-3	GRIT BUILDING MODIFICATION PLAN AND SECTIONS
M-4	HEADWORKS LOWER LEVEL PLAN
M-5	HEADWORKS UPPER LEVEL PLAN
M-6	DISINFECTION BUILDING I DEMOLITION PLAN AND SECTIONS
M-7	DISINFECTION BUILDING I MODIFICATION PLAN AND SECTIONS
M-8	DISINFECTION BUILDING II DEMOLITION PLAN AND SECTIONS
M-9	DISINFECTION BUILDING II PLAN AND SECTIONS
M-10	SOLIDS HANDLING BUILDING LOWER LEVEL PLAN AND SECTIONS
M-11	SOLIDS HANDLING BUILDING UPPER LEVEL PLAN AND SECTIONS
M-12	CONTROL BUILDING DEMOLITION PLAN AND SECTIONS
M-13	CONTROL BUILDING LOWER LEVEL PLAN
M-14	CONTROL BUILDING UPPER LEVEL PLAN
M-15	EQUIPMENT SCHEDULES I
M-16	EQUIPMENT SCHEDULES II
M-17	MECHANICAL DETAILS I
M-18	MECHANICAL DETAILS II

PLUMBING

DRAWING NO.	TITLE
P-1	PLUMBING NOTES, LEGEND, ABBREVIATIONS AND SCHEDULES
P-2	GRIT BUILDING DEMOLITION PLAN AND SECTIONS
P-3	GRIT BUILDING MODIFICATION PLAN AND SECTIONS
P-4	HEADWORKS LOWER LEVEL PLAN
P-5	HEADWORKS UPPER LEVEL PLAN
P-6	DISINFECTION BUILDING I DEMOLITION PLAN AND SECTIONS
P-7	DISINFECTION BUILDING I MODIFICATION PLAN AND SECTIONS
P-8	DISINFECTION BUILDING II DEMOLITION PLAN AND SECTIONS
P-9	DISINFECTION BUILDING II PLAN AND SECTIONS
P-10	SOLIDS HANDLING BUILDING LOWER LEVEL PLAN AND SECTIONS
P-11	SOLIDS HANDLING BUILDING UPPER LEVEL PLAN AND SECTIONS
P-12	CONTROL BUILDING DEMOLITION PLAN AND SECTIONS
P-13	CONTROL BUILDING LOWER LEVEL PLAN
P-14	CONTROL BUILDING UPPER LEVEL PLAN
P-15	EQUIPMENT SCHEDULES I
P-16	RISER DIAGRAMS
P-17	DETAILS I
P-18	DETAILS II

FIRE PROTECTION

DRAWING NO.	TITLE
FP-1	GENERAL NOTES, LEGEND AND ABBREVIATIONS
FP-2	SOLIDS HANDLING BUILDING
FP-3	CONTROL BUILDING

INSTRUMENTATION

DRAWING NO.	TITLE
I-1	INSTRUMENTATION NOTES, LEGEND AND ABBREVIATIONS
I-2	NETWORK DIAGRAM I
I-3	NETWORK DIAGRAM II
I-4	INSTRUMENTATION LOOPS I
I-5	INSTRUMENTATION LOOPS II
I-6	INSTRUMENTATION LOOPS III
I-7	INSTRUMENTATION LOOPS IV
I-8	INSTRUMENTATION LOOPS V
I-9	INSTRUMENTATION LOOPS VI
I-10	INSTRUMENTATION LOOPS VII
I-11	INSTRUMENTATION LOOPS VIII
I-12	INSTRUMENTATION LOOPS IX
I-13	INSTRUMENTATION LOOPS X
I-14	INSTRUMENTATION LOOPS XI
I-15	INSTRUMENTATION LOOPS XII

ELECTRICAL

DRAWING NO.	TITLE
E-1	ELECTRICAL LEGEND, CONDUIT INSTALLATION SCHEDULE AND NEMA SCHEDULE
E-2	ELECTRICAL NOTES AND ABBREVIATIONS
E-3	SINGLE LINE DIAGRAM – SWITCHGEAR SWGR-SB-1
E-4	SINGLE LINE DIAGRAM – MCC NO. 1
E-5	SINGLE LINE DIAGRAM – MCC NO. 2 AND 3
E-6	SINGLE LINE DIAGRAM – MCC-HW, MCC-SEP
E-7	SINGLE LINE DIAGRAM – MCC-SB-1A, MCC-SB-1B
E-8	SINGLE LINE DIAGRAM – MCC-PW-1A, MCC-PW-1B
E-9	SINGLE LINE DIAGRAM – MCC-CB-1, MCC-SB-2
E-10	ELECTRICAL SITE PLAN – DEMOLITION
E-11	ELECTRICAL SITE PLAN – MODIFICATION
E-12	ELECTRICAL SITE PLAN – PART PLAN
E-13	ELECTRICAL SITE PLAN – PART PLAN
E-14	GRIT REMOVAL BUILDING DEMOLITION AND MODIFICATIONS
E-15	PANELBOARD SCHEDULES
E-16	CONDUIT AND WIRE SCHEDULES
E-17	HEADWORKS POWER PLAN – LOWER
E-18	HEADWORKS POWER PLAN – UPPER
E-19	HEADWORKS LIGHTING PLAN – LOWER
E-20	HEADWORKS LIGHTING PLAN – UPPER
E-21	PANELBOARD SCHEDULES
E-22	CONDUIT AND WIRE SCHEDULES
E-23	DISINFECTION BUILDING I DEMOLITION AND MODIFICATIONS
E-24	DISINFECTION BUILDING II DEMOLITION
E-25	DISINFECTION BUILDING II POWER PLAN
E-26	DISINFECTION BUILDING II LIGHTING PLAN
E-27	PANELBOARD SCHEDULES
E-28	CONDUIT AND WIRE SCHEDULES
E-29	SOLIDS HANDLING BUILDING POWER PLAN – LOWER
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E-31	SOLIDS HANDLING BUILDING LIGHTING PLAN – LOWER
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E-33	PANELBOARD SCHEDULES
E-34	CONDUIT AND WIRE SCHEDULES
E-35	CONTROL BUILDING DEMOLITION I
E-36	CONTROL BUILDING DEMOLITION II
E-37	CONTROL BUILDING POWER PLAN – LOWER
E-38	CONTROL BUILDING POWER PLAN – UPPER
E-39	CONTROL BUILDING LIGHTING PLAN – LOWER
E-40	CONTROL BUILDING LIGHTING PLAN – UPPER
E-41	PANELBOARD SCHEDULES
E-42	CONDUIT AND WIRE SCHEDULES
E-43	SEPTAGE RECEIVING TANK DEMOLITION AND MODIFICATIONS
E-44	AERATION TANKS POWER/LIGHTING PLAN
E-45	AERATION TANKS ELECTRICAL WIRING DETAILS
E-46	SECONDARY CLARIFIERS ELECTRICAL POWER/LIGHTING PLAN
E-47	SLUDGE STORAGE TANKS POWER/LIGHTING PLAN
E-48	SLUDGE STORAGE TANKS ELECTRICAL WIRING DETAILS
E-49	PARSHALL FLUME DEMOLITION AND MODIFICATIONS
E-50	ODOR CONTROL SYSTEMS
E-51	FIRE ALARM RISER DIAGRAMS
E-52	FIRE ALARM RISER DIAGRAMS
E-53	HVAC ATC DIAGRAMS
E-54	HVAC ATC DIAGRAMS
E-55	ELECTRICAL SCHEMATIC DIAGRAMS I
E-56	ELECTRICAL SCHEMATIC DIAGRAMS II
E-57	ELECTRICAL SCHEMATIC DIAGRAMS III
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E-60	ELECTRICAL SCHEMATIC DIAGRAMS VI
E-61	CONTROL AND INSTRUMENTATION DIAGRAMS I
E-62	CONTROL AND INSTRUMENTATION DIAGRAMS II
E-63	CONTROL AND INSTRUMENTATION DIAGRAMS III
E-64	CONTROL AND INSTRUMENTATION DIAGRAMS IV
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E-67	CONDUIT AND WIRING SCHEDULES I
E-68	CONDUIT AND WIRING SCHEDULES II
E-69	ELECTRICAL DETAILS
E-70	ELECTRICAL DETAILS
E-71	ELECTRICAL DETAILS

NOTES:

1. BLACK TEXT INDICATES DRAWINGS INCLUDED IN PDR SUBMISSION.
2. LIGHT TEXT INDICATES DRAWINGS TO BE INCLUDED IN FINAL SUBMISSION.

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		
1			
2			
3			
4			

DESIGNED BY:
CAD COORD: APC
CAD:
CHECKED BY:
DATE:
APPROVED BY:
DATE:
PROJECT NO: 12883

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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT FACILITY UPGRADES

DRAWING INDEX

DRAWING
G-1

LEGEND

EXISTING — PROPOSED

- PROPERTY/ROW LINE
- SETBACK LINE
- EASEMENT LINE
- CENTERLINE
- EDGE OF PAVEMENT
- CURBING
- EDGE OF GRAVEL
- EDGE OF CONCRETE
- CONTOUR (existing: 122; proposed: 123)
- BUILDING
- STONEWALL
- TREELINE
- CHAIN LINK FENCE
- STOCKADE FENCE
- BARB WIRE FENCE
- RETAINING WALL
- GUARDRAIL
- SEWER (8"S)
- SEWER FORCE MAIN (4"FM)
- GAS (4"G)
- WATER (4"W / 8"W)
- STORM DRAIN (15"SD)
- UNDERDRAIN (6"UD)
- CULVERT (12" CMP)
- UNDERGROUND ELECTRIC (UGE)
- OVERHEAD ELECTRIC (OHE)
- IRON PIPE/REBAR
- DRILLHOLE
- MONUMENT
- SURVEY CONTROL POINT
- SPOT ELEVATION (existing: 124.6; proposed: 134.5)
- SEWER MANHOLE (SMH)
- DRAINAGE MANHOLE (DMH)
- CATCH BASIN (CB)
- ELECTRIC MANHOLE (EMH)
- TELEPHONE MANHOLE (TMH)
- GATE VALVE
- CURB STOP
- YARD HYDRANT
- HYDRANT
- UTILITY POLE
- UTILITY POLE W/ GUY
- UTILITY POLE W/ LIGHT
- LIGHT POLE
- BOLLARD
- FLAGPOLE
- CONIFEROUS TREE
- DECIDUOUS TREE
- SHRUB
- EDGE OF WATER
- STREAM
- EDGE OF WETLANDS
- FLOODPLAIN
- WETLANDS
- DRAINAGE FLOW
- DRAINAGE SWALE
- PAVEMENT MARKINGS
- SIGN
- MAILBOX (MB)
- TEMPORARY BENCH MARK
- TEST PIT (TP-2)
- TEST BORING (B-3)
- TEST PROBE (P-4)
- MONITORING WELL (MW)
- LIMIT OF WORK

LEGEND (CONTINUED)

EXISTING — PROPOSED

- SILT FENCE
- RIPRAP
- INVASIVE SPECIES (PHRAGMITES)
- INVASIVE SPECIES ALL OTHER
- RAILROAD
- MATCHLINE
- ROCK OUTCROP
- SEWER (8"S)
- SEWER FORCE MAIN (4"FM)
- GAS (4"G)
- WATER (8"W)
- STORM DRAIN (15"SD)
- UNDERDRAIN (6"UD)
- CULVERT (12" CMP)
- PIPE SPOT ELEVATION (128.11)
- CULVERT/UNDERDRAIN (6"XX)
- PIPING (6"XX)
- LARGE DIA PIPING (18"+) (30"XX)
- PIPE PREVIOUSLY ABANDONED (6"XX (AB))
- PIPING TO BE DEMOLISHED (6"XX)
- PIPING TO ABANDON (6"XX)

"XX" DENOTES PIPE DESCRIPTION

SEE LIST OF CIVIL ABBREVIATIONS FOR PIPE DESCRIPTIONS

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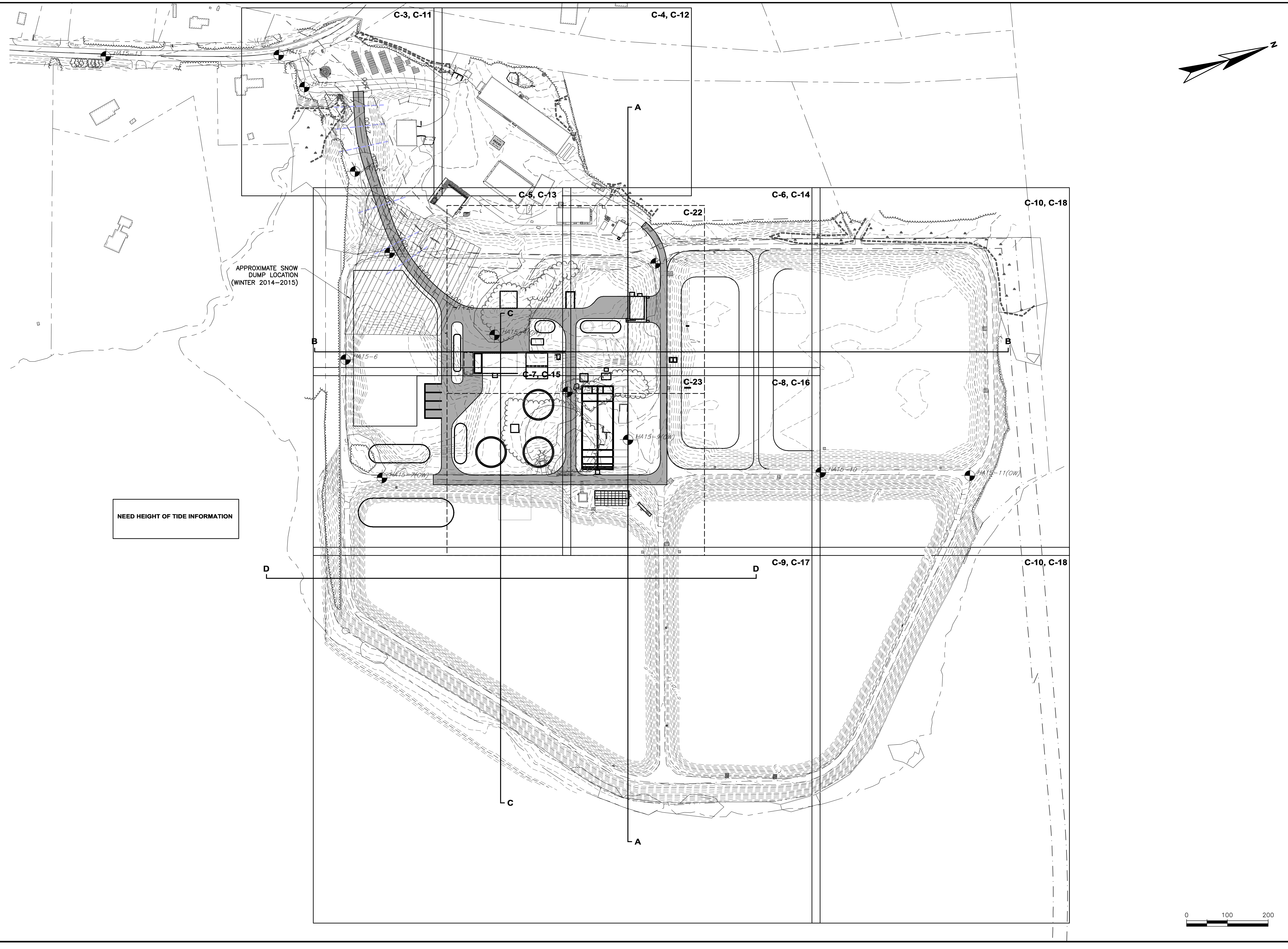
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

GENERAL NOTES, LEGEND, & ABBREVIATIONS

DRAWING
C-1



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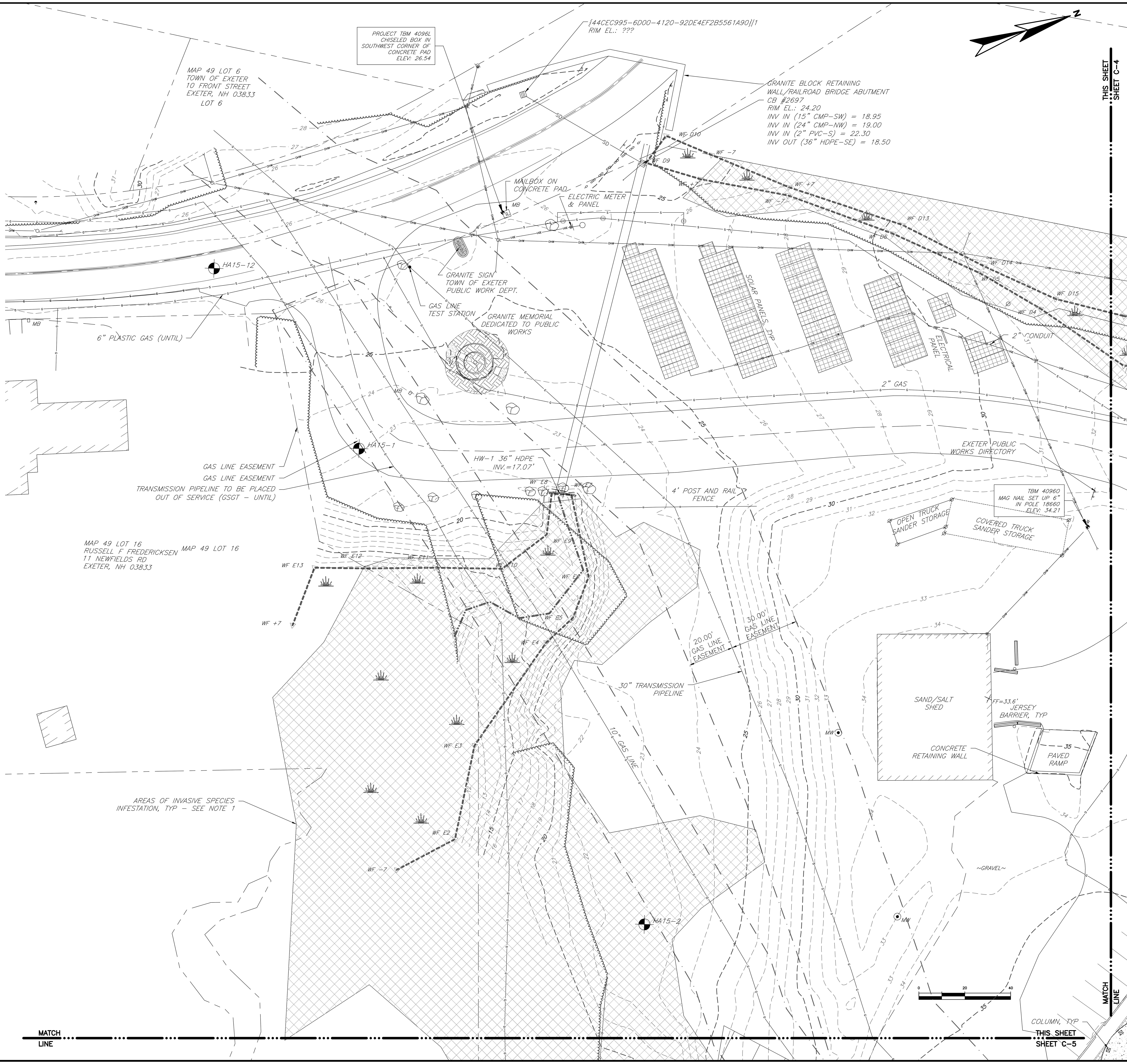
WASTEWATER TREATMENT
FACILITY UPGRADES

SITE KEY PLANS

DRAWING
C–2



NOTES

1. SEE "INVASIVE SPECIES MANAGEMENT PLAN FOR EXETER WASTEWATER TREATMENT FACILITY" FOR DESCRIPTION OF EACH INVASIVE SPECIES. DATED SEPTEMBER 2015, BY GROVE ENVIRONMENTAL SERVICES, INC.

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
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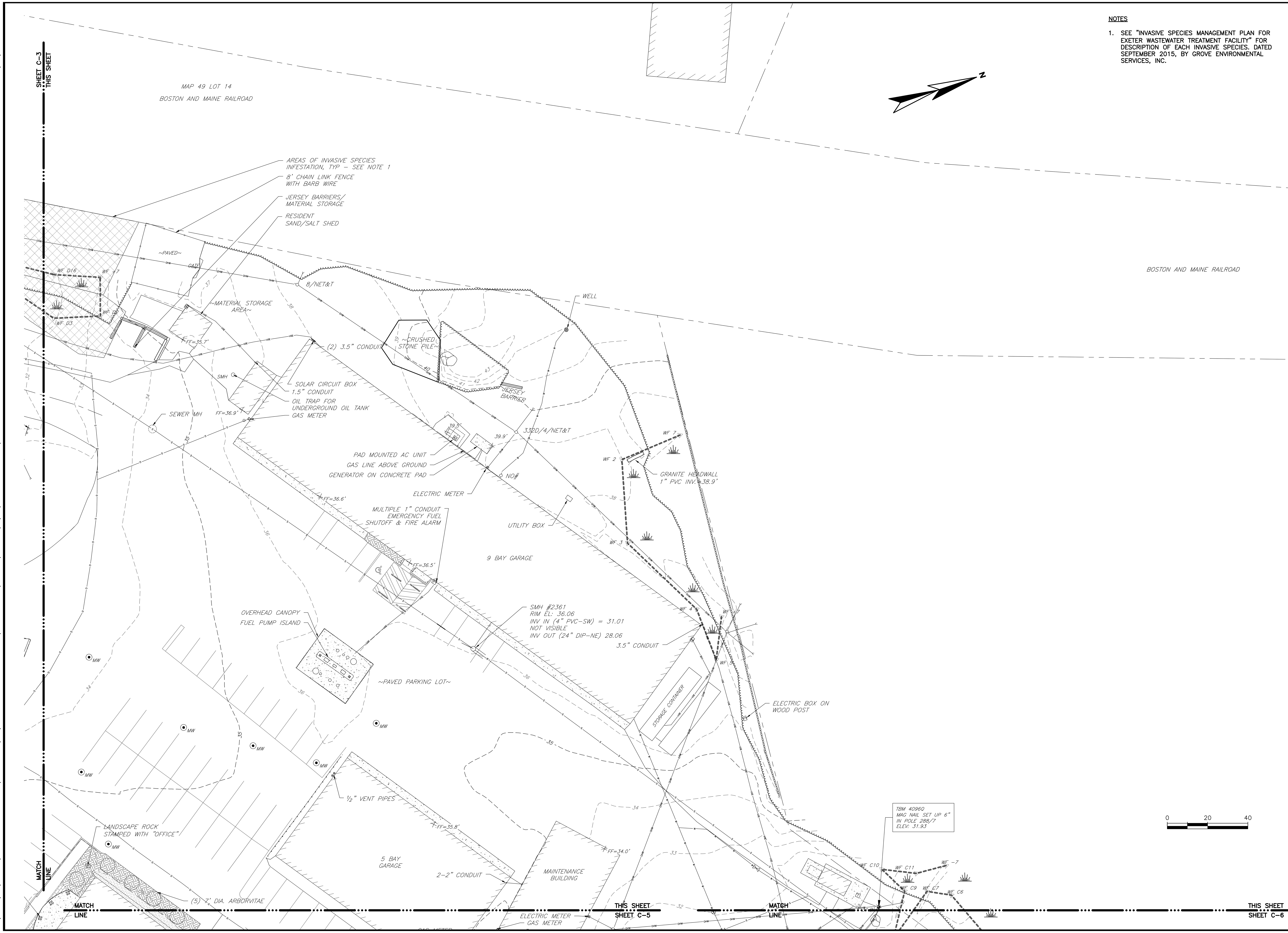
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT FACILITY UPGRADES

EXISTING SITE CONDITIONS AND DEMOLITION PLAN I

DRAWING
C-3



NOTES

1. SEE "INVASIVE SPECIES MANAGEMENT PLAN FOR EXETER WASTEWATER TREATMENT FACILITY" FOR DESCRIPTION OF EACH INVASIVE SPECIES. DATED SEPTEMBER 2015, BY GROVE ENVIRONMENTAL SERVICES, INC.

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EXISTING CONDITIONS AND DEMOLITION PLAN II

DRAWING
C-4

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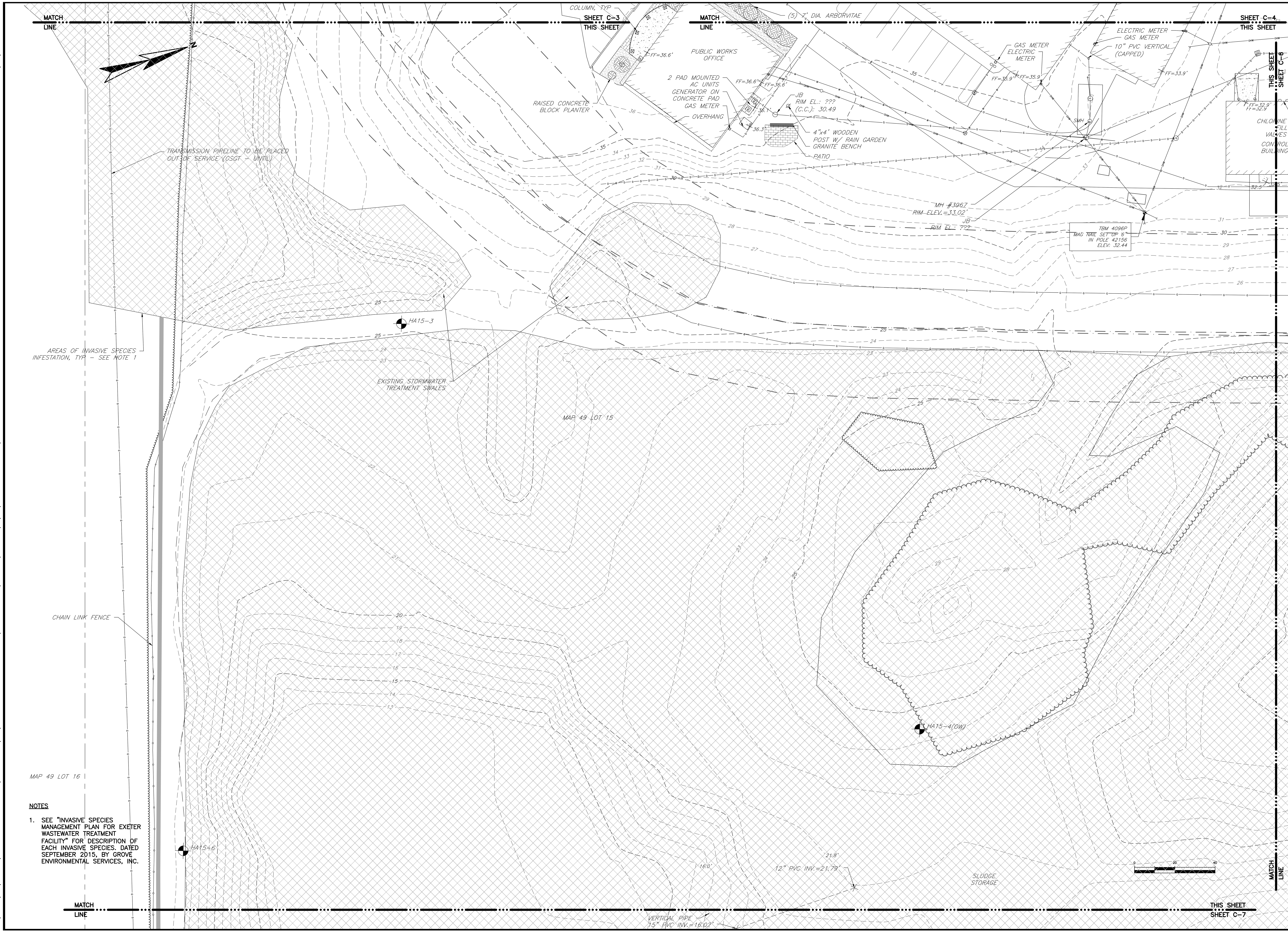

NOTES

1. SEE "INVASIVE SPECIES MANAGEMENT PLAN FOR EXETER WASTEWATER TREATMENT FACILITY" FOR DESCRIPTION OF EACH INVASIVE SPECIES. DATED SEPTEMBER 2015, BY GROVE ENVIRONMENTAL SERVICES, INC.

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EXETER, NEW HAMPSHIRE
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WASTEWATER TREATMENT
FACILITY UPGRADES

EXISTING SITE CONDITIONS AND DEMOLITION PLAN III

DRAWING
C-5

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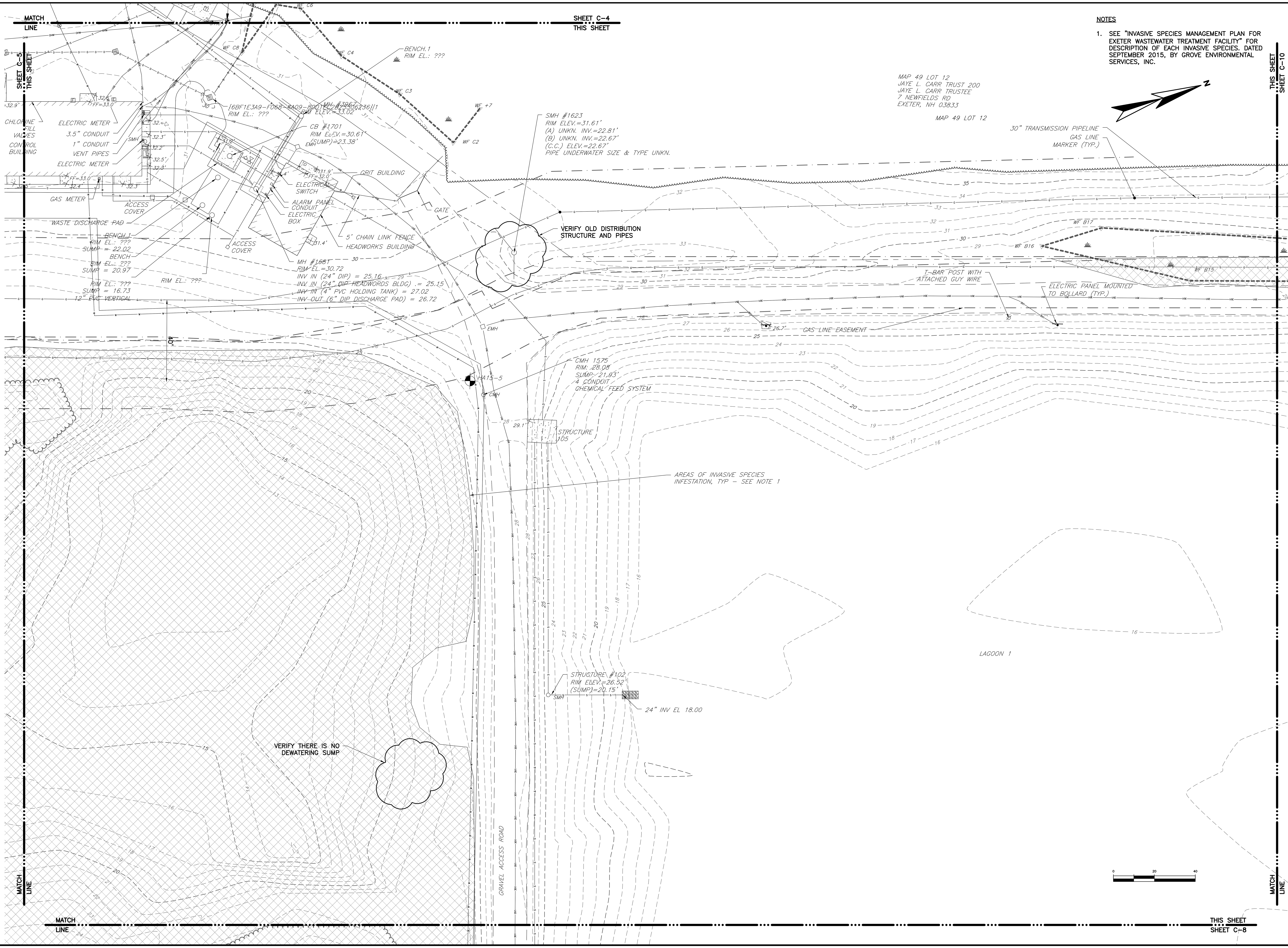

NOTES

1. SEE "INVASIVE SPECIES MANAGEMENT PLAN FOR EXETER WASTEWATER TREATMENT FACILITY" FOR DESCRIPTION OF EACH INVASIVE SPECIES. DATED SEPTEMBER 2015, BY GROVE ENVIRONMENTAL SERVICES, INC.

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EXISTING SITE CONDITIONS AND DEMOLITION PLAN IV

DRAWING
C-6

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NOTES

1. SEE "INVASIVE SPECIES MANAGEMENT PLAN FOR EXETER WASTEWATER TREATMENT FACILITY" FOR DESCRIPTION OF EACH INVASIVE SPECIES. DATED SEPTEMBER 2015, BY GROVE ENVIRONMENTAL SERVICES, INC.

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EXISTING SITE CONDITIONS AND DEMOLITION PLAN V

DRAWING
C-7

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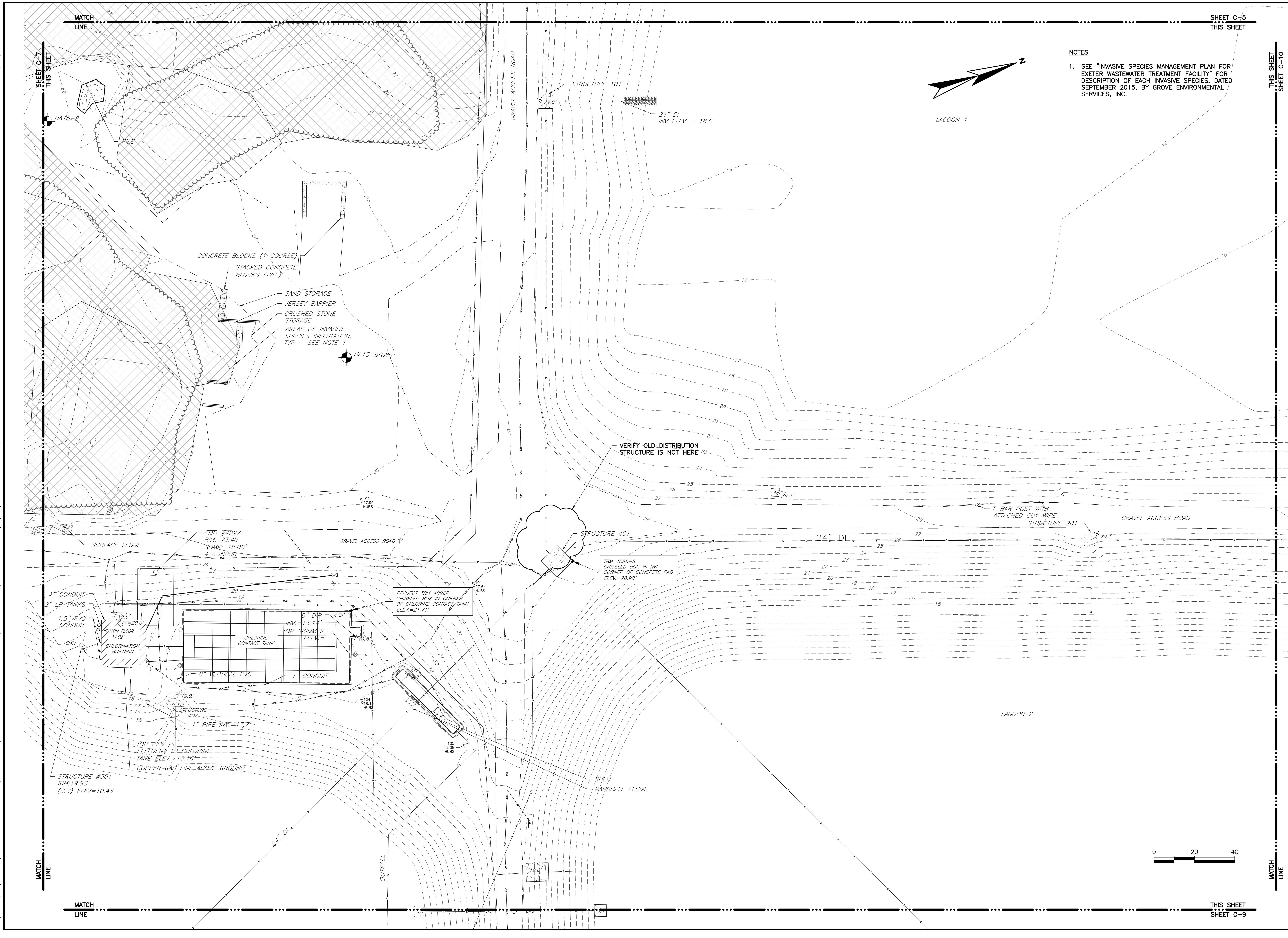

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FACILITY UPGRADES

EXISTING SITE CONDITIONS AND DEMOLITION PLAN VI

DRAWING
C-8

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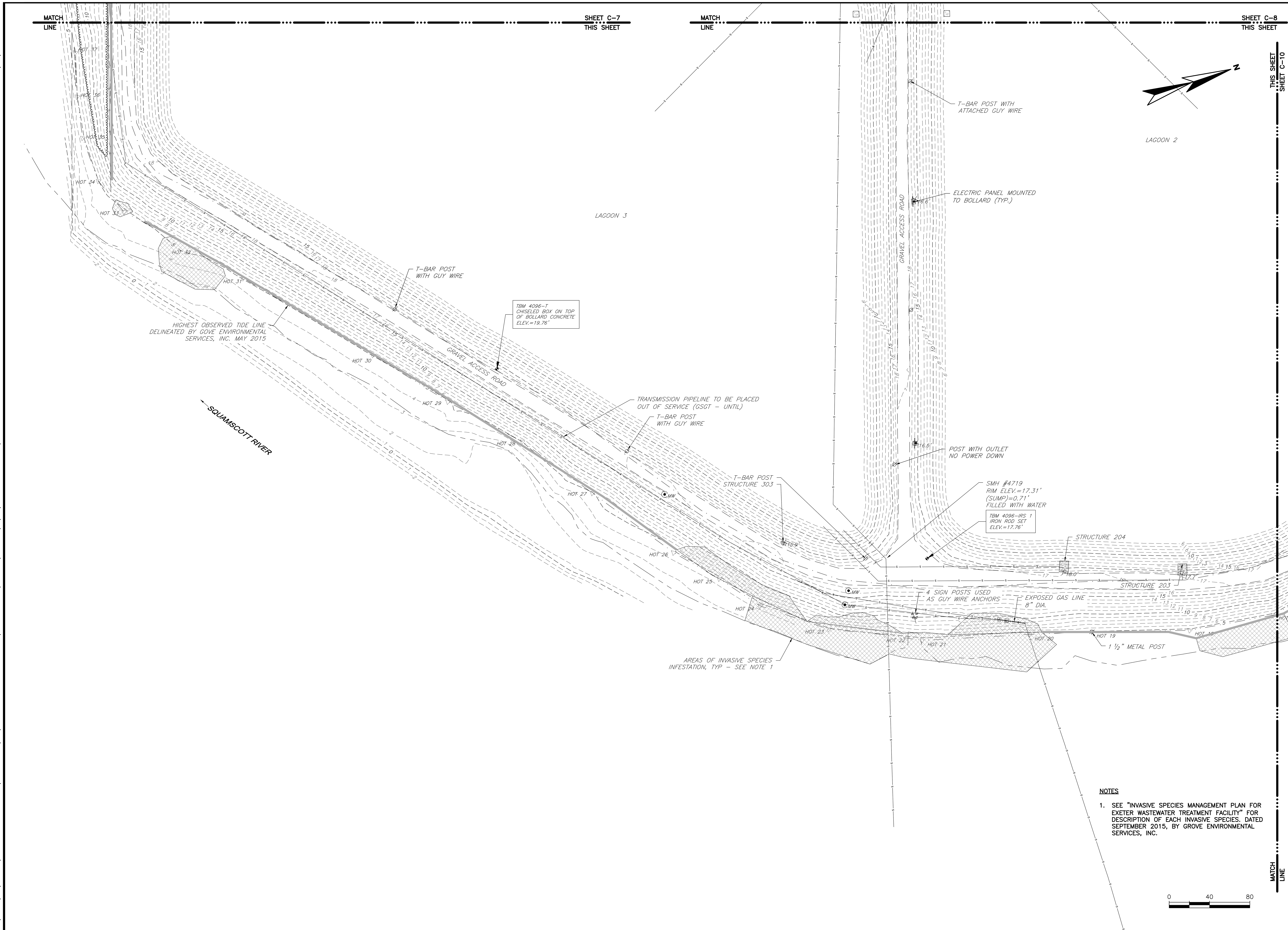

NOTES

1. SEE "INVASIVE SPECIES MANAGEMENT PLAN FOR EXETER WASTEWATER TREATMENT FACILITY" FOR DESCRIPTION OF EACH INVASIVE SPECIES. DATED SEPTEMBER 2015, BY GROVE ENVIRONMENTAL SERVICES, INC.

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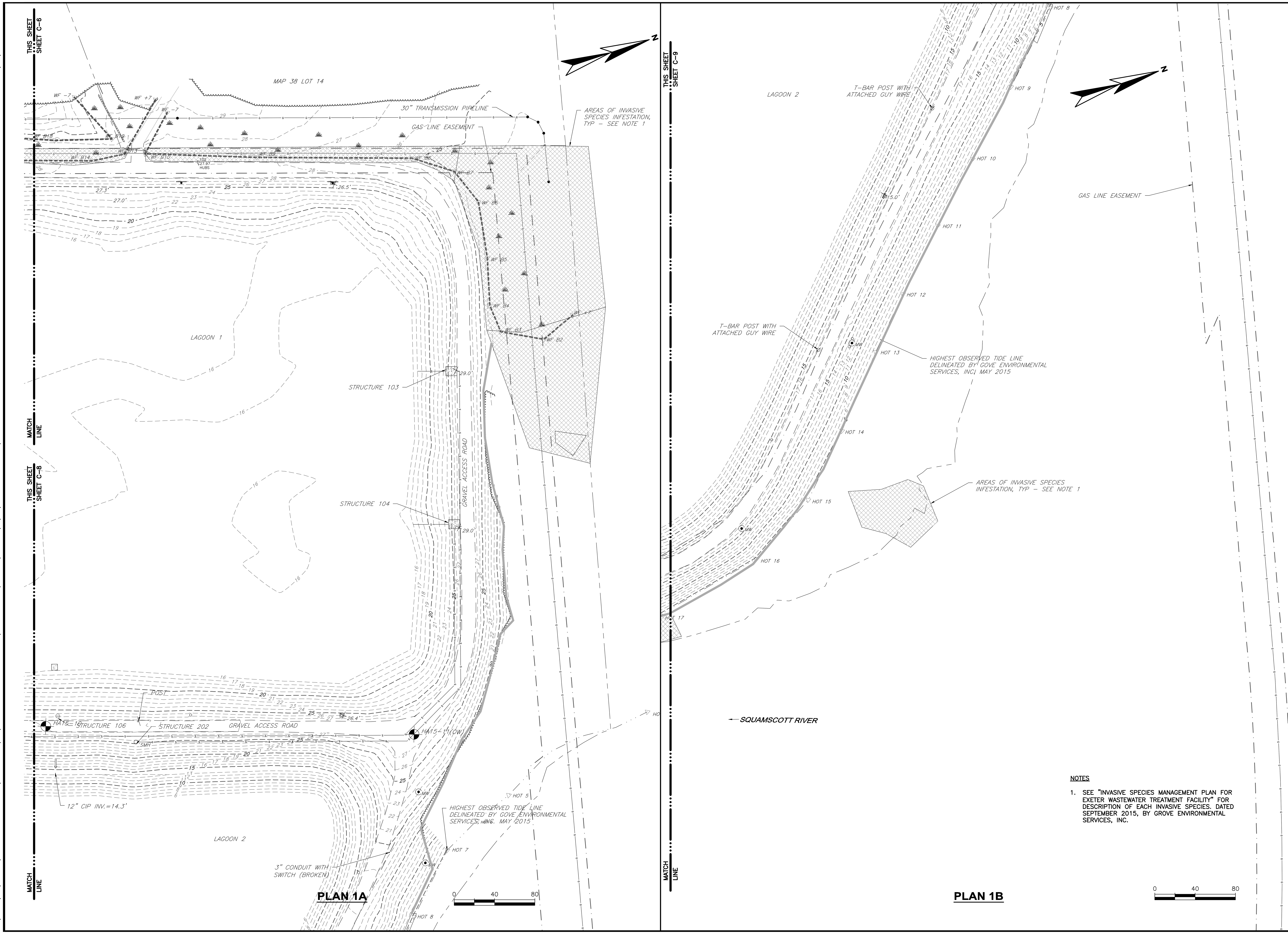
WASTEWATER TREATMENT FACILITY UPGRADES

EXISTING SITE CONDITIONS AND DEMOLITION PLAN VII

DRAWING
C-9



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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

EXISTING SITE CONDITIONS AND DEMOLITION PLAN VIII

DRAWING
C-10

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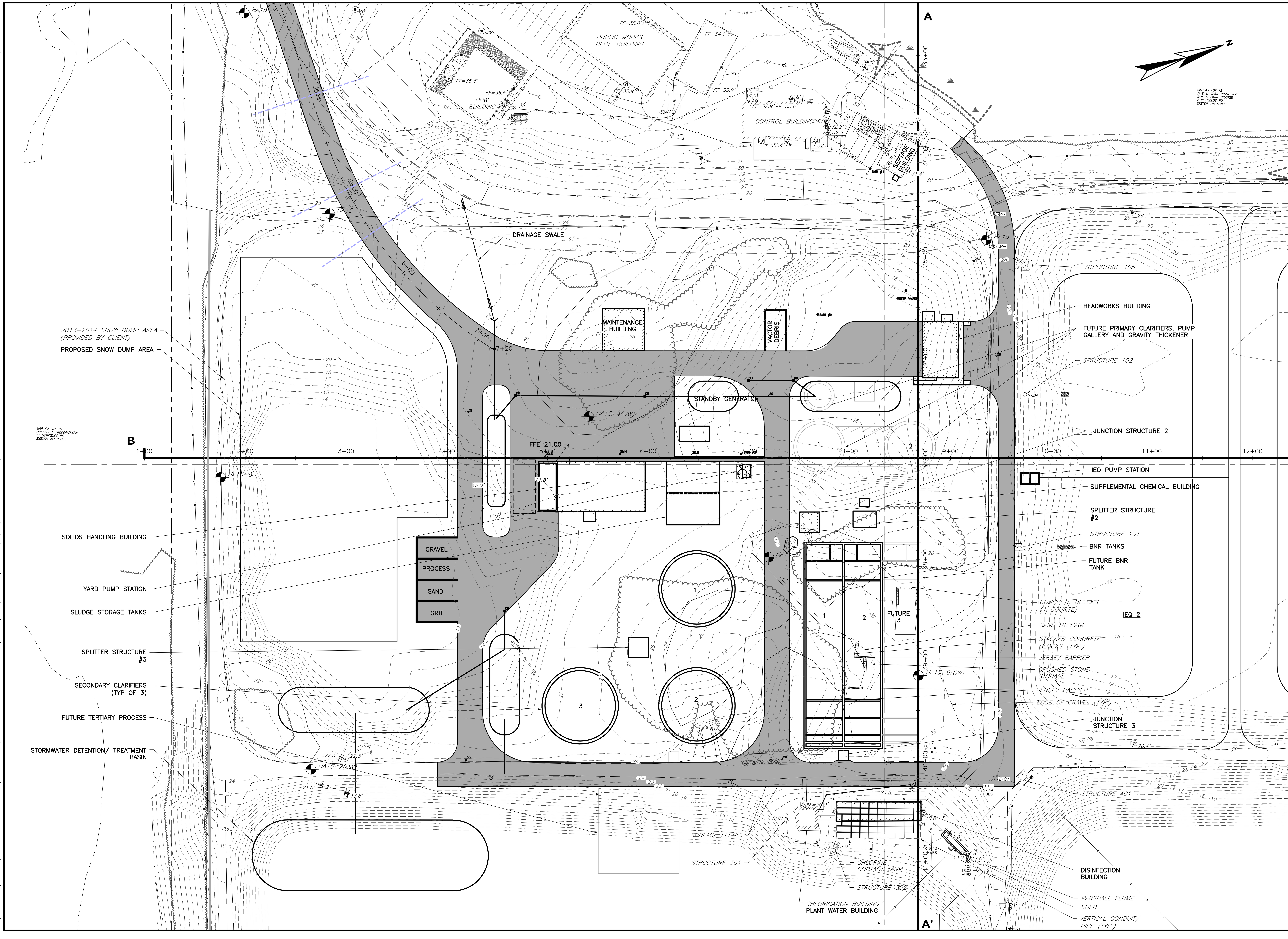

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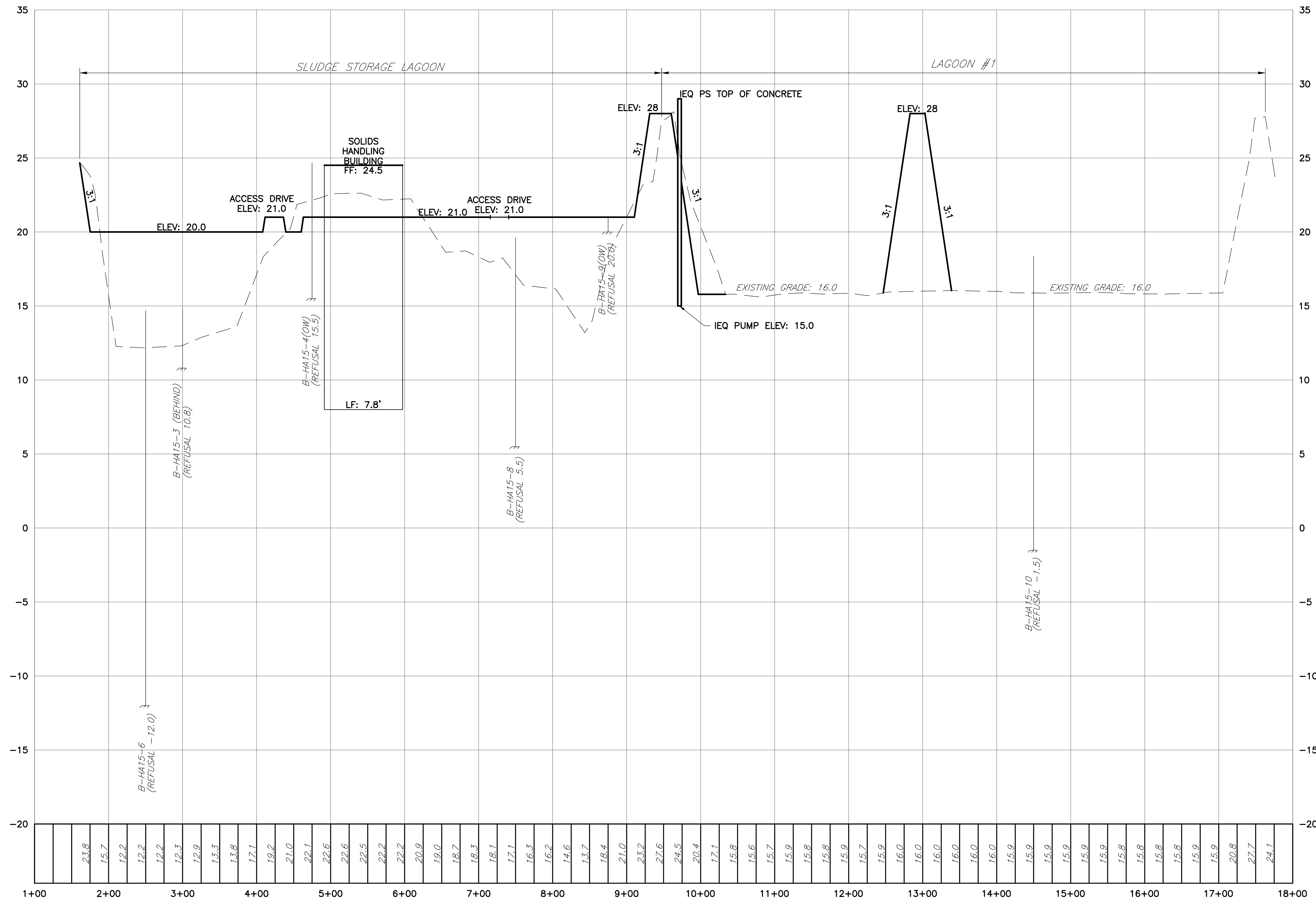
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT FACILITY UPGRADES

FOCUS SITE PLAN

DRAWING
C-10A



PROFILE: SOUTH TO NORTH (B - B')

SCALES:
HORZ: 1"=80'
VERT: 1"=4'

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
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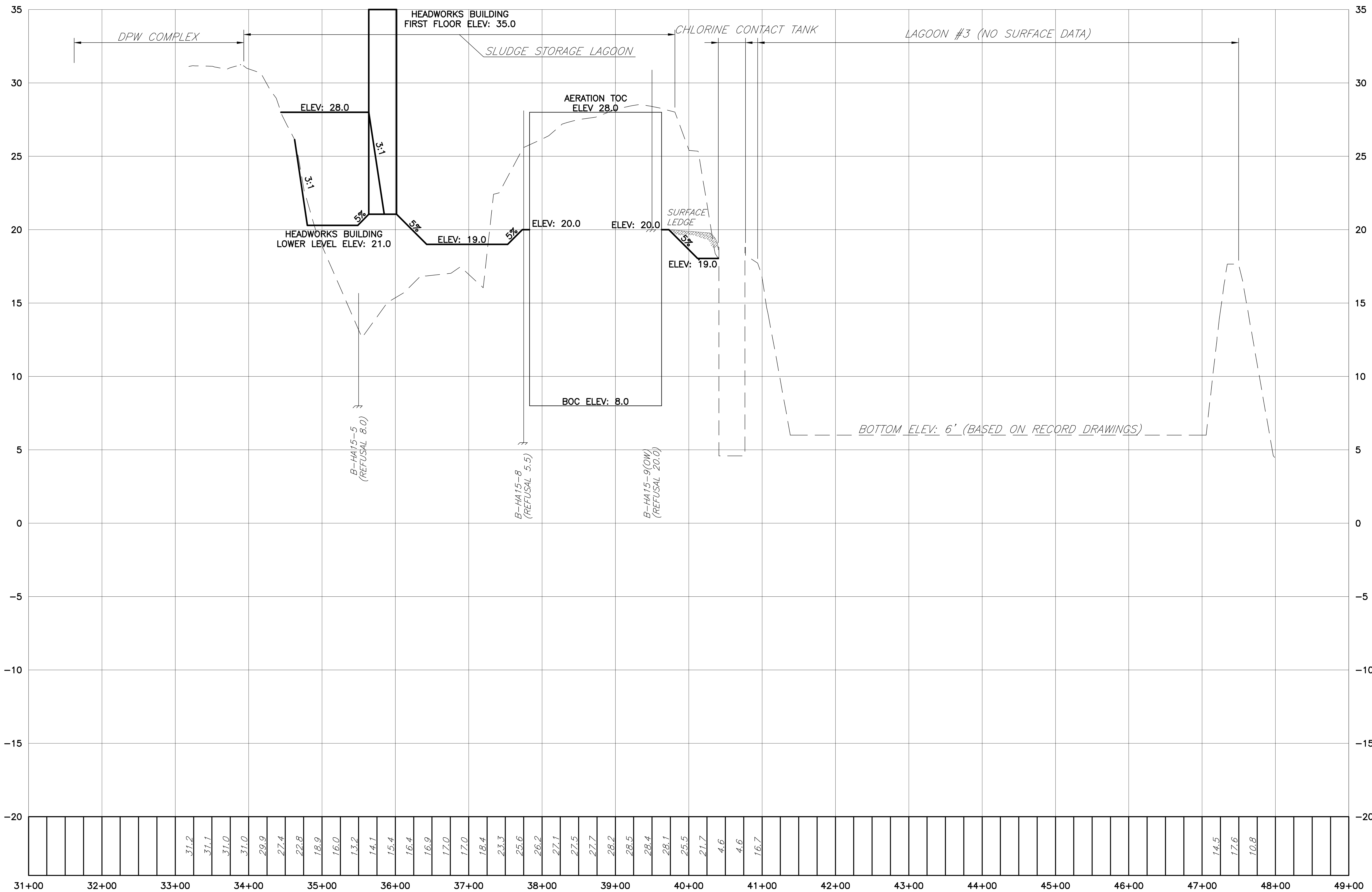
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

SITE PROFILE
PROFILE A

DRAWING
C-10B



PROFILE: WEST TO EAST (A - A')

SCALES:
HORZ: 1"=80'
VERT: 1"=4'

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
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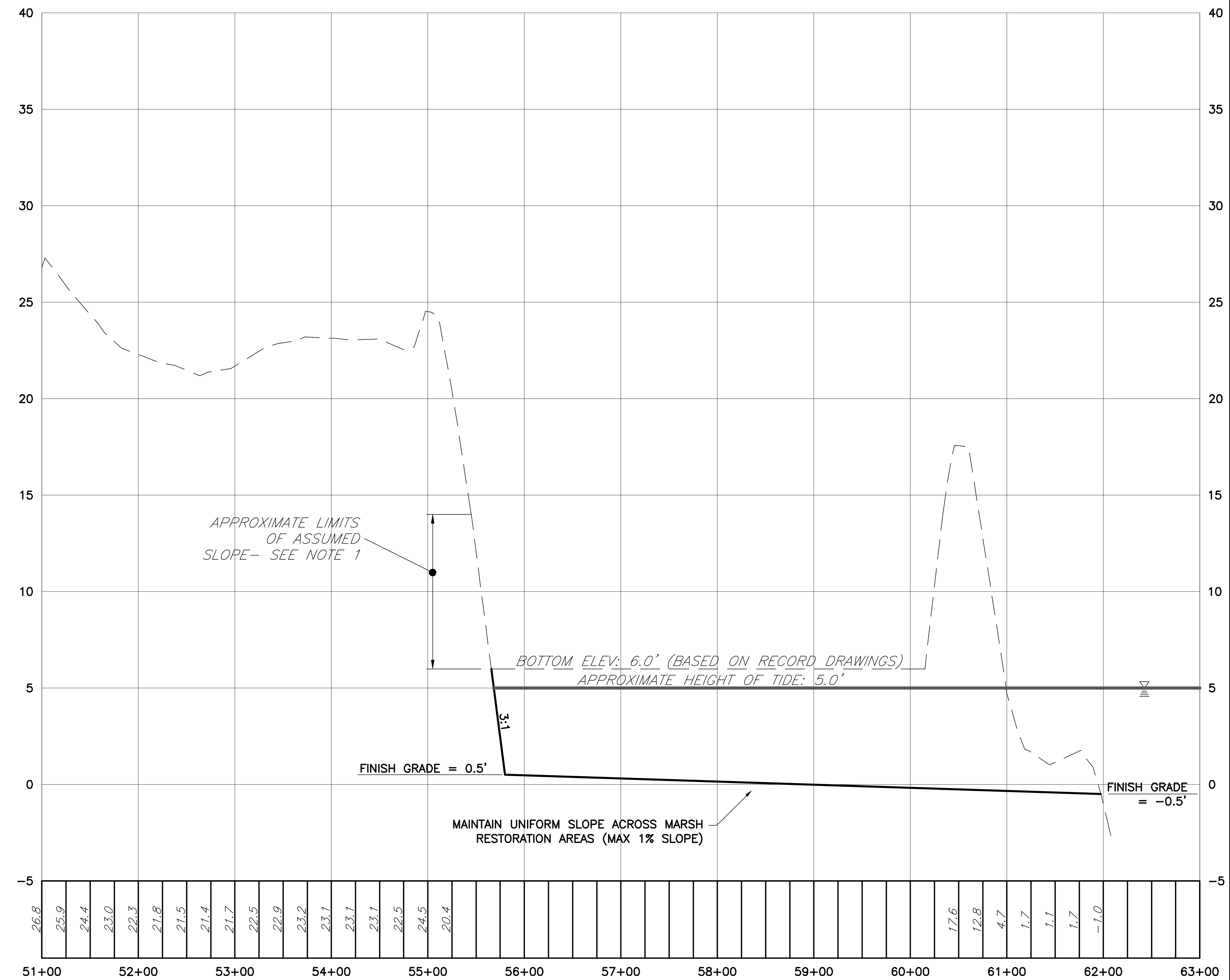
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

SITE PROFILE
PROFILE B

DRAWING
C-10C

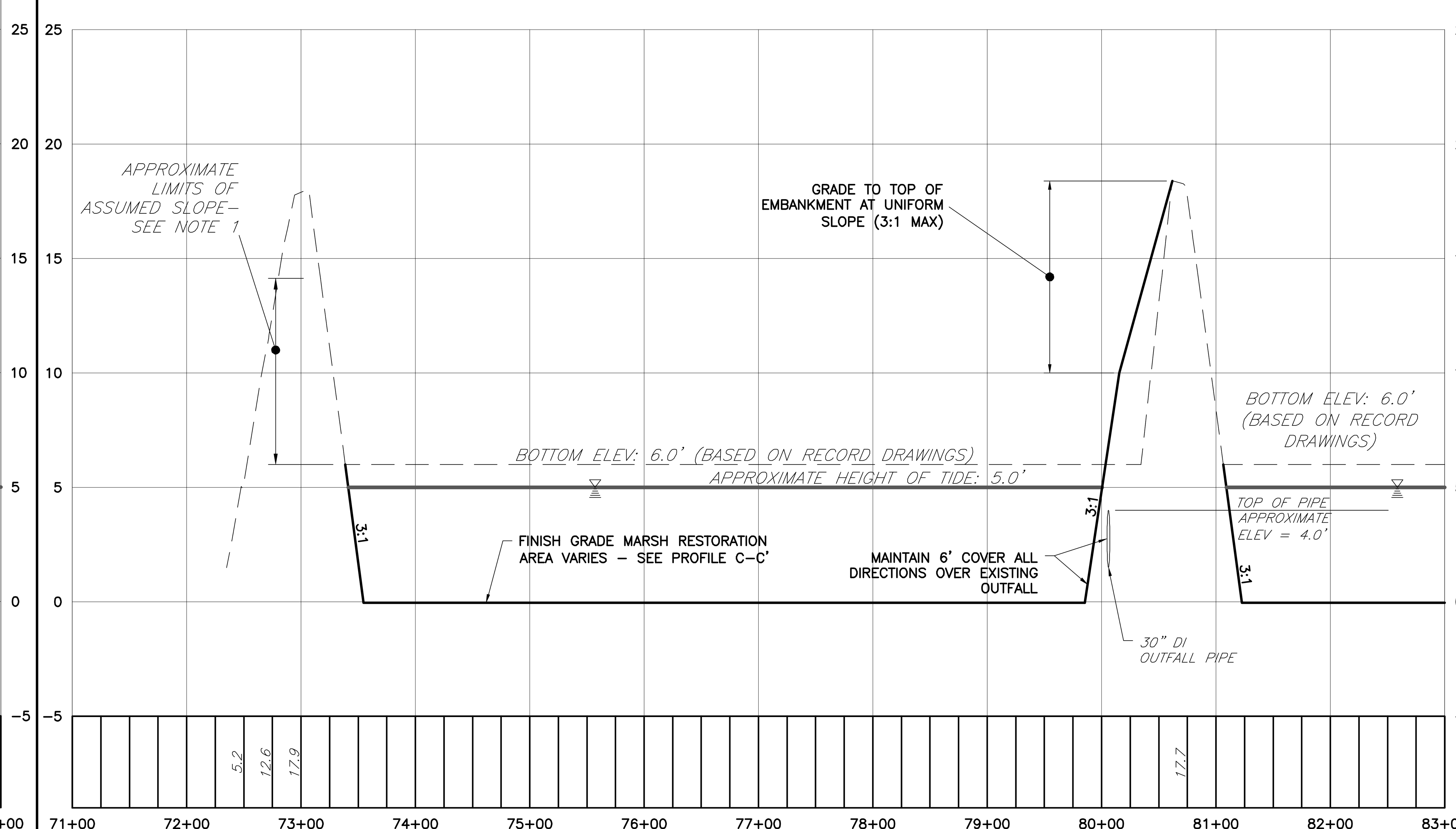
NOTES
1. TOPOGRAPHIC SURVEY PERFORMED BY DOUCET SURVEY INC. DATED JULY, 2015.
2. ASSUMED TOPOGRAPHIC DATA FOR LAGOONS & OUTFALL PIPE BASED ON AS-BUILT DRAWINGS PROVIDED BY OWNER.
3. UEI 2002 (NAVD 29)

100 YR FLOOD	+8.0
MHW	+4.3
NEEP LOW	-1.7
MEAN LOW	-3.0
SPRING LOW	-4.2
BOTTOM RIVER	-9.0 +/-



PROFILE: C-C'

SCALES:
HORZ: 1"=80'
VERT: 1"=4'



PROFILE: D-D'

SCALES:
HORZ: 1"=80'
VERT: 1"=4'

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
1	PRELIMINARY DESIGN REPORT		

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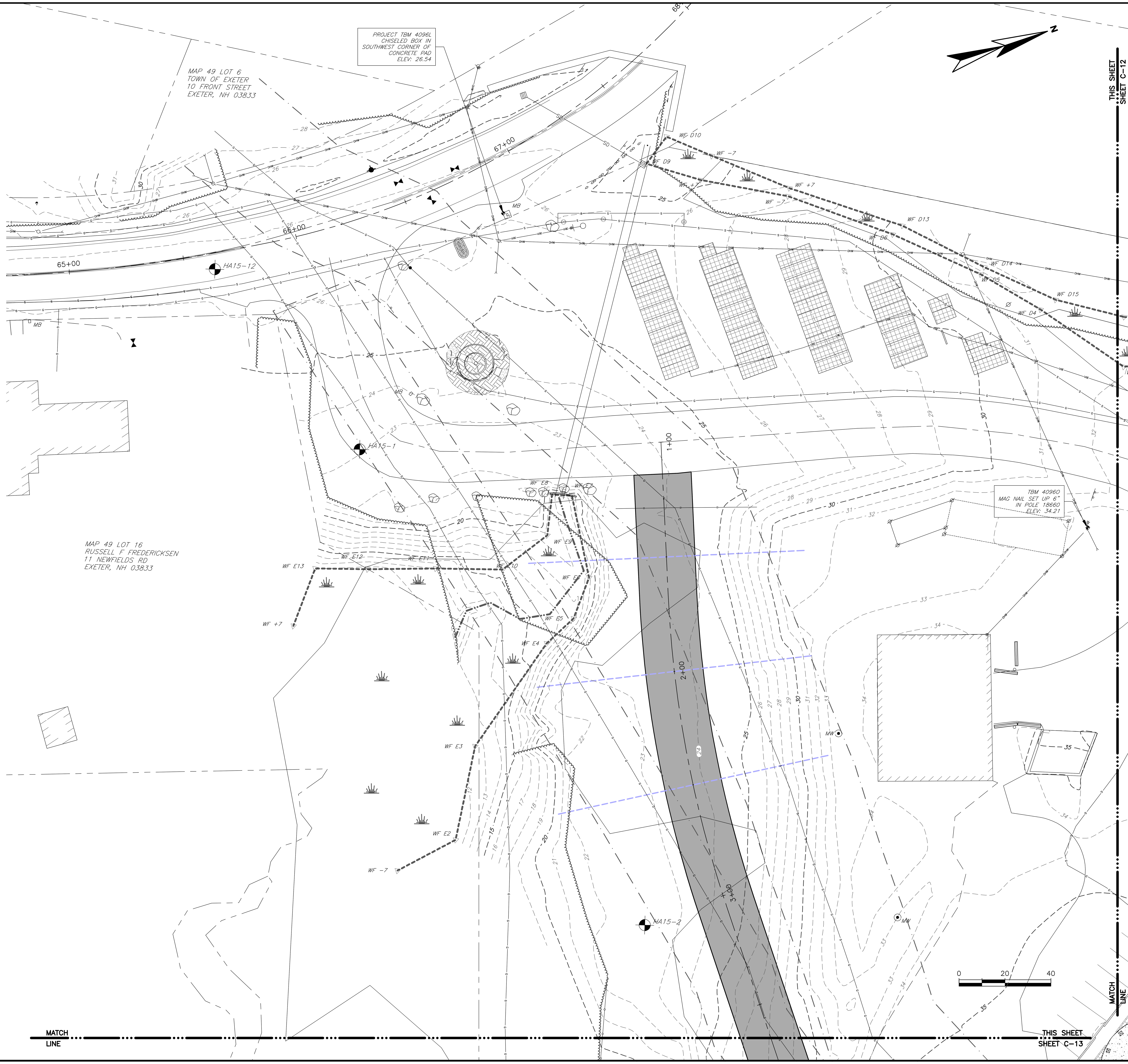
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT FACILITY UPGRADES

SITE PROFILE
PROFILE C & PROFILE D

DRAWING
C-10D



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EXETER, NEW HAMPSHIRE
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WASTEWATER TREATMENT
FACILITY UPGRADES

SITE LAYOUT PLAN I

DRAWING
C-11

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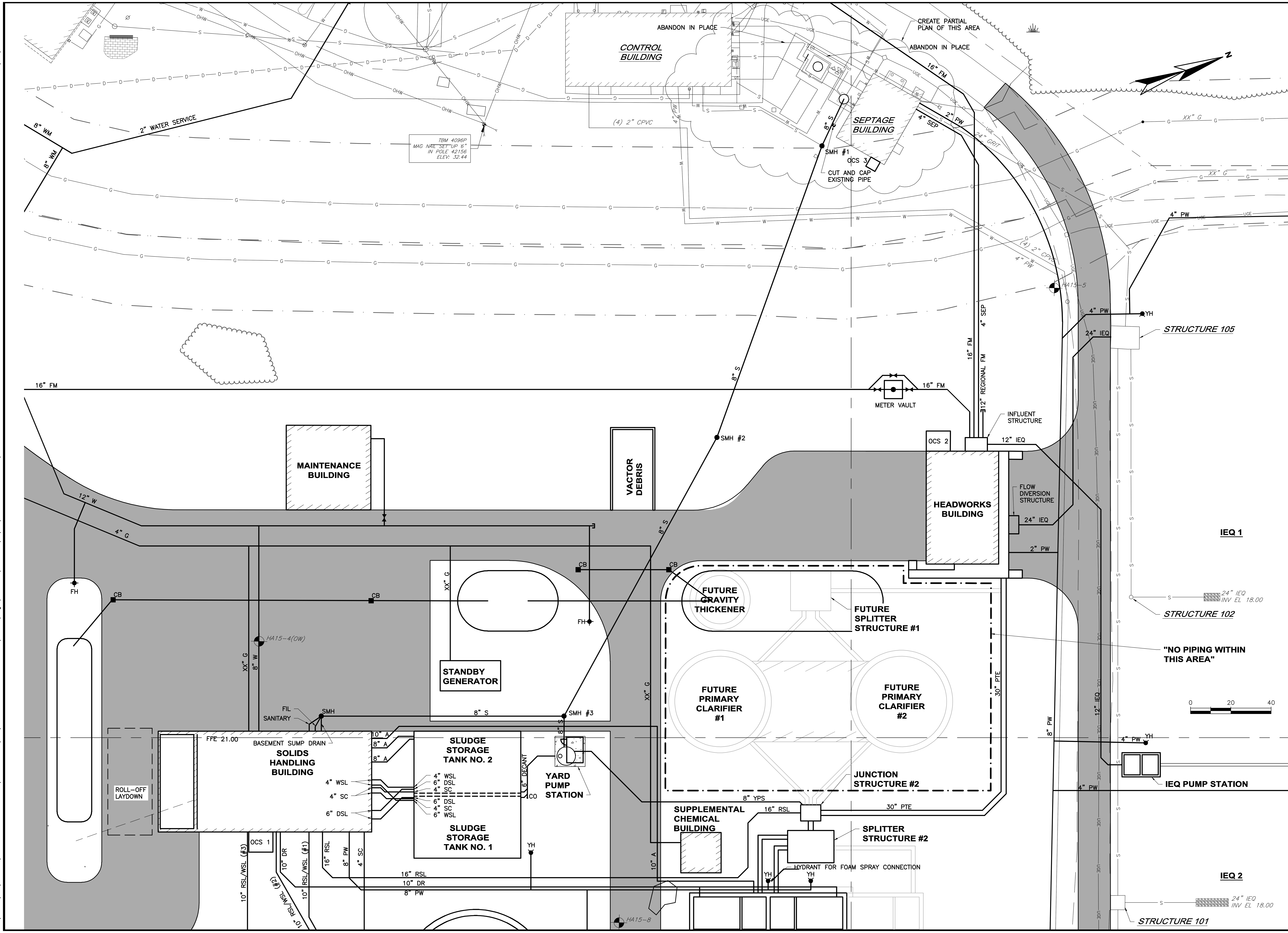

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	PRELIMINARY DESIGN REPORT		

DESIGNED BY: APC
CAD COORD:
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DATE:
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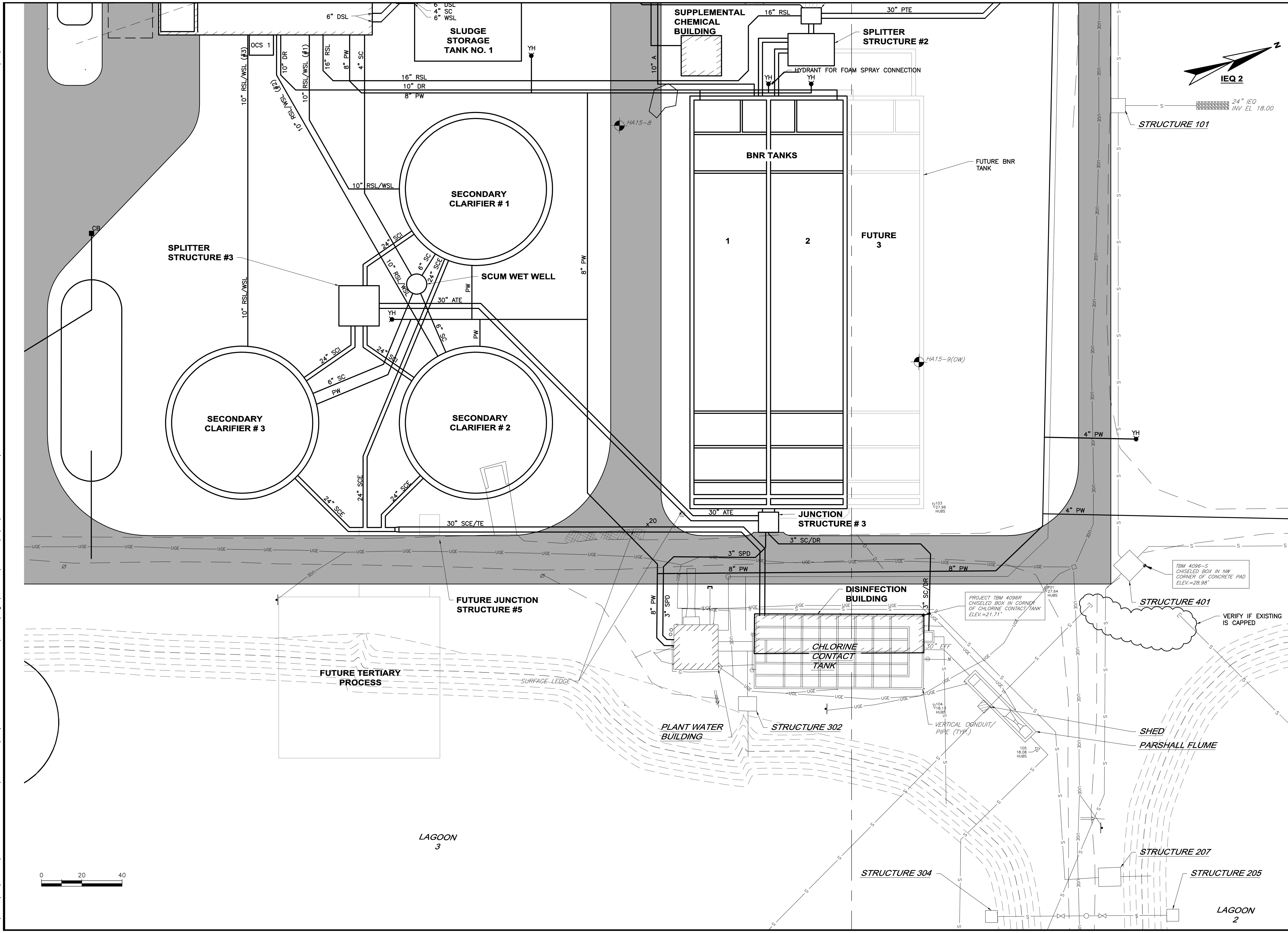
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

SITE PIPING PLAN I

DRAWING
C-23



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EXETER, NEW HAMPSHIRE
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WASTEWATER TREATMENT FACILITY UPGRADES

SITE PIPING PLAN II

DRAWING
C-24

LAST SAVED BY: ADAM.COUTURE 9/24/2015 2:10 PM

G:\DWGS\NH\EXETER\12883-WWTF-UPGRADE\12883-PDR\CIV\12883-CS-SITEPIPING.DWG | SitePipingIII | 1:4.56 | ---- | 9/24/2015 2:43:51 PM | ADAM.COUTURE

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
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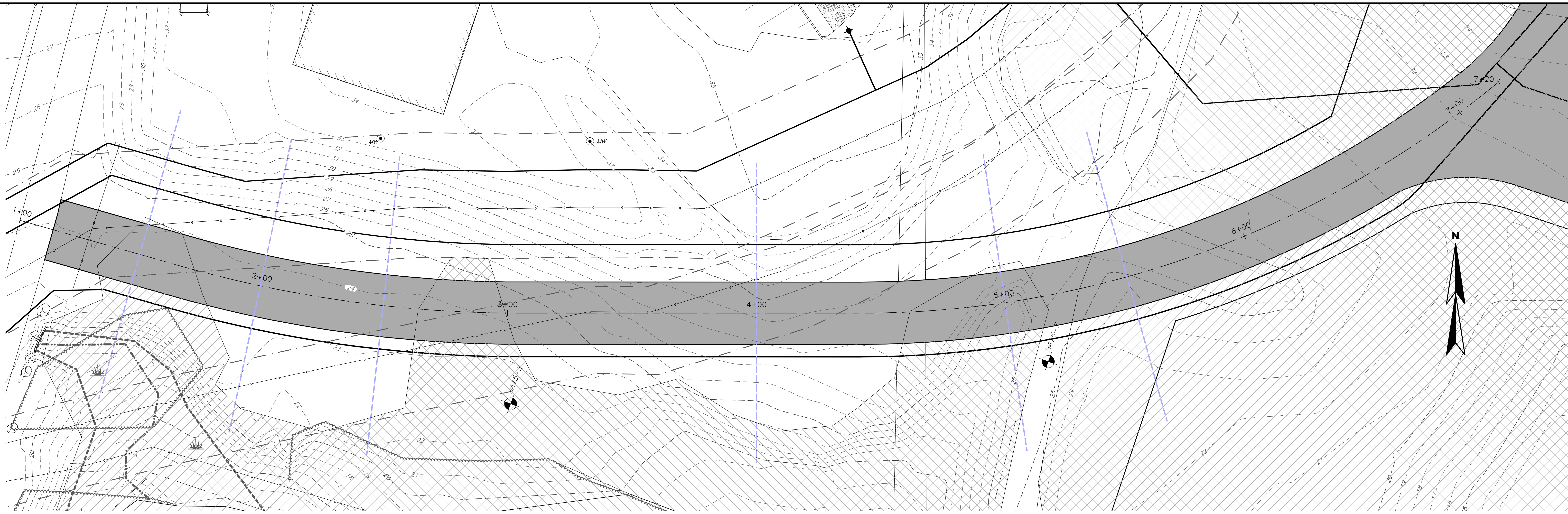
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

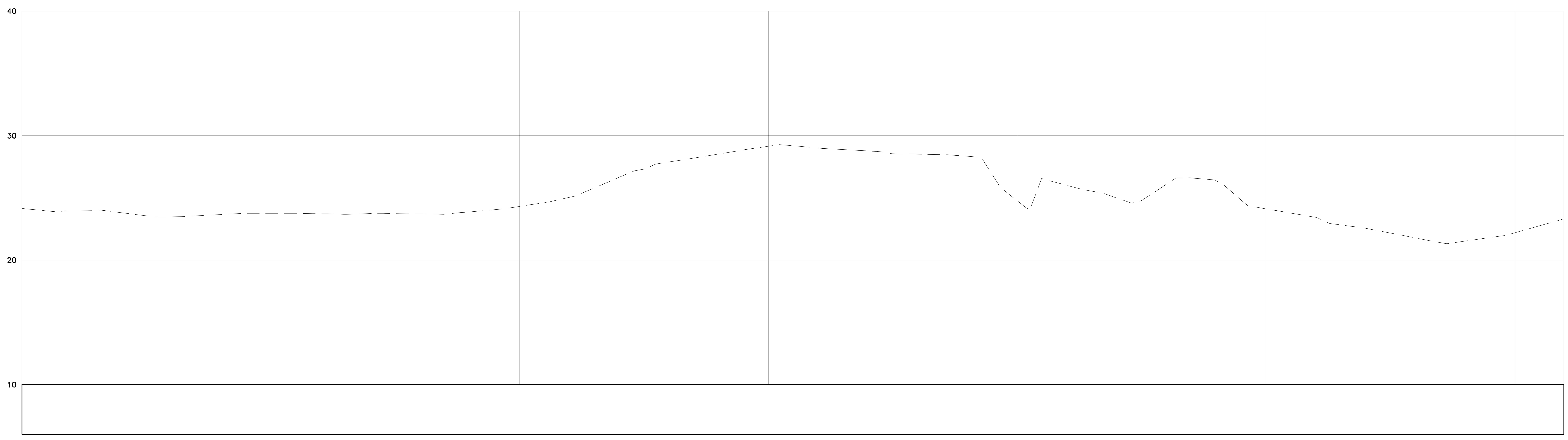
SITE PIPING III

DRAWING
C-25



PLAN

SCALE: 1"=20'



PROFILE

SCALES:
HORZ: 1"=20'
VERT: 1"=4'

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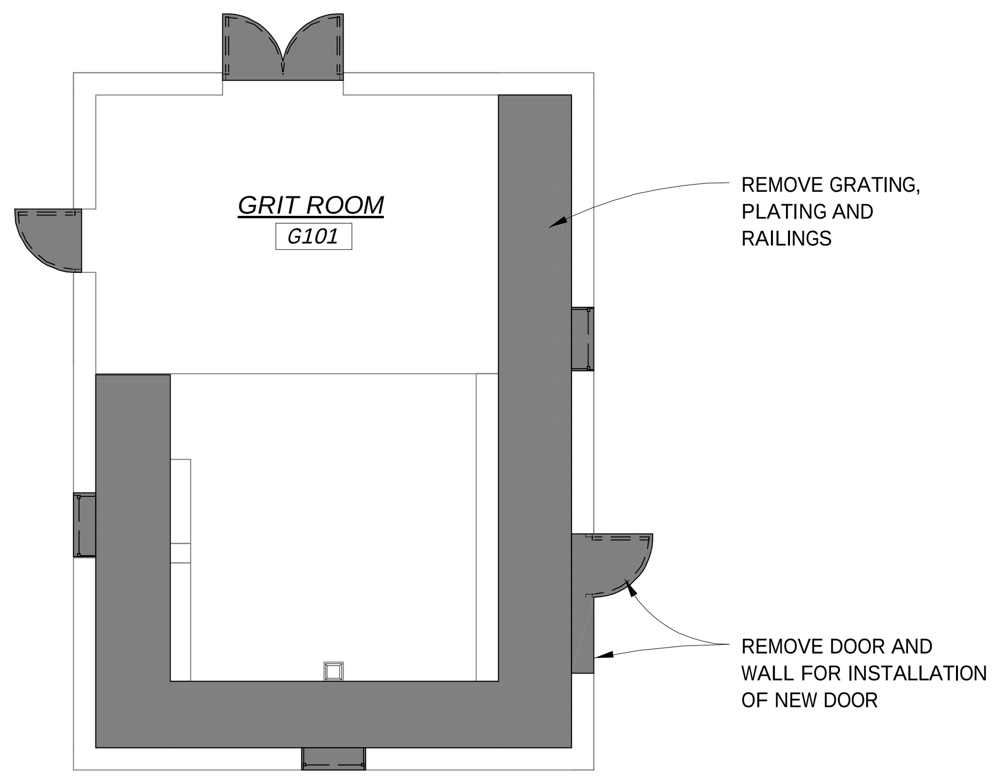
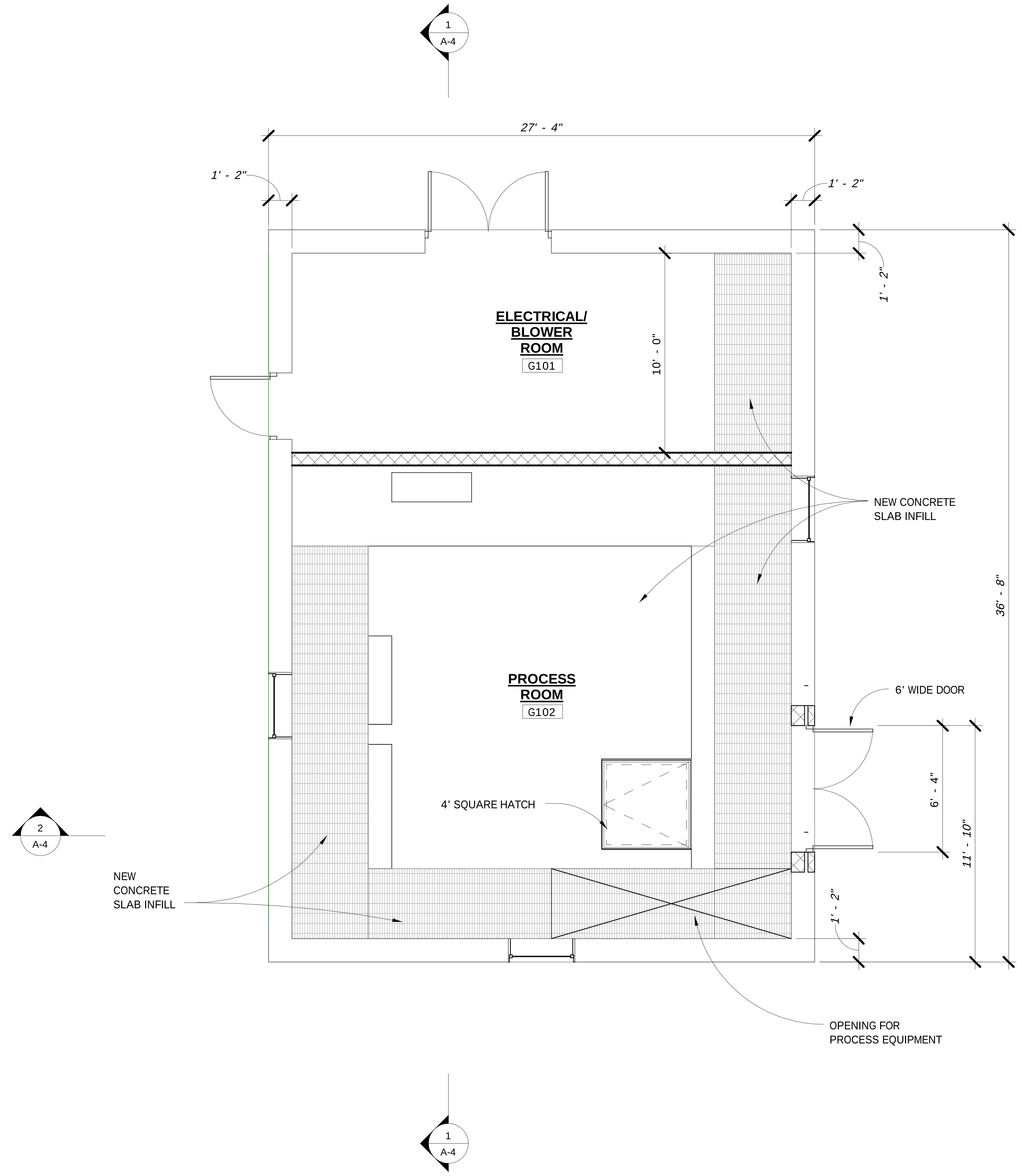
PLAN & PROFILE: ACCESS ROAD
STA 1+00 TO STA 7+20

DRAWING
C-100A



GRIT BUILDING DEMO PLAN

SCALE: 1 / 8" = 1' - 0"



SEPTAGE BUILDING MODIFICATION PLAN

SCALE: 1 / 4" = 1' - 0"

PROJECT NORTH

NO.	SUBMISSIONS / REVISIONS	APP'D	DATE
1	PRELIMINARY DESIGN REPORT		
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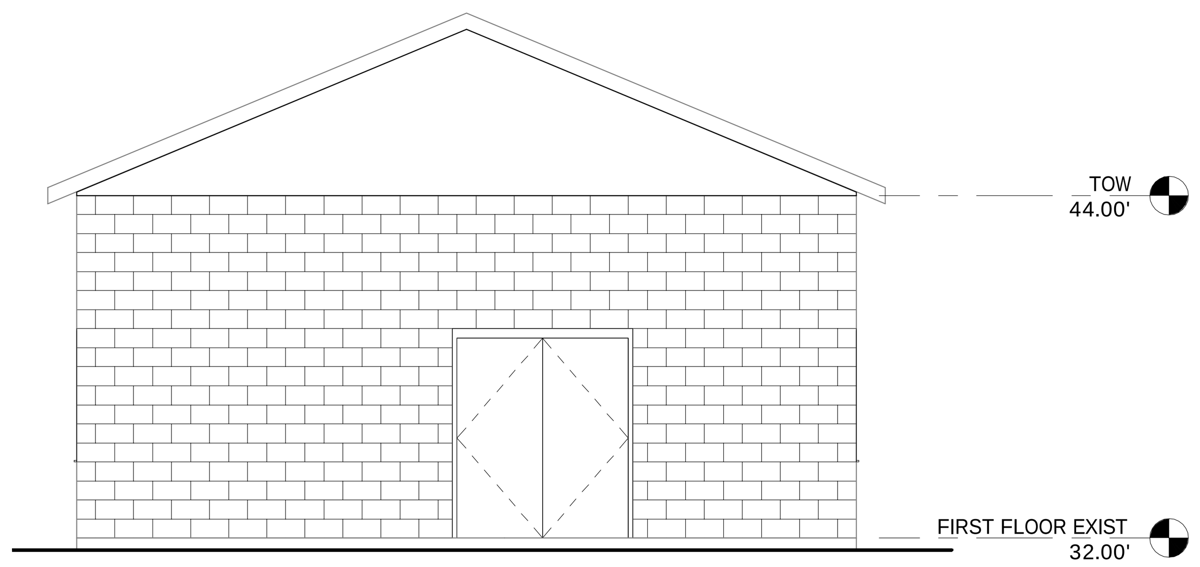
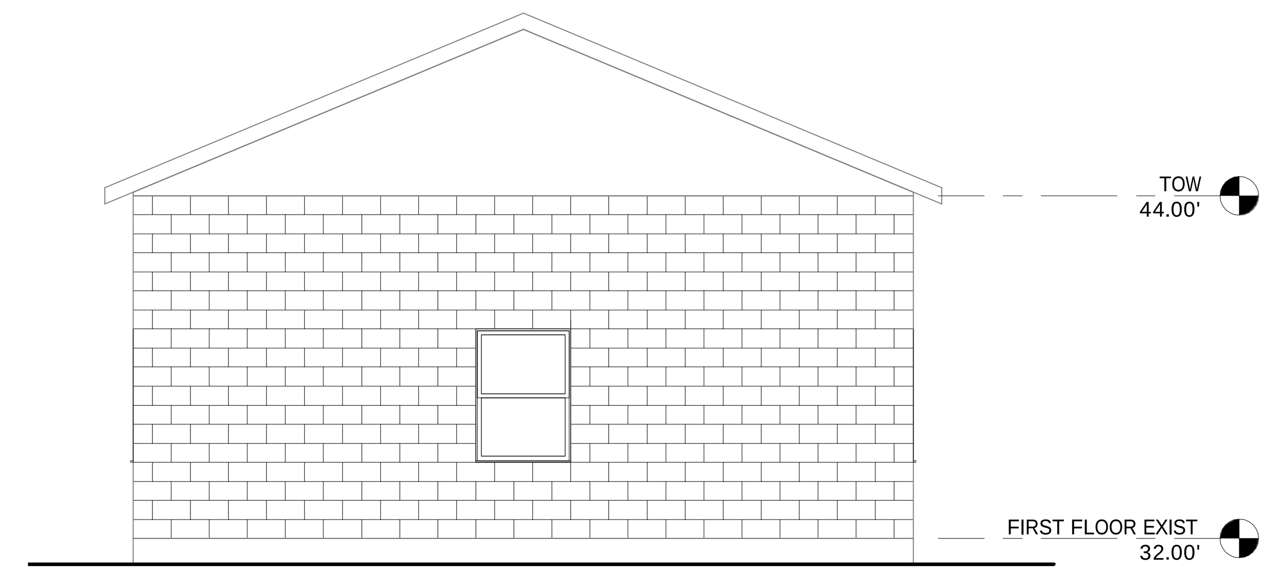
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

GRIT / SEPTAGE BUILDING - FLOOR PLANS

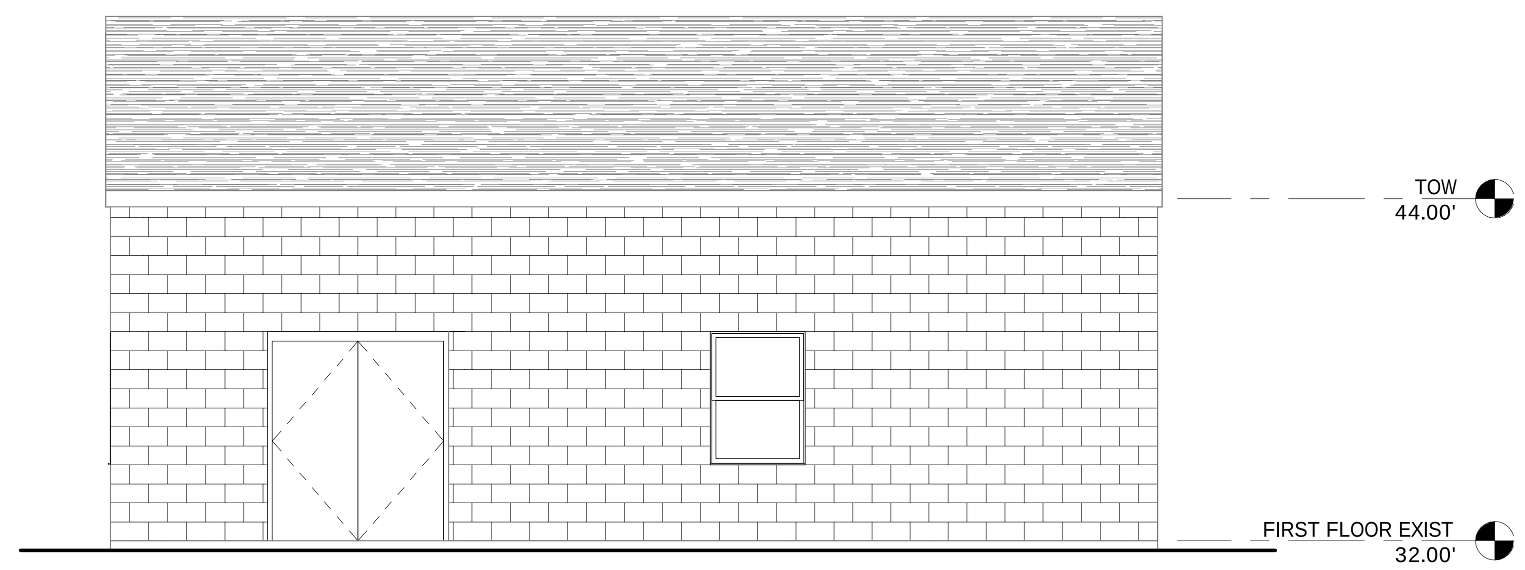
DRAWING
A - 3

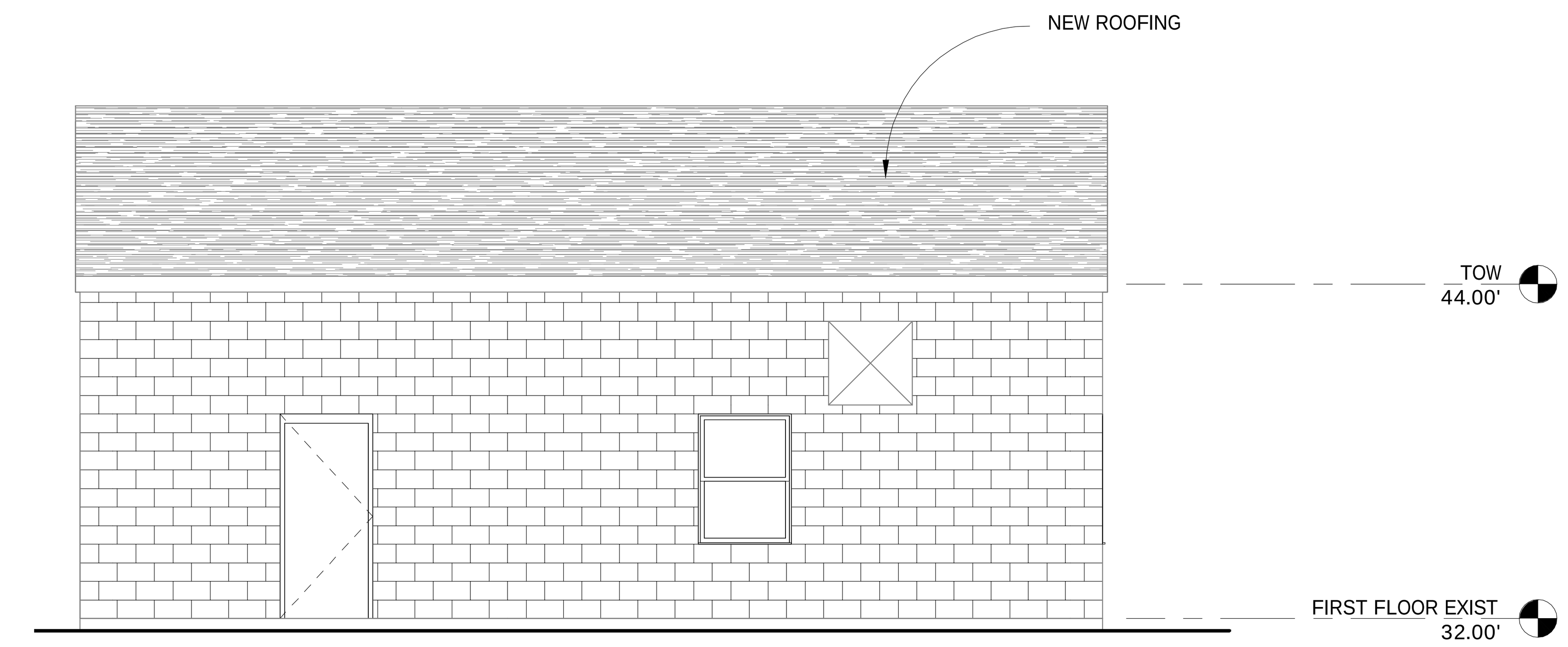




NORTH ELEVATION
SCALE: 3/16" = 1'-0"

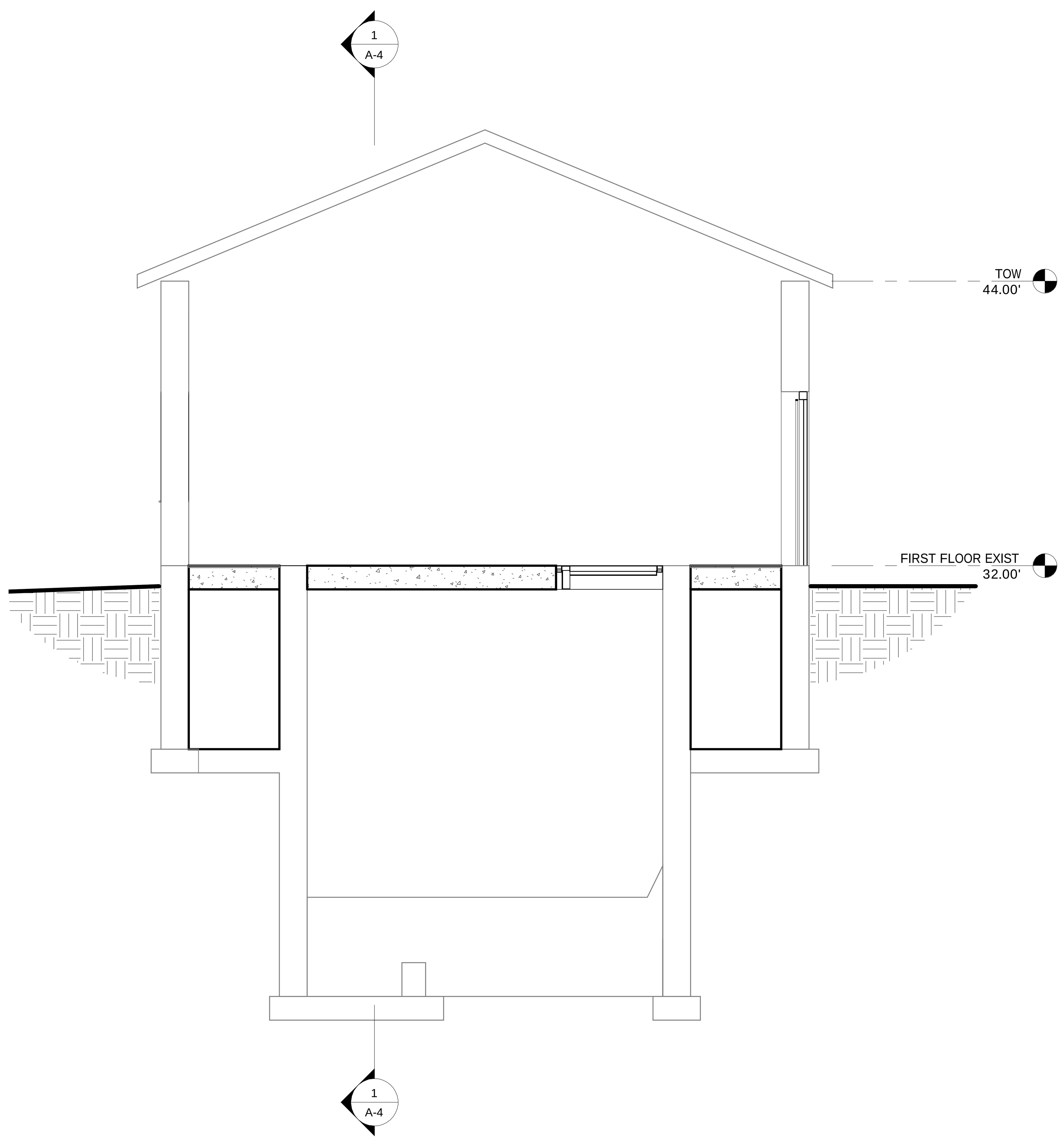
SOUTH ELEVATION
SCALE: 3/16" = 1'-0"

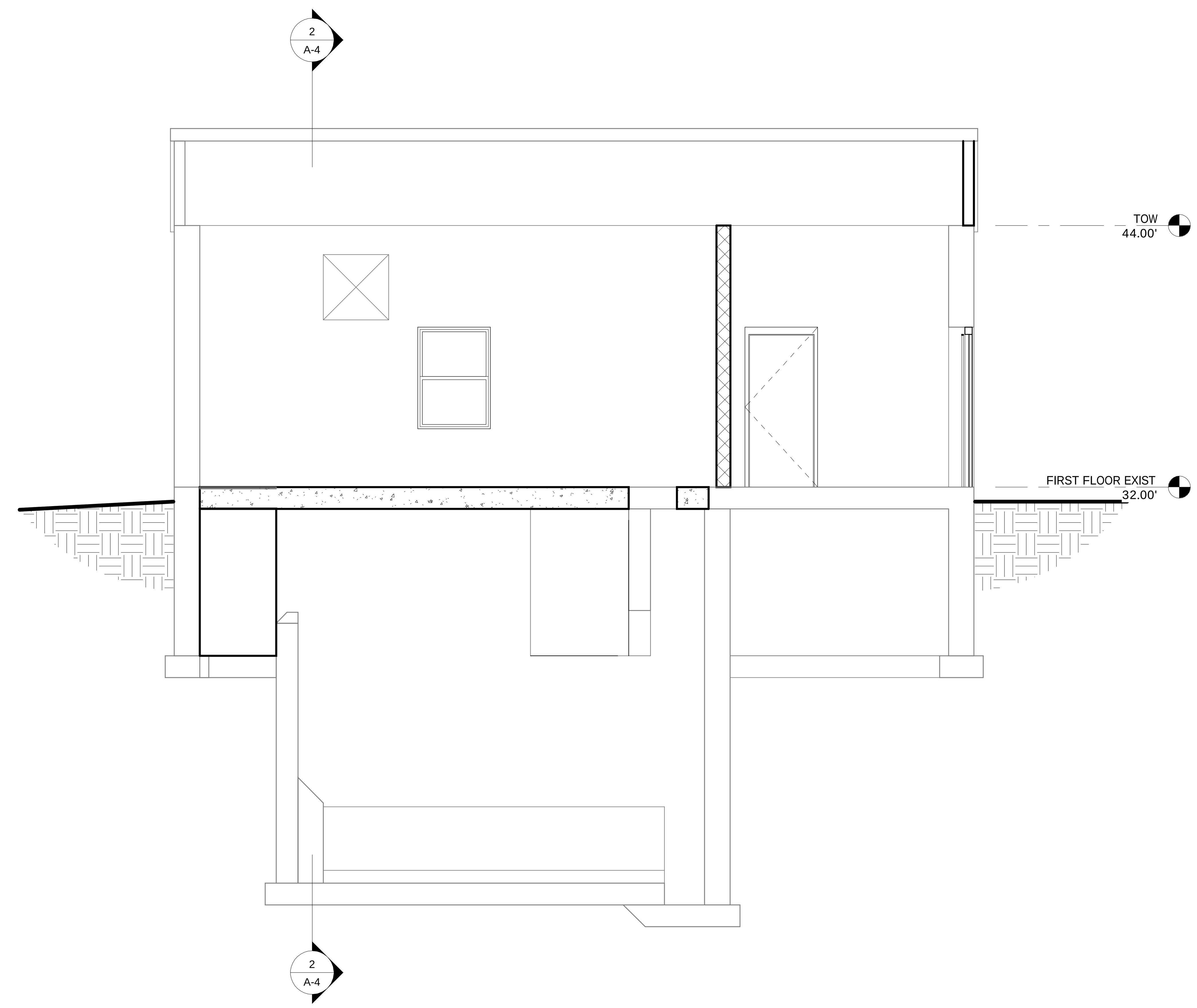




EAST ELEVATION
SCALE: 3/16" = 1'-0"

WEST ELEVATION
SCALE: 3/16" = 1'-0"





2 A-3 **SECTION**
SCALE: 1/4" = 1'-0"

1 A-3 **SECTION**
SCALE: 1/4" = 1'-0"

NO	SUBMISSIONS / REVISIONS	APP'D	DATE
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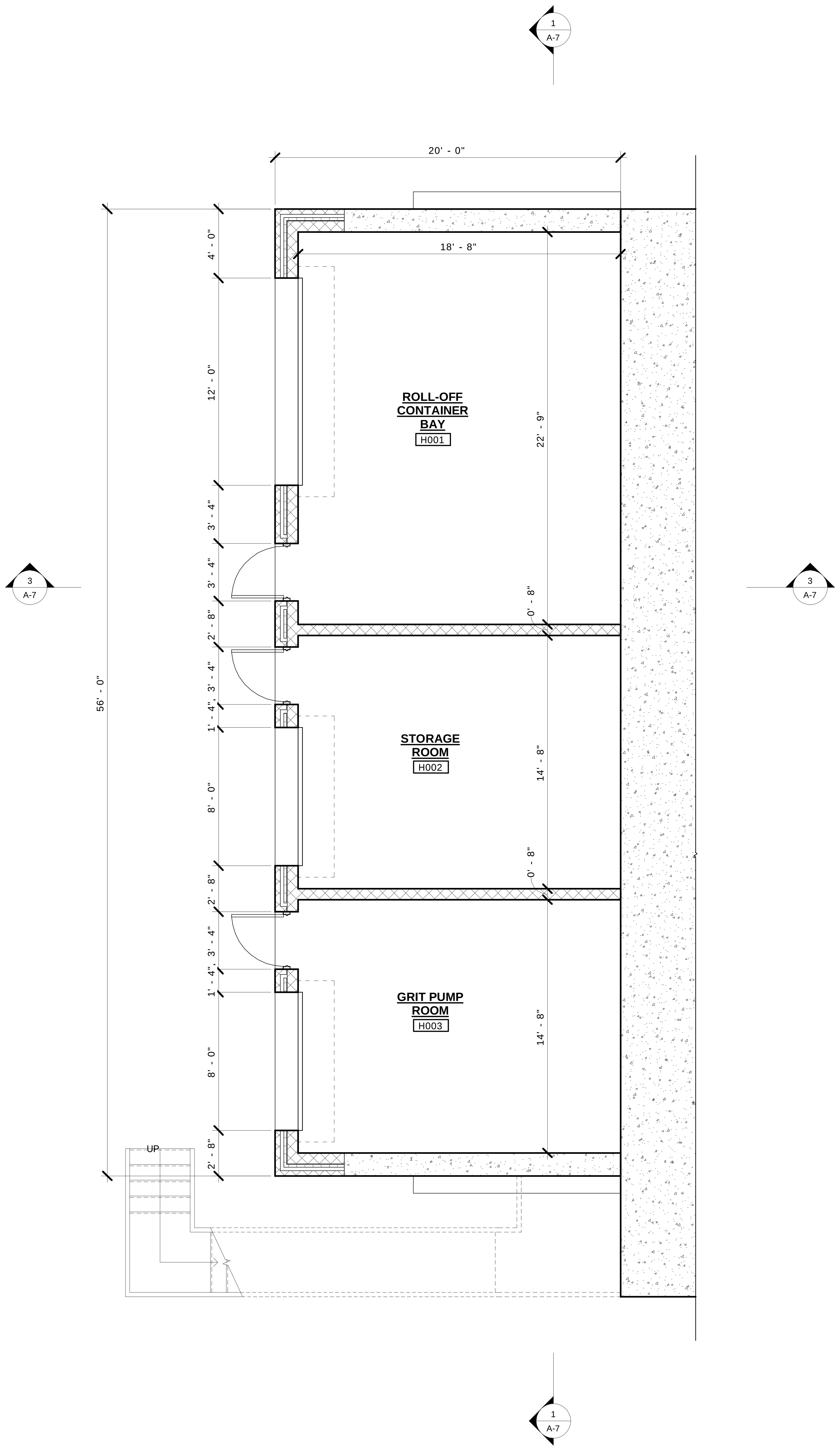
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

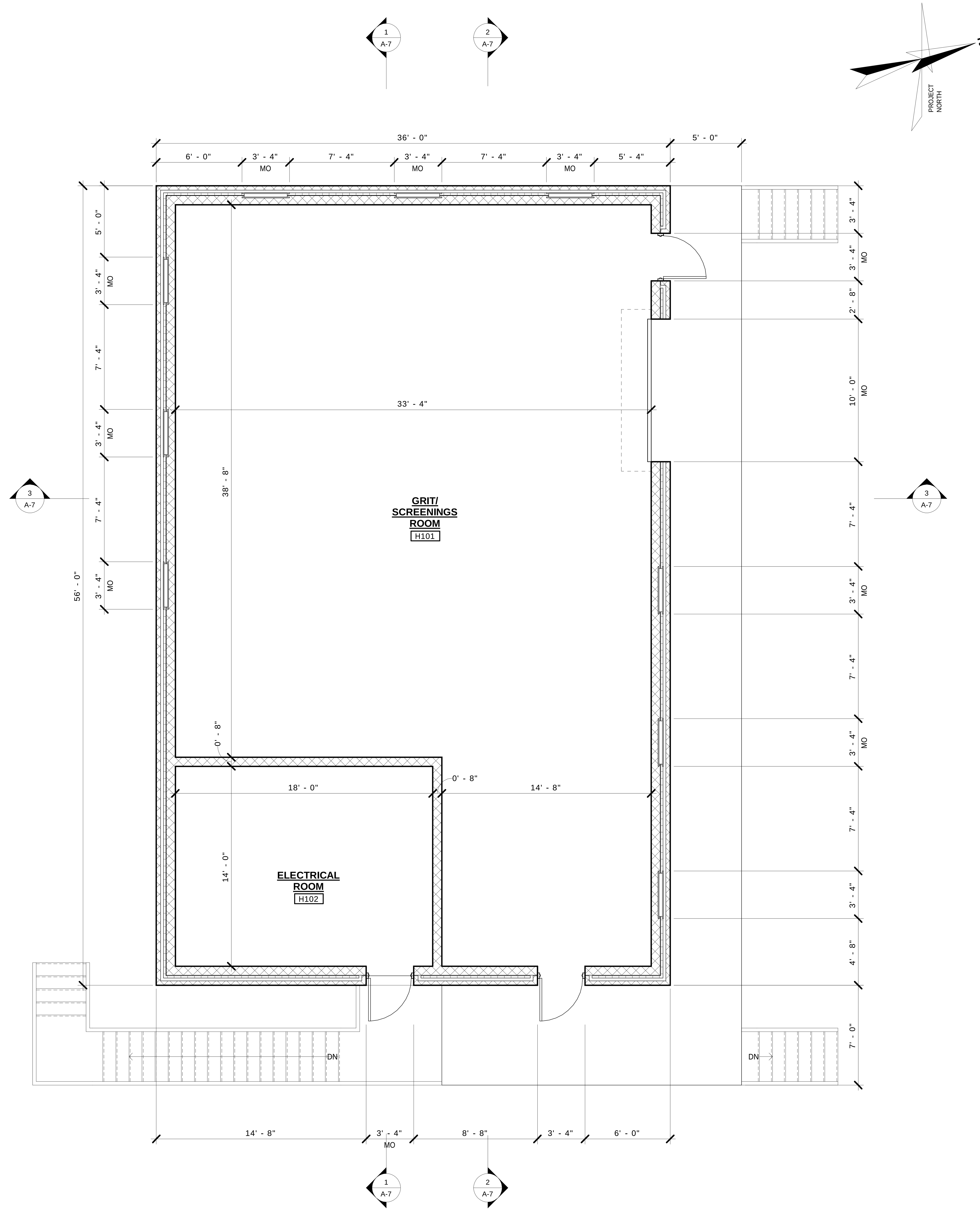
SEPTAGE BUILDING - EXTERIOR ELEVATIONS, SECTIONS AND DETAILS

DRAWING
A - 4



LOWER FLOOR PLAN

SCALE: 1/4" = 1'-0"



FIRST FLOOR PLAN

SCALE: 1/4" = 1'-0"

NO	SUBMISSIONS / REVISIONS	APP'D	DATE
1	PRELIMINARY DESIGN REPORT		
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3			
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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
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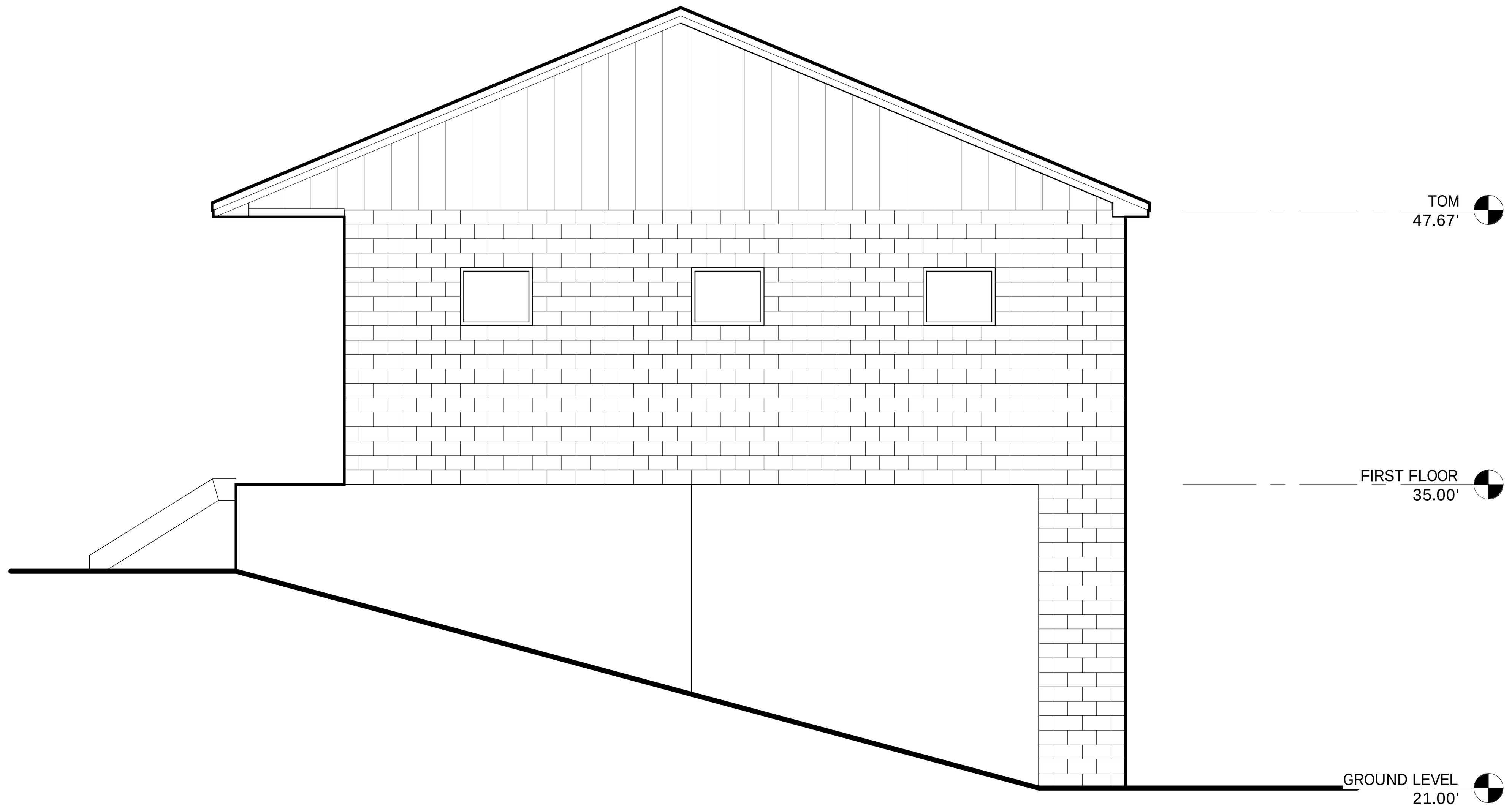
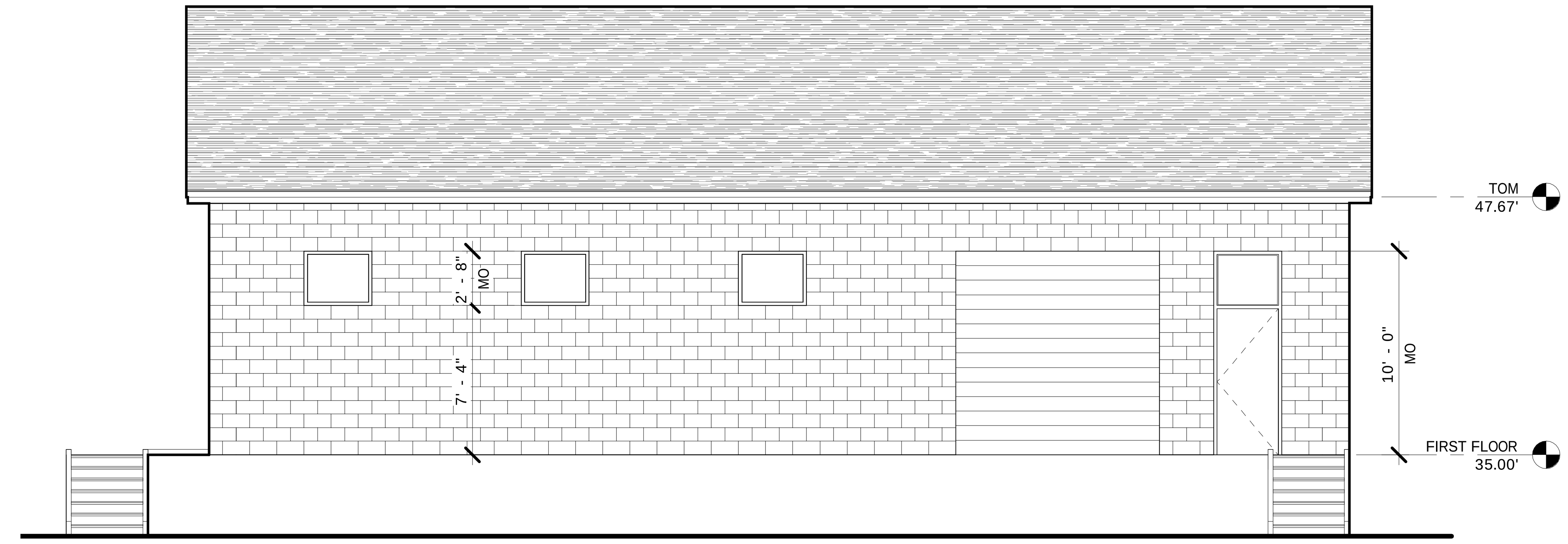
HEADWORKS BUILDING - FLOOR PLANS

DRAWING
A - 5



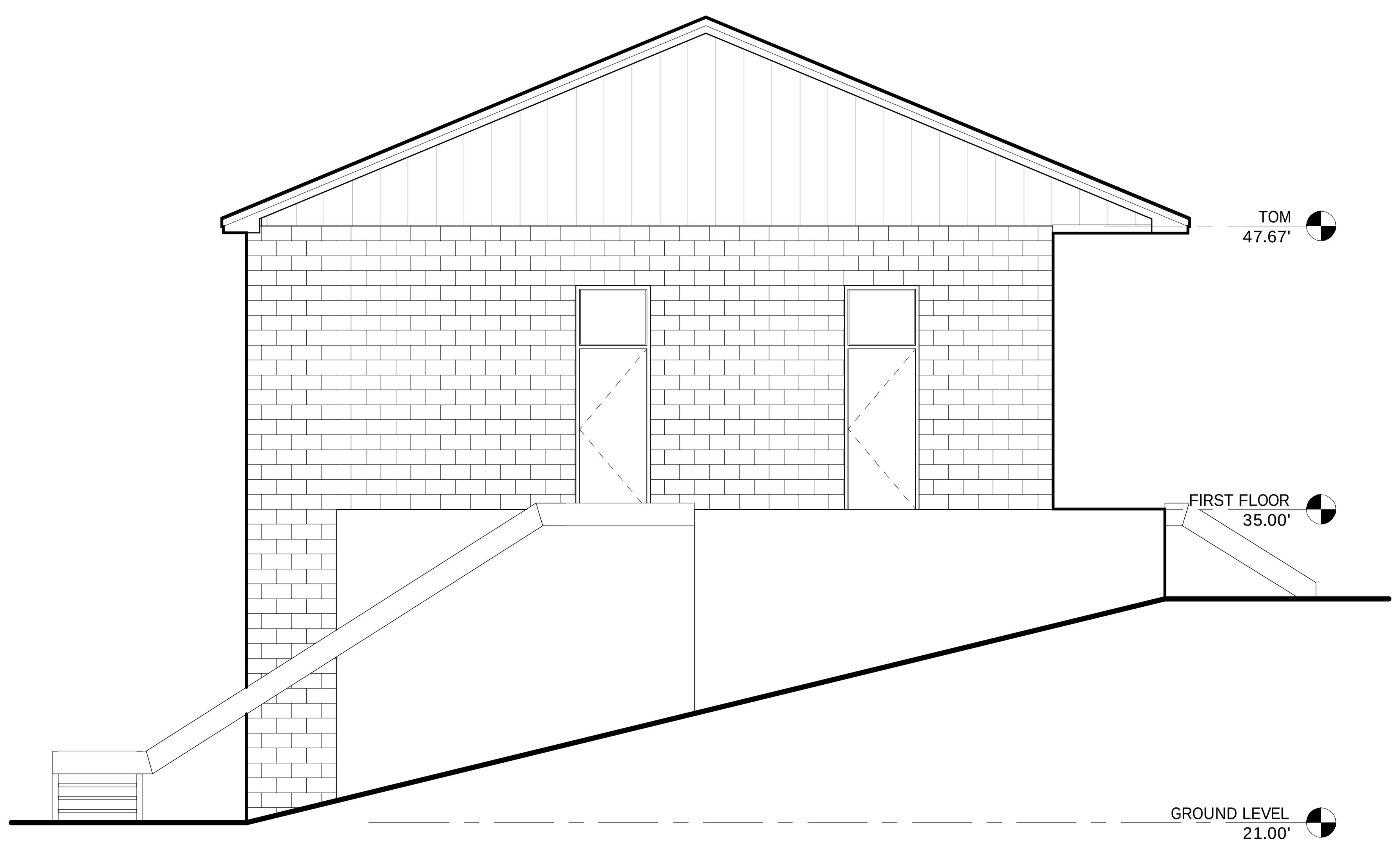
NORTH ELEVATION

SCALE: 3 / 16" = 1' - 0"



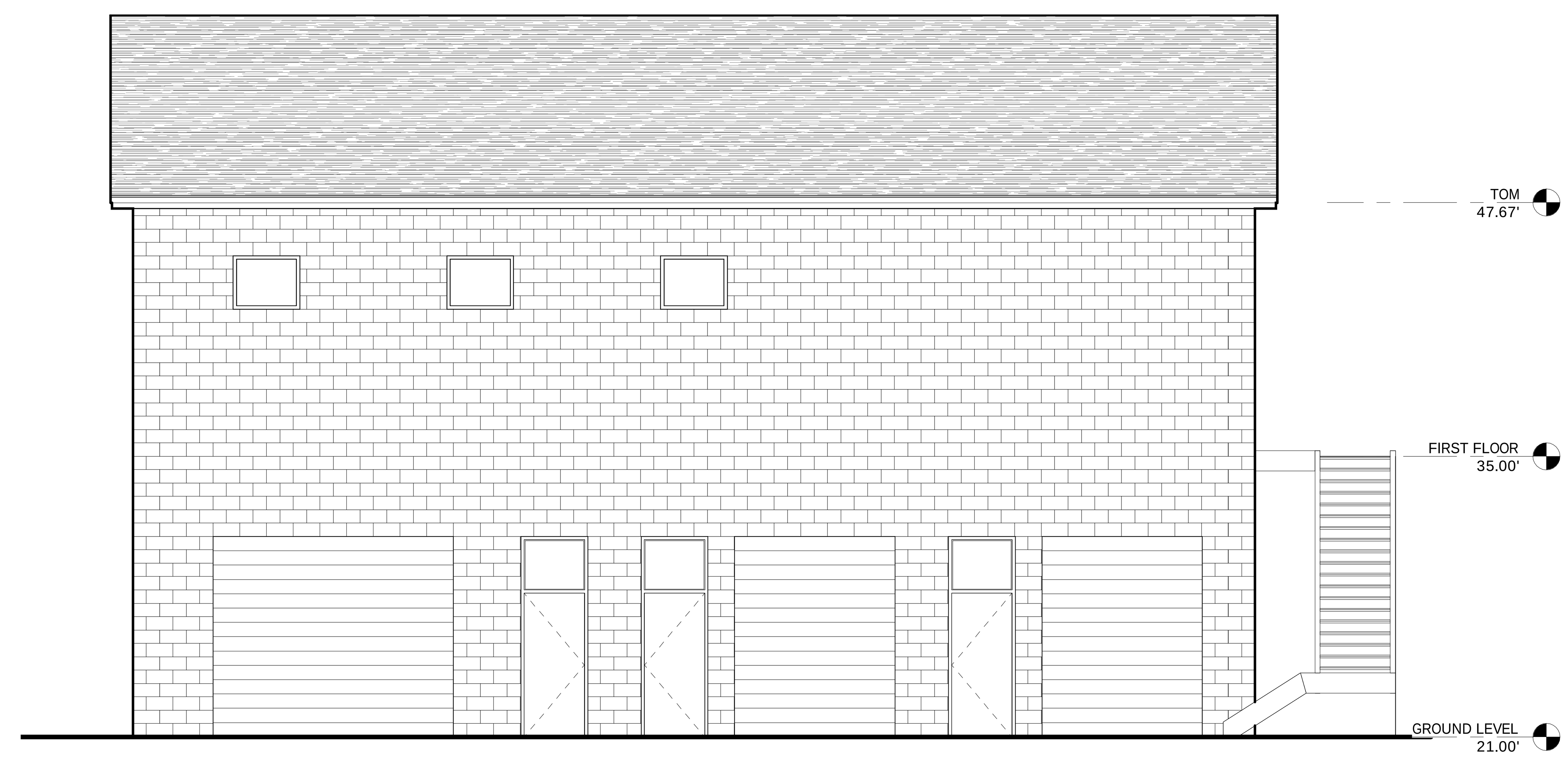
EAST ELEVATION

SCALE: 3 / 16" = 1' - 0"



SOUTH ELEVATION

SCALE: 3 / 16" = 1' - 0"



WEST ELEVATION

SCALE: 3 / 16" = 1' - 0"

NO.	SUBMISSIONS / REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		
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CONTRACT NO. 1
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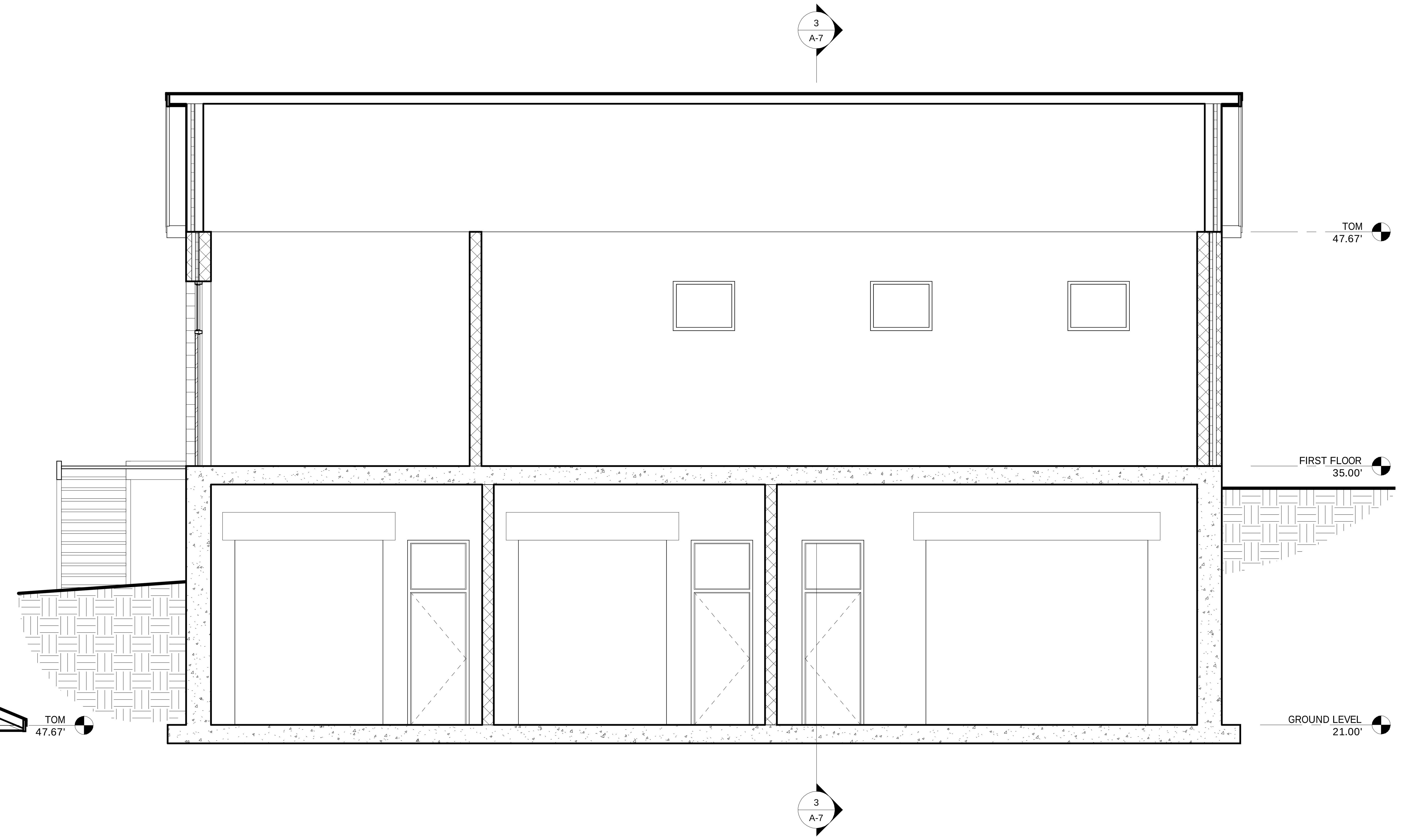
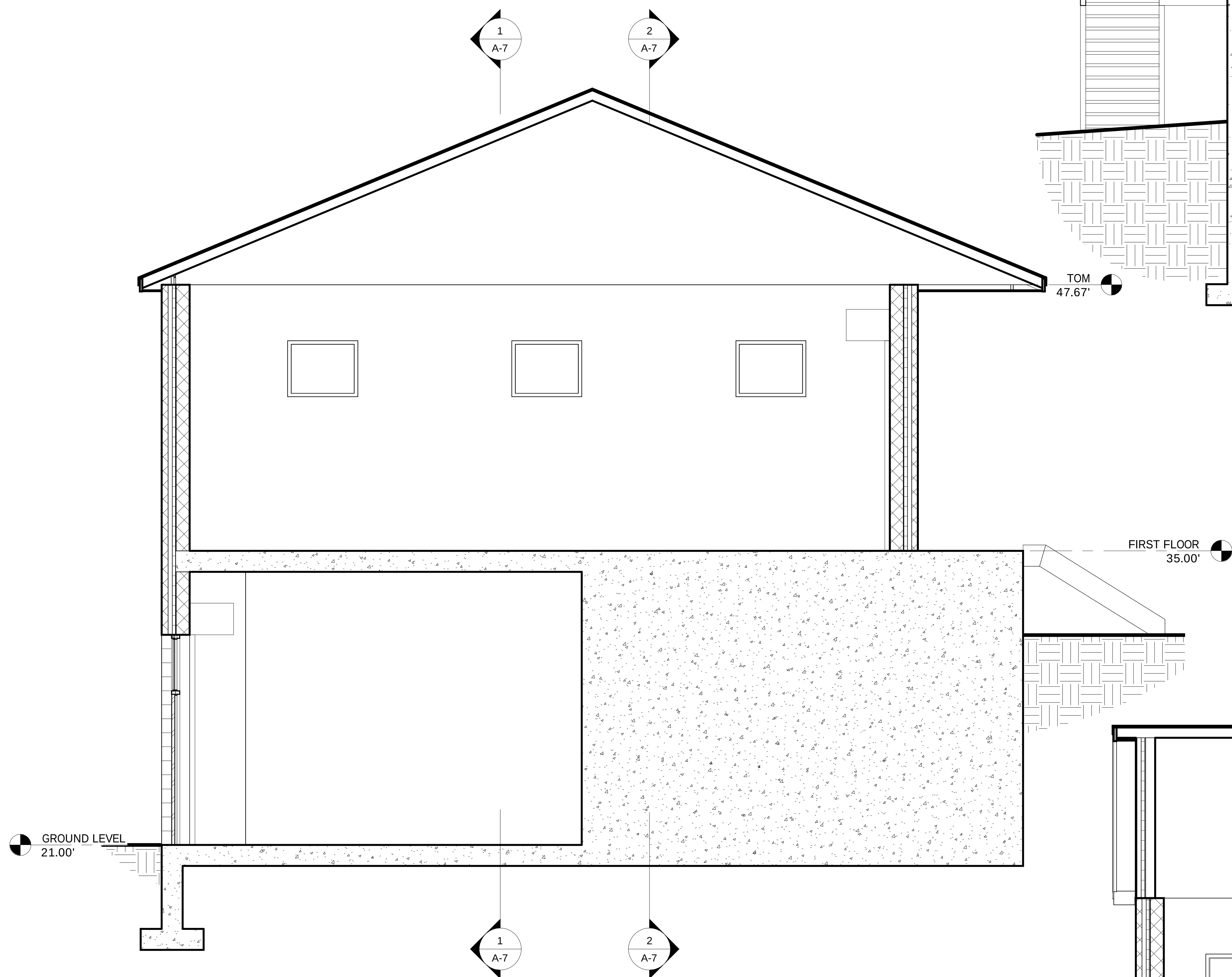
HEADWORKS BUILDING - EXTERIOR ELEVATIONS

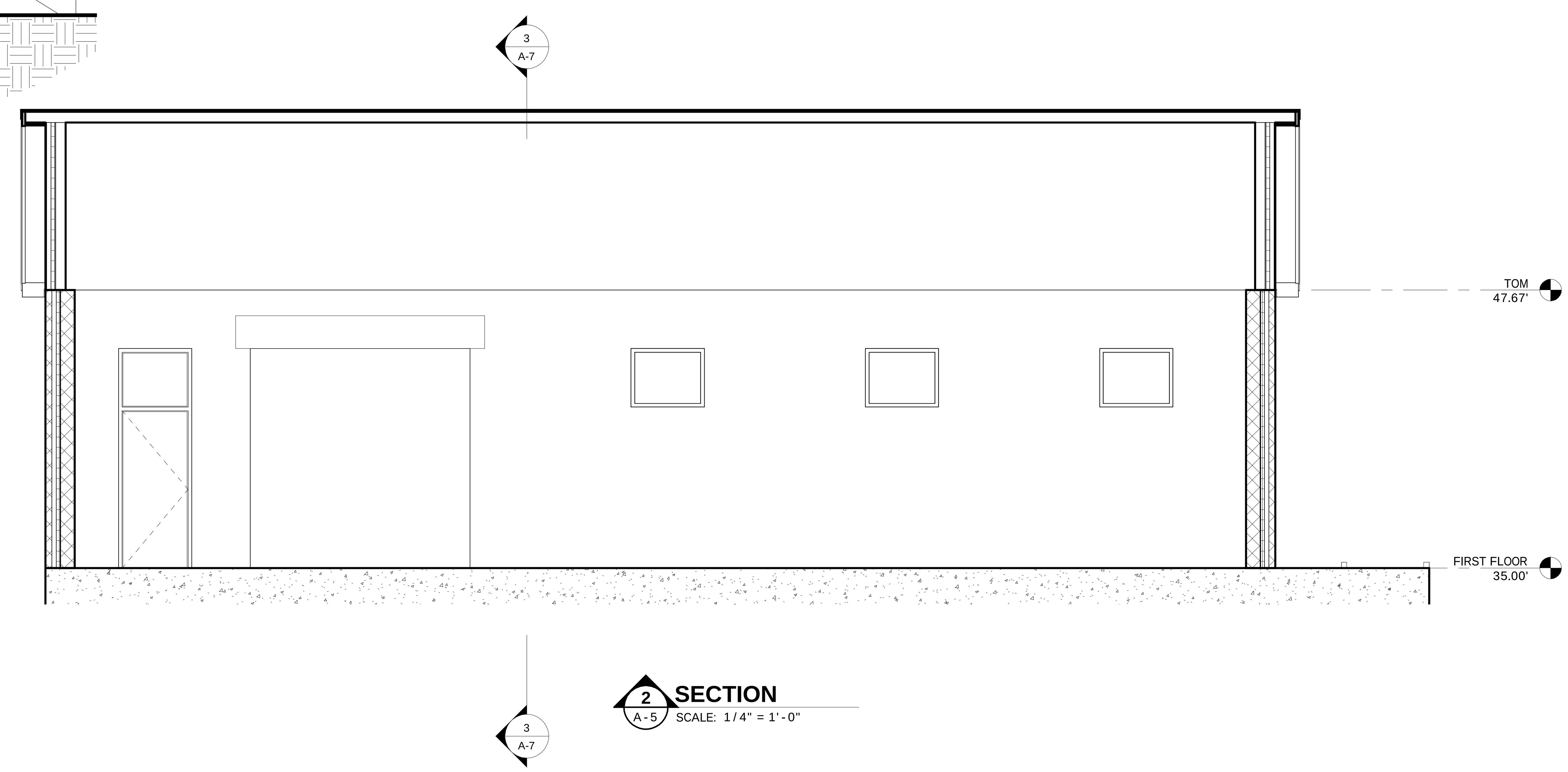
DRAWING
A - 6



1 SECTION
A-5 SCALE: 1/4" = 1'-0"



3 SECTION
A-5 SCALE: 1/4" = 1'-0"



2 SECTION
A-5 SCALE: 1/4" = 1'-0"

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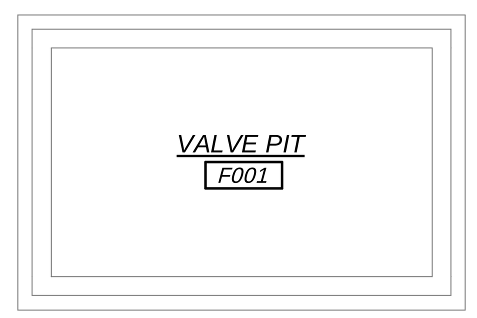
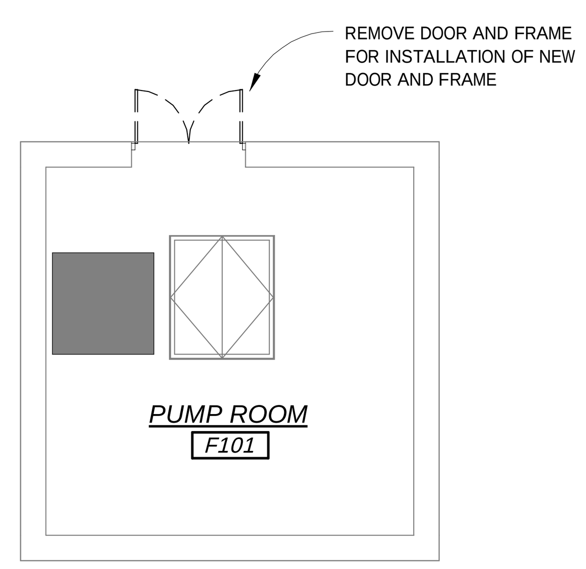
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

HEADWORKS BUILDING - SECTIONS

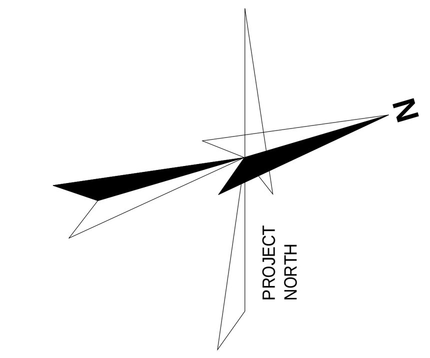
DRAWING
A - 7

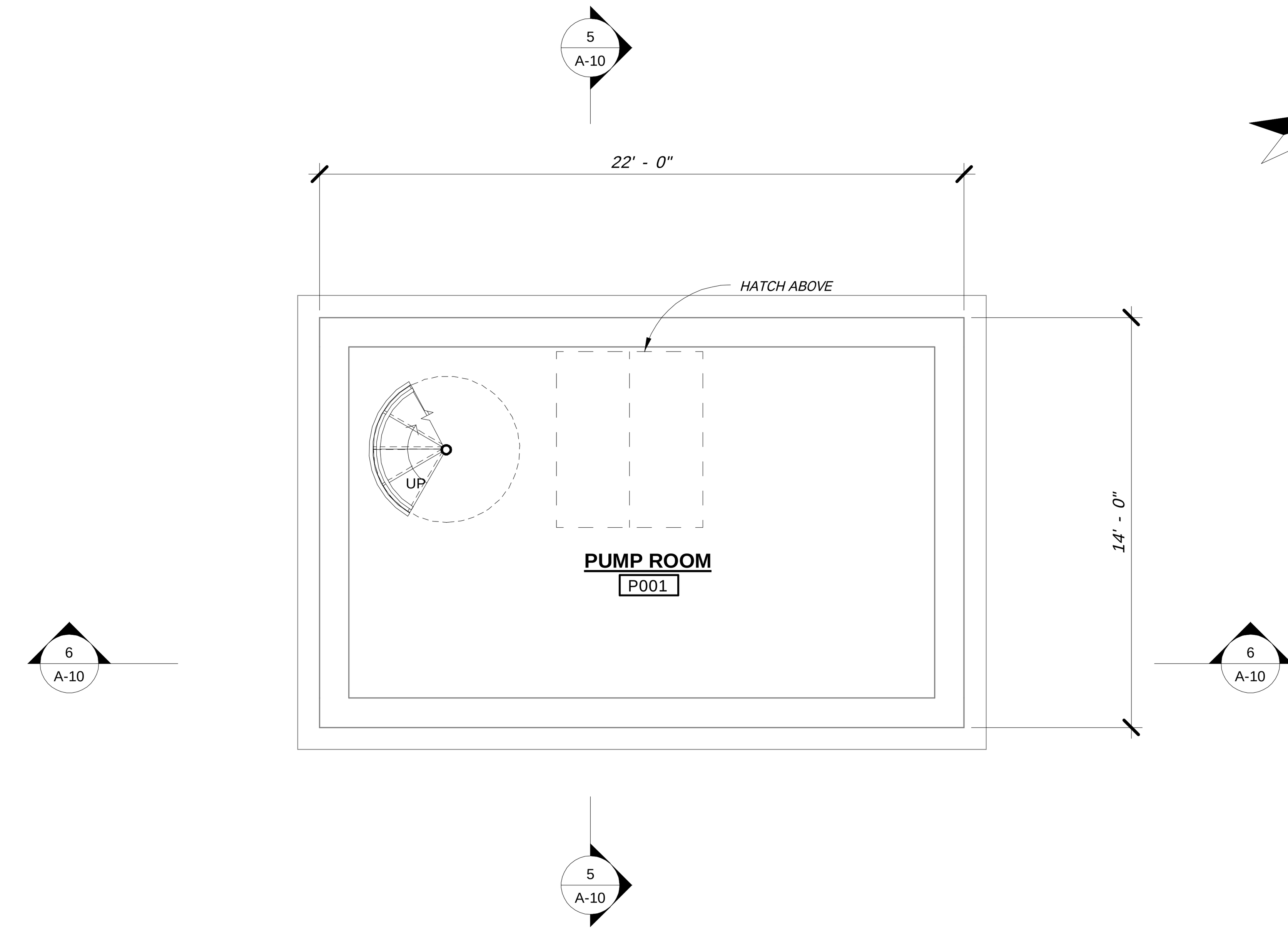


CHLORINATION BUILDING
LOWER FLOOR DEMO PLAN
SCALE: 1 / 8" = 1' - 0"

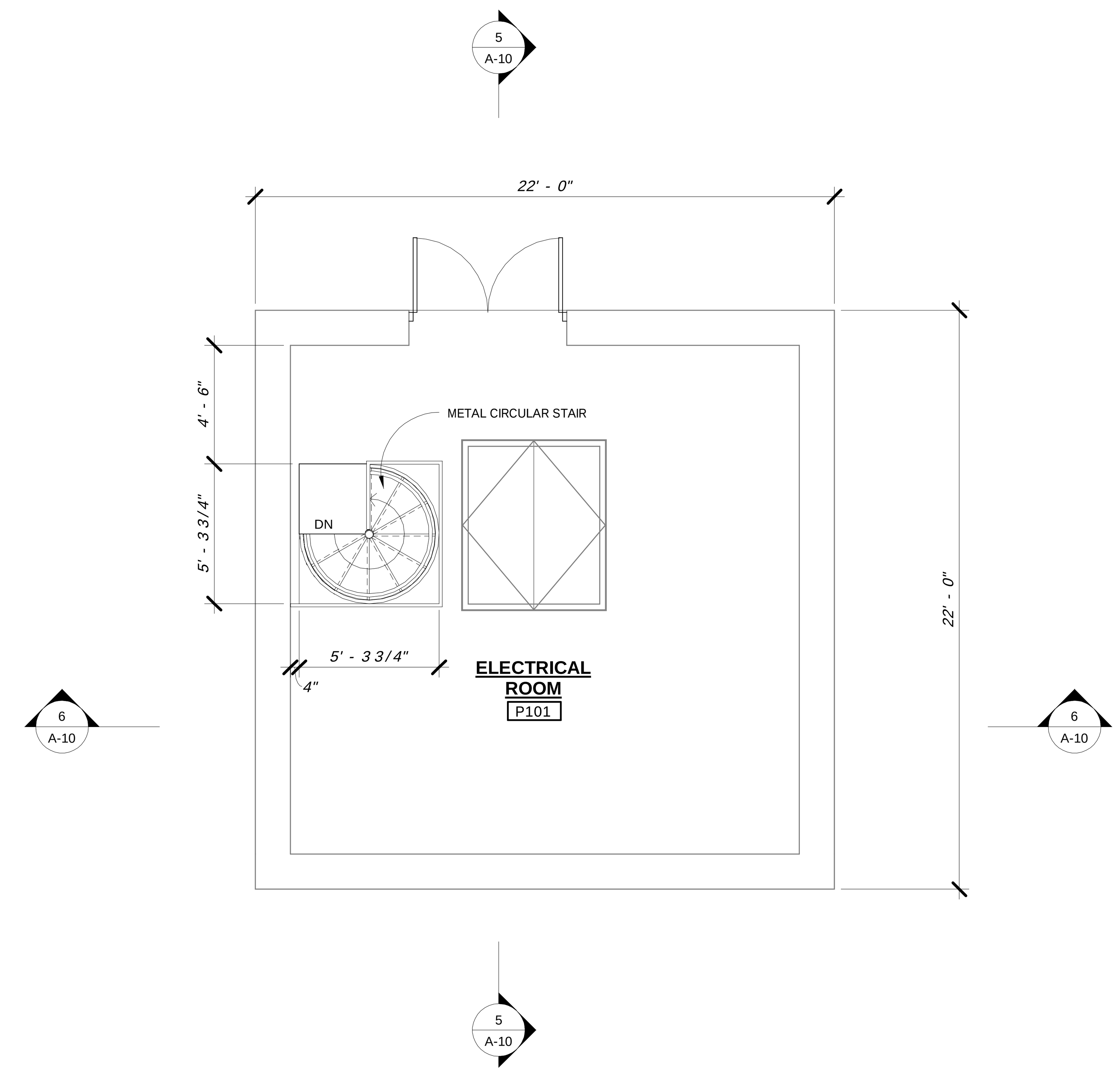


CHLORINATION BUILDING
FIRST FLOOR DEMO PLAN
SCALE: 1 / 8" = 1' - 0"





PLANT WATER BUILDING
LOWER FLOOR MODIFICATION PLAN
SCALE: 1 / 4" = 1' - 0"



PLANT WATER BUILDING
FIRST FLOOR MODIFICATION PLAN
SCALE: 1 / 4" = 1' - 0"

NO	SUBMISSIONS / REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		
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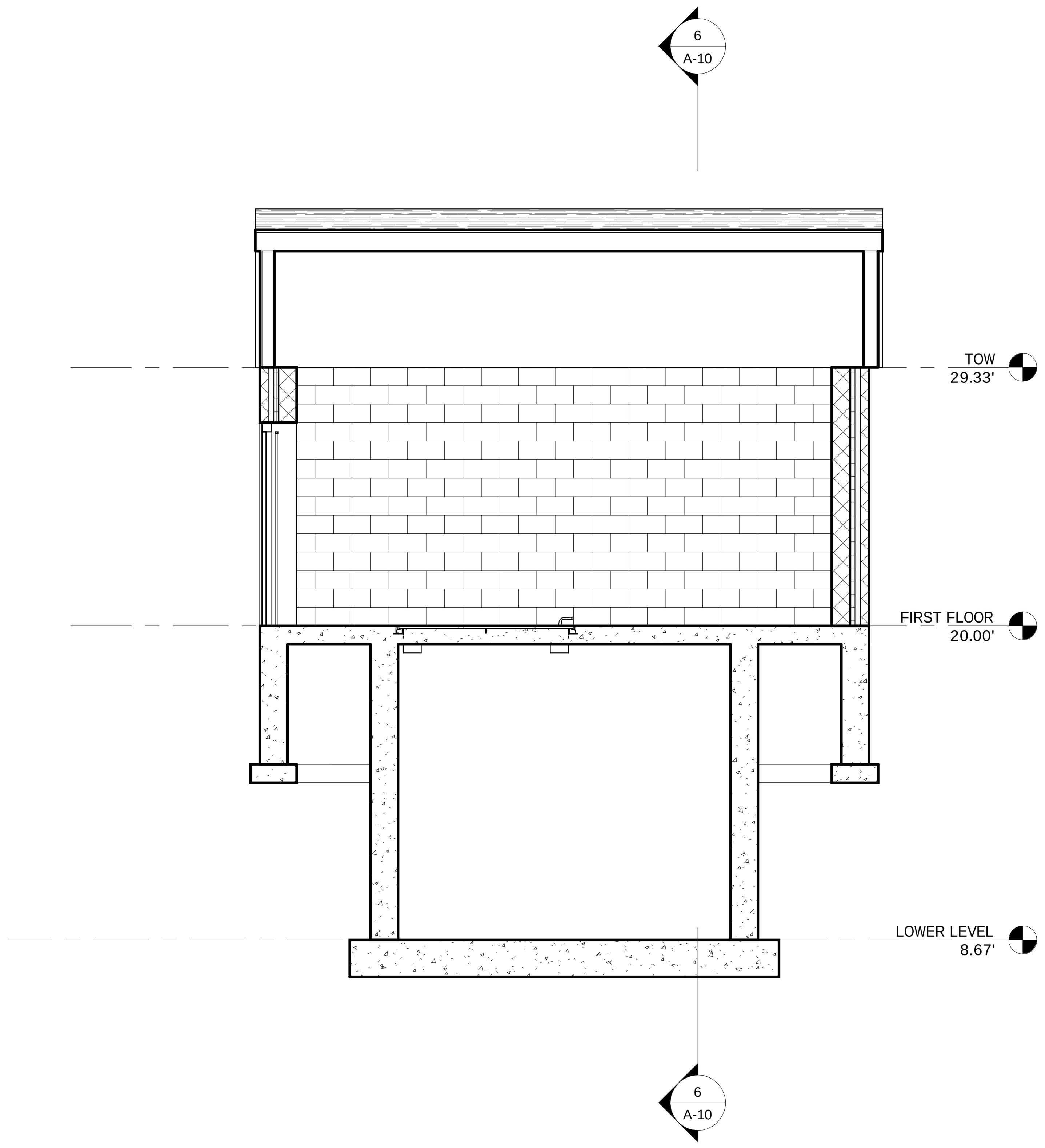
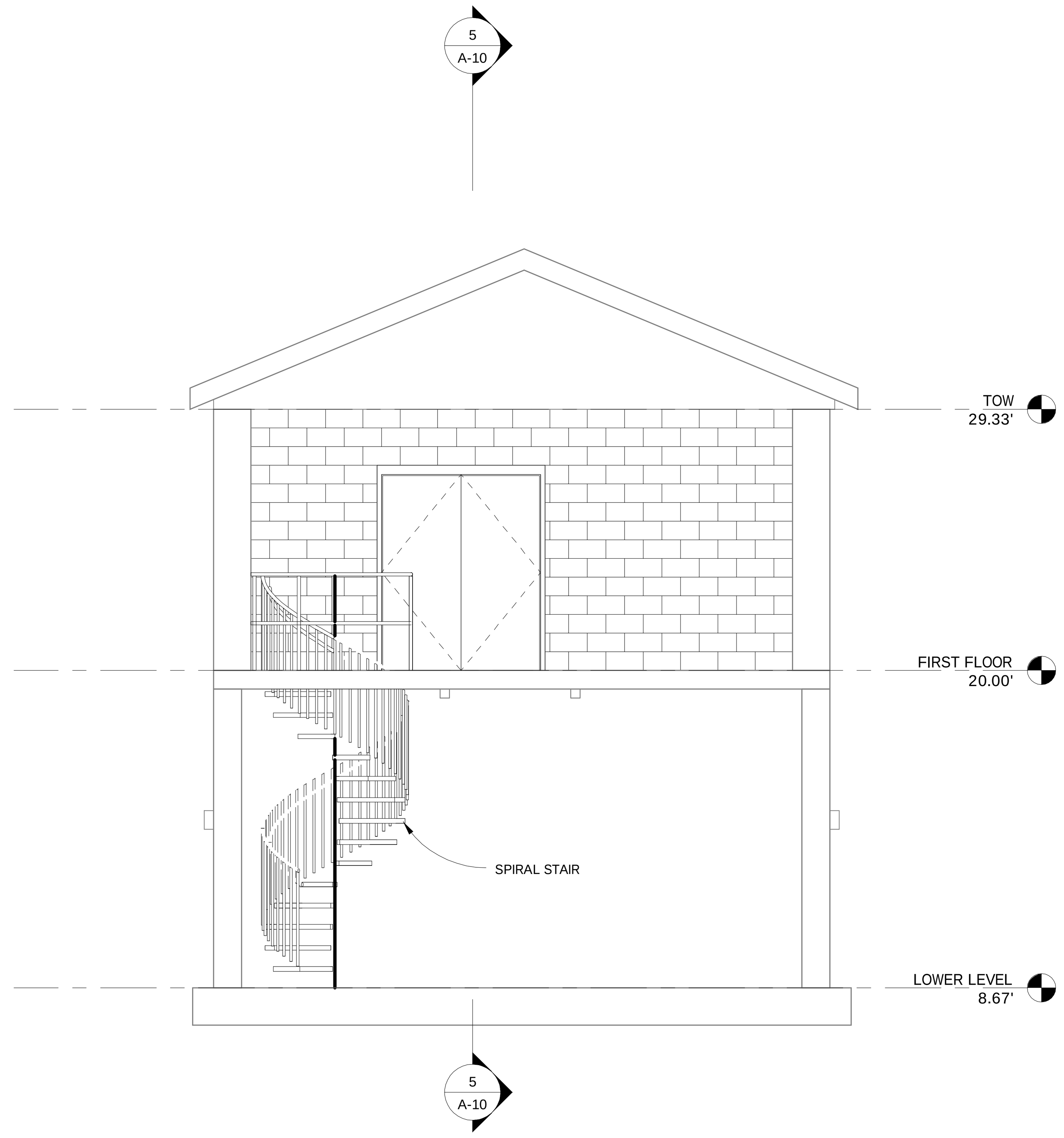
FACILITY UPGRADES

CHLORINATION / PLANT WATER BUILDING - FLOOR PLANS

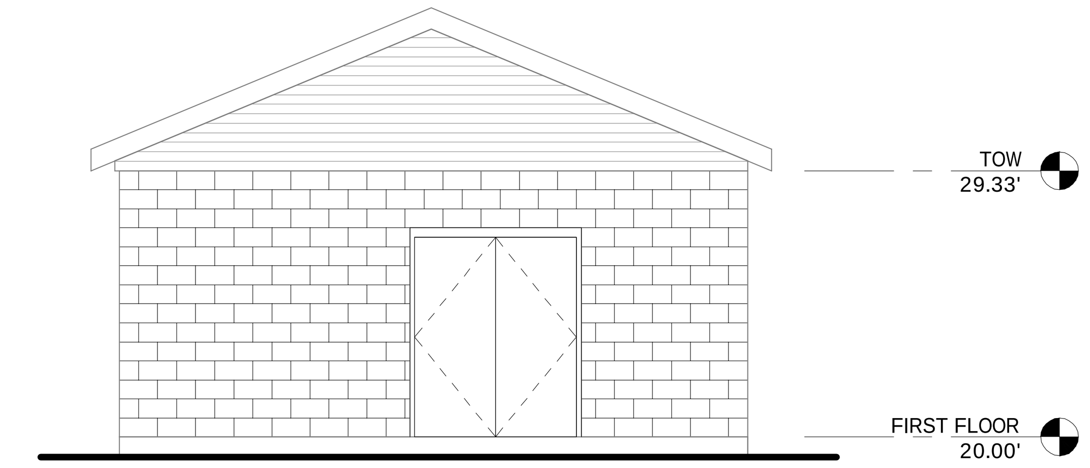
DRAWING
A - 9



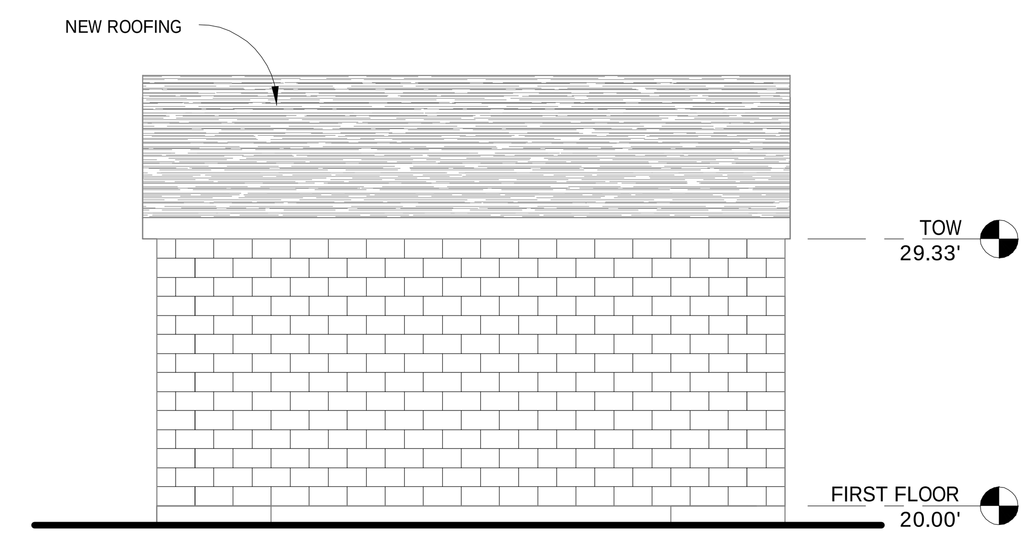
5 A-9 **SECTION**
SCALE: 1/4" = 1'-0"



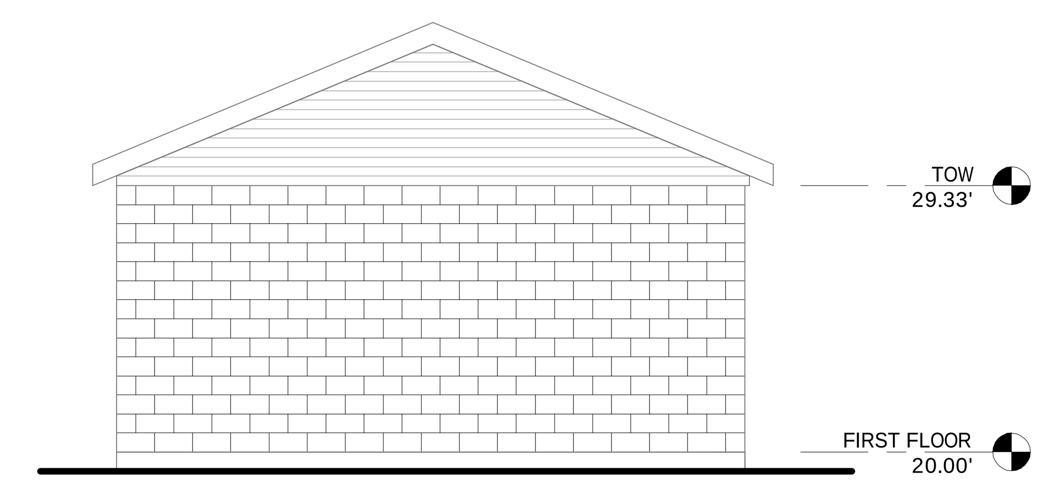
6 A-9 **SECTION**
SCALE: 1/4" = 1'-0"



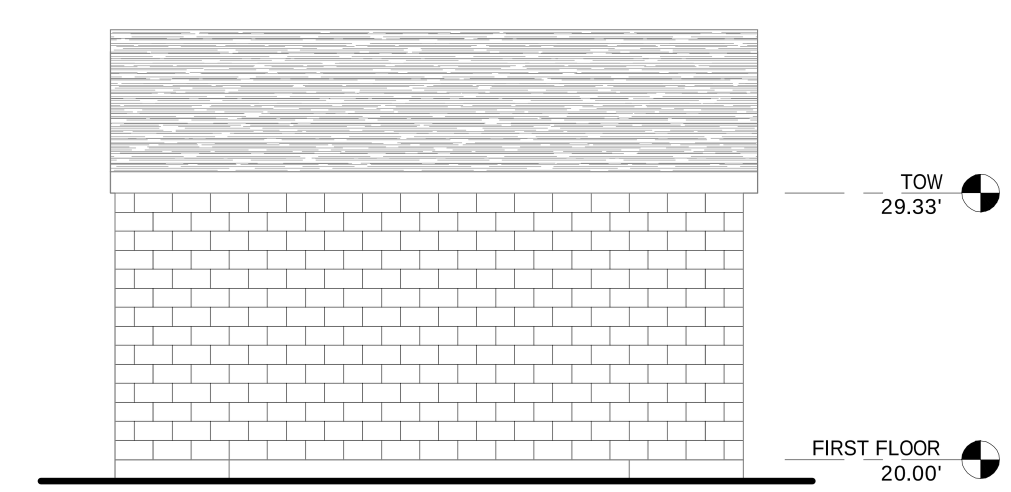
NORTH ELEVATION
SCALE: 3/16" = 1'-0"



EAST ELEVATION
SCALE: 3/16" = 1'-0"



SOUTH ELEVATION
SCALE: 3/16" = 1'-0"



WEST ELEVATION
SCALE: 3/16" = 1'-0"

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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
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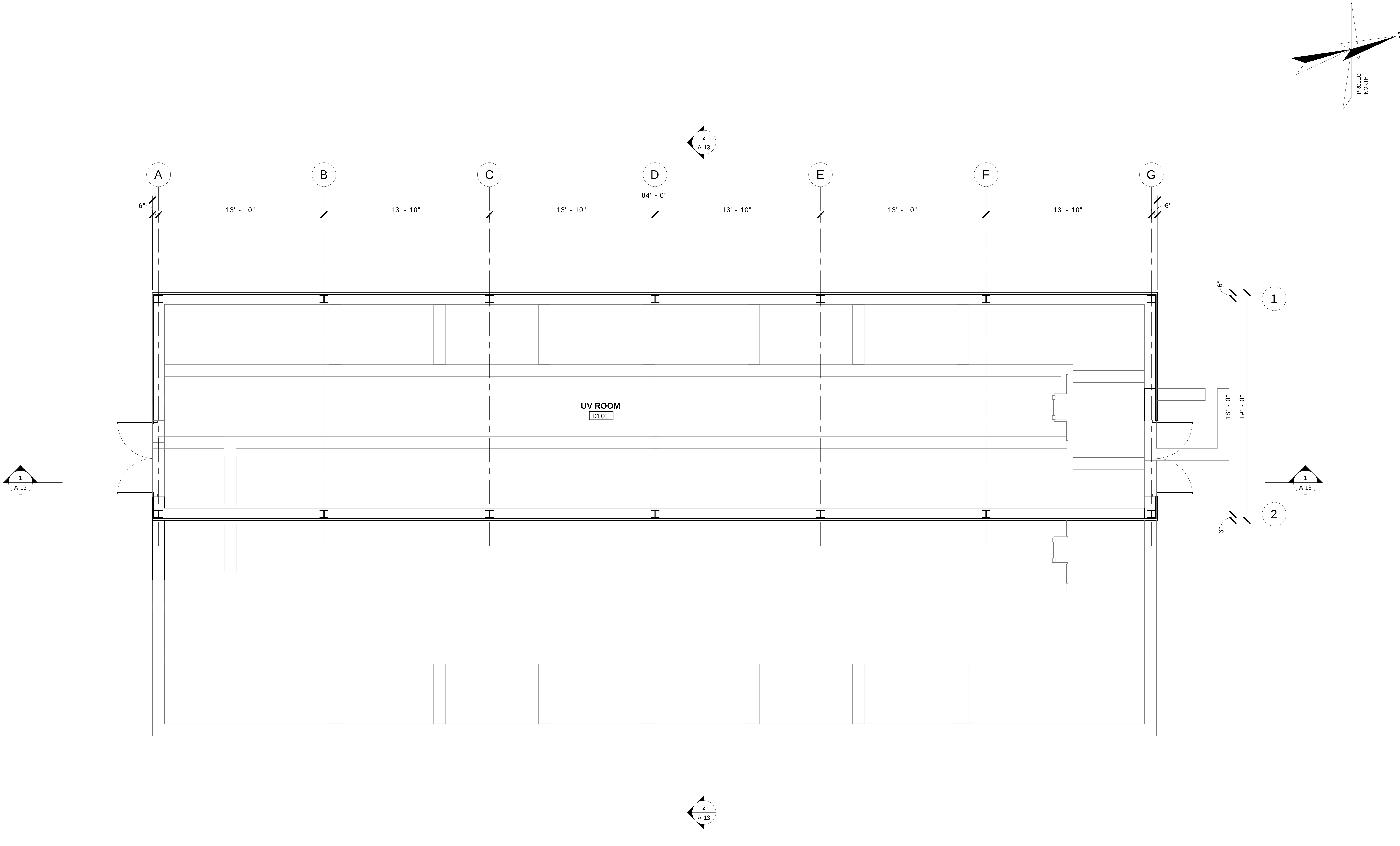
FACILITY UPGRADES

PLANT WATER BUILDING - ELEVATIONS, SECTIONS AND DETAILS

DRAWING
A - 10



FIRST FLOOR PLAN

SCALE: 1 / 4" = 1' - 0"

NO	SUBMISSIONS / REVISIONS	APP'D	DATE
1	PRELIMINARY DESIGN REPORT		
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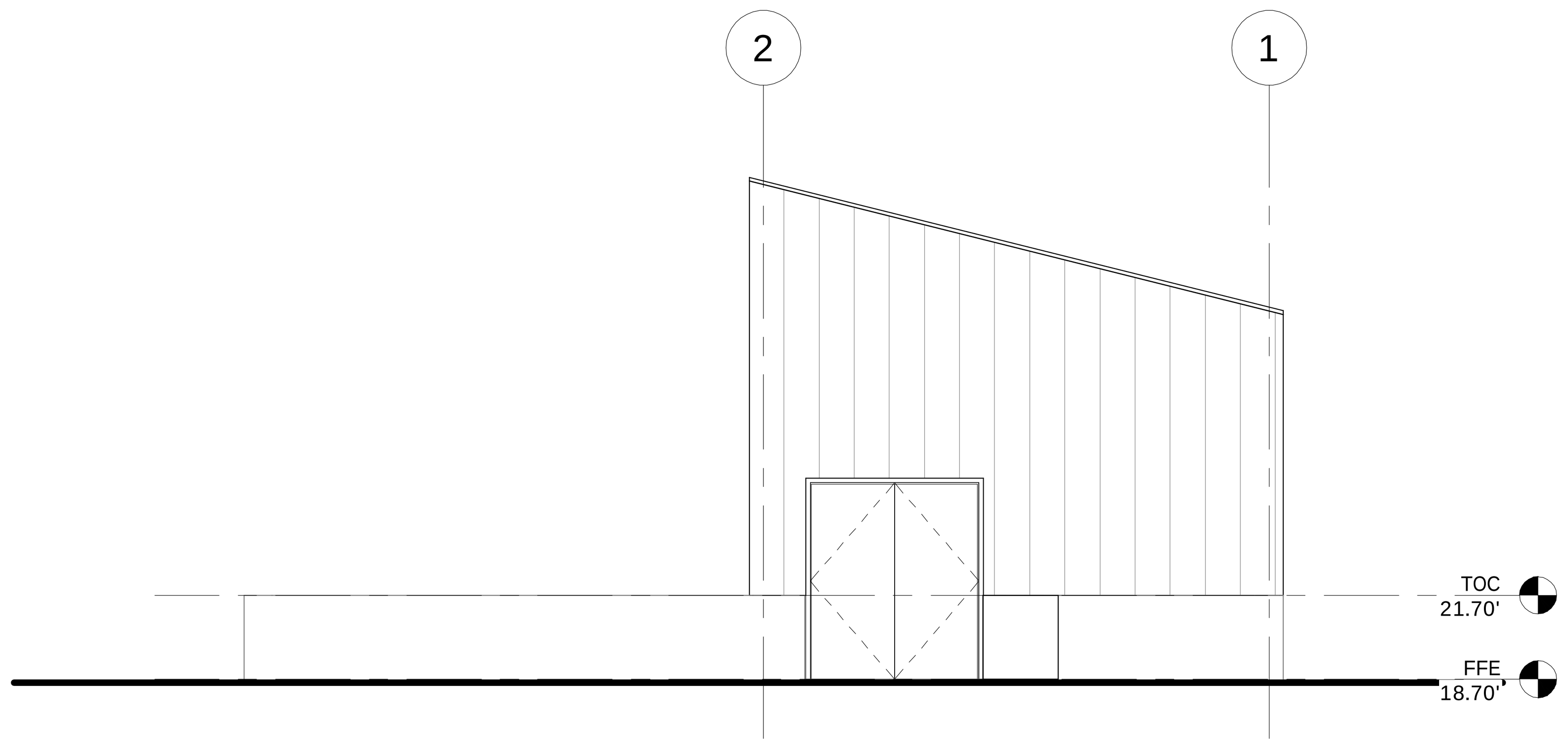
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

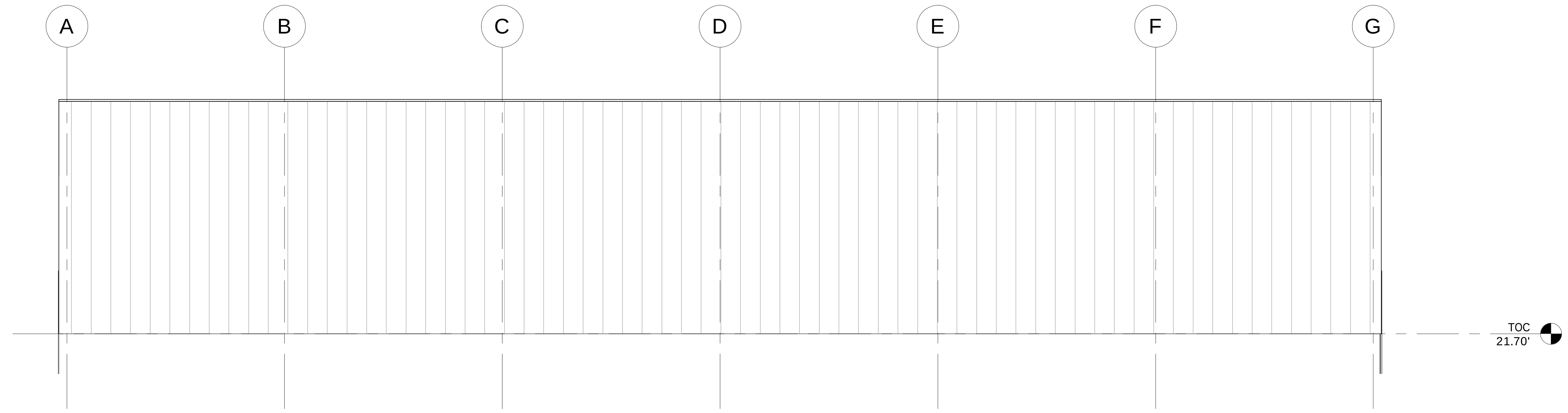
DISINFECTION TANK / BUILDING - FLOOR PLAN

DRAWING
A - 11



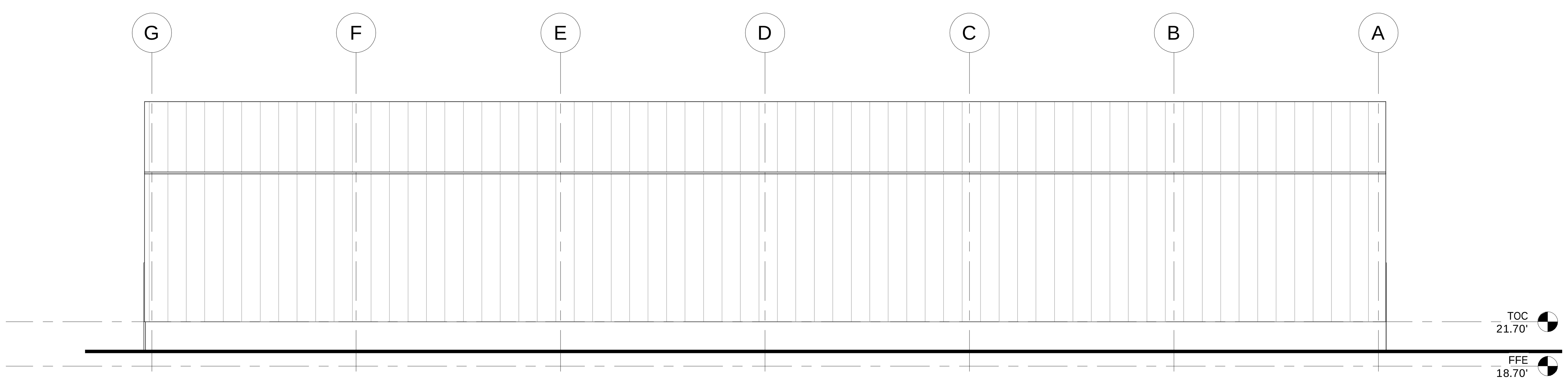
EAST ELEVATION

SCALE: 3/16" = 1'-0"



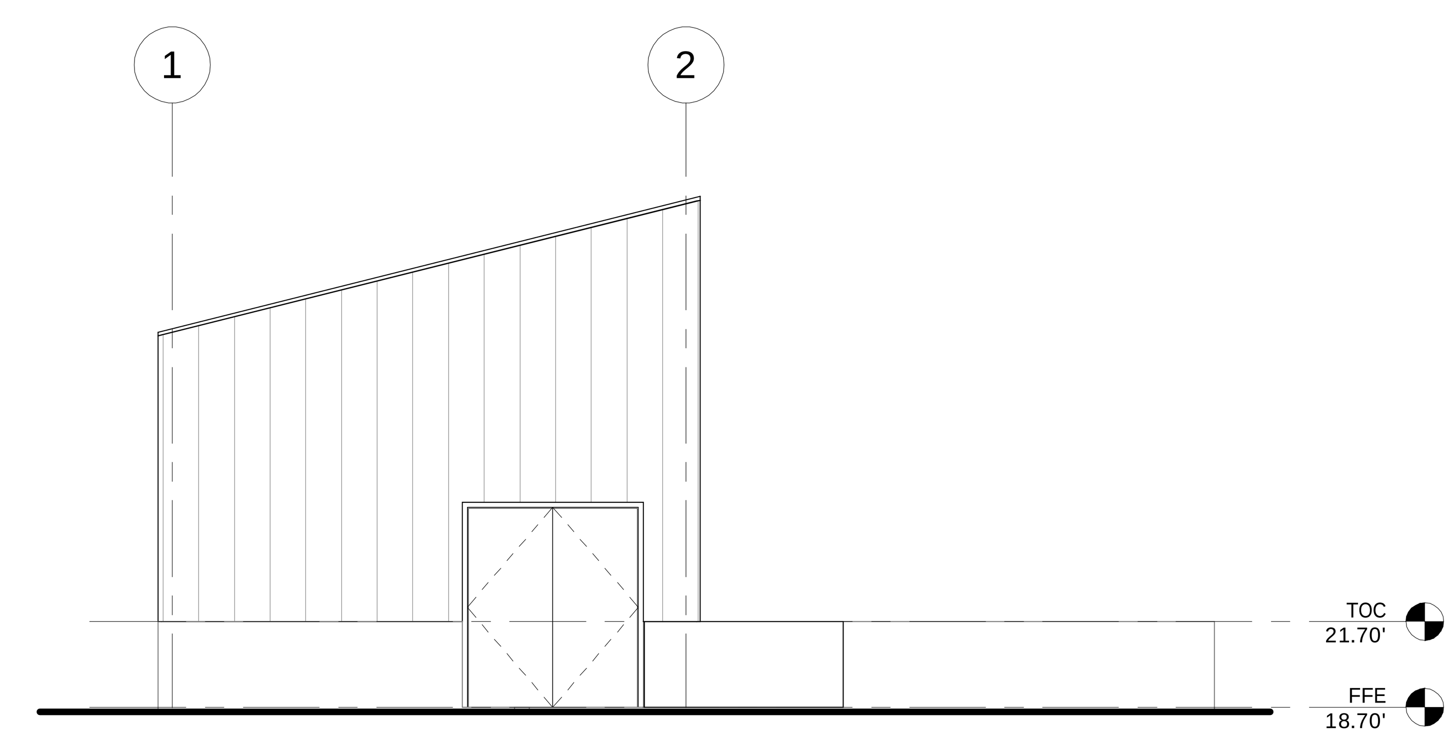
SOUTH ELEVATION

SCALE: 3/16" = 1'-0"



NORTH ELEVATION

SCALE: 3/16" = 1'-0"



WEST ELEVATION

SCALE: 3/16" = 1'-0"

NO	SUBMISIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		
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CONTRACT NO. 1
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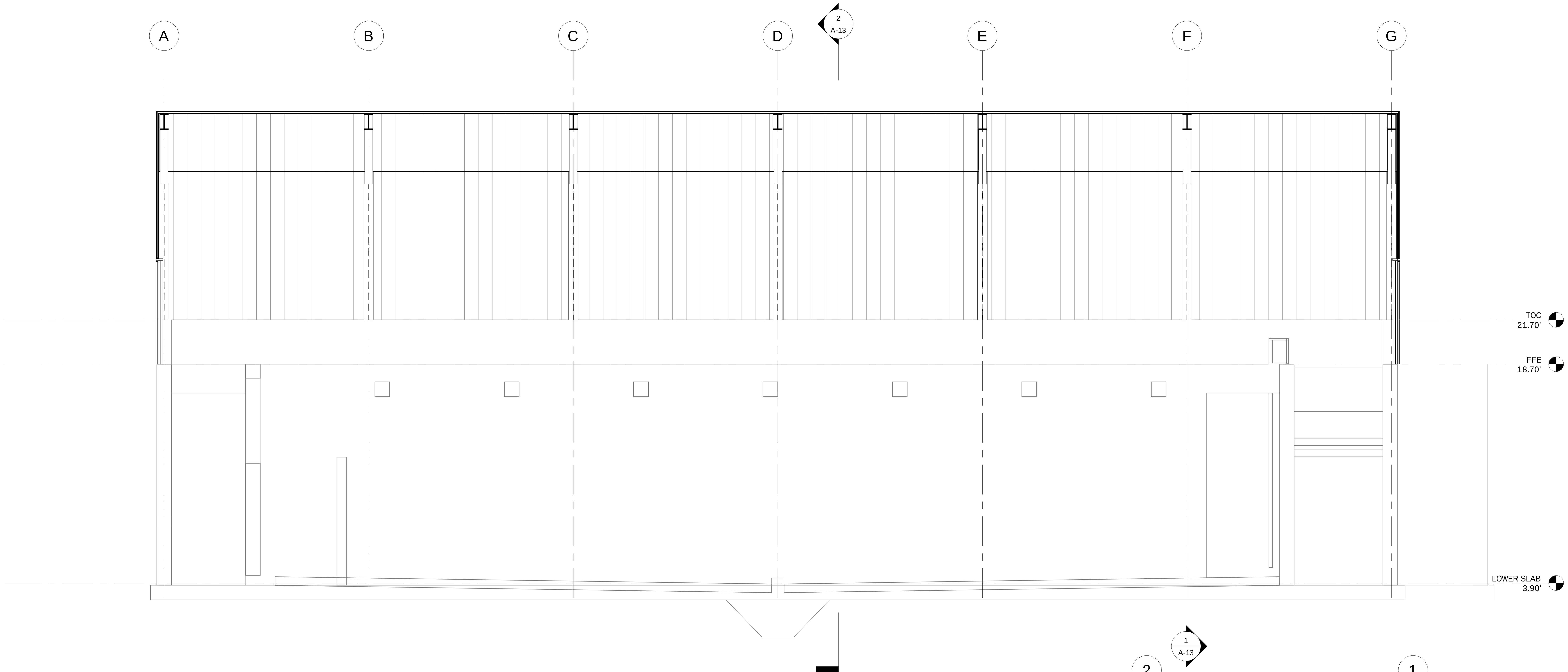
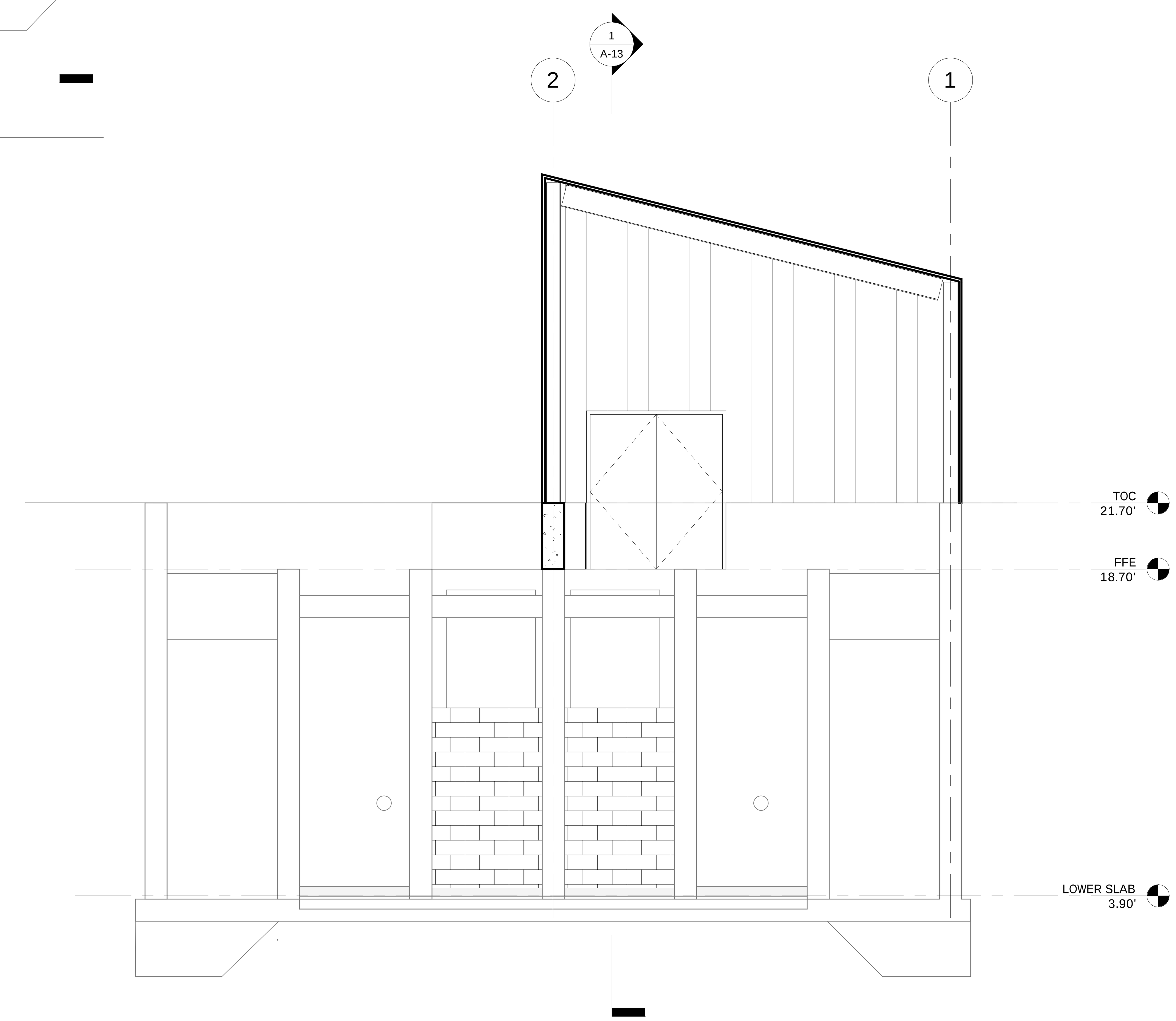
DISINFECTION TANK / BUILDING - EXTERIOR ELEVATIONS

DRAWING
A - 12



1 A-11 **SECTION**
SCALE: 1/4" = 1'-0"



2 A-11 **SECTION**
SCALE: 1/4" = 1'-0"

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		
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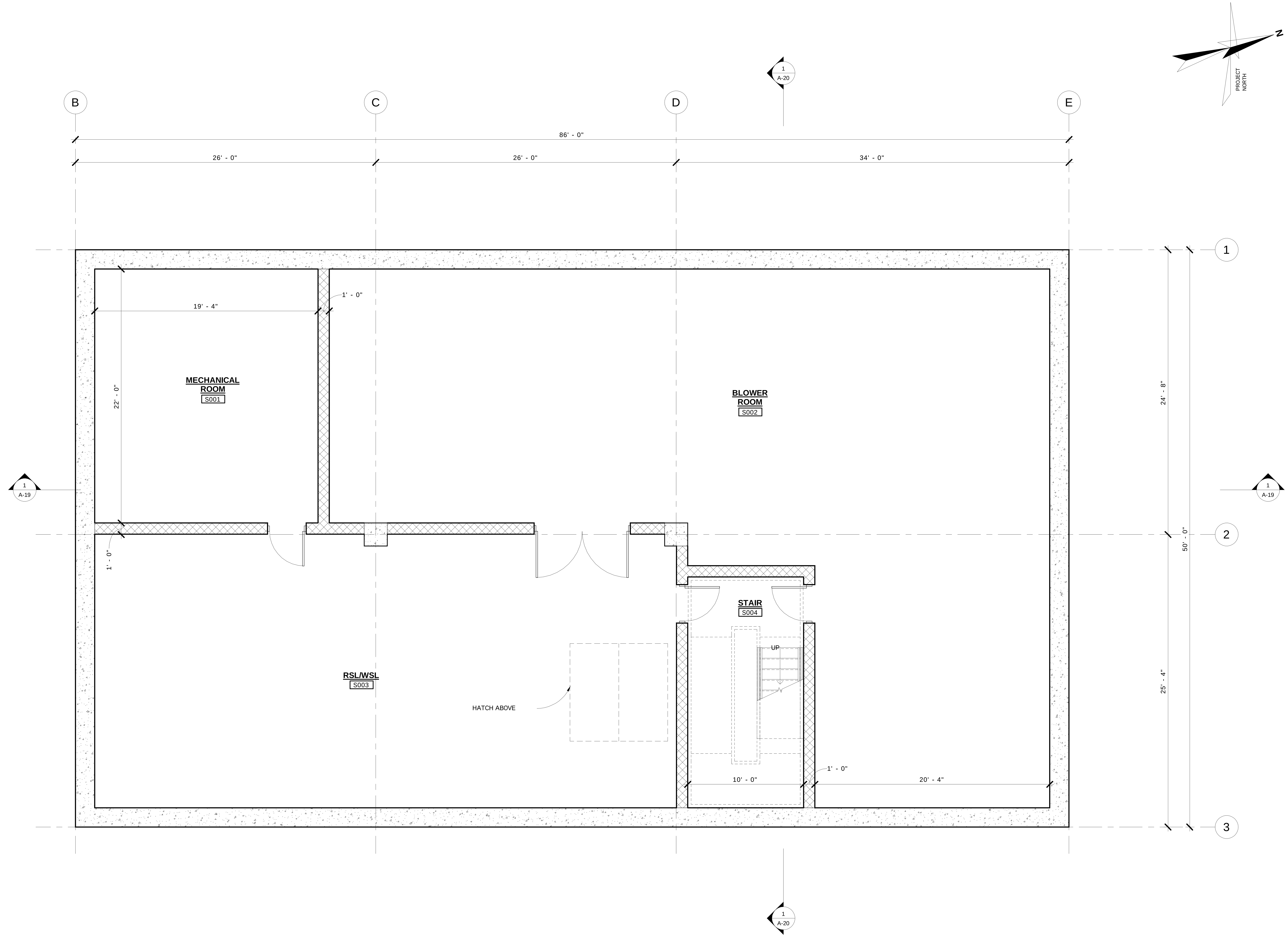
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

DISINFECTION TANK / BUILDING - SECTIONS

DRAWING
A - 13



LOWER FLOOR PLAN

SCALE: 1 / 4" = 1' - 0"

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		
1			
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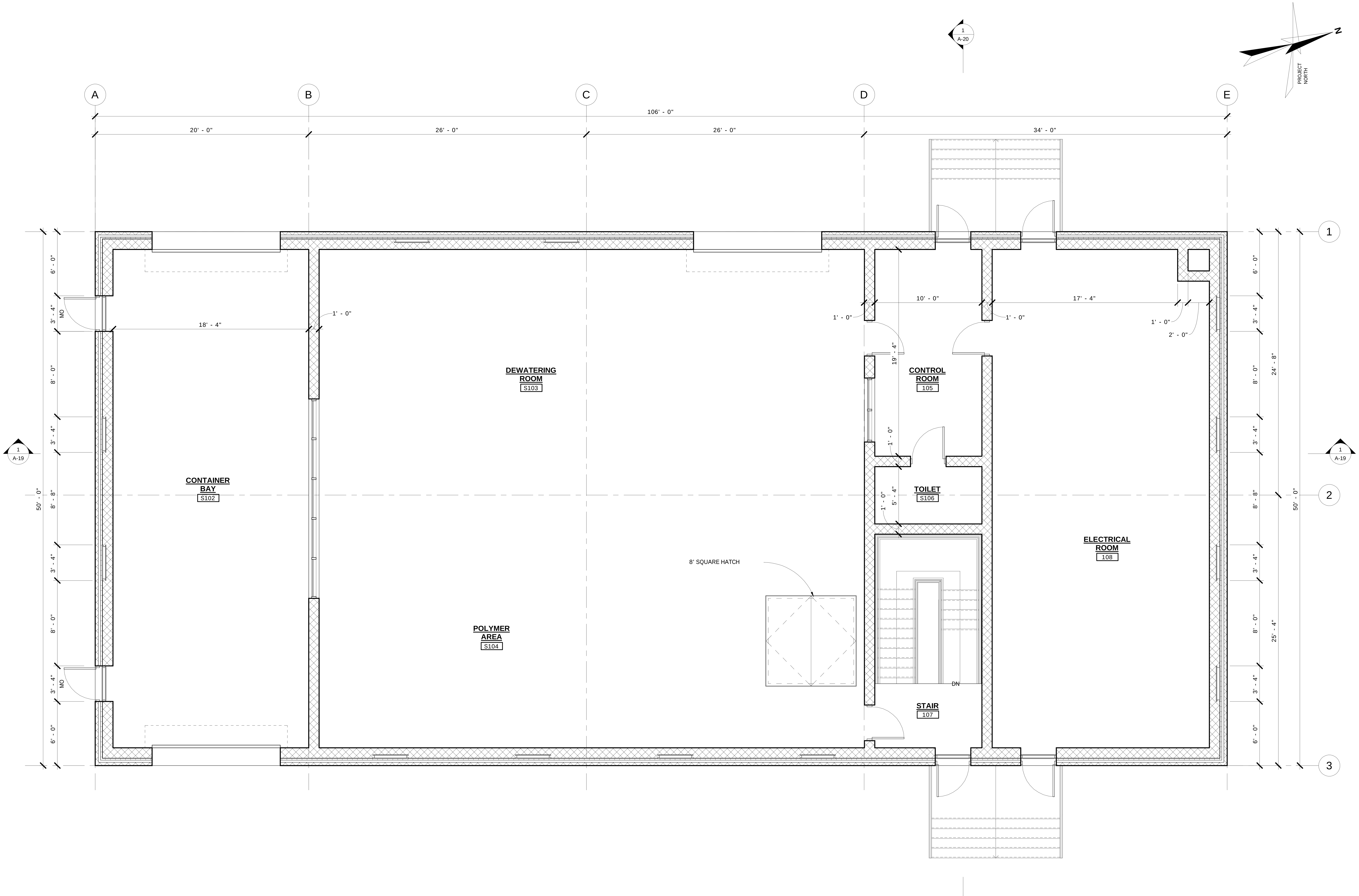
SOLIDS HANDLING BUILDING - LOWER FLOOR PLAN

DRAWING
A - 15



FIRST FLOOR PLAN

SCALE: 1/4" = 1'-0"

NO	SUBMISSIONS / REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		
1			
2			
3			
4			

DESIGNED BY: Designer
CAD COORD: APC
CAD: Author
CHECKED BY: Checker
DATE:
APPROVED BY: Approver
DATE:
PROJECT NO: 12883

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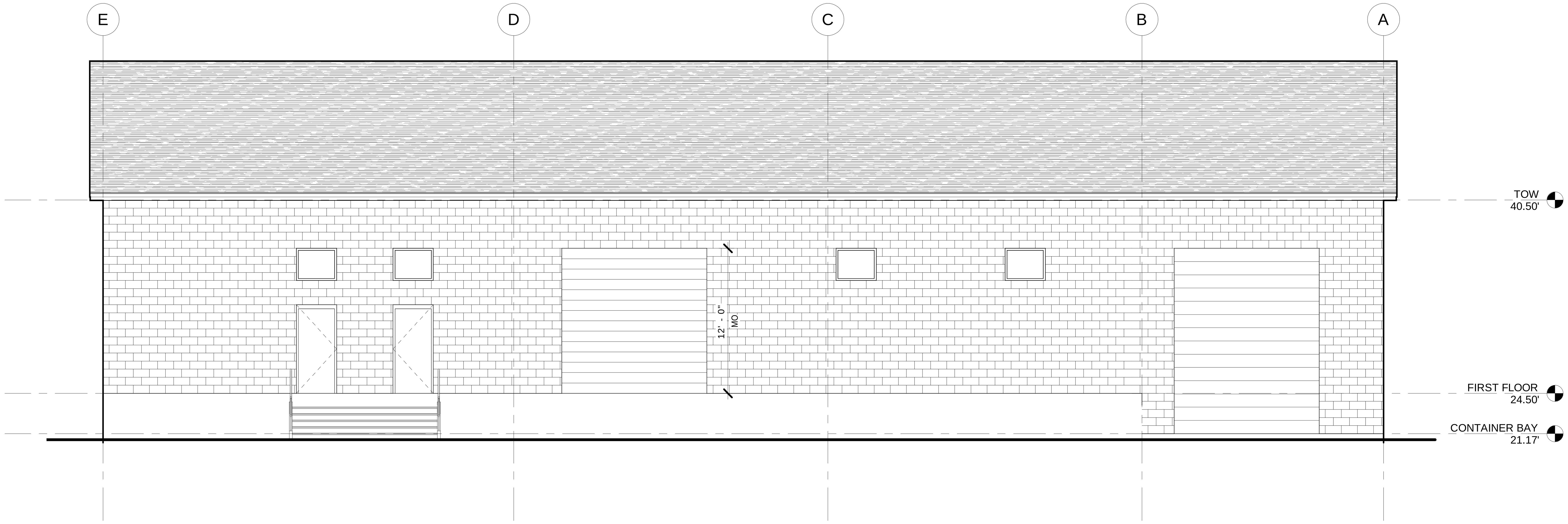
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

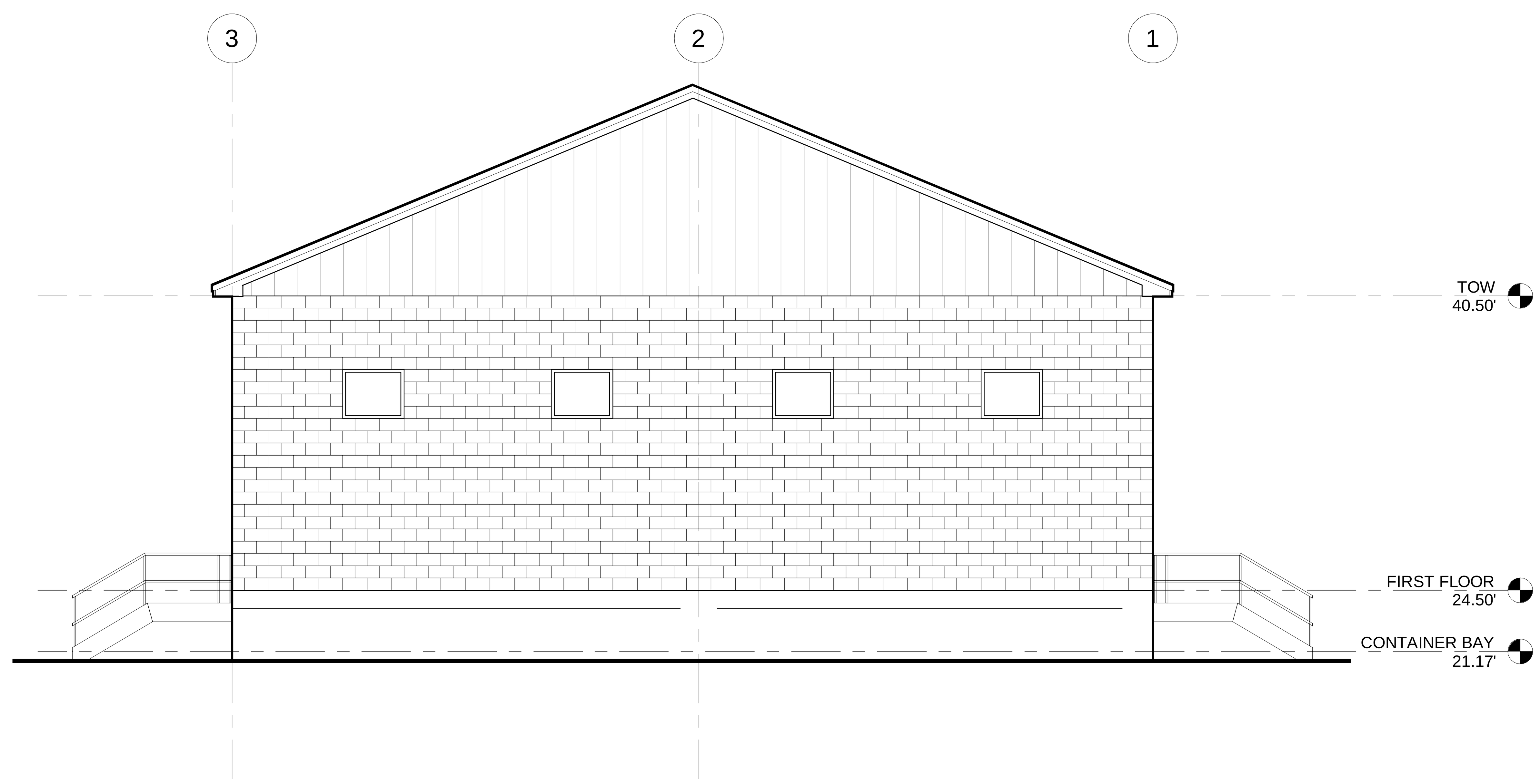
SOLIDS HANDLING BUILDING - FIRST FLOOR PLAN

DRAWING
A - 16



NORTH ELEVATION

SCALE: 3 / 16" = 1' - 0"



EAST ELEVATION

SCALE: 3 / 16" = 1' - 0"

NO	SUBMISIONS / REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		
1			
2			
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4			

DESIGNED BY: RDW
CAD COORD: APC
CAD: JWB2
CHECKED BY:
DATE:
APPROVED BY:
DATE:
PROJECT NO: 12883

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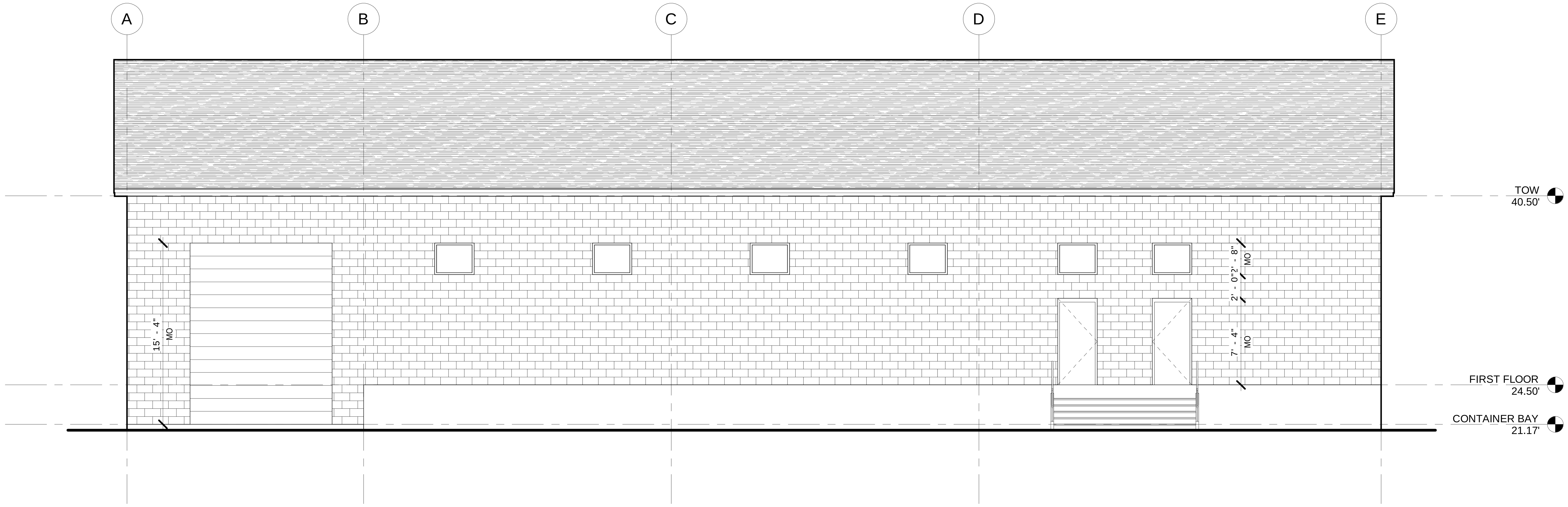
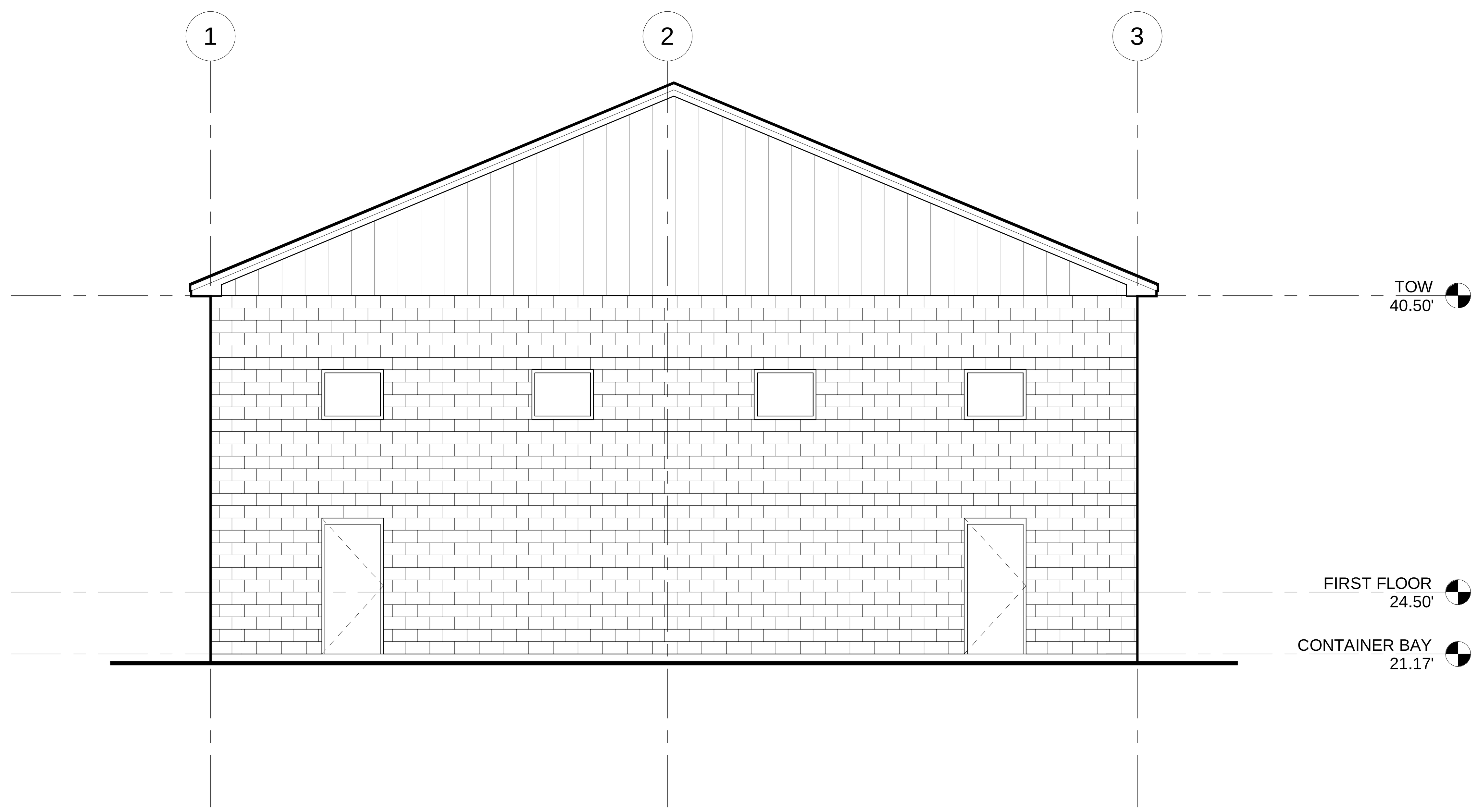
SOLIDS HANDLING BUILDING - EXTERIOR ELEVATIONS I

DRAWING
A - 17



SOUTH ELEVATION

SCALE: 3 / 16" = 1' - 0"



WEST ELEVATION

SCALE: 3 / 16" = 1' - 0"

NO	SUBMISSIONS / REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		
1			
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DESIGNED BY: Designer
CAD COORD: APC
CAD: Author
CHECKED BY: Checker
DATE:
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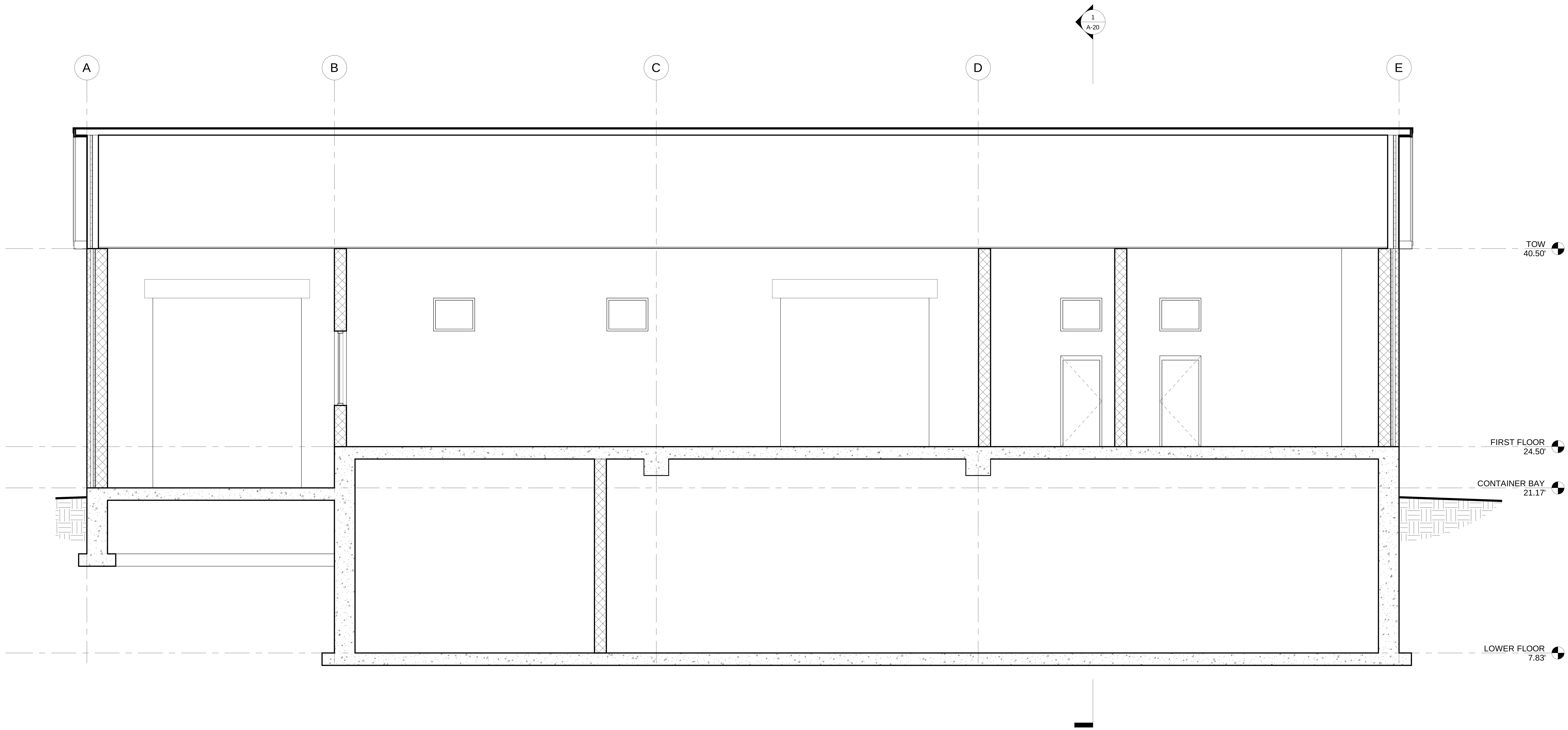
SOLIDS HANDLING BUILDING - EXTERIOR ELEVATIONS II

DRAWING
A - 18



SECTION 1 A - 15
SCALE: 1 / 4" = 1' - 0"

NO	SUBMISSIONS / REVISIONS	APP'D	DATE
1	PRELIMINARY DESIGN REPORT		
2			
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4			

DESIGNED BY: Designer
CAD COORD: APC
CAD: Author
CHECKED BY: Checker
DATE:
APPROVED BY: Approver
DATE:
PROJECT NO: 12883

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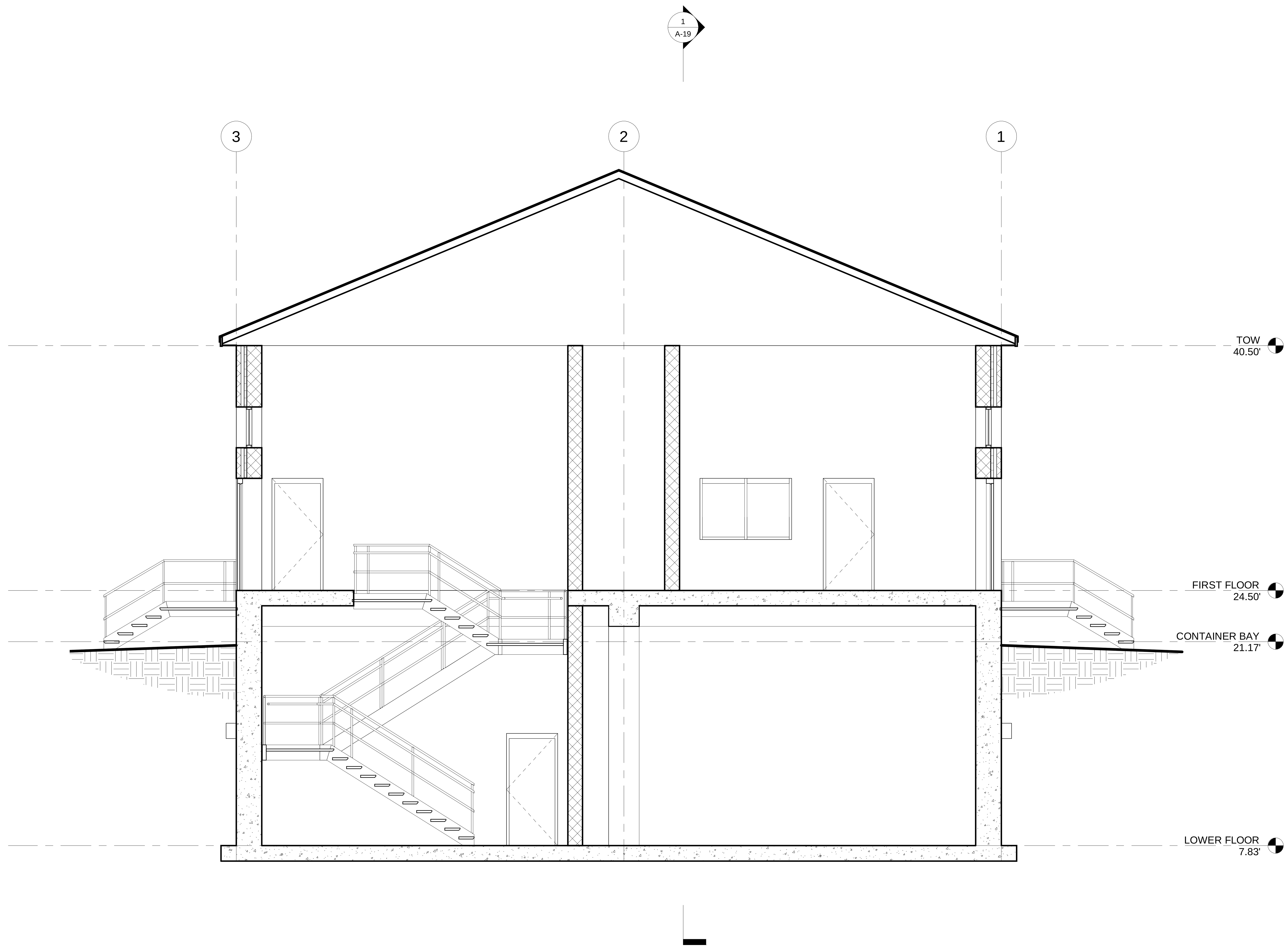
SOLIDS HANDLING BUILDING - SECTIONS I

DRAWING
A - 19



1 SECTION
A - 15 SCALE: 1 / 4" = 1' - 0"

NO	SUBMISSIONS / REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		
1			
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DESIGNED BY: Designer
CAD COORD: APC
CAD: Author
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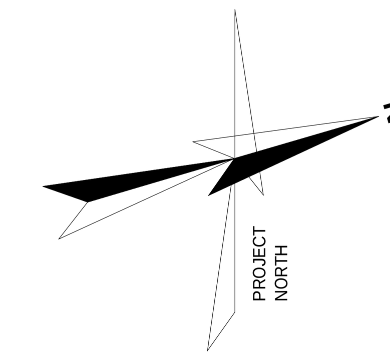
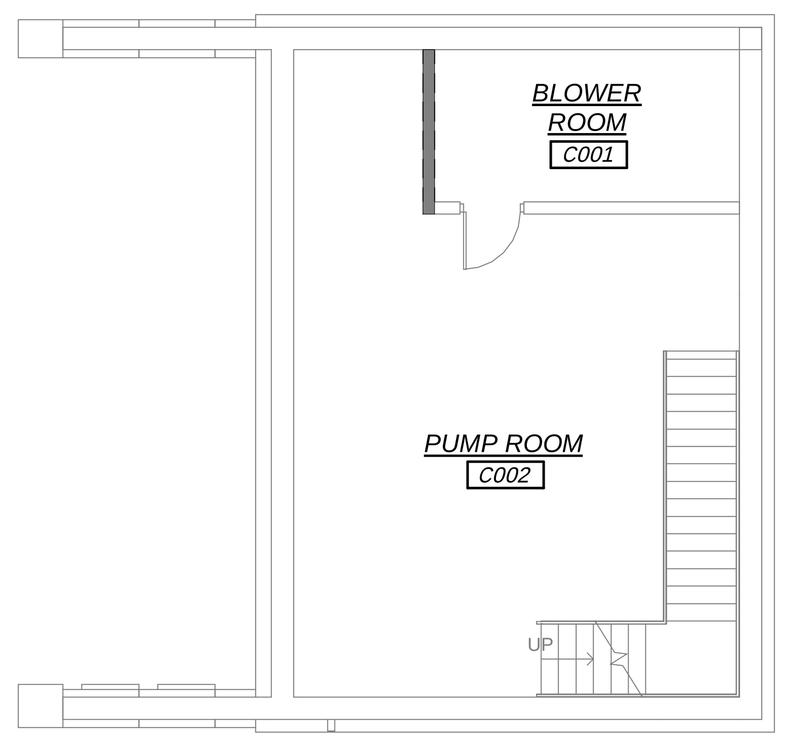
SOLIDS HANDLING BUILDING - SECTIONS II

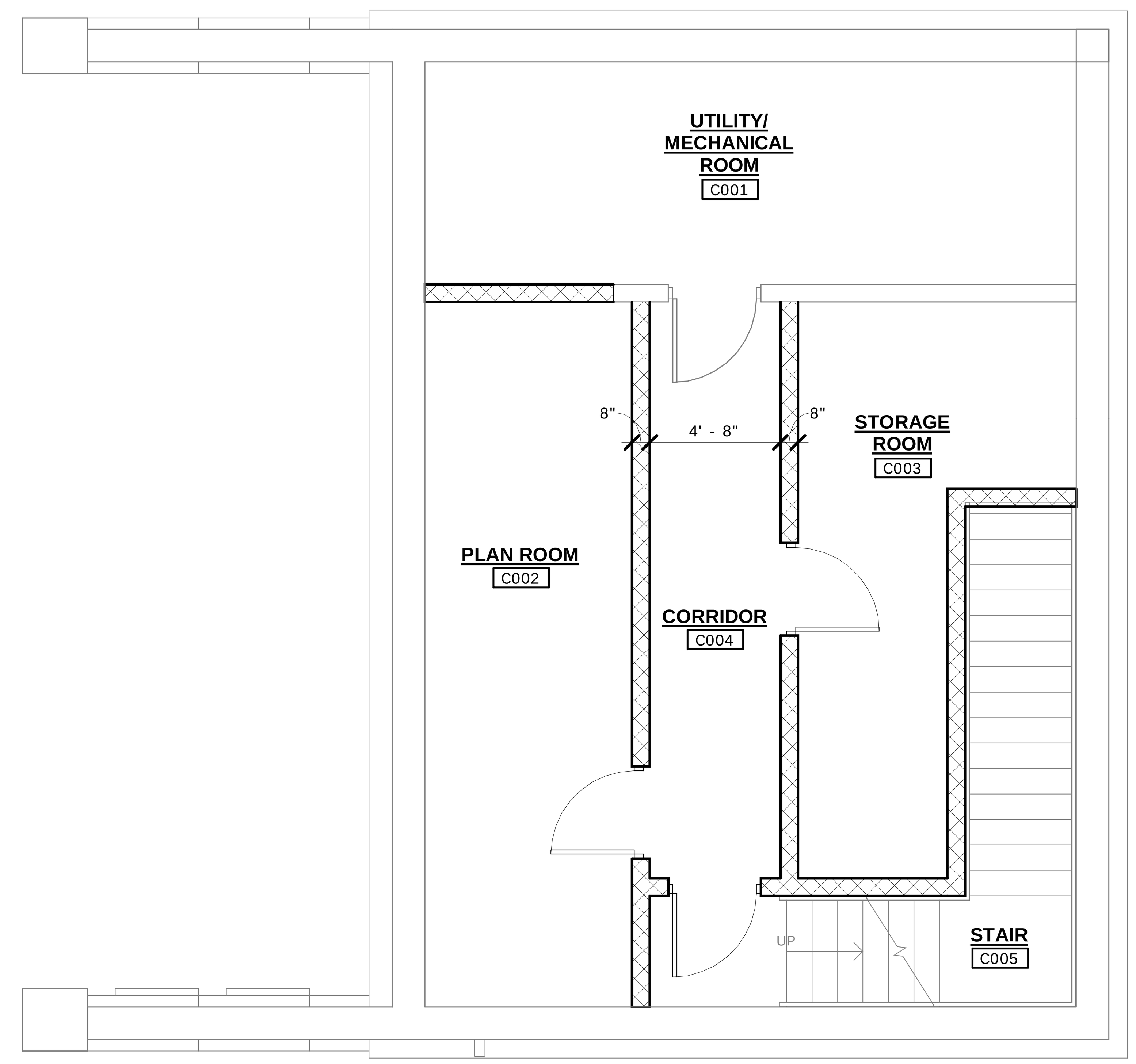
DRAWING
A - 20





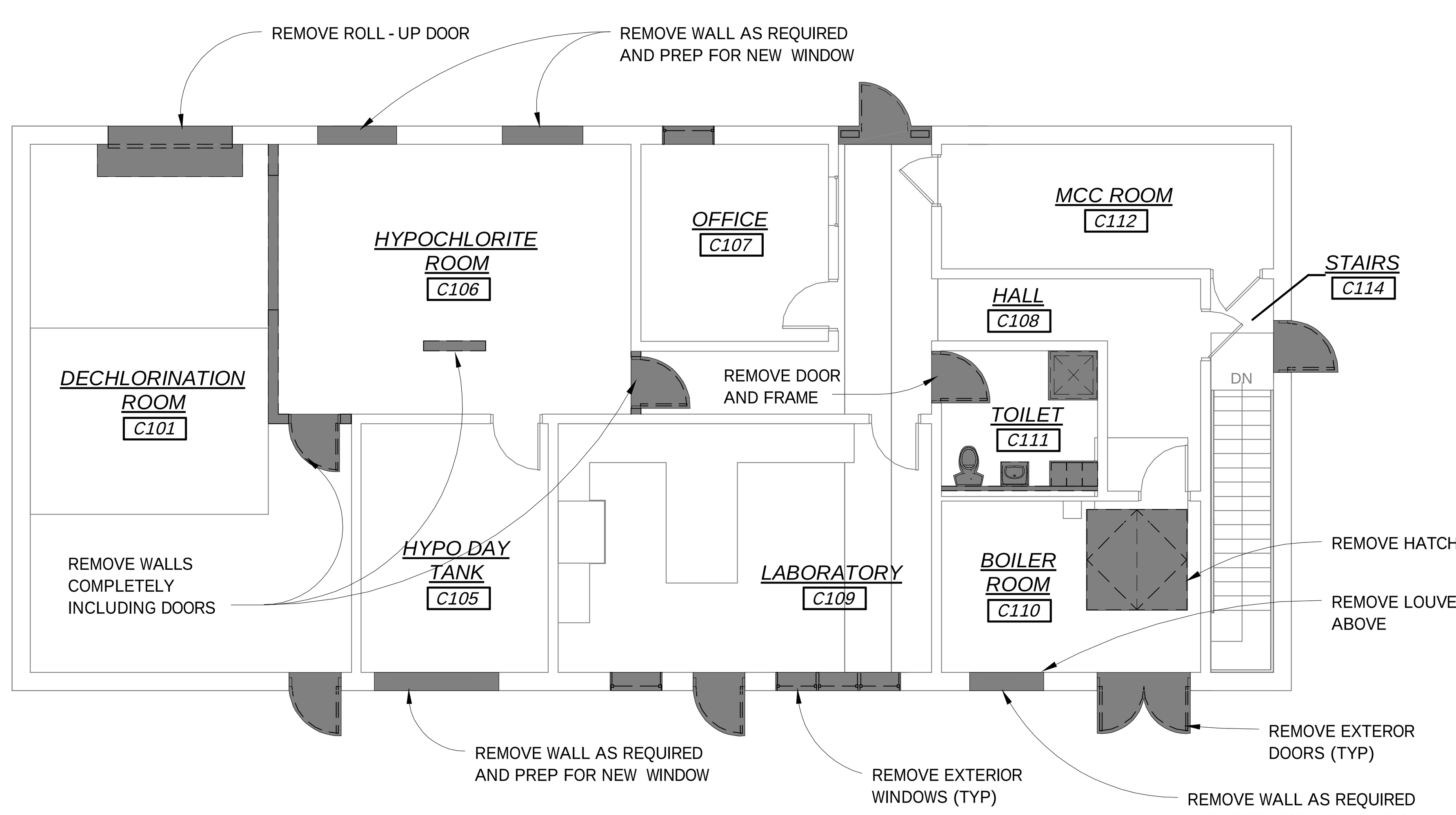
LOWER FLOOR DEMO PLAN

SCALE: 1 / 8" = 1' - 0"



LOWER FLOOR MODIFICATION PLAN

SCALE: 1 / 4" = 1' - 0"



FIRST FLOOR DEMO PLAN

SCALE: 1 / 8" = 1' - 0"

NO	SUBMISSIONS / REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		
1			
2			
3			
4			

DESIGNED BY: Designer
CAD COORD: APC
CAD: Author
CHECKED BY: Checker
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APPROVED BY: Approver
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PROJECT NO: 12883

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EXETER, NEW HAMPSHIRE
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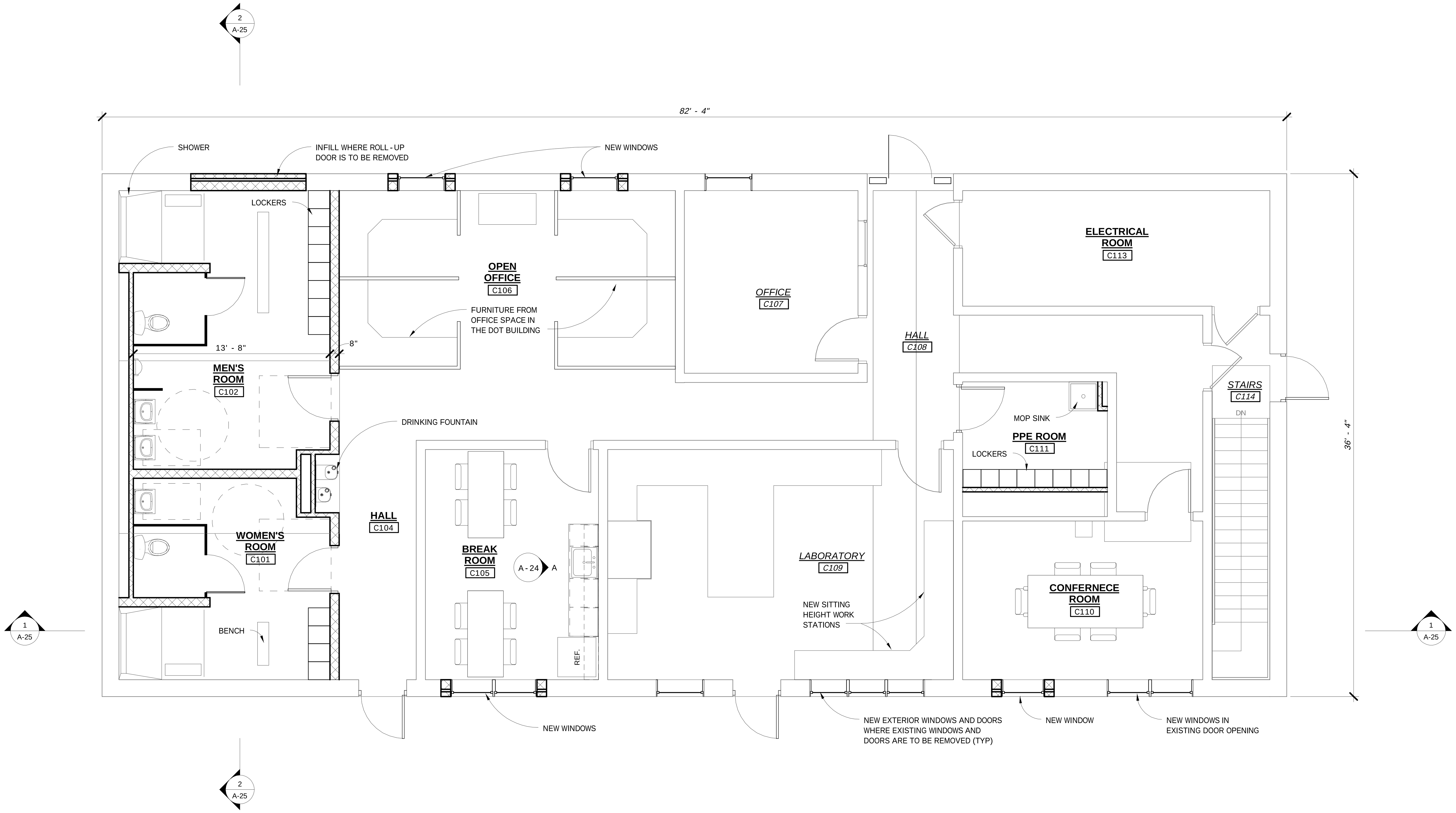
CONTROL BUILDING - DEMO PLANS AND LOWER FLOOR MODIFICATION PLAN

DRAWING
A - 22



FIRST FLOOR MODIFICATION PLAN

SCALE: 1 / 4" = 1' - 0"

PROJECT NORTH

NO	SUBMISSIONS / REVISIONS	APP'D	DATE
1	PRELIMINARY DESIGN REPORT		
2			
3			
4			

DESIGNED BY: Designer
CAD COORD: APC
CAD: Author
CHECKED BY: Checker
DATE:
APPROVED BY: Approver
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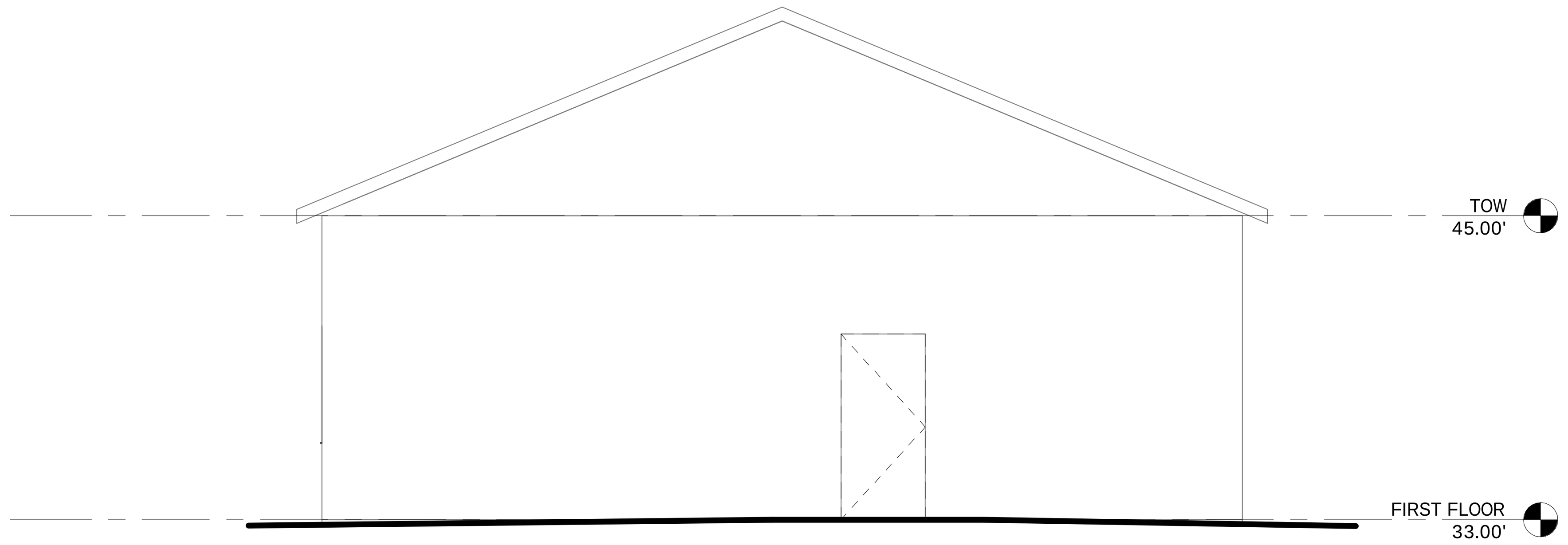
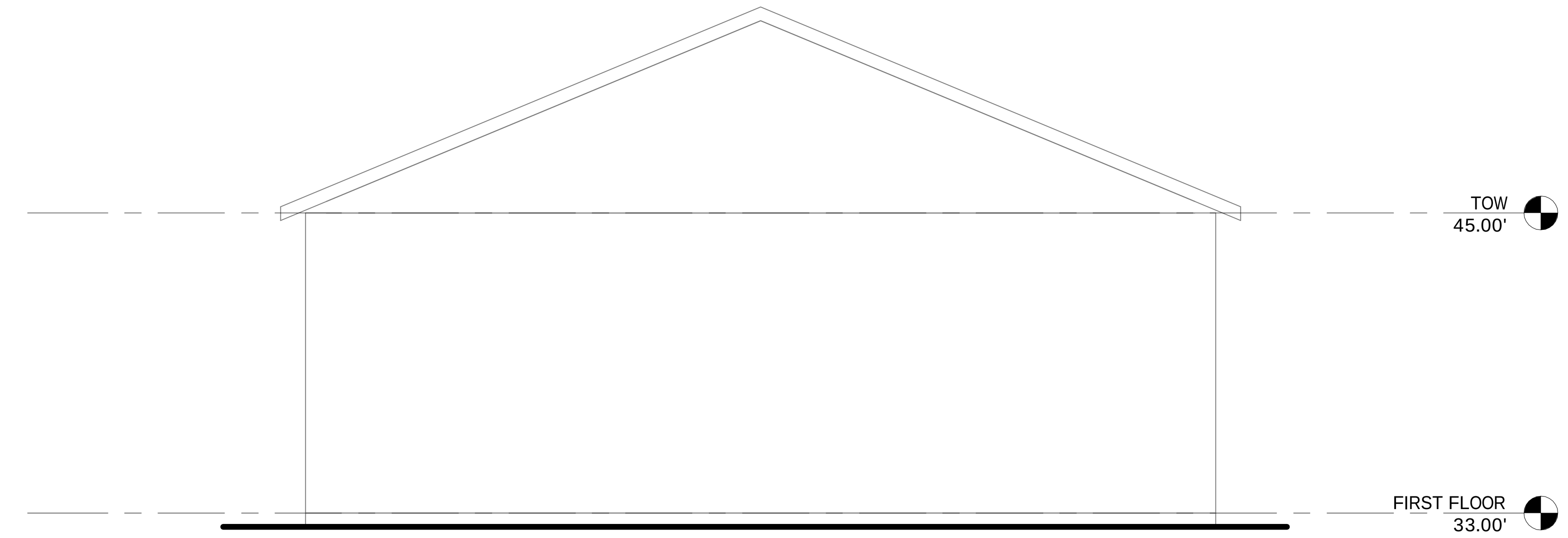
CONTROL BUILDING - FIRST FLOOR MODIFICATION PLAN

DRAWING
A - 23



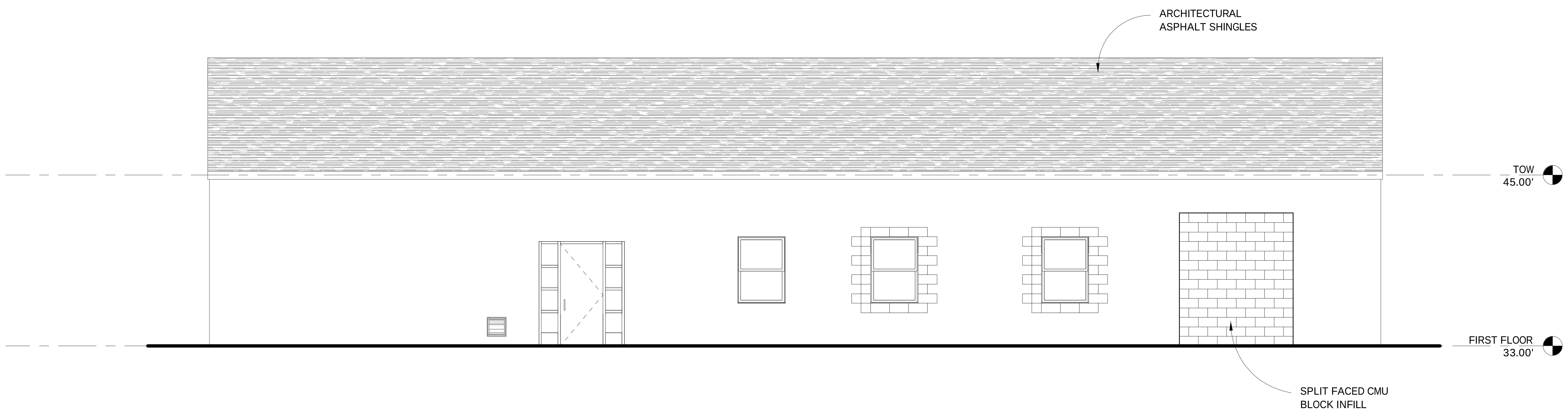
EAST ELEVATION

SCALE: 3 / 16" = 1' - 0"



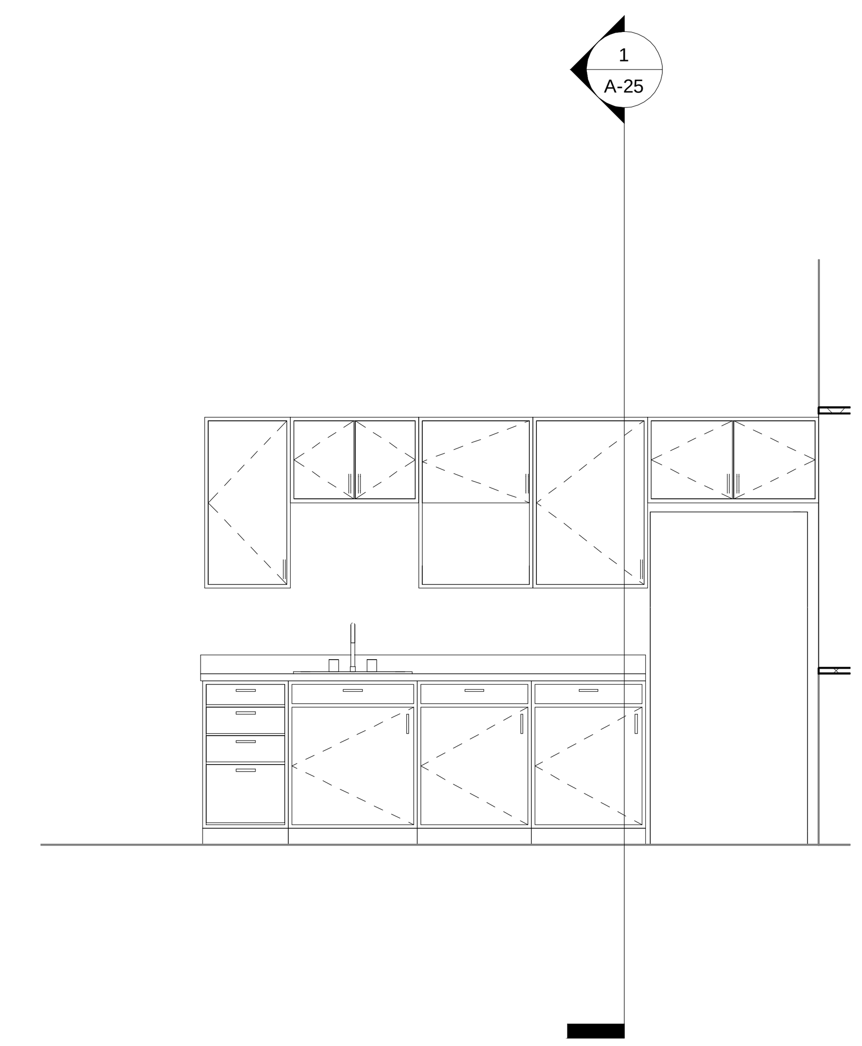
WEST ELEVATION

SCALE: 3 / 16" = 1' - 0"



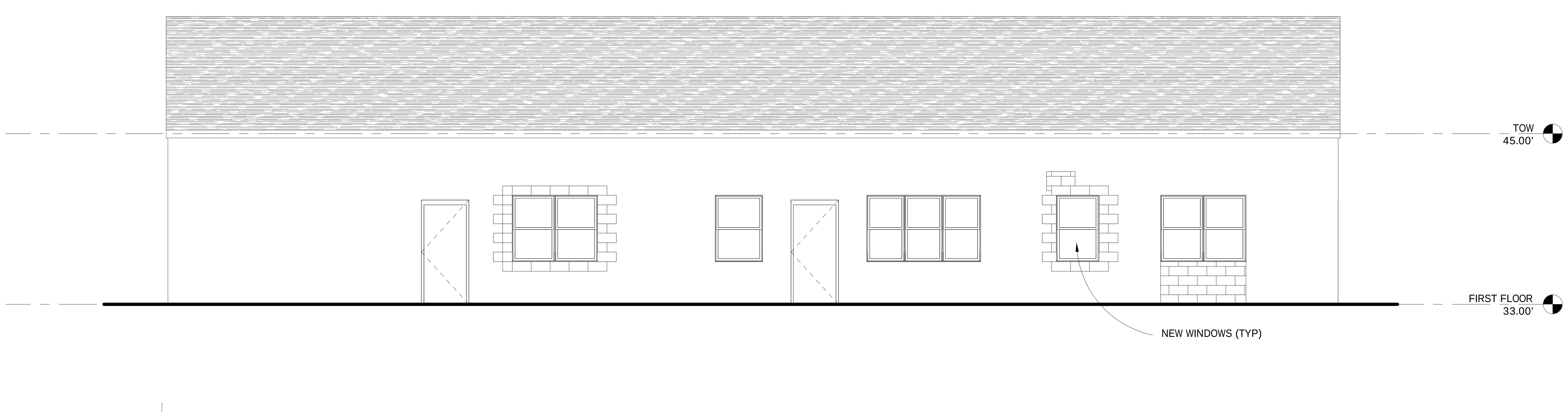
NORTH ELEVATION

SCALE: 3 / 16" = 1' - 0"



INTERIOR ELEVATION A

SCALE: 3 / 8" = 1' - 0"



SOUTH ELEVATION

SCALE: 3 / 16" = 1' - 0"

NO	SUBMISSIONS / REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		
1			
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DESIGNED BY: Designer
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EXETER, NEW HAMPSHIRE
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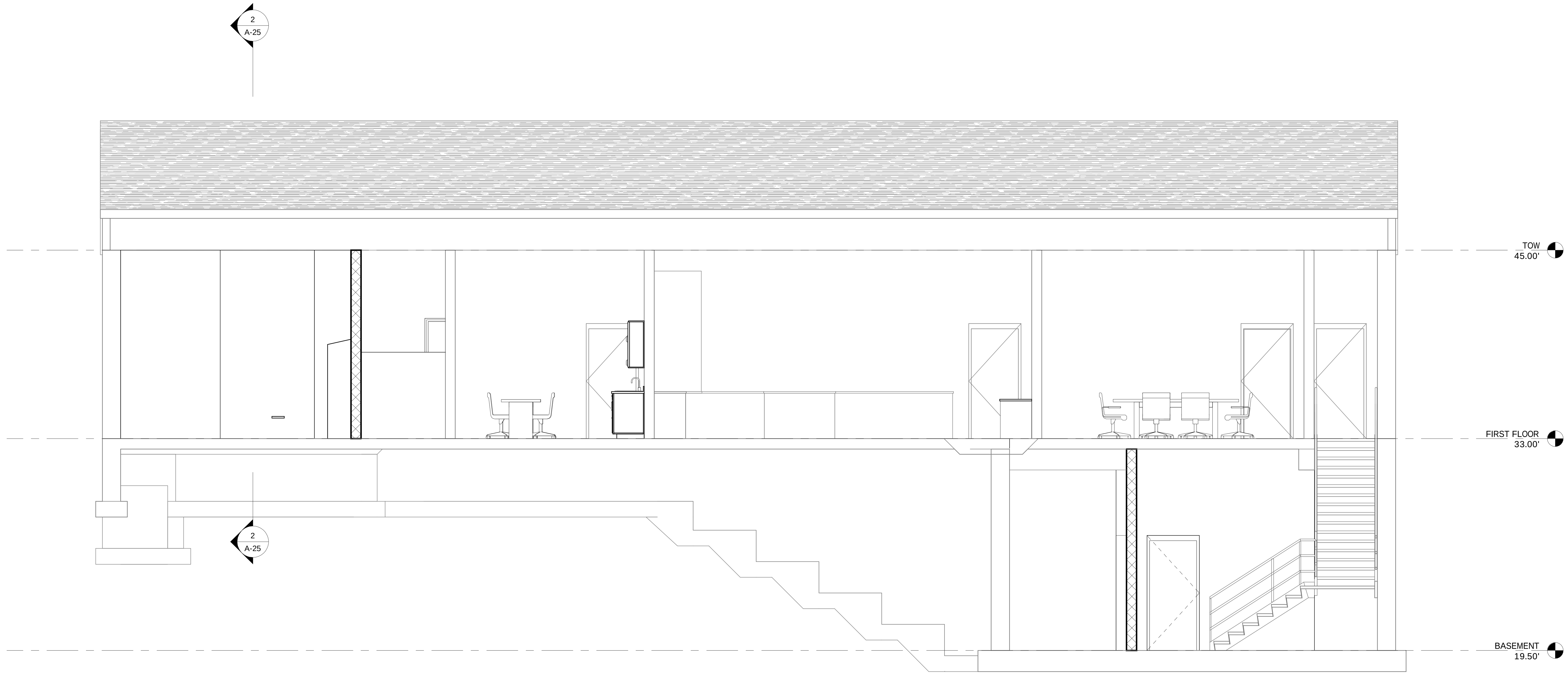
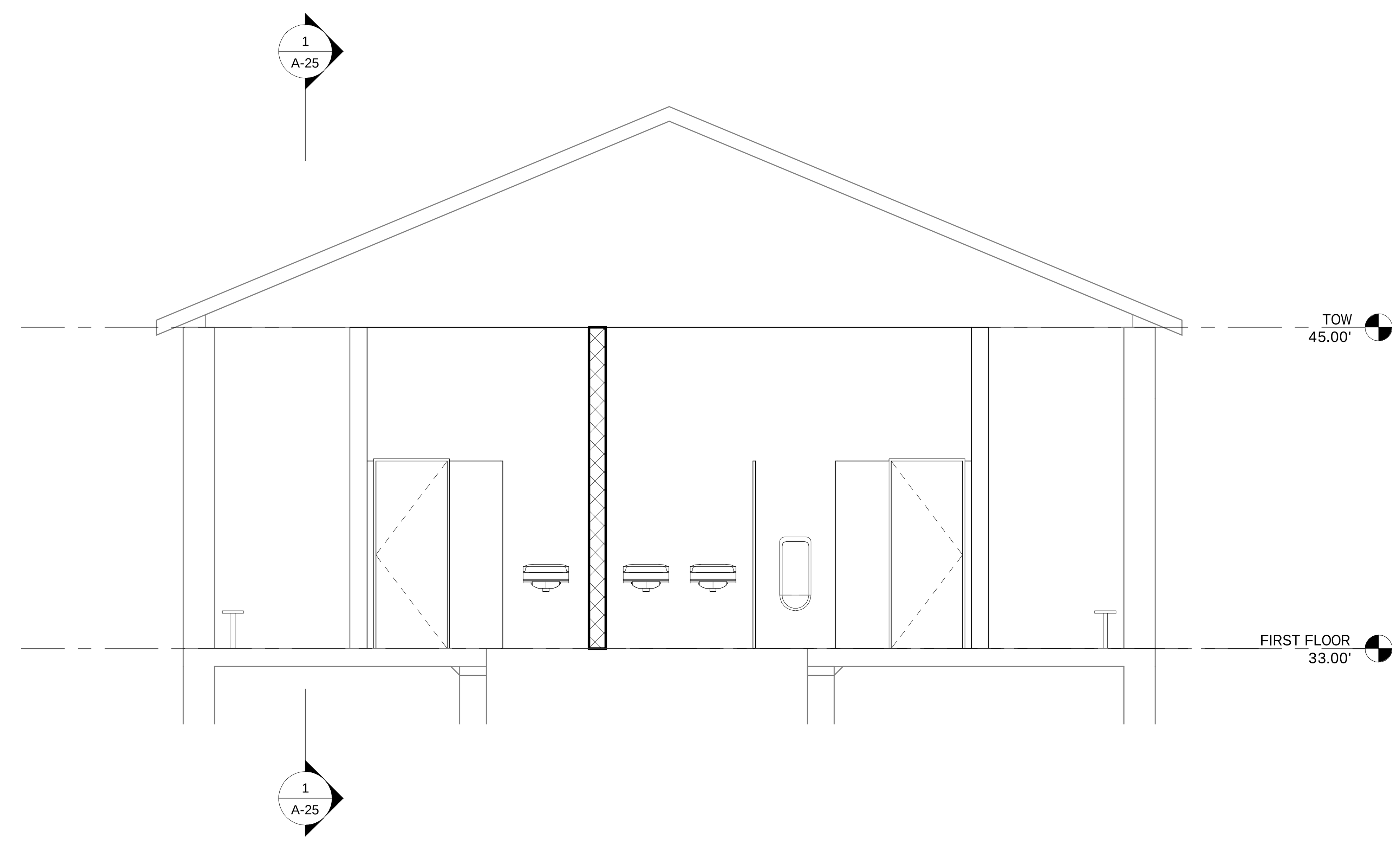
CONTROL BUILDING - ELEVATIONS

DRAWING
A - 24



1 SECTION
A-23 SCALE: 1 / 4" = 1' - 0"



2 SECTION
A-23 SCALE: 1 / 4" = 1' - 0"

NO.	SUBMISSIONS / REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		
1			
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3			
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DESIGNED BY: Designer
CAD COORD: APC
CAD: Author
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EXETER, NEW HAMPSHIRE
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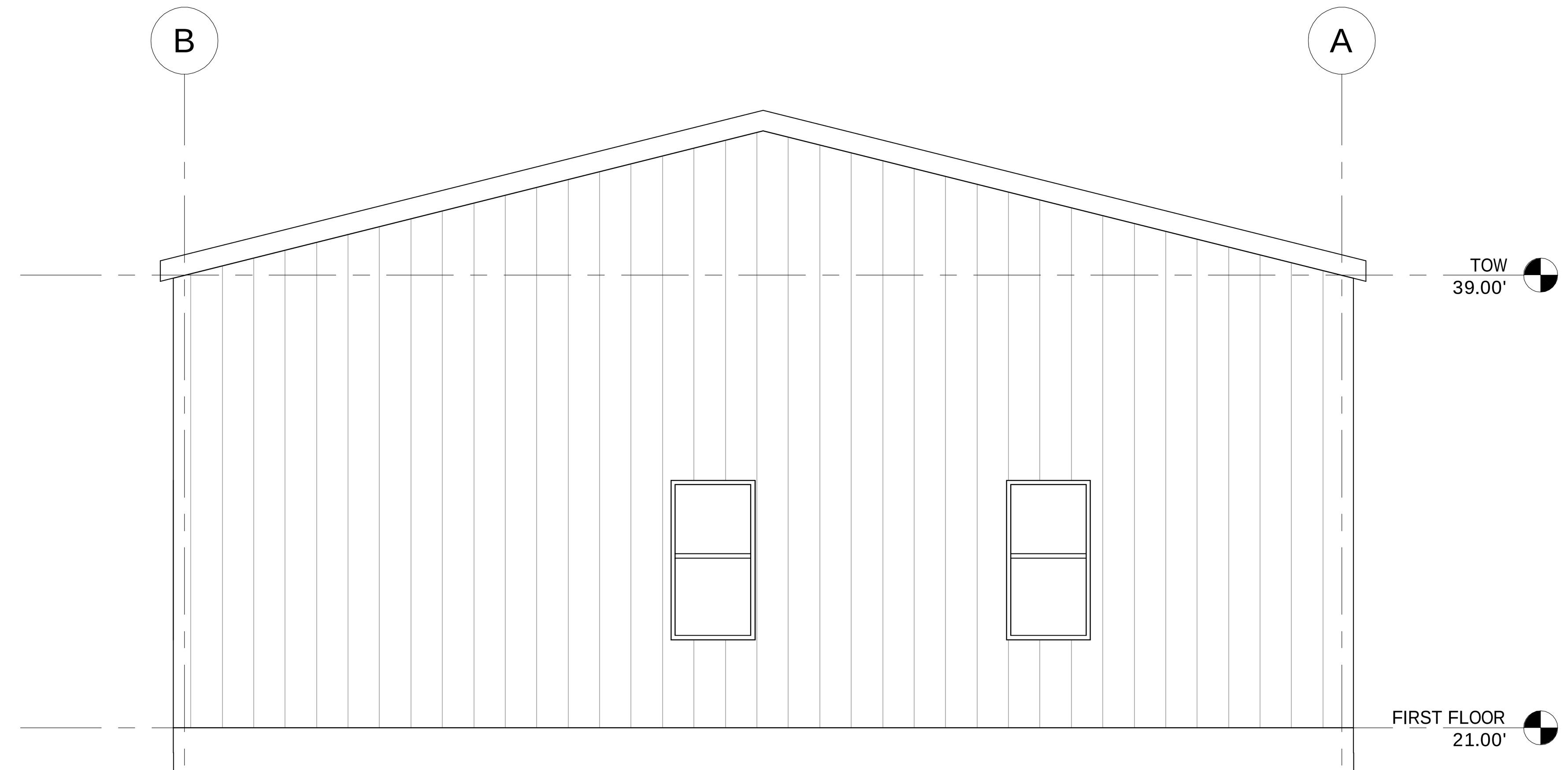
FACILITY UPGRADES

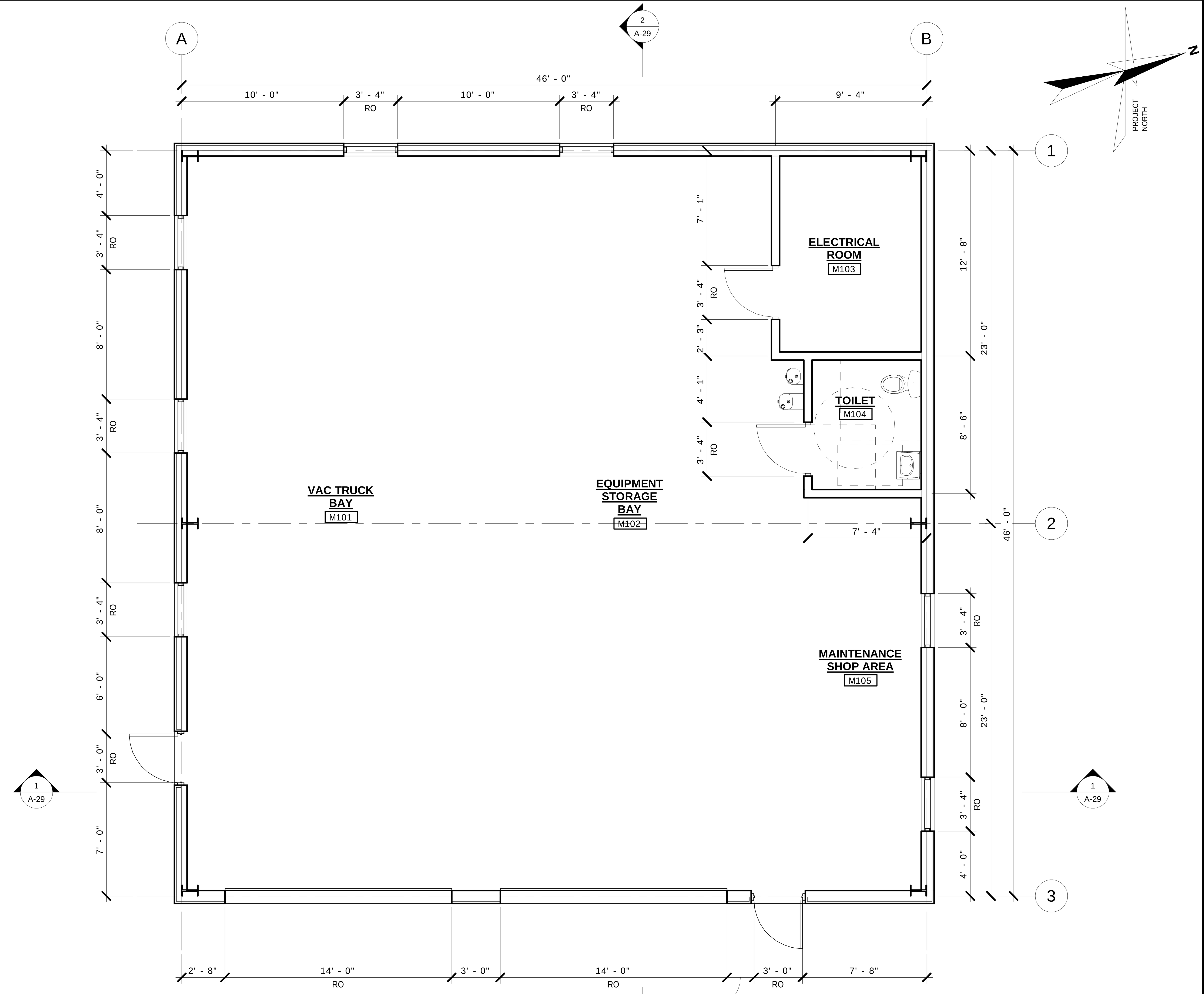
CONTROL BUILDING - SECTIONS

DRAWING
A - 25



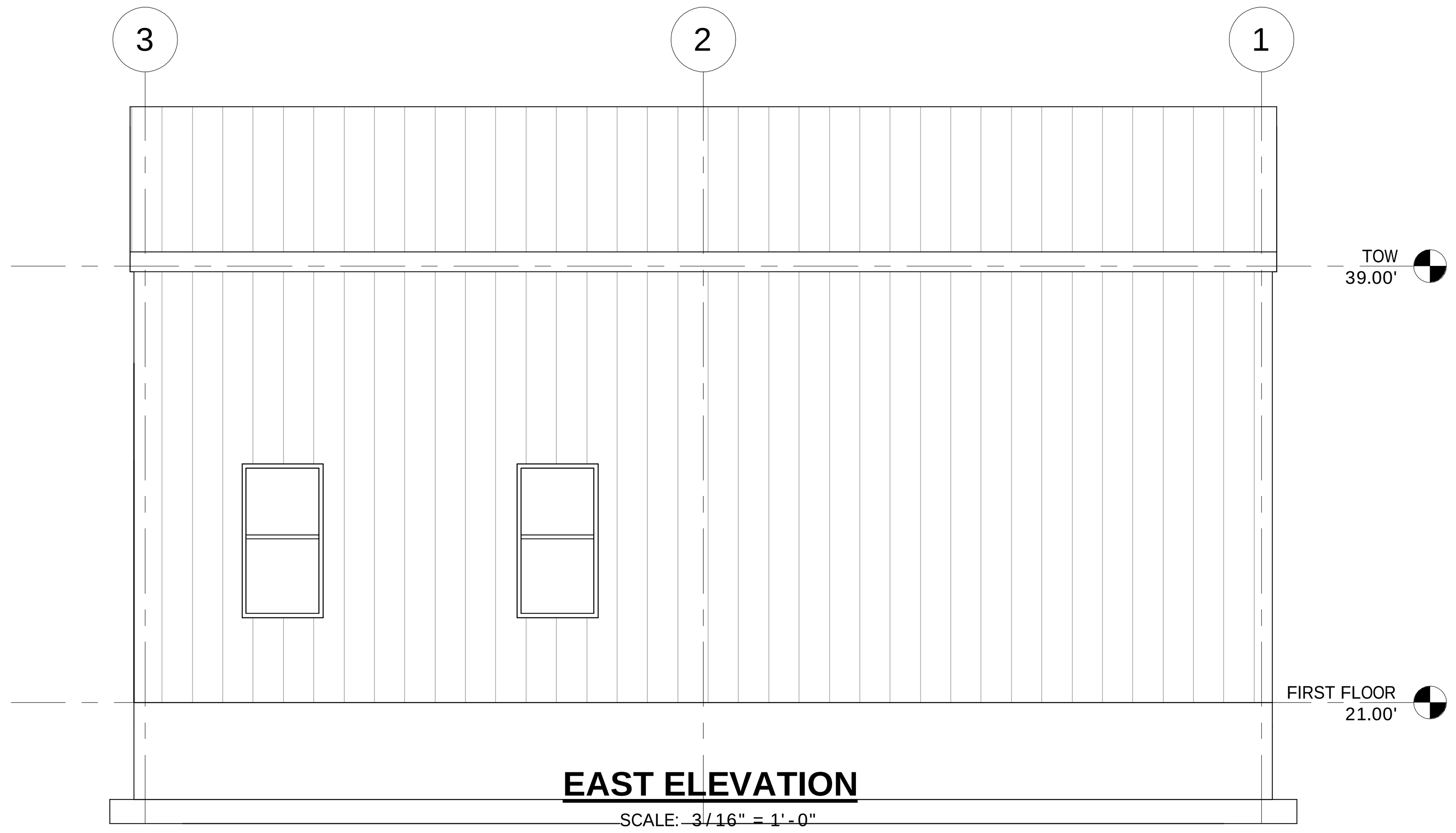
NORTH ELEVATION

SCALE: 3 / 16" = 1' - 0"



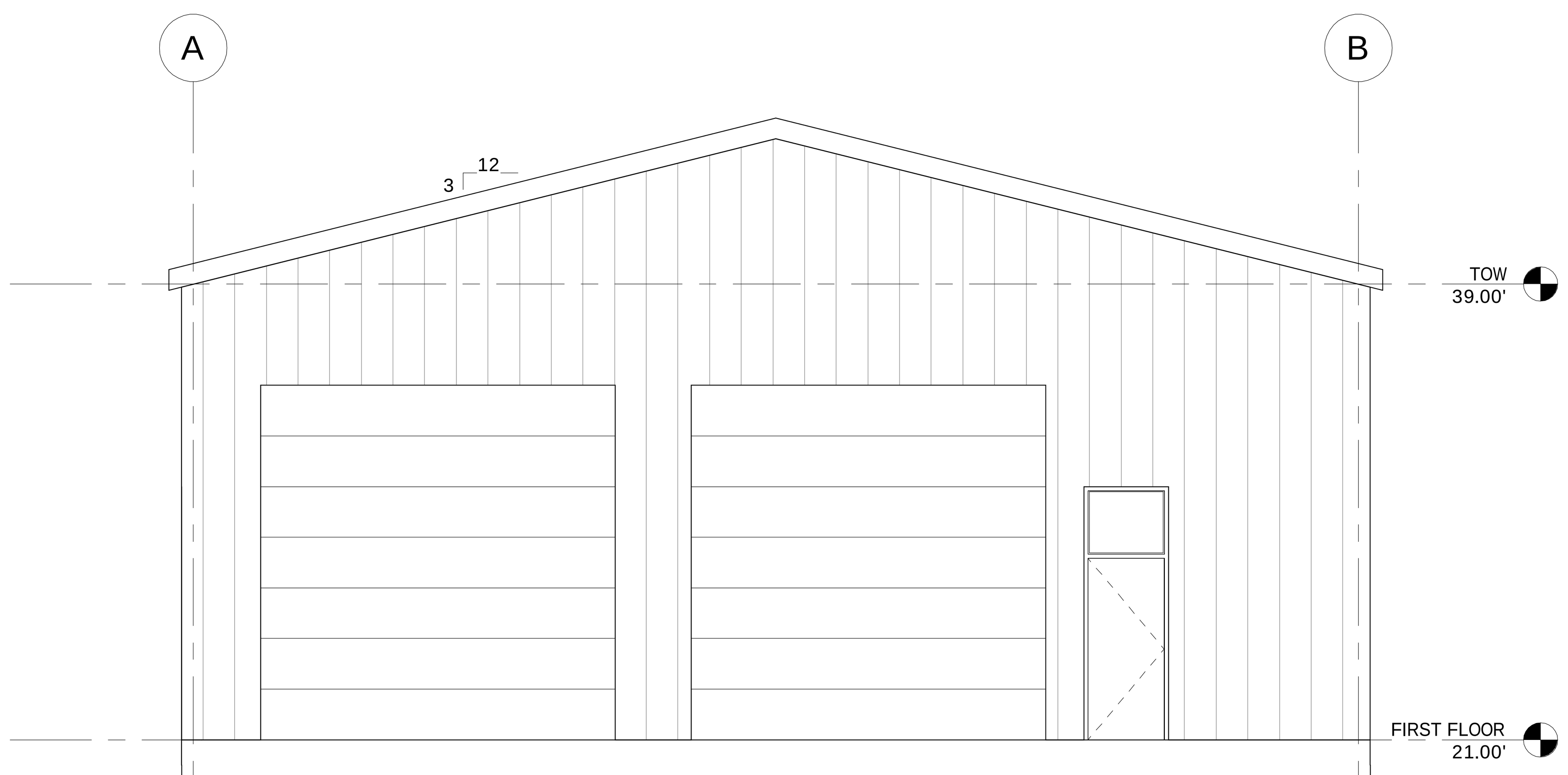
FIRST FLOOR PLAN

SCALE: 1 / 4" = 1' - 0"



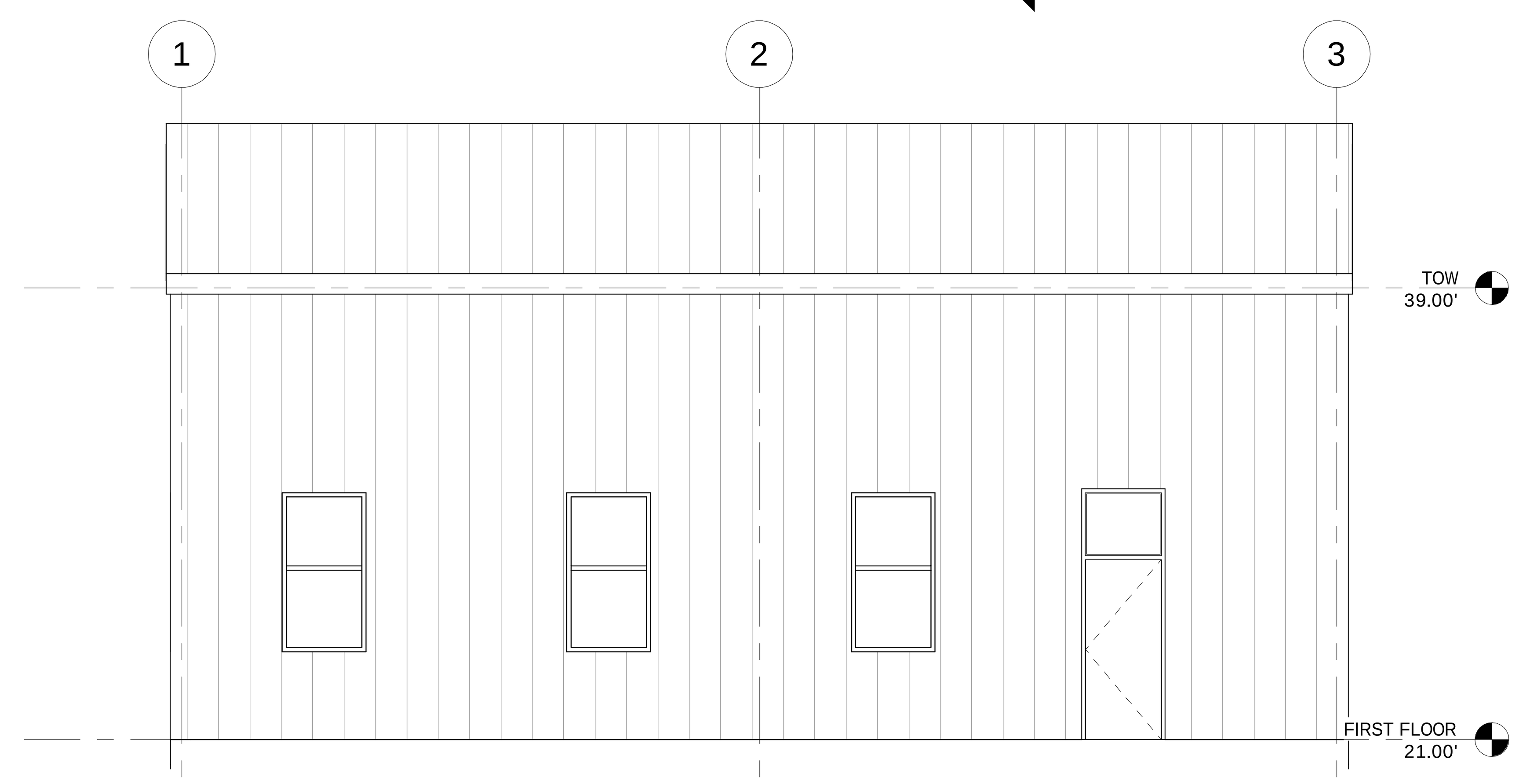
EAST ELEVATION

SCALE: 3 / 16" = 1' - 0"



SOUTH ELEVATION

SCALE: 3 / 16" = 1' - 0"



WEST ELEVATION

SCALE: 3 / 16" = 1' - 0"

NO	SUBMISSIONS / REVISIONS	APPD	DATE
1	PRELIMINARY DESIGN REPORT		
2			
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4			

DESIGNED BY: Designer
CAD COORD: APC
CAD: Author
CHECKED BY: Checker
DATE:
APPROVED BY: Approver
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PROJECT NO. 12883

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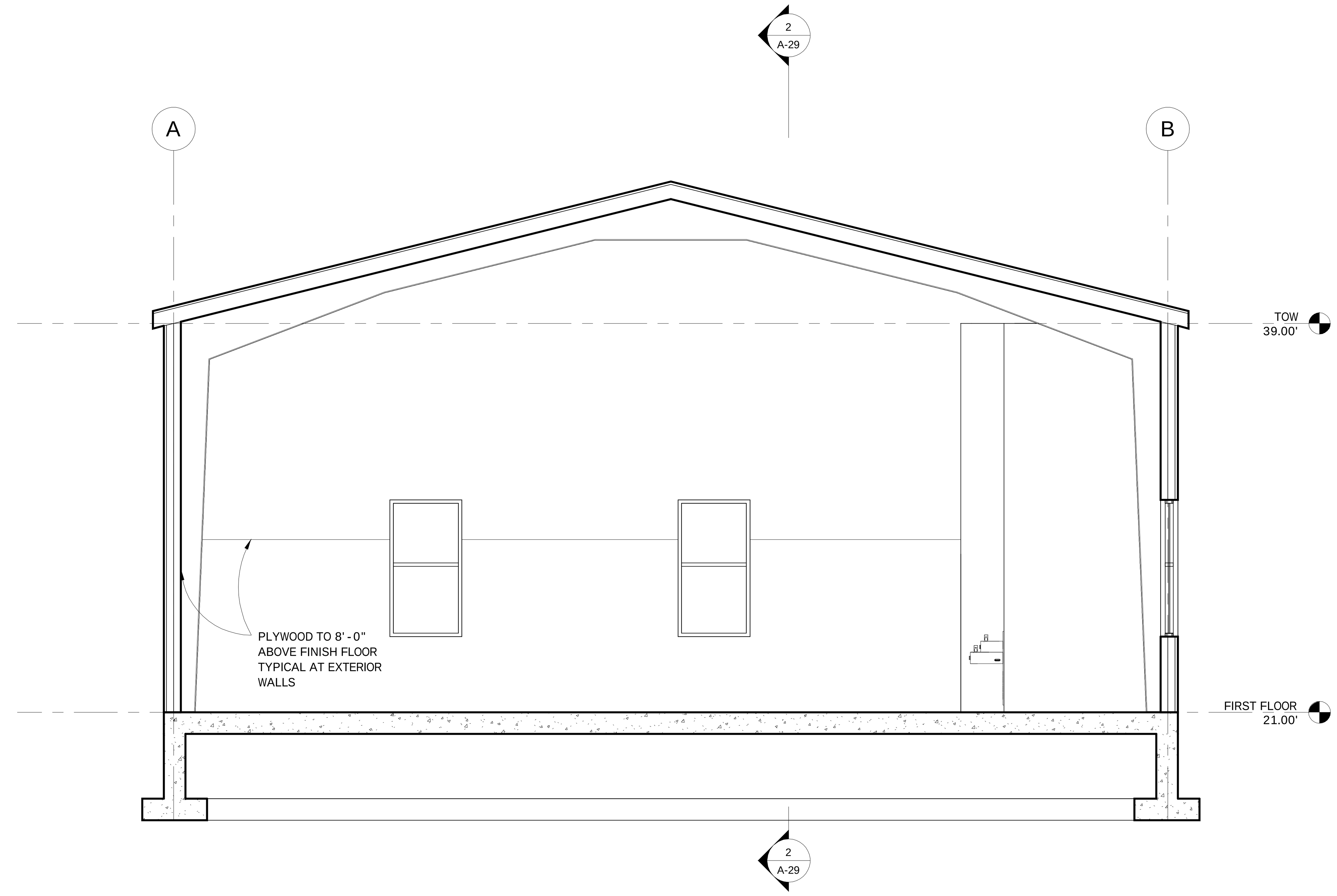
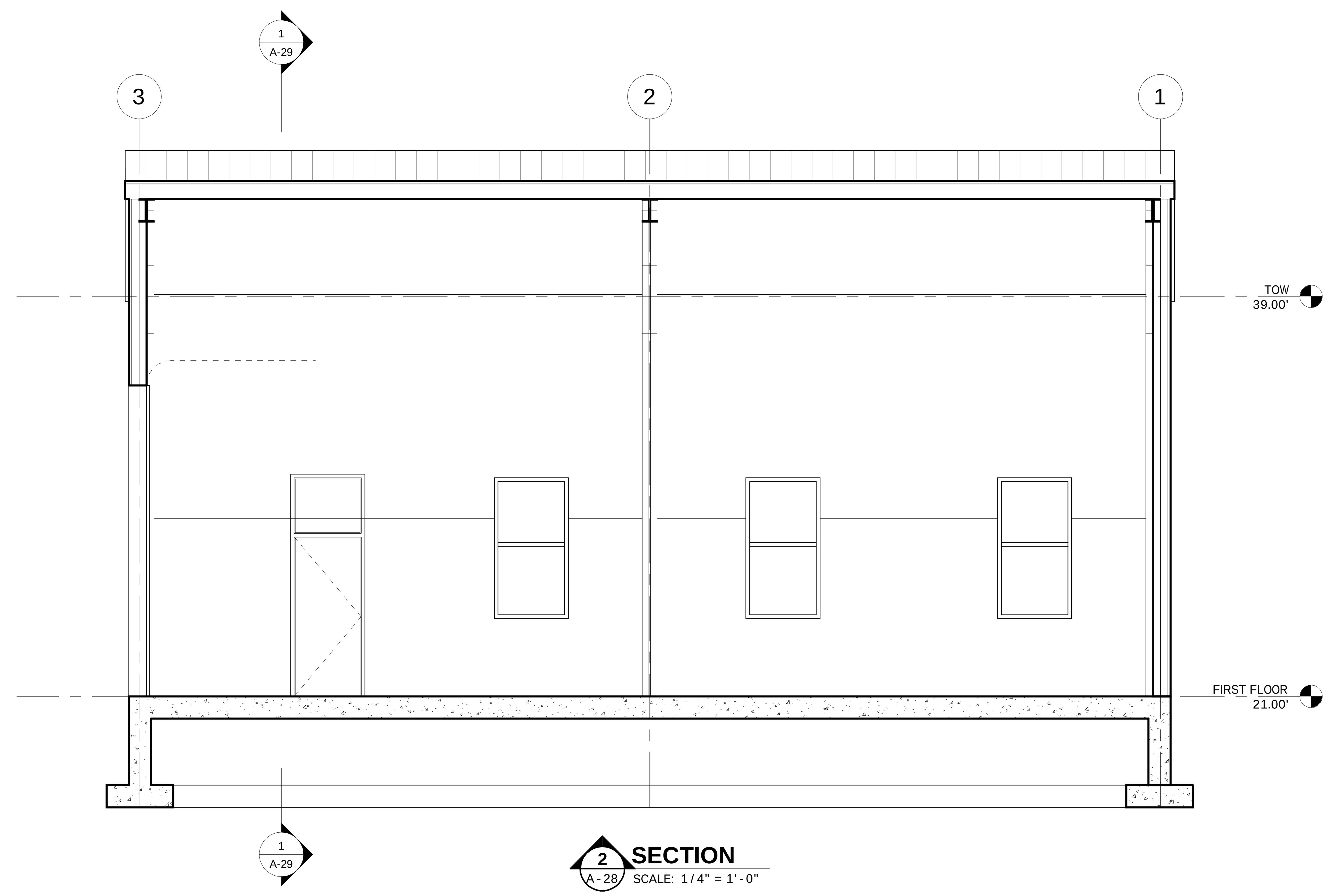
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

MAINTENANCE BUILDING - FLOOR PLAN AND ELEVATIONS

DRAWING
A - 28



1 SECTION
A - 28 SCALE: 1 / 4" = 1' - 0"



2 SECTION
A - 28 SCALE: 1 / 4" = 1' - 0"

NO	SUBMISIONS / REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		
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DESIGNED BY: Designer
CAD COORD: APC
CAD: Author
CHECKED BY: Checker
DATE:
APPROVED BY: Approver
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PROJECT NO: 12883

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CONTRACT NO. 1
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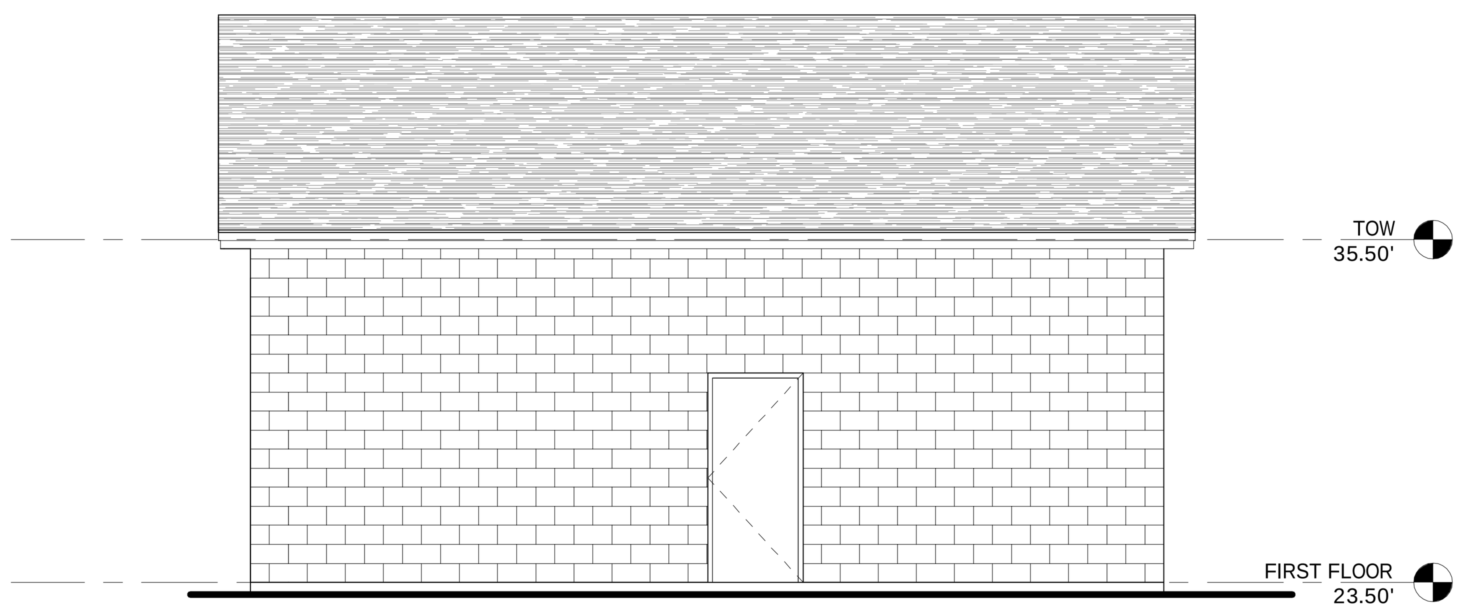
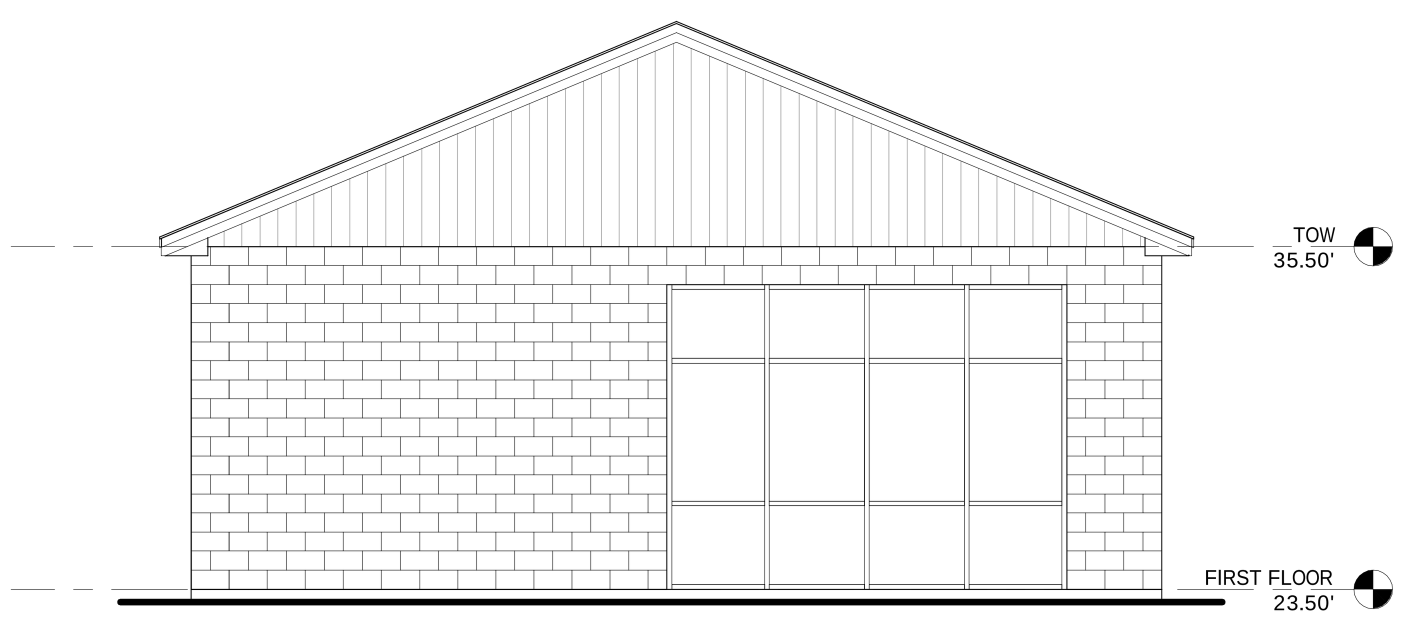
MAINTENANCE BUILDING - SECTIONS AND DETAILS

DRAWING
A - 29



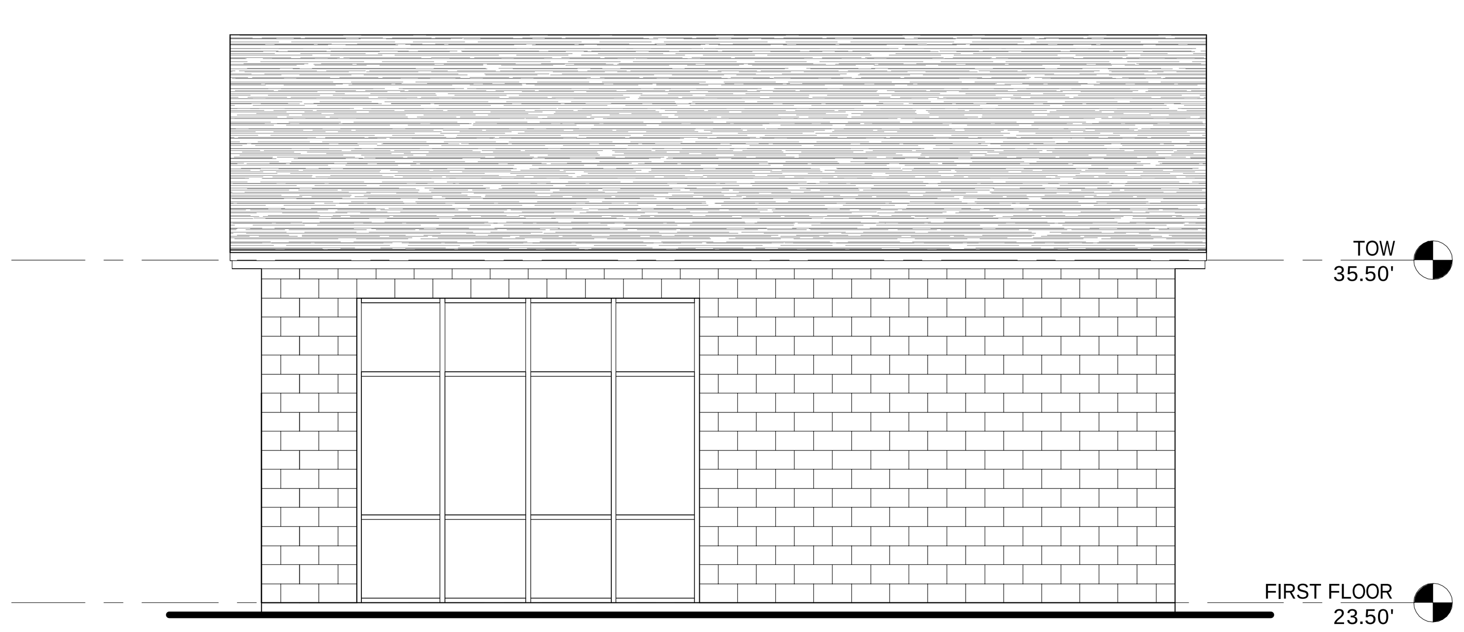
NORTH ELEVATION

SCALE: 3 / 16" = 1' - 0"



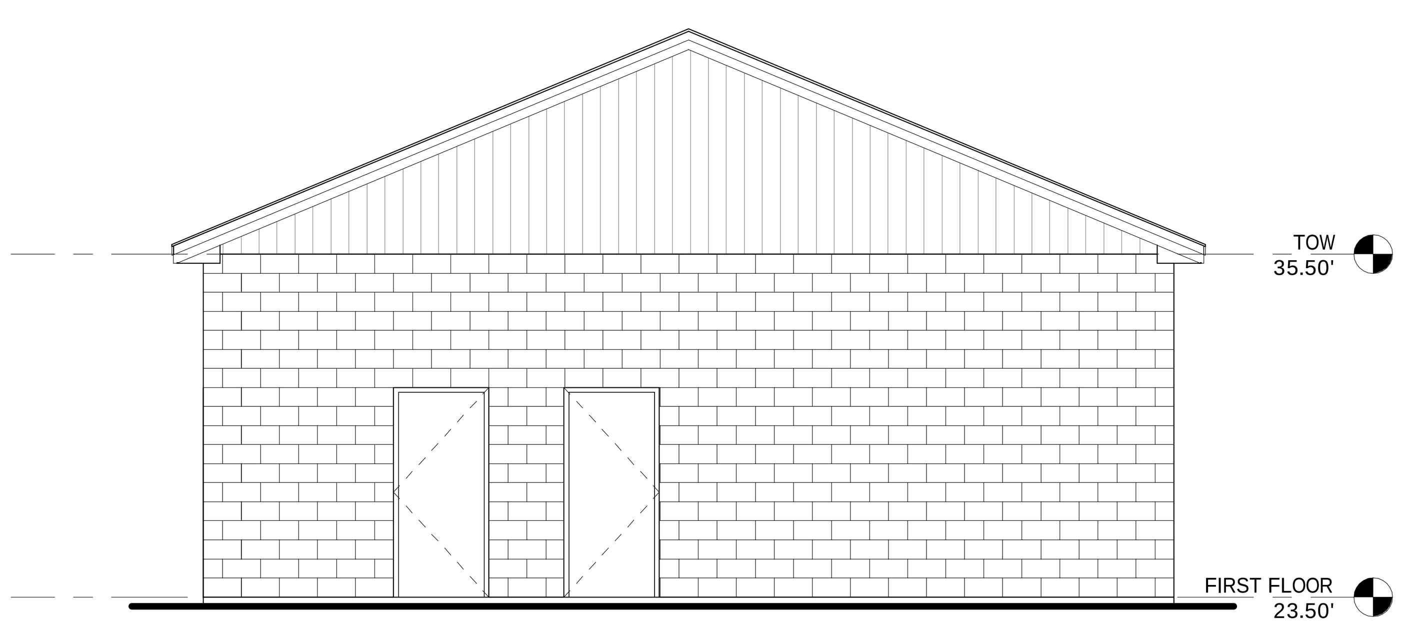
EAST ELEVATION

SCALE: 3 / 16" = 1' - 0"



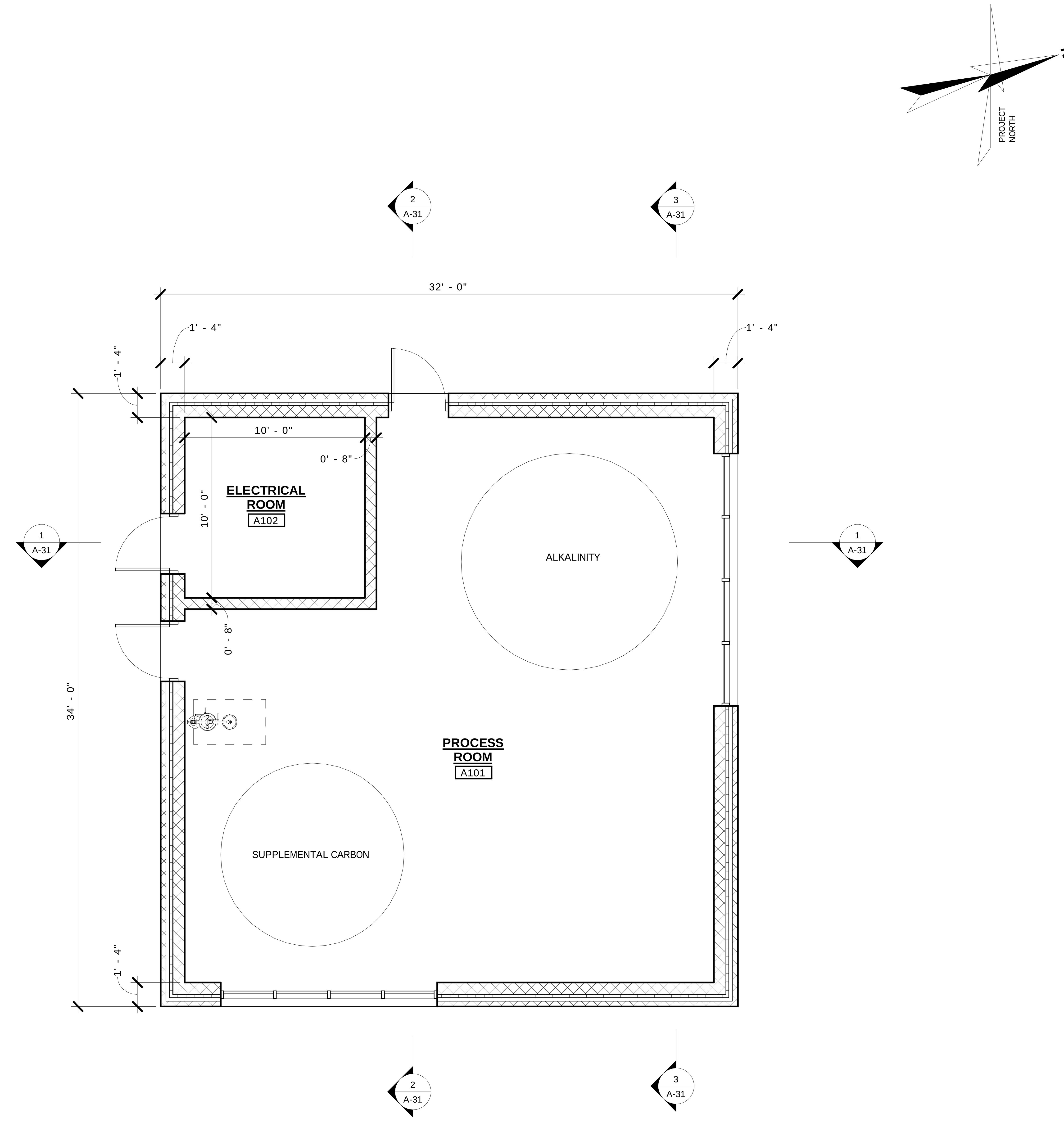
SOUTH ELEVATION

SCALE: 3 / 16" = 1' - 0"



WEST ELEVATION

SCALE: 3 / 16" = 1' - 0"



FLOOR PLAN

SCALE: 1 / 4" = 1' - 0"

NO	SUBMISSIONS / REVISIONS	APP'D	DATE
1	PRELIMINARY DESIGN REPORT		
2			
3			
4			

DESIGNED BY: Designer
CAD COORD: APC
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EXETER, NEW HAMPSHIRE
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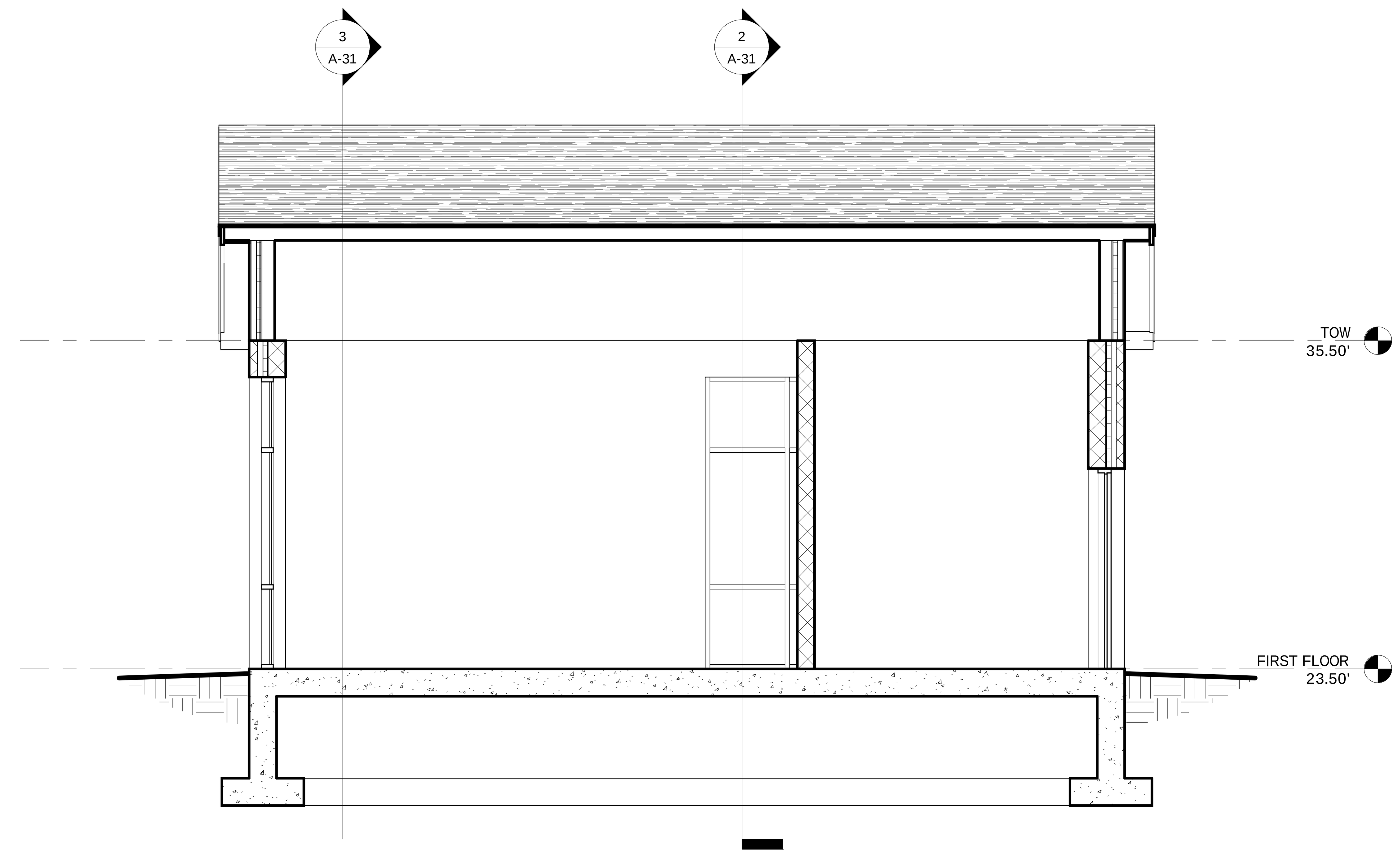
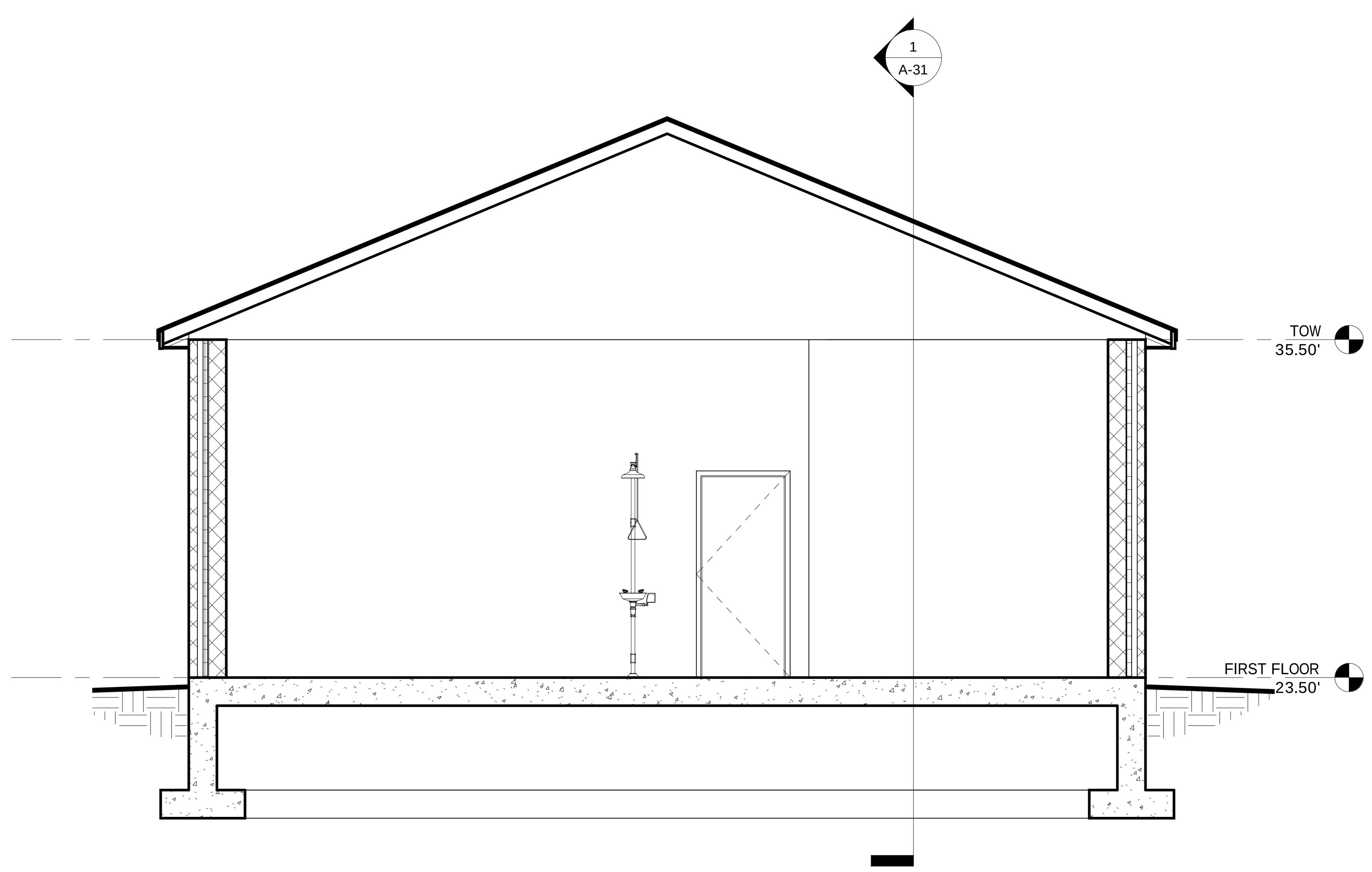
FACILITY UPGRADES

SUPPLEMENTAL CHEMICAL BUILDING - PLANS AND ELEVATIONS

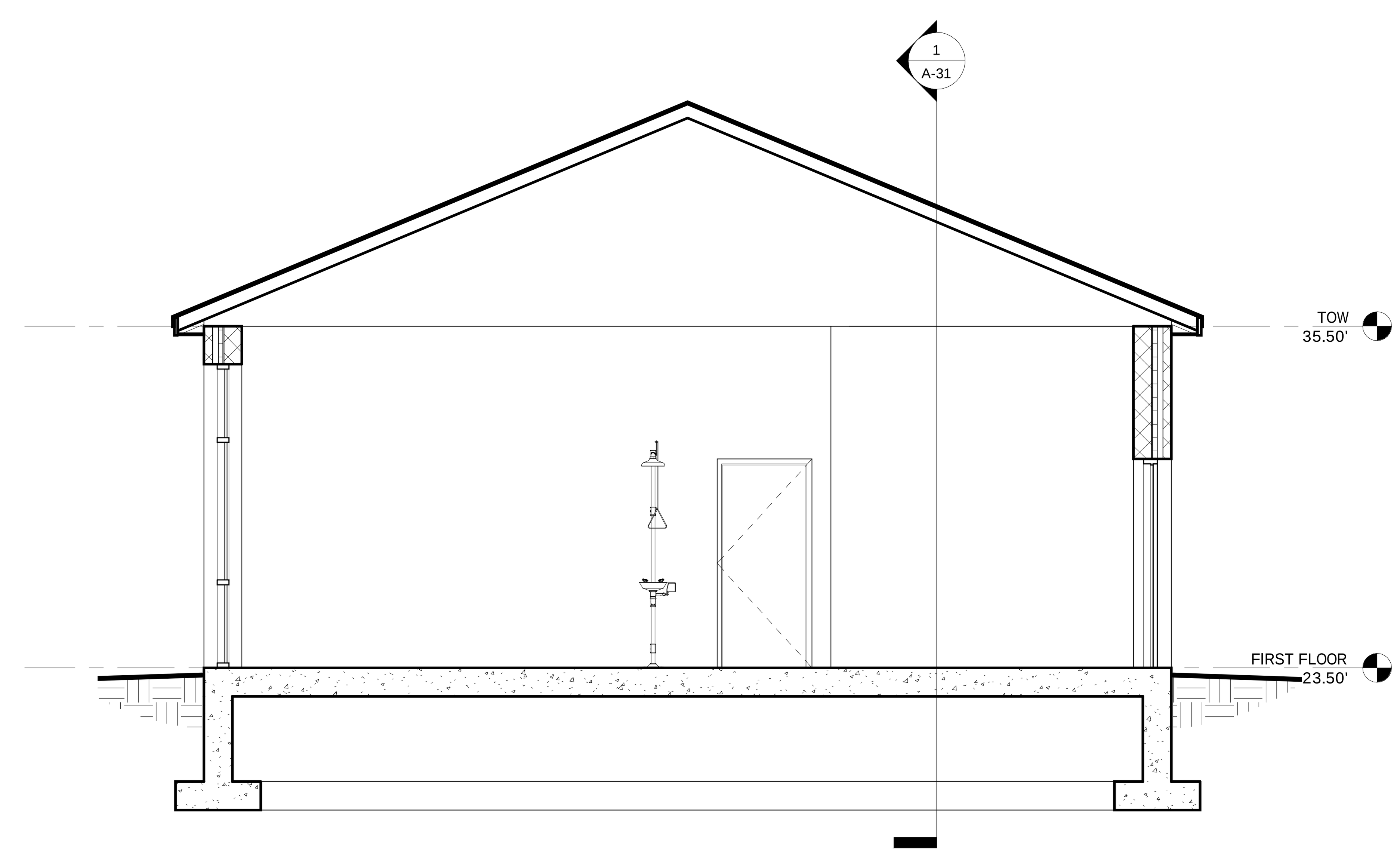
DRAWING
A - 30



1 SECTION
A-30
SCALE: 1 / 4" = 1' - 0"



3 SECTION
A-30
SCALE: 1 / 4" = 1' - 0"



2 SECTION
A-30
SCALE: 1 / 4" = 1' - 0"

NO	SUBMISSIONS / REVISIONS	APP'D	DATE
1	PRELIMINARY DESIGN REPORT		
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DESIGNED BY: Designer
CAD COORD: APC
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EXETER, NEW HAMPSHIRE
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FACILITY UPGRADES

SUPPLEMENTAL CHEMICAL BUILDING - SECTIONS AND DETAILS

DRAWING
A - 31

VALVES AND FITTINGS

EXISTING | NEW | ORTHOGRAPHIC

- GATE VALVE
- BALL VALVE
- PLUG VALVE
- GLOBE VALVE
- BUTTERFLY VALVE
- CHECK VALVE
- DOUBLE DISC CHECK VALVE
- DIAPHRAGM VALVE
- MUD VALVE
- TIDE CHECK VALVE
- NEEDLE VALVE
- PINCH VALVE
- 3-WAY VALVE
- KNIFE GATE
- TELESCOPING VALVE
- CONCENTRIC REDUCER
- ECCENTRIC REDUCER
- UNION
- BARBED FITTING
- PRESSURE SAFETY (RELIEF) VALVE (*air or liquid*) — PSV
- VACUUM RELIEF (*air or liquid*)
- BACKPRESSURE VALVE — BPV
- PRESSURE REDUCING VALVE — PRV
- BACKFLOW PREVENTER
- DUPLEX STRAINER
- SIMPLEX STRAINER
- WYE STRAINER
- EXPANSION JOINT (*air or liquid*)
- ROTAMETER
- CALIBRATION COLUMN
- PULSATION DAMPENER
- DIAPHRAGM SEAL

ACTUATORS

- CONTROL ACTUATOR — CV-###
- SOLENOID ACTUATOR — SV-###
- LIMIT SWITCH — ZSH-### OR ZSL-###
- PNEUMATIC DIAPHRAGM ACTUATOR
- PNEUMATIC/HYDRAULIC CYLINDER
- PNEUMATIC/HYDRAULIC CYLINDER (*spring return*)

PUMPS

EXISTING | NEW

- POSITIVE DISPLACEMENT
- PROGRESSIVE CAVITY
- SCREW PUMP
- CENTRIFUGAL
- SUBMERSIBLE PUMP
- HOSE
- CHEMICAL METERING
- CHEMICAL TRANSFER

BLOWERS

EXISTING | NEW

- CENTRIFUGAL
- POSITIVE DISPLACEMENT
- COMPRESSOR/TURBO
- AIR INTAKE FILTER

MISCELLANEOUS SYMBOLS

EXISTING | NEW

- MIXER
- IN-LINE STATIC MIXER
- GRINDER
- WEIR (*straight, compound, or "V"-notch weir*) — FW-XXX
- STOP GATE — STG-XXX
- SLIDE GATE — SLD-XXX
- SHEAR GATE — SG
- MISCELLANEOUS PROCESS CONNECTION — XXX FROM PR-
- CHEMICAL INJECTION NOZZLE — XXX FROM PR-, FLOW TAG
- FLOW ARROW

INSTRUMENTATION

FOR ADDITIONAL INFORMATION REFER TO INSTRUMENTATION DWG I-1

FIELD INSTRUMENTS

EXISTING | NEW

- FIELD PIPE MOUNTED DEVICE (PSH, TE, dPE,)
- PADDLE OR LEVER TYPE PROBE
- SUBMERSIBLE PRESSURE TRANSDUCER
- FLOAT SWITCH
- CAPACITANCE OR ADMITTANCE TYPE PROBE
- BUBBLE LIQUID LEVEL ELEMENT

ELEMENT TYPE (SEE INSTRUMENTATION DWG I-1)
ELEMENT (SEE INSTRUMENTATION DWG I-1)
ELEMENT NUMBER

- ULTRASONIC LEVEL TRANSDUCER
- PRESSURE TRANSDUCER
- RADAR LEVEL TRANSDUCER
- GUIDED WAVE RADAR

FLOW METERS

EXISTING | NEW

- MAGNETIC FLOW METER
- VENTURI FLOW METER
- PARSHALL FLUME
- ULTRASONIC FLOW METER
- PITOT FLOW METER
- AVERAGING PITOT FLOW METER
- THERMAL MASS FLOW METER
- TURBINE FLOW METER
- ORIFICE PLATE

MISCELLANEOUS SYMBOLS, cont'd

- PROCESS LINE CONTINUANCE — FROM XXXX / DWG. NO. / FLOW TAG / TO XXXX
- TO, OR FROM, AN OUT OF CONTRACT PIPE OR PROCESS

ABBREVIATIONS

Ø / DIA	DIAMETER
A	AIR (LOW PRESSURE)
AT	AERATION TANK
ATE	AERATION TANK EFFLUENT
ATI	AERATION TANK INFLUENT
AE	ANALYZING ELEMENT
AL	ALUMINUM
ALK	ALKALINITY
ALT	ALTERNATE
BF	BLIND FLANGE
BFV	BUTTERFLY VALVE
BLDG	BUILDING
BOT	BOTTOM
BPV	BACKPRESSURE VALVE
BW	BACKWASH
BWW	BELT WASH WATER
CA	COMPRESSED AIR
CB	CATCH BASIN
CCC	CHLORINE CONTACT CHAMBER
CCT	CHLORINE CONTACT TANK
CEN	CENTRATE
CI	CAST IRON
CIP	CLEAN-IN-PLACE
CKV	CHECK VALVE
CMH	CHEMICAL MANHOLE
CO	CLEANOUT
CONC	CONCRETE
CONT	CONTINUED
CO2	CARBON DIOXIDE
CPL	COUPLING
CRS	CHLORINE RESIDUAL SAMPLE
CV	CONTROL VALVE (ACTUATED)
D, DR	DRAIN
DEC	DECHLORINATION SOLUTION
DEF	DEFOAMER
DET	DETAIL
DEW	DEWATERING (TANKS)
DG	DIGESTER GAS
DIA	DIAMETER
DMH	DRAIN MANHOLE
DI	DUCTILE IRON
DIM	DIMENSION
DN	DOWN
DPOL	DILUTED POLYMER
DSL	DEWATERING SLUDGE
DWG	DRAWING
ECC	ECCENTRIC
ED	EDUCTOR
EFF	EFFLUENT (FINAL)
EL (ELEV)	ELEVATION
ELL	ELBOW
EQUIP	EQUIPMENT
EXIST (EX)	EXISTING
EXP	EXPANSION
FP	FIRE PROTECTION
FC	FLUSHING CONNECTION
FD	FLOOR DRAIN
FE	FLOW ELEMENT
FES	FINAL EFFLUENT SAMPLE
FF/ FFE	FINISHED FLOOR/ FINISHED FLOOR ELEVATION
FIL	FILTRATE
FLG	FLANGE
FLOC	FLOCCULATION
FLR	FLOOR
FM	FORCE MAIN
FOT	FLAT ON TOP
FPHB	FROST PROOF HOSE BIBB
FRP	FIBERGLASS REINFORCED POLYESTER
FS	FLOW SWITCH
FSW	FOAM SPRAY WATER
FW	FIXED WEIR
G	GAS
GA	GAUGE
GAC	GRANULAR ACTIVATED CARBON
GAL	GALLON
GALV	GALVANIZED
GR	GREASE
GT	GRIT
GTDW	GRAVITY THICKENER DILUTION WATER
GTD	GRIT DRAIN
GTO	GRAVITY THICKENER OVERFLOW
GTR	GRAVITY THICKENER
GTS	GRAVITY THICKENER SLUDGE
GV	GATE VALVE
HB	HOSE BIBB
HDPE	HIGH DENSITY POLYEHTYLENE
HP	HIGH POINT
HW	HOT WATER
HYD	HYDRANT
HYP	SODIUM HYPOCHLORITE
ID	INSIDE DIAMETER
INF	INFLUENT
INV	INVERT
IR	INTERNAL RECYCLE
ISS	INFLUENT SEWAGE SAMPLE
JT	JOINT
KV	KNIFE GATE VALVE
LE	LEVEL ELEMENT
LR	LONG RADIUS
MAX	MAXIMUM
MECH	MECHANICAL
MFG	MANUFACTURER
MH	MANHOLE
MIN	MINIMUM
MJ	MECHANICAL JOINT
MTD	MOUNTED
NAOH	SODIUM HYDROXIDE
NG	NATURAL GAS
NIC	NOT IN CONTRACT
NO	NUMBER
NPT	NATIONAL PIPE THREAD
NTS	NOT TO SCALE
OC	ON CENTER
OCF	ODOR CONTROL FAN
OCRP	ODOR CONTROL RECIRCULATION PUMP
OCS	ODOR CONTROL SYSTEM
OD	OUTSIDE DIAMETER
OFL	OVERFLOW
OH	OVERHEAD
PBU	POLYMER BLENDING UNIT
PCCP	PRESTRESSED CONCRETE CYLINDER PIPE
PCE	PRIMARY CLARIFIER EFFLUENT
PCI	PRIMARY CLARIFIER INFLUENT
PE	POLYETHYLENE OR PRESSURE ELEMENT
PERM	POTASSIUM PERMANGANATE
PES	PRIMARY EFFLUENT SAMPLE
POL	POLYMER (NEAT)
PP	POLYPROPYLENE
PSV	PRESSURE SAFETY RELIEF VALVE
PRV	PRESSURE REGULATING VALVE
PRW	PROCESS WATER (CITY WATER USED FOR PROCESS – NON POTABLE)
PS	PRESSURE SWITCH
PSL	PRIMARY SLUDGE
PSLS	PRIMARY SLUDGE SAMPLE
PTE	PRELIMINARY TREATMENT EFFLUENT
PV	PLUG VALVE
PVC	POLYVINYL CHLORIDE
PW	PLANT WATER
RCP	REINFORCED CONCRETE PIPE
REC	RECYCLE
RED	REDUCER
REQ'D	REQUIRED
RD	ROOF DRAIN
RPZ	REDUCED PRESSURE ZONE BACKFLOW PREVENTER
RS	RETURN SLUDGE
S	SEWER
SAM	SAMPLE LINE
SAN	SANITARY WASTE
SC	SCUM
SCD	SCUM DECANT
SCE	SECONDARY CLARIFIER EFFLUENT
SCH	SCHEDULE
SCI	SECONDARY CLARIFIER INFLUENT
SCS	SCUM SAMPLE
SD	STORM DRAIN
SECT	SECTION
SEP	SEPTAGE
SG	SHEAR GATE
SHT	SHEET
SL	SLUDGE
SLD	SLIDE GATE
SLG	SLUICE GATE
SMH	SANITARY SEWER MANHOLE
SP	SUMP PUMP
SPC	SUPPLEMENTAL CARBON
SPD	SUMP PUMP DISCHARGE
SQ	SQUARE
SS	STAINLESS STEEL
SSL	SECONDARY SLUDGE
STD	STANDARD
STG	STOP GATE
STL	STEEL
SUP	SUPERNATANT
SV	SOLENOID VALVE
SW	SEAL WATER
TE	TERTIARY EFFLUENT
THK	THICKNESS
TI	TERTIARY INFLUENT
TK	TANK
TPSL	THICKENED PRIMARY SLUDGE
TSL	TERTIARY SLUDGE
TWSL	THICKENED WASTE SLUDGE
TYP	TYPICAL
UD	UNDERDRAIN
UFL	UNDERFLOW
UV	ULTRAVIOLET DISINFECTION SYSTEM
V	VENT
VERT	VERTICAL
W	POTABLE WATER
WS	WASTE SLUDGE
WSE	WATER SURFACE ELEVATION
WSS	WASTE SLUDGE SAMPLE
YH	YARD HYDRANT

LINETYPES

EXISTING | NEW

- STRUCTURES
- WASTEWATER
- STORAGE/BYPASS FLOW
- FUTURE EQUIPMENT/PIPING
- EQUIPMENT/PIPING
- GRIT
- PLANT WATER
- AIR
- SCUM
- SEPTAGE
- DRAIN
- SLUDGE
- PNEUMATIC
- HYDRAULIC

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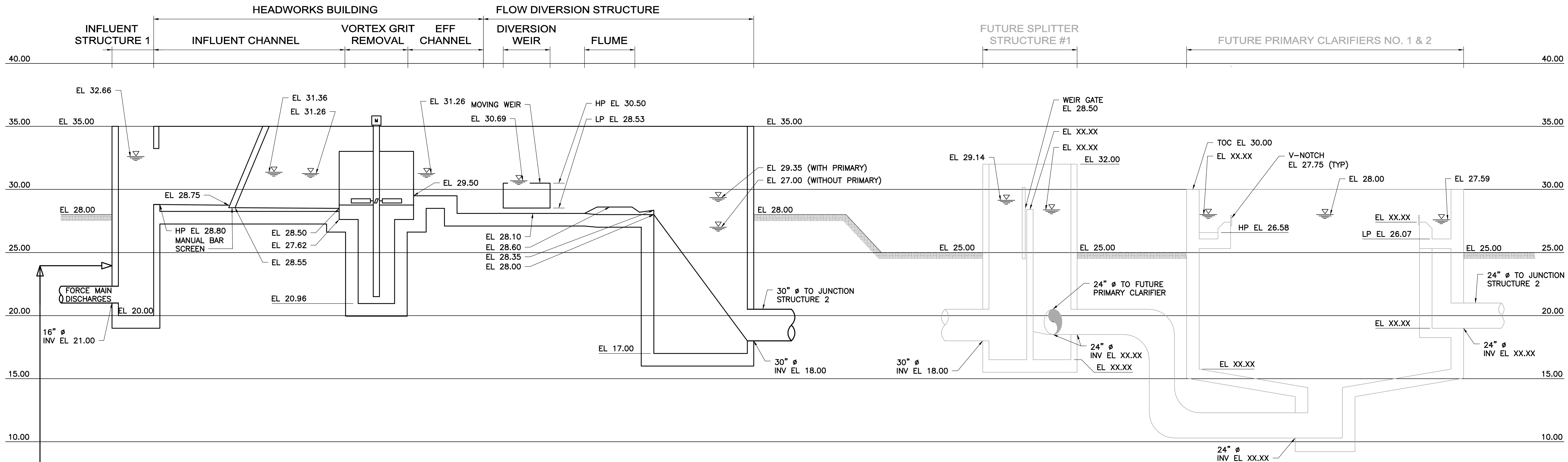
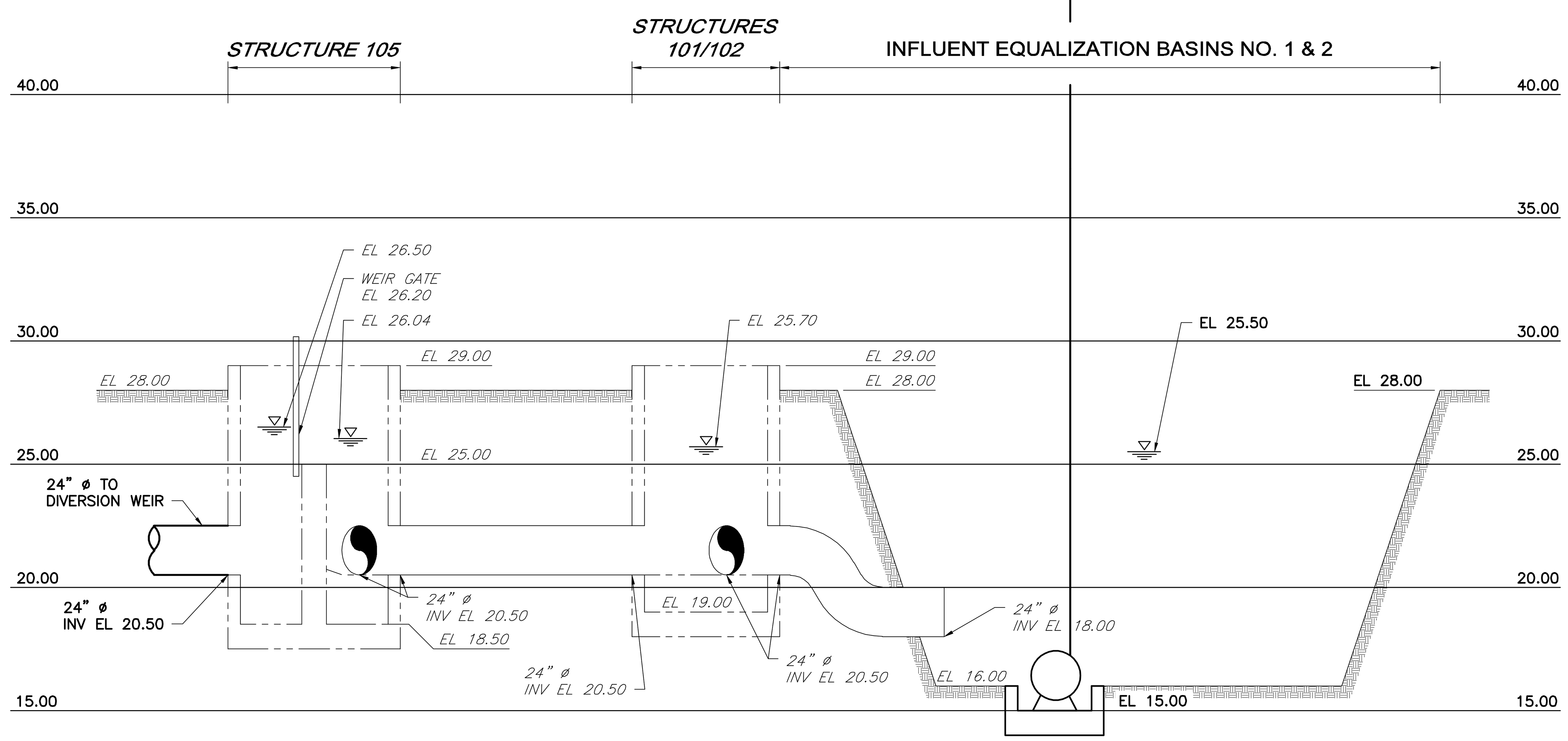
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT FACILITY UPGRADES

PROCESS LEGEND AND ABBREVIATIONS

DRAWING
PR-2



HYDRAULIC PROFILE
SCALE: HORIZONTAL: NTS – VERTICAL: 1/4"=1'–0"



HYDRAULIC PROFILE
SCALE: HORIZONTAL: NTS – VERTICAL: 1/4"=1'–0"

BASIS OF HYDRAULIC PROFILE

HYDRAULIC GRADE LINE ELEVATIONS:	I	II	III	IV	IV	IV
DESIGN FLOW PHASE	MINIMUM DAY MHW	ANNUAL AVERAGE MHW	MAXIMUM MONTH MHW	PEAK DAY 100–YR	PEAK HOUR 25–YR	PEAK HOUR 100–YR
FLOW - MGD						
INFLUENT PRE–EQ	1.68	3.08	5.18	6.68	12.58	12.58
INFLUENT POST–EQ	1.68	3.08	5.18	6.68	6.68	6.68
RETURN SLUDGE RATE	1.08	1.97	3.00	3.00	3.00	3.00
INFLUENT + RETURN SLUDGE	2.76	5.06	8.18	9.68	9.68	9.68
INTERNAL RECYCLE	5.05	9.25	10.00	10.00	10.00	10.00
INF+RS+IR	7.81	14.31	18.18	19.68	19.68	19.68
SECONDARY EFF/TERTIARY INF–EFF	1.68	3.08	5.18	6.68	6.68	6.68
UNIT PROCESSES	**NUMBER OF UNITS IN SERVICE**					
INFLUENT SCREENING	1	1	1	1	1	1
GRIT REMOVAL	1	1	1	1	1	1
PRIMARY SETTLING TANKS (FUTURE)	1	2	2	2	2	1
AERATION TANK TRAINS	1	2	2	2	2	1
SECONDARY SETTLING TANKS	2	2	3	3	3	2
TERTIARY FILTRATION (FUTURE)	1	2	3	3	3	2
UV CHANNELS	1	1	1	1	1	1

NOTES:

1. SHADING IS REPRESENTATIVE OF SCENARIO VI PEAK HOUR HYDRAULIC GRADE LINE. AN ASTERISK (*) HAS BEEN PLACED BY THE HGL ELEVATION CORRESPONDING TO THE SHADING.
2. SCENARIO VI HYDRAULICS BASED ON A 100–YEAR FLOOD EVENT IN SQUAMSCOTT RIVER AND NUMBER OF UNIT PROCESSES IN SERVICE AS NOTED ABOVE.
3. ALL ELEVATIONS ARE SHOWN IN NAVD 1929.

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR–1 AND PR–2.

LAST SAVED BY: ADAM.COUTURE 9/23/2015 12:34 PM
G:\DWGS\NH\EXETER\12883–WWTF–UPGRADE\12883–PDR\PRO\12883–PRS–HYDPRO.DWG | Layout1 | 1:10.1236 | ----- | 9/24/2015 1:53:12 PM | ADAM.COUTURE

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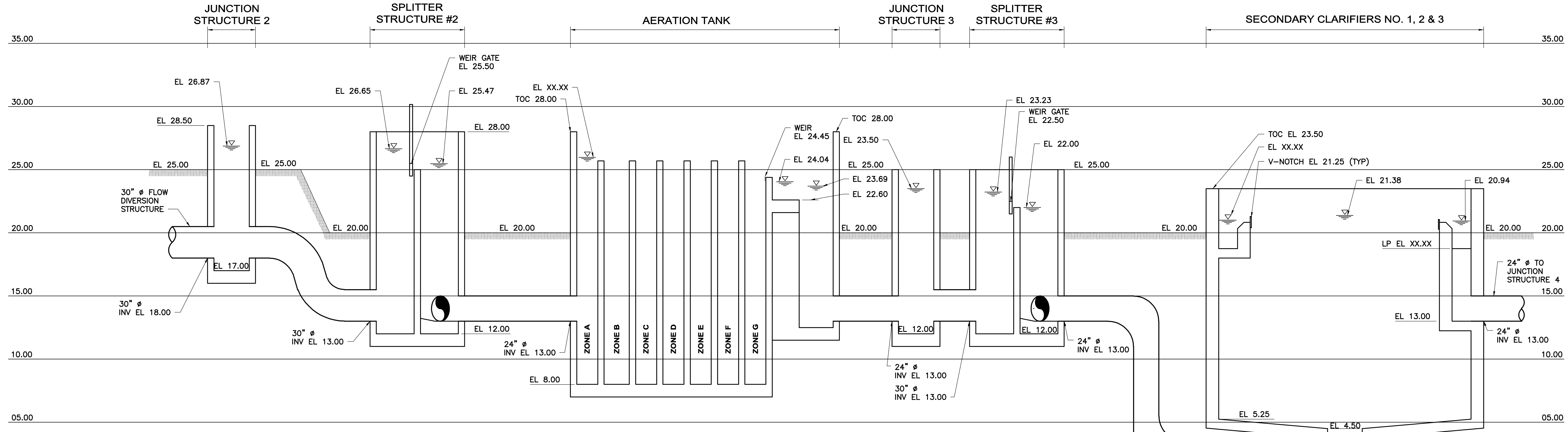
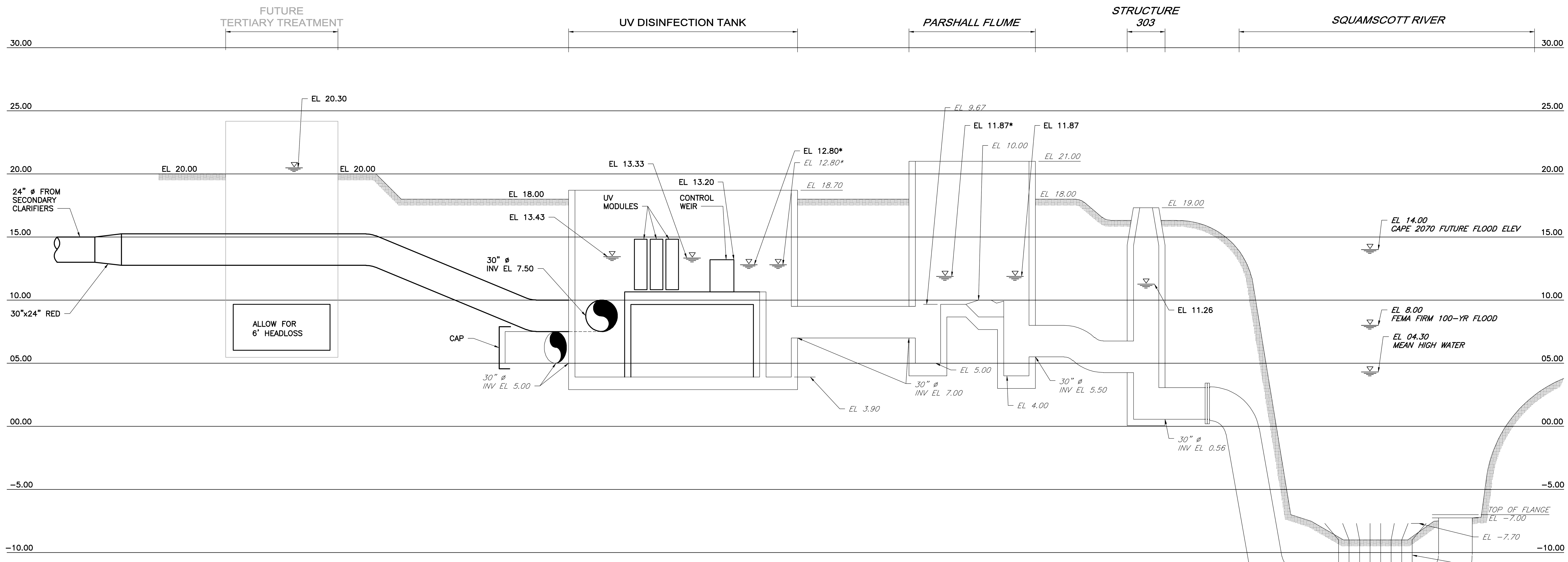
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

HYDRAULIC PROFILE I

DRAWING
PR–3



HYDRAULIC PROFILE
SCALE: HORIZONTAL: NTS – VERTICAL: 1/4"=1'-0"



HYDRAULIC PROFILE
SCALE: HORIZONTAL: NTS – VERTICAL: 1/4"=1'-0"

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1, PR-2, AND PR-3.

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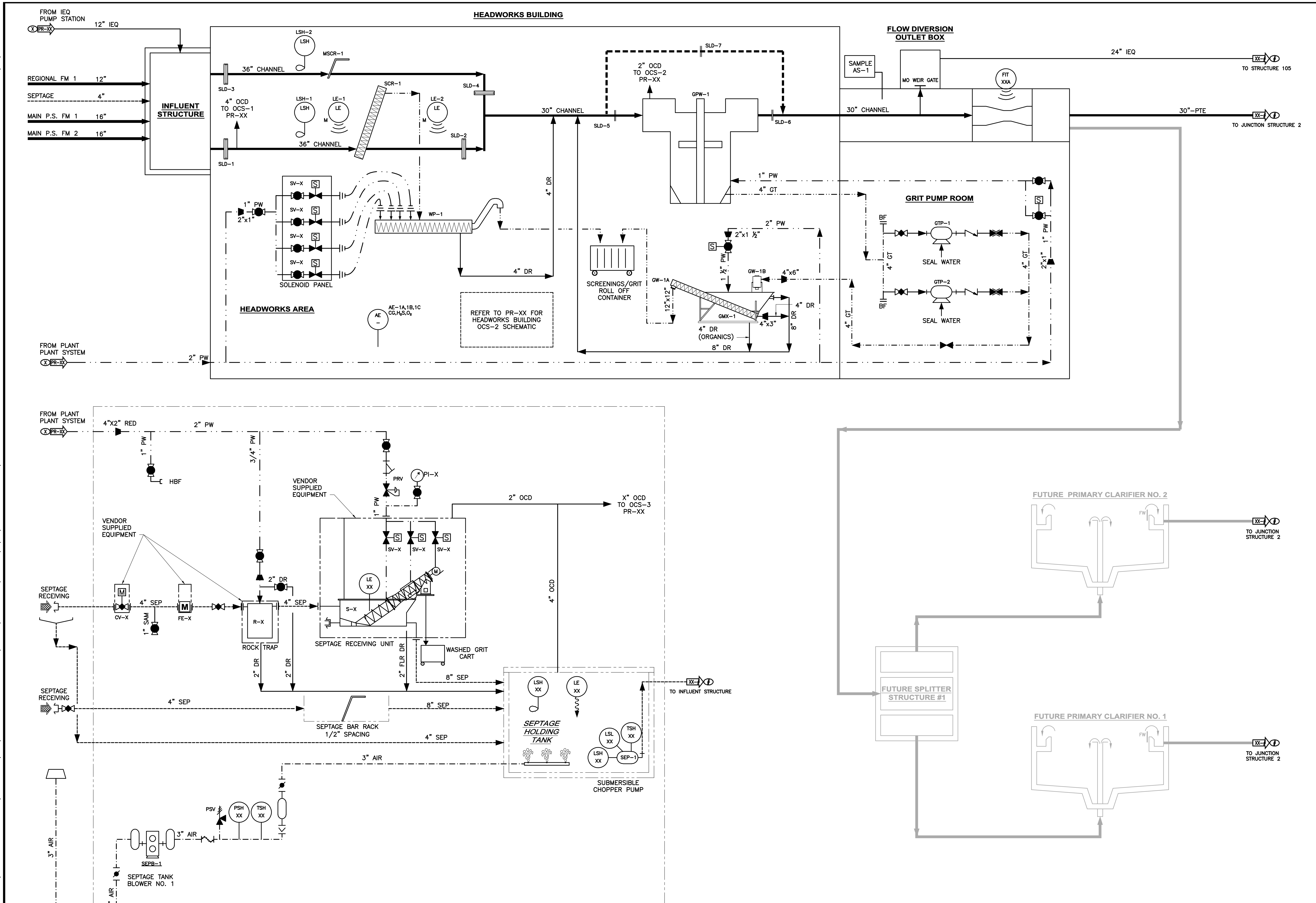
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT FACILITY UPGRADES

HYDRAULIC PROFILE II

DRAWING
PR-4



NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

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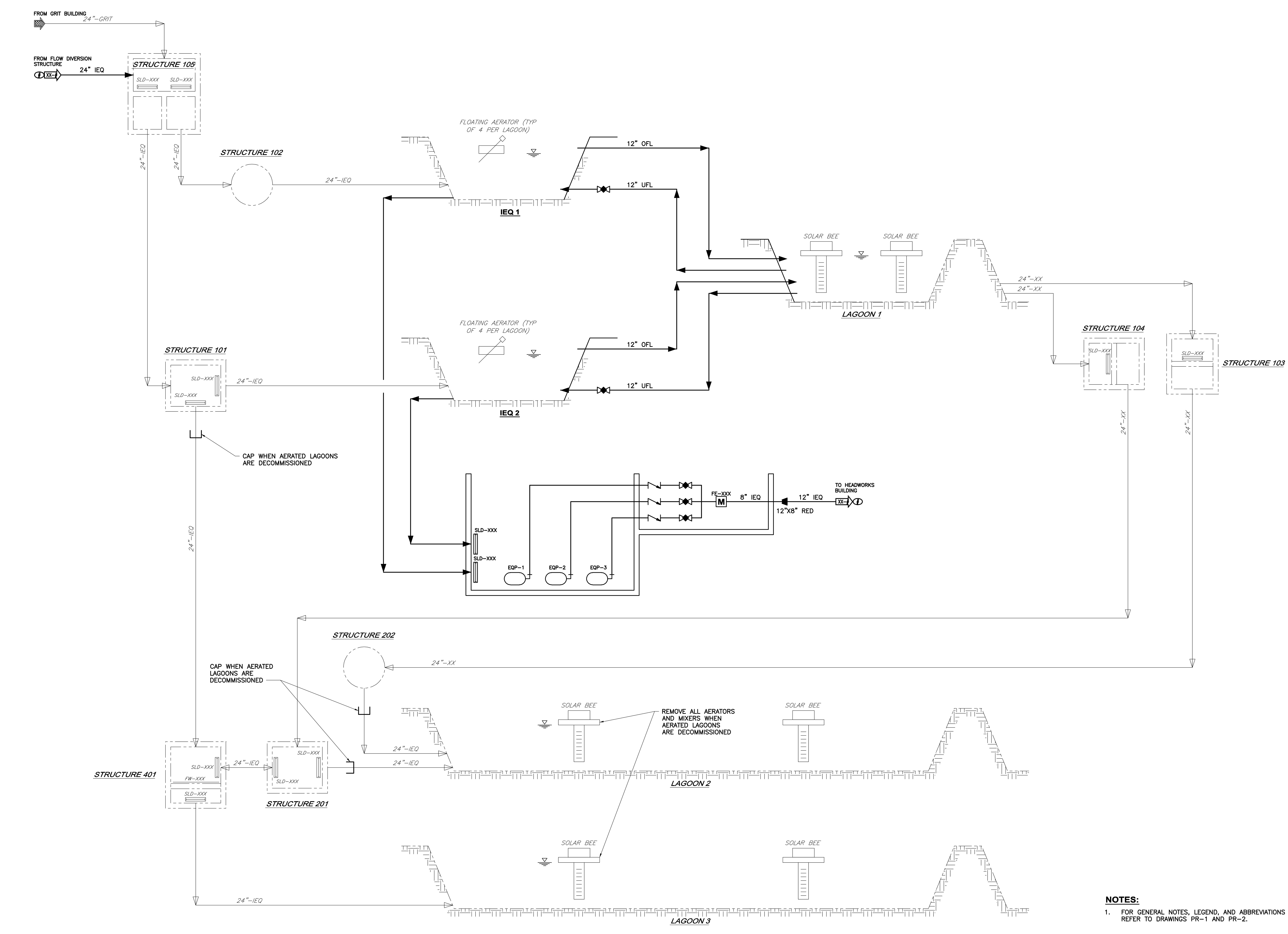
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT FACILITY UPGRADES

PROCESS FLOW SCHEMATIC
HEADWORKS

DRAWING
PR-5



NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

PROCESS FLOW SCHEMATIC
INFLUENT EQUALIZATION

DRAWING
PR-6

LAST SAVED BY: ADAM.COUTURE 9/23/2015 12:42 PM

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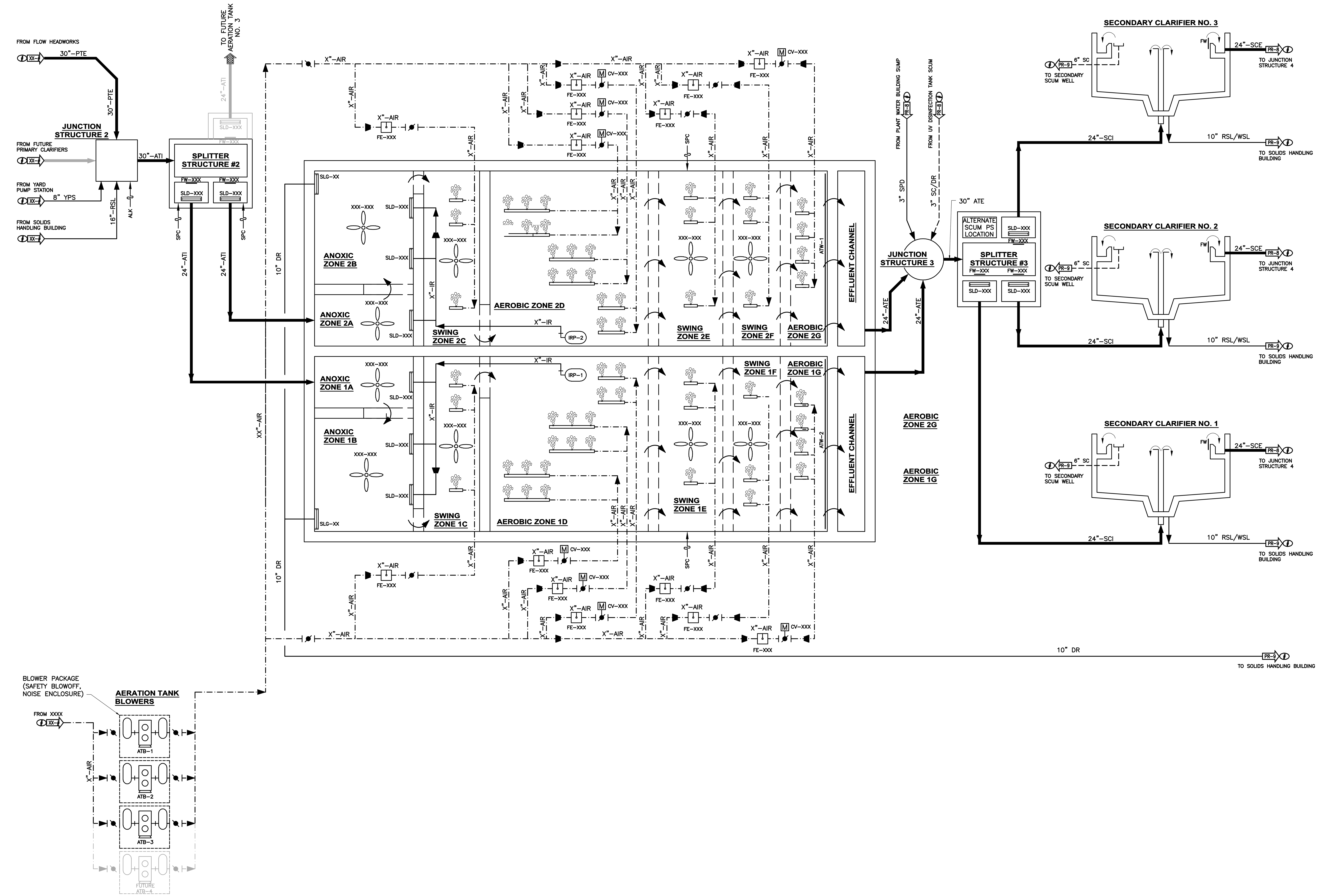

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
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WASTEWATER TREATMENT
FACILITY UPGRADES

PROCESS FLOW SCHEMATIC
BNR/SECONDARY TREATMENT

DRAWING
PR-7

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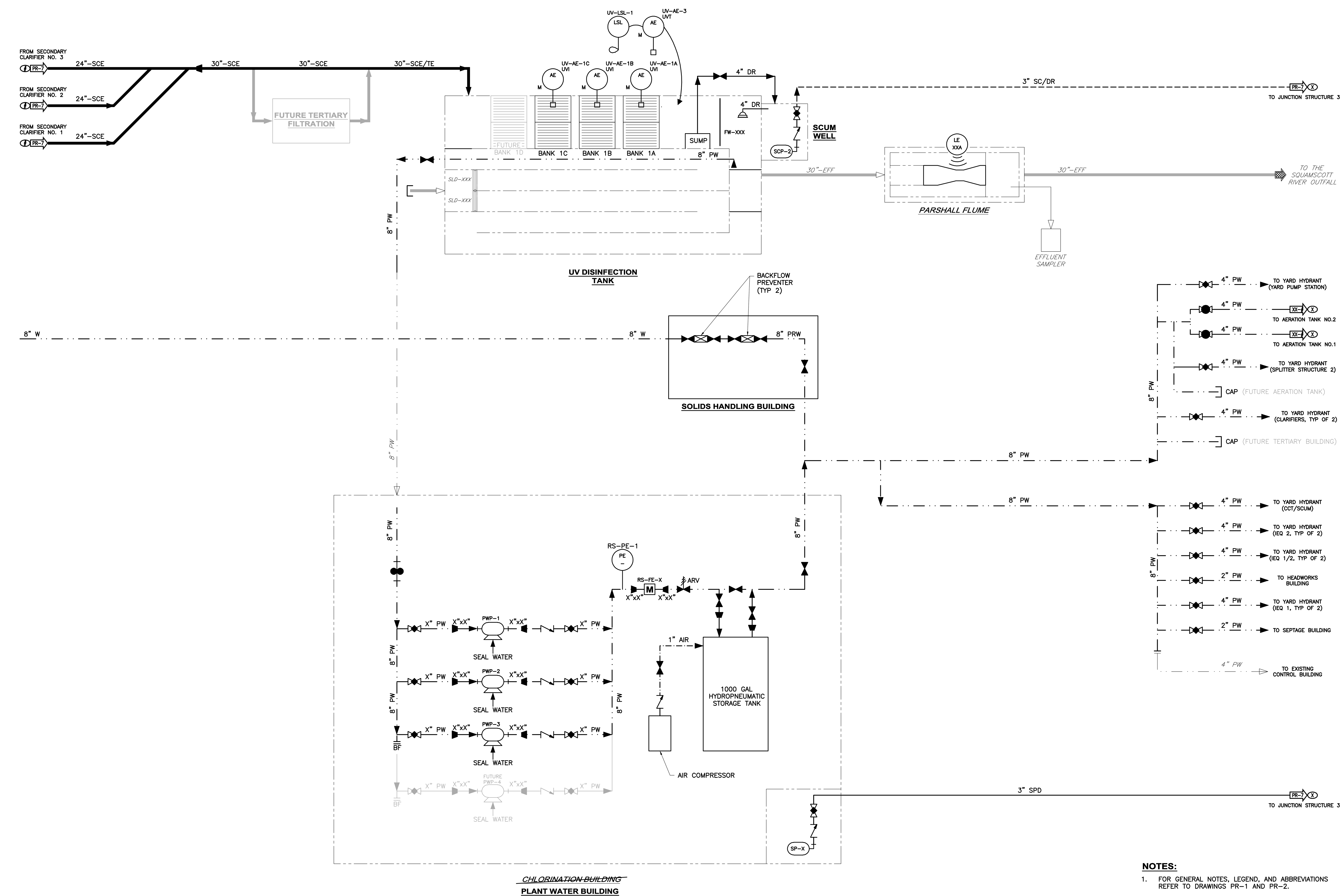

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.
2. 6" DR TIES INTO 12" FIL MANHOLE UPSTREAM OF HEADWORKS BUILDING.

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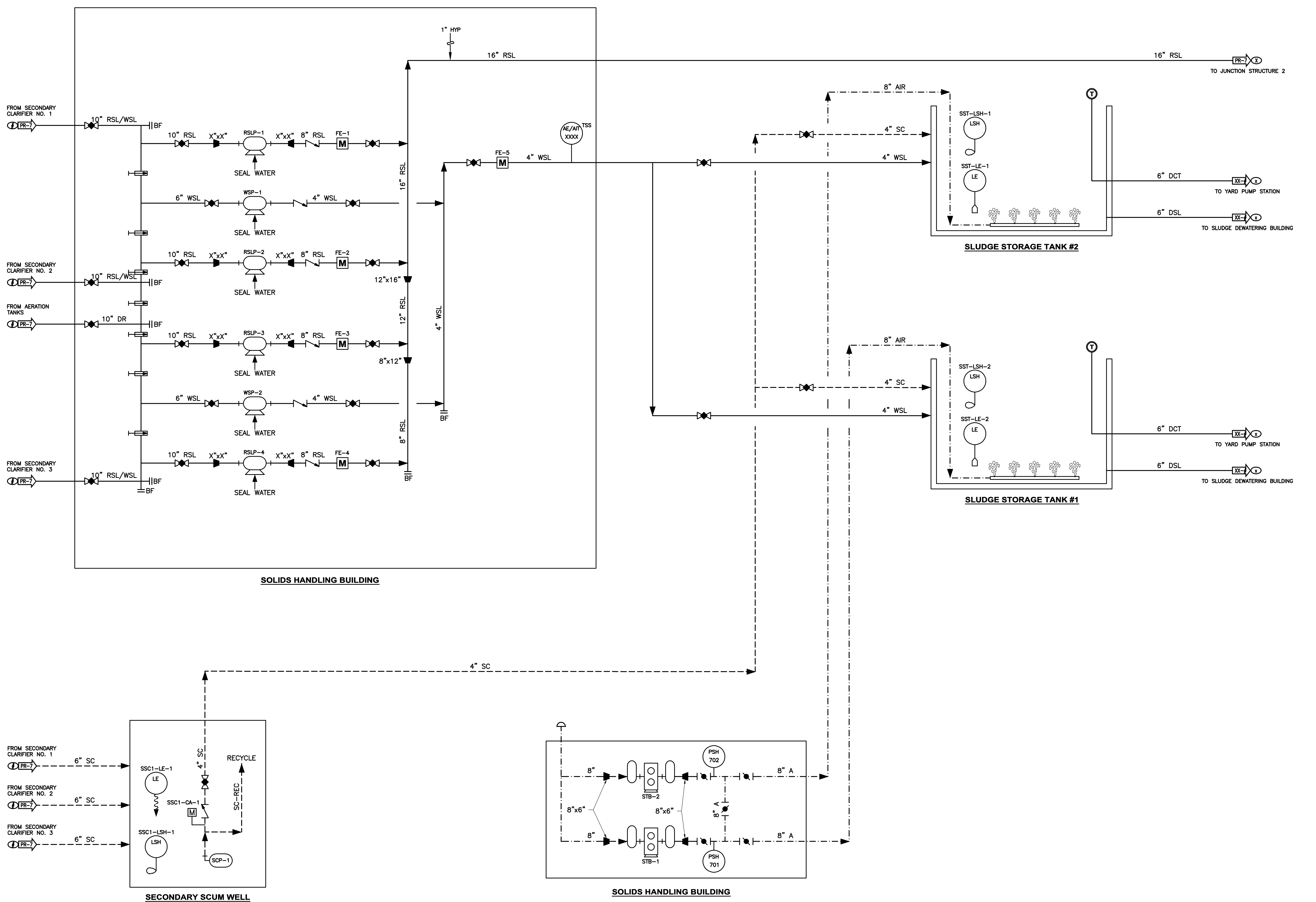
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT FACILITY UPGRADES

PROCESS FLOW SCHEMATIC
DISINFECTION

DRAWING
PR-8



NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

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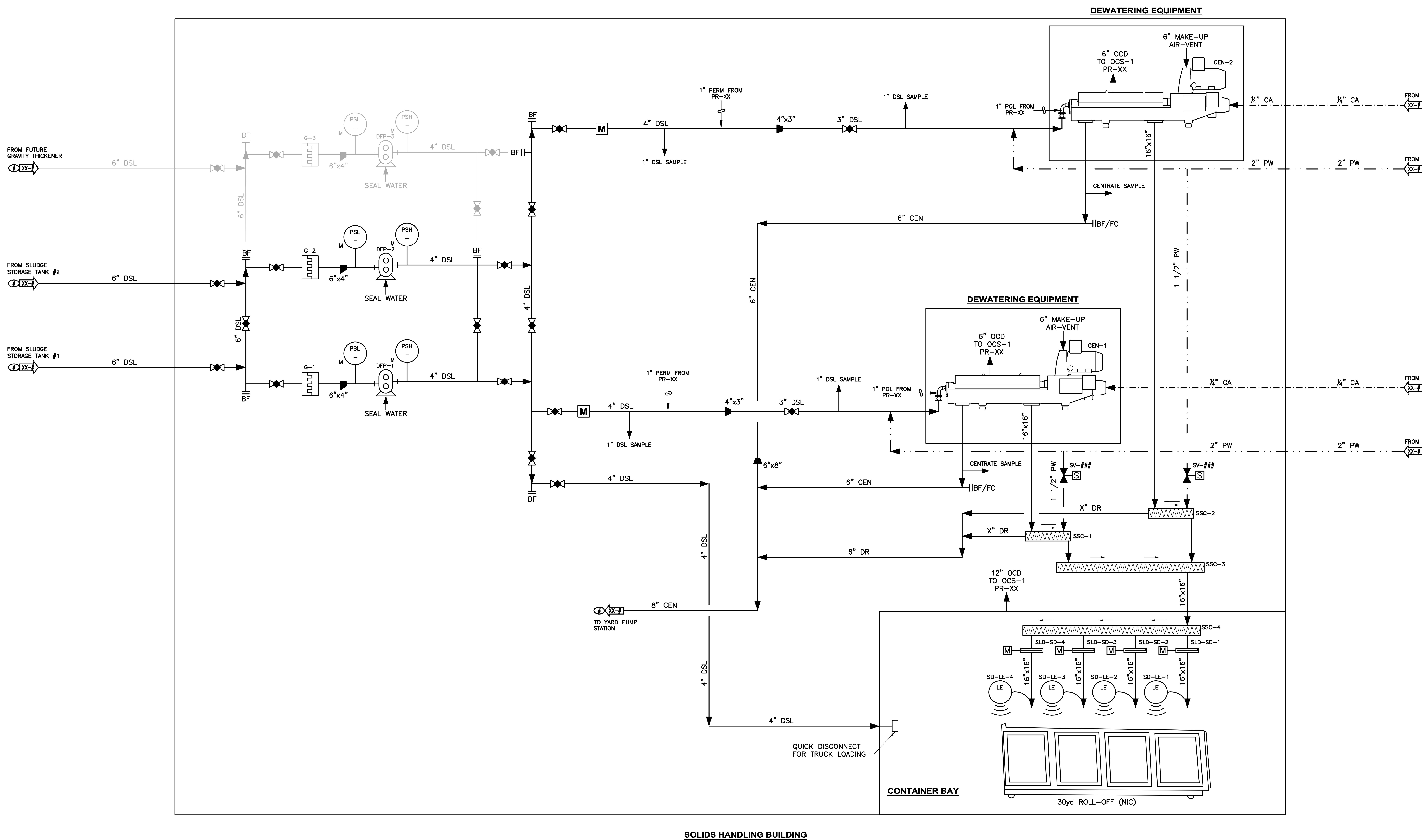
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

PROCESS FLOW SCHEMATIC
SLUDGE HANDLING

DRAWING
PR-9



NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

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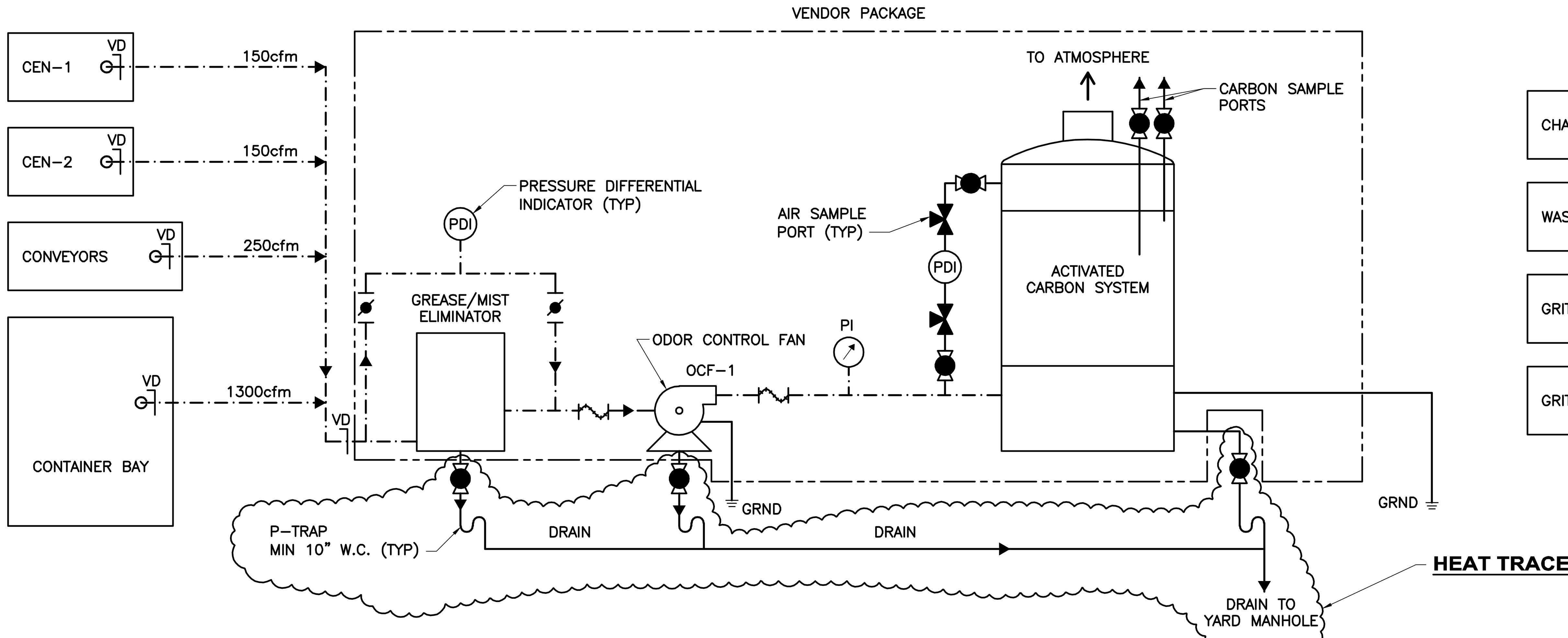
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT FACILITY UPGRADES

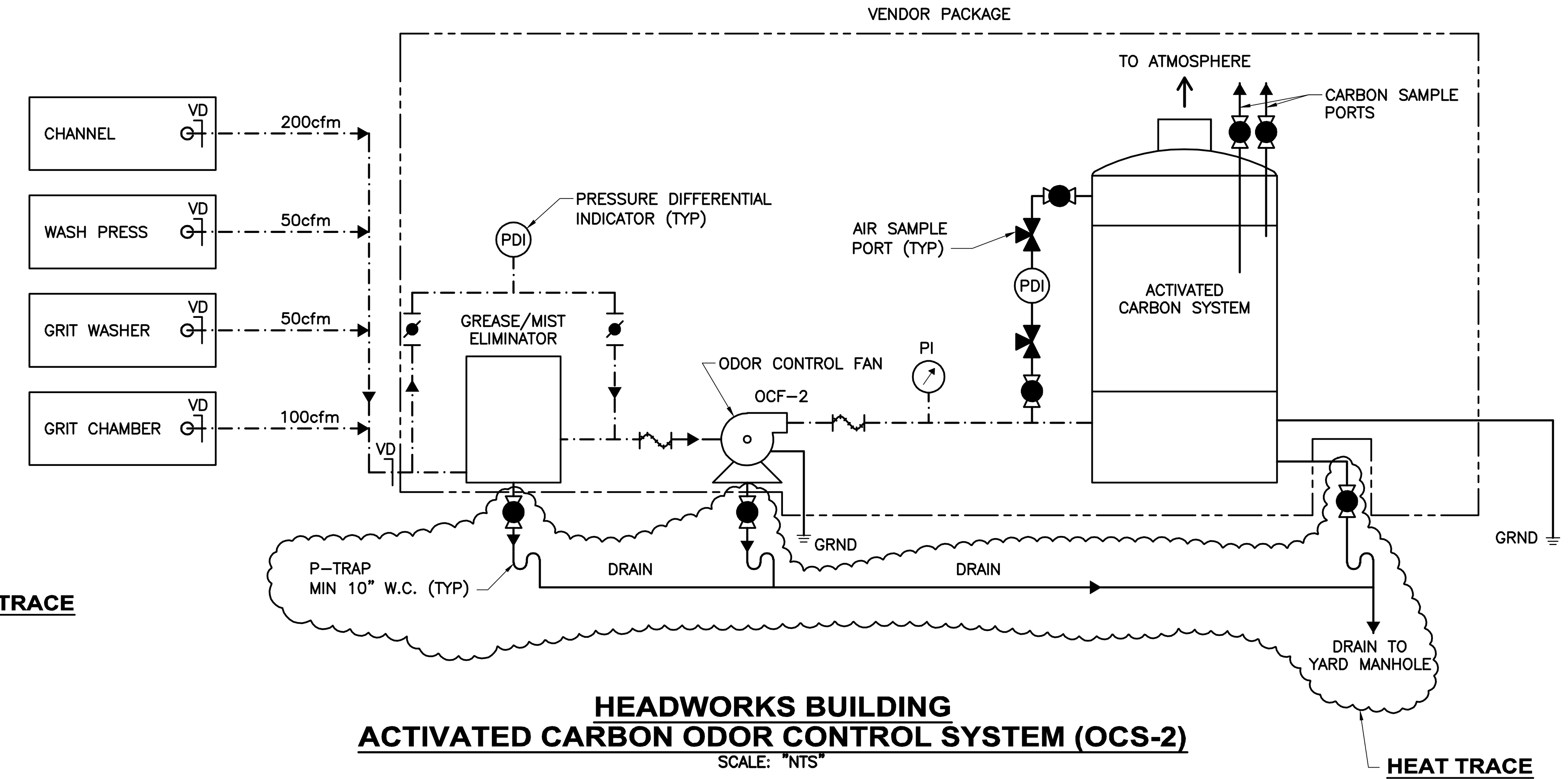
PROCESS FLOW SCHEMATIC
DEWATERING

DRAWING
PR-10



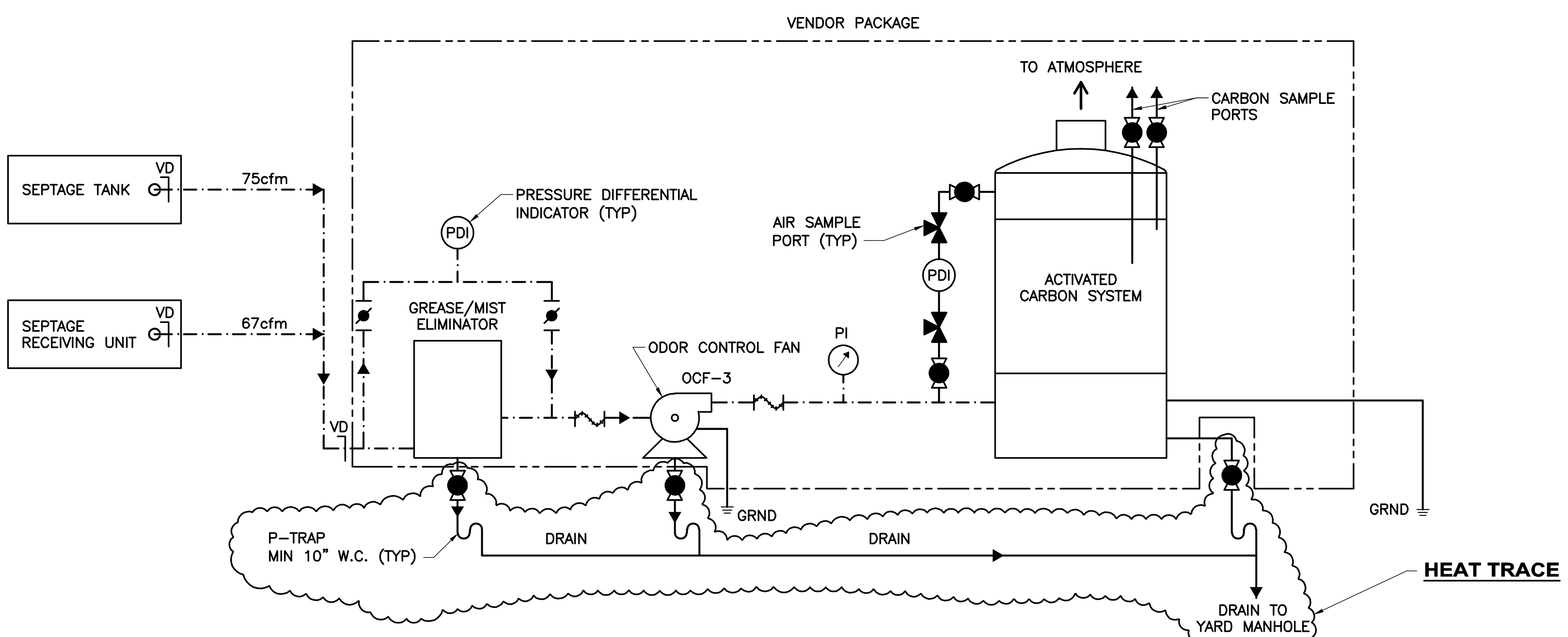
DEWATERING BUILDING ACTIVATED CARBON ODOR CONTROL SYSTEM (OCS-1)

SCALE: "NTS"



HEADWORKS BUILDING ACTIVATED CARBON ODOR CONTROL SYSTEM (OCS-2)

SCALE: "NTS"



SEPTAGE RECEIVING ACTIVATED CARBON ODOR CONTROL SYSTEM (OCS-3)

SCALE: "NTS"

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

SUBMISSIONS/REVISIONS

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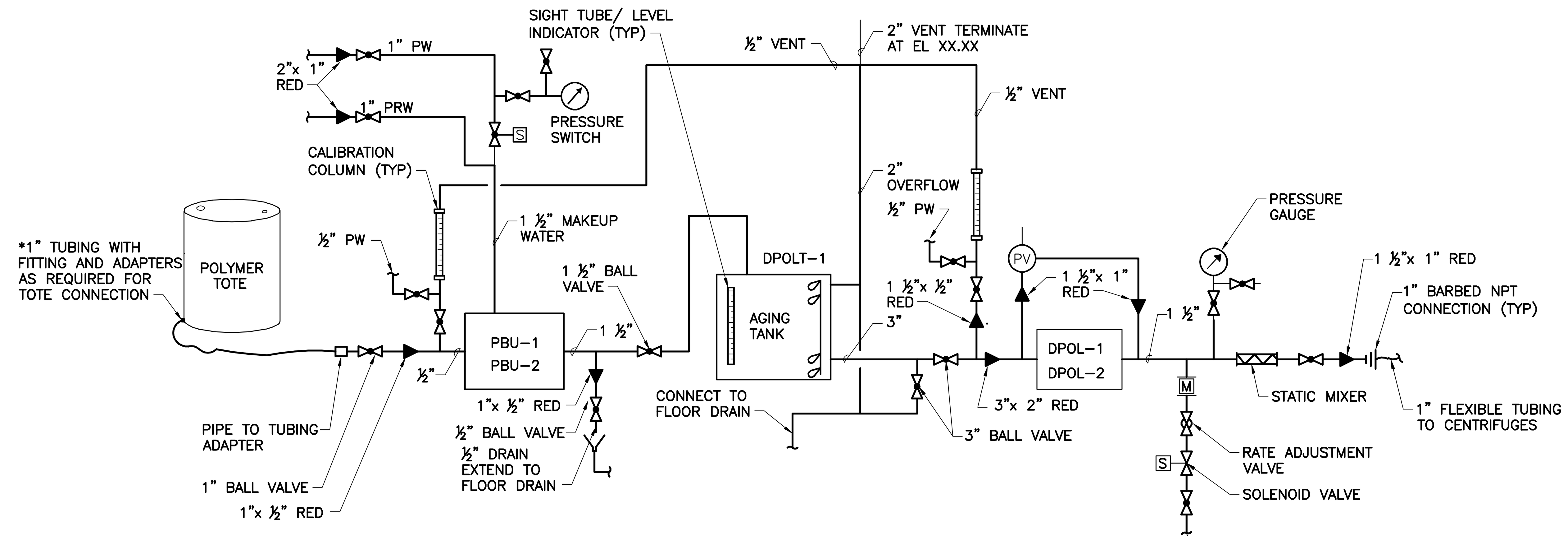
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT FACILITY UPGRADES

PROCESS FLOW SCHEMATIC
ODOR CONTROL

DRAWING
PR-11



DEWATERING POLYMER SYSTEM SCHEMATIC

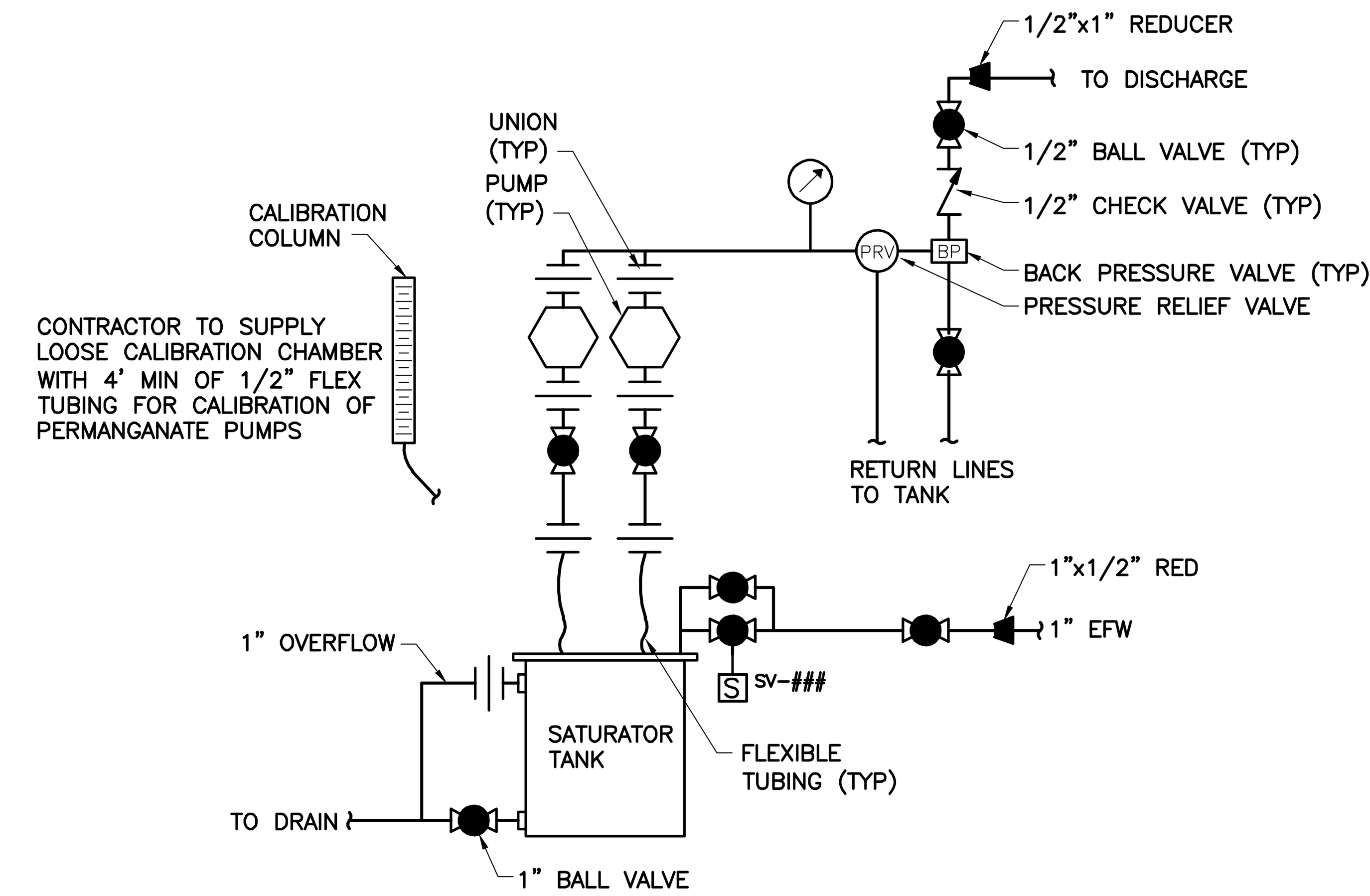
NTS

NOTES:

* CONTRACTOR TO VERIFY TUBING SIZE, FITTINGS, AND ADAPTERS AS NECESSARY PER POLYMER TOTE MANUFACTURER.

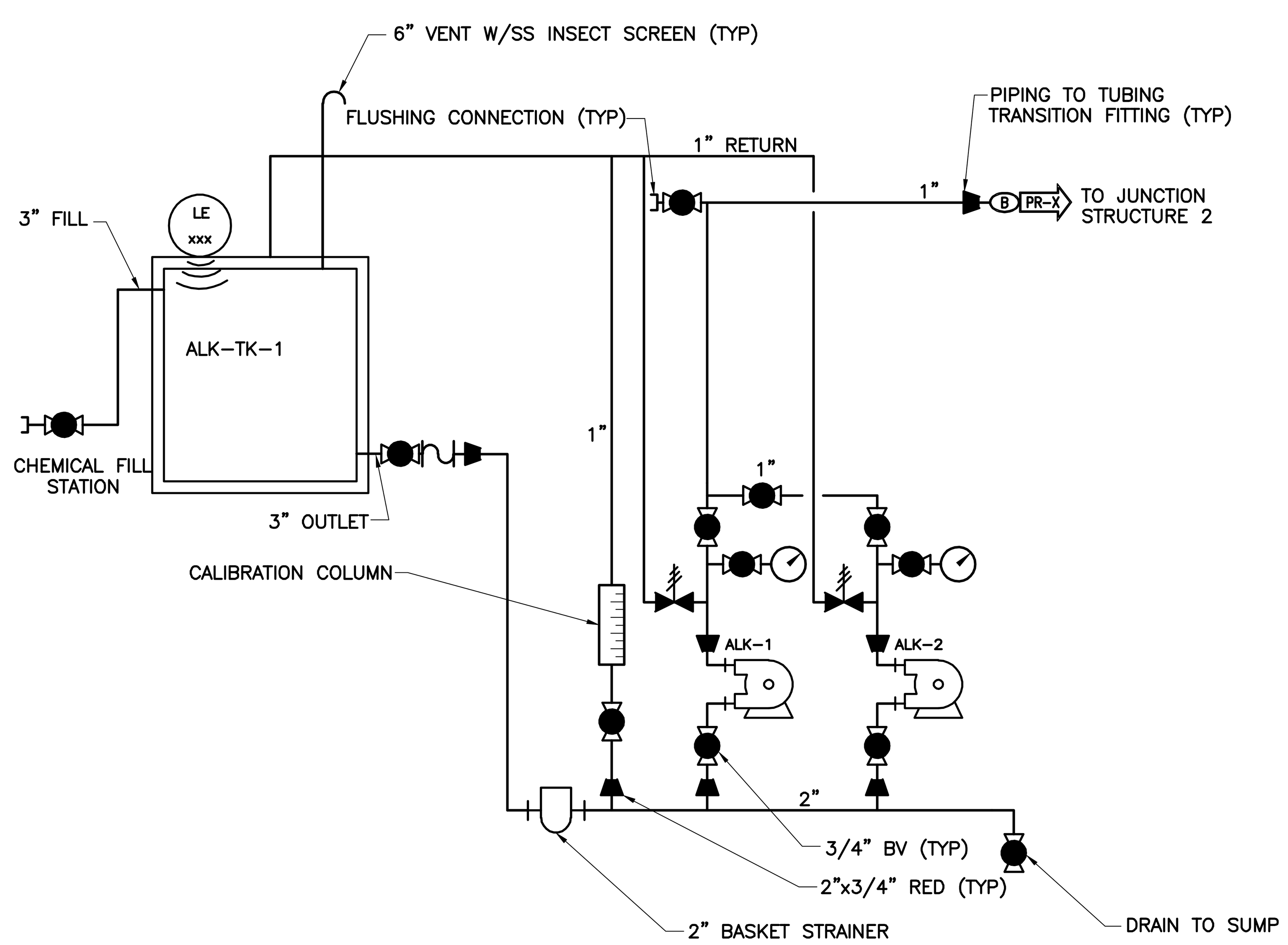
1. POLYMER ASSEMBLY, VALVES AND EQUIPMENT TO BE FURNISHED BY POLYMER SYSTEM SUPPLIER. CONTRACTOR TO FURNISH INTERCONNECTING PIPING, VALVES, ETC. AS REQUIRED.

2. REFER TO SPECIFICATION SECTIONS 11232A FOR POLYMER BLENDING ASSEMBLIES, AGING/HOLDING TANK ASSEMBLIES AND POLYMER FINAL FEED ASSEMBLIES.



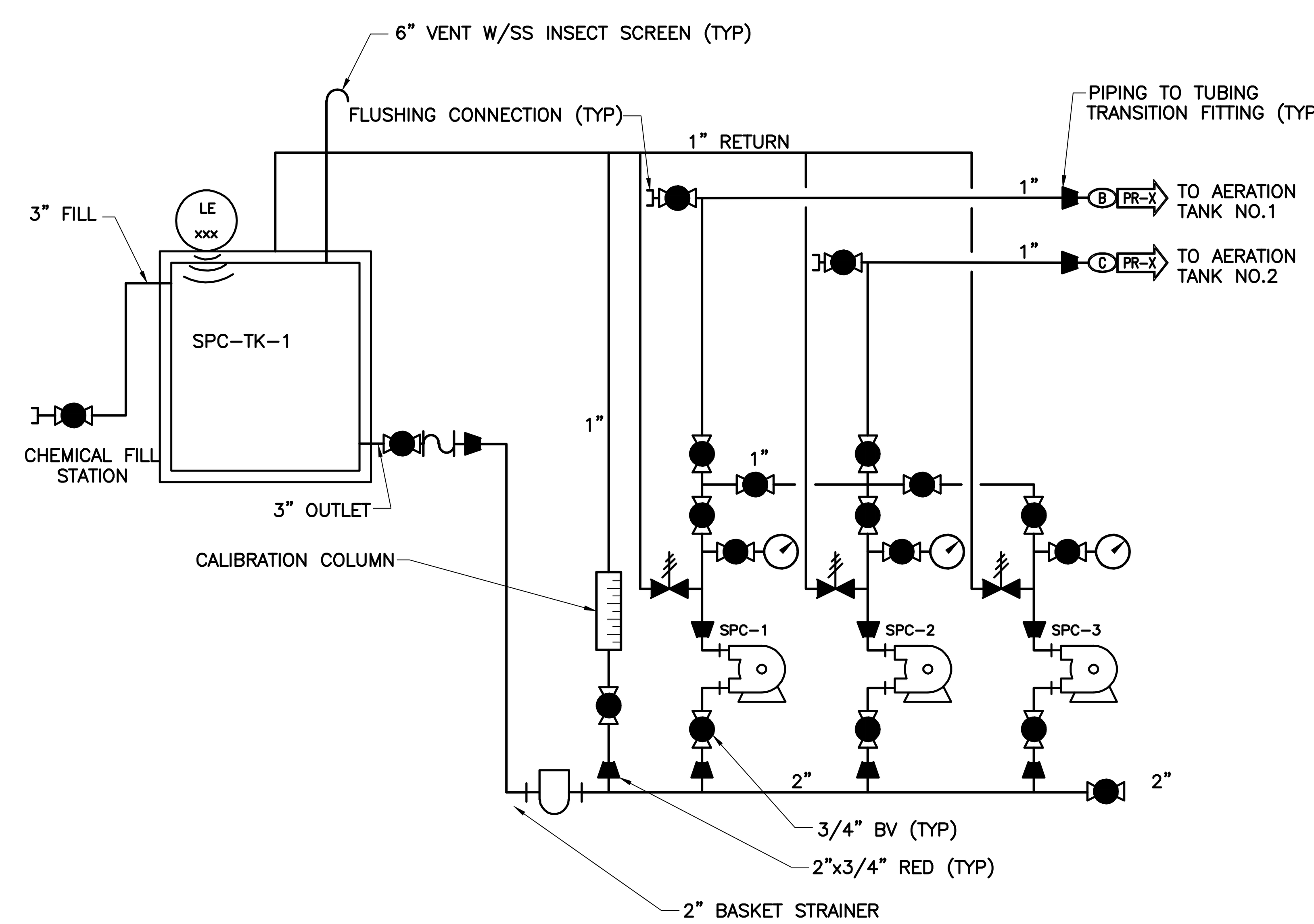
PERMANGANATE SYSTEM SCHEMATIC (FUTURE)

NTS



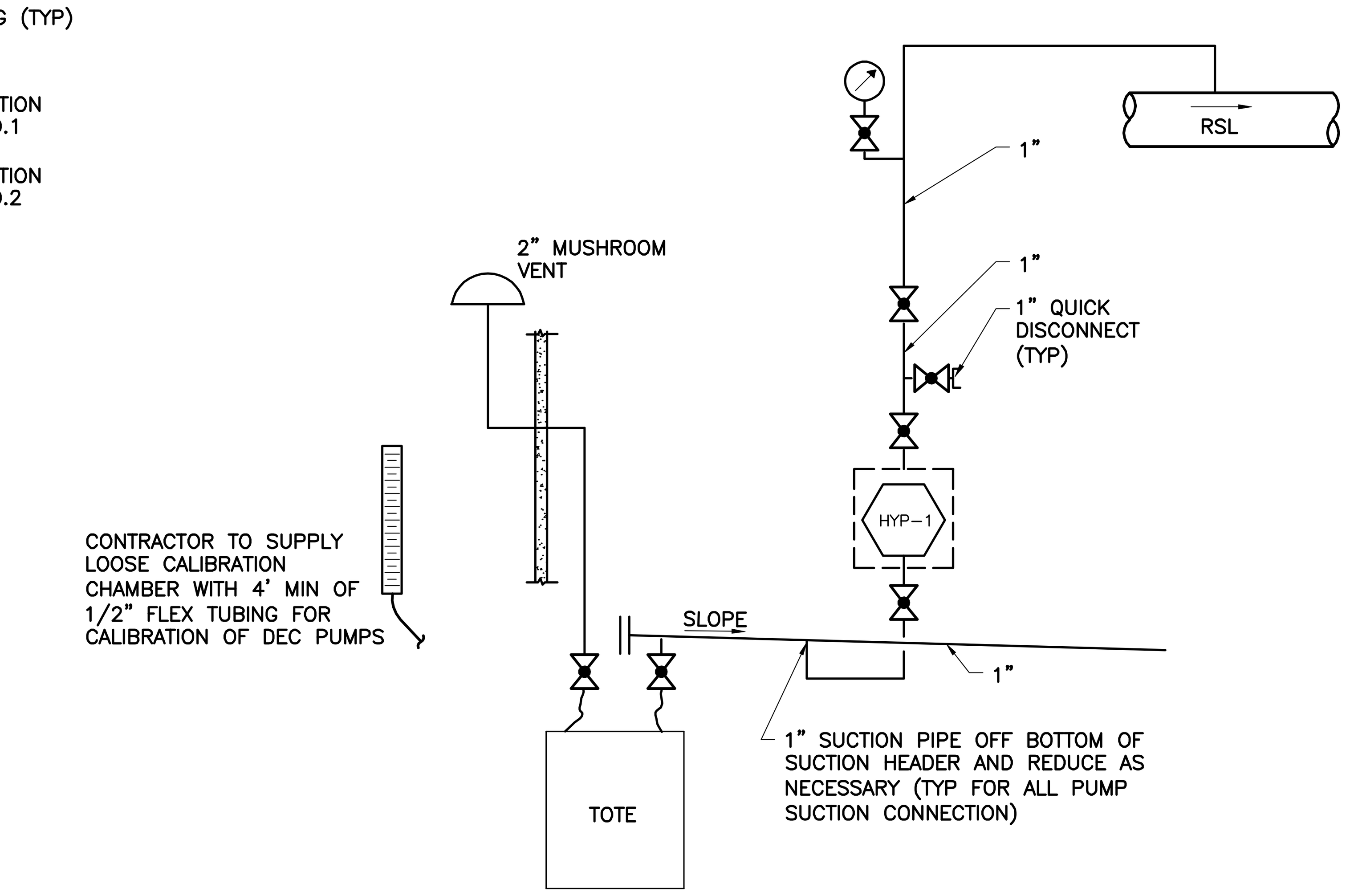
SUPPLEMENTAL ALKALINITY SCHEMATIC

NTS



SUPPLEMENTAL CARBON SCHEMATIC

NTS



HYPOCHLORITE SYSTEM SCHEMATIC

NTS

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

PROCESS FLOW SCHEMATICS
CHEMICAL FEED SYSTEMS

DRAWING
PR-12

LAST SAVED BY: ADAM.COUTURE 7/31/2015 4:33 PM

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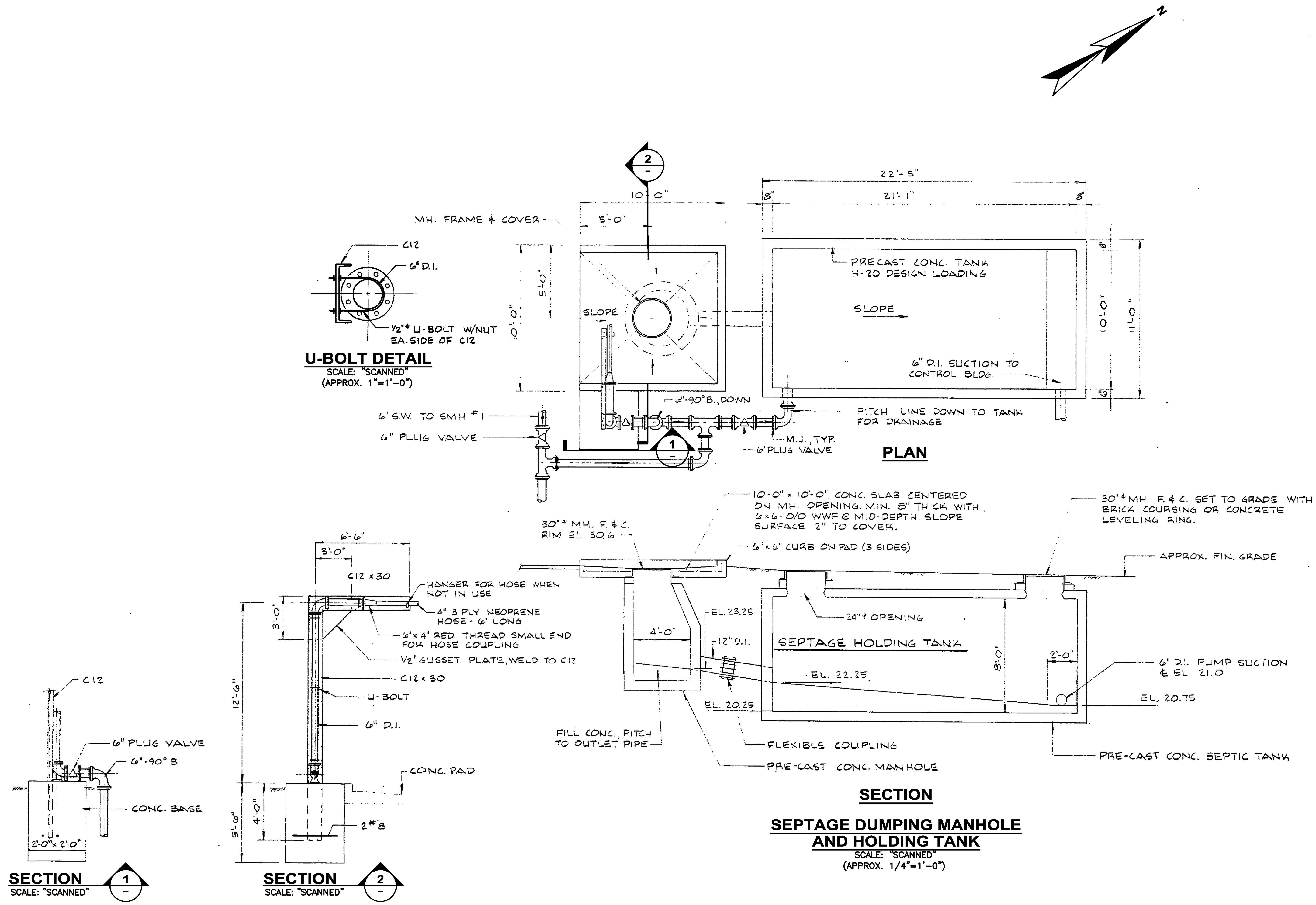

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.
2. CONTRACTOR TO NOTE A SCANNED IMAGE HAS BEEN USED. REFER TO PROCESS GENERAL NOTES ON DRAWING PR-1.

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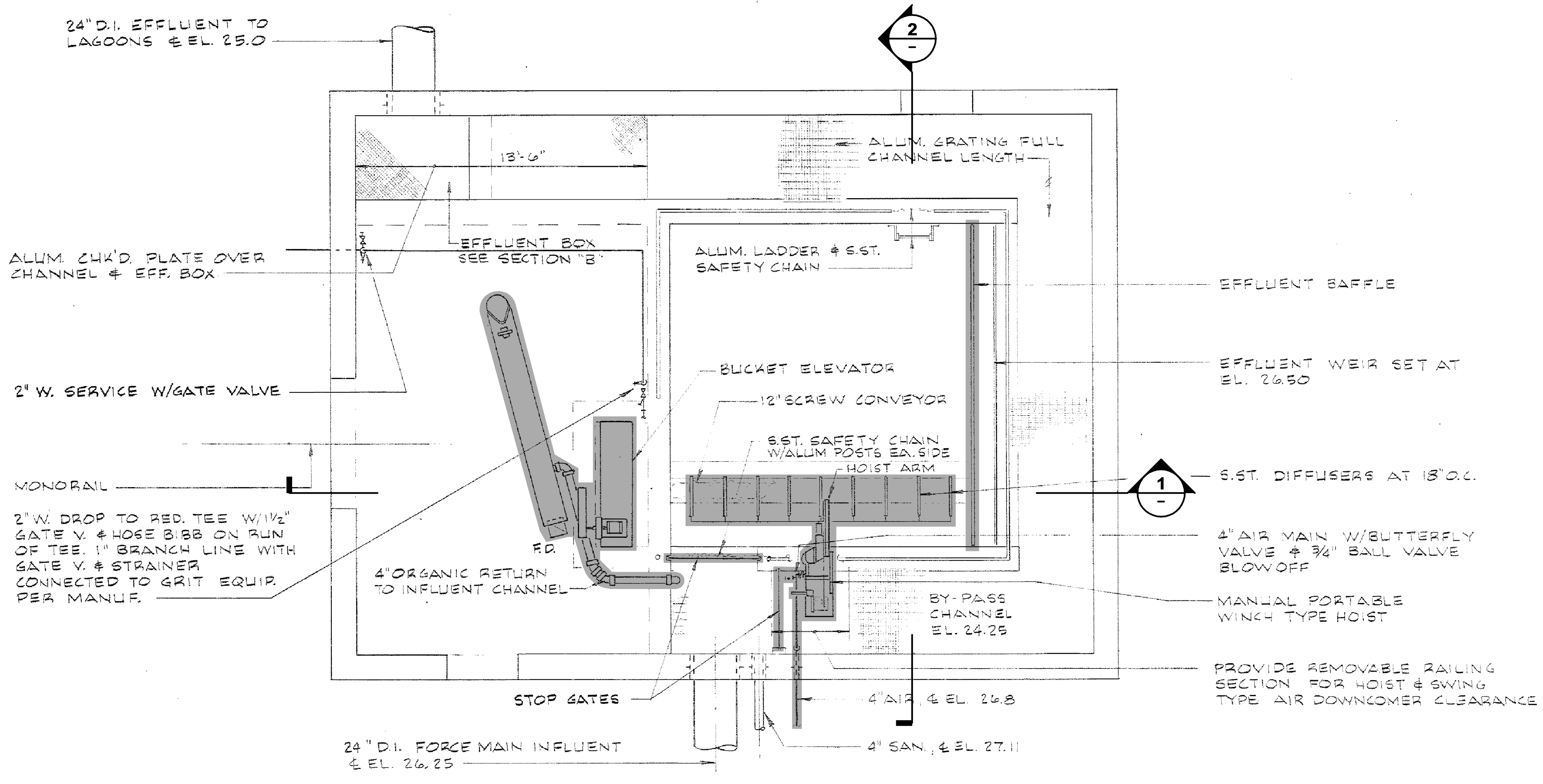
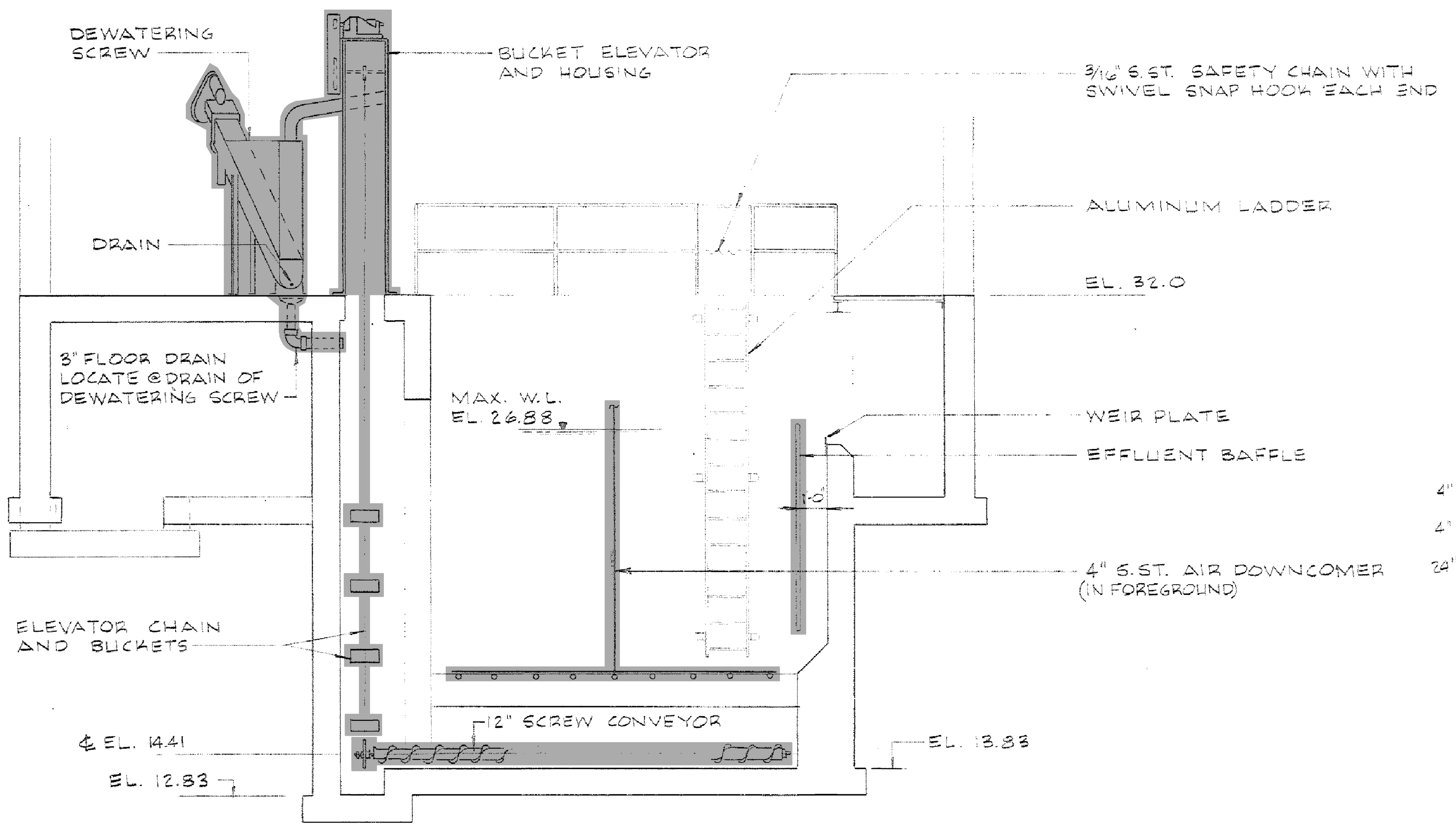
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT FACILITY UPGRADES

SEPTAGE RECEIVING TANK DEMOLITION AND MODIFICATION PLANS AND SECTIONS

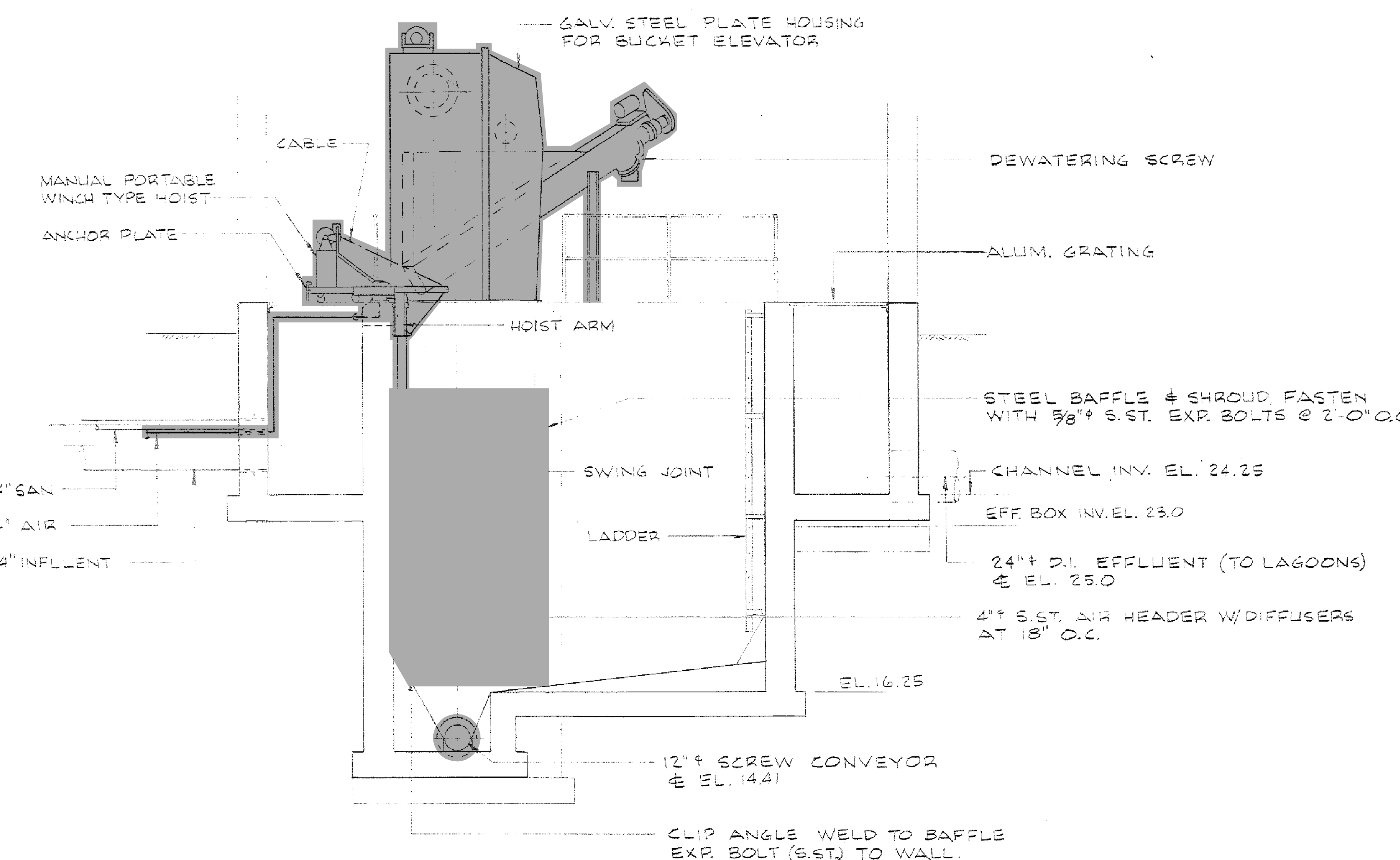
DRAWING
PR-13



PLAN
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")



SECTION 1
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")



SECTION 2
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.
2. CONTRACTOR TO NOTE A SCANNED IMAGE HAS BEEN USED. REFER TO PROCESS GENERAL NOTES ON DRAWING PR-1.

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY:
CAD COORD: APC
CAD:
CHECKED BY:
DATE:
APPROVED BY:
DATE:
PROJECT NO. 12883

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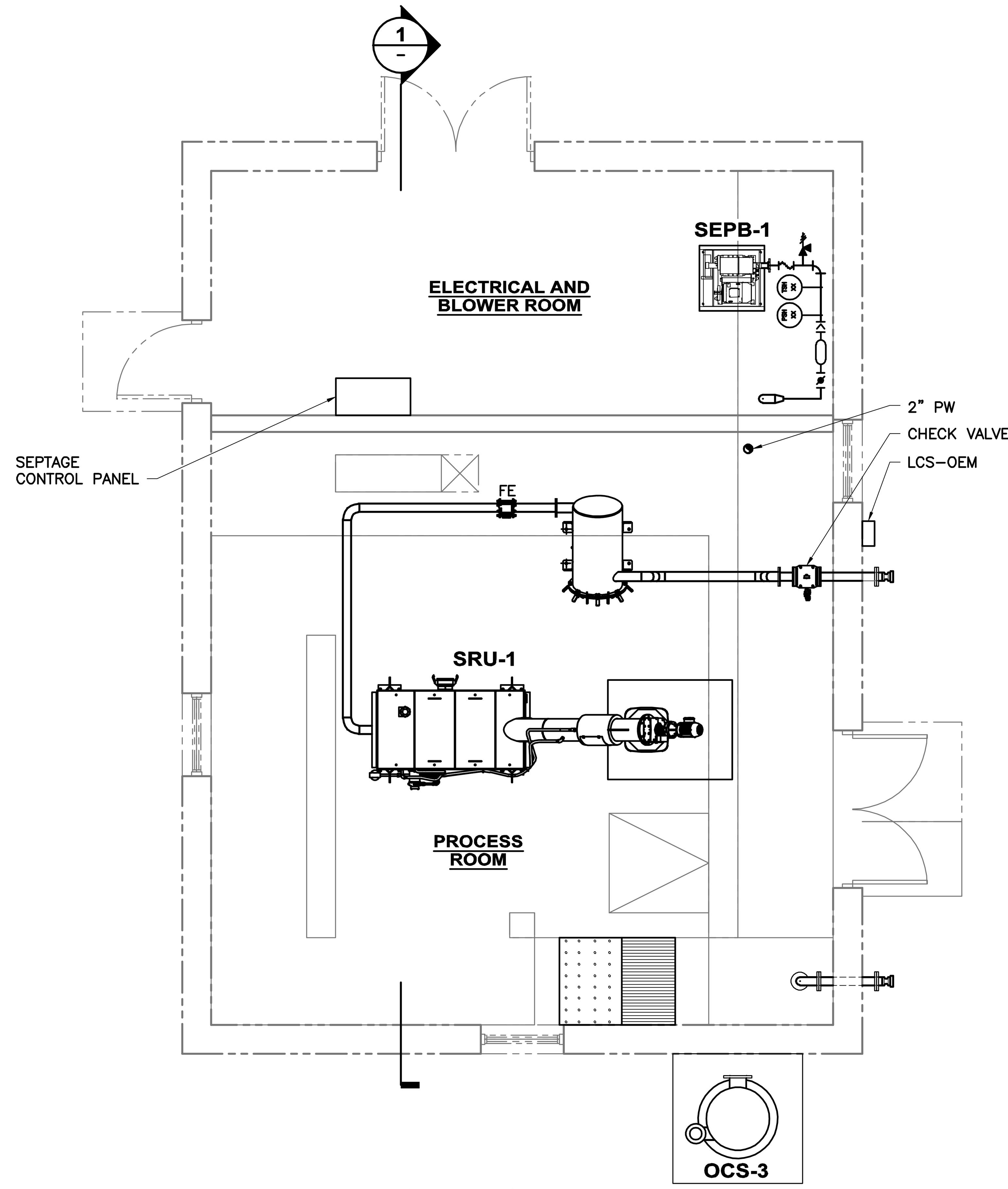
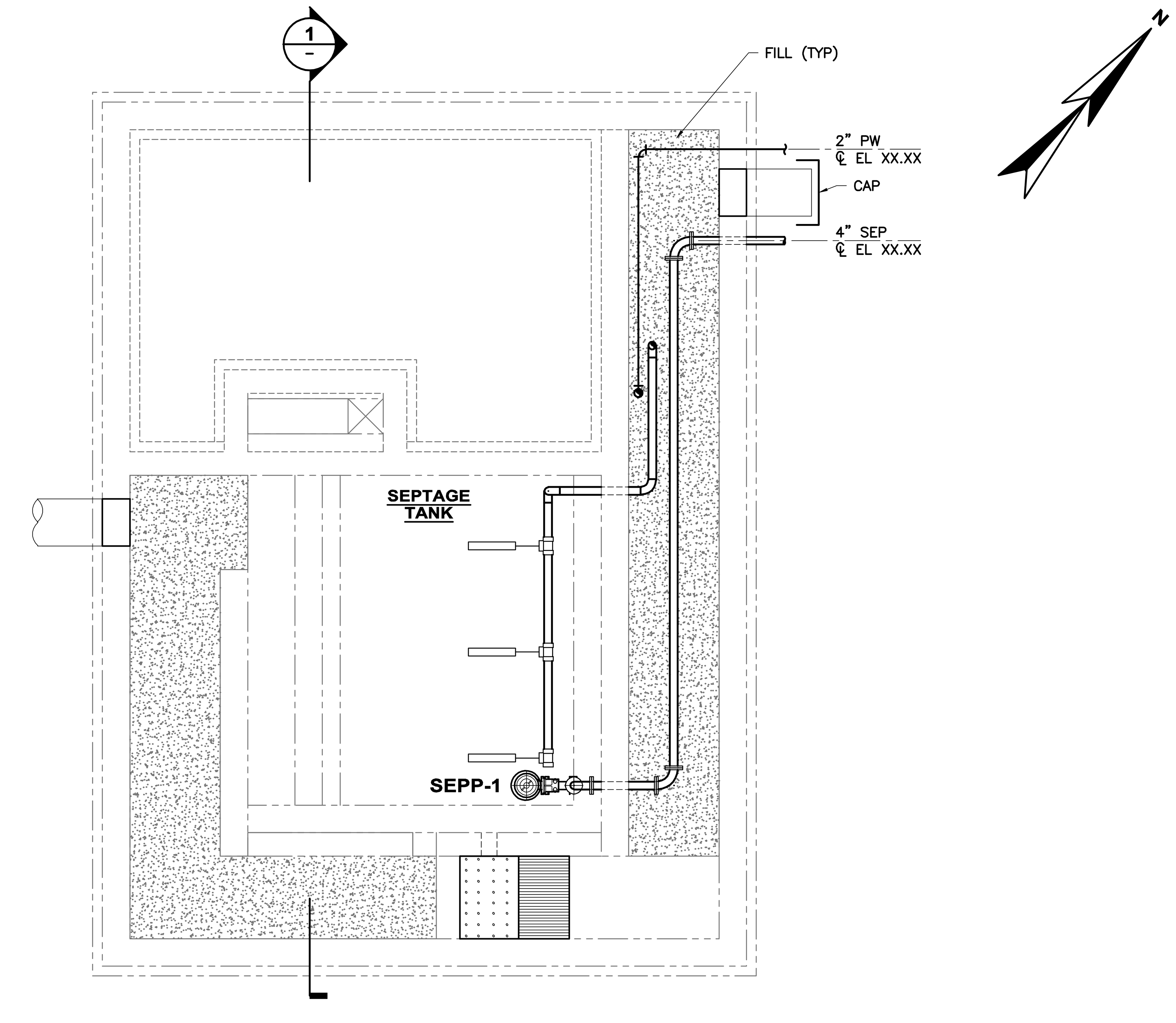
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT FACILITY UPGRADES

GRIT BUILDING
DEMOLITION PLAN AND SECTIONS

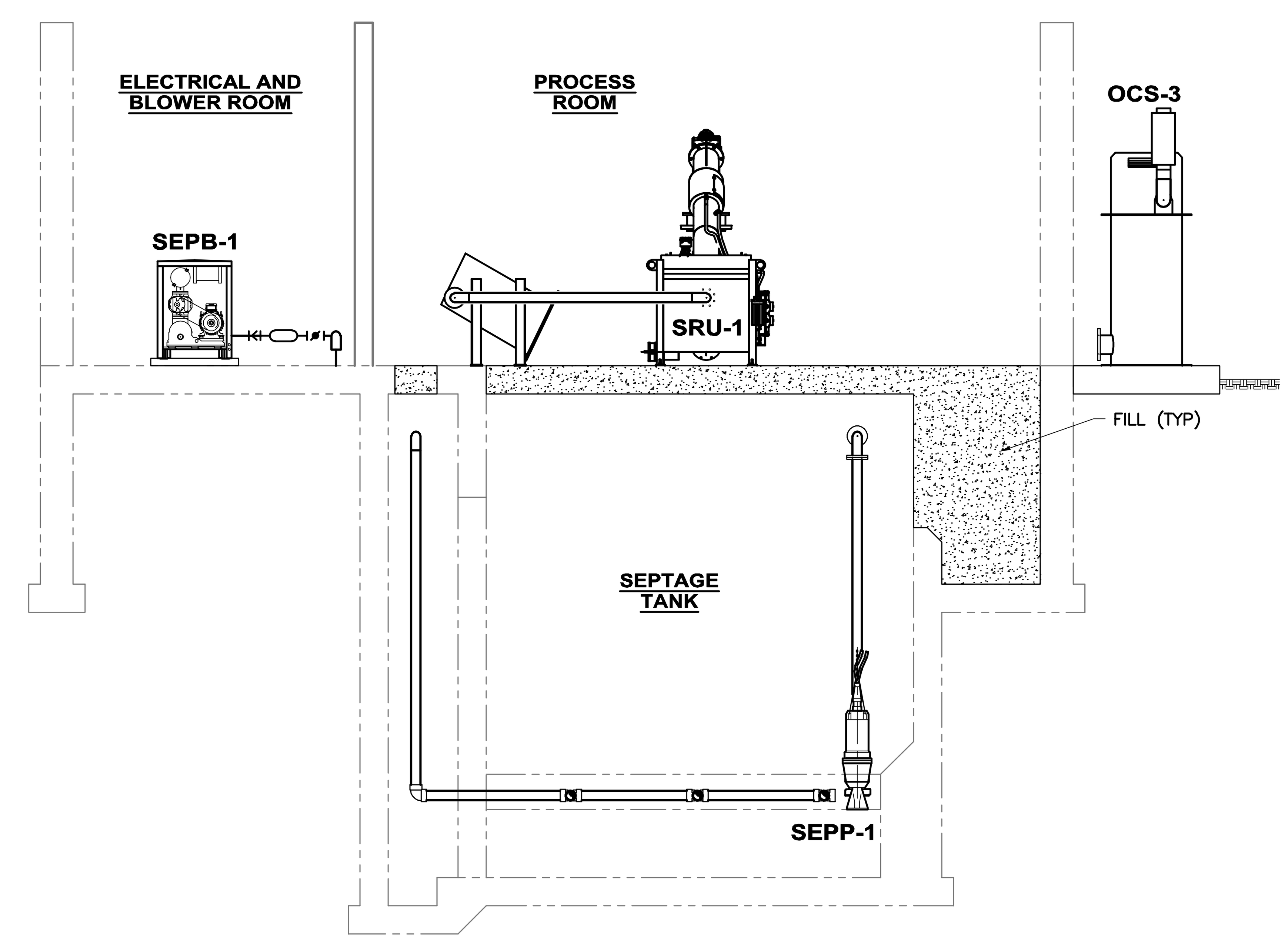
DRAWING
PR-14



FIRST FLOOR PLAN
SCALE: 1/4"=1'-0"



LOWER FLOOR PLAN
SCALE: 1/4"=1'-0"



SECTION
SCALE: 1/4"=1'-0"

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

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PROJECT NO: 12883

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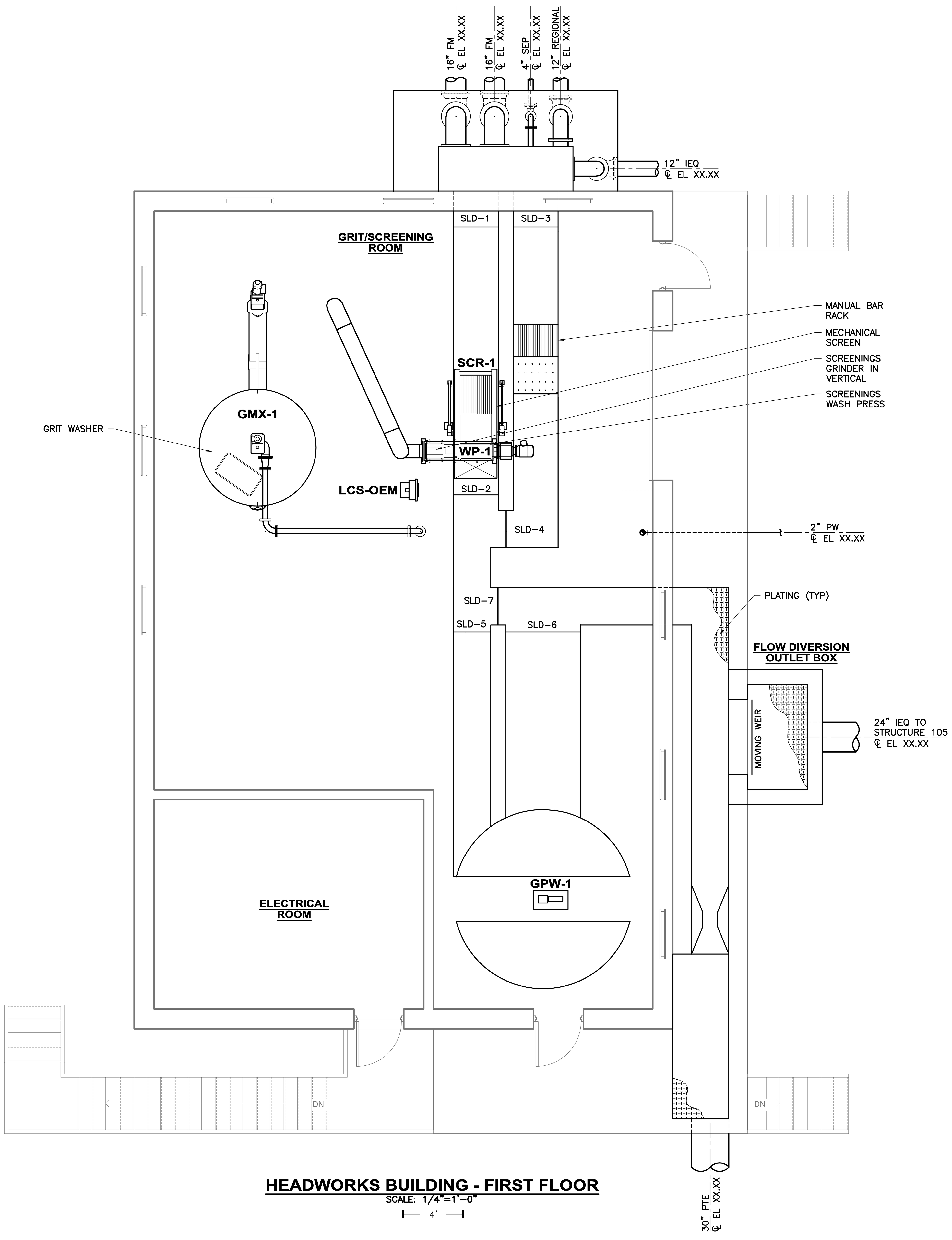
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

SEPTAGE BUILDING
MODIFICATION PLAN AND SECTIONS

DRAWING
PR-15

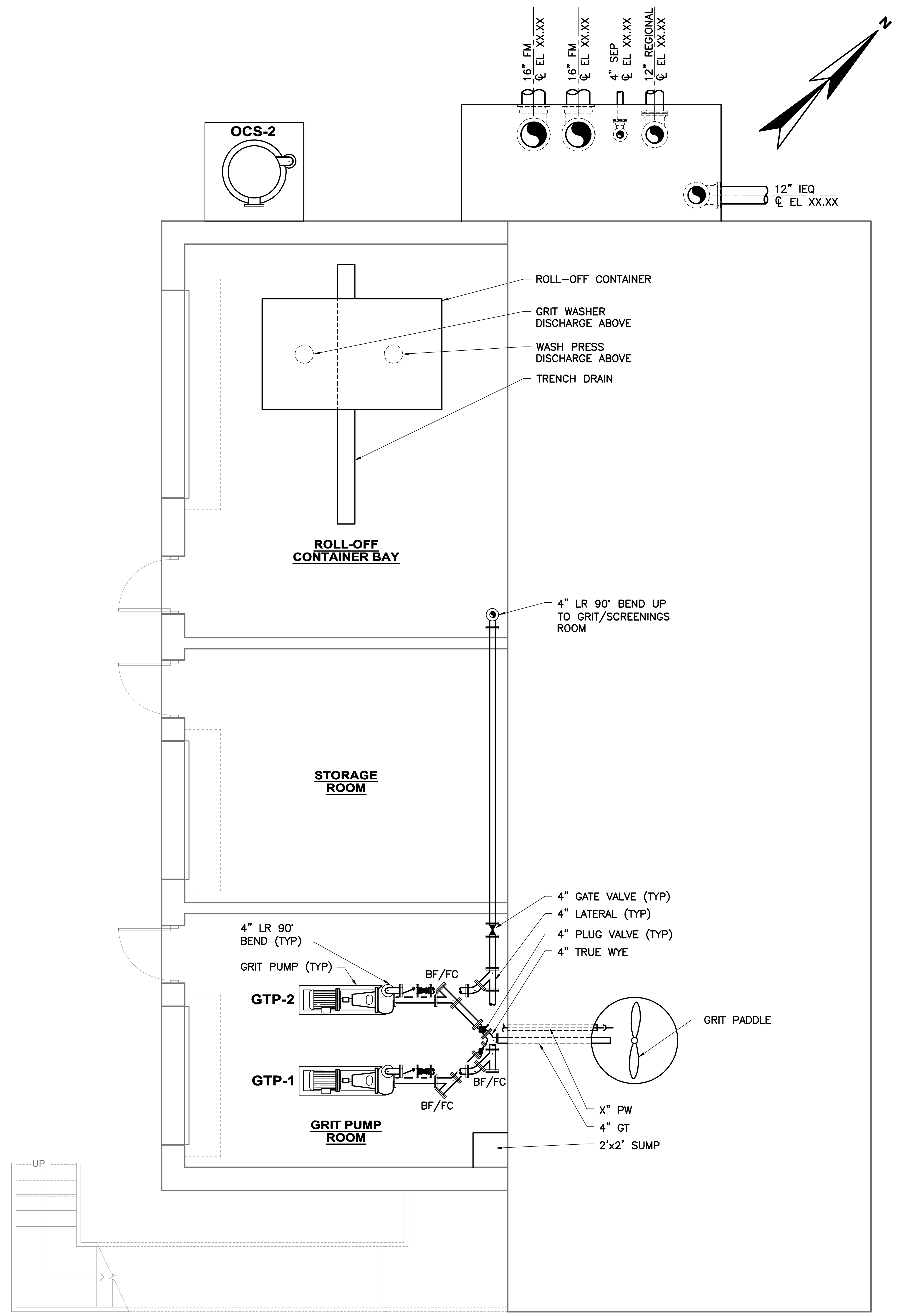
LAST SAVED BY: ADAM.COUTURE 9/22/2015 3:50 PM



HEADWORKS BUILDING - FIRST FLOOR

SCALE: 1/4"=1'-0"

4'



HEADWORKS BUILDING - LOWER FLOOR PLAN

SCALE: 1/4"=1'-0"

4'

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

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CAD COORD: APC
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DATE:
APPROVED BY:
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PROJECT NO: 12883

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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

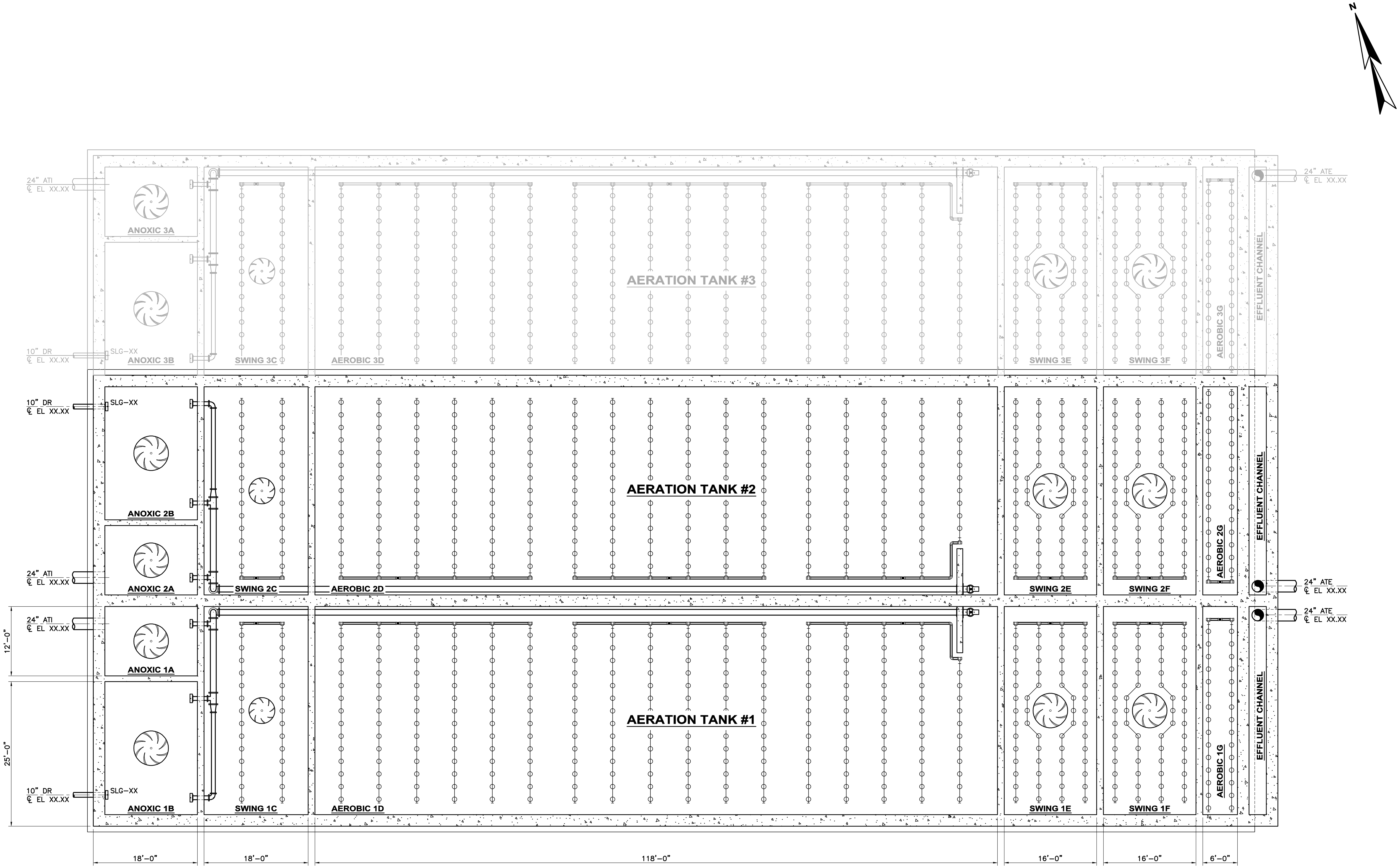
HEADWORKS UPPER AND LOWER LEVEL PLANS

DRAWING
PR-16

G:\DWGS\NH\EXETER\12883-WWTF-UPGRADE\12883-PDR\PRO\12883-PRS-HEADWORKS-MOD.DWG | Layout1 | 1:10.1236 | ---- | 9/24/2015 1:54:47 PM | ADAM.COUTURE

LAST SAVED BY: ADAM.COUTURE 9/23/2015 6:45 AM

G:\DWGS\NH\EXETER\12883-WWTF-UPGRADE\12883-PDR\PRO\12883-PRS-AERATIONTANK-MOD.DWG | Lower Lvl | 1:10.1236 | ---- | 9/24/2015 1:55:00 PM | ADAM.COUTURE



LOWER PLAN

SCALE: 1/8"=1'-0"

8'

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY: APC
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DATE:
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PROJECT NO: 12883

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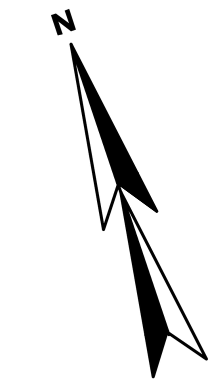
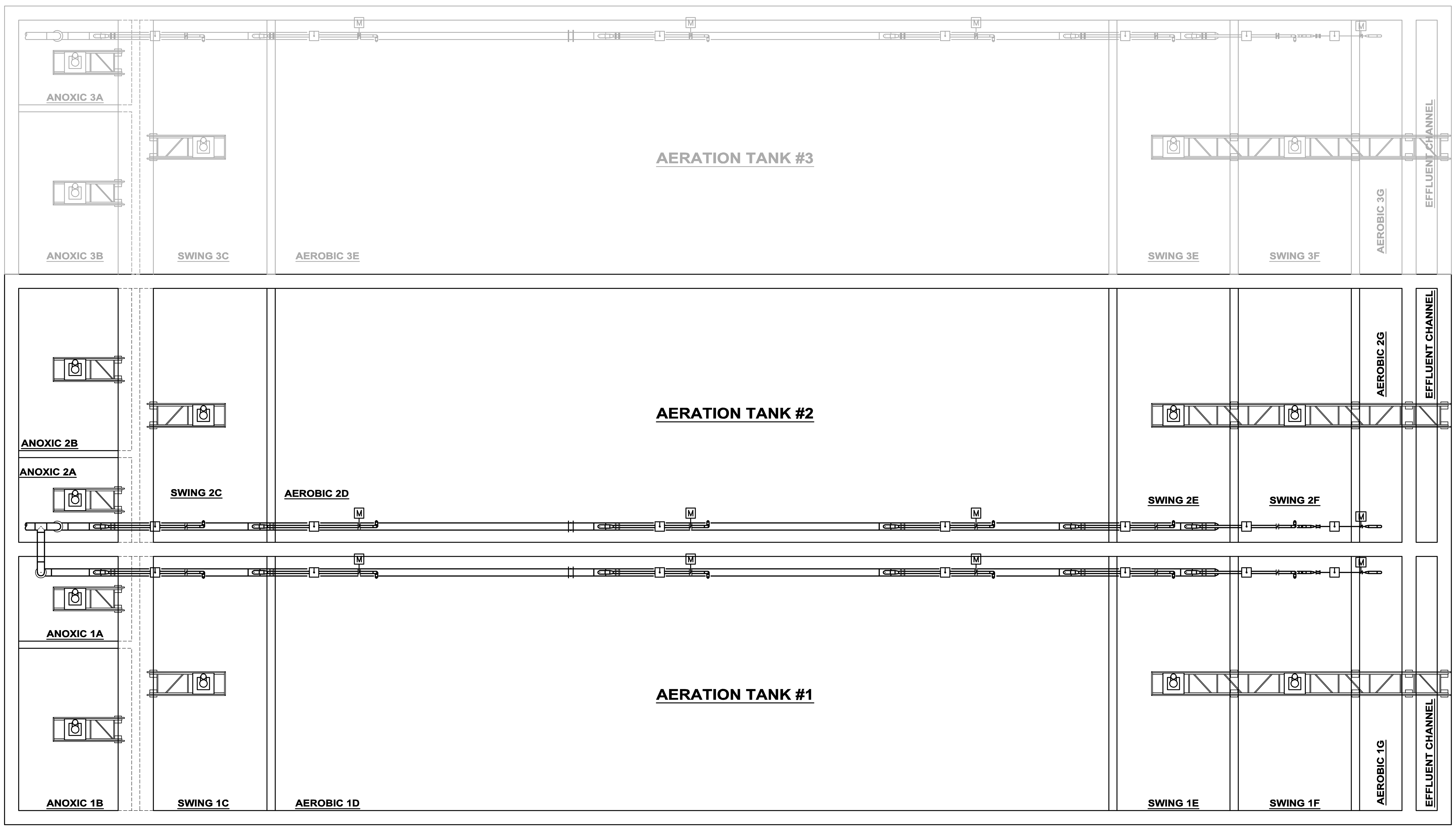
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

AERATION TANKS
LOWER LEVEL PLAN

DRAWING

PR-18





MISSING:
- **SECTIONS**

UPPER PLAN
SCALE: 1/8"=1'-0"
8'

NOTES:
1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

LAST SAVED BY: ADAM.COUTURE 9/23/2015 6:45 AM

G:\DWGS\NH\EXETER\12883-WWTF-UPGRADE\12883-PDR\PRO\12883-PRS-AERATIONTANK-MOD.DWG | Upper Lvl | 1:10.1236 | ----- | 9/24/2015 1:55:08 PM | ADAM.COUTURE

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

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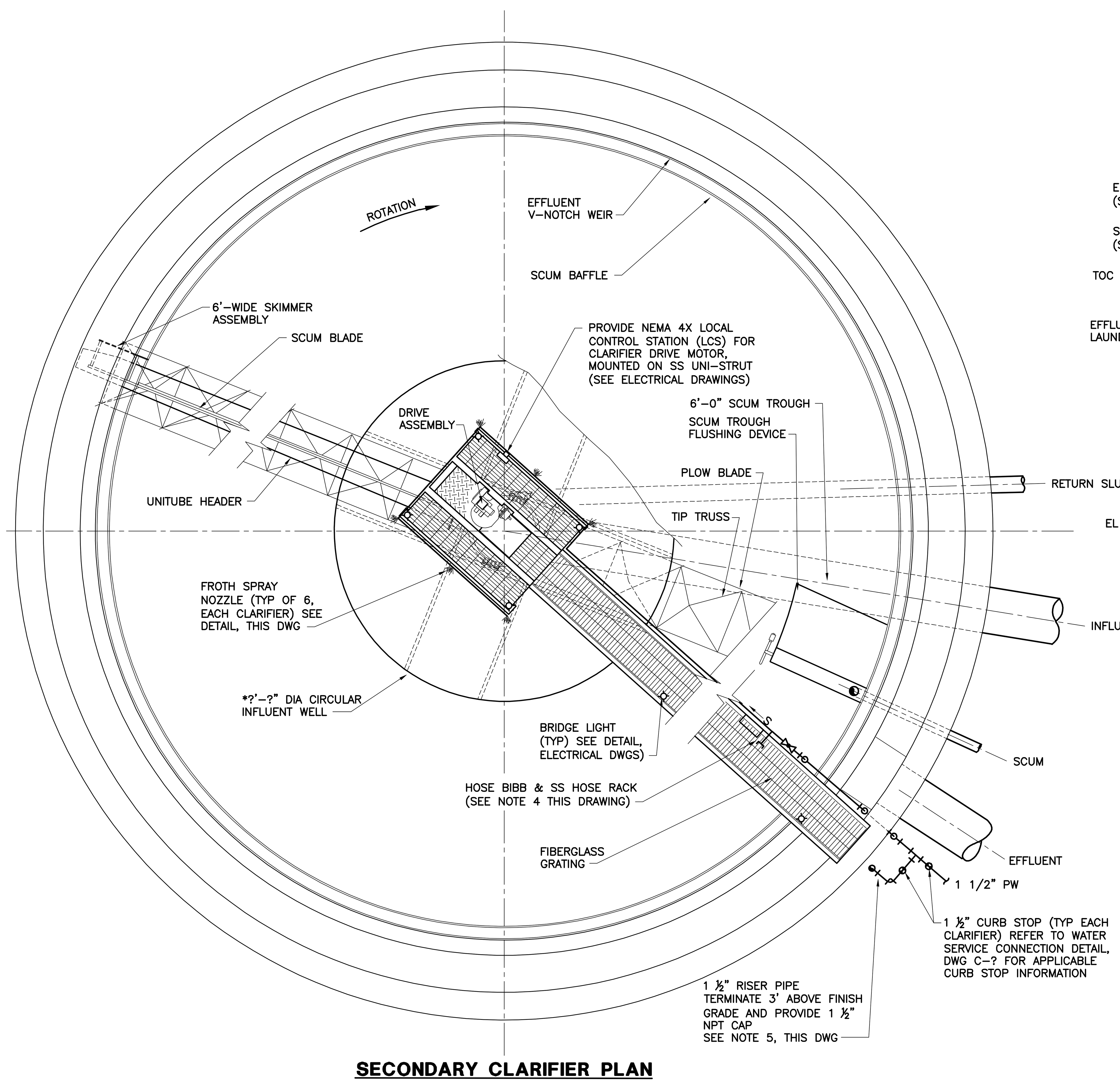
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

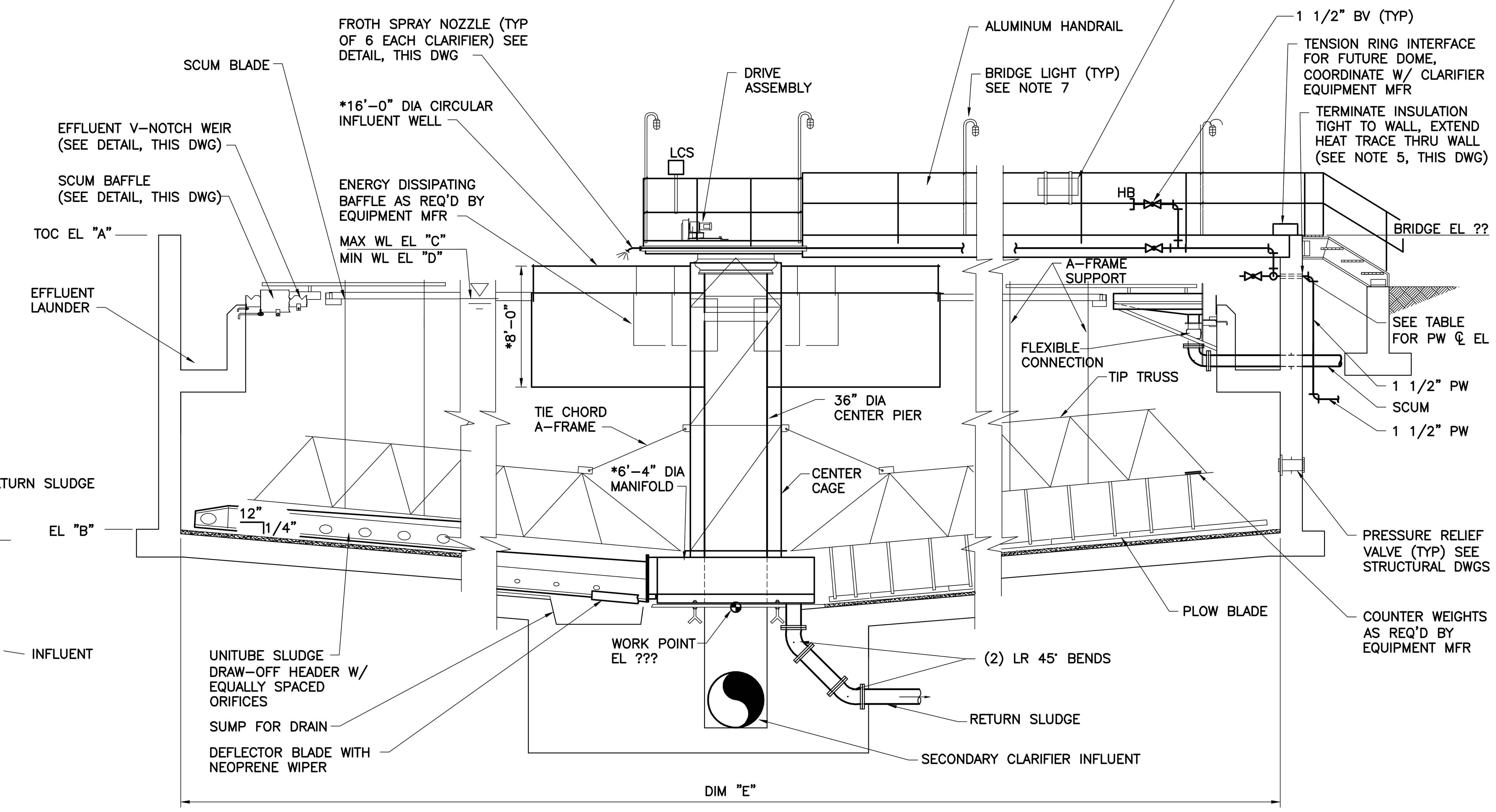
AERATION TANKS
UPPER LEVEL PLAN

DRAWING
PR-19

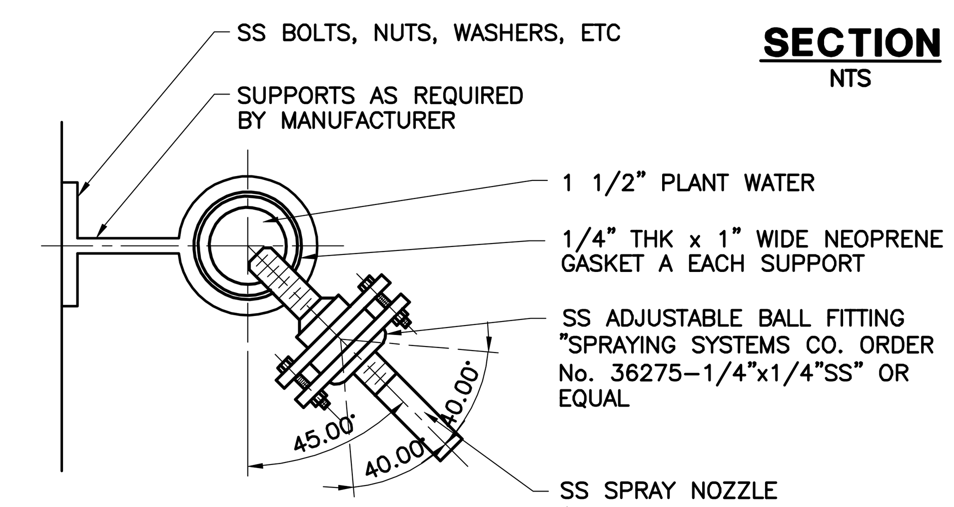


SECONDARY CLARIFIER PLAN
SCALE: NTS

PIPING NOT ADJUSTED FOR CORRECT ORIENTATION AT THIS TIME



SECTION
NTS

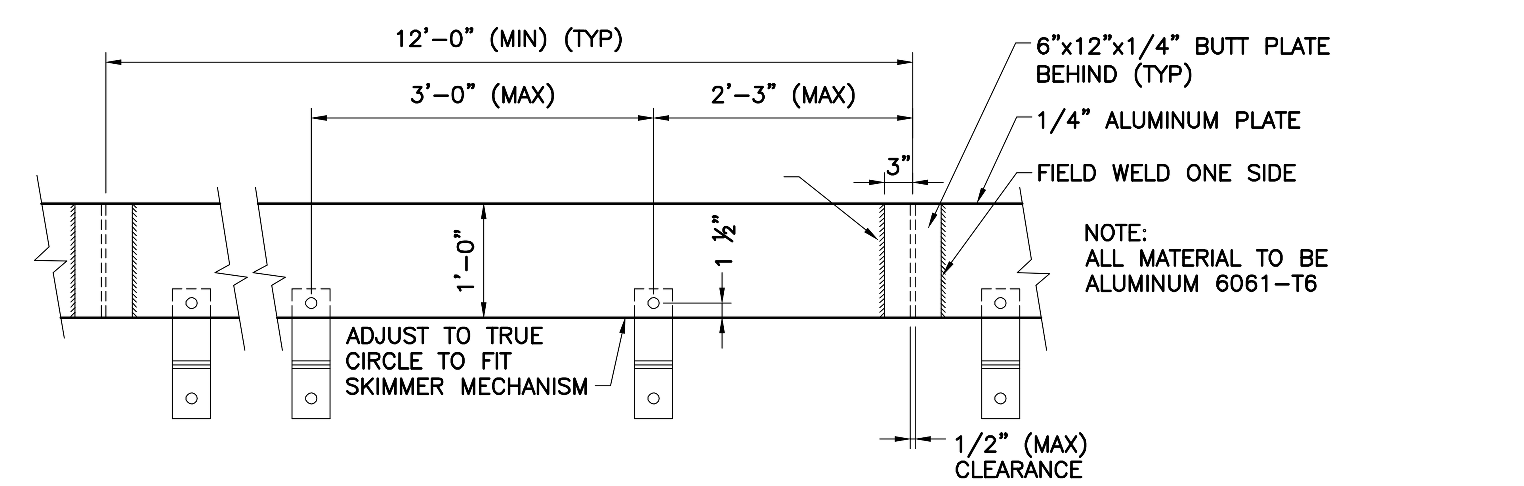


FROTH SPRAY NOZZLE
NTS

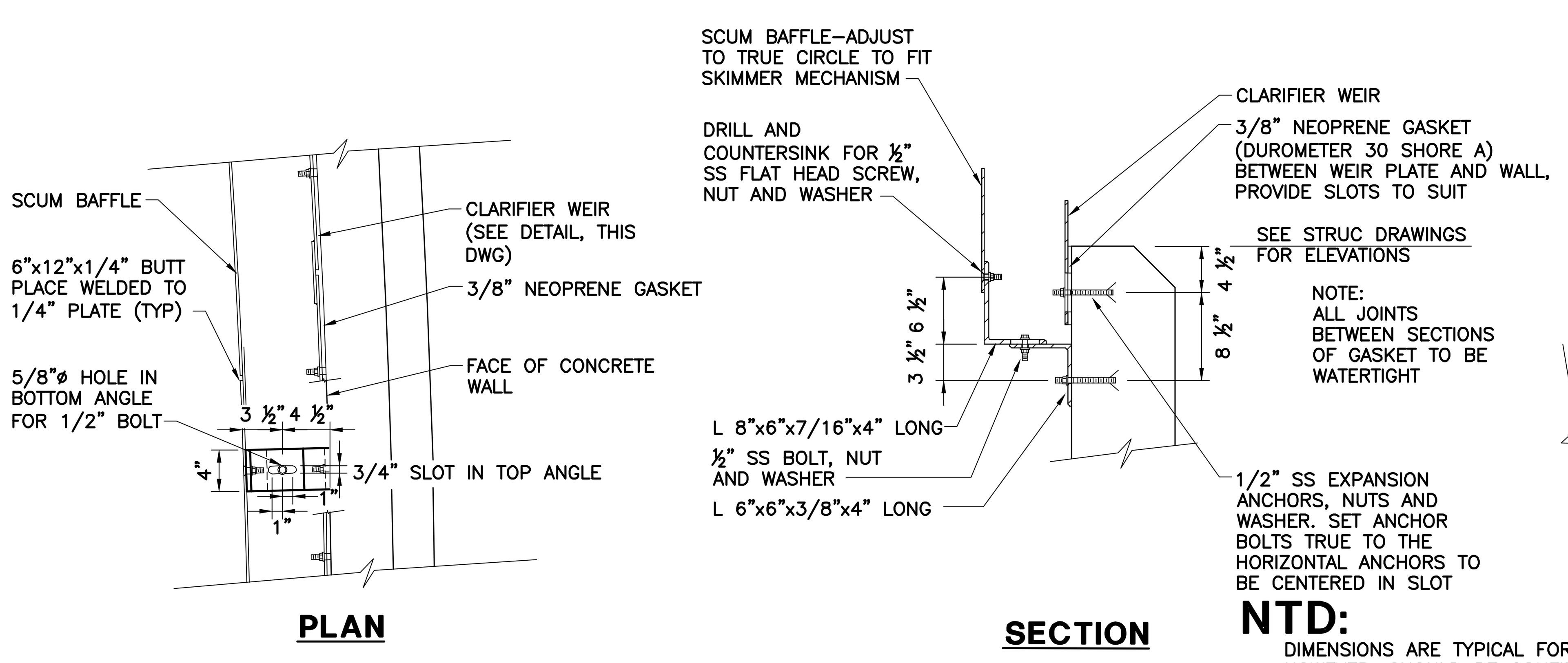
NOTES:

1. REFER TO TABLE FOR ADDITIONAL DIMENSIONS AND ELEVATIONS.
2. REFER TO STRUCTURAL DRAWINGS FOR DOME REQUIREMENTS AND ADDITIONAL INFORMATION.
3. PROVIDE WALKWAY ACCESS STAIRS AND A LAUNDER ACCESS PLATFORM WITH LADDER TO INTERFACE WITH DOME. REFER TO STRUCTURAL DRAWINGS AND SPECIFICATION SECTION 11351. COORDINATE WITH DOME MANUFACTURER.
4. CLARIFIER COMPONENTS ARE ROTATED FOR CLARITY IN SECTION. SEE STRUCTURAL DRAWINGS FOR STRUCTURE, EQUIPMENT AND PIPING ORIENTATIONS. REFER TO SITE PIPING DRAWING FOR PIPING CONTINUATIONS.
5. ALL PLANT WATER WITHIN THE CLARIFIERS SHALL BE INSULATED & HEAT TRACED PER SPECIFICATION SECTIONS 15188 AND 15402. INSULATION AND HEAT TRACE SHALL EXTEND THROUGH WALL SLEEVE & TO 6'-0" BELOW GRADE OR TO INVERT OF PIPE BENEATH TRENCH PIPE INSULATION WHEN LESS THAN 6'-0" OF COVER IS OBTAINED. ALL PLANT WATER PIPING WITHIN THE CLARIFIER SHALL BE SLOPED TO THE SPRAY NOZZLES OR DRAIN. 1½" RISER PIPE SUPPLIED TO ALLOW OWNER TO FURTHER EVACUATE OR ADD ANTI-FREEZE TO PLANT WATER LINE WHEN NOT IN SERVICE.
6. NOTE THAT CENTERLINE ELEVATIONS ARE GIVEN AT THE OUTSIDE FACE OF CLARIFIER WALL.
7. THE CLARIFIER ELECTRICAL (LIGHT AND POWER FEED), ARE PROVIDED BY THE CONTRACTOR.
8. REFER TO DRAWING PR-1 FOR ADDITIONAL NOTES.

PIPE, ELEV AND DIM	SECONDARY CLARIFIER NO.1, 2 AND 3
INFLUENT	__ ABE ℄ EL ___
SCUM	__ SC ℄ EL ___
WASTE SLUDGE	__ WS ℄ EL ___
RETURN SLUDGE	__ RS ℄ EL ___
EFFLUENT	__ SCE ℄ EL ___
PLANT WATER	1 1/2" PW ℄ EL ___
WEIR INV EL	____
EL "A"	____
EL "B"	____
EL "C"	____
EL "D"	____
DIM "E"	____

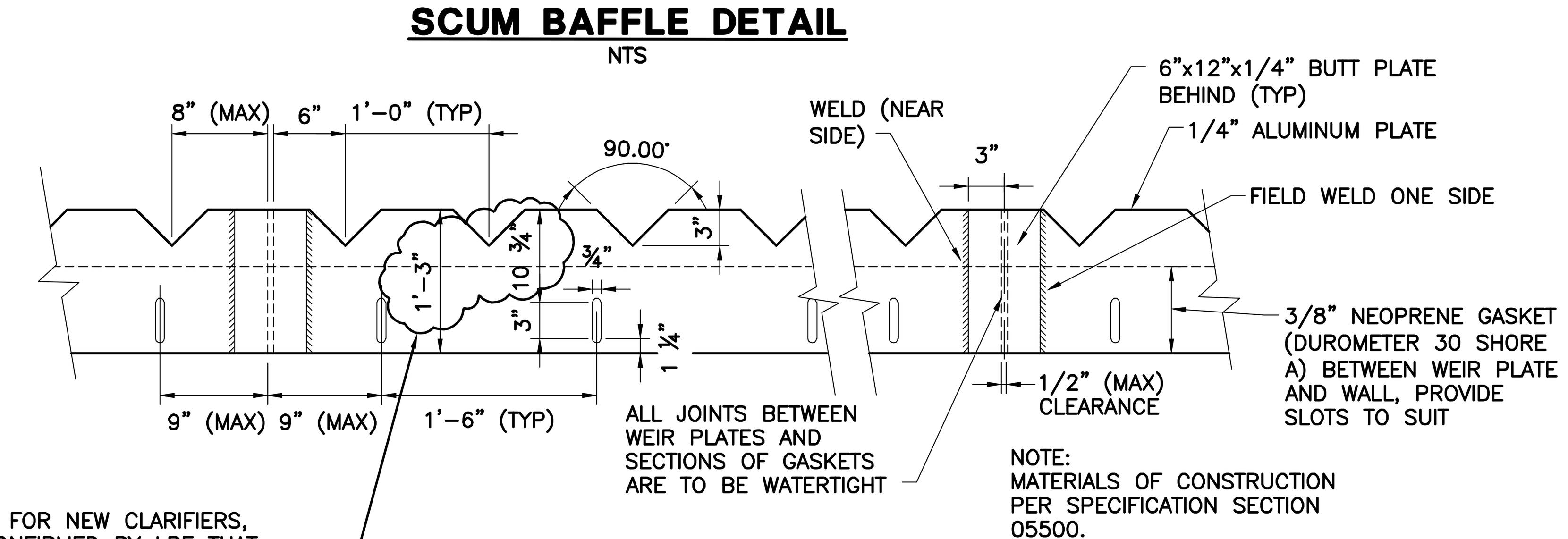


SCUM BAFFLE DETAIL
NTS



SCUM BAFFLE AND CLARIFIER WEIR DETAIL
NTS

NTD:
DIMENSIONS ARE TYPICAL FOR NEW CLARIFIERS, HOWEVER, SHOULD BE CONFIRMED BY LPE THAT THEY SUIT HYDRAULICS, ESPECIALLY ON MODS TO EXISTING CLARIFIER LAUNDERS



CLARIFIER WEIR DETAIL
NTS

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	PRELIMINARY DESIGN REPORT		

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PROJECT NO. 12883

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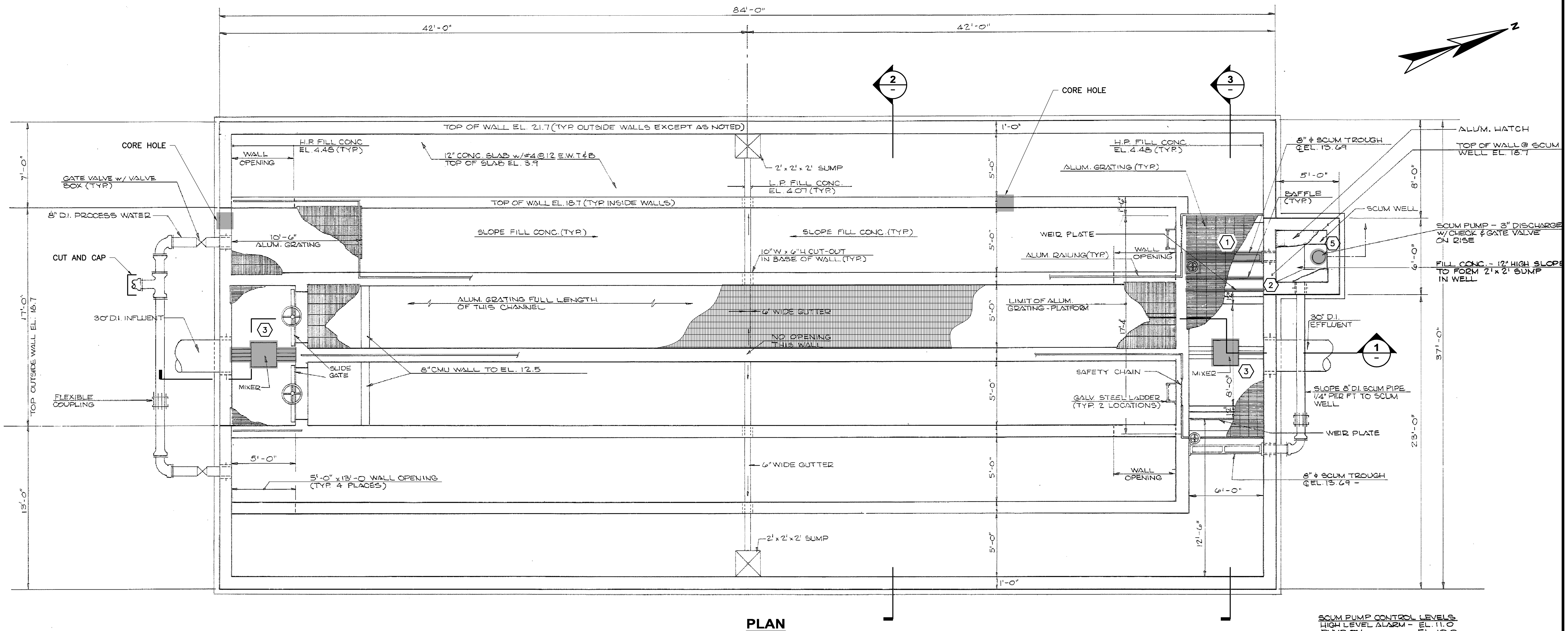
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT FACILITY UPGRADES

SECONDARY CLARIFIERS
PLAN, SECTION AND DETAILS

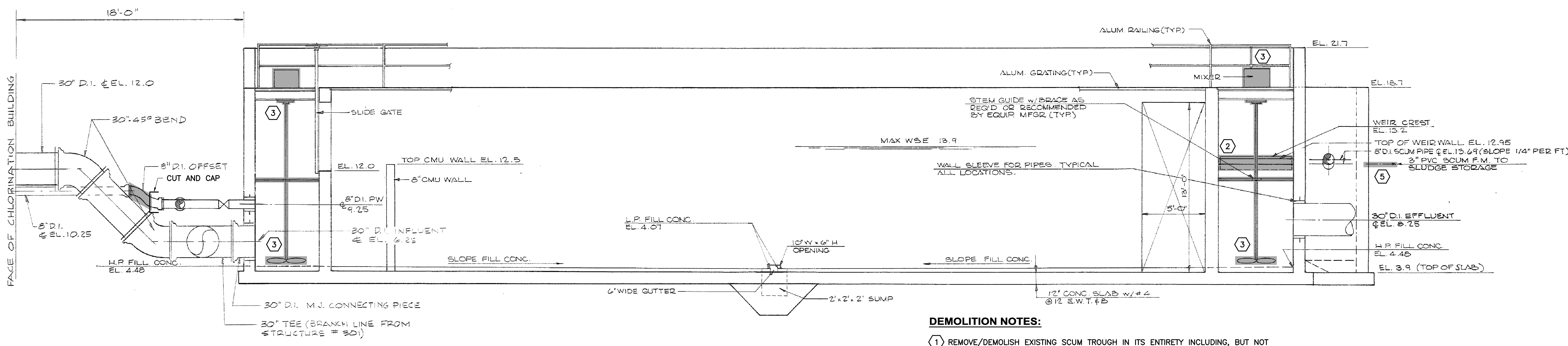
DRAWING
PR-21



PLAN
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")

SCUM PUMP CONTROL LEVELS

HIGH LEVEL ALARM -	EL. 11.0
PUMP ON	EL. 10.0
PUMP OFF	EL. 4.0



SECTION 1
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")

DEMOLITION NOTES:

1. REMOVE/DEMOLISH EXISTING SCUM TROUGH IN ITS ENTIRETY INCLUDING, BUT NOT LIMITED TO; TROUGH, BAFFLE, PIPING, ACTUATORS, HANGERS, SUPPORTS, AND ALL ASSOCIATED APPURTENANCES.
2. REMOVE/DEMOLISH EXISTING WEIR IN ITS ENTIRETY INCLUDING, BUT NOT LIMITED TO; FRP WEIR BAFFLE, BOLTS, AND ALL ASSOCIATED APPURTENANCES.
3. REMOVE/DEMOLISH EXISTING MIXER IN ITS ENTIRETY INCLUDING, BUT NOT LIMITED TO; MIXER, BEAM, STEM, STEM GUIDE, SUPPORTS, AND ALL ASSOCIATED APPURTENANCES.
4. REMOVE/DEMOLISH PORTION OF EXISTING WEIR WALL. REFER TO STRUCTURAL DRAWINGS FOR EXTENT OF DEMOLITION.
5. REMOVE/DEMOLISH EXISTING SCUM PUMP IN ITS ENTIRETY INCLUDING, BUT NOT LIMITED TO; PUMP, PIPING, VALVES, AND ALL ASSOCIATED APPURTENANCES.

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.
2. CONTRACTOR TO NOTE A SCANNED IMAGE HAS BEEN USED. REFER TO PROCESS GENERAL NOTES ON DRAWING PR-1.

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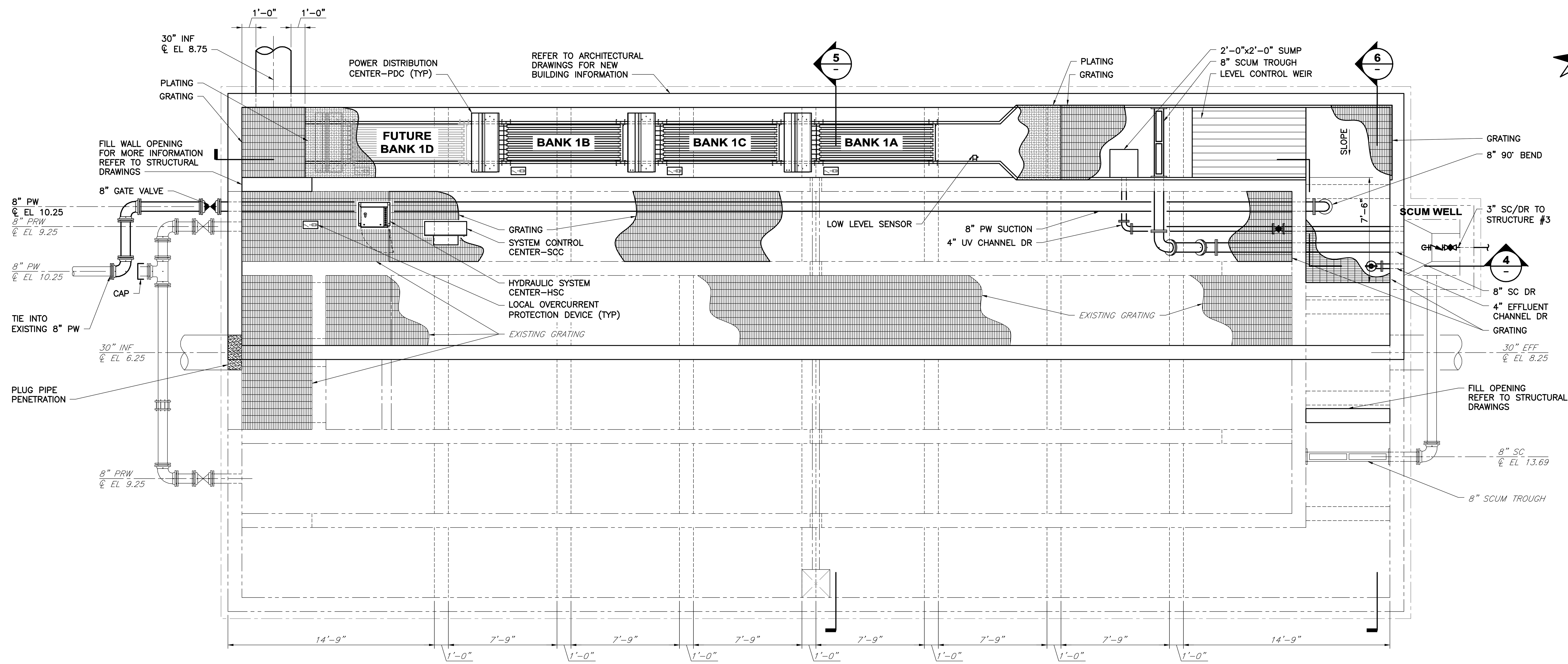
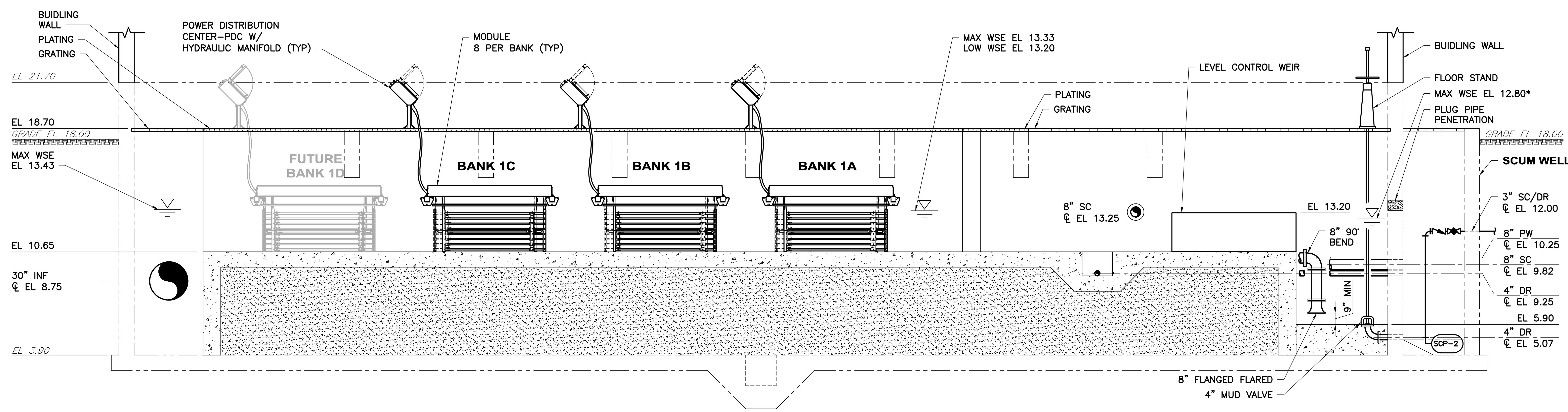
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT FACILITY UPGRADES

CHLORINE CONTACT TANK
DEMOLITION PLAN AND SECTION

DRAWING
PR-23



PLAN
SCALE: 1/4"=1'-0"
4'



SECTION 4 D-#
SCALE: 1/4"=1'-0"
4'

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

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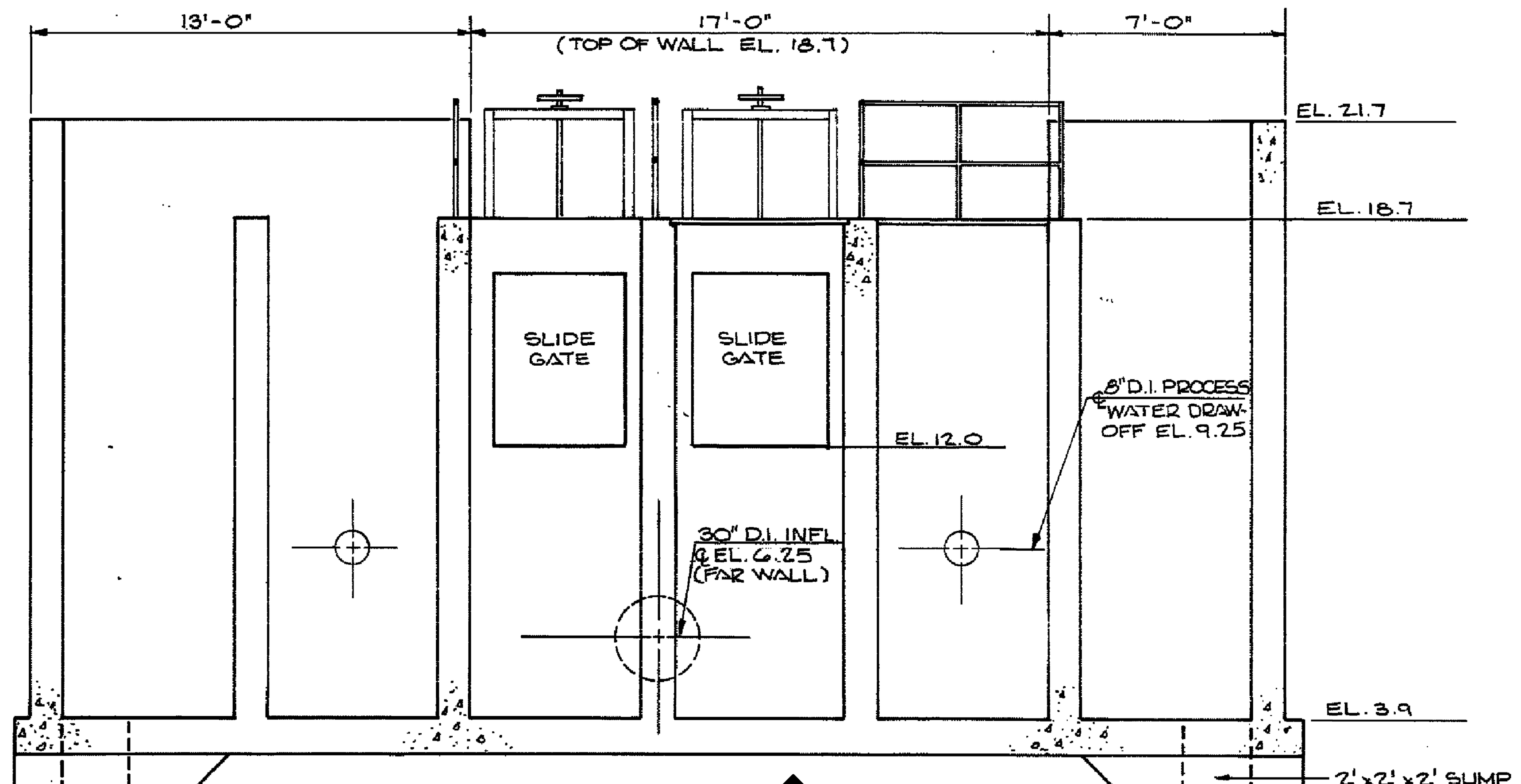
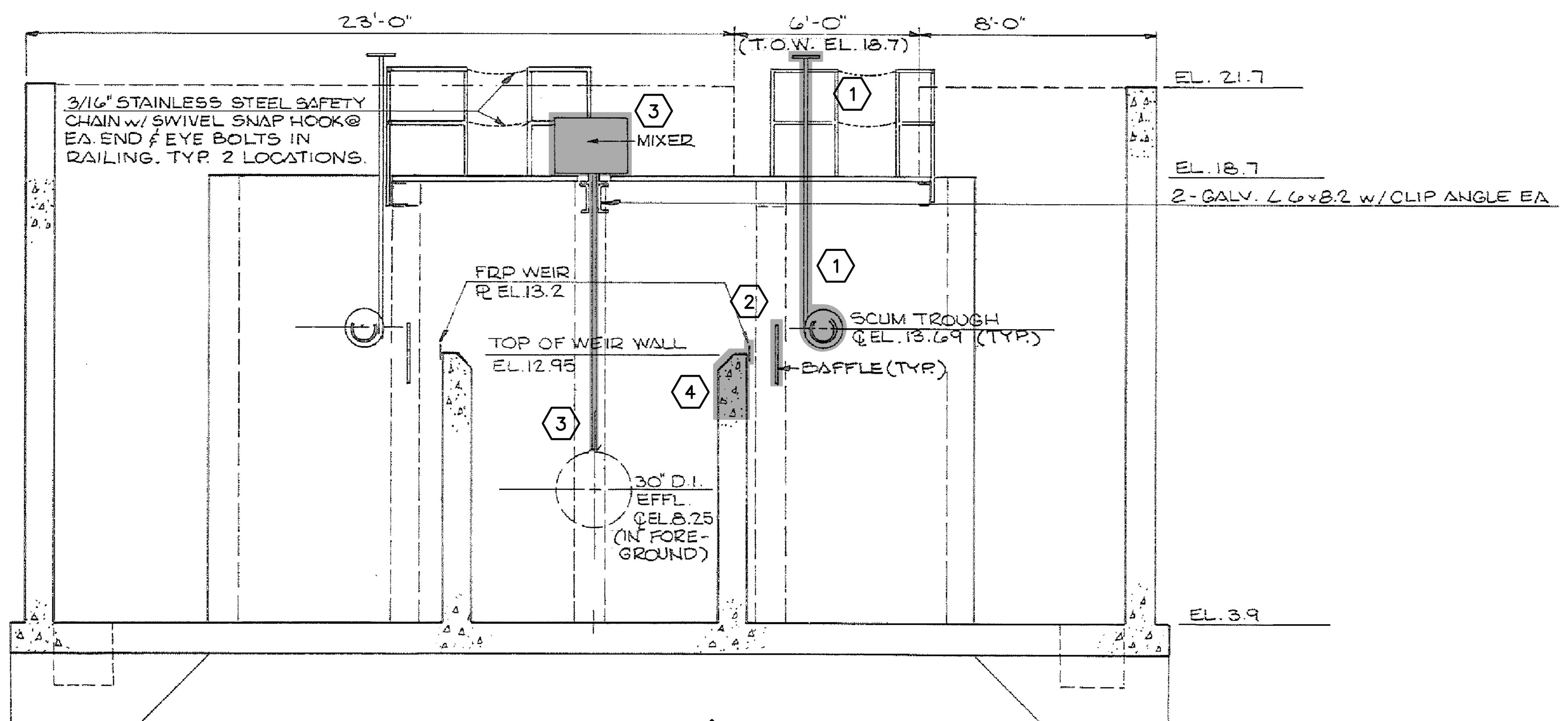
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

DISINFECTION TANK/BUILDING
MODIFICATION PLAN AND SECTION

DRAWING
PR-24



SECTION 2
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")

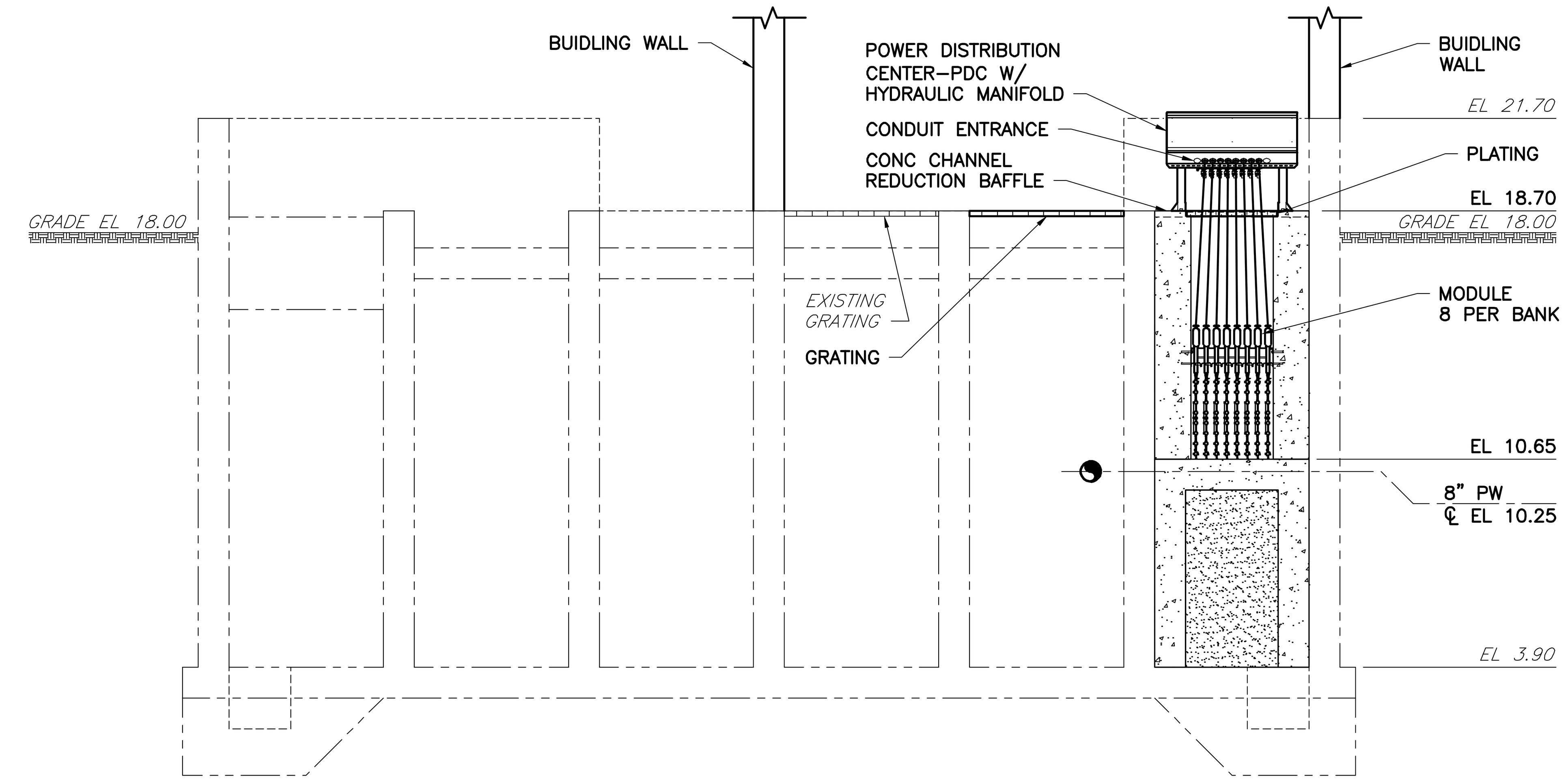


SECTION 3
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")

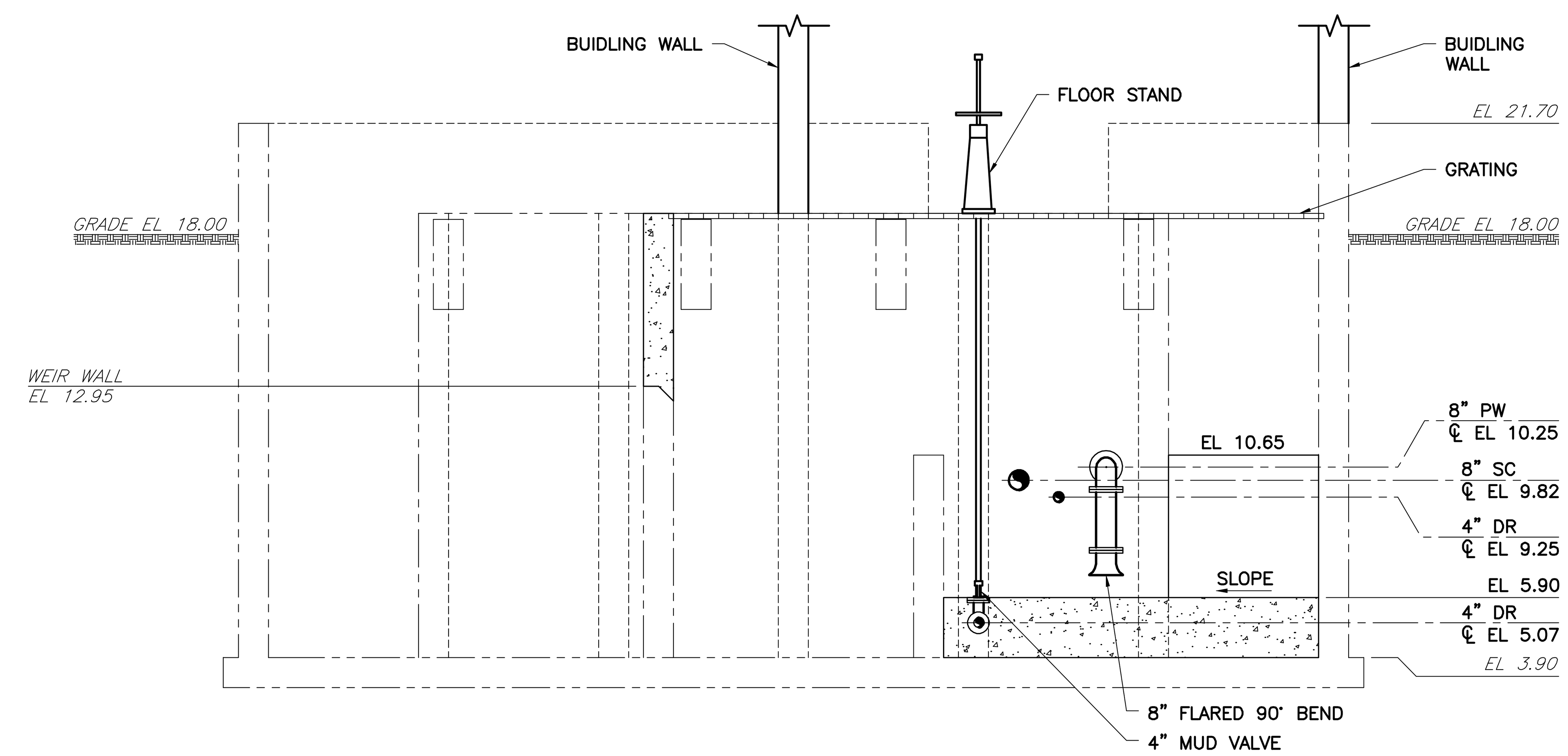
CHLORINE CONTACT TANK DEMOLITION SECTIONS

NOTES:

1. CONTRACTOR TO NOTE A SCANNED IMAGE HAS BEEN USED. REFER TO PROCESS GENERAL NOTES ON DRAWING PR-1.



SECTION 5 D-#
SCALE: 1/4"=1'-0"
4'



SECTION 6 D-#
SCALE: 1/4"=1'-0"
4'

DISINFECTION TANK/BUILDING MODIFICATION SECTIONS

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

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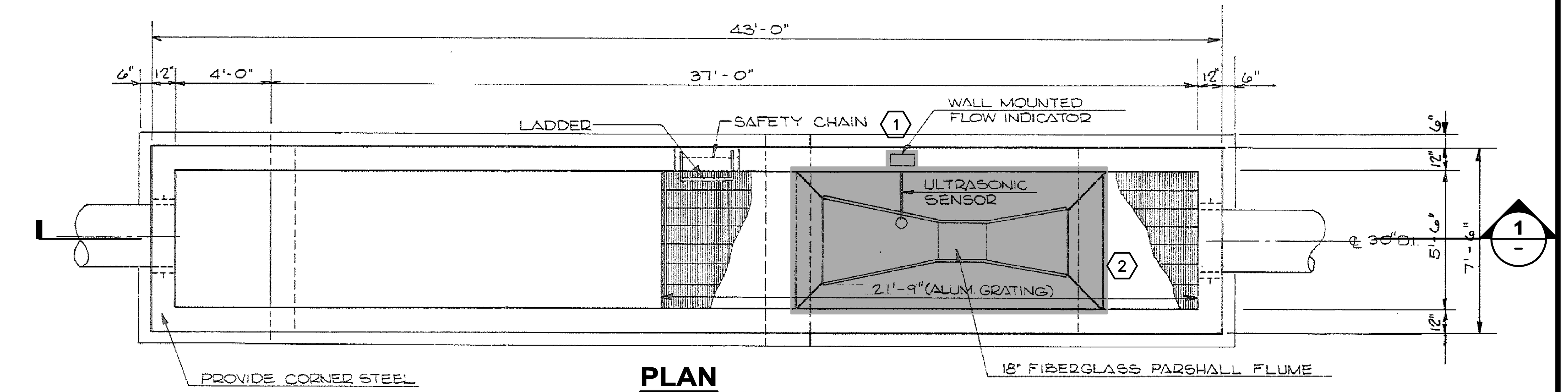
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

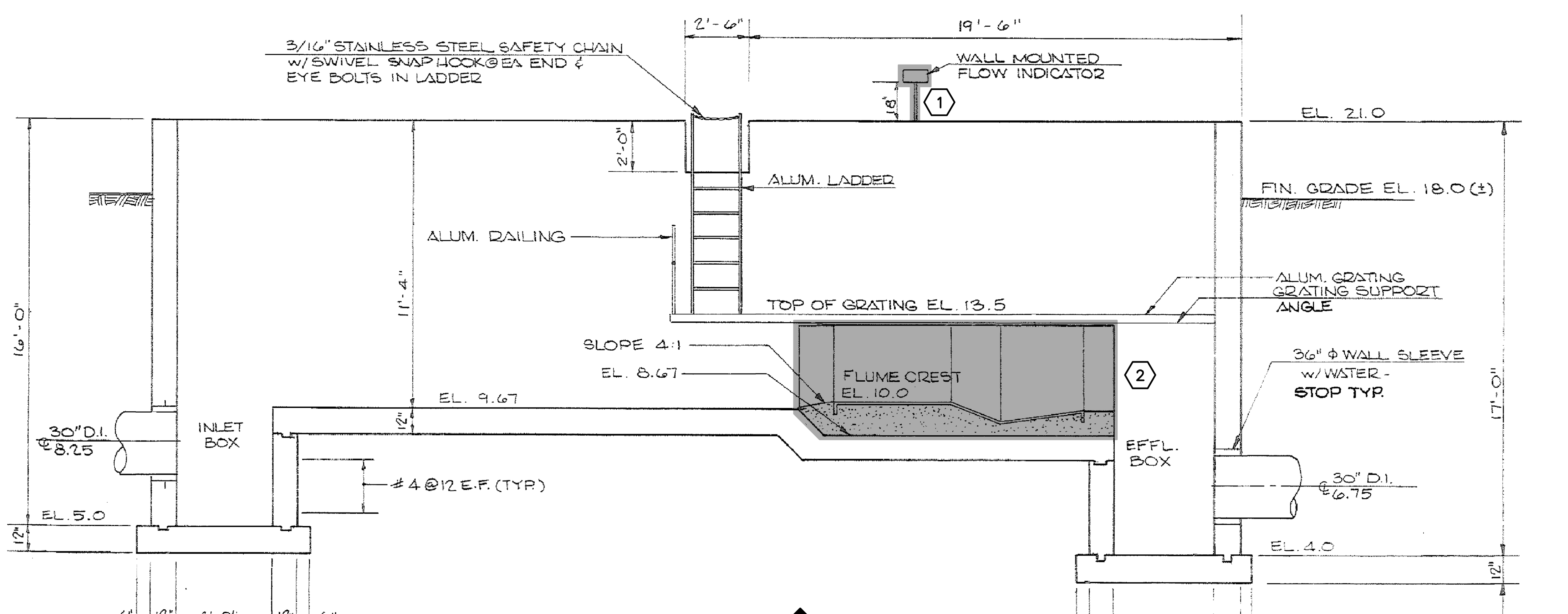
CHLORINE CONTACT TANK / DISINFECTION TANK/BUILDING
DEMOLITION AND MODIFICATION SECTIONS

DRAWING
PR-25

LAST SAVED BY: ADAM.COUTURE 9/23/2015 1:54 PM
G:\DWGS\NH\EXETER\12883-WWTF-UPGRADE\12883-PDR\PRO\12883-PRS-CCT-UV-DEMOMOD.DWG | Demo-Mod-Sect | 1:10.1236 | ----- | 9/24/2015 1:55:39 PM | ADAM.COUTURE



PLAN
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")



SECTION 1
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")

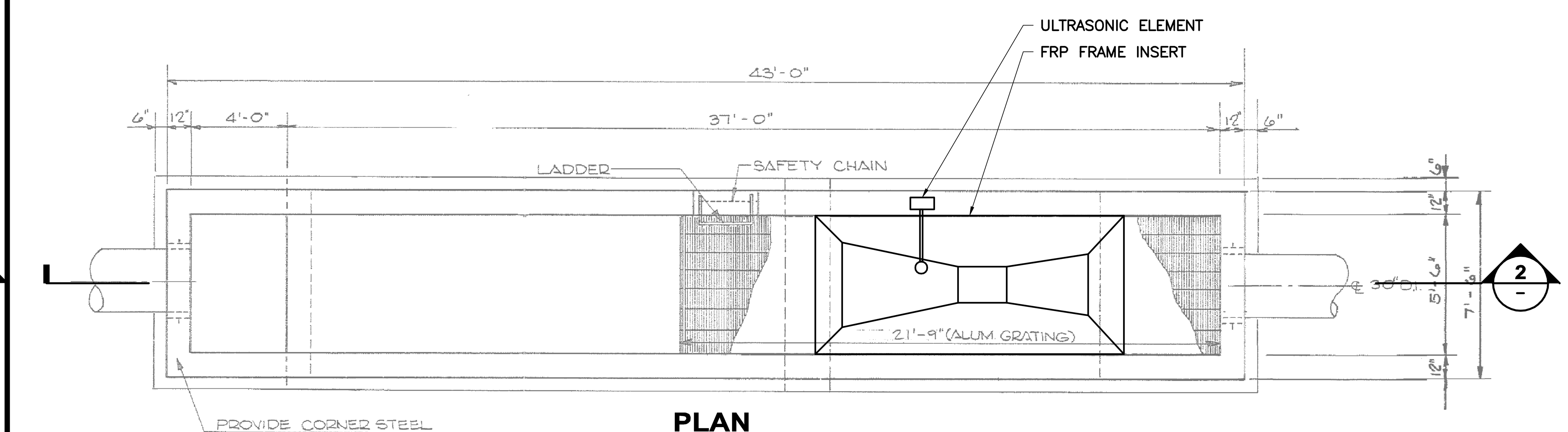
DEMOLITION NOTES:

1. REMOVE/DEMOLISH EXISTING ULTRASONIC ELEMENT IN ITS ENTIRETY INCLUDING, BUT NOT LIMITED TO; MOUNTING BRACKETS, WIRING, SUPPORTS, AND ALL ASSOCIATED APPURTENANCES.
2. REMOVE/DEMOLISH EXISTING FRP FRAME INSERT AND GROUT IN ITS ENTIRETY INCLUDING, BUT NOT LIMITED TO; FRP FRAME INSERT, BOLTS, BRACKETS, GROUT, AND ALL ASSOCIATED APPURTENANCES.

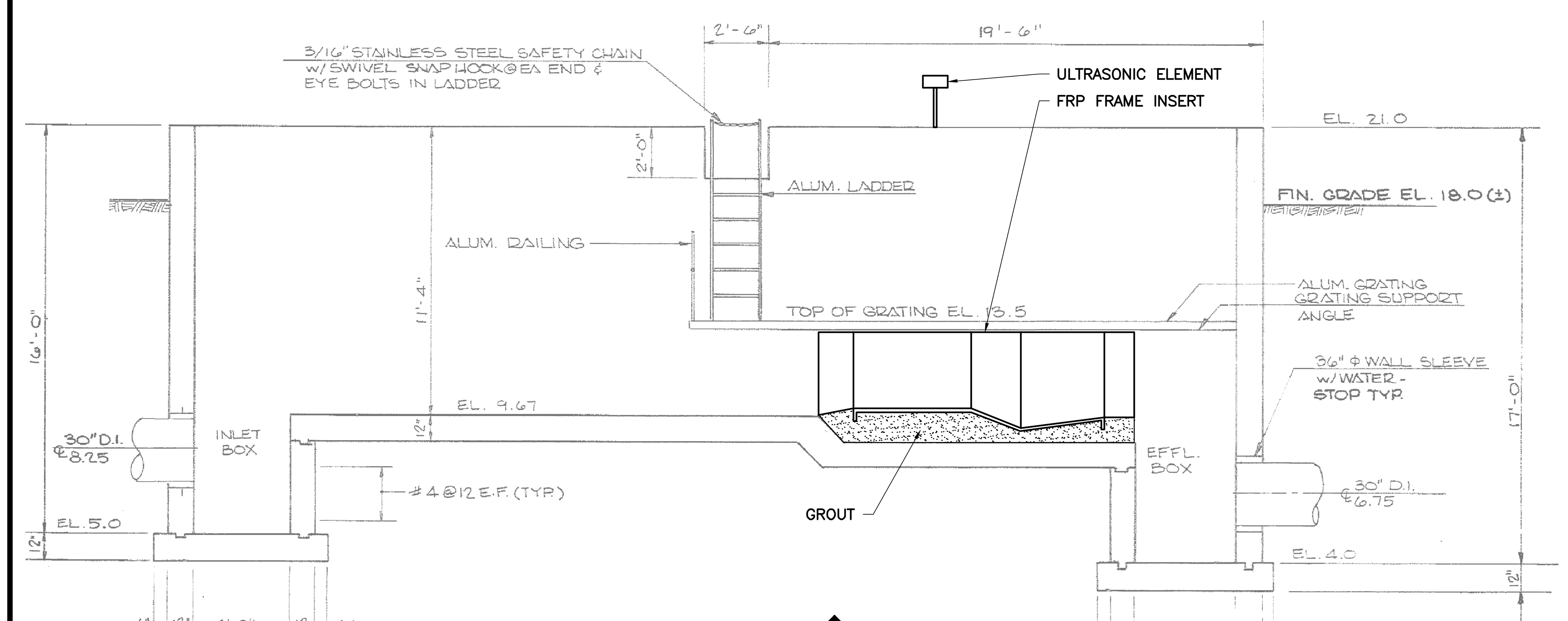
PARSHALL FLUME
DEMOLITION SECTIONS

NOTES:

1. CONTRACTOR TO NOTE A SCANNED IMAGE HAS BEEN USED. REFER TO PROCESS GENERAL NOTES ON DRAWING PR-1.



PLAN
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")



SECTION 2
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")

PARSHALL FLUME
MODIFICATION SECTIONS

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY: APC
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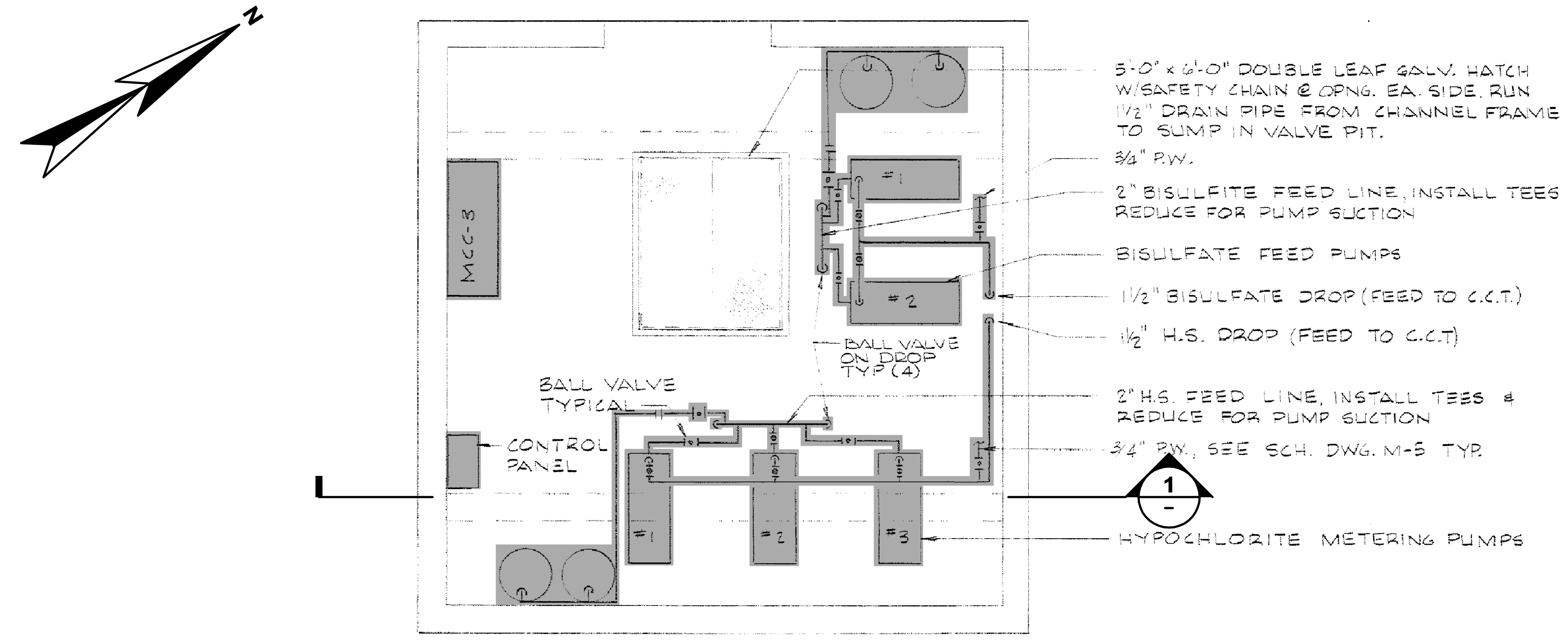
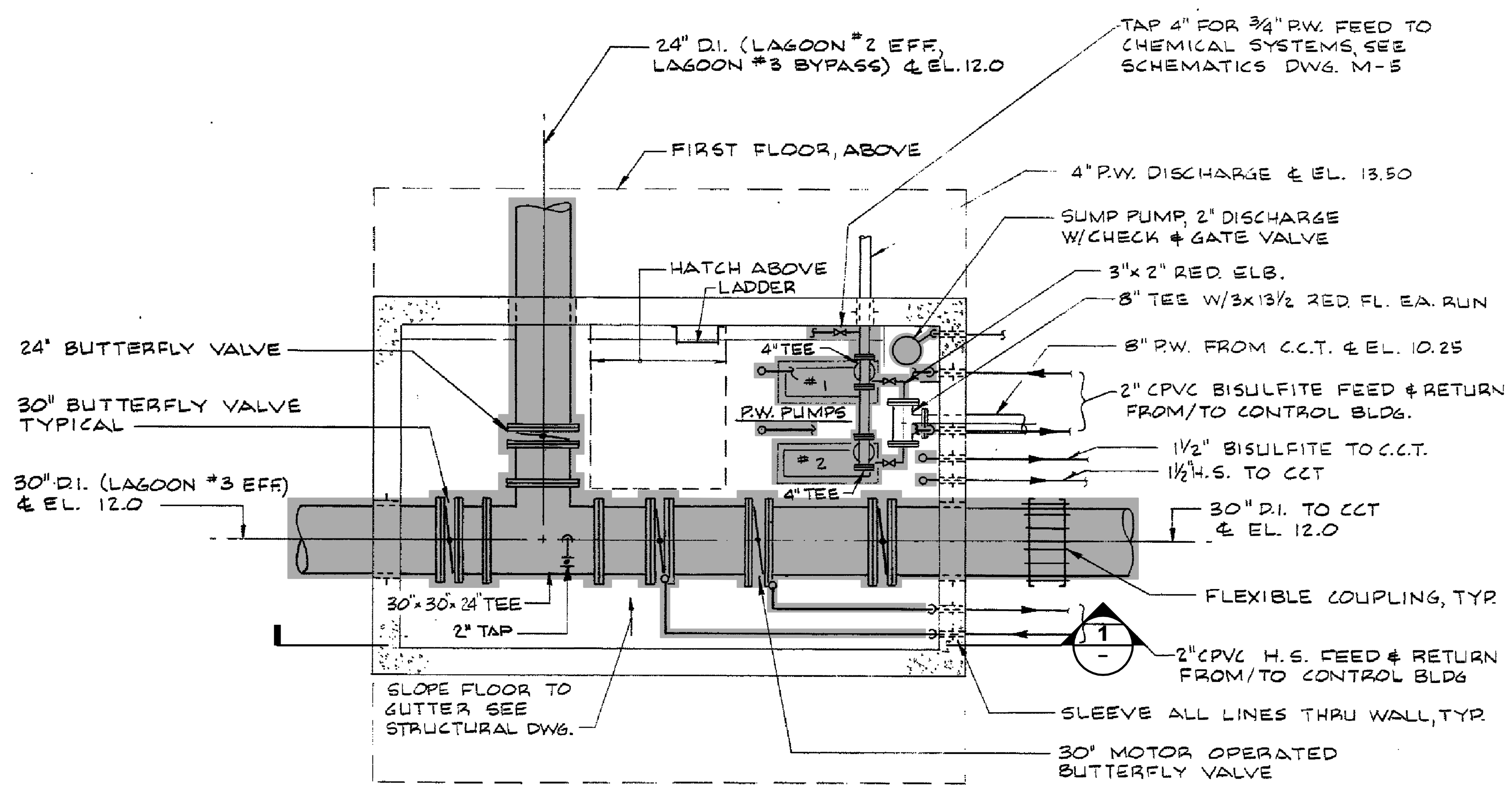
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

PARSHALL FLUME
DEMOLITION AND MODIFICATION PLAN AND SECTION

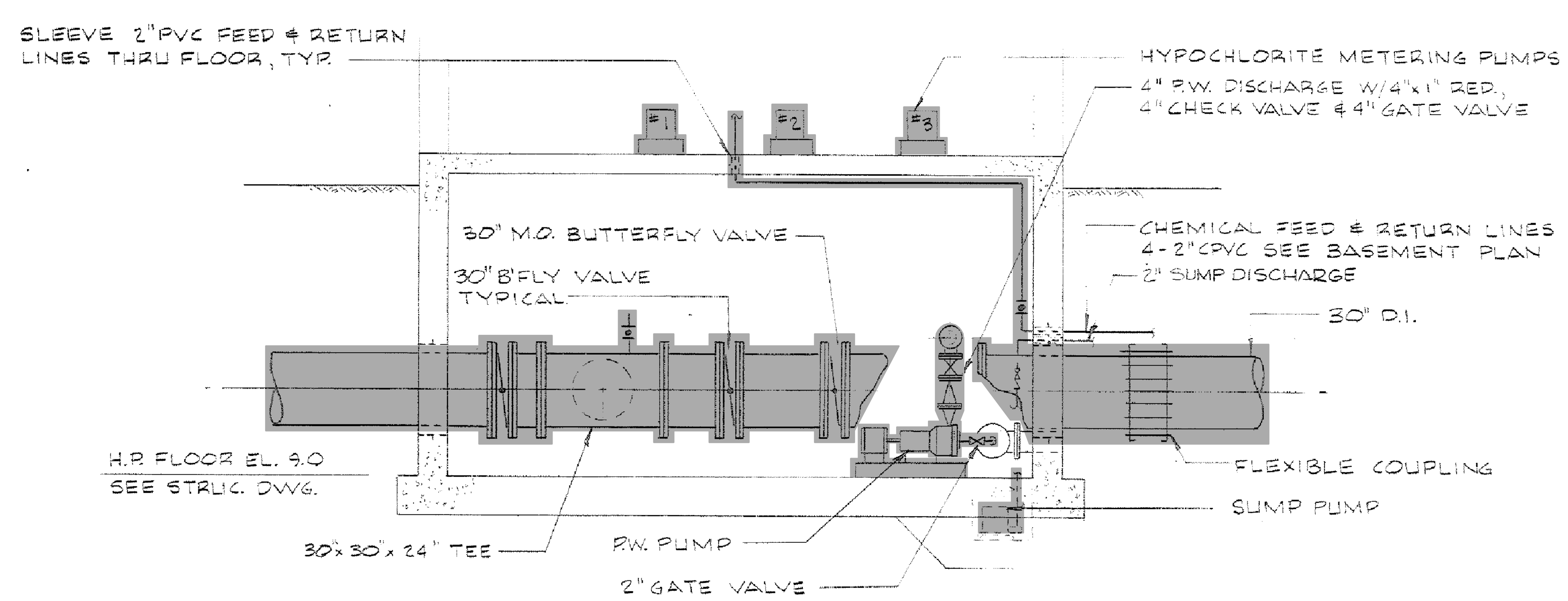
DRAWING
PR-26



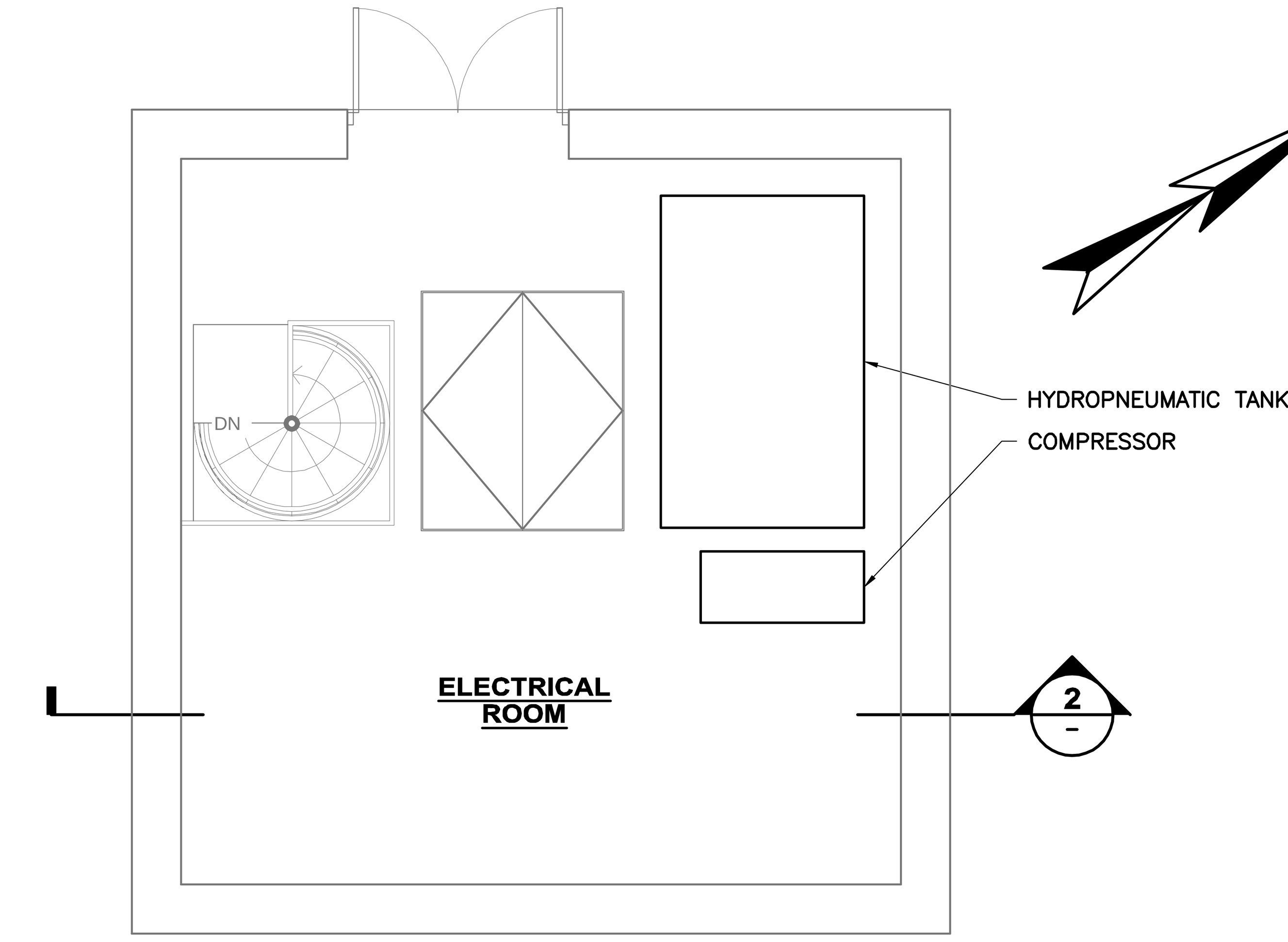
FIRST FLOOR PLAN
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")



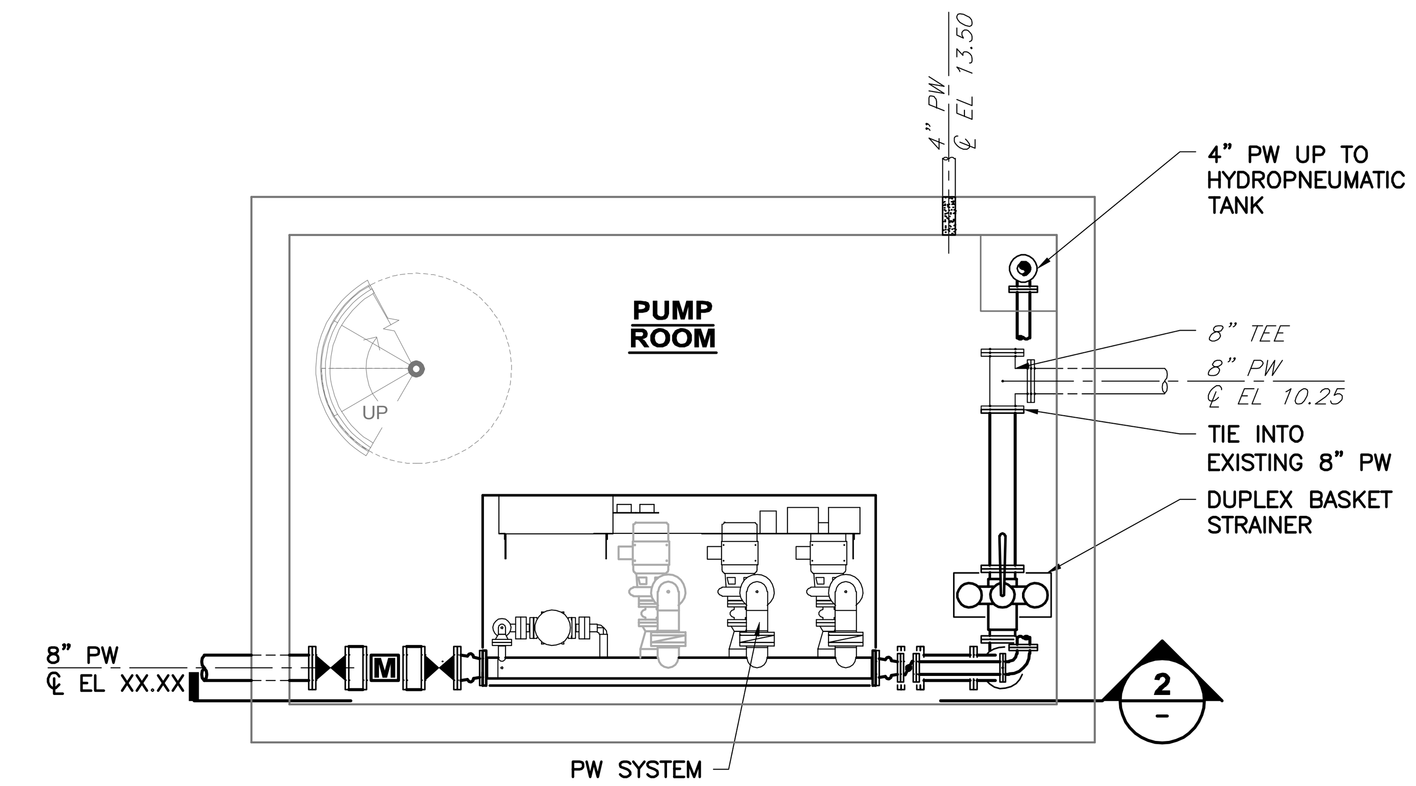
LOWER LEVEL PLAN
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")



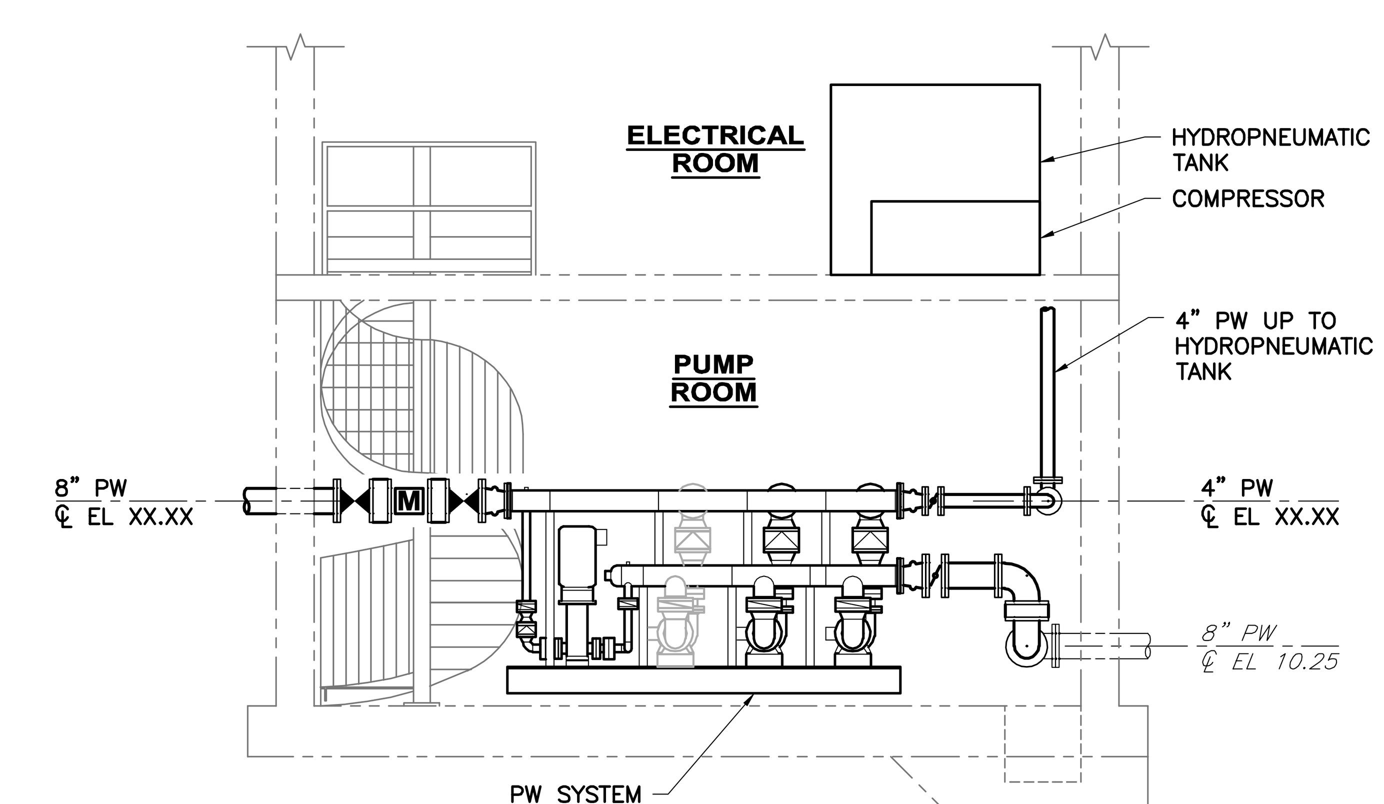
SECTION 1
SCALE: "SCANNED"



FIRST FLOOR PLAN
SCALE: 1/4"=1'-0"
4'



LOWER LEVEL PLAN
SCALE: 1/4"=1'-0"
4'



SECTION 2
SCALE: 1/4"=1'-0"
4'

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.
2. CONTRACTOR TO NOTE A SCANNED IMAGE HAS BEEN USED. REFER TO PROCESS GENERAL NOTES ON DRAWING PR-1.

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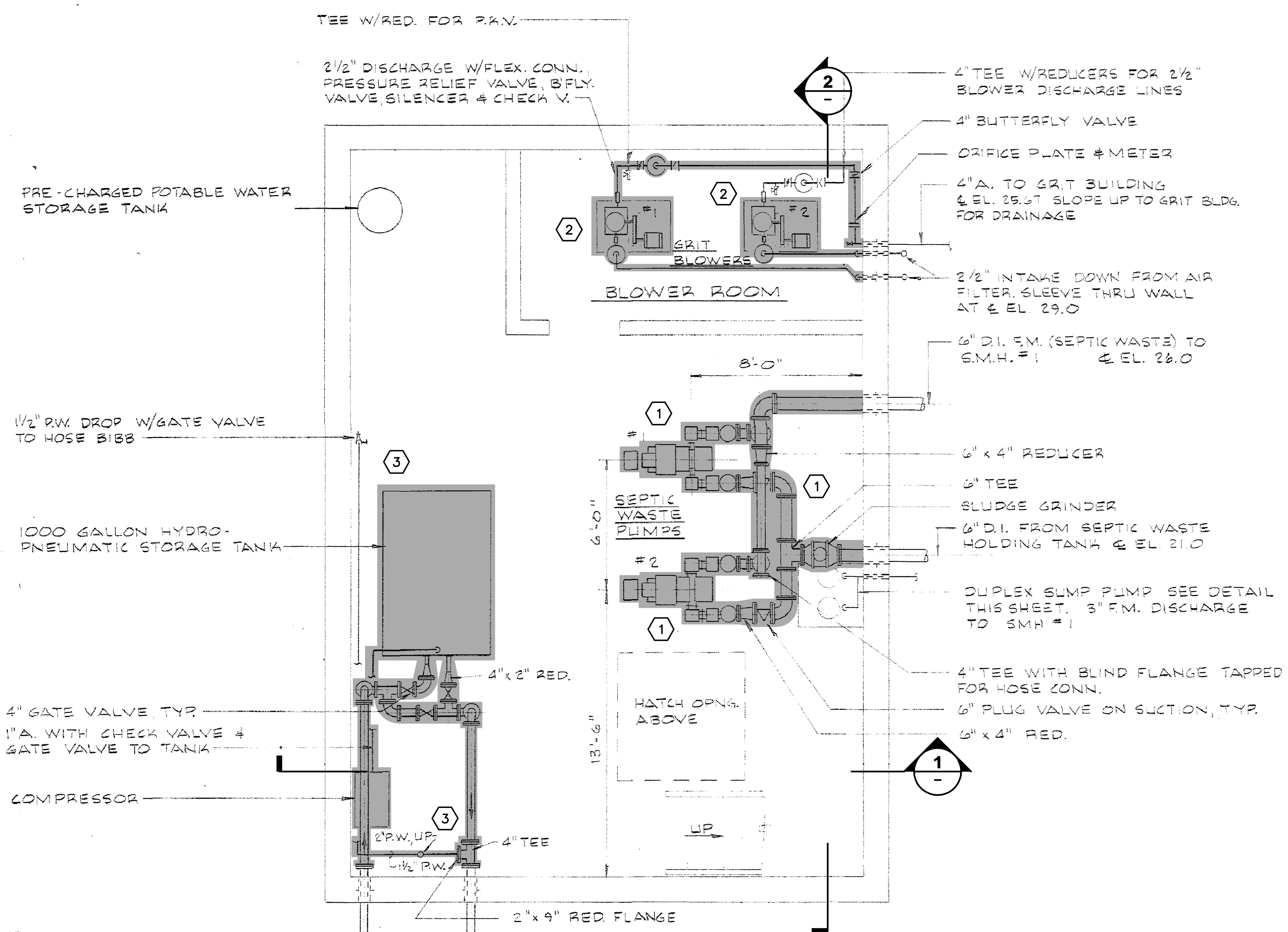
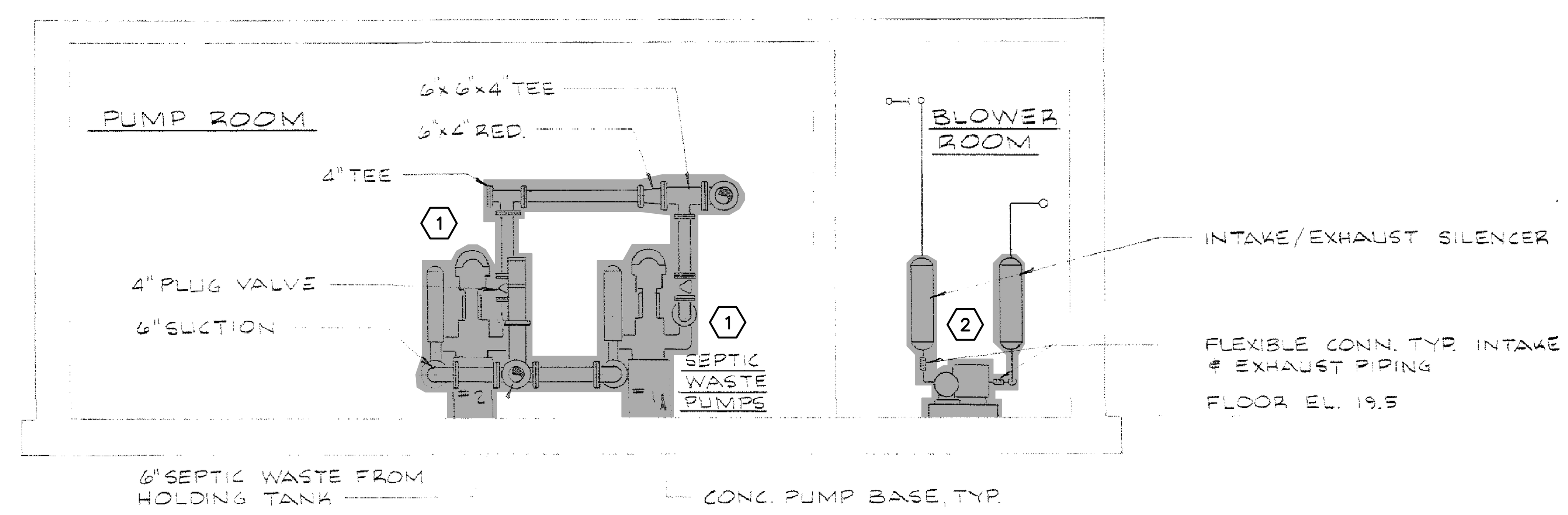
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

CHEMICAL/PLANT WATER BUILDING
DEMOLITION AND MODIFICATION PLANS AND SECTIONS

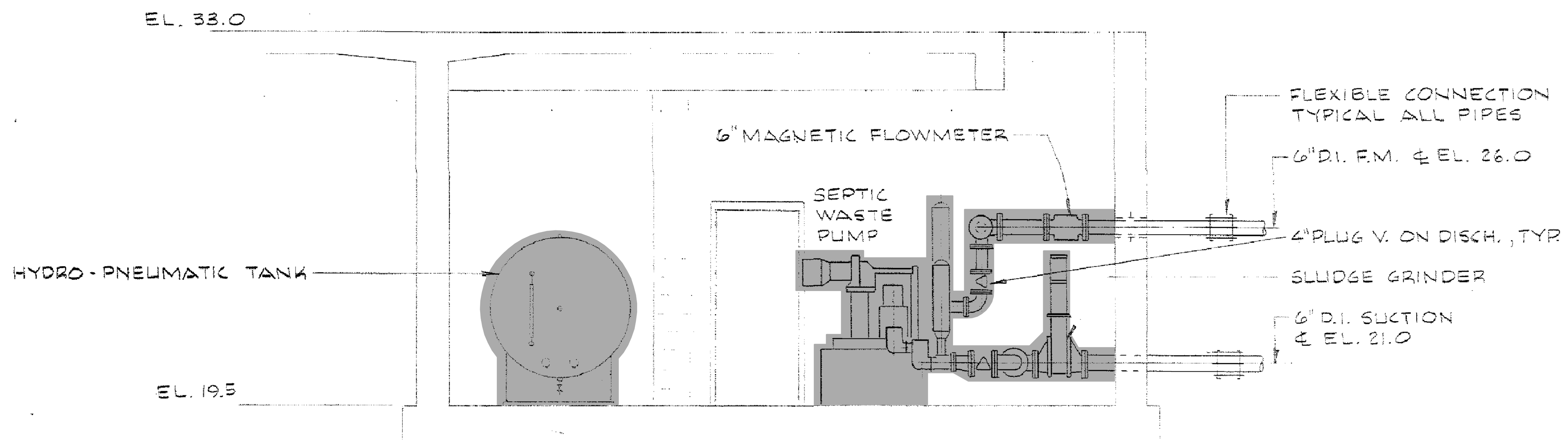
DRAWING
PR-27



BASEMENT PLAN
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")



SECTION 2
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")



SECTION 1
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")

DEMOLITION NOTES:

1. REMOVE/DEMOLISH EXISTING SEPTAGE PUMPS IN THEIR ENTIRETY INCLUDING, BUT NOT LIMITED TO; PUMP, BASE, SUPPORTS, WIRING, CONTROLS, ELECTRICAL, VALVES, PIPING TO THE EXTENTS SHOWN ON DRAWINGS, AND ALL ASSOCIATED APPURTENANCES.
2. REMOVE/DEMOLISH EXISTING BLOWERS IN THEIR ENTIRETY INCLUDING, BUT NOT LIMITED TO; BLOWER, BASE, SUPPORTS, WIRING, CONTROLS, ELECTRICAL, VALVES, PIPING TO THE EXTENTS SHOWN ON DRAWINGS, AND ALL ASSOCIATED APPURTENANCES.
3. REMOVE/DEMOLISH EXISTING PLANT WATER SYSTEM IN ITS ENTIRETY INCLUDING, BUT NOT LIMITED TO; STORAGE TANK, COMPRESSOR, BASE, SUPPORTS, WIRING, CONTROLS, ELECTRICAL, VALVES, PIPING TO THE EXTENTS SHOWN ON DRAWINGS, AND ALL ASSOCIATED APPURTENANCES.

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.
2. CONTRACTOR TO NOTE A SCANNED IMAGE HAS BEEN USED. REFER TO PROCESS GENERAL NOTES ON DRAWING PR-1.

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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

CONTROL BUILDING
DEMOLITION PLAN AND SECTIONS

DRAWING
PR-28

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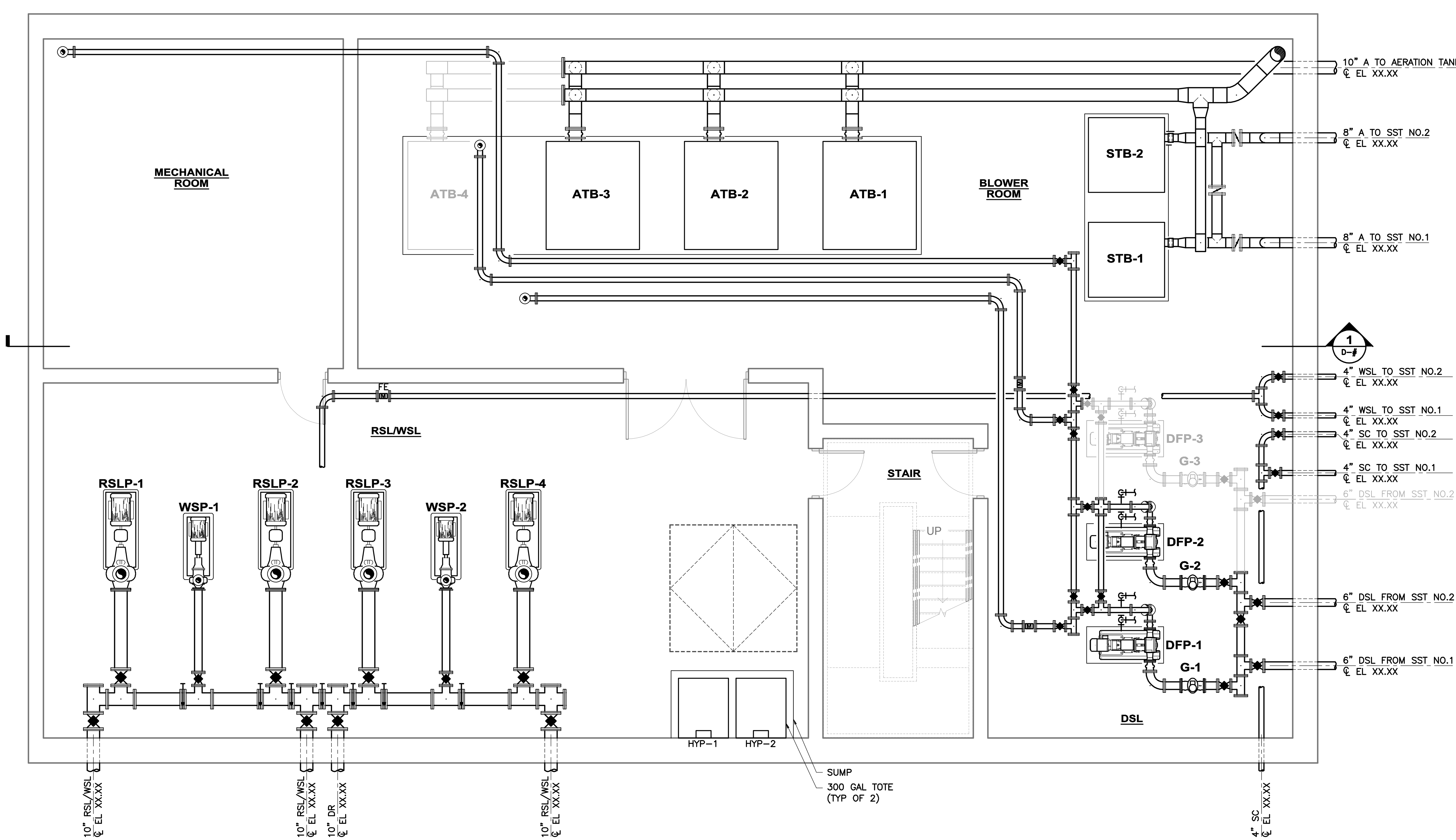
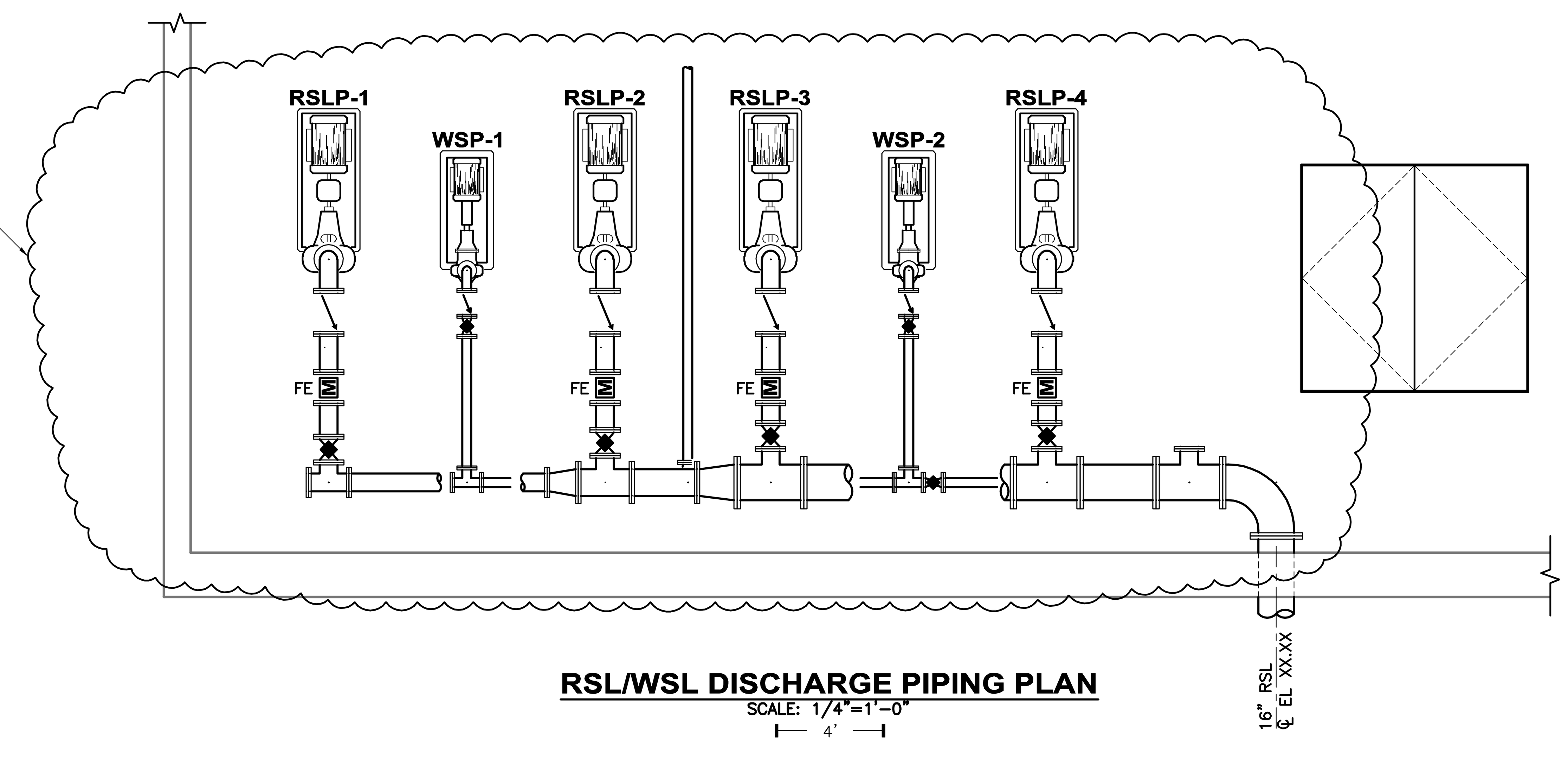
G:\DWGS\NH\EXETER\12883-WWTF-UPGRADE\12883-PDR\PRO\12883-PRS-CONTRLBLDG-DEMO.DWG | CntrlBldgLower | 1:10.1236 | ---- | 9/24/2015 1:56:06 PM | ADAM.COUTURE

LAST SAVED BY: ADAM.COUTURE 9/22/2015 6:17 PM



LOWER FLOOR PLAN
SCALE: 1/4"=1'-0"
4'

FLOW METER: 3/2 RUN DISCHARGE WILL NEED TO MATCH SCHEMATICS



RSL/WSL DISCHARGE PIPING PLAN
SCALE: 1/4"=1'-0"
4'

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

SOLIDS HANDLING BUILDING
LOWER FLOOR PLAN

DRAWING
PR-29

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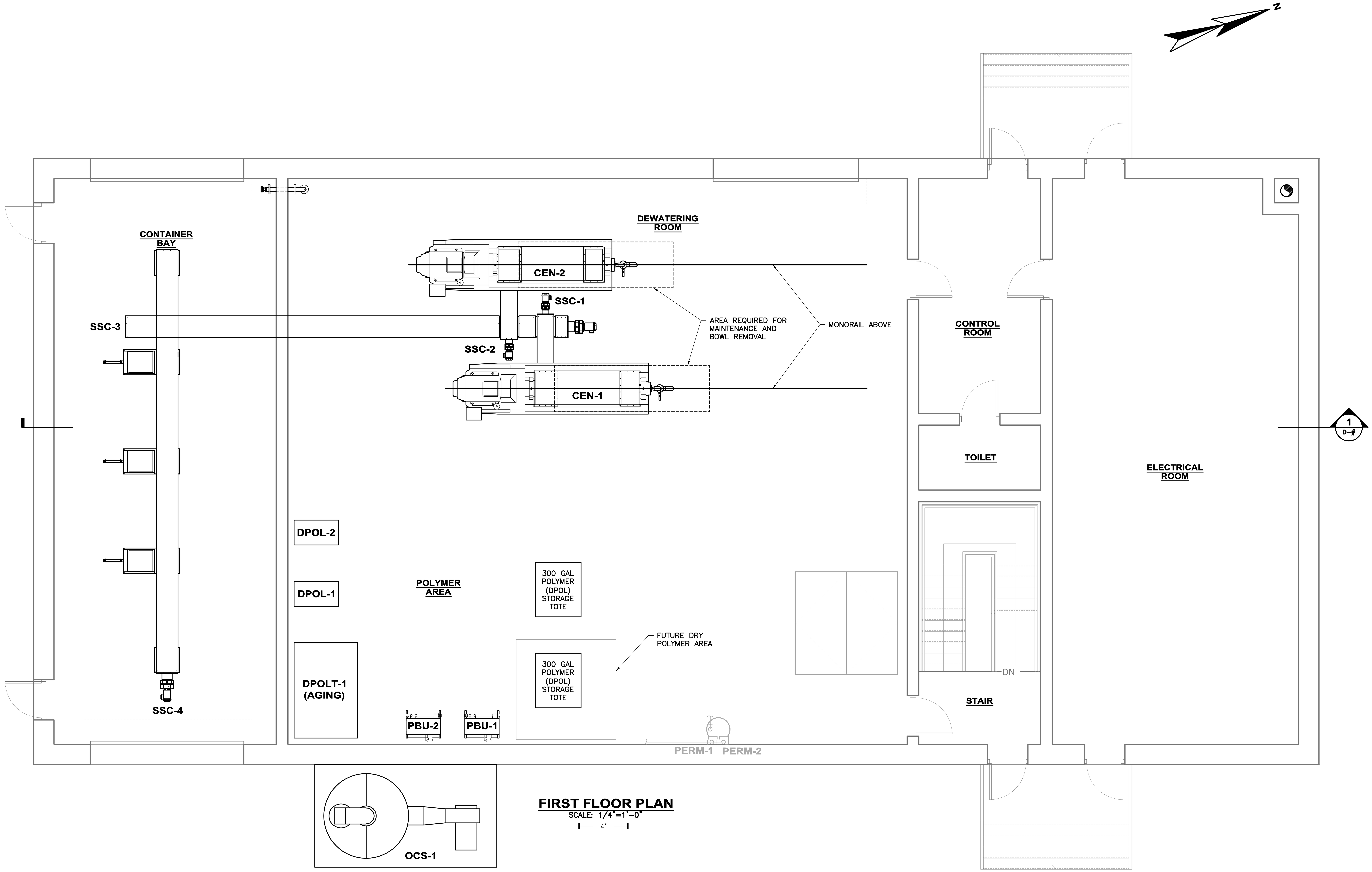
LAST SAVED BY: ADAM.COUTURE 9/22/2015 6:17 PM



FIRST FLOOR PLAN

SCALE: 1/4"=1'-0"

4'

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

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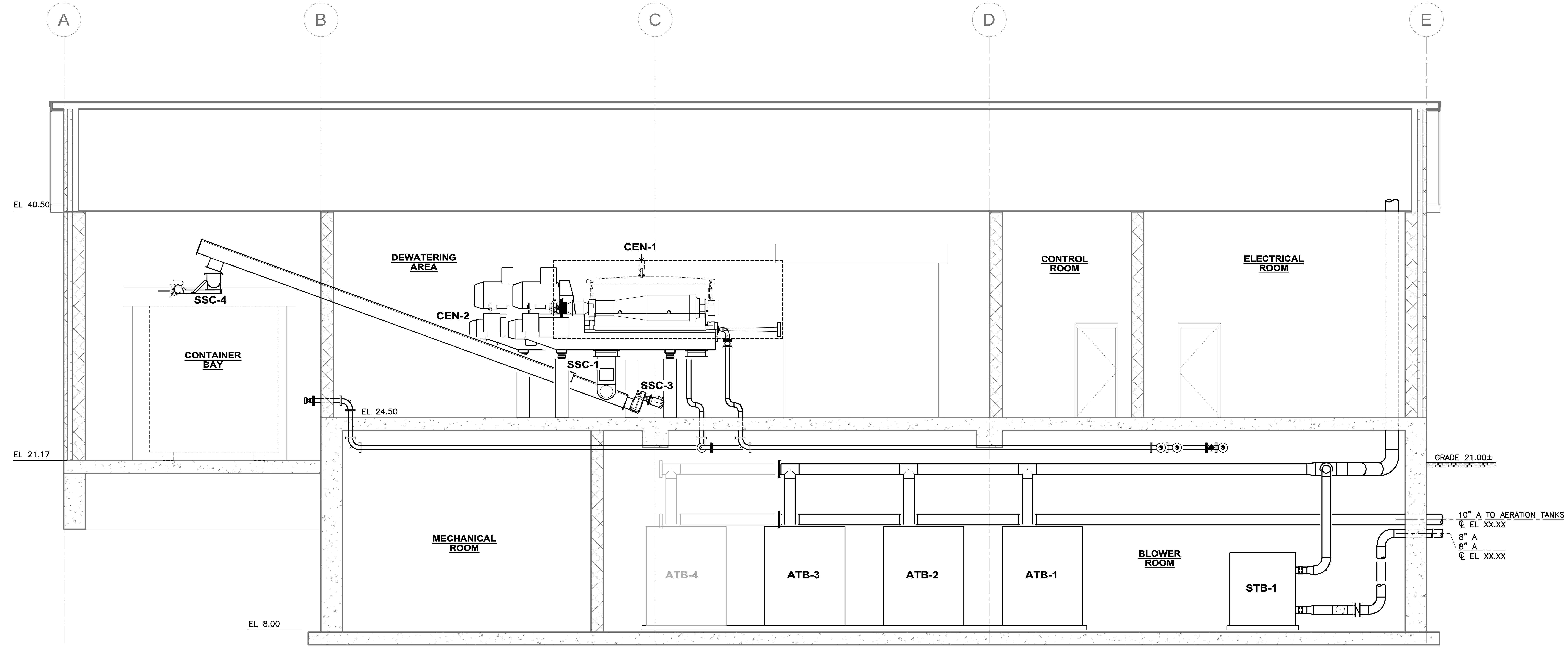
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

SOLIDS HANDLING BUILDING
FIRST FLOOR PLAN

DRAWING
PR-30



SECTION # D-#

SCALE: 1/4"=1'-0"

4'

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

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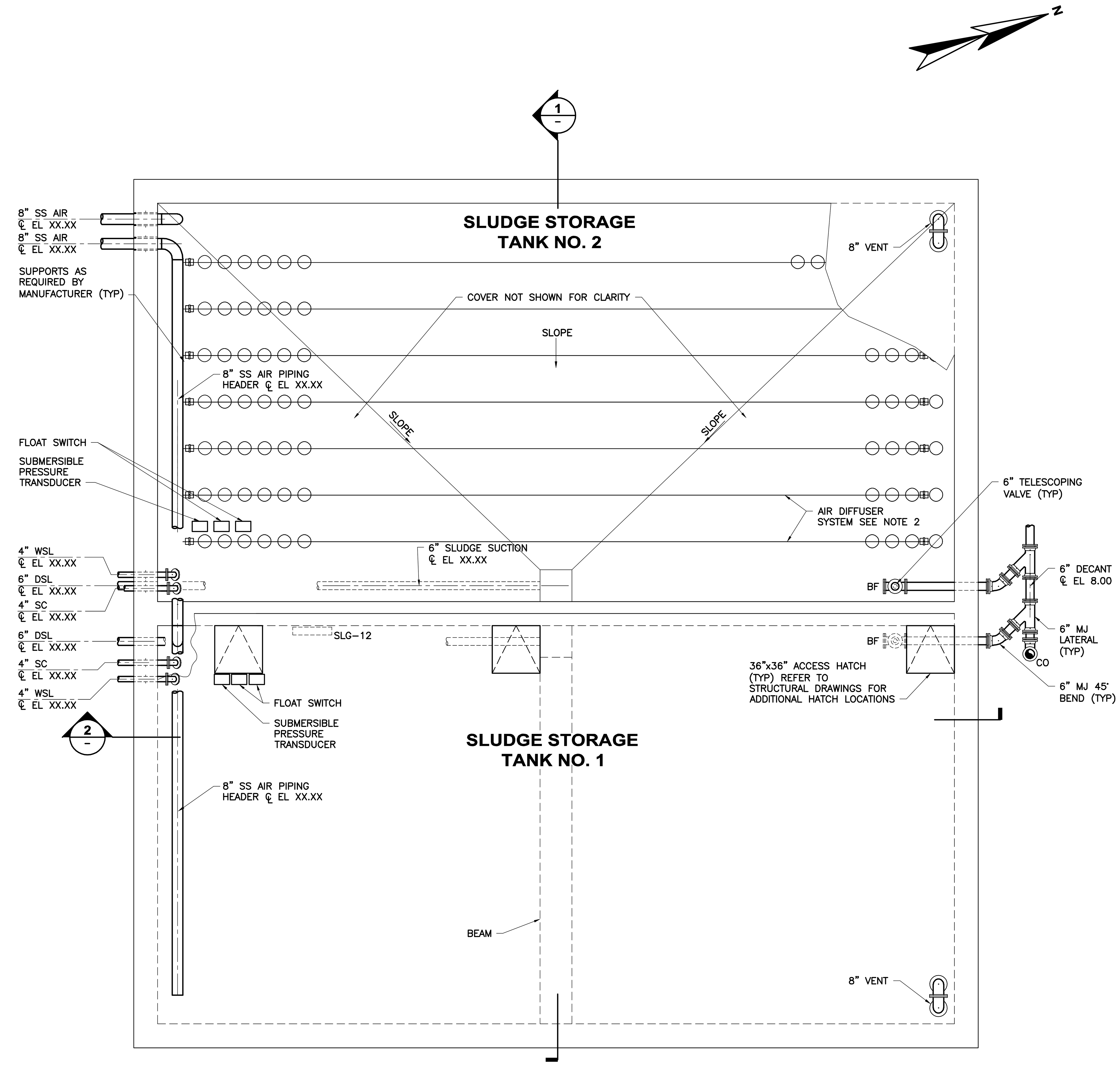
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

SOLIDS HANDLING BUILDING
SECTIONS I

DRAWING
PR-31



SLUDGE STORAGE TANKS

SCALE: 1/4"=1'-0"

4'

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.
2. COMPLETE AERATION SYSTEM NOT SHOWN FOR CLARITY. CONTRACTOR TO COORDINATE NUMBER OF DIFFUSERS, DROPLEGS, LOCATIONS AND SUPPORTS WITH EQUIPMENT MANUFACTURER. REFER TO SPECIFICATION SECTION 11378.

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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

SLUDGE STORAGE TANK PLAN

DRAWING
PR-33

LAST SAVED BY: ADAM.COUTURE 9/23/2015 2:48 PM
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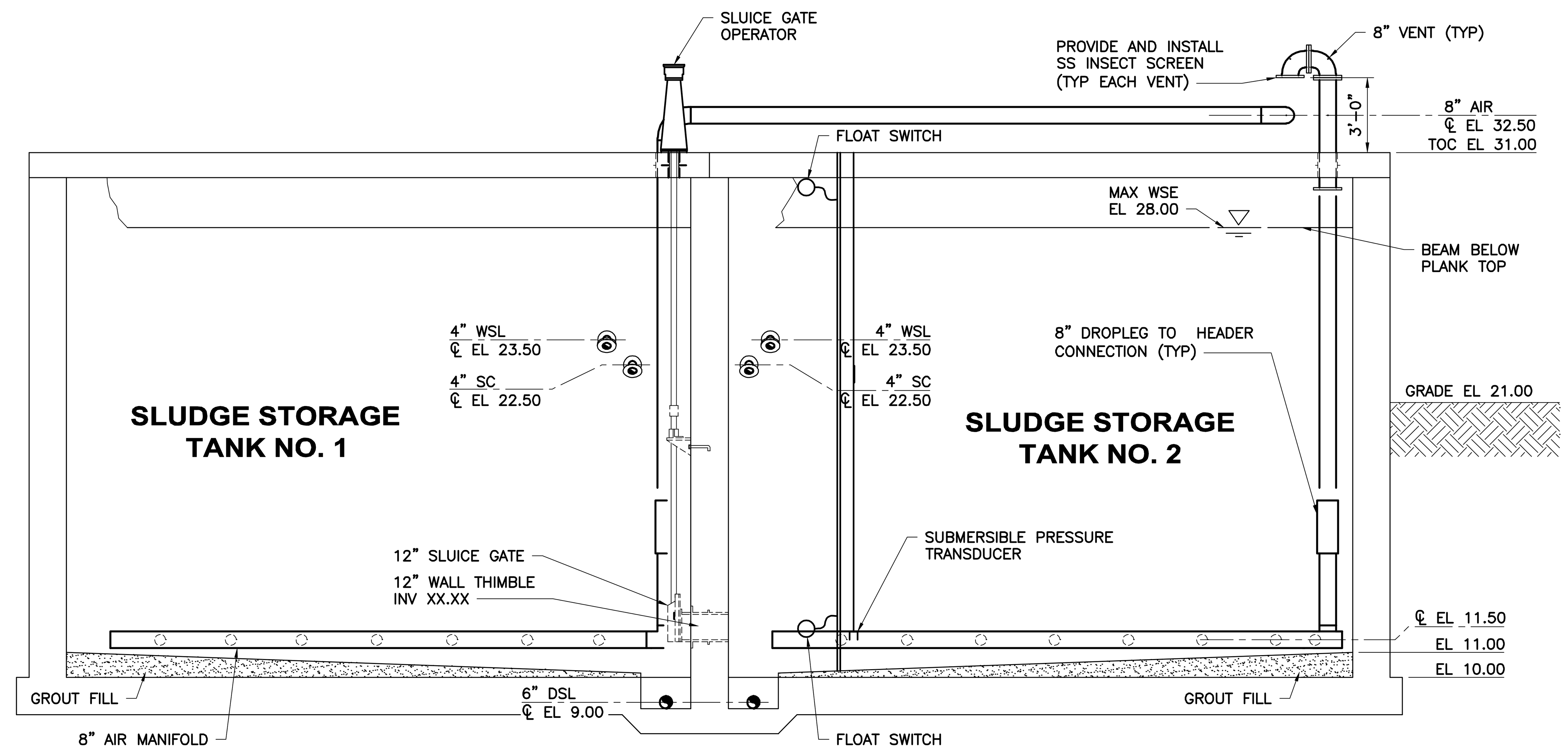
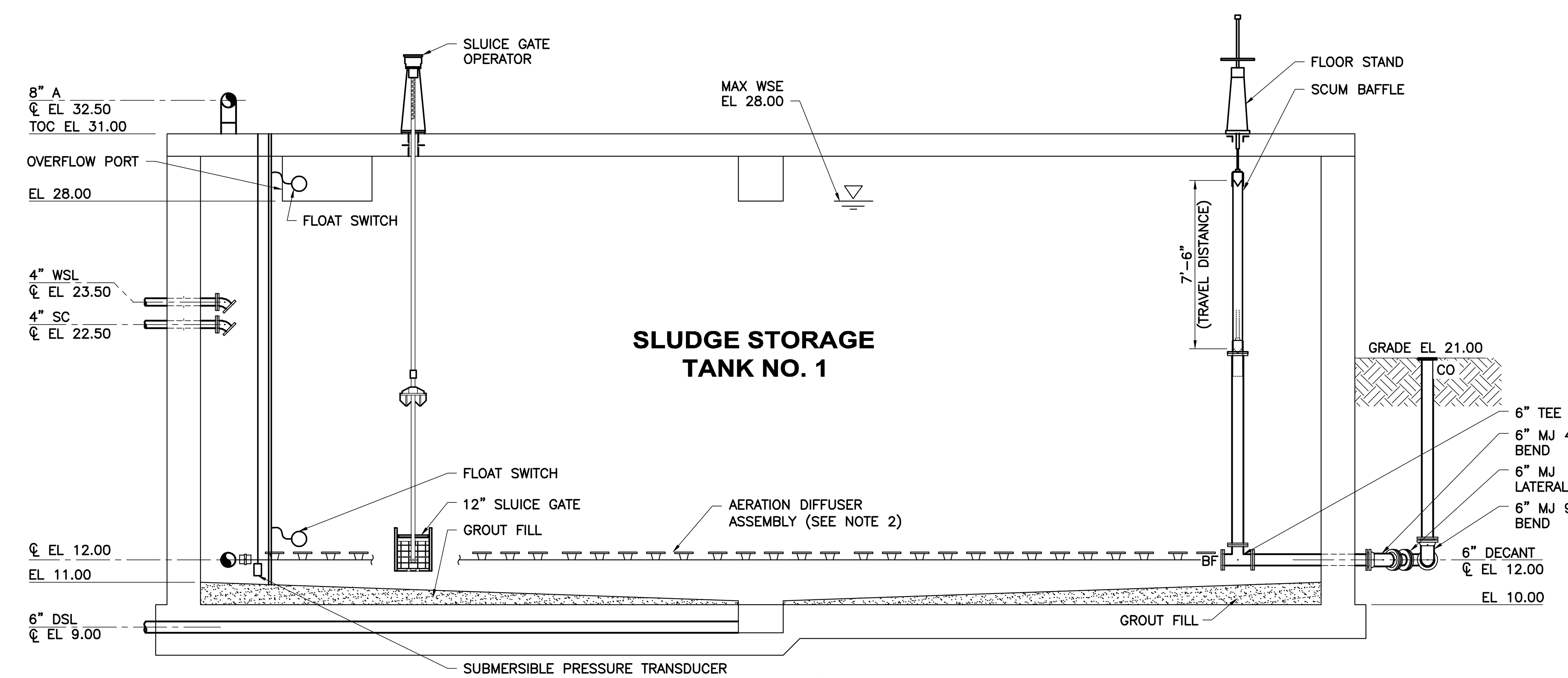


SECTION 1 / –
SCALE: 1/4"=1'-0"
4'



SECTION 2 / –
SCALE: 1/4"=1'-0"
4'

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.
2. COMPLETE AERATION SYSTEM NOT SHOWN FOR CLARITY. CONTRACTOR TO COORDINATE NUMBER OF DIFFUSERS, DROPLEGS, LOCATIONS AND SUPPORTS WITH EQUIPMENT MANUFACTURER. REFER TO SPECIFICATION SECTION 11378 AND DRAWING PR-XX FOR ADDITIONAL INFORMATION.

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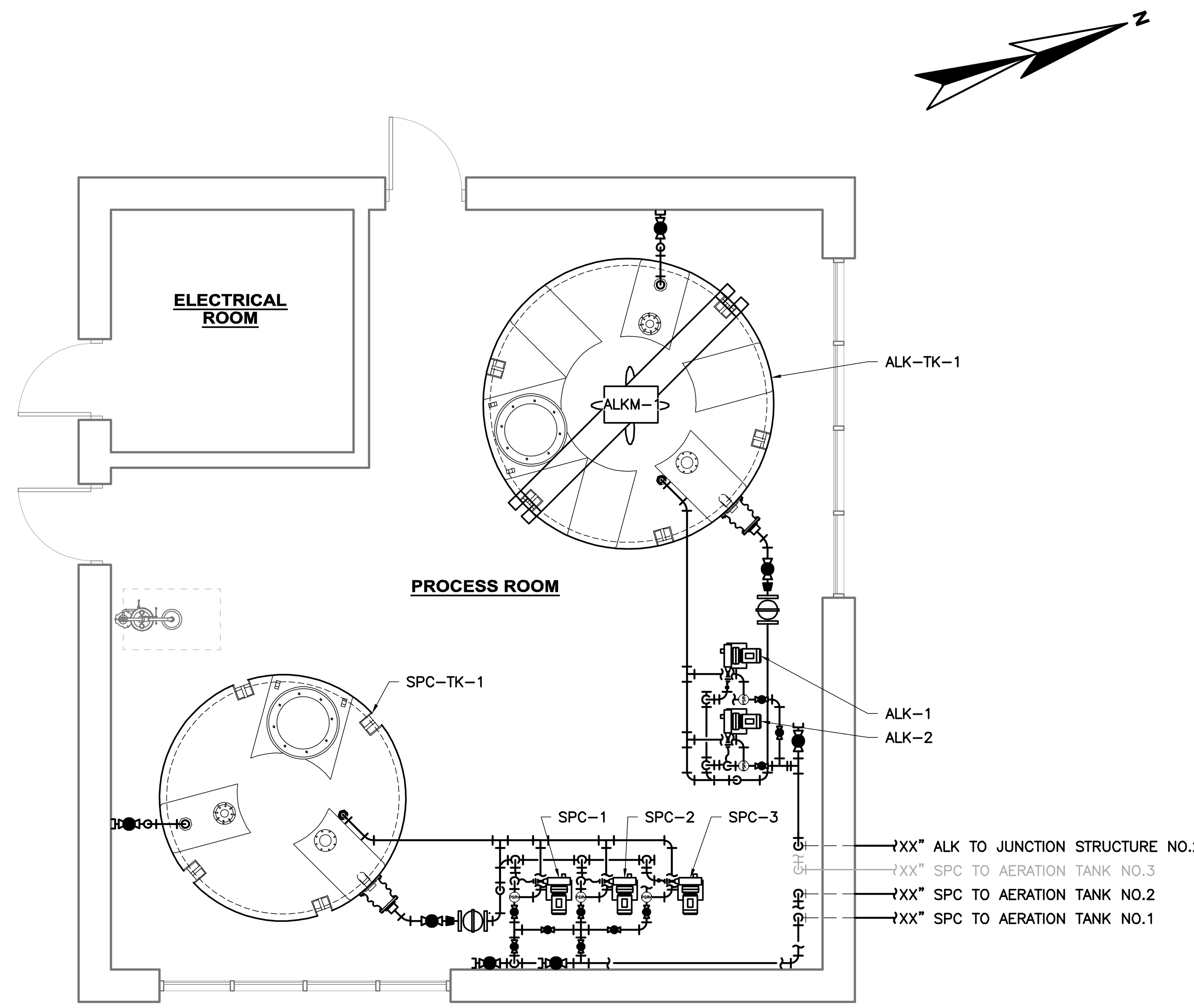
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

SLUDGE STORAGE TANK SECTIONS

DRAWING
PR-34



PLAN
SCALE: 1/4"=1'-0"
4'

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

SUPPLEMENTAL CHEMICAL BUILDING
PLAN AND SECTIONS

DRAWING
PR-35

LAST SAVED BY: ADAM.COUTURE 9/22/2015 6:50 PM
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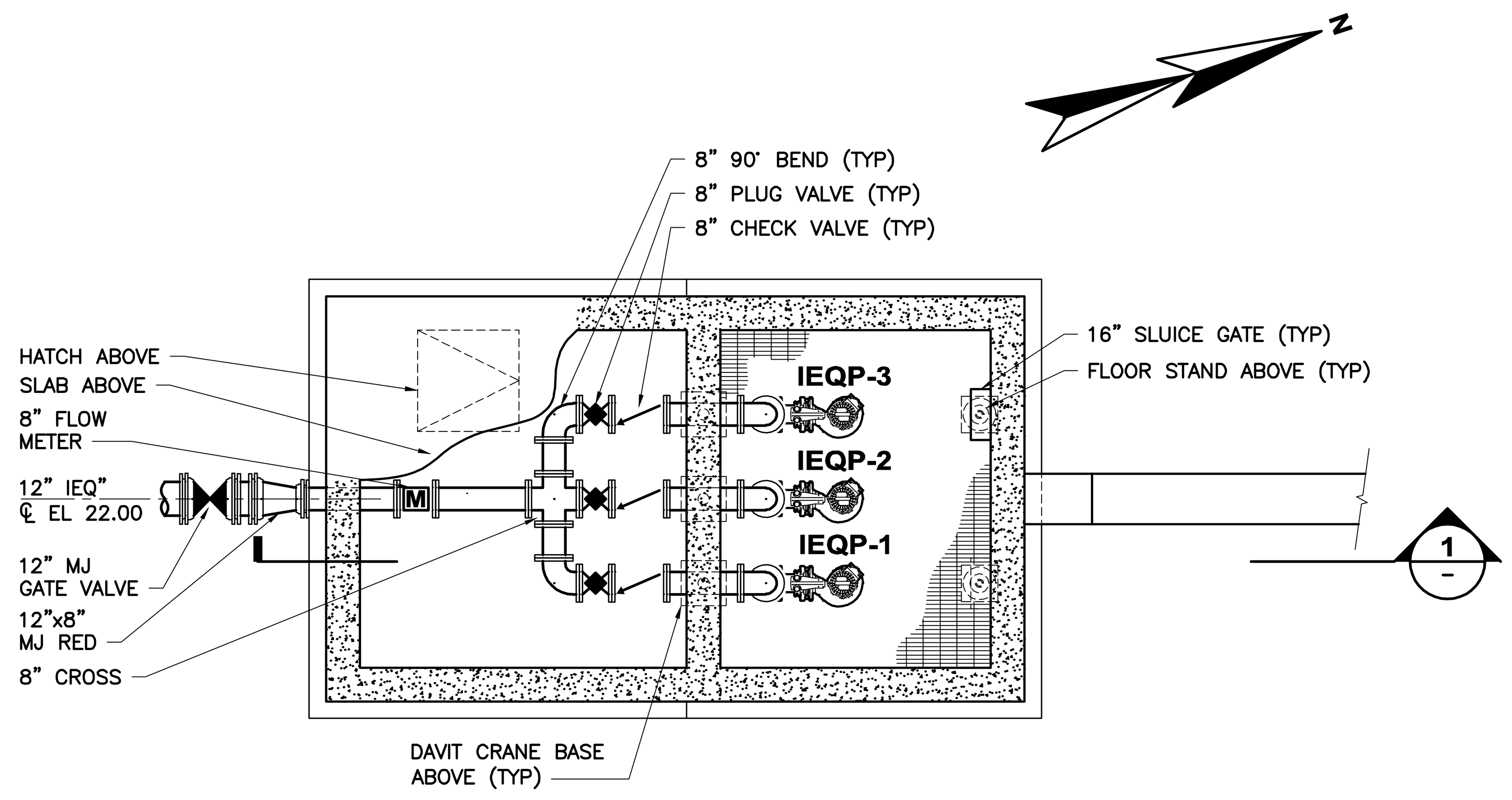
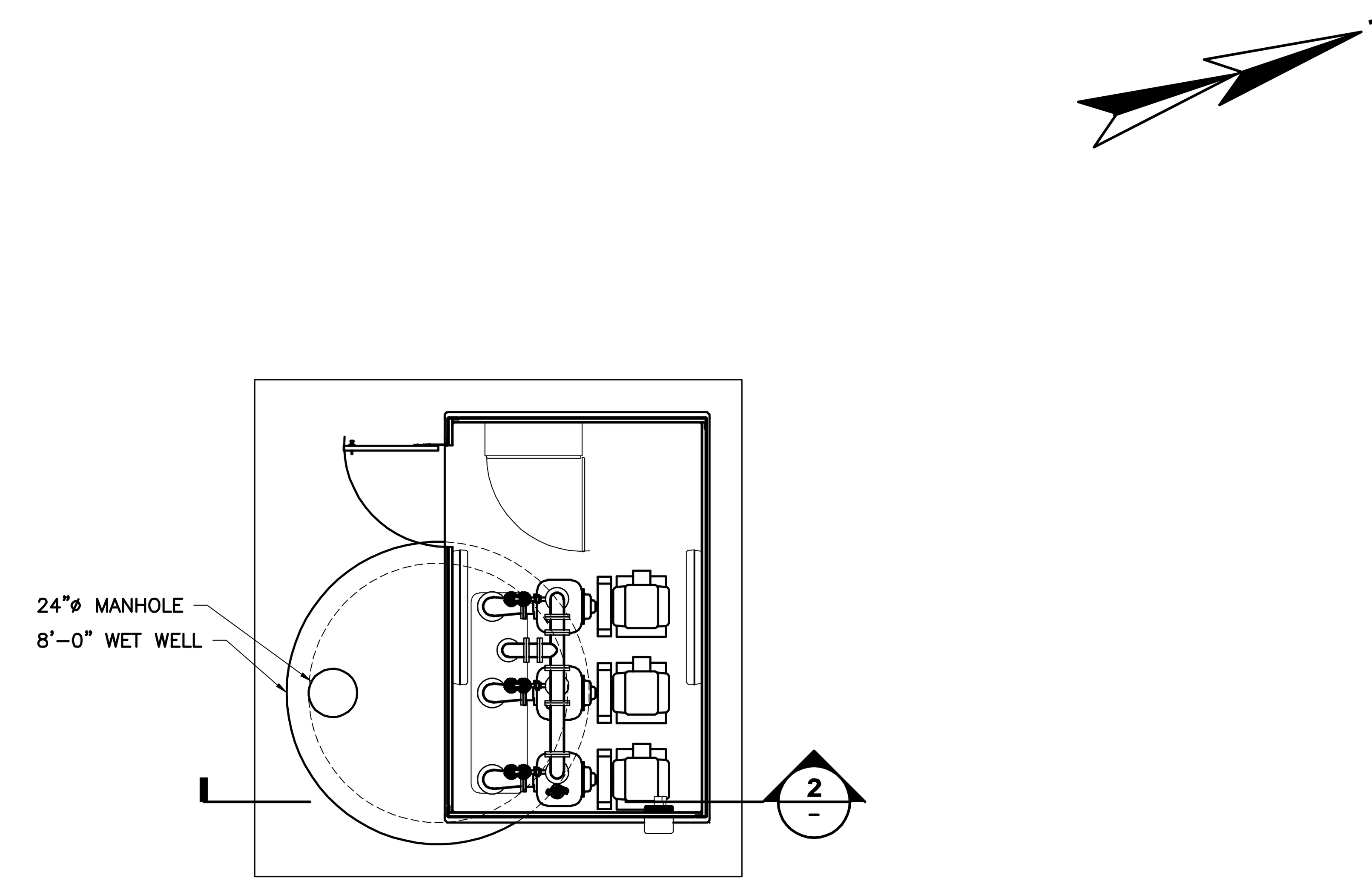
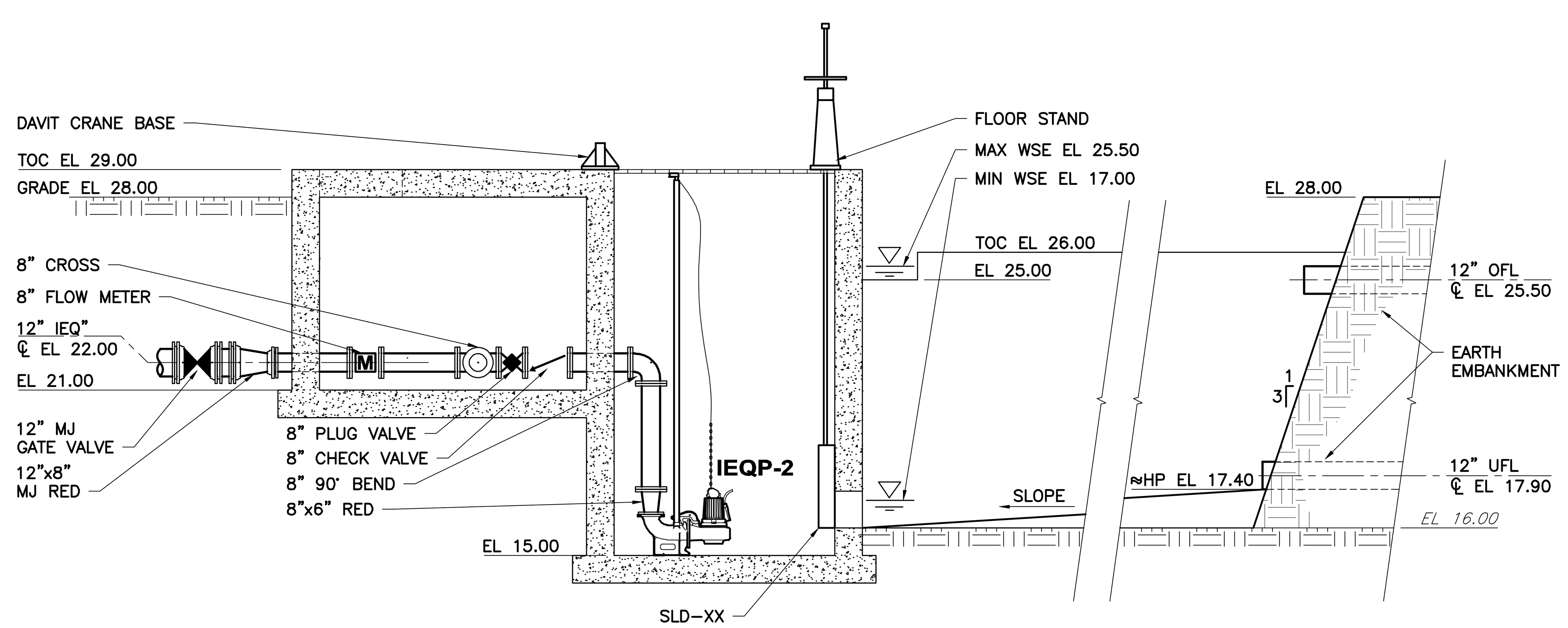


INFLUENT EQUALIZATION PUMP STATION PLAN
SCALE: 1/4"=1'-0"
4'

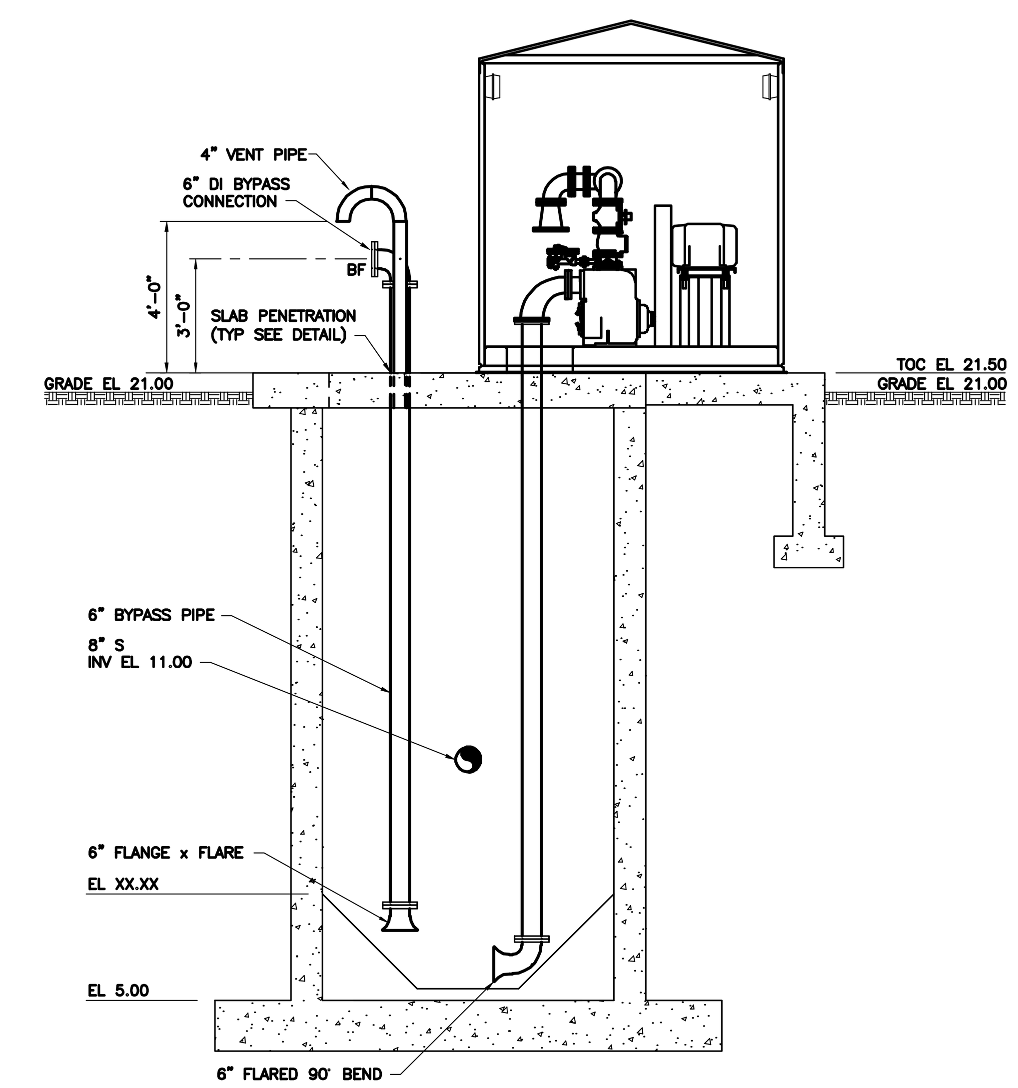


YARD PUMP STATION AND WETWELL PLAN
SCALE: 1/4"=1'-0"
4'



SECTION 1
SCALE: 1/4"=1'-0"
4'

INFLUENT FLOW EQUALIZATION PUMP STATION



SECTION 2
SCALE: 1/2"=1'-0"
4'

YARD PUMP STATION

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1 AND PR-2.

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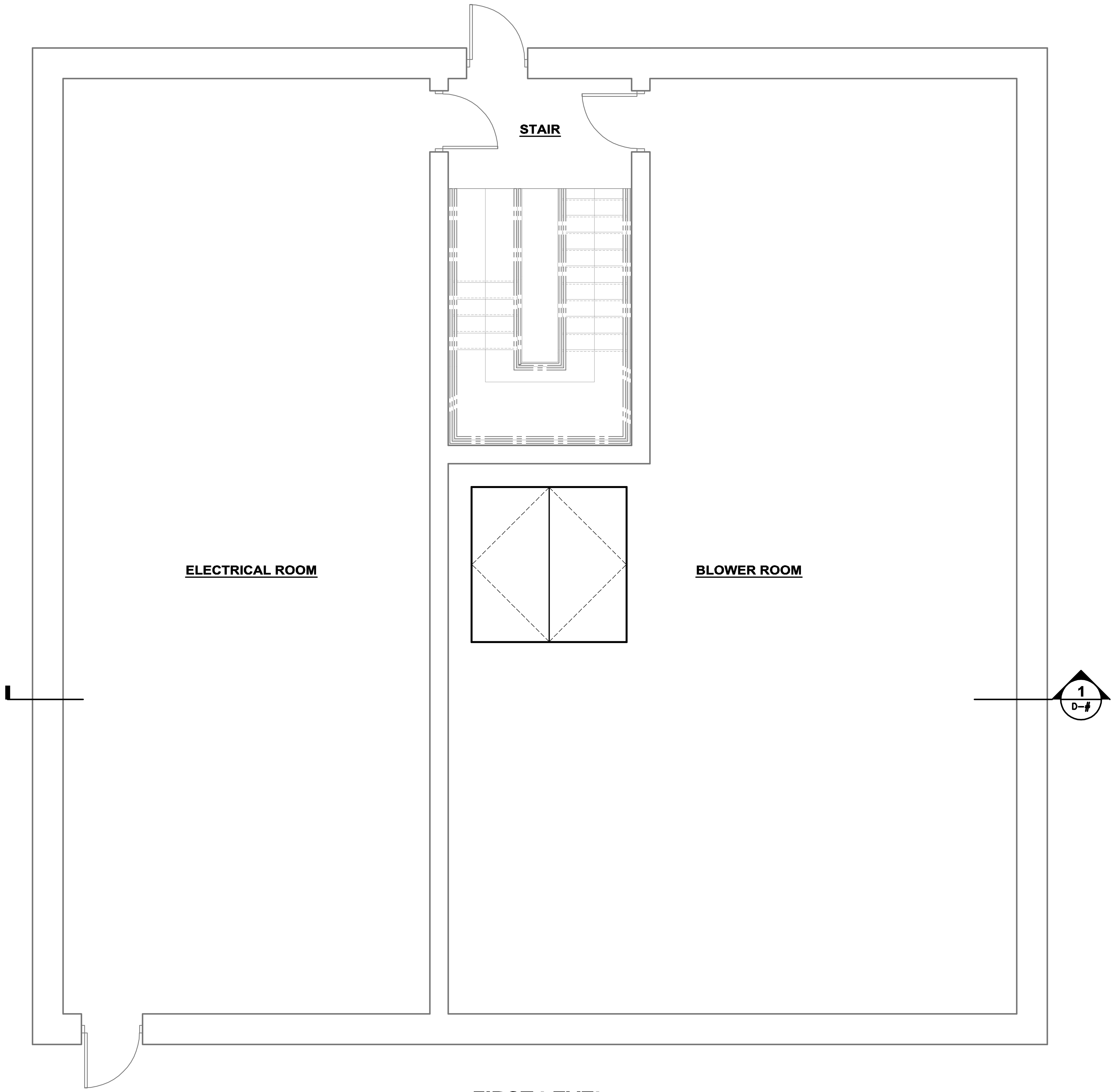
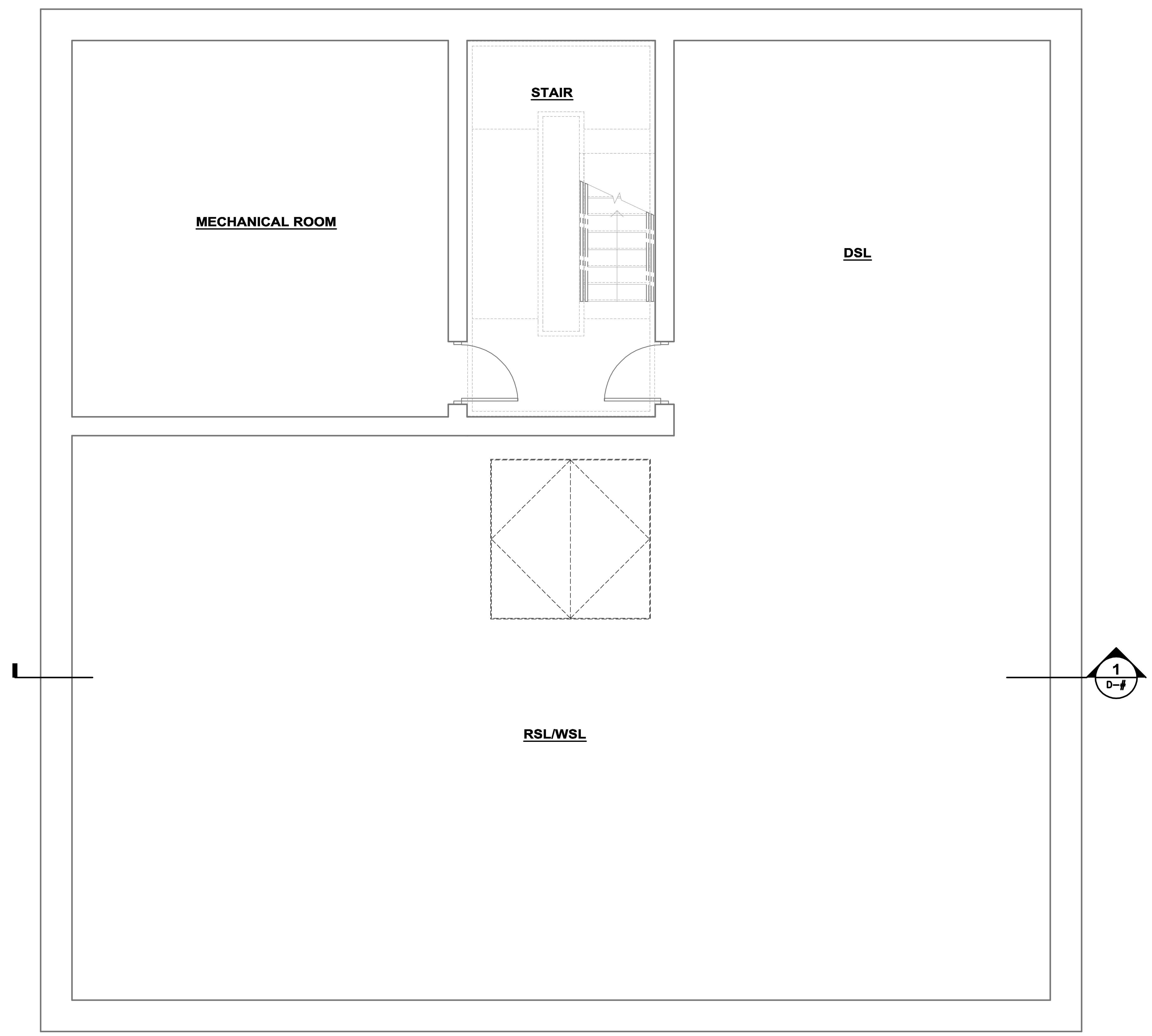
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

INFLUENT FLOW EQUALIZATION AND YARD PUMP STATIONS
PLANS AND SECTIONS

DRAWING
PR-36



FIRST LEVEL
SCALE: 1/4"=1'-0"



LOWER LEVEL
SCALE: 1/4"=1'-0"

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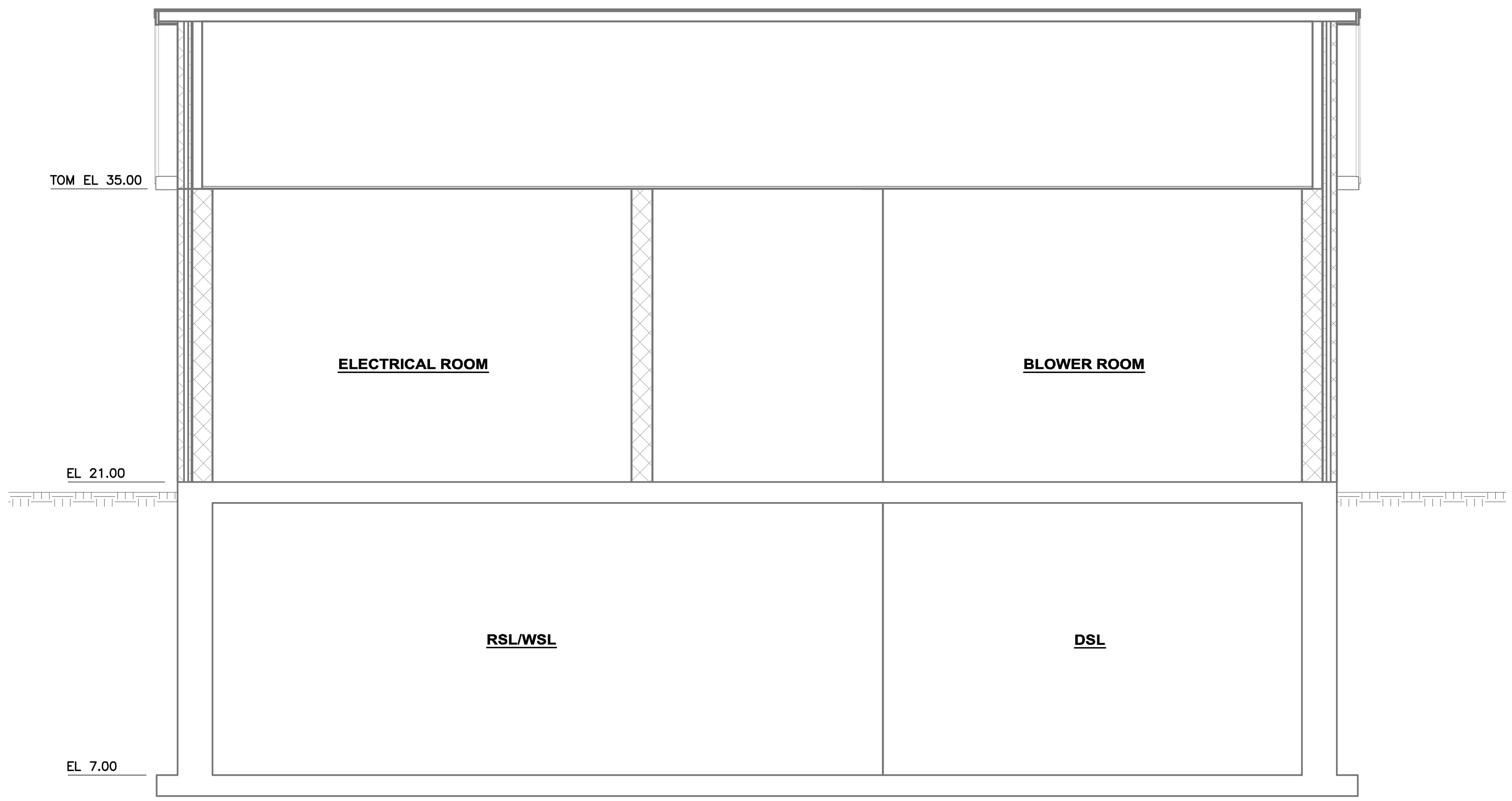
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

ALTERNATE "PROCESS BUILDING" PLANS

DRAWING
FIG 4-2



SECTION
SCALE: 1/4"=1'-0"
1
D-#

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
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1			
2			
3			
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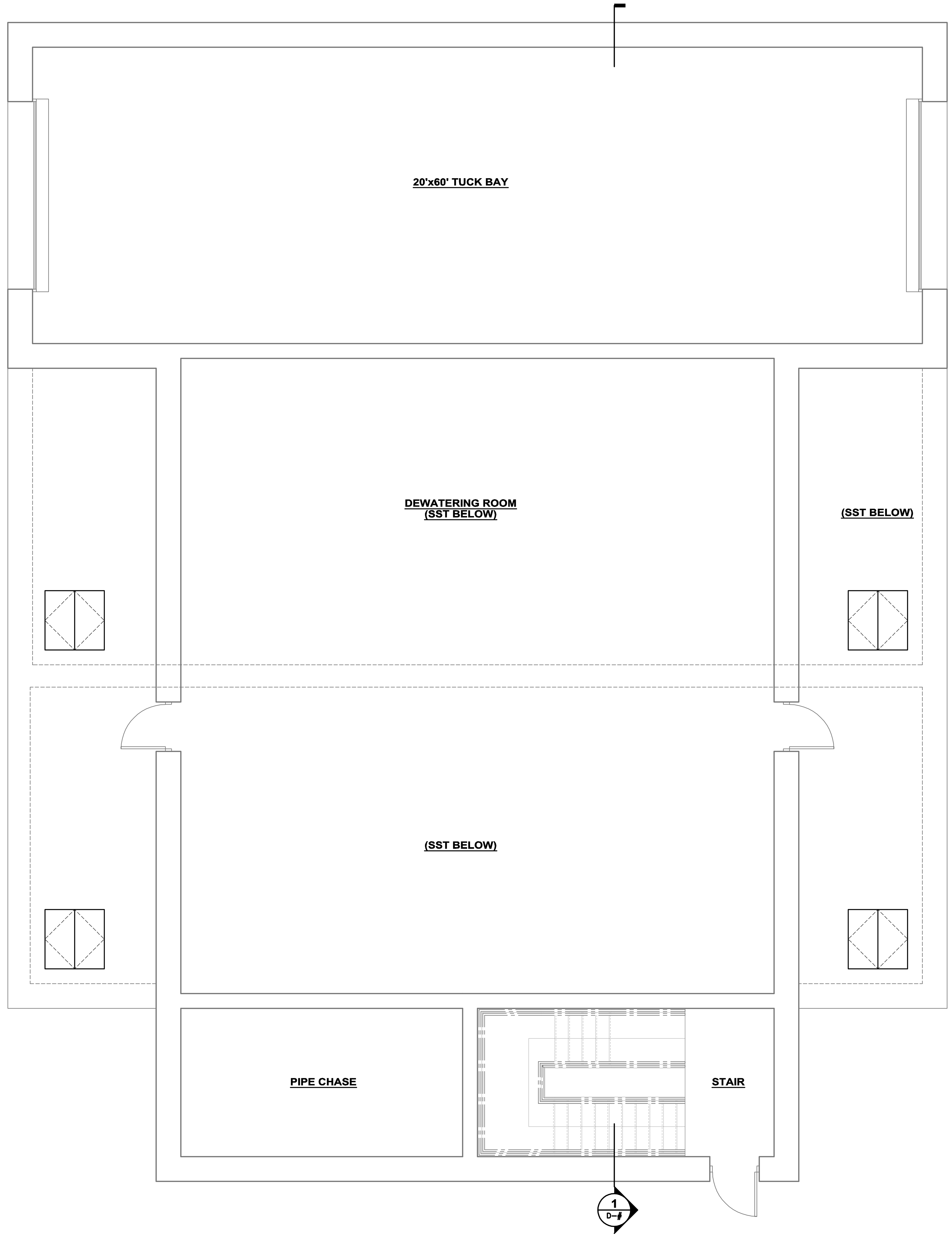
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

ALTERNATE "PROCESS BUILDING" SECTION

DRAWING
FIG 4-3



UPPER LEVEL

SCALE: 1/4"=1'-0"

EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

ALTERNATE "DEWATERING BUILDING" PLANS

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3			
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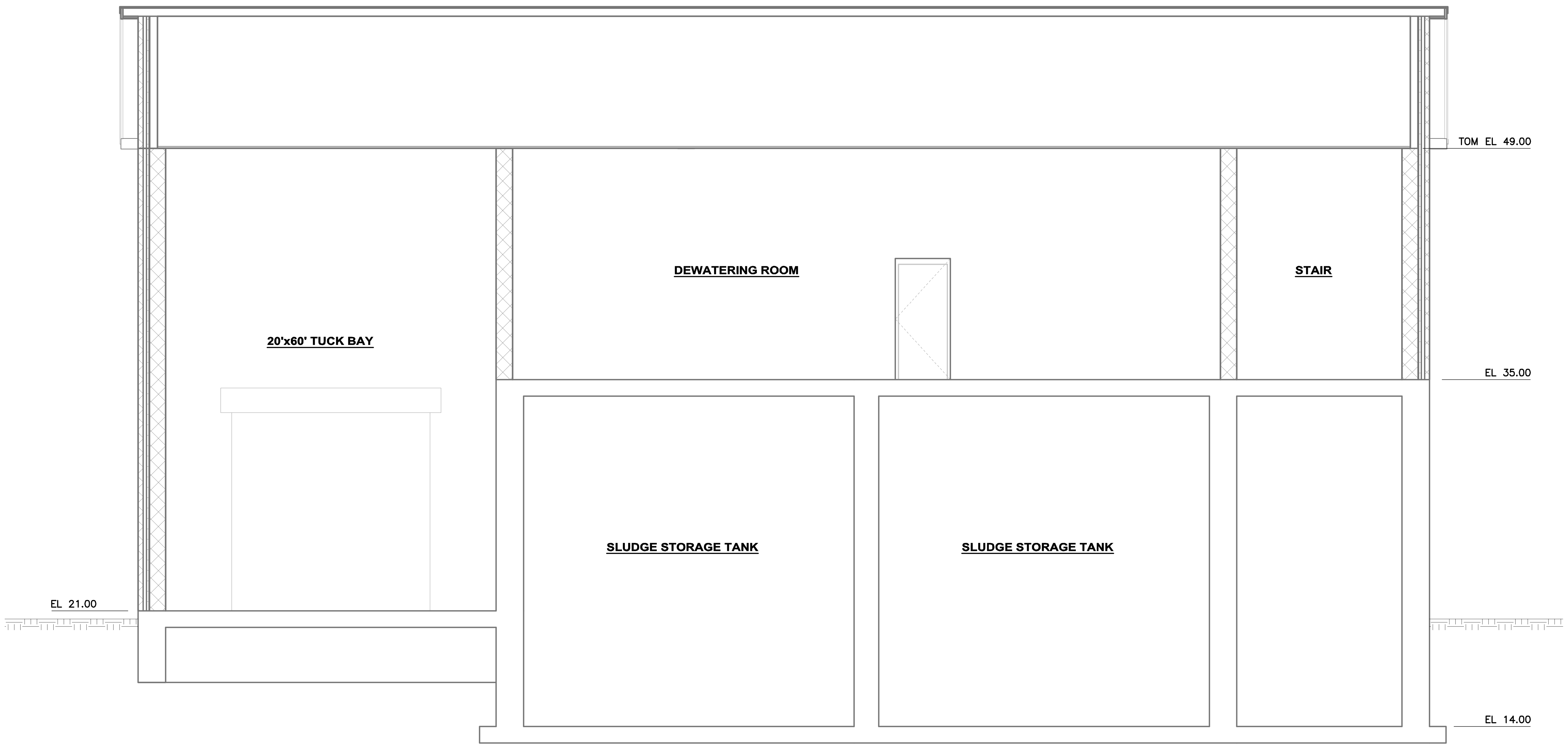
DRAWING
FIG 4-4



SECTION 1 / D-#
SCALE: 1/4"= 1'-0"

EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

ALTERNATE "DEWATERING BUILDING" SECTION

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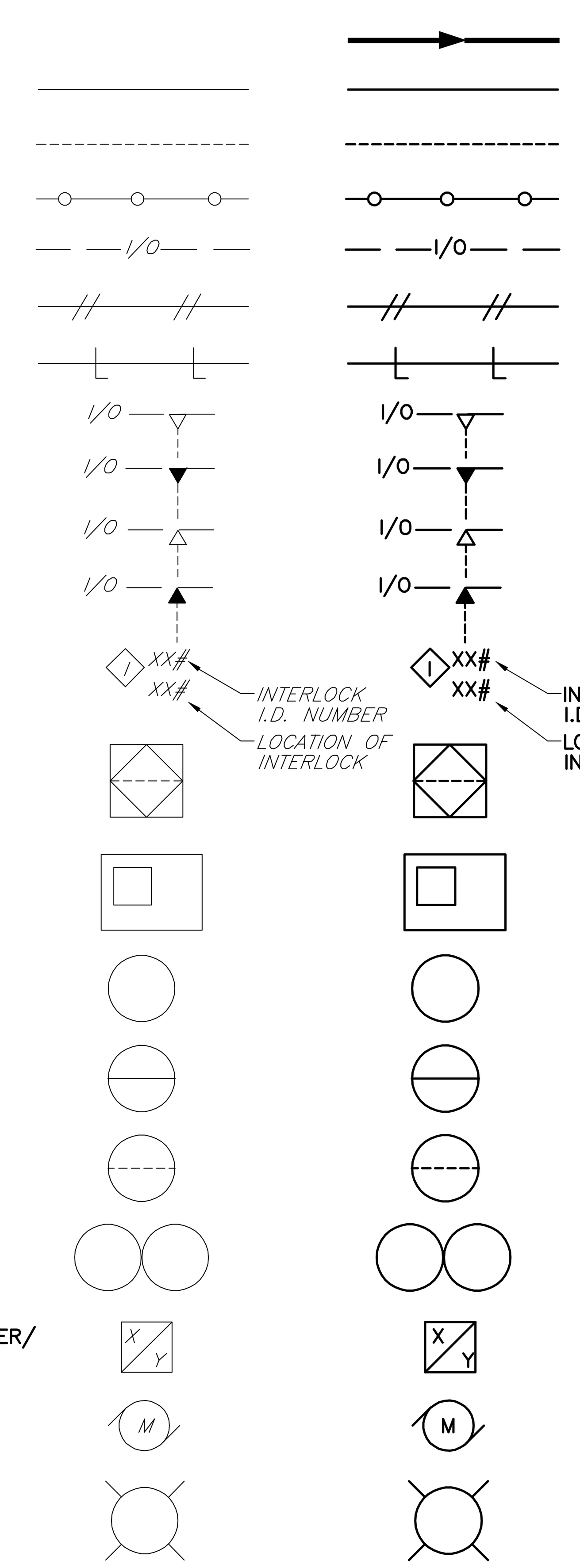
DRAWING
FIG 4-5

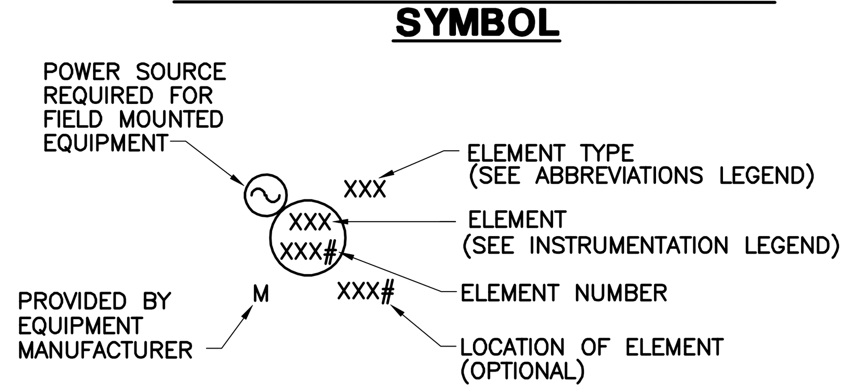
INSTRUMENTATION SYMBOL LEGEND

DESCRIPTION — EXISTING — NEW

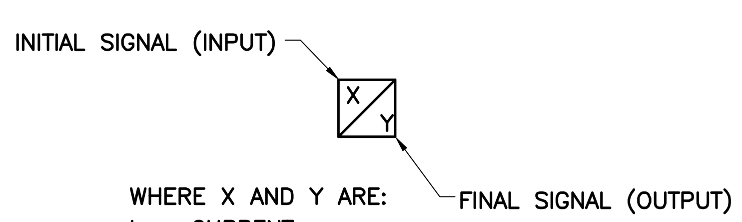
- PROCESS FLOW
- ELECTRICAL POWER OR PROCESS CONNECTION
- ELECTRICAL SIGNAL
- DATA LINK
- PLC INPUT/OUTPUT
- PNEUMATIC SIGNAL
- HYDRAULIC SIGNAL
- DISCRETE OUTPUT SIGNAL
- ANALOG OUTPUT SIGNAL
- DISCRETE INPUT SIGNAL
- ANALOG INPUT SIGNAL
- HARDWIRE INTERLOCK
- PROGRAMMABLE LOGIC CONTROLLER
- OPERATOR TERMINAL INTERFACE
- LOCAL (FIELD MOUNTED)
- FRONT PANEL MOUNTED
- REAR PANEL MOUNTED
- INTEGRAL EQUIPMENT
- SIGNAL SPLITTER CONVERTER/BOOSTER (SEE BELOW)
- MOTOR
- ALARM/ STATUS LIGHT



TYPICAL INSTRUMENTATION SYMBOL



TYPICAL SIGNAL CONVERTER SYMBOL



WHERE X AND Y ARE:
- I CURRENT
- E VOLTAGE
- P PRESSURE
- H HYDRAULIC

* ALSO USED AS A MODIFIER AFTER FIRST LETTER (i.e. PDIT: PRESSURE DIFFERENTIAL INDICATING TRANSMITTER)

** ALSO USED AS A MODIFIER AFTER LAST LETTER (i.e. LSHH: LEVEL SWITCH HIGH HIGH)

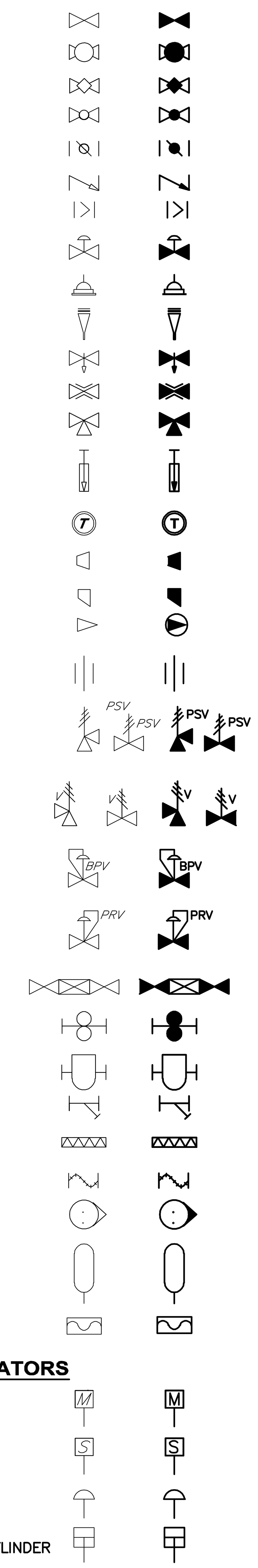
VALVES AND FITTINGS

DESCRIPTION — EXISTING — NEW

- GATE VALVE
- BALL VALVE
- PLUG VALVE
- GLOBE VALVE
- BUTTERFLY VALVE
- CHECK VALVE
- DOUBLE DISC CHECK VALVE
- DIAPHRAGM VALVE
- MUD VALVE
- TIDE CHECK VALVE
- NEEDLE VALVE
- PINCH VALVE
- 3-WAY VALVE
- KNIFE GATE
- TELESCOPING VALVE
- CONCENTRIC REDUCER
- ECCENTRIC REDUCER
- FLOW ARROW
- UNION
- PRESSURE SAFETY VALVE
- VACUUM RELIEF
- BACKPRESSURE VALVE
- PRESSURE REDUCING VALVE
- BACKFLOW PREVENTER
- DUPLEX STRAINER
- SIMPLEX STRAINER
- WYE STRAINER
- IN-LINE MIXER
- EXPANSION JOINT
- ROTAMETER
- PULSATION DAMPENER
- DIAPHRAGM SEAL

ACTUATORS

- CONTROL ACTUATOR
- SOLENOID ACTUATOR
- PNEUMATIC DIAPHRAGM ACTUATOR
- PNEUMATIC/HYDRAULIC CYLINDER



PUMPS

DESCRIPTION — EXISTING — NEW

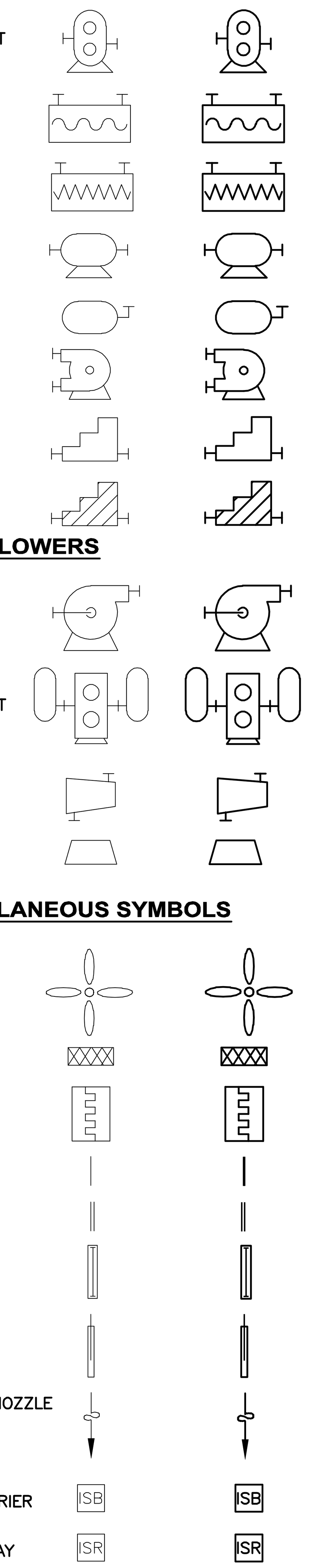
- POSITIVE DISPLACEMENT
- PROGRESSIVE CAVITY
- SCREW PUMP
- CENTRIFUGAL
- SUBMERSIBLE PUMP
- HOSE
- CHEMICAL METERING
- CHEMICAL TRANSFER

BLOWERS

- CENTRIFUGAL
- POSITIVE DISPLACEMENT
- COMPRESSOR/TURBO
- AIR INTAKE FILTER

MISCELLANEOUS SYMBOLS

- MIXER
- IN-LINE STATIC MIXER
- GRINDER
- WEIR
- STOP GATE
- SLIDE GATE
- SHEAR GATE
- CHEMICAL INJECTION NOZZLE
- INTRINSIC SAFETY BARRIER
- INTRINSIC SAFETY RELAY



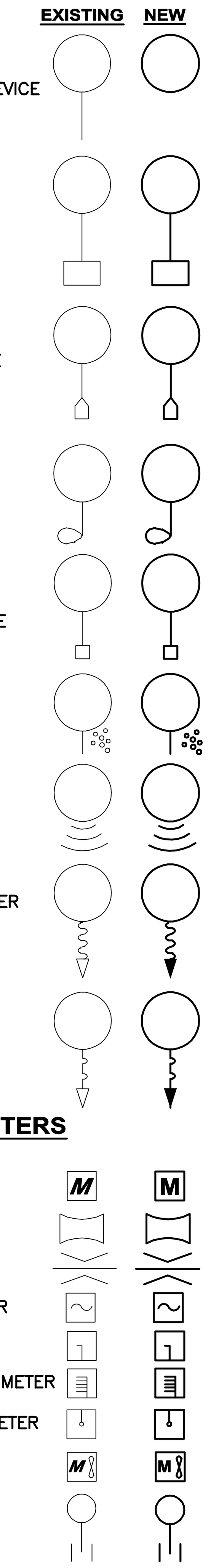
FIELD INSTRUMENTS

DESCRIPTION — EXISTING — NEW

- FIELD PIPE MOUNTED DEVICE
- PADDLE OR LEVER TYPE PROBE
- SUBMERSIBLE PRESSURE TRANSDUCER
- FLOAT SWITCH
- CAPACITANCE OR ADMITTANCE TYPE PROBE
- BUBBLE LIQUID LEVEL ELEMENT
- ULTRASONIC LEVEL TRANSDUCER
- RADAR LEVEL TRANSDUCER
- GUIDED WAVE RADAR

FLOW METERS

- MAGNETIC FLOW METER
- VENTURI FLOW METER
- PARSHALL FLUME
- ULTRASONIC FLOW METER
- PITOT FLOW METER
- AVERAGING PITOT FLOW METER
- THERMAL MASS FLOW METER
- TURBINE FLOW METER
- ORIFICE PLATE



INSTRUMENTATION LEGEND

FIRST LETTER 1		SUCCEEDING LETTER 2	3
A	ANALYSIS	ALARM	--
B	--	--	--
C	CONTROL	CONTROL	CONTROL
D	DIFFERENTIAL*	DETECT	--
E	--	ELEMENT	--
F	FLOW	--	--
G	GAS	GLASS	GLASS
H	HAND (MANUAL)	--	HIGH**
I	CURRENT	INDICATE	INDICATE
J	POWER	--	--
K	TIME*	--	--
L	LEVEL	LIGHT	LOW**
M	MOTOR	--	INTERMEDIATE
P	PRESSURE	--	--
Q	QUANTITY OR TOTALIZE*	QUANTITY	--
R	RADIATION	RECORD	RECORD
S	SPEED OR FREQUENCY	SWITCH	SIGNAL
T	TEMPERATURE	TRANSMIT	TRANSMIT
V	VIBRATION	VALVE	VALVE
W	TORQUE, WEIGHT, FORCE	--	--
X	--	--	--
Y	STATUS	RELAY, COMPUTE, OR CONVERT	RELAY, COMPUTE, OR CONVERT
Z	POSITION	--	--

ABBREVIATIONS LEGEND

ADM	ADMITTANCE
CAP	CAPACITANCE
CL	CHLORINE
CP	CONTROL PANEL
DO	DISSOLVED OXYGEN
ES	ETHERNET SWITCH
ESTOP	EMERGENCY STOP
FOR	FORWARD-OFF-REVERSE
FSR	FORWARD-STOP-REVERSE
FRSA	FORWARD-STOP-REVERSE-AUTO
HOA	HAND-OFF-AUTO
I	CURRENT
INF	INFLUENT
LOE	LOSS OF ECHO
LOR	LOCAL-OFF-REMOTE
MCC	MOTOR CONTROL CENTER
MES	MANAGED ETHERNET SWITCH
OCR	OPEN-CLOSE-REMOTE
OPT	OPERATOR TERMINAL
PLC	PROGRAMMABLE LOGIC CONTROLLER
PP	PATCH PANEL
RESET	ALARM RESET
ROL	RAISE OFF LOWER
ROR	RUN-OFF-REMOTE
SCR	SPEED CONTROL RECTIFIER
TURB	TURBIDITY
ULT	ULTRASONIC
VFD	VARIABLE FREQUENCY DRIVE

INDICATOR LIGHT COLOR LEGEND

RUN	RED
STOP	GREEN
WARNING	AMBER
ALARM	RED
POWER	WHITE

NOTES:

1. REFER TO ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION.
2. PROVIDE SIGNAL REPEATERS/CONVERTERS/BOOSTERS AS REQUIRED BASED UPON EQUIPMENT SELECTED BY INSTRUMENTATION SUPPLIER, DISTANCE AND LOCATION.
3. PROVIDE DRIP SHIELDS TO PROTECT ALL PANELS LOCATED UNDERNEATH PIPES OR OTHER LIQUID-CONTAINING STRUCTURES.
4. REFERENCE PROCESS AND ELECTRICAL DRAWINGS FOR LOCATION OF PANELS AND FIELD INSTRUMENTATION.
5. CONTRACTOR TO COORDINATE NEEDED VOLTAGE BASED UPON EQUIPMENT SUPPLIED.
6. ALL FLOOR MOUNTED CONTROL PANELS SHALL BE INSTALLED ON 4" HIGH CONCRETE EQUIPMENT PADS.
7. WHERE INPUT AND OUTPUT SIGNALS TO A PLC IS REQUIRED, PROVIDE PROPER TYPE AND QUANTITY OF INPUT/OUTPUT MODULES (I/O).
8. CONTRACTOR SHALL COORDINATE THE TYPE OF ANALOG SIGNAL PROVIDED BY THE EQUIPMENT OR FIELD DEVICES WITH THE PROPER TYPE PLC I/O.
9. ALL ANALOG SIGNALS WILL BE 4-20mA, UNLESS OTHERWISE INDICATED OR REQUIRED.

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY: AJM
CAD COORD: APC
CAD: AJM
CHECKED BY:
DATE:
APPROVED BY:
DATE:
PROJECT NO: 12883

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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT FACILITY UPGRADES

INSTRUMENTAION NOTES, LEGEND AND ABBREVIATIONS

DRAWING
I-1

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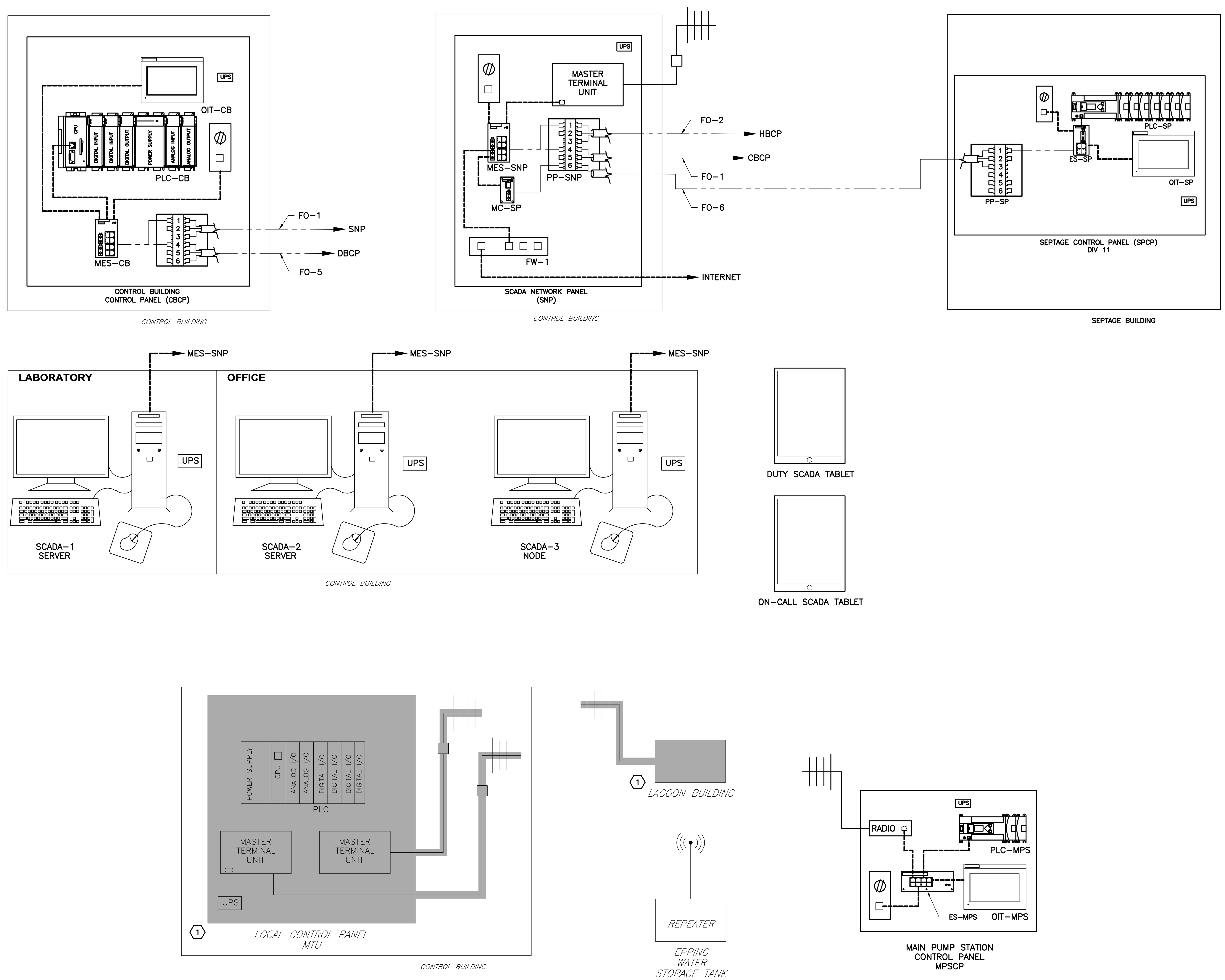
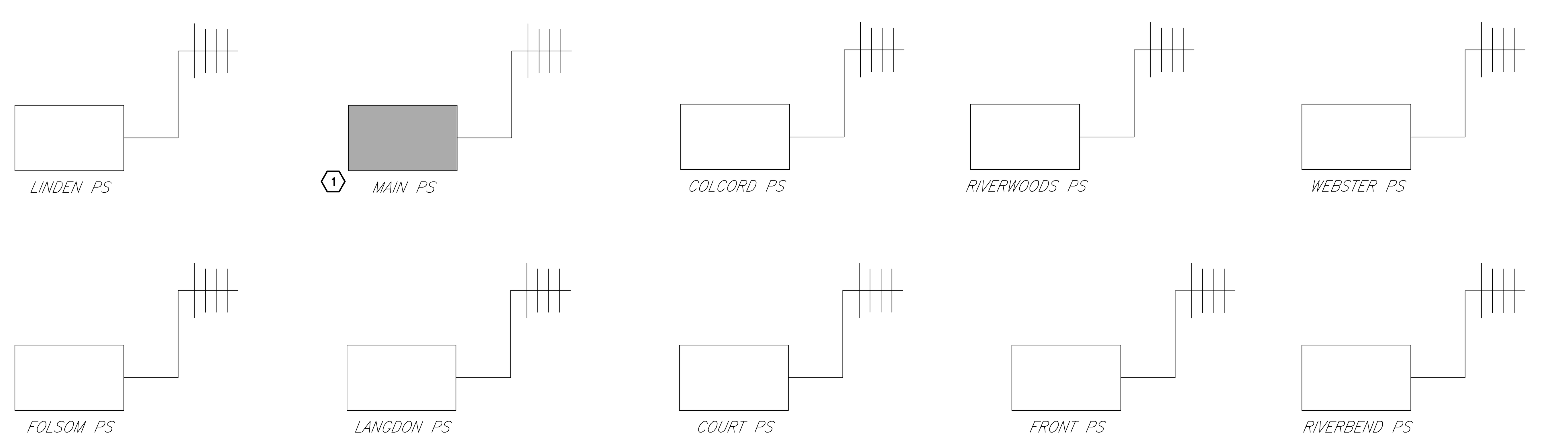
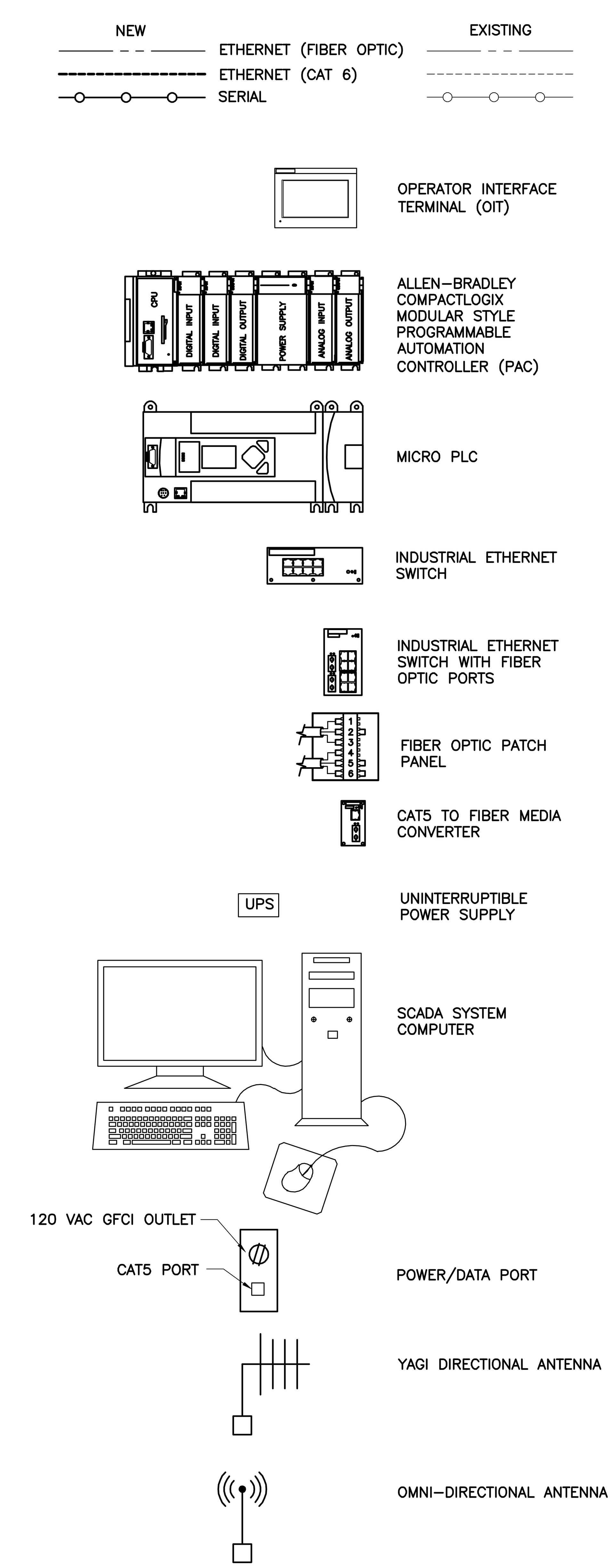




LEGEND:



DEMOLITION NOTES:

1. DISCONNECT AND REMOVE EXISTING PANEL AND RELATED EQUIPMENT.
2. N/A
3. RELOCATE RADIO PLC AND EQUIPMENT TO CBCP. DIVISION 13 TO PROVIDE ALL REQUIRED EQUIPMENT, CABLES, WIRING AND CONNECTORS.
4. DISCONNECT AND REMOVE EXISTING RTU. RELOCATE RADIO TO NEW CONTROL PANEL. DIVISION 13 TO PROVIDE ALL REQUIRED EQUIPMENT, CABLES, WIRING AND CONNECTORS.

NOTES:

1. THE NUMBER OF PORTS, CABLES, AND I/O MODULES SHOWN ON EQUIPMENT ARE FOR DIAGRAM PURPOSES ONLY, FOR ADDITIONAL INFORMATION REFER TO THE REMAINING CONTRACT DOCUMENTS.

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

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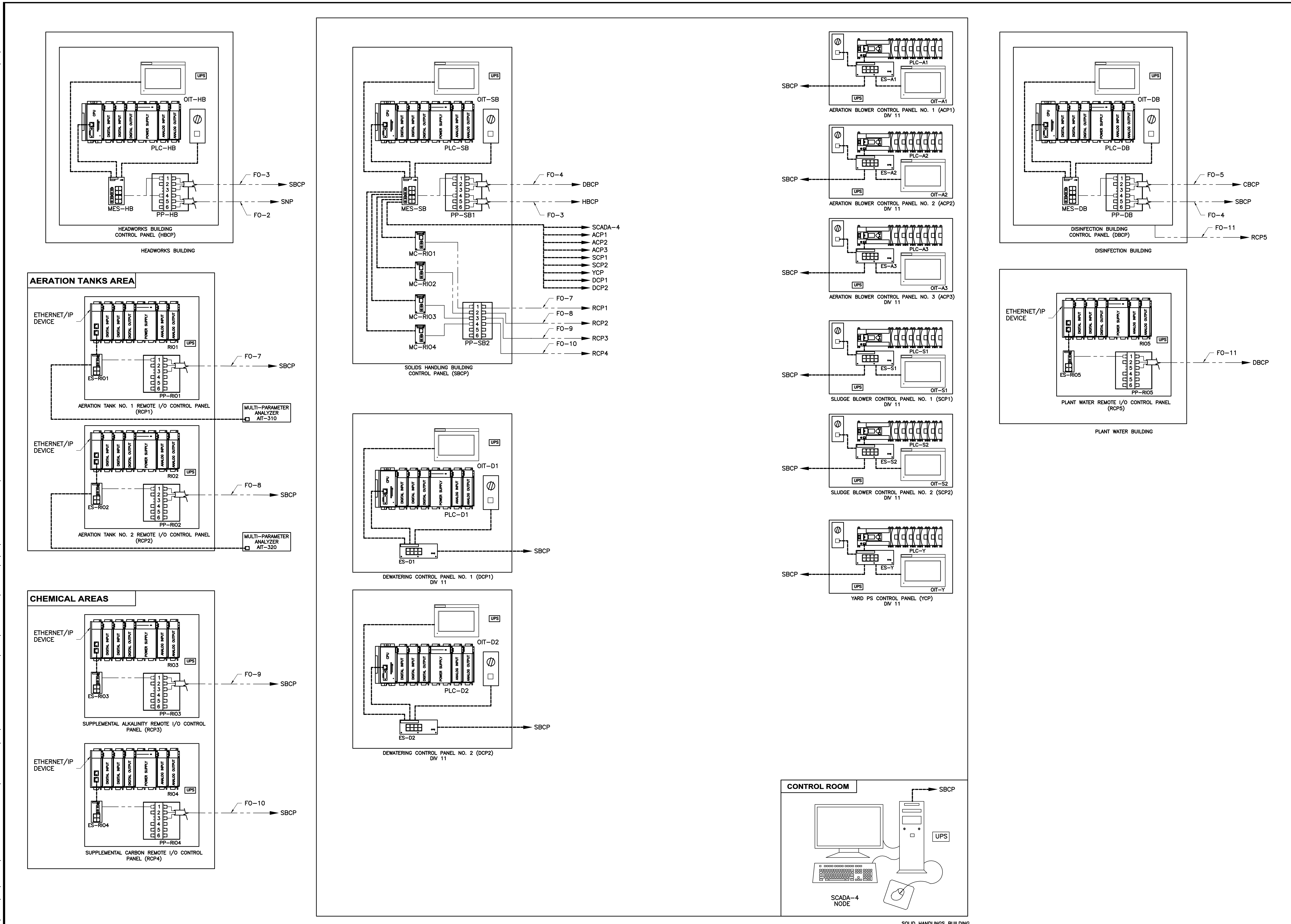
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

NETWORK DIAGRAM I

DRAWING
I-2



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DESIGNED BY: AJM
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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

NETWORK DIAGRAM II

DRAWING
I-3

POWER

DESCRIPTION

200/3 UNFUSED SAFETY SWITCH, RATING AS NOTED
- POLES
- AMPERES

30/15/3 FUSED SAFETY SWITCH, RATING AS NOTED
- POLES
- FUSE AMPERE RATING
- SWITCH AMPERE RATING

1 MAGNETIC MOTOR STARTER, RATING AS NOTED
- NEMA SIZE

COMBINATION TYPE MAGNETIC MOTOR STARTER, RATING AS NOTED

PUSHBUTTON OR SELECTOR SWITCH STATION

MAINTAINED RED MUSHROOM-HEAD EMERGENCY STOP P.B.

SOLENOID

R RELAY

MOD MOTOR OPERATED DAMPER

C LIGHTING OR POWER CONTACTOR

CB ENCLOSED CIRCUIT BREAKER

T THERMOSTAT
- C COOLING ONLY
- F FREEZESTAT
- D DUCT-MOUNTED

UTILITY METER

PANELBOARD, SURFACE MTD.

PANELBOARD, FLUSH MTD.

EQUIPMENT, TERMINAL, OR CONTROL CABINET

MOTOR

T TRANSFORMER

PAD MOUNTED TRANSFORMER

EWH ELECTRIC WATER HEATER

H ELECTRICAL HANDHOLE

J J JUNCTION BOX

PS PRESSURE SWITCH

E ELECTRIC ACTUATED VALVE

P PHOTOELECTRIC CELL

MS MANUAL MOTOR STARTER

FI FIROMATIC SWITCH

GROUNDING

DESCRIPTION

GROUND ROD

EXOTHERMIC WELD CONNECTION

BOLTED CONNECTION

—G— BARE COPPER CONDUCTOR RUN EXPOSED

---G--- BARE COPPER CONDUCTOR EMBEDDED IN CONCRETE OR BURIED

NOTE:

1. ALL SYMBOL LISTS SHALL BE CONSIDERED AS APPLICABLE TO ALL ELECTRICAL DRAWINGS FOR THIS PROJECT. SYMBOLS SHOWN ON THIS SHEET ARE FOR REFERENCE ONLY AND DO NOT INDICATE THEIR INCORPORATION IN THE DESIGN.

SINGLE LINE DIAGRAM

DESCRIPTION

SAFETY DISCONNECT SWITCH

TRANSFORMER

CT CURRENT TRANSFORMER

PT POTENTIAL TRANSFORMER

100AF FRAME SIZE CIRCUIT BREAKER
70AT TRIP AMPS

SURGE CAPACITOR

LIGHTNING ARRESTER

COMBINATION MOTOR STARTER AND BREAKER

AUTOTRANSFORMER-TYPE MOTOR STARTER

REVERSING MOTOR STARTER

TWO-SPEED TWO-WINDING MOTOR STARTER

REDUCED VOLTAGE SOLID-STATE MOTOR STARTER

DELTA CONNECTION

WYE CONNECTION

GROUND CONNECTION

5 MOTOR (HP AS SHOWN)

GENERATOR

N E TRANSFER SWITCH

ES EMERGENCY STOP MUSHROOM SWITCH (RED)

SPD SURGE PROTECTIVE DEVICE

A METER
- A – AMMETER
- V – VOLTMETER
- W – WATTMETER
- WH – WATT HOURMETER
- KWH – KILOWATT HOUR
- VAR – VAR METER
- HZ – FREQUENCY METER
- PF – POWER FACTOR METER

LIGHTING FIXTURES

DESCRIPTION

37Mh FLUORESCENT FIXTURE, 2x4 SURFACE TROFFER TYPE
- CIRCUIT (37) FIXTURE (M) SWITCH (h)

FLUORESCENT FIXTURE, STRIP, OPEN REFLECTOR, ENCLOSED OR WRAPAROUND TYPE

INCANDESCENT WALL MOUNTED FIXTURE

INCANDESCENT CEILING FIXTURE

INCANDESCENT LIGHT WITH GLOBE AND GUARD

H.I.D. WALL MOUNTED FIXTURE

H.I.D. CEILING FIXTURE

EXIT SIGN, CEILING MOUNTED ARROW INDICATES EGRESS DIRECTION SHADING INDICATES SIGN FACE

EXIT SIGN, WALL MOUNTED SHADING INDICATES SIGN FACE

EMERGENCY LIGHTING BATTERY UNIT WITH 2 LAMP HEADS

REMOTE EMERGENCY LIGHTING 1 OR 2 LAMP HEADS

POLE MOUNTED SITE LIGHT

SCHEMATIC DIAGRAM

DESCRIPTION

MS MANUAL MOTOR STARTER, O/L, RIL FRACTIONAL H.P.

CR CONTROL RELAY

M MOTOR CONTACTOR

CONTACT NORMALLY OPEN

CONTACT NORMALLY CLOSED

OVERLOAD HEATER ELEMENT

SINGLE POLE SINGLE THROW SWITCH

SELECTOR SWITCH

START PUSHBUTTON, MOMENTARY CONTACT

STOP PUSHBUTTON, MOMENTARY CONTACT

RED MUSHROOM-HEAD MAINTAINED-TYPE EMERGENCY STOP PUSHBUTTON

LIMIT SWITCH

TEMPERATURE SWITCH

FLOAT SWITCH

PRESSURE SWITCH

TIMED CONTACT

R PILOT LIGHT, LETTER INDICATES COLOR
- G GREEN
- R RED
- A AMBER

FUSE

CONNECTION POINT FOR EXTERNAL DEVICE

INTERNAL CONNECTION POINT

FIRE ALARM SYSTEM

DESCRIPTION

F MANUAL PULL STATION

F AUDIO/VISUAL ALARM STATION (ADA COMPLIANT)

L VISUAL ALARM (ADA COMPLIANT)

S SMOKE DETECTOR

H 135° HEAT DETECTOR TEMP RATING

SD DUCT-MOUNTED SMOKE DETECTOR, REMOTE ALARM & TEST

FACP FIRE ALARM SYSTEM CONTROL PANEL

TS SPRINKLER SYSTEM TAMPER SWITCH

FAA FIRE ALARM ANNUNCIATOR

FS SPRINKLER SYSTEM FLOW SWITCH

FRPS FIRE ALARM REMOTE POWER SUPPLY

MM FIRE ALARM SYSTEM "MONITOR MODULE"

FIM FAULT ISOLATING MODULE

TS REMOTE TEST STATION

TELEPHONE/PAGING/INTERCOM SYSTEM

DESCRIPTION

S PAGING SPEAKER, CEILING MTD.

PAGING HORN, WALL MTD.

TELEPHONE OUTLET RJ11

TD TELEPHONE RJ11/DATA RJ45

W WALL MOUNTED

HS PAGING HANDSET, WALL MOUNTED

WIRING DEVICES

DESCRIPTION

20 AMPERE, 120 VOLT DUPLEX RECEPTACLE

GFI 20 AMPERE, 120 VOLT DUPLEX RECEPTACLE

+48" INDICATES INCHES AFF MOUNTING HEIGHT

WP WEATHERPROOF

IG ISOLATED GROUND

CTR COUNTER TOP

20 AMPERE, 120 VOLT QUAD RECEPTACLE

20 AMPERE, 120 VOLT SINGLE RECEPTACLE

CLOCK OUTLET

30 SINGLE SPECIAL PURPOSE RECEPTACLE
- INDICATES AMPERE SIZE

PLUGMOLD

S SINGLE POLE WALL SWITCH
- DP DOUBLE POLE SWITCH
- 3 THREE WAY SWITCH
- 4 FOUR WAY SWITCH
- P NEON PILOT LIGHT
- WP WEATHERPROOF
- K KEY OPERATED
- EP EXPLOSION PROOF
- D DIMMER SWITCH
- T MOTOR RATED
- EM EMERGENCY SHUT-OFF

WIRING

DESCRIPTION

WIRING, CONCEALED IN FINISHED AREAS, EXPOSED WHERE PERMITTED BY SPECIFICATIONS

WIRING INSTALLED IN OR BELOW FLOOR SLAB

EBU-XX HOME RUN TO DEVICE (EBU, ATC, ETC.)

P101 HOME RUN (NO. REFERS TO CONDUIT AND WIRE SCHEDULE)

—DC— DC WIRING

3C#12 W/GND, .75"C CONDUIT AND WIRE

CONDUIT DOWN

CONDUIT UP

#XX INDICATES THE CIRCUIT # OF THE RESPECTIVE PANELBOARD REFERENCED. SEE GENERAL NOTES 6 AND 26 FOR CONDUIT AND WIRING REQUIREMENTS

SECURITY SYSTEM

DESCRIPTION

SACP SECURITY ALARM CONTROL PANEL

K WP SECURITY SYSTEM FUNCTION KEYPAD
- WEATHERPROOF

D OH DOOR CONTACT
- OVERHEAD DOOR TYPE

W GLASS BREAK CONTACT, GLASS MOUNTED TYPE

R A INFRARED INTRUDER SENSOR

G A AREA GLASS BREAK DETECTOR

NEMA CLASSIFICATIONS FOR ELECTRICAL EQUIPMENT AND ENCLOSURES

(UNLESS OTHERWISE NOTED – SEE NOTE BELOW)

ROOM NO.	ROOM NAME	NEMA RATING

NOTE:

THE AREAS NOTED SHALL BE RATED AS INDICATED, EXCEPT THAT EQUIPMENT SUCH AS MOTOR CONTROL CENTERS, SWITCHBOARDS, AND TRANSFORMERS SHALL BE RATED AS SPECIFIED. PANELBOARDS AND TRANSFORMERS SHALL BE, AT A MINIMUM, RATED NEMA 12 IF NOT SPECIFIED.

** CONDUIT INSTALLATION SCHEDULE

AREA NEMA RATING PER E-1	CONDUIT REQUIRED IN EXPOSED AREAS	CONDUIT REQUIRED IN NON EXPOSED AREAS	CONDUITS EMERGING FROM GRADE OR SLAB 12" AFF
1	ALUMINUM	EMT	RGS PVC COATED
12	ALUMINUM	EMT	RGS PVC COATED
3R	ALUMINUM	EMT	RGS PVC COATED
4	ALUMINUM	EMT	RGS PVC COATED
4X	ALUMINUM	EMT	RGS PVC COATED
4X CORROSIVE	RGS PVC COATED	EMT	RGS PVC COATED
4X CORROSIVE ABOVE 8'	PVC SCHEDULE 80	EMT	N/A
7	RGS PVC COATED	RGS	RGS PVC COATED
* IN CONCRETE SLAB	PVC SCHEDULE 40	PVC SCHEDULE 40	RGS PVC COATED
* BELOW GRADE DUCT ENCASED IN CONCRETE	PVC SCHEDULE 40	PVC SCHEDULE 40	RGS PVC COATED
* BELOW GRADE DUCT NON ENCASED	PVC SCHEDULE 80	PVC SCHEDULE 80	RGS PVC COATED

** SEE SPECIFICATIONS FOR FURTHER INFORMATION
* SIGNAL CONDUITS BELOW GRADE SHALL BE RGS

GRAPHIC SCALE NOTE

EACH PLAN AND SECTION VIEW IS PROVIDED WITH A GRAPHIC BAR SCALE SIMILAR TO THAT INDICATED HEREIN. 40' IF THE BAR SCALE IS NOT PRESENT ON ANY PLAN OR SECTION THE CONTRACTOR SHALL NOTIFY THE ENGINEER. DRAWING SCALES ARE PROVIDED FOR THE CONTRACTORS USE, HOWEVER, ALL SPECIFICALLY INDICATED DIMENSIONS TAKE PRECEDENCE OVER THIS GRAPHIC SCALE.

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY: SAL
CAD COORD: APC
CAD: SJM
CHECKED BY:
DATE:
APPROVED BY:
DATE:
PROJECT NO: 12883

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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT FACILITY UPGRADES

ELECTRICAL LEGEND, CONDUIT INSTALLATION SCHEDULE AND NEMA SCHEDULE

DRAWING
E-1

LAST SAVED BY: STEVEN.LAPRISE 8/17/2015 4:00 PM

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ABBREVIATIONS

A	AMPERE
AC	ALTERNATING CURRENT
ACR	CONTROL RELAY "A" (TYP)
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
AI	ANALOG INPUT (PLC)
AIC	AMPERE INTERRUPTING CAPACITY
AL	ALUMINUM
AO	ANALOG OUTPUT (PLC)
ASYM	ASYMMETRICAL
ATC	AUTOMATIC TEMPERATURE CONTROL
ATS	AUTOMATIC TRANSFER SWITCH
AUX	AUXILIARY
AWG	AMERICAN WIRE GAUGE
BFG	BELOW FINISHED GRADE
BKR	BREAKER
BOS	BOTTOM OF STEEL
C	CONDUIT
CATV	CABLE TELEVISION
CB	CIRCUIT BREAKER
CCF	CARBON CANISTER FILTER
CI	CONTROL INTERLOCK
CKT	CIRCUIT
CP	CONTROL PANEL
CR	CONTROL RELAY
CPT	CONTROL POWER TRANSFORMER
CT	CURRENT TRANSFORMER
CU	COPPER
DACT	DIGITAL ALARM COMMUNICATOR TRANSMITTER
DB	DIRECT BURIED
DBH	DIESEL BLOCK HEATER
DC	DIRECT CURRENT
DI	DIGITAL INPUT (PLC)
DISC	DISCONNECT
DN	DOWN
DO	DIGITAL OUTPUT (PLC)
EBU	EMERGENCY BATTERY UNIT
EC	ELECTRICAL CONTRACTOR
EF	EXHAUST FAN
EG	EQUIPMENT GROUND
EH	ELECTRICALLY HELD
EHH	ELECTRICAL HANDHOLE
EM	EMERGENCY
EMT	ELECTRICAL METALLIC TUBING
EO	ELECTRICALLY OPERATED
EP	EXPLOSION PROOF CL I DIV 1 GR D
EPR	ETHYLENE PROPYLENE RUBBER
EQUIP	EQUIPMENT
ES	EMERGENCY STOP
EWC	ELECTRIC WATER COOLER
EWH	ELECTRIC WATER HEATER
EX	EXTERIOR
EXIT	EXISTING
F	FIELD
FA	FIRE ALARM
FAA	FIRE ALARM ANNUNCIATOR
FACP	FIRE ALARM CONTROL PANEL
FBO	FURNISHED BY OTHERS
FC	FOOTCANDLE
FE	FLOW ELEMENT
FIT	FLOW INDICATOR TRANSMITTER
FLUOR	FLUORESCENT
FNR	FORWARD NEUTRAL REVERSE
FS	FLOW SWITCH
FTR	FIN TUBE RADIATOR
FU	FUSE
FWE	FURNISHED WITH EQUIPMENT
FVNR	FULL VOLTAGE NON-REVERSING
FVR	FULL VOLTAGE REVERSING
GCP	GENERATOR CONTROL PANEL
GEN	GENERATOR
GF	GROUND FAULT
GFI	GROUND FAULT CIRCUIT INTERRUPTER
GND	GROUND
HH	HANDHOLE
HID	HIGH INTENSITY DISCHARGE
HIT	HIGH INTENSITY TUNGSTEN
HOA	HAND-OFF-AUTOMATIC
HP	HORSEPOWER
HPS	HIGH PRESSURE SODIUM
HTR	HEATER
HV	HIGH VOLTAGE
HVAC	HEATING VENTILATING AIR CONDITIONING
HWV	HOT WATER VALVE
HZ	HERTZ
IG	ISOLATED GROUND
IMC	INTERMEDIATE METAL CONDUIT
INCAND	INCANDESCENT
ISR	INTRINSICALLY SAFE RELAY
JB	JUNCTION BOX
K	KILO
KCMIL	THOUSAND CIRCULAR MILS
KV	KILOVOLT
KVA	KILOVOLT-AMPERE
KVAR	KILOVOLT-AMPERE REACTIVE
KW	KILOWATT
KWH	KILOWATT-HOUR
L	LOCAL
LA	LIGHTNING ARRESTER
LCP	LOCAL CONTROL PANEL
LCS	LOCAL CONTROL STATION
LE	LEVEL ELEMENT
LI	LEVEL INDICATOR
LIT	LEVEL INDICATOR TRANSMITTER
LP	LIGHTING PANEL
LPS	LOW PRESSURE SODIUM
LSW	LIGHT SWITCH
LS	LEVEL SWITCH L=LOW, H=HIGH, LL=LOW LOW, HH=HIGH HIGH
LT	LEVEL TRANSMITTER
LTG	LIGHTING
LV	LOW VOLTAGE
MC	METAL CLAD
MCB	MAIN CIRCUIT BREAKER
MCC	MOTOR CONTROL CENTER
MCP	MOTOR CIRCUIT PROTECTOR
MFR	MANUFACTURER
MI	MINERAL INSULATED
MH	MANHOLE
MLO	MAIN LUG ONLY
MO	MECHANICALLY OPERATED
MOD	MOTOR OPERATED DAMPER
MOV	MOTOR OPERATED VALVE
MS	MOTOR STARTER
MTD	MOUNTED
MTS	MANUAL TRANSFER SWITCH
MVA	MEGAVOLT-AMPERE
MV	MEDIUM VOLTAGE
NC	NORMALLY CLOSED
NEG	NEGATIVE
NEU	NEUTRAL
NIC	NOT IN CONTRACT
NO	NORMALLY OPEN
NTS	NOT TO SCALE
OEM	FURNISHED BY MANUFACTURER
OH	OVERHEAD
OL	OVERLOAD
OOA	ON-OFF-AUTOMATIC
OSY	OUTSIDE STEM AND YOKE VALVE (FA SYSTEM)
P	POLE
PB	PUSHBUTTON
PC	PERSONAL COMPUTER
PE	PRESSURE ELEMENT
PF	POWER FACTOR
PH	PHASE
PIT	PRESSURE INDICATOR TRANSMITTER
PLC	PROGRAMMABLE LOGIC CONTROLLER
PNL	PANEL
PRI	PRIMARY
PT	POTENTIAL TRANSFORMER
PT	PRESSURE TRANSMITTER
PVC	POLYVINYL CHLORIDE
QI	LOAD KW INDICATOR
R	REMOTE
RGS	RIGID GALVANIZED STEEL CONDUIT
RIL	RED INDICATING LIGHT (TYP) B=BLUE, G=GREEN, A=AMBER
RSC	RIGID STEEL CONDUIT
RTD	RESISTANCE TEMPERATURE DETECTOR
RVSS	REDUCED VOLTAGE SOLID STATE
S	SURFACE
SEC	SECONDARY
SF	SUPPLY FAN
SHLD	SHIELDED CABLE
SI	SPEED INDICATOR
SN	SOLID NEUTRAL
SP	SPARE
SS	SURGE SUPPRESSOR
STP	SHIELDED TWISTED PAIR
STT	SHIELDED TWISTED TRIPLET
SV3	3 WAY VALVE
SW	SWITCH
SWBD	SWITCHBOARD
SWGR	SWITCHGEAR
SYM	SYMMETRICAL
T	TRANSFORMER
TB	TERMINAL BLOCKS
TOS	TOP OF STEEL
TS	THERMOSTAT
TC	COOLING THERMOSTAT
TD	TEL DIALER
TDR	TIME DELAY RELAY
TE	TEMPERATURE ELEMENT
TEL	TELEPHONE
TF	FREEZE STAT
TH	HUMIDISTAT
TIT	TEMPERATURE INDICATING TRANSMITTER
TL	TEMPERATURE LOW
TOA	THERMOSTAT OUTSIDE AIR
TRANSF	TRANSFORMER
TS	THERMOSTAT
TS	TEMPERATURE SWITCH
TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSOR
TWS	TWISTED SHIELDED CABLE
UG	UNDERGROUND
UH	UNIT HEATER
UPS	UNINTERRUPTIBLE POWER SUPPLY
V	VOLT
VA	VOLT-AMPERE
VAR	VOLT-AMPERE REACTIVE
VFD	VARIABLE FREQUENCY DRIVE
VPS	VACUUM PRESSURE SWITCH
W	WIRE
WH	WATT HOUR
WM	WATT METER
WP	WEATHERPROOF
XLP	CROSS LINKED POLYETHYLENE
XFMR	TRANSFORMER
ZSC	LIMIT SWITCH CLOSED
ZSO	LIMIT SWITCH OPEN

NOTE:

1. ALL GENERAL NOTES, AND ABBREVIATIONS SHALL BE CONSIDERED AS APPLICABLE TO ALL ELECTRICAL DRAWINGS FOR THIS PROJECT. ABBREVIATIONS SHOWN ON THIS SHEET ARE FOR REFERENCE ONLY AND DO NOT INDICATE THEIR INCORPORATION IN THE DESIGN.

GENERAL DEMOLITION NOTES:

1. THE EXISTING ELECTRICAL DRAWINGS FOR THIS PROJECT ARE BASED ON INFORMATION PRESENTED IN THE AS-BUILT CONTRACT DRAWINGS PROVIDED FOR THIS PROJECT. GENERAL CONTRACTOR SHALL FIELD VERIFY ALL DIMENSIONS AND ELEVATIONS AND NOTIFY THE ENGINEER OF ANY DISCREPANCIES.
2. FIELD VERIFY ALL CONDITIONS AFFECTING THE WORK PRIOR TO CONSTRUCTION AND NOTIFY THE ENGINEER OF ANY DISCREPANCIES.
3. PROTECT ALL EXISTING ITEMS AND EQUIPMENT ADJACENT TO THE WORK AREA. ALL EXISTING ITEMS, EQUIPMENT AND MATERIALS DAMAGED OR AFFECTED BY THE WORK SHALL BE REPAIRED OR REPLACED AT NO ADDITIONAL COST TO THE OWNER.
4. THE FACILITY WILL REMAIN IN OPERATION DURING THE CONSTRUCTION OF THE PROJECT. THE CONTRACTOR WILL COORDINATE THE DEMOLITION AND CONSTRUCTION WITH THE OWNER'S REQUIREMENTS TO MAINTAIN PLANT OPERATION.
5. PROVIDE ALL TEMPORARY BRACING REQUIRED AND SUPPORT ALL ITEMS AND EQUIPMENT MOUNTED TO THE WALLS WHICH ARE DESIGNATED TO BE REMOVED. REINSTALL ALL ITEMS AFTER THE NEW WALLS ARE COMPLETED.
6. PATCH, REPAIR AND REFINISH ALL EXISTING SURFACES AFFECTED BY THE WORK, TO THE SATISFACTION OF THE ENGINEER.
7. REMOVE, REINSTALL OR REPLACE ALL MISCELLANEOUS ITEMS MOUNTED TO THE WALLS DESIGNATED TO BE REMOVED OR RENOVATED.
8. ALL ITEMS SHOWN ON THE PLANS WITH SHADING ARE TO BE REMOVED AND DISPOSED OF, UNLESS OTHERWISE INDICATED. THIS SHALL INCLUDE ALL ASSOCIATED CONDUIT, WIRING, BOXES, DEVICES, CONTROLS, ETC. UNLESS OTHERWISE NOTED. THE OWNER RESERVES THE RIGHT TO RETAIN ANY EQUIPMENT OR MATERIALS. THE CONTRACTOR WILL STORE ON SITE AND PROTECT SUCH ITEMS IN A MANNER ACCEPTABLE TO THE OWNER AND ENGINEER. ALSO REFER TO THE STRUCTURAL, MECHANICAL, PROCESS AND ELECTRICAL DRAWINGS FOR A COMPLETE REQUIREMENT OF DEMOLITION WORK FOR THIS PROJECT.

GENERAL NOTES

1. ALL CONDUIT AND EQUIPMENT SHALL BE INSTALLED AND GROUNDED IN ACCORDANCE WITH THE RULES AND REGULATIONS OF THE CURRENT NATIONAL ELECTRICAL CODE.
2. CONDUIT RUNS ARE SHOWN DIAGRAMMATICALLY ONLY AND SHALL BE INSTALLED IN A MANNER TO PREVENT CONFLICTS WITH EQUIPMENT AND STRUCTURES. CONDUITS SHALL BE CONCEALED IN WALLS, AND ABOVE ANY SUSPENDED CEILINGS WHERE APPLICABLE. EXPOSED CEILING CONDUITS SHALL BE PERMITTED WHERE SUSPENDED CEILINGS ARE NOT USED. EXPOSED CONDUITS SHALL BE INSTALLED PARALLEL TO BEAMS AND WALLS.
3. CONDUITS SHALL BE PROPERLY TERMINATED WITH NEAT CONNECTIONS TO ALL ASSOCIATED EQUIPMENT.
4. CONTROL AND INSTRUMENTATION CONDUIT SIZES AND NUMBER OF CONDUCTORS ARE TO BE DETERMINED FROM SCHEMATIC DIAGRAMS, INSTRUMENTATION DIAGRAMS, AND/OR SPECIFICATIONS, IF NOT DIRECTLY SHOWN ON POWER PLANS. THE WIRING DIAGRAMS, QUANTITY AND SIZE OF WIRES AND CONDUIT REPRESENT A SUGGESTED ARRANGEMENT BASED UPON SELECTED STANDARD COMPONENTS OF ELECTRICAL AND INSTRUMENTATION EQUIPMENT. MODIFICATIONS REVIEWED BY THE ENGINEER WITH NO EXCEPTIONS TAKEN, MAY BE MADE BY THE CONTRACTOR TO ACCOMMODATE EQUIPMENT ACTUALLY PURCHASED. THE BASIC SEQUENCE AND METHOD OF CONTROL MUST BE MAINTAINED AS INDICATED ON THE DRAWINGS AND SPECIFICATIONS. EACH CONTROL AND INSTRUMENTATION CONDUIT SHALL ALSO CONTAIN 10 PER CENT SPARE CONDUCTORS, WITH A MINIMUM OF TWO SPARES, UP TO THE LIMIT OF CONDUIT FILL AS SPECIFIED BY THE NATIONAL ELECTRICAL CODE. INSTRUMENTATION SHIELDED CABLES SHALL BE INSTALLED IN RGS CONDUIT. SEPARATE FROM OTHER POWER WIRING.
5. EACH CONDUIT TO CARRY GROUND WIRE(S) ACCORDING TO SPECIFICATION #16450, IN ADDITION TO NUMBER OF CONDUCTORS SHOWN ON DRAWINGS OR PER NOTE 4 ABOVE. ALL GROUNDING MUST CONFORM TO ARTICLE 250 OF CURRENT NATIONAL ELECTRICAL CODE.
6. MINIMUM CONDUIT SIZE SHALL BE 3/4" TRADE SIZE, UNLESS OTHERWISE NOTED ON THE ELECTRICAL DRAWINGS. GENERAL LIGHTING, RECEPTACLE AND HVAC POWER CIRCUITS MAY BE 1/2" TRADE SIZE CONDUIT INSTALLED PER NEC. MINIMUM POWER WIRING SHALL BE 2C#12 AWG WITH GROUND AND 2C#14 AWG FOR CONTROL. MINIMUM INSTRUMENTATION CABLE SHALL BE 2/C#16 AWG TWS AND 3C#16 AWG TWS FOR SPEED POTENTIOMETERS AND RTD'S. PROVIDE CONDUIT AND WIRING AS INDICATED.
7. ALL PANELBOARDS SHALL BE MOUNTED SO THAT THE DISTANCE FROM THE TOP CIRCUIT BREAKER OPERATING HANDLE TO FINISHED FLOOR SHALL NOT EXCEED 6'-6".
8. ALL SURFACE MOUNTED PANELS AND PANELBOARDS ON THE INSIDE OF EXTERIOR WALLS ABOVE GRADE, OR IN OTHER LOCATIONS CONSIDERED AS DAMP, SHALL BE MOUNTED TO MAINTAIN A 1/4" AIR SPACE BETWEEN THE ENCLOSURE AND THE WALL.
9. ELECTRICAL EQUIPMENT LOCATIONS ARE APPROXIMATE ONLY. COORDINATE LOCATIONS WITH PROCESS PIPING, ARCHITECTURAL, STRUCTURAL, AND MECHANICAL DRAWINGS. CONTRACTOR SHALL COORDINATE MANUFACTURERS EQUIPMENT REQUIREMENTS WITH SPACE AVAILABLE. FINAL CONTROL PANEL LOCATIONS SHALL BE FIELD COORDINATED.
10. ALL FIELD CONTROL CONDUCTORS WILL TERMINATE AT INDIVIDUAL TERMINAL BLOCKS WITHIN THE CONTROL ENCLOSURE. SERIES AND PARALLEL CONNECTION OF FIELD CONTROL CONDUCTORS WILL BE MADE ONLY AT CONTROL PANEL OR MOTOR CONTROL CENTER TERMINAL BLOCKS.
11. GROUND ALL CONDUCTOR SHIELDS AT PANEL ONLY – DO NOT GROUND SHIELDS AT BOTH ENDS.
12. AT THE FOLLOWING LOCATIONS, UNLESS OTHERWISE NOTED, PULL, JUNCTION, TERMINAL, SWITCH, AND OUTLET BOXES SHALL BE CAST IRON WHERE STEEL CONDUIT IS TERMINATED; OR SHALL BE CAST ALUMINUM WHERE ALUMINUM CONDUIT IS TERMINATED:

    A – AT LOCATIONS WHERE VAPORTIGHT LIGHTING FIXTURES AND/OR WATERTIGHT RECEPTACLES ARE INDICATED.
    B – AT LOCATIONS ON OR IN ALL OUTSIDE WALLS.
    C – OUTDOORS
13. NAMEPLATES SHALL CONFORM STRICTLY TO INSTRUCTIONS IN THE ELECTRICAL SPECIFICATIONS AND ON THE DRAWINGS. THE FOLLOWING SHALL HAVE NAMEPLATES:

    A – ALL MAIN BREAKERS AND TIE BREAKERS.
    B – ALL COMPARTMENTS OF MOTOR CONTROL CENTERS EXCLUDING UNUSED COMPARTMENTS.
    C – ALL LOCAL CONTROL STATIONS AT OR NEAR EQUIPMENT.
    D – ALL PANELBOARDS.
    E – GANGED LIGHT SWITCHES.
14. PIPE SLEEVES FOR CONDUITS PASSING FROM NON-HAZARDOUS AREAS TO HAZARDOUS AREAS SHALL HAVE CAULKING APPLIED TO MAKE THE INSTALLATION GASTIGHT.
15. COORDINATE ELECTRICAL DEVICES WITH LAB EQUIPMENT AND FURNITURE ARRANGEMENT, WHERE APPLICABLE.
16. COORDINATE ELECTRICAL DEVICES WITH OFFICE/KITCHEN EQUIPMENT ARRANGEMENT, WHERE APPLICABLE.
17. CONTRACTOR SHALL PROVIDE ALL DISCONNECTS AND SERVICE RECEPTACLES FOR HVAC AS REQUIRED BY NEC.
18. CONTRACTOR SHALL PROVIDE ALL CONDUIT, WIRING, EQUIPMENT, AND CONTROL DEVICES AS INDICATED BY SCHEMATICS, SINGLE LINE DIAGRAMS, SCHEDULES, PLANS, SPECIFICATIONS, AND VENDOR DOCUMENTATION TO PROVIDE A COMPLETE WORKING SYSTEM. SINCE NOT ALL HOME RUNS ARE SHOWN ON PLANS, THE CONTRACTOR SHALL REFERENCE ALL SINGLE LINE AND SCHEMATIC DIAGRAMS, SCHEDULES, AND VENDOR DOCUMENTATION TO DETERMINE CONDUIT AND WIRING REQUIREMENTS.
19. PROVIDE CONDUIT FREEZE EXPANSION FITTINGS FOR ALL EXTERIOR CONDUIT SYSTEMS.
20. EXACT NUMBER, LOCATION, HORSEPOWER, VOLTAGE, AND PHASE OF ALL MOTORS AND DEVICES ASSOCIATED WITH THE ODOR CONTROL SYSTEM, CHEMICAL FEED SYSTEM, GRIT, SCREENING AND PLANT WATER, AND OTHER EQUIPMENT SYSTEMS AS APPLICABLE, PROVIDED UNDER THIS CONTRACT SHALL BE COORDINATED WITH THE ACTUAL EQUIPMENT SUPPLIER. CONDUIT AND WIRING TO BE PROVIDED SHALL BE ADJUSTED ACCORDINGLY AT NO ADDITIONAL COST TO THE OWNER.
21. PROVIDE CONCRETE HOUSEKEEPING PADS (4" HIGH) UNDER FLOOR MOUNTED ELECTRICAL AND INSTRUMENTATION EQUIPMENT. PROVIDE SUBMITTAL SKETCH FOR ENGINEER REVIEW.
22. COORDINATE ELECTRICAL EMBEDMENTS WITH STRUCTURAL.
23. CONTRACTOR SHALL PROVIDE A COMPLETE WORKING OPERATING SYSTEM IN ACCORDANCE WITH ALL DRAWINGS, SPECIFICATIONS, CODES AND STANDARDS.
24. HANDHOLES SHALL BE PREMANUFACTURED ASSEMBLIES SEPARATED FOR 480V AND 120V POWER. POWER CONDUIT UNDERGROUND SHALL BE SCHEDULE 80 PVC WITH RGS FITTINGS ABOVE GROUND. RGS FITTINGS SHALL EXTEND 2'-6" BELOW GROUND. INSTRUMENTATION AND CONTROL HANDHOLES SHALL BE SEGREGATED FOR INSTRUMENTATION AND 120 VOLT CONTROL.
25. THE ELECTRICAL SUBCONTRACTOR SHALL BE RESPONSIBLE FOR REVIEWING ALL OF THE ELECTRICAL DRAWINGS AND CONDUIT AND WIRE SCHEDULES RELATIVE TO THE CONDUIT AND WIRE TO BE PROVIDED ON THIS PROJECT. THE INTENT OF THE CONTRACT DOCUMENTS IS TO PROVIDE DETAILED INFORMATION OF SPECIFIC INDIVIDUAL RUNS OF CONDUIT AND WIRE TO SPECIFIC EQUIPMENT. THE ELECTRICAL SUBCONTRACTOR IS DIRECTED TO COMBINE CONDUIT AND WIRE RUNS AS MUCH AS POSSIBLE, AS DEFINED IN SPECIFICATION SECTION 16050, PARAGRAPH 3.1.E.15. THE LIMITING FACTOR FOR COMBINING CONDUIT AND WIRE SHALL BE BASED ON THE DERATING FACTORS ALLOWED PER THE NATIONAL ELECTRICAL CODE (NEC) BASED ON EQUIPMENT RATINGS AND REQUIRED AMPACITY RATINGS. ALL MEDIUM VOLTAGE FEEDER CONDUIT AND WIRE SHALL NOT BE ALLOWED TO BE COMBINED AND SHALL BE INSTALLED AS INDICATED IN THE CONTRACT DOCUMENTS. ELECTRICAL SUBCONTRACTOR IS DIRECTED TO USE THE MOST COST-EFFECTIVE CONDUIT AND WIRE RUNS CONSISTENT WITH THESE REQUIREMENTS.
26. 120V CIRCUITS EXCEEDING 100 FEET IN LENGTH SHALL BE NO 10 AWG WIRING, MINIMUM.
27. POWER CONDUITS FOR THREE PHASE AND SINGLE PHASE CIRCUITS (DESIGNATED WITH "P" NUMBERS) ARE SHOWN ON POWER PLANS, WITH CONDUIT SIZES AND WIRING INFORMATION INDICATED IN THE CONDUIT AND WIRE SCHEDULES.
28. CONTROL AND INSTRUMENTATION SIGNAL CONDUITS (DESIGNATED WITH "C" AND "S" NUMBERS) ARE SHOWN ON CONTROL AND INSTRUMENTATION WIRING DIAGRAMS, WITH CONDUIT SIZES AND WIRING INFORMATION INDICATED IN THE CONDUIT AND WIRE SCHEDULES. FOR INSTRUMENTS REQUIRING 120V POWER SUPPLIES, THIS INFORMATION IS ALSO SHOWN ON THE CONTROL AND INSTRUMENTATION WIRING DIAGRAMS.
29. CONTRACTOR SHALL LABEL EACH RESPECTIVE DISTRIBUTION PANEL, SWITCHBOARD OR MCC WITH THE FEEDER POWER CIRCUIT NAME AND LOCATION PER NEC REQUIREMENTS.
30. ALL PRIMARY FEEDER DISCONNECTS SERVING REMOTELY LOCATED TRANSFORMERS SHALL BE LOCKABLE. CONTRACTOR SHALL LABEL PRIMARY DISCONNECT LOCATION AT THE TRANSFORMER SERVED PER NEC REQUIREMENTS.

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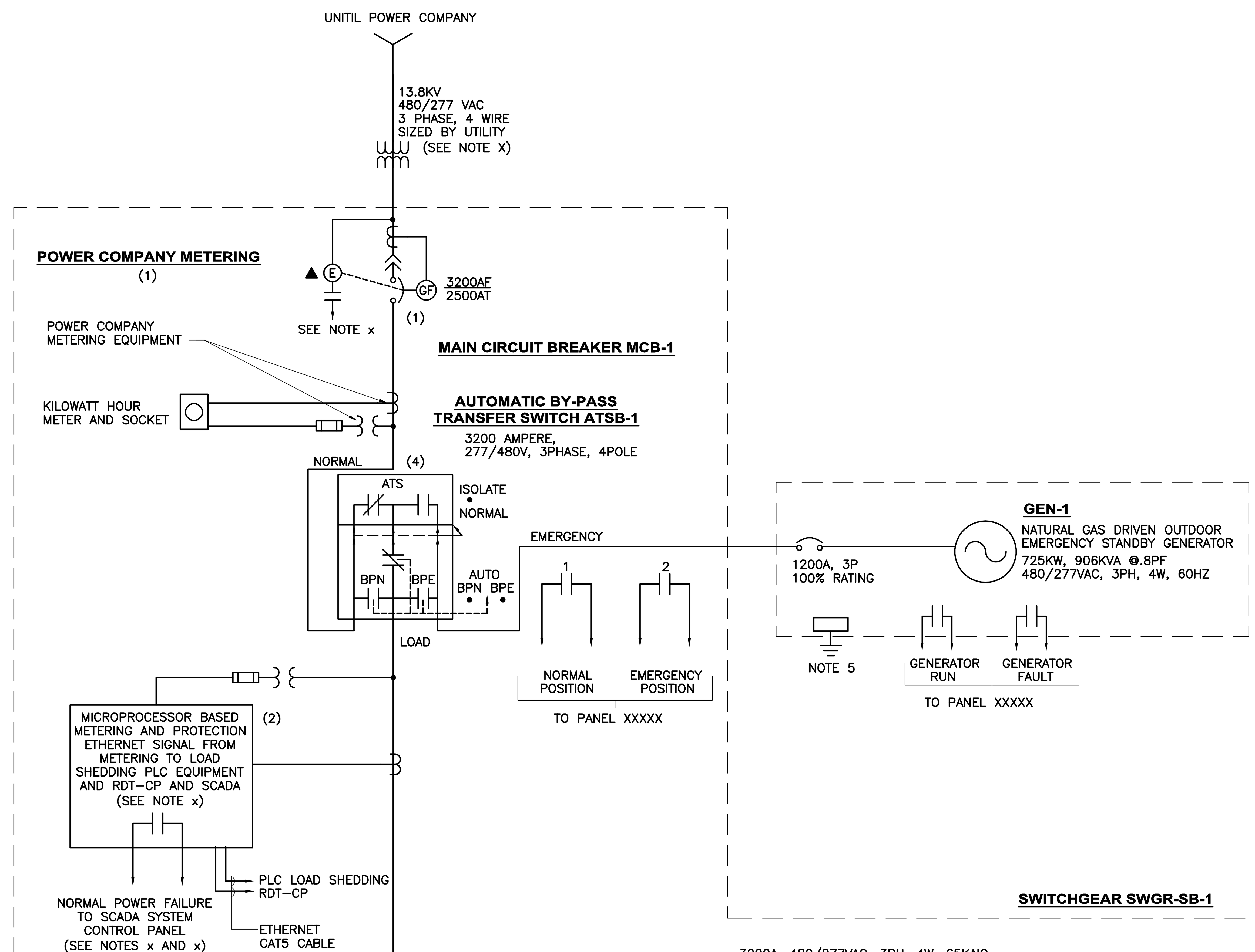
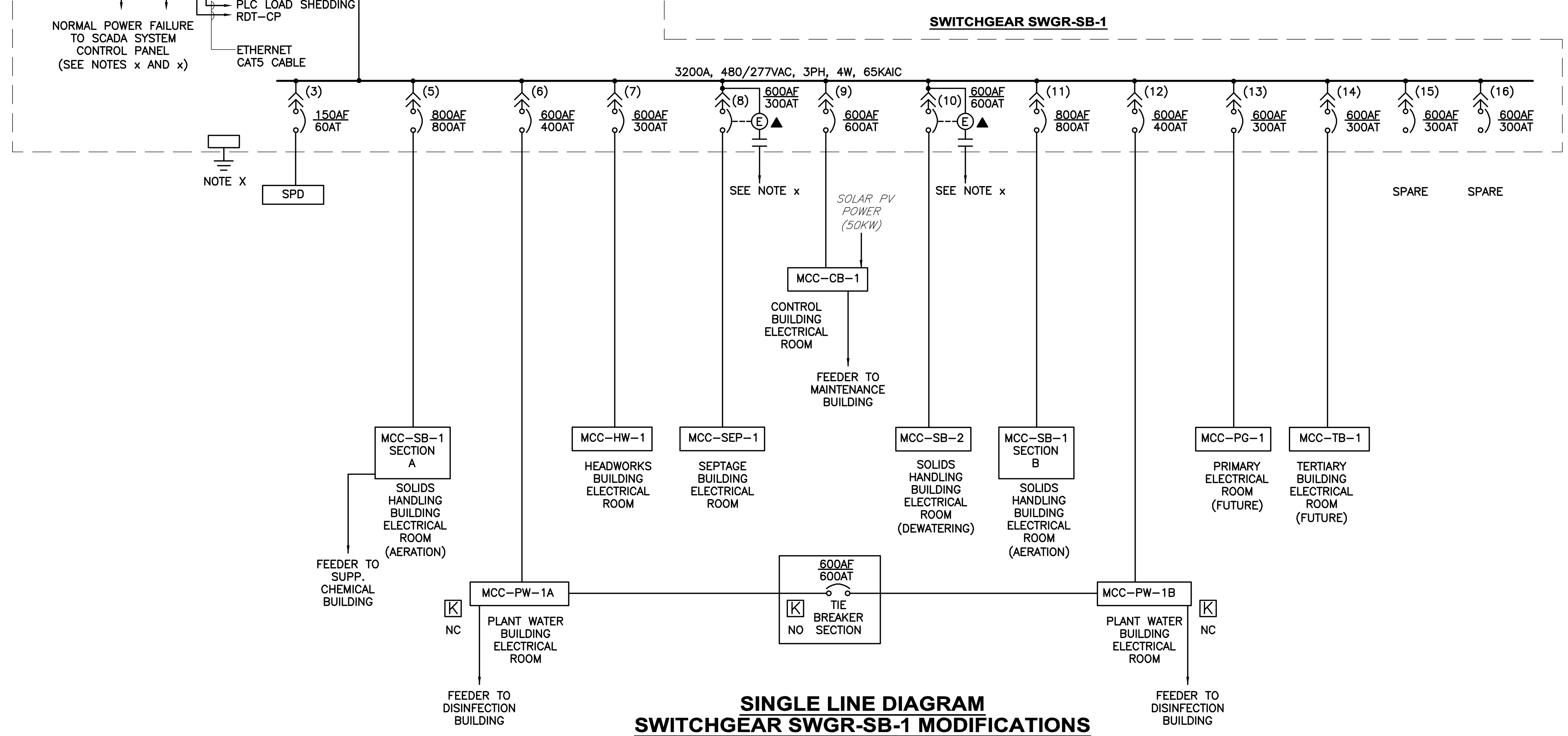
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

ELECTRICAL NOTES AND ABBREVIATIONS

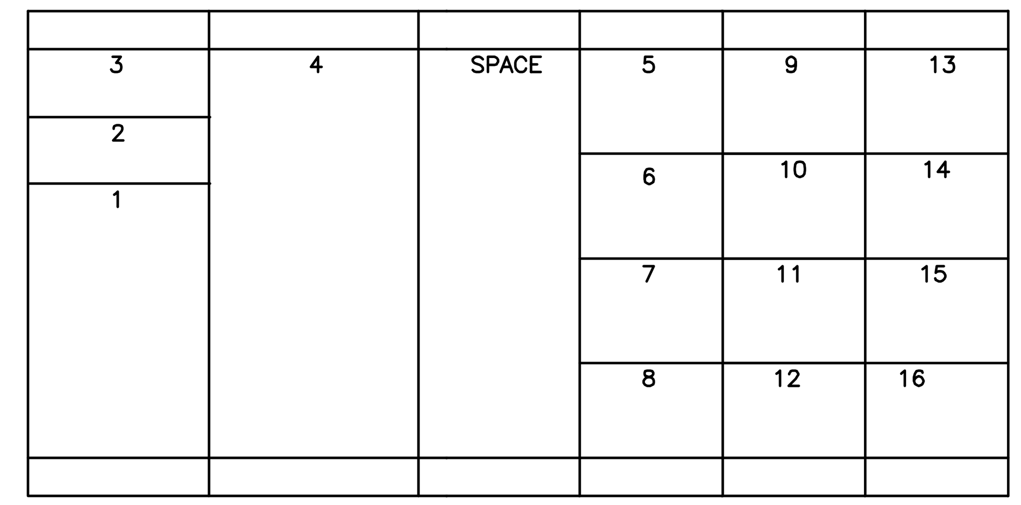
DRAWING
E-2





SINGLE LINE DIAGRAM
SWITCHGEAR SWGR-SB-1 MODIFICATIONS

NTS



SWITCHGEAR SWGR-SB-1 ELEVATION

NTS

NOTES:

1. FOR ELECTRICAL LEGEND, ABBREVIATIONS AND NOTES, REFER TO DRAWINGS E-1 AND E-2.
2. CIRCUIT NUMBERS INDICATED ON THIS DRAWING REFER TO PANELBOARD LP-2, UNLESS OTHERWISE NOTED.
3. FOR INFORMATION REGARDING CONDUIT AND WIRING REQUIREMENTS, REFER TO GENERAL NOTES 27 AND 28 ON DRAWING E-2.
4.

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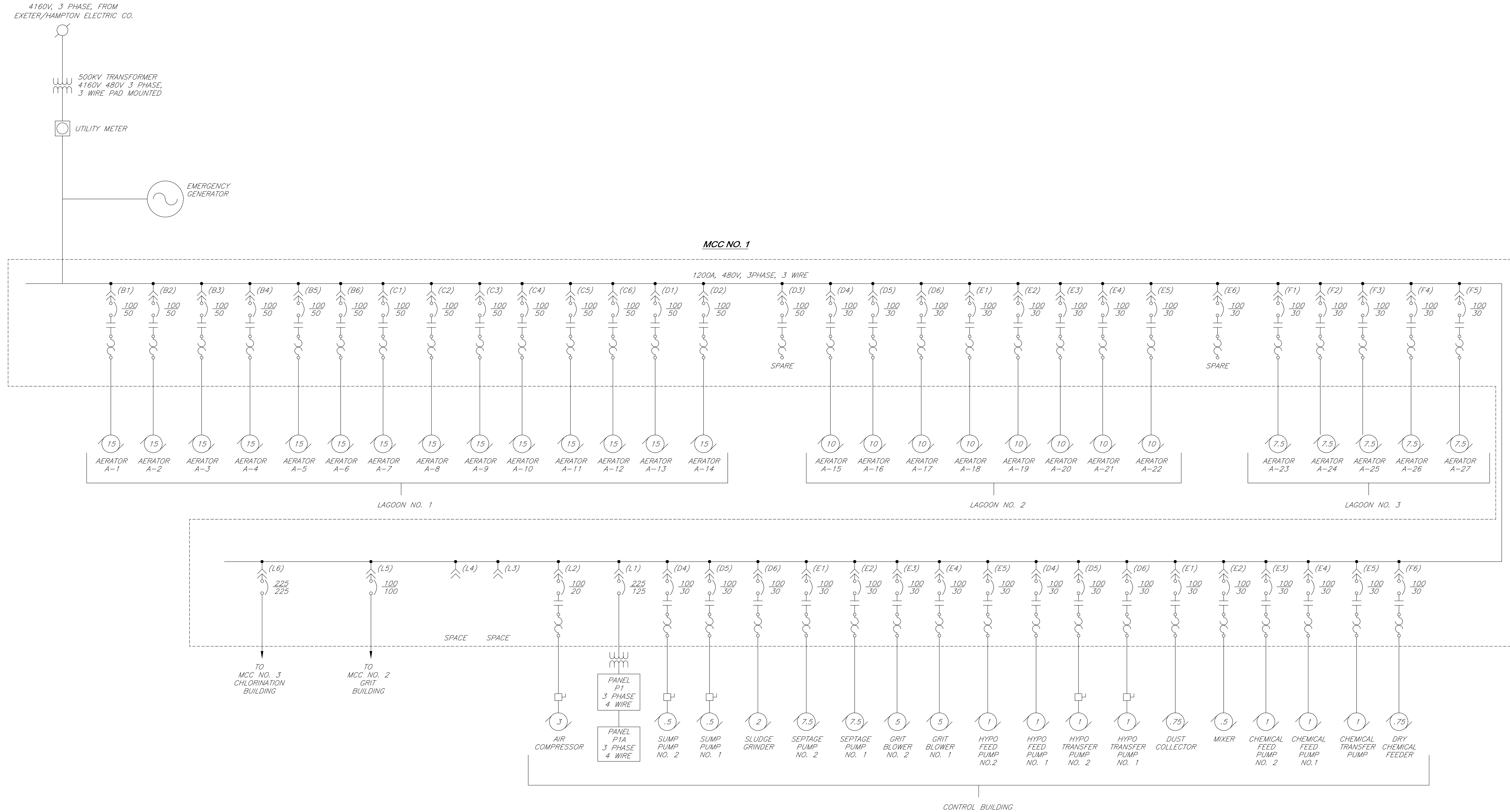
WASTEWATER TREATMENT
FACILITY UPGRADES

SINGLE LINE DIAGRAM
SWITCHGEAR SWGR-SB-1

DRAWING
E-3



NOTES:

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2. CIRCUIT NUMBERS INDICATED ON THIS DRAWING REFER TO PANELBOARD LP-2, UNLESS OTHERWISE NOTED.
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DEMOLITION NOTES:

(1) ELECTRICAL EQUIPMENT INDICATED WITH SHADING SHALL BE DISCONNECTED AND REMOVED ALONG WITH ALL OF THE ASSOCIATED CONDUIT, WIRE, PULLBOXES, ETC. IN IT'S ENTIRETY FOR A COMPLETE DEMOLITION. ALL ABANDONED BELOW GRADE CONDUIT SHALL BE CUT AND CAPPED AT GRADE LEVEL. REFER TO TO NOTE 1 ON THIS DRAWING FOR ADDITIONAL DEMOLITION NOTES.

(2) INFORMATION CONTAINED IN THESE PLANS AND DIAGRAMS HAS BEEN OBTAINED IN PART FROM EXISTING PLANT ELECTRICAL DRAWINGS, SITE CONDITIONS AND SHOP DRAWINGS. THE CONTRACTOR SHALL FIELD VERIFY ALL INFORMATION AND CIRCUITRY AFFECTING HIS OR HER WORK PRIOR TO COMMENCING THE WORK FOR THIS CONTRACT. THE CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY DISCREPANCIES.

(3)

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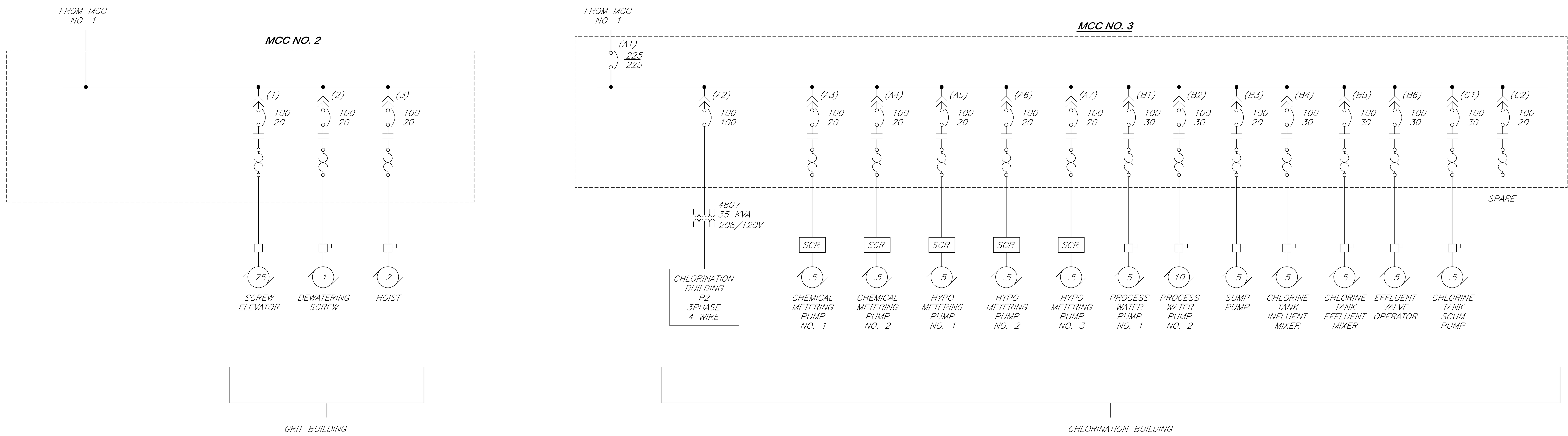
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

SINGLE LINE DIAGRAM
MCC NO. 1

DRAWING
E-4



NOTES:

1. FOR ELECTRICAL LEGEND, ABBREVIATIONS AND NOTES, REFER TO DRAWINGS E-1 AND E-2.
2. CIRCUIT NUMBERS INDICATED ON THIS DRAWING REFER TO PANELBOARD LP-2, UNLESS OTHERWISE NOTED.
3. FOR INFORMATION REGARDING CONDUIT AND WIRING REQUIREMENTS, REFER TO GENERAL NOTES 27 AND 28 ON DRAWING E-2.
4.

DEMOLITION NOTES:

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(2) INFORMATION CONTAINED IN THESE PLANS AND DIAGRAMS HAS BEEN OBTAINED IN PART FROM EXISTING PLANT ELECTRICAL DRAWINGS, SITE CONDITIONS AND SHOP DRAWINGS. THE CONTRACTOR SHALL FIELD VERIFY ALL INFORMATION AND CIRCUITRY AFFECTING HIS OR HER WORK PRIOR TO COMMENCING THE WORK FOR THIS CONTRACT. THE CONTRACTOR SHALL

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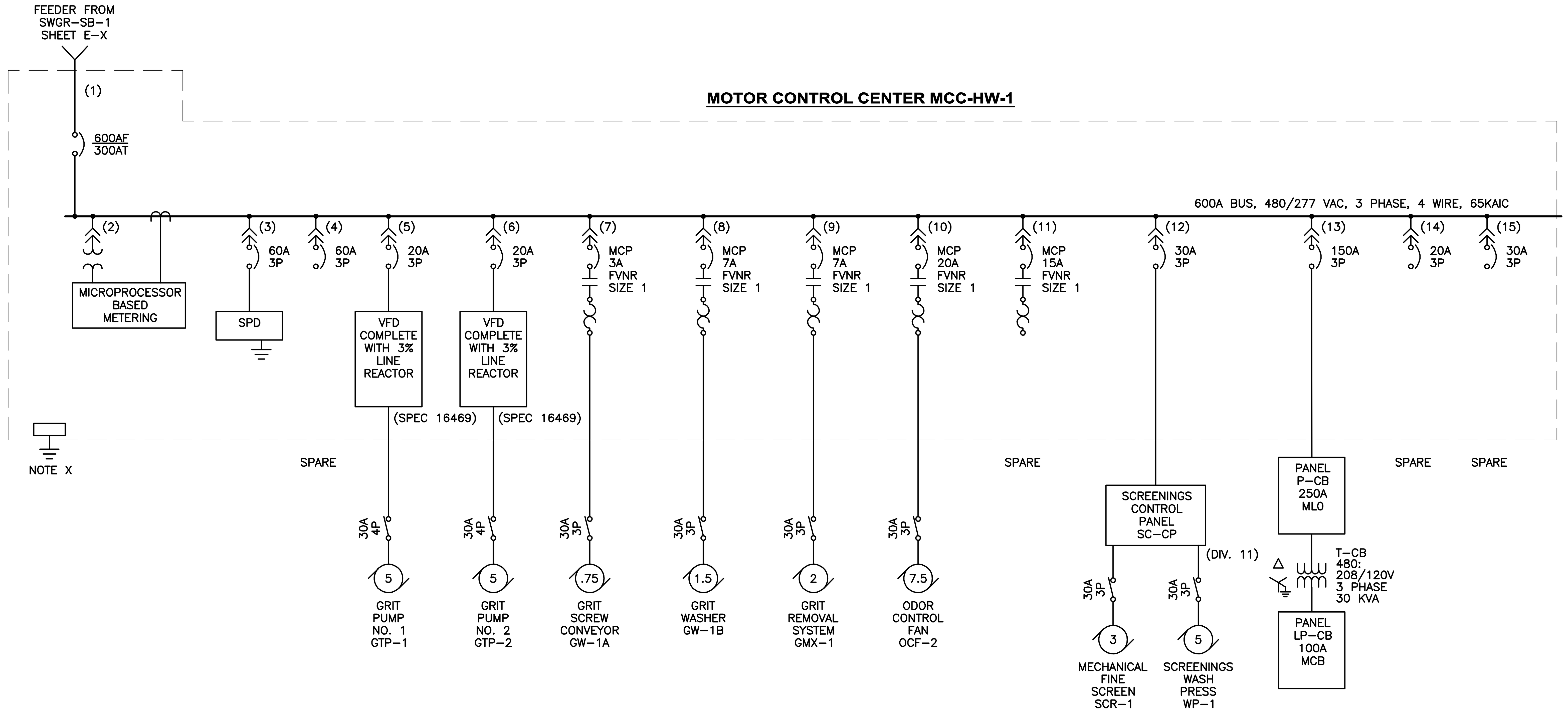
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

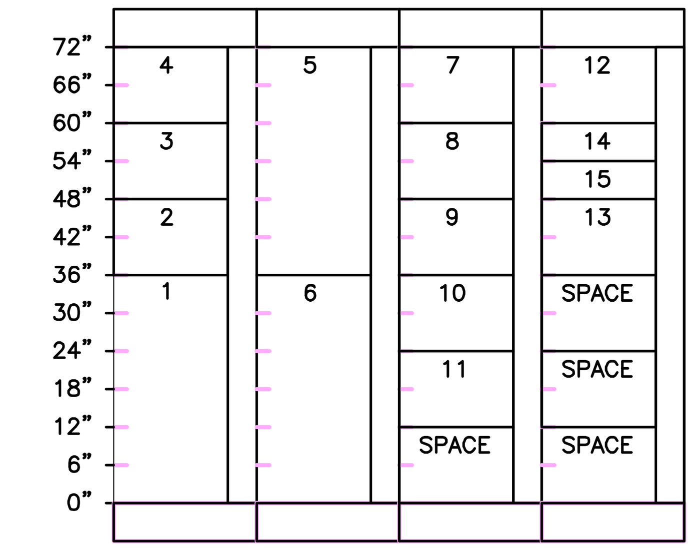
SINGLE LINE DIAGRAM
MCC NO. 2 AND 3

DRAWING
E-5



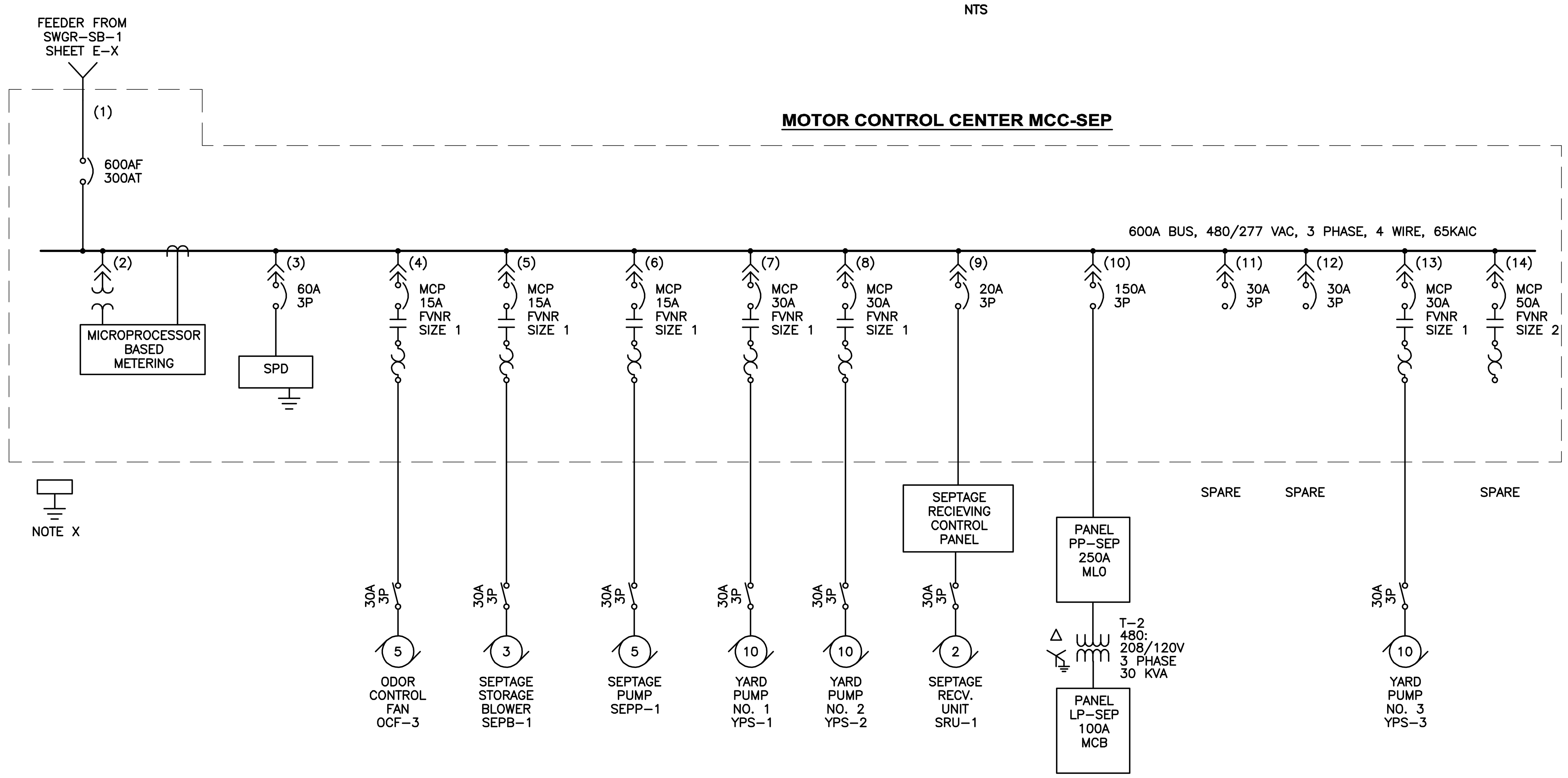
SINGLE LINE DIAGRAM
MCC-HW-1 MODIFICATIONS

NTS



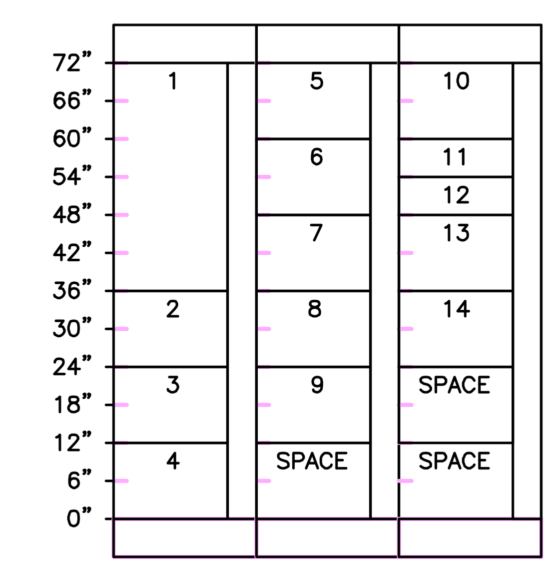
MCC-HW ELEVATION

NTS



SINGLE LINE DIAGRAM
MCC-SEP MODIFICATIONS

NTS



MCC-SEP-1 ELEVATION

NTS

NOTES:

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2. CIRCUIT NUMBERS INDICATED ON THIS DRAWING REFER TO PANELBOARD LP-2, UNLESS OTHERWISE NOTED.
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4.

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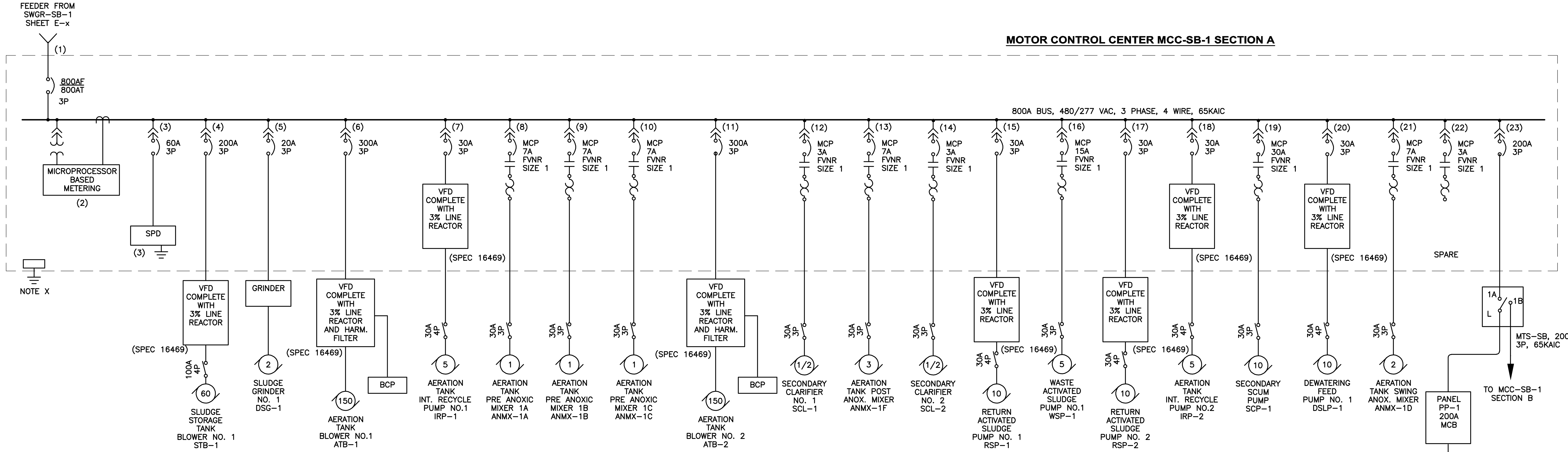
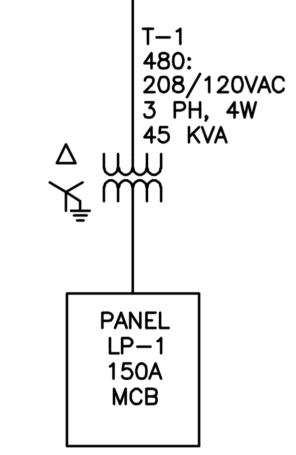
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

SINGLE LINE DIAGRAM
MCC-HW, MCC-SEP

DRAWING
E-6

MOTOR CONTROL CENTER MCC-SB-1 SECTION A





SINGLE LINE DIAGRAM
MCC-1 SECTION A MODIFICATIONS

NTS

NOTES:

1. FOR ELECTRICAL LEGEND, ABBREVIATIONS AND NOTES, REFER TO DRAWINGS E-1 AND E-2.
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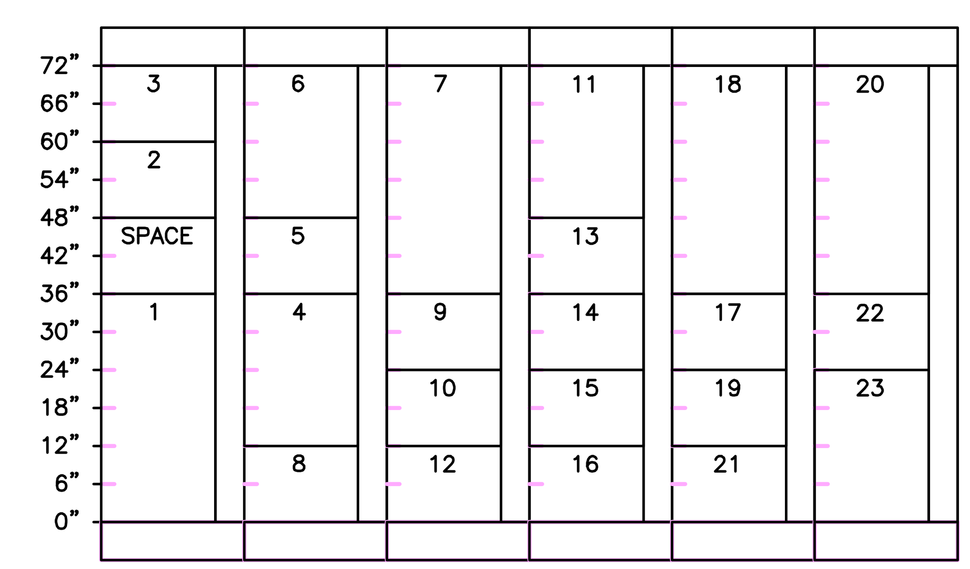
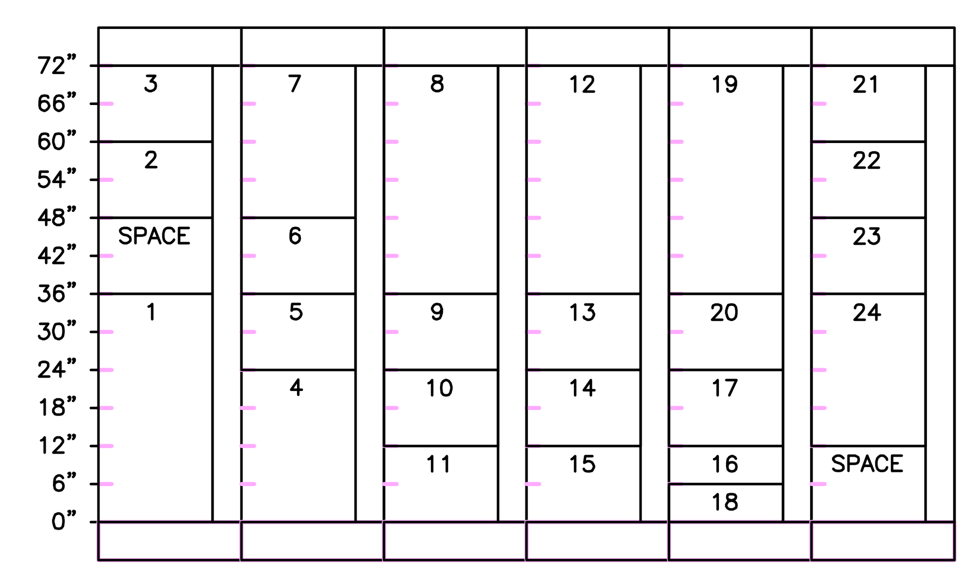


MCC-SB-1SECTION A ELEVATION

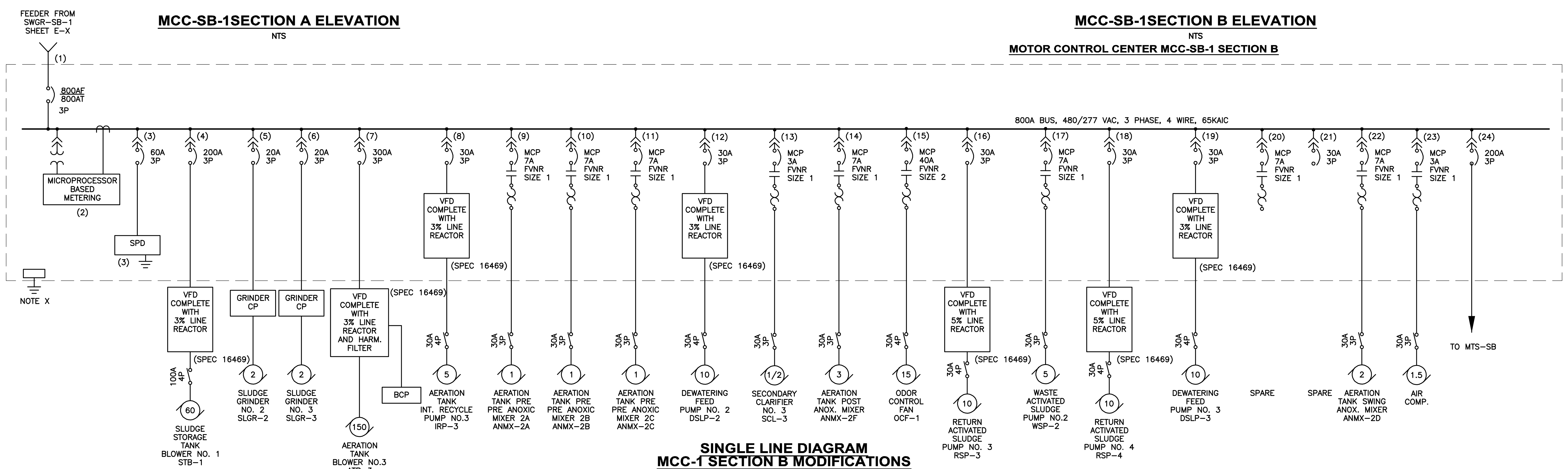
NTS



MCC-SB-1SECTION B ELEVATION

NTS

MOTOR CONTROL CENTER MCC-SB-1 SECTION B



SINGLE LINE DIAGRAM
MCC-1 SECTION B MODIFICATIONS

NTS

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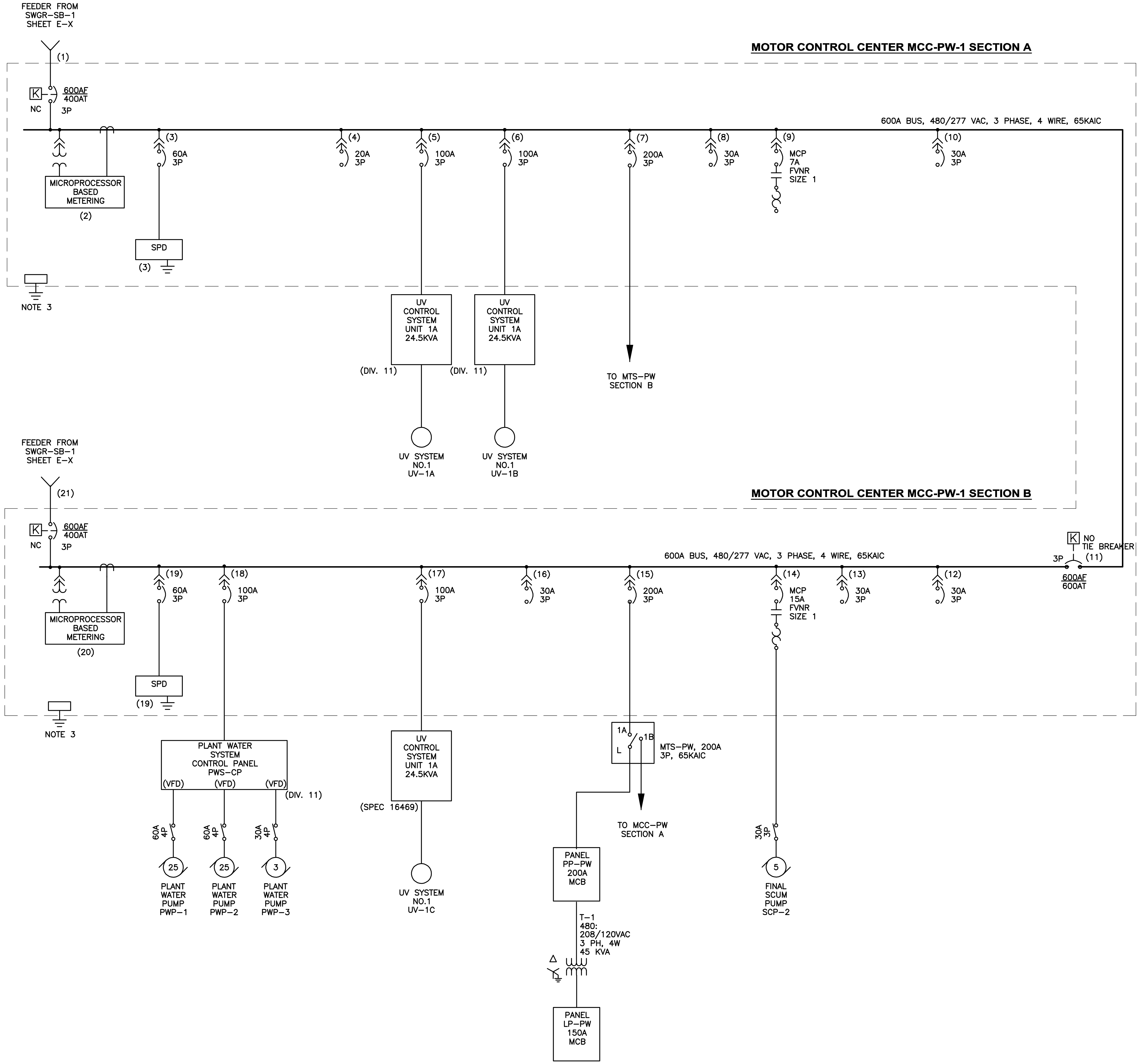
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

SINGLE LINE DIAGRAMS
MCC-SB-1A, MCC-SB-1B

DRAWING
E-7

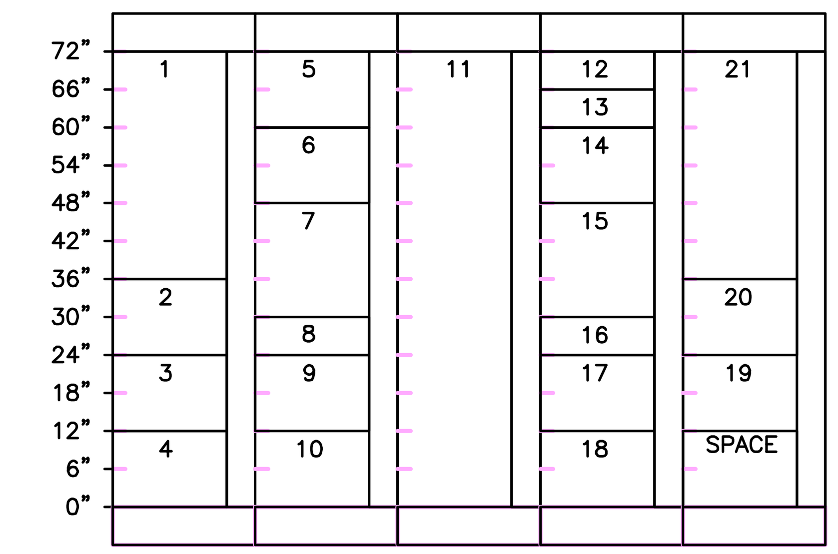
LAST SAVED BY: STEVEN.LAPRISE 8/26/2015 5:08 PM

G:\DWGS\NH\EXETER\12883-WWTF-UPGRADE\12883-PDR\ELE\12883-ES-SINGLELINE.DWG | MCC-PW-1A MCC-PW-1B | 1:10.1236 | ---- | 9/24/2015 1:58:48 PM | ADAM.COUTURE



SINGLE LINE DIAGRAM MCC-PW-1 SECTION A AND B MODIFICATIONS

NTS



MCC-PW-1 SECTIONS A AND B ELEVATIONS

NTS

NOTES:

1. FOR ELECTRICAL LEGEND, ABBREVIATIONS AND NOTES, REFER TO DRAWINGS E-1 AND E-2.
2. CIRCUIT NUMBERS INDICATED ON THIS DRAWING REFER TO PANELBOARD LP-2, UNLESS OTHERWISE NOTED.
3. FOR INFORMATION REGARDING CONDUIT AND WIRING REQUIREMENTS, REFER TO GENERAL NOTES 27 AND 28 ON DRAWING E-2.
4.

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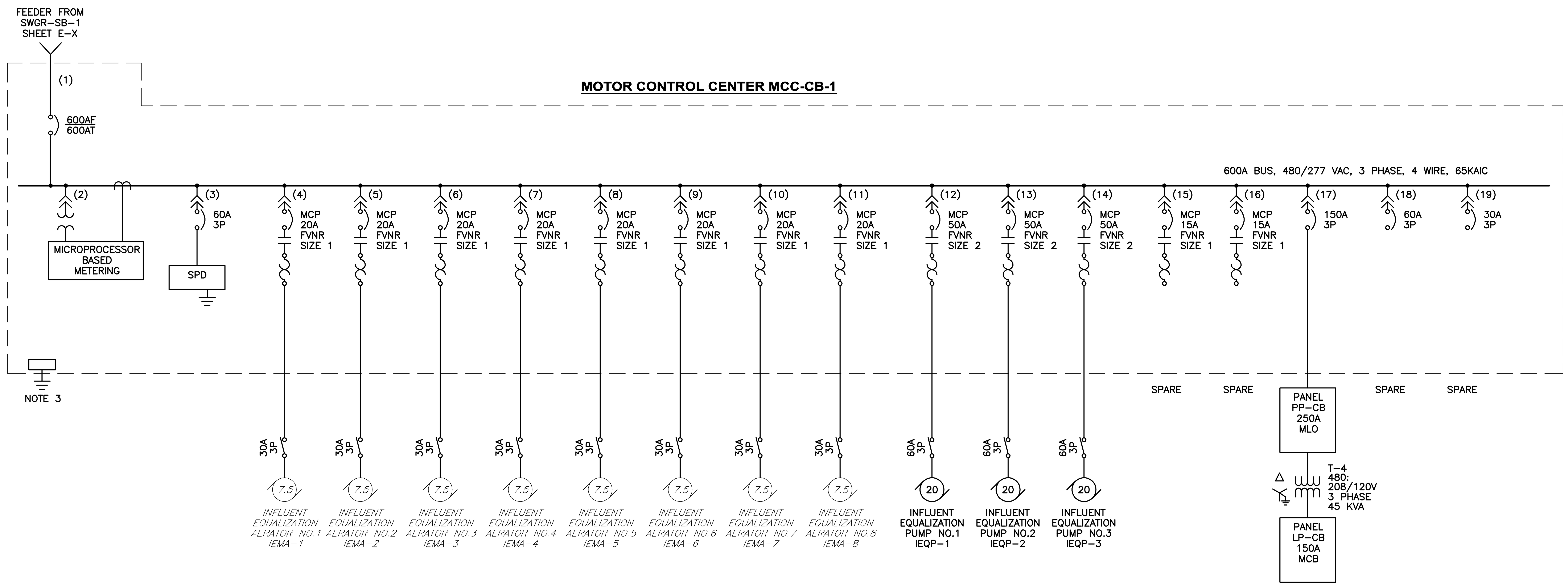
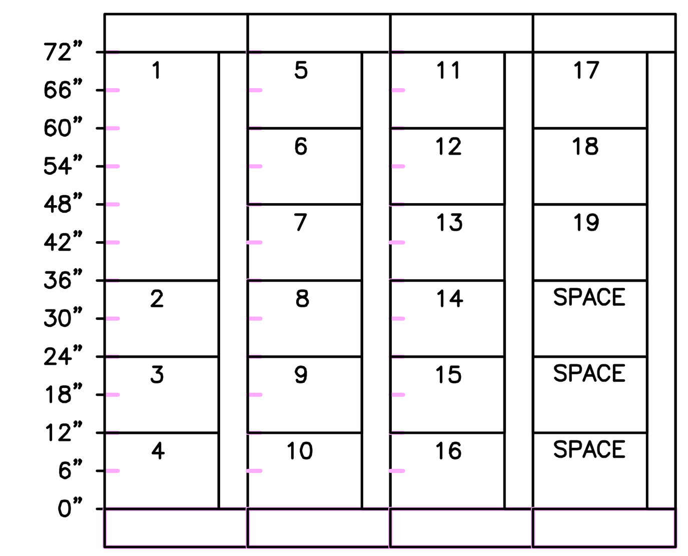
EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

SINGLE LINE DIAGRAMS
MCC-PW-1A, MCC-PW-1B

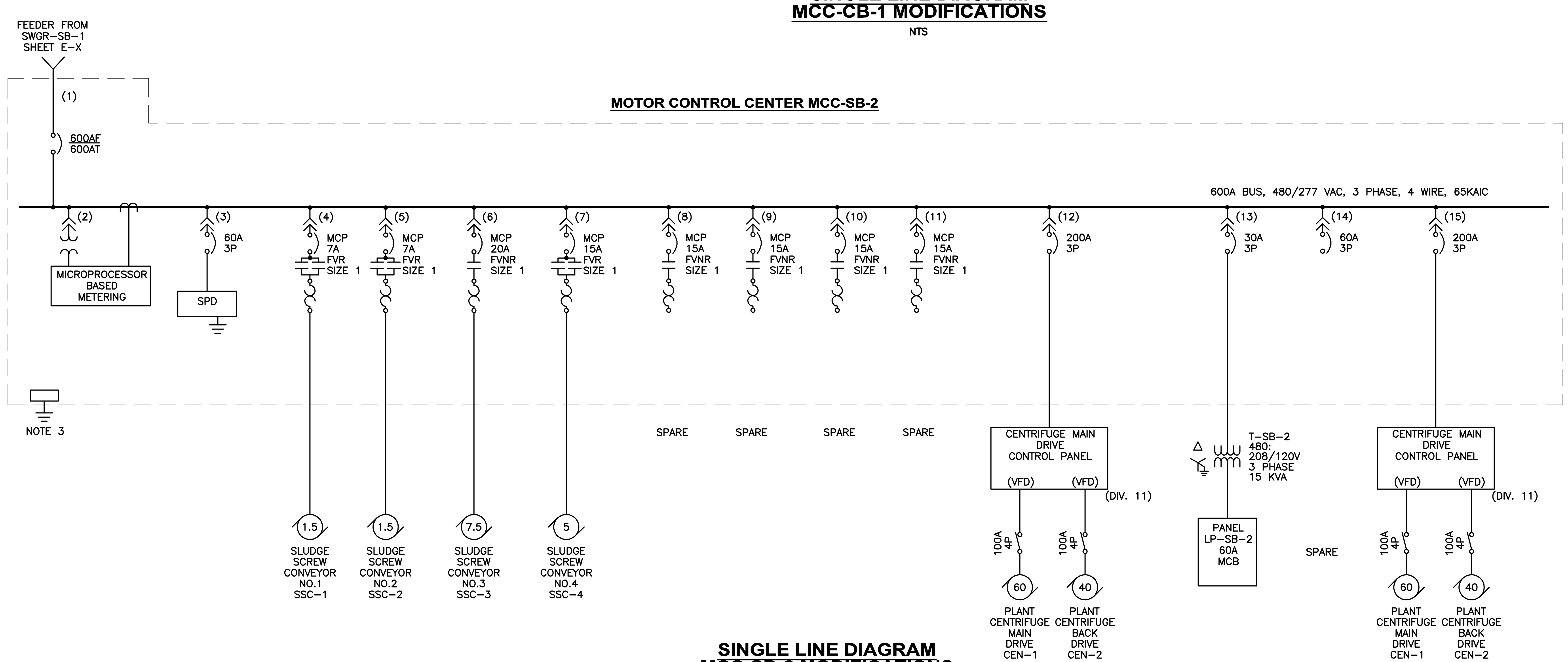
DRAWING
E-8



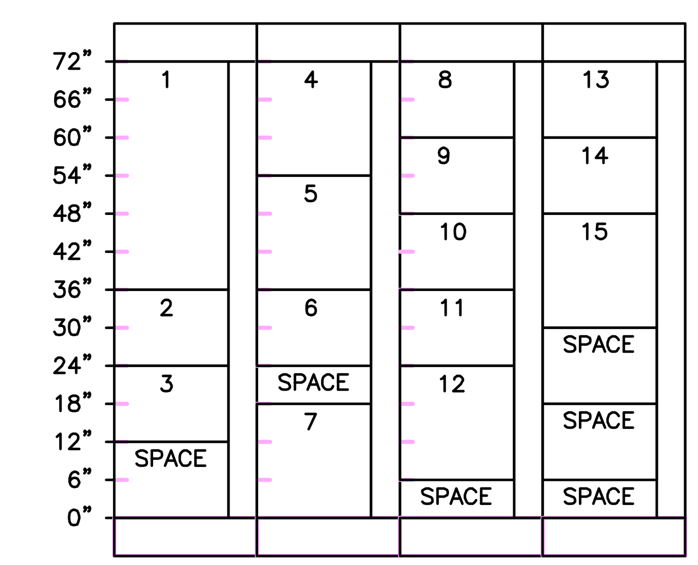
SINGLE LINE DIAGRAM
MCC-CB-1 MODIFICATIONS
NTS



MCC-CB-1 ELEVATION
NTS



SINGLE LINE DIAGRAM
MCC-SB-2 MODIFICATIONS
NTS



MCC-SB-2 ELEVATION
NTS

NOTES:

1. FOR ELECTRICAL LEGEND, ABBREVIATIONS AND NOTES, REFER TO DRAWINGS E-1 AND E-2.
2. CIRCUIT NUMBERS INDICATED ON THIS DRAWING REFER TO PANELBOARD LP-2, UNLESS OTHERWISE NOTED.
3. FOR INFORMATION REGARDING CONDUIT AND WIRING REQUIREMENTS, REFER TO GENERAL NOTES 27 AND 28 ON DRAWING E-2.
4.

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY: SAL
CAD COORD: APC
CAD: SAL
CHECKED BY:
DATE:
APPROVED BY:
DATE:
PROJECT NO: 12883

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EXETER, NEW HAMPSHIRE
CONTRACT NO. 1
WASTEWATER TREATMENT
FACILITY UPGRADES

SINGLE LINE DIAGRAMS
MCC-CB-1, MCC-SB-2

DRAWING
E-9

BID SET No. ____________

TOWN OF EXETER, NEW HAMPSHIRE

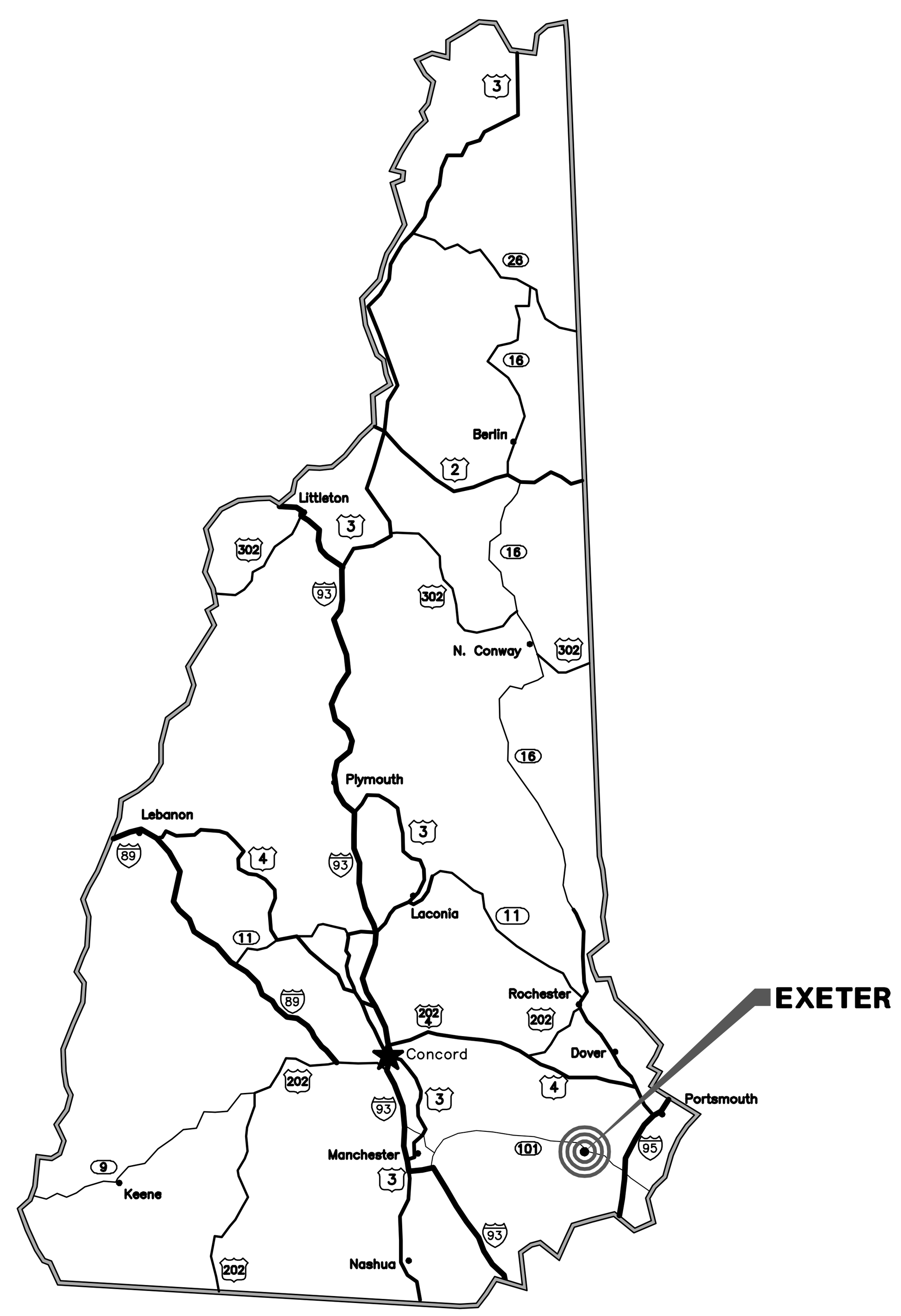
CONTRACT DRAWINGS FOR

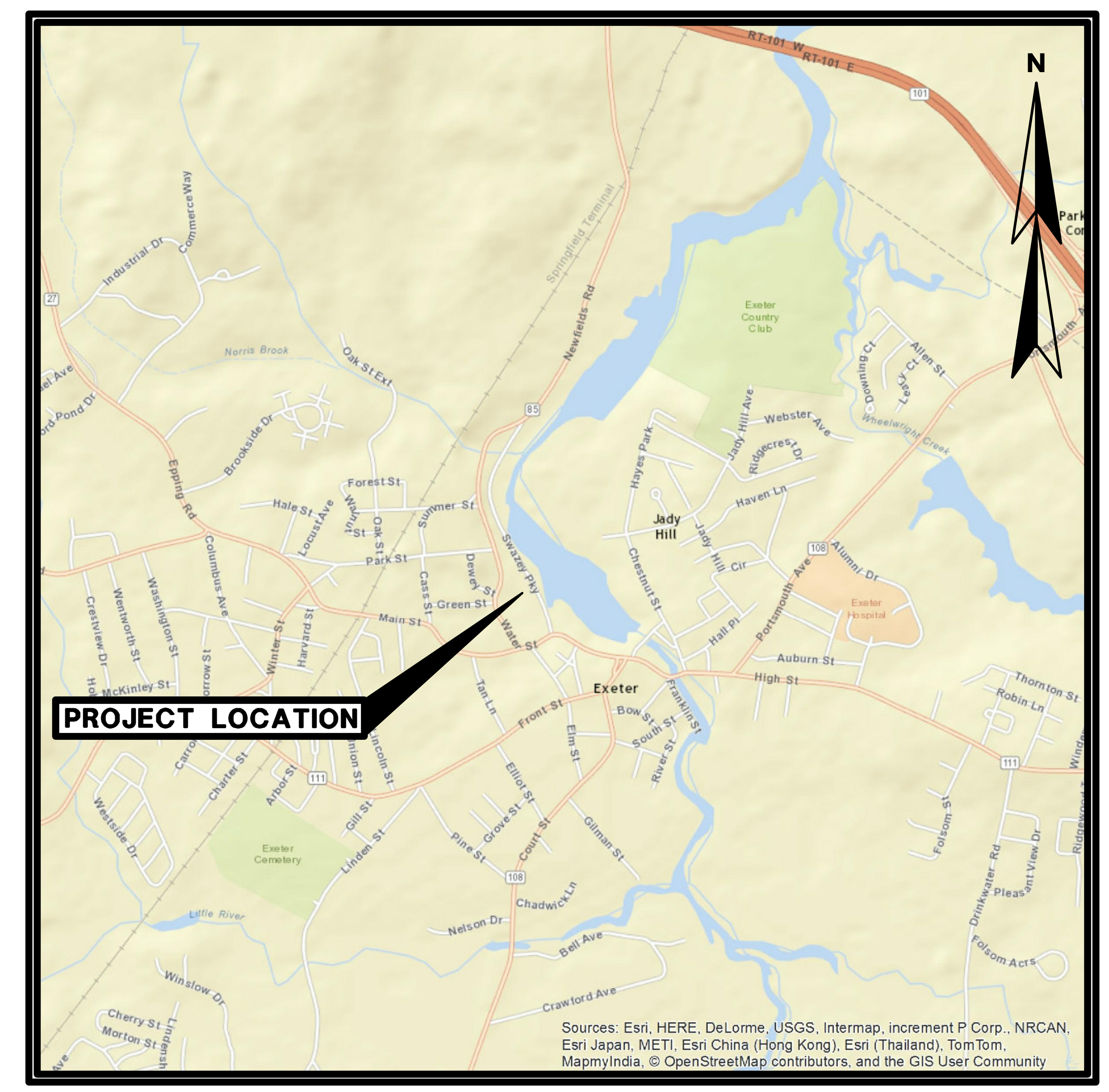
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

SRF NO. XX-XXXXXX-XX

SEPTEMBER 2015

PDR SUBMITTAL





LOCATION PLAN
SCALE: 1" = 2000'

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FOR REVIEW SEPTEMBER 2015

FOR BIDDING ____________

WP PROJECT NO. 12883B

DRAWING N0.	TITLE
GENERAL	
--	COVER
G-1	DRAWING INDEX
CIVIL	
C-1	PROJECT OVERVIEW, LEGEND, AND ABBREVIATIONS
C-2	EXISTING SITE CONDITIONS, DEMOLITION PLAN, AND MAIN PUMP STATION SITE LAYOUT PLAN
C-3	PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD STA 10+00 TO STA 16+00
C-4	PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD STA 16+00 TO STA 22+00
C-5	PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD STA 22+00 TO STA 28+00
C-6	PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD STA 28+00 TO STA 34+00
C-7	PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD STA 34+00 TO STA 40+00
C-8	PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD STA 40+00 TO STA 46+00
C-9	PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD STA 46+00 TO STA 52+00
C-10	PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD STA 52+00 TO STA 58+00
C-11	PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD STA 58+00 TO STA 64+00
C-12	PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD STA 62+00 TO STA 68+00
C-13	PLAN AND PROFILE: WATER STREET STA 101+00 TO STA 107+00
C-14	PLAN AND PROFILE: WATER STREET STA 107+00 TO STA 113+00
C-15	DETAILS I (SEWER)
C-16	DETAILS II (WATER)
C-17	DETAILS III (DRAINAGE & MISC)
C-18	EROSION CONTROL NOTES AND DETAILS
ARCHITECTURAL	
A-1	ARCHITECTURAL NOTES, LEGEND AND ABBREVIATIONS
A-2	FLOOR PLANS AND EXTERIOR ELEVATIONS
A-3	SECTIONS
A-4	ROOF LAYOUT PLAN AND DETAILS
A-5	DETAILS I
STRUCTURAL	
S-1	STRUCTURAL NOTES, LEGEND AND ABBREVIATIONS
S-2	DEMOLITION PLAN AND SECTIONS
S-3	MODIFICATION PLAN AND SECTIONS
S-4	ROOF LAYOUT PLAN AND DETAILS
S-5	DETAILS I

DRAWING N0.	TITLE
PROCESS	
PR-1	PROCESS NOTES, LEGEND AND ABBREVIATIONS
PR-2	DEMOLITION PLANS AND SECTIONS
PR-3	MODIFICATION PLANS
PR-4	MODIFICATION SECTIONS
PR-5	DETAILS I
MECHANICAL	
M-1	MECHANICAL NOTES, LEGEND, ABBREVIATIONS AND DESIGN DATA
M-2	PLANS AND SECTIONS
M-3	DETAILS I
INSTRUMENTATION	
I-1	INSTRUMENTATION NOTES, ABBREVIATIONS, AND LEGEND
I-2	INSTRUMENTATION LOOPS I
I-3	INSTRUMENTATION LOOPS II
ELECTRICAL	
E-1	ELECTRICAL LEGEND AND NEMA SCHEDULE
E-2	ELECTRICAL NOTES AND ABBREVIATIONS
E-3	ELECTRICAL SITE PLAN - DEMOLITION AND MODIFICATIONS
E-4	SINGLE LINE DIAGRAMS - DEMOLITION AND MODIFICATIONS
E-5	POWER PLANS
E-6	PANEL AND LIGHTING PLANS AND SCHEDULES
E-7	SCHEDULES AND DETAILS
E-8	SCHEMATICS AND DIAGRAMS
E-9	SCHEMATICS AND DIAGRAMS
E-10	CONDUIT AND WIRING SCHEDULE

NOTES:

1. BLACK TEXT INDICATES DRAWINGS INCLUDED IN PDR SUBMISSION.
2. LIGHT TEXT INDICATES DRAWINGS TO BE INCLUDED IN FINAL SUBMISSION.

SUBMISSIONS/REVISIONS: PRELIMINARY DESIGN REPORT

DESIGNED BY: APC
PROJECT NO: 12883

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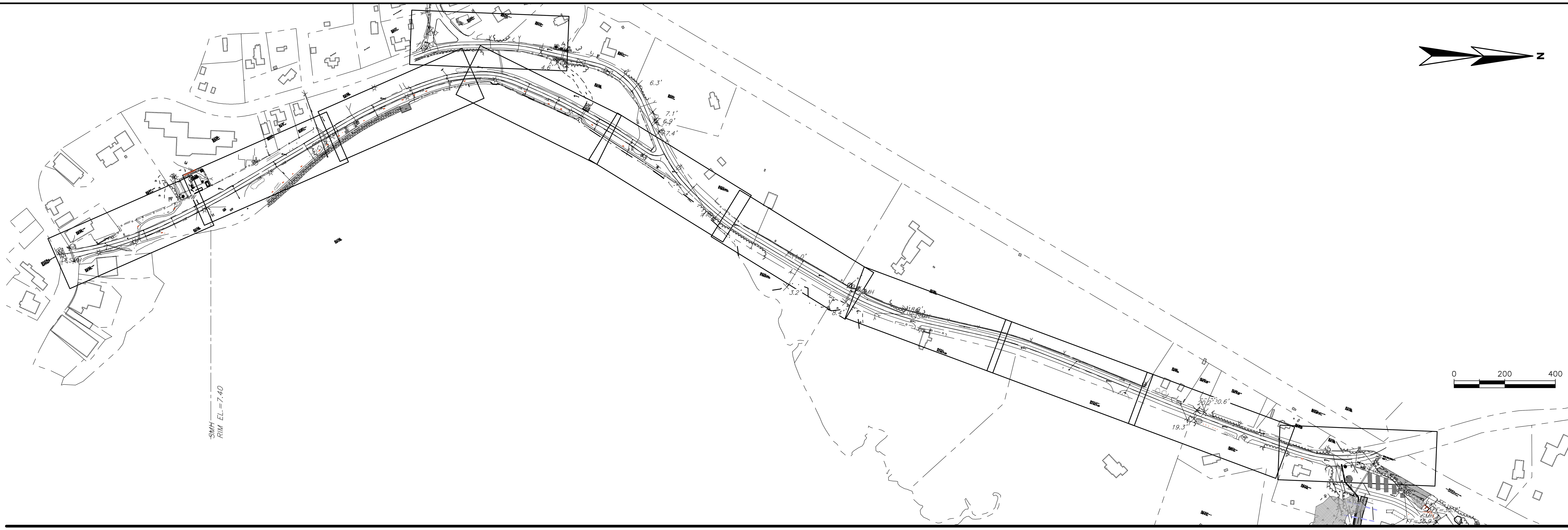
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

DRAWING INDEX

DRAWING G-1

LAST SAVED BY: CHRIS.CRONIN 9/8/2015 10:45 AM



ABBREVIATIONS

A	AIR
ABE	AERATION BASIN EFFLUENT
CB	CATCH BASIN
CI	CAST IRON PIPE
CLS	CHLORINE SOLUTION
CW	CITY WATER
DEC	SODIUM BISULFITE SOLUTION
DEW	DEWATERING
DI	DUCTILE IRON PIPE
DR	DRAIN
FE	FINAL EFFLUENT
FM	FORCE MAIN
GS	GALVANIZED STEEL PIPE
GT	GAS TRANSMISSION
H	HEAT
HYD	HYDRANT
INF	INFLUENT SEWER
INV	INVERT ELEVATION
OHE	OVERHEAD ELECTRICAL
OUT	OUTFALL
P.C.	POINT OF CURVATURE
PE	POLYETHYLENE PIPE
PRW	PROCESS WATER
PTE	PRELIMINARY TREATMENT EFFLUENT
PVC	POLYVINYL CHLORIDE PIPE
PW	PLANT WATER
RCP	REINFORCED CONCRETE PIPE
S	SEWER
SAM	SAMPLER LINE CONDUIT
SC	SCUM
SCE	SECONDARY CLARIFIER EFFLUENT
SD	STORM DRAIN
SEP	SEPTAGE
SL	SLUDGE
SMH	SEWER MANHOLE
SS	STAINLESS STEEL PIPE
SUP	SUPERNATANT
UD	UNDERDRAIN
UDC	UNDERDRAIN COLLECTOR
UGE	UNDERGROUND ELECTRIC
VC	VITRIFIED CLAY
W	WATER
XFMR	TRANSFORMER

LEGEND

EXISTING / PROPOSED

- PROPERTY/ROW LINE
- SETBACK LINE
- EASEMENT LINE
- CENTERLINE
- EDGE OF PAVEMENT
- CURBING
- EDGE OF GRAVEL
- EDGE OF CONCRETE
- CONTOUR (existing: 122; proposed: 123)
- BUILDING
- STONEWALL
- TREELINE
- CHAIN LINK FENCE
- STOCKADE FENCE
- BARB WIRE FENCE
- RETAINING WALL
- GUARDRAIL
- SEWER (8" S / 8"S)
- SEWER FORCE MAIN (4" FM / 4"FM)
- GAS (4" G / 4"G)
- WATER (4" W / 8"W)
- STORM DRAIN (15" SD / 15"SD)
- UNDERDRAIN (6" UD / 6"UD)
- CULVERT (12" CMP / 12" CMP)
- UNDERGROUND ELECTRIC (UGE / UGE)
- OVERHEAD ELECTRIC (OHE / OHE)
- IRON PIPE/REBAR
- DRILLHOLE
- MONUMENT
- SURVEY CONTROL POINT
- SPOT ELEVATION (124.6 / 134.5)
- SEWER MANHOLE (SMH / SMH)
- DRAINAGE MANHOLE (DMH / DMH)
- CATCH BASIN (CB CB / CB CB)
- ELECTRIC MANHOLE (EMH / EMH)
- TELEPHONE MANHOLE (TMH / TMH)
- GATE VALVE
- CURB STOP
- YARD HYDRANT
- HYDRANT
- UTILITY POLE
- UTILITY POLE W/ GUY
- UTILITY POLE W/ LIGHT
- LIGHT POLE
- LANDSCAPE AREA

LEGEND (cont.)

EXISTING / PROPOSED

- BOLLARD
- FLAGPOLE
- CONIFEROUS TREE
- DECIDUOUS TREE
- SHRUB
- EDGE OF WATER
- STREAM
- EDGE OF WETLANDS
- FLOODPLAIN
- WETLANDS
- DRAINAGE FLOW
- DRAINAGE SWALE
- PAVEMENT MARKINGS
- SIGN
- MAILBOX (MB)
- TEMPORARY BENCH MARK
- TEST PIT (TP-2)
- TEST BORING (B-3)
- TEST PROBE (P-4)
- MONITORING WELL (MW)
- LIMIT OF WORK
- SILT FENCE
- RIPRAP
- RAILROAD
- MATCHLINE
- ROCK OUTCROP
- SEWER (8" S / 8"S)
- SEWER FORCE MAIN (4" FM / 4"FM)
- GAS (4" G / 4"G)
- WATER (8" W / 8"W)
- STORM DRAIN (15" SD / 15"SD)
- UNDERDRAIN (6" UD / 6"UD)
- CULVERT (12" CMP / 12" CMP)
- PIPE SPOT ELEVATION (128.11 / 128.11)
- CULVERT/UNDERDRAIN (6"XX / 6"XX)
- PIPING (6"XX / 6"XX)
- LARGE DIA PIPING (18"+) (30"XX / 30"XX)
- PIPE PREVIOUSLY ABANDONED (6"XX (AB))
- PIPING TO BE DEMOLISHED (6"XX)
- PIPING TO ABANDON (6"XX)

"XX" DENOTES PIPE DESCRIPTION

SEE LIST OF CIVIL ABBREVIATIONS FOR PIPE DESCRIPTIONS

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY: DAM/JDP
CAD COORD: APC
CAD: CMC
CHECKED BY:
DATE:
APPROVED BY:
DATE:
PROJECT NO: 12883

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EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

PROJECT OVERVIEW, LEGEND, & ABBREVIATIONS

DRAWING
C-1

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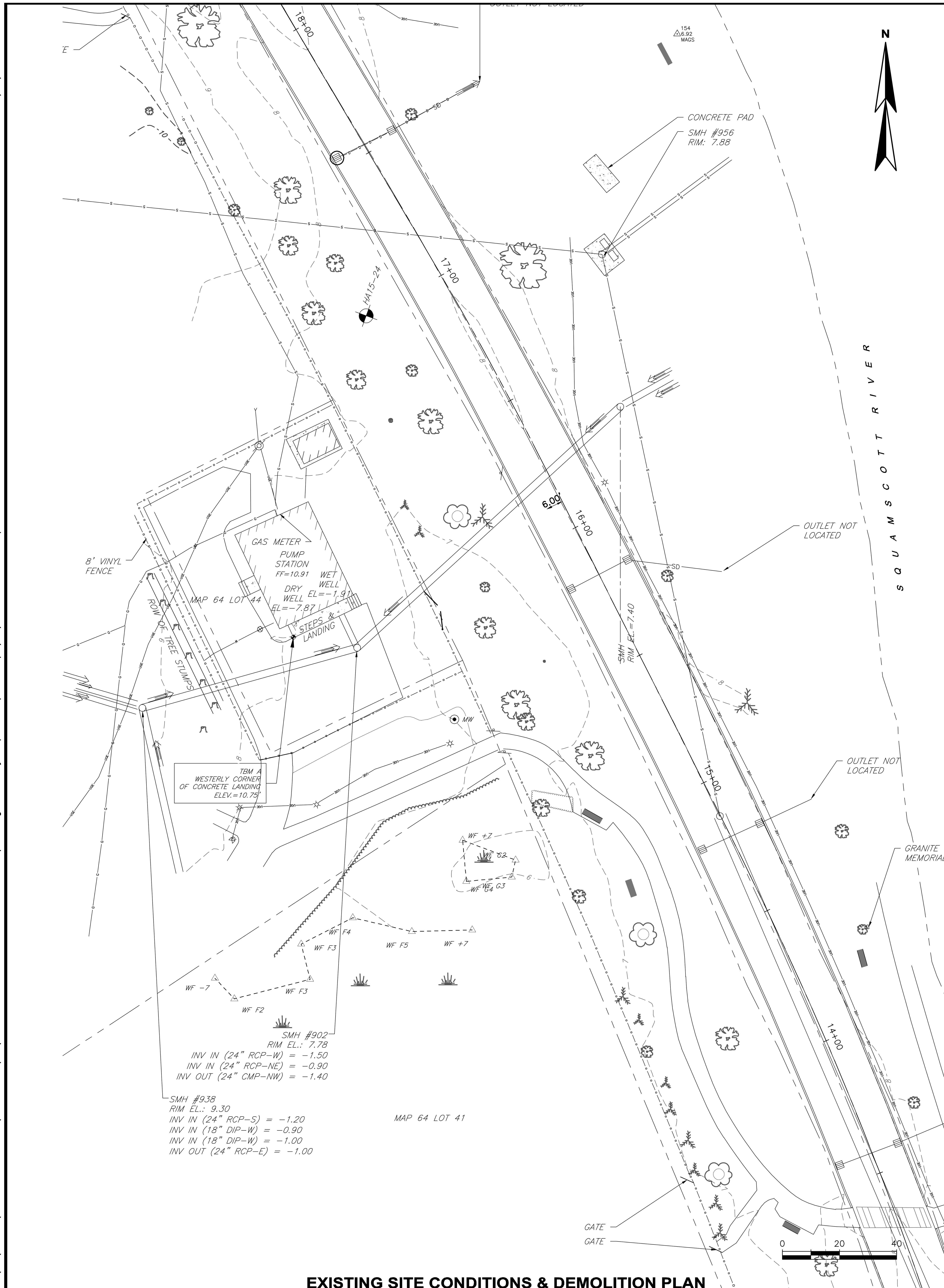
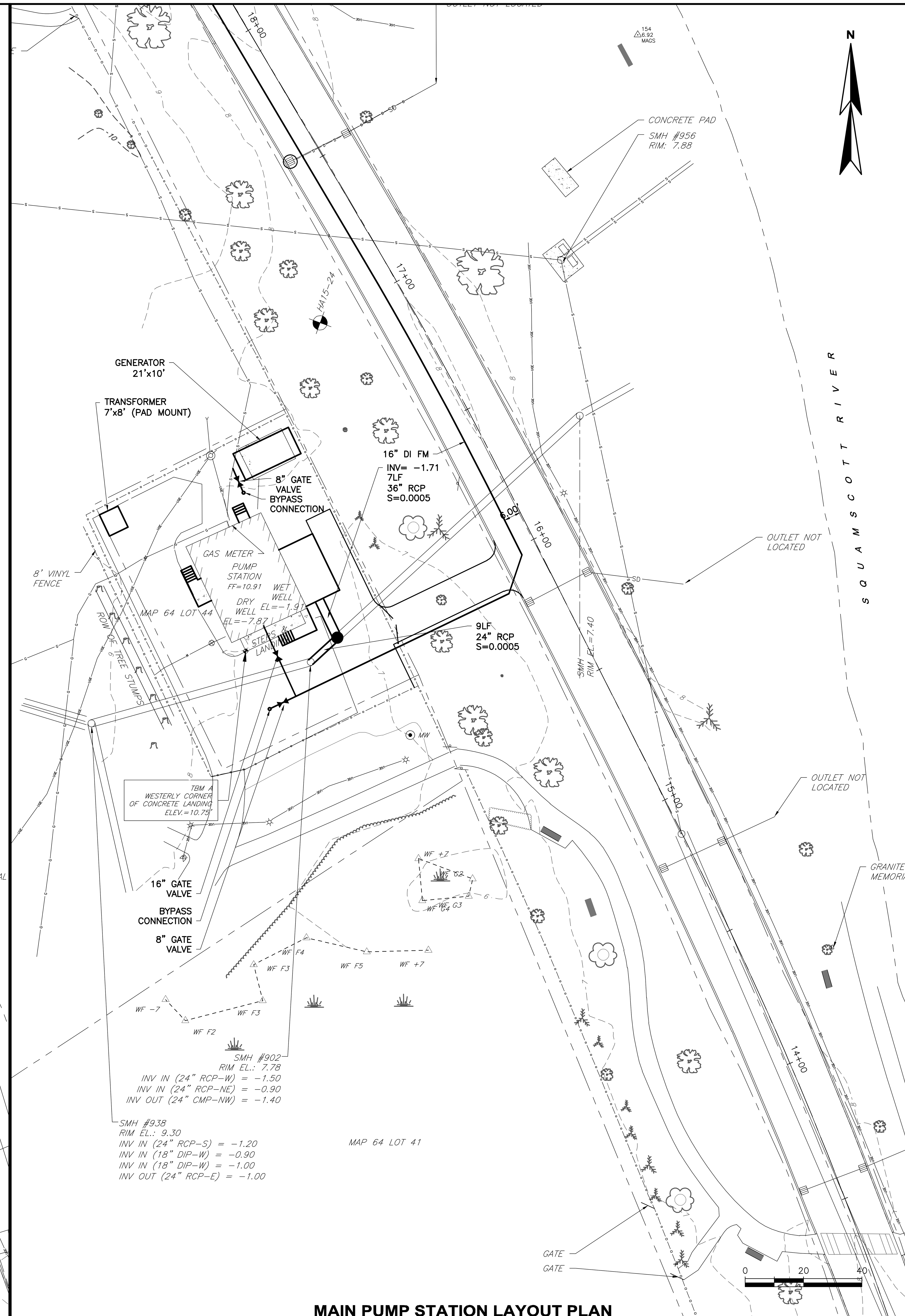


EXISTING SITE CONDITIONS & DEMOLITION PLAN



MAIN PUMP STATION LAYOUT PLAN

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		
1			
2			
3			
4			

DESIGNED BY: DAM/JDP
CAD COORD: APC
CAD: CMC
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EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

EXISTING SITE CONDITIONS, DEMOLITION PLAN, AND MAIN PUMP STATION SITE LAYOUT PLAN

DRAWING
C-2

LAST SAVED BY: ADAM.COUTURE 9/24/2015 9:47 AM

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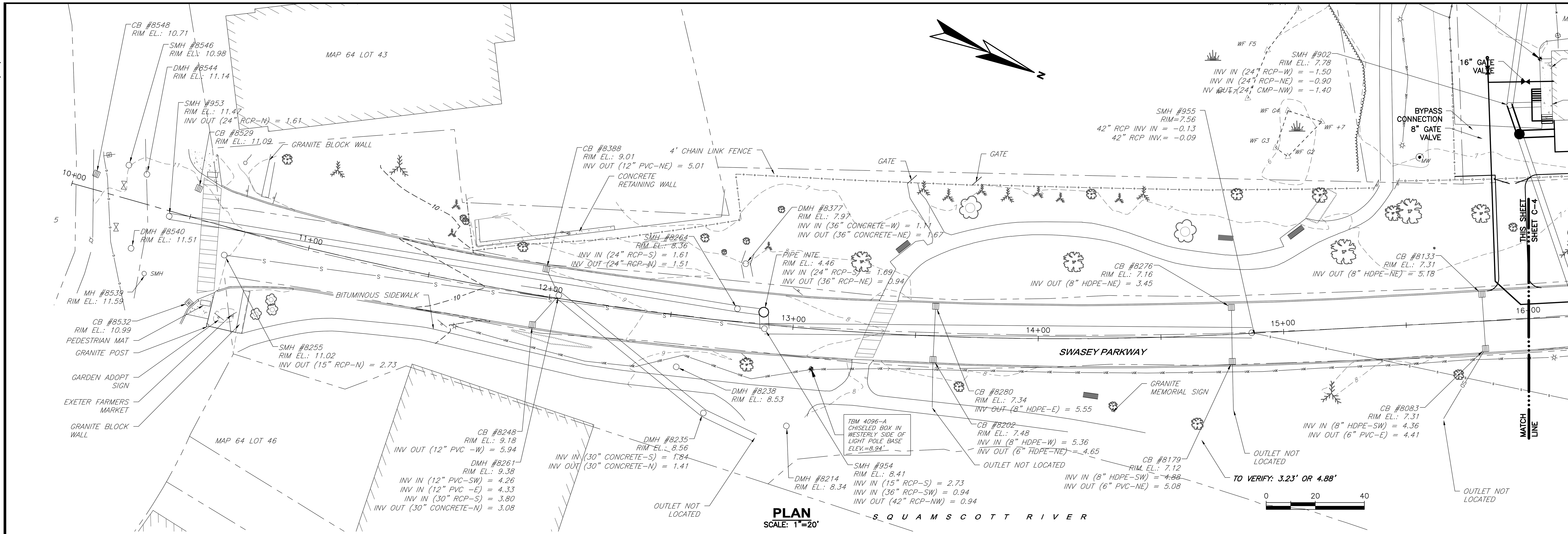

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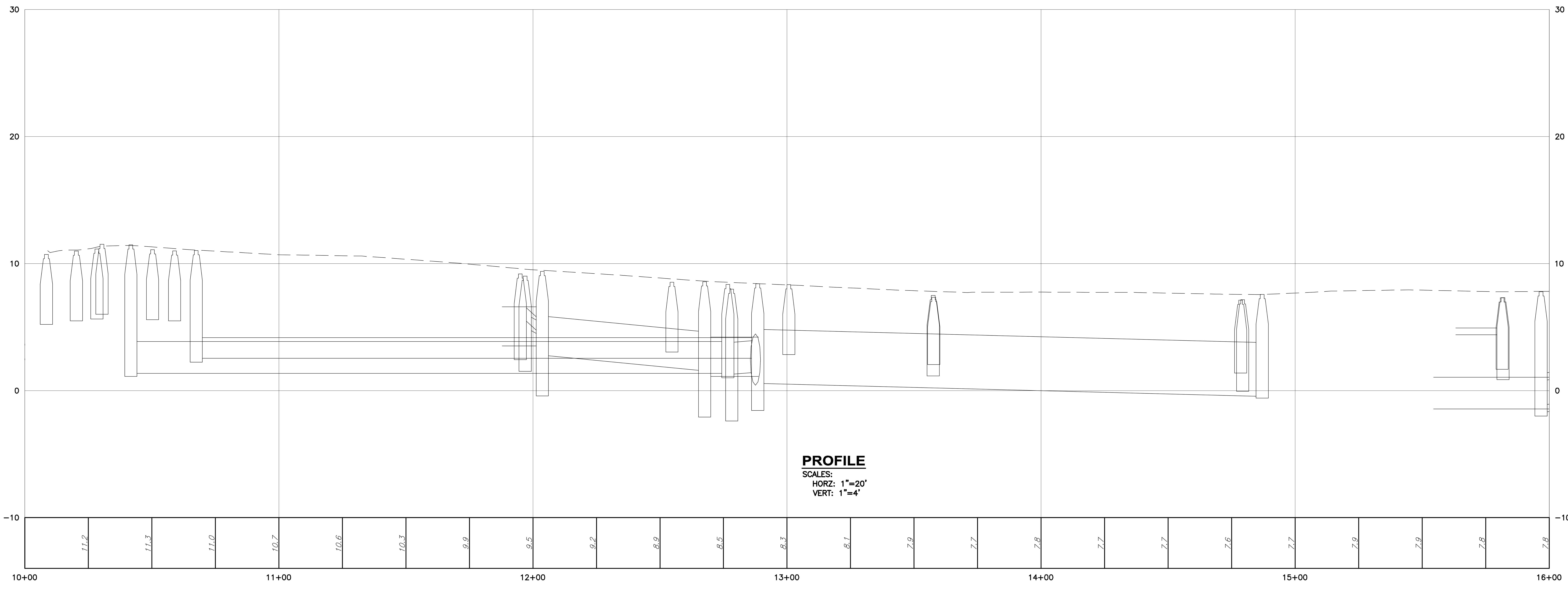

PROFILE
SCALES:
HORZ: 1"=20'
VERT: 1"=4'

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
1	PRELIMINARY DESIGN REPORT		

DESIGNED BY: DAM/JDP
CAD COORD: APC
CAD: CMC
CHECKED BY:
DATE:
APPROVED BY:
DATE:
PROJECT NO: 12883

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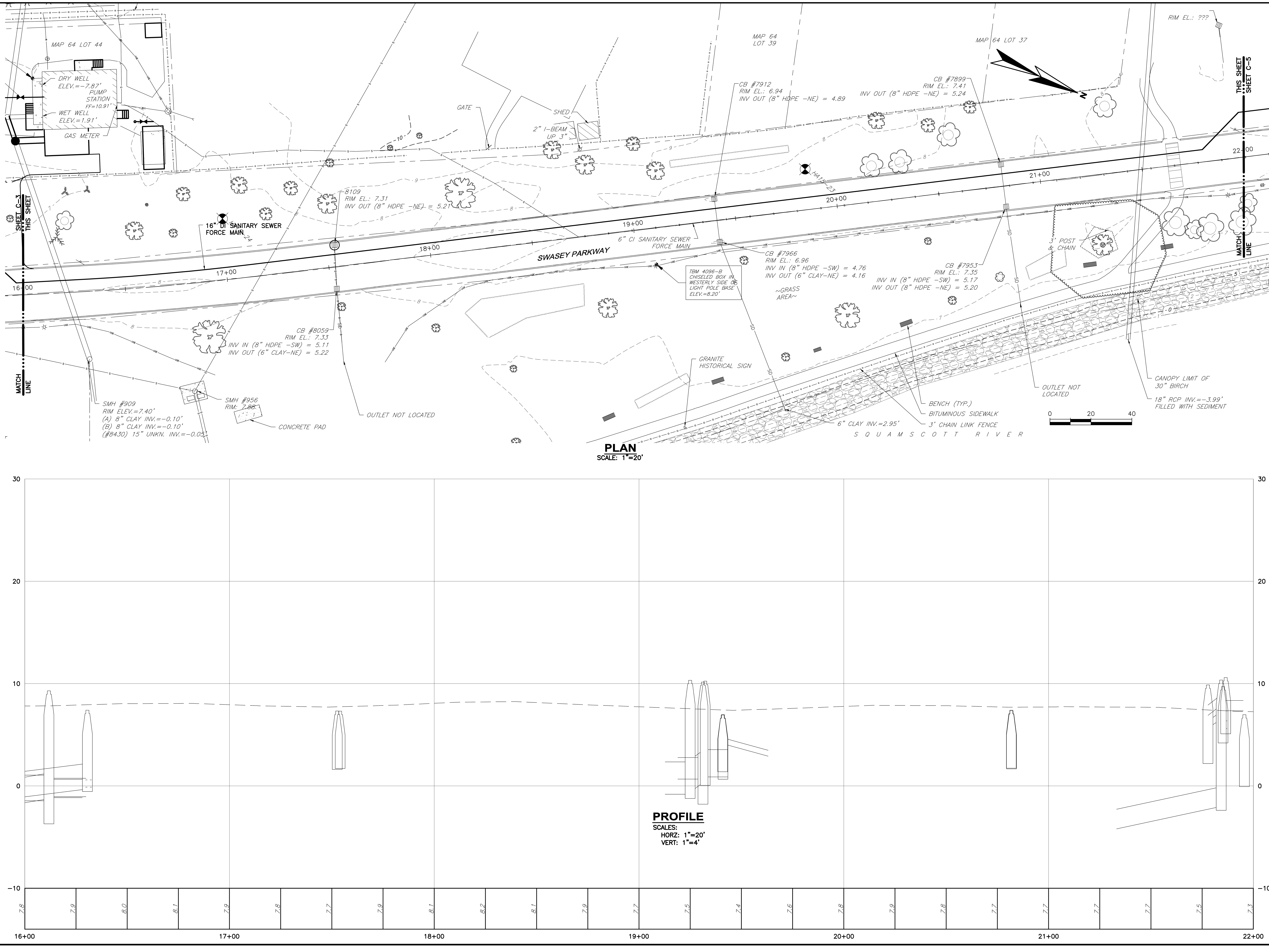
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN,
AND WATER MAIN IMPROVEMENTS

PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD
STA 10+00 TO STA 16+00

DRAWING
C-3



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NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY: DAM/JDP
CAD COORD: APC
CAD: CMC
CHECKED BY:
DATE:
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DATE:
PROJECT NO. 12883

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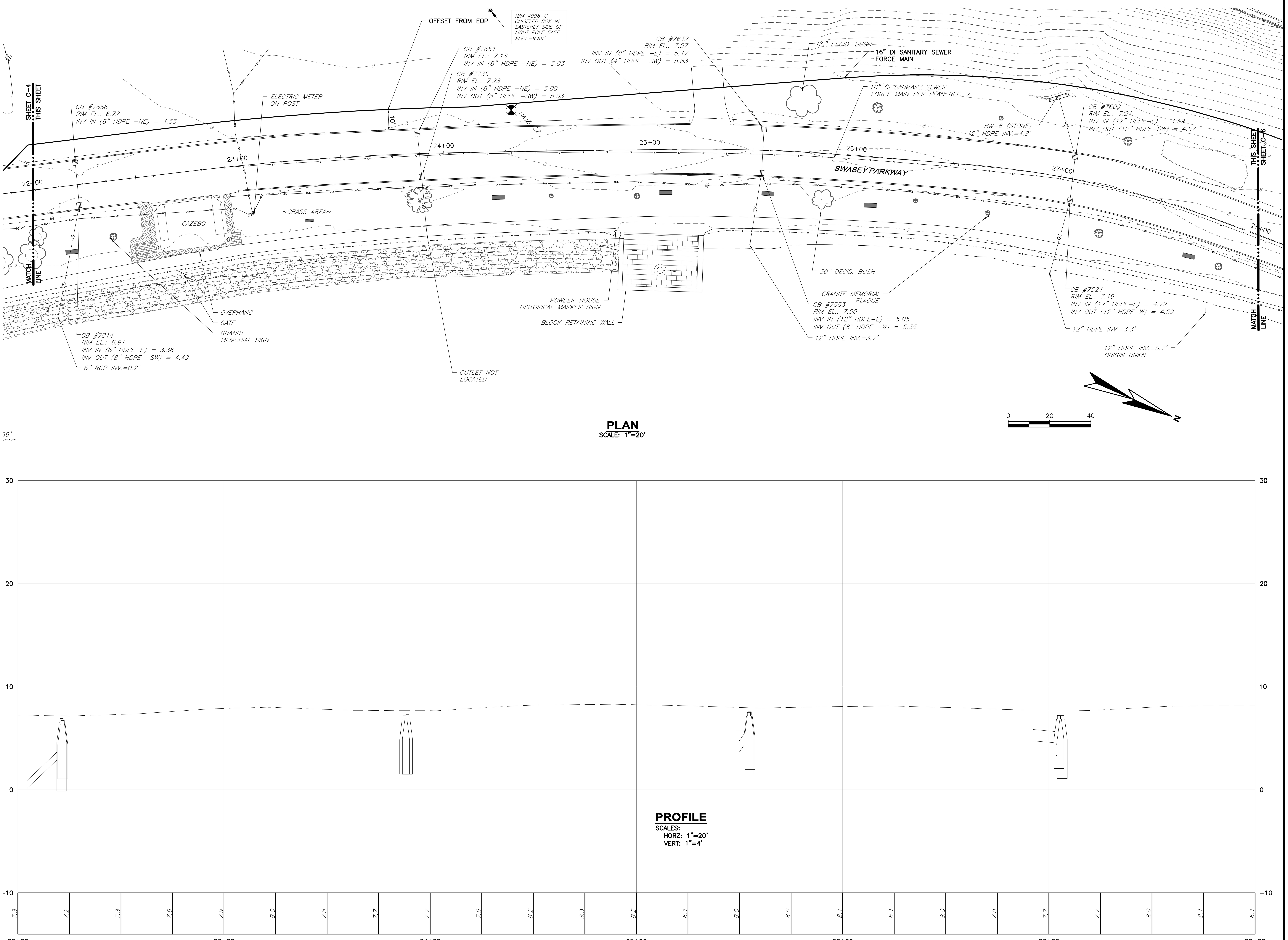
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD
STA 16+00 TO STA 22+00

DRAWING
C-4



NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		
1			
2			
3			
4			

DESIGNED BY: DAM/JDP
CAD COORD: APC
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DATE:
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PROJECT NO: 12883

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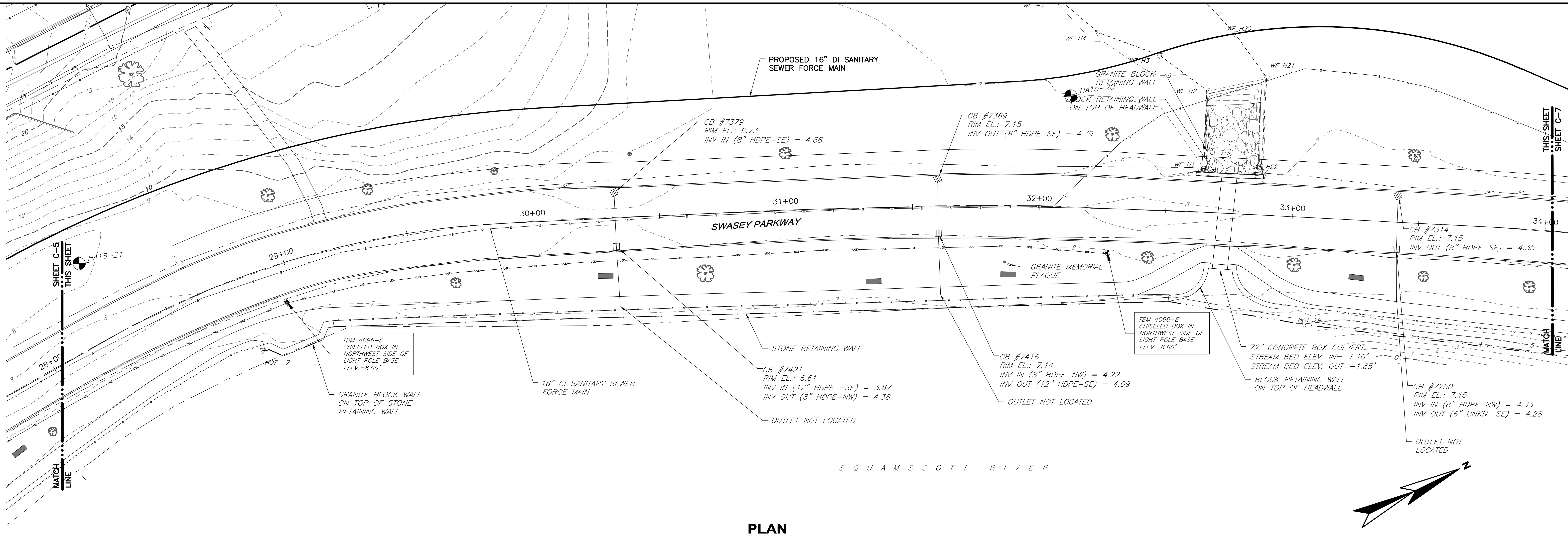
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD
STA 22+00 TO STA 28+00

DRAWING
C-5



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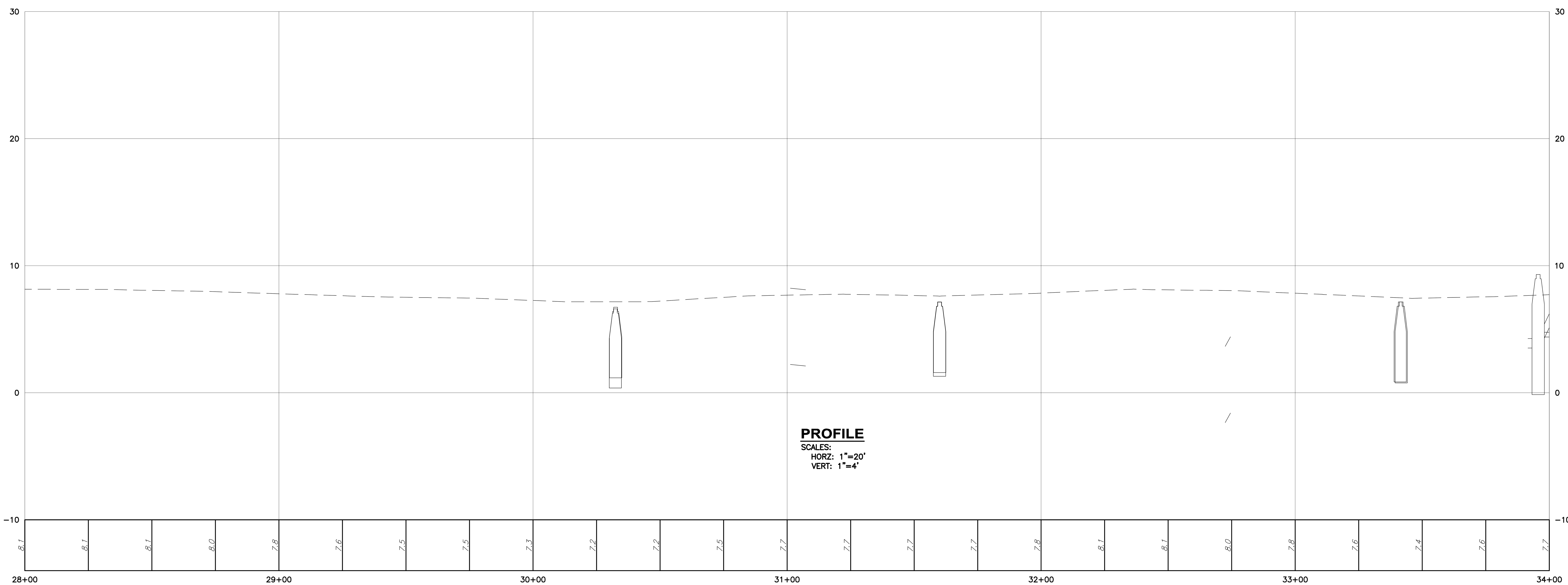

PROFILE
SCALES:
HORZ: 1"=20'
VERT: 1"=4'

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
1	PRELIMINARY DESIGN REPORT		

DESIGNED BY: DAM/JDP
CAD COORD: APC
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DATE:
APPROVED BY:
DATE:
PROJECT NO. 12883

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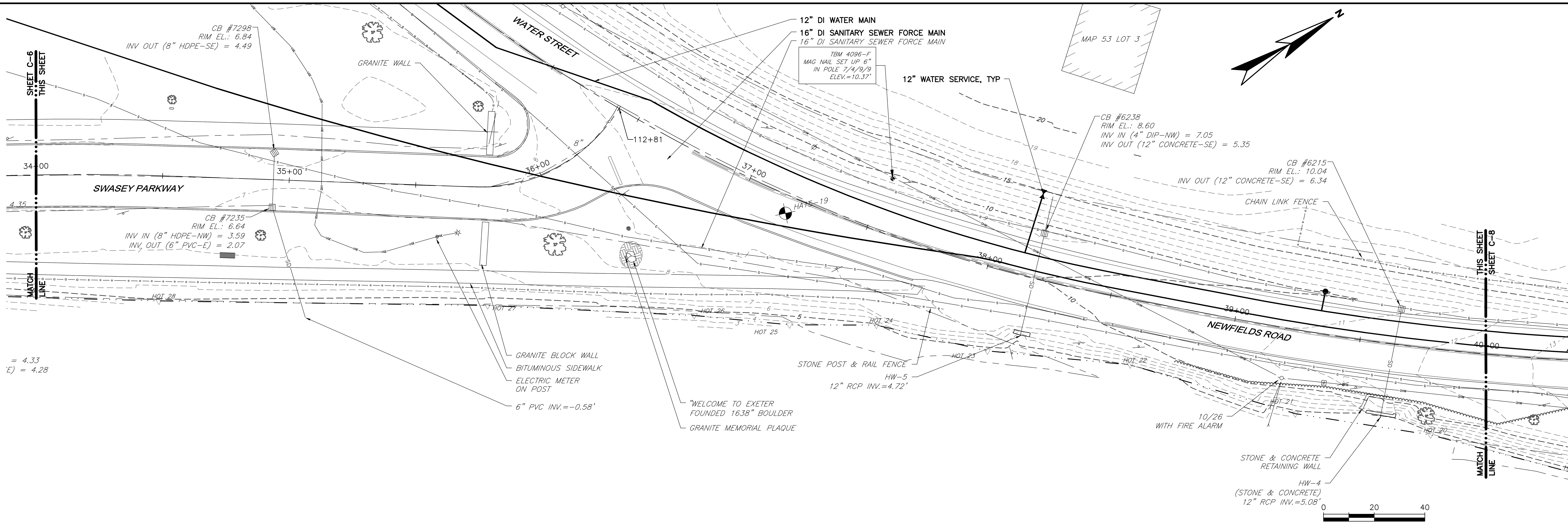
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD
STA 28+00 TO STA 34+00

DRAWING
C-6



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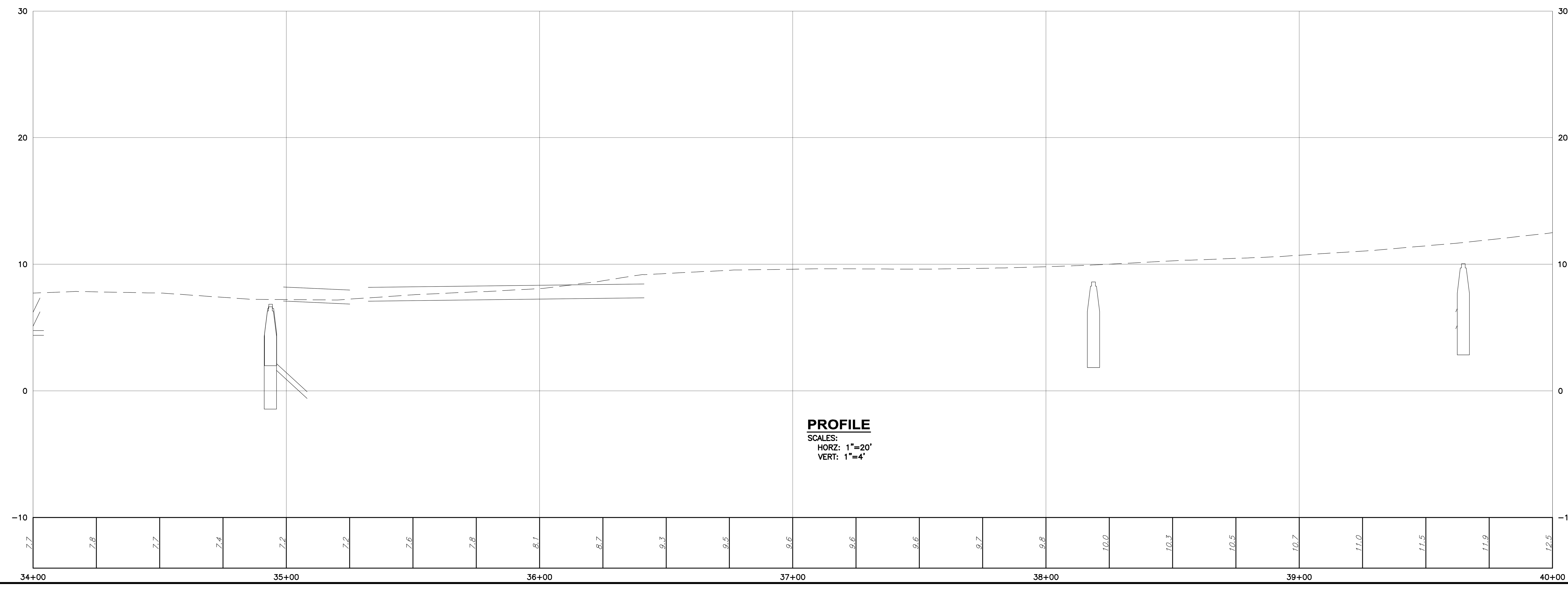

PROFILE
SCALES:
HORZ: 1"=20'
VERT: 1"=4'

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY: DAM/JDP
CAD COORD: APC
CAD: CMC
CHECKED BY:
DATE:
APPROVED BY:
DATE:
PROJECT NO. 12883

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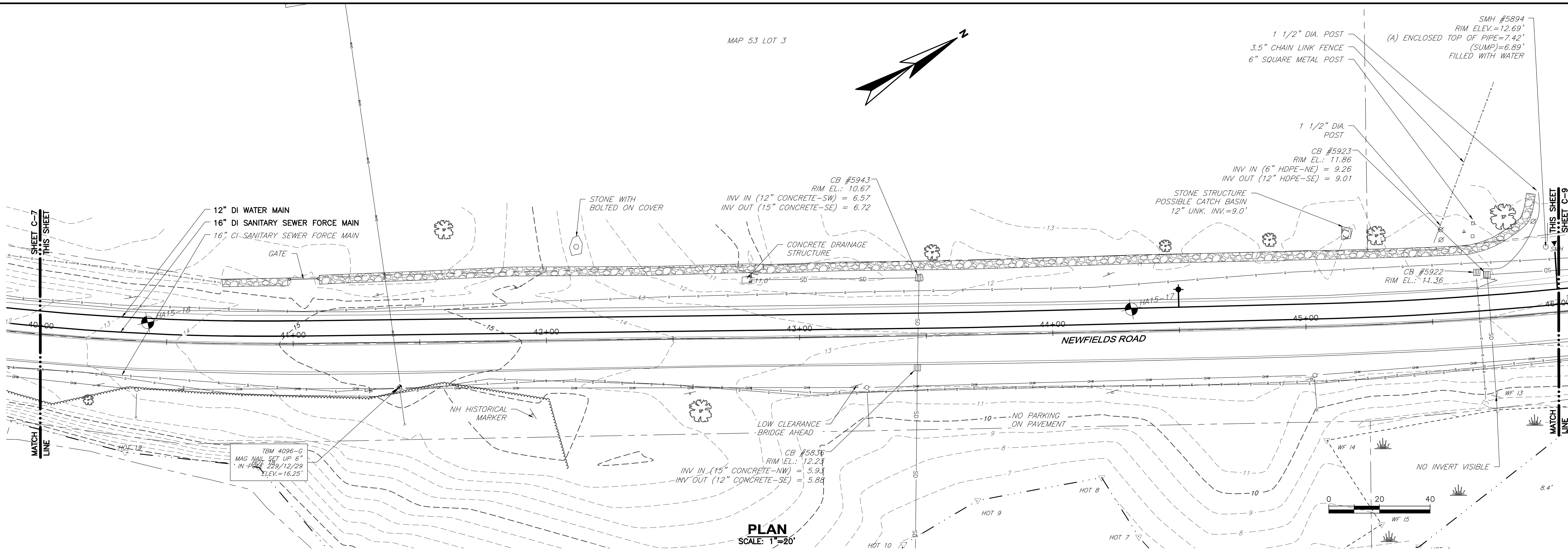
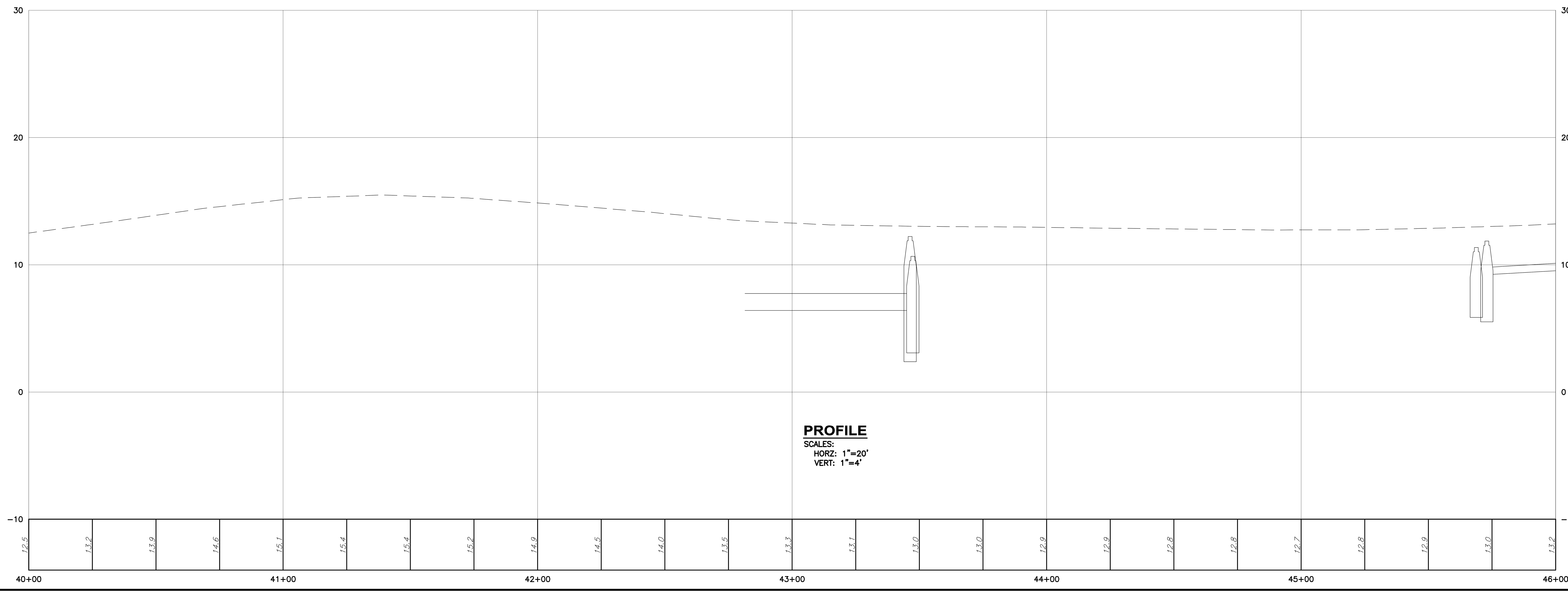
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD
STA 34+00 TO STA 40+00

DRAWING
C-7

LAST SAVED BY: ADAM.COUTURE 9/24/2015 9:47 AM





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NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY: DAM/JDP
CAD COORD: APC
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DATE:
APPROVED BY:
DATE:
PROJECT NO. 12883

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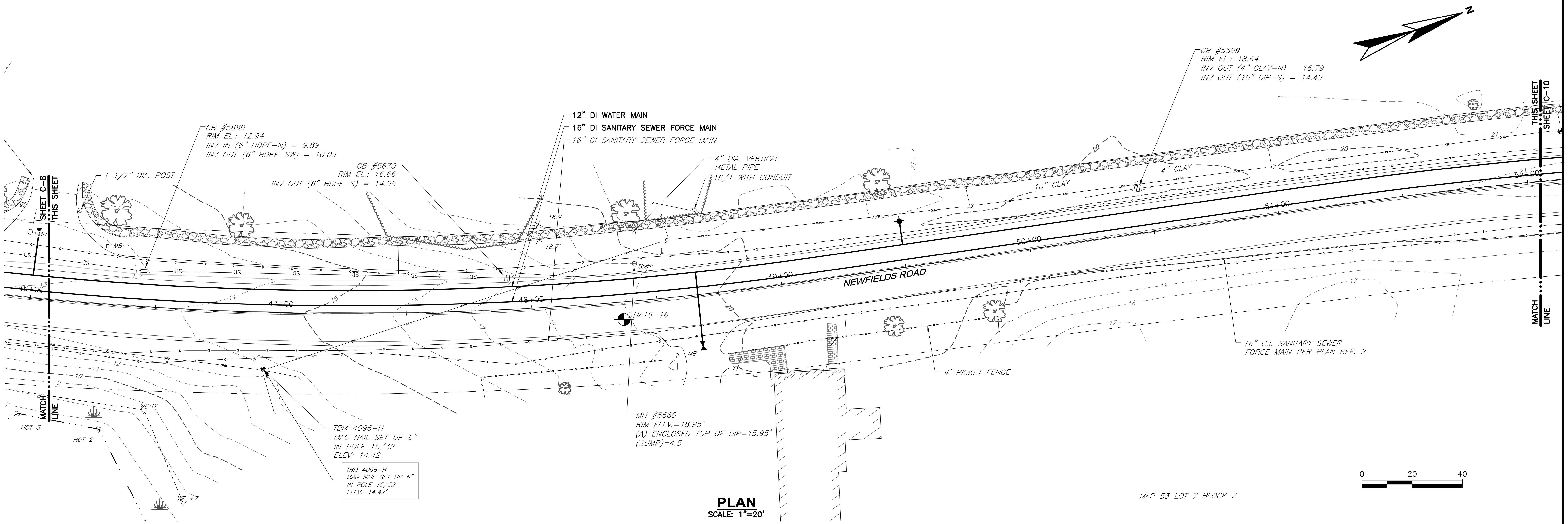
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD
STA 40+00 TO STA 46+00

DRAWING
C-8



PLAN
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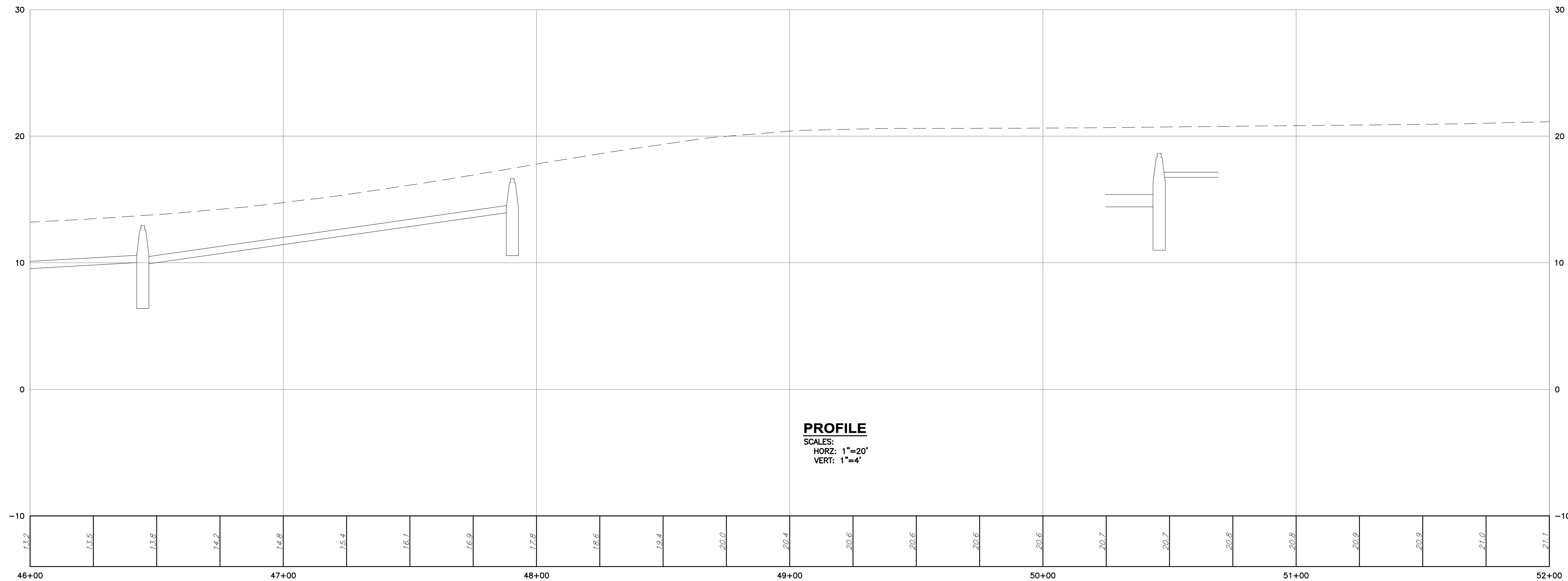

PROFILE
SCALES:
HORZ: 1"=20'
VERT: 1"=4'

G:\DWGS\NH\EXETER\12883-PS-UPGRADE\12883-PDR\CIV\12883A-PS-PLANPROFILE.DWG | PlanProfile-7 | 1:4.56 | ---- | 9/24/2015 11:00:27 AM | ADAM.COUTURE

LAST SAVED BY: ADAM.COUTURE 9/24/2015 9:47 AM

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY: DAM/JDP
CAD COORD: APC
CAD: CMC
CHECKED BY:
DATE:
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PROJECT NO. 12883

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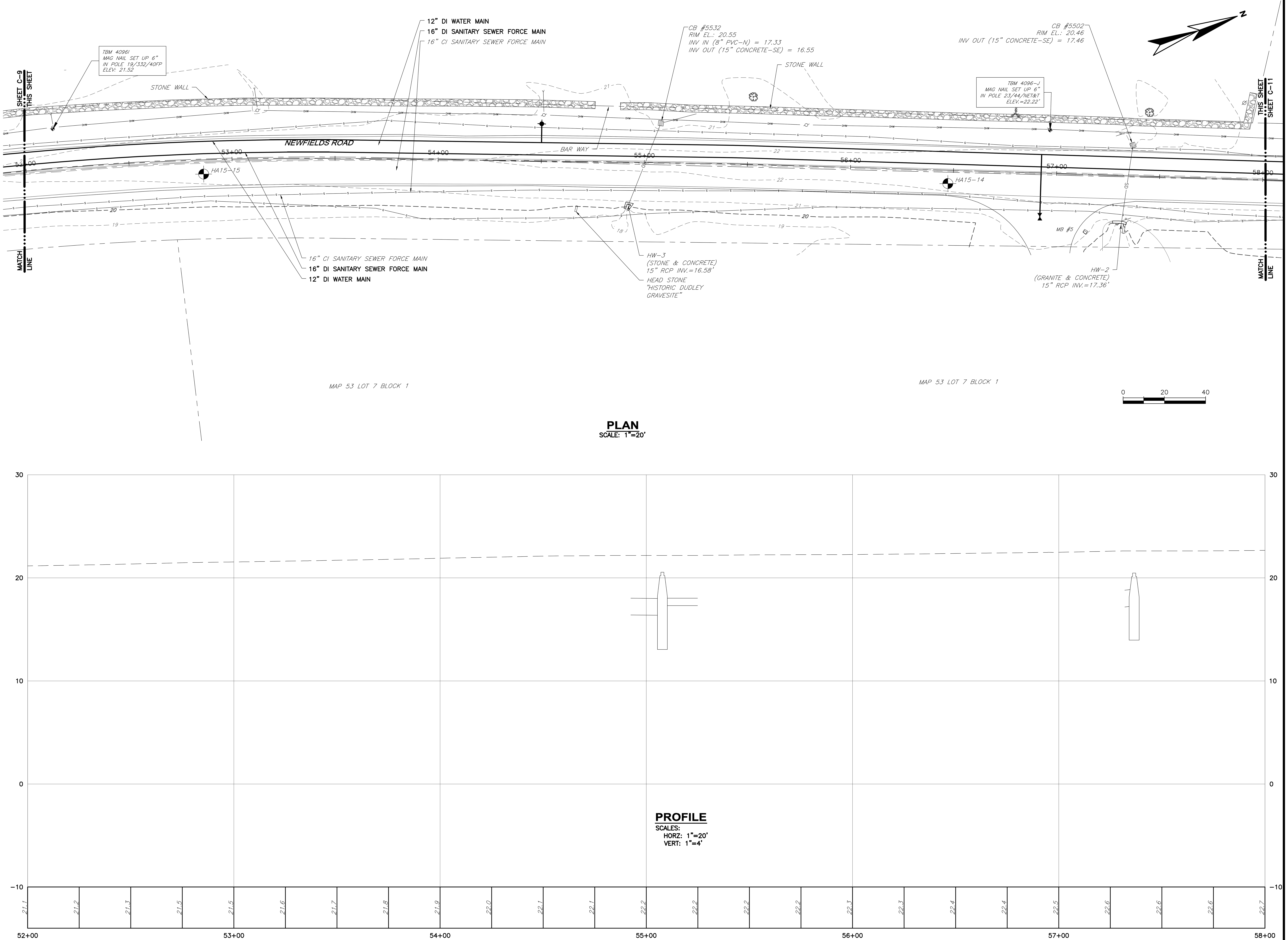
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD
STA 46+00 TO STA 52+00

DRAWING
C-9



NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY: DAM/JDP
CAD COORD: APC
CAD: CMC
CHECKED BY:
DATE:
APPROVED BY:
DATE:
PROJECT NO. 12883

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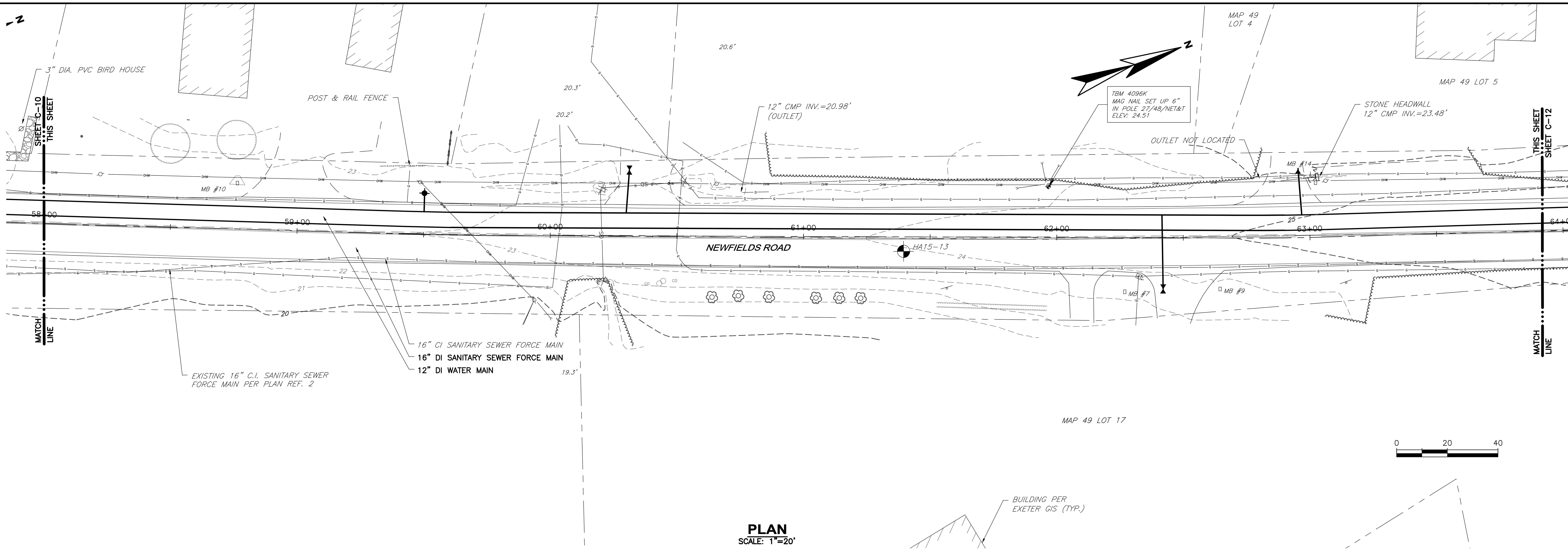
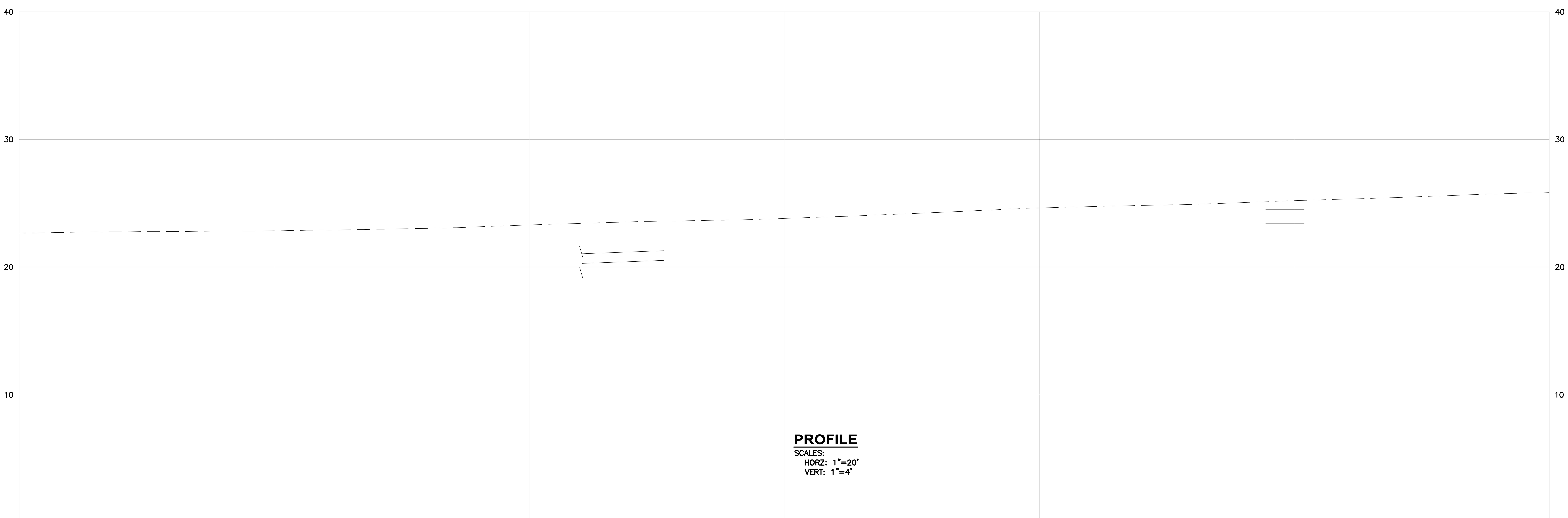
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN,
AND WATER MAIN IMPROVEMENTS

PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD
STA 52+00 TO STA 58+00

DRAWING
C-10



PLAN
SCALE: 1"=20'



PROFILE
SCALES:
HORZ: 1"=20'
VERT: 1"=4'

22.7	22.7	22.8	22.8	22.8	22.9	23.0	23.1	23.3	23.5	23.6	23.7	23.8	24.0	24.2	24.4	24.6	24.8	24.9	25.0	25.2	25.4	25.5	25.7	25.8

58+00 59+00 60+00 61+00 62+00 63+00 64+00

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

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CAD: CMC
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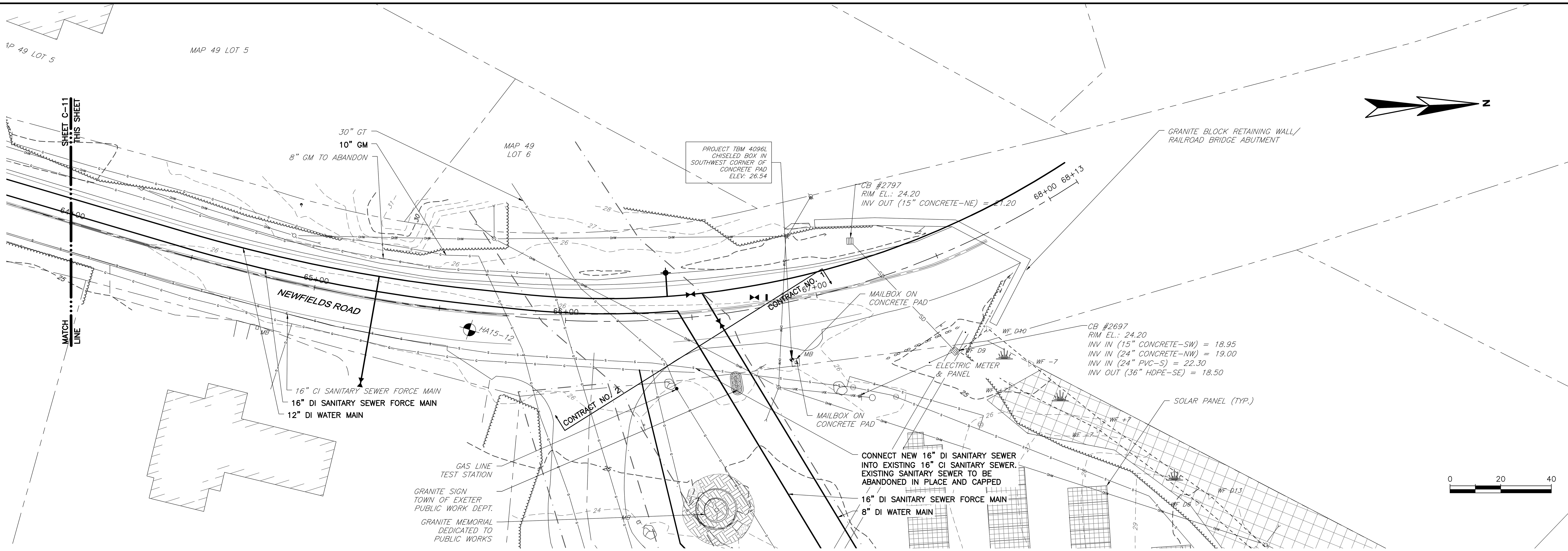
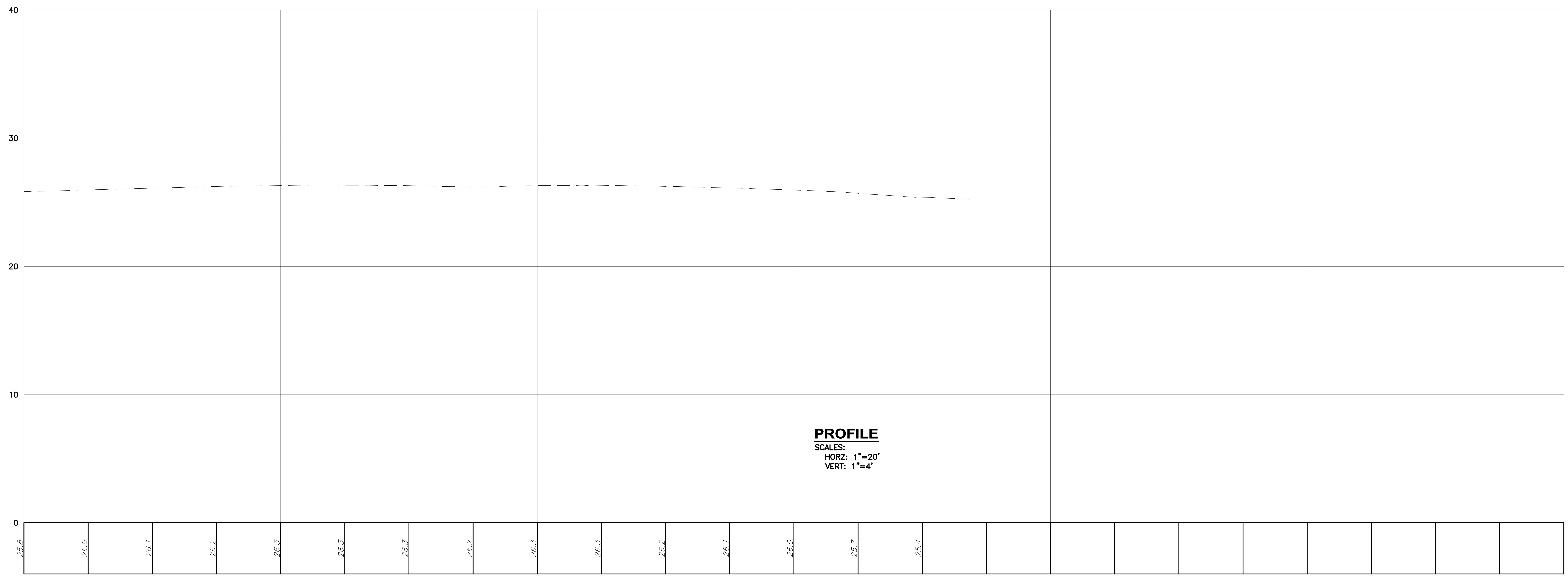
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD
STA 58+00TO STA 64+00

DRAWING
C-11



PLAN
SCALE: 1"=20'



PROFILE
SCALES:
HORZ: 1"=20'
VERT: 1"=4'

LAST SAVED BY: ADAM.COUTURE 9/24/2015 9:47 AM

G:\DWGS\NH\EXETER\12883-PS-UPGRADE\12883-PDR\CIV\12883A-PS-PLANPROFILE.DWG | PlanProfile-10 | 1:4.56 | ---- | 9/24/2015 11:01:43 AM | ADAM.COUTURE

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

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CAD: CMC
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EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN,
AND WATER MAIN IMPROVEMENTS

PLAN AND PROFILE: SWAZEY PARKWAY & NEWFIELDS ROAD
STA 62+00 TO STA 68+00

DRAWING
C-12

LAST SAVED BY: ADAM.COUTURE 9/24/2015 9:47 AM | ADAM.COUTURE

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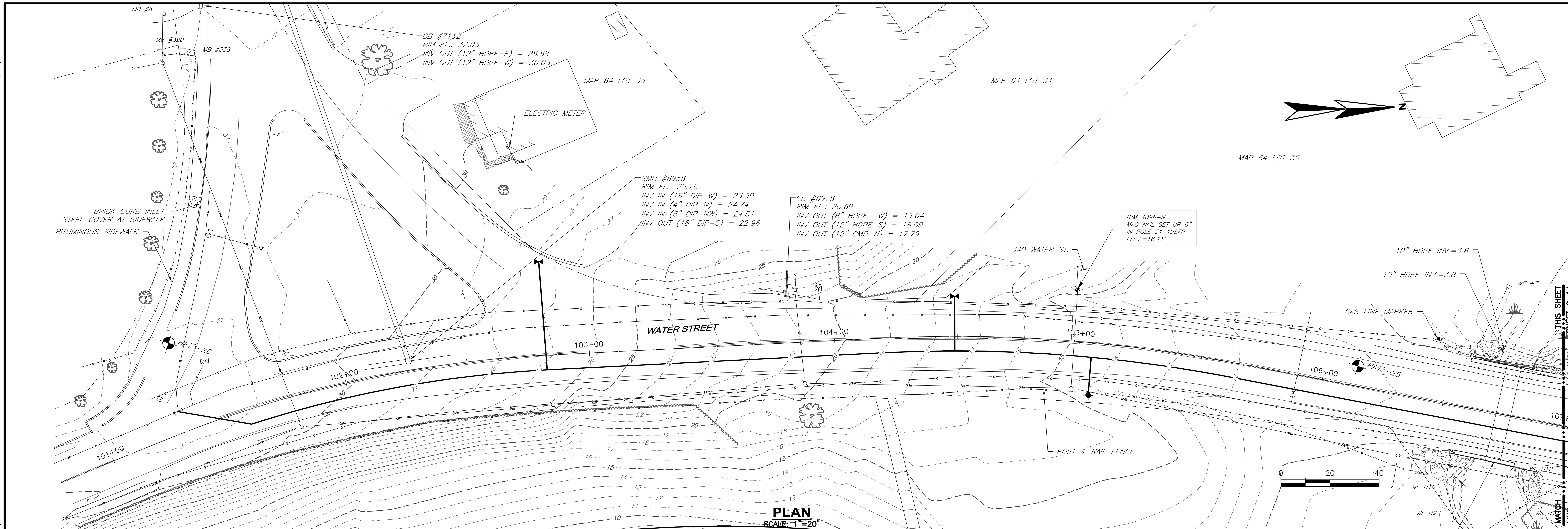

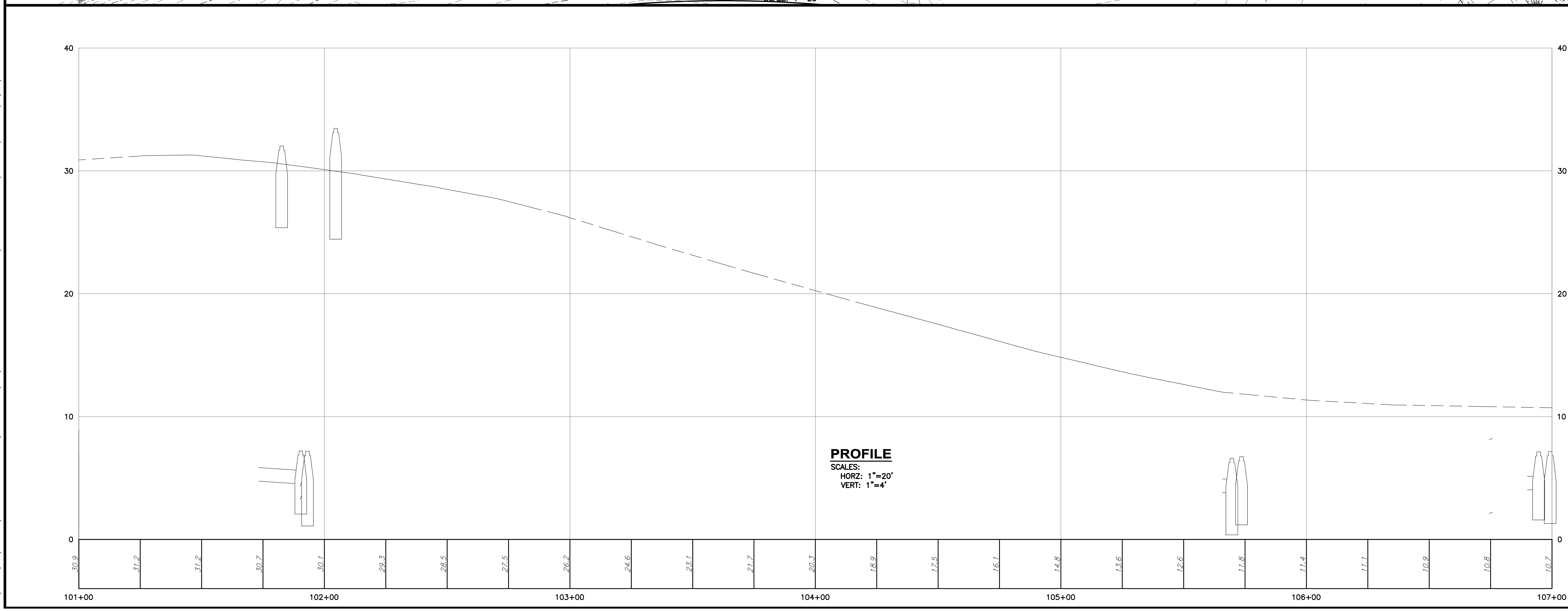

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

DESIGNED BY: DAM/JDP
CAD COORD: APC
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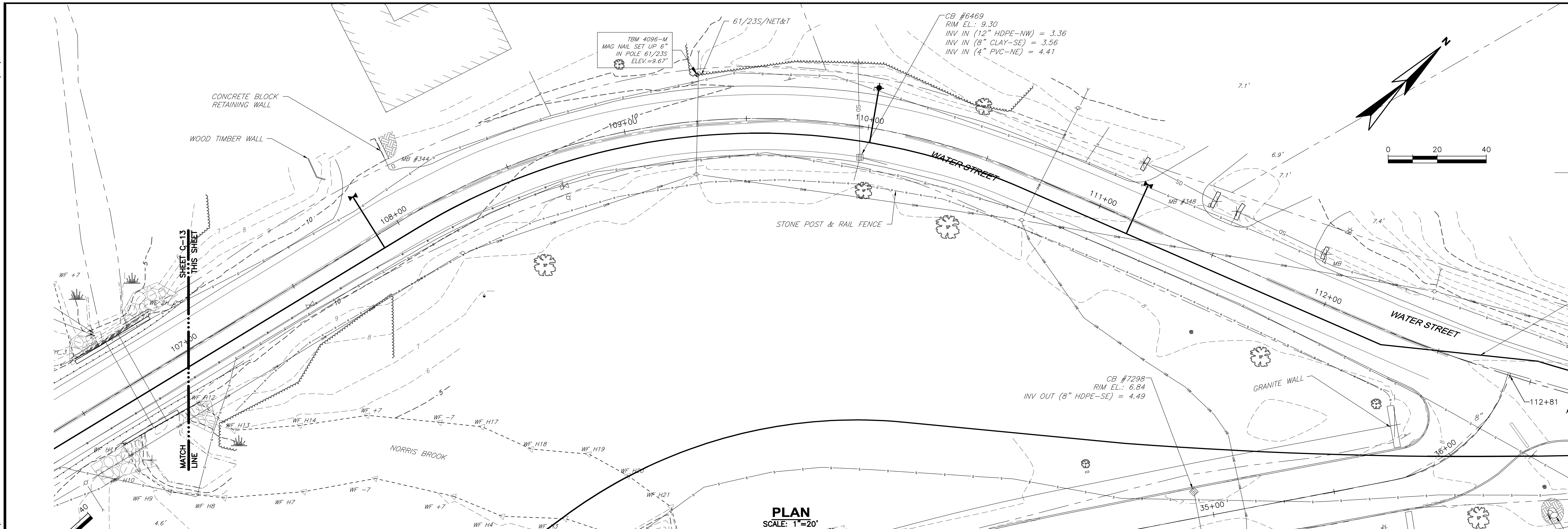
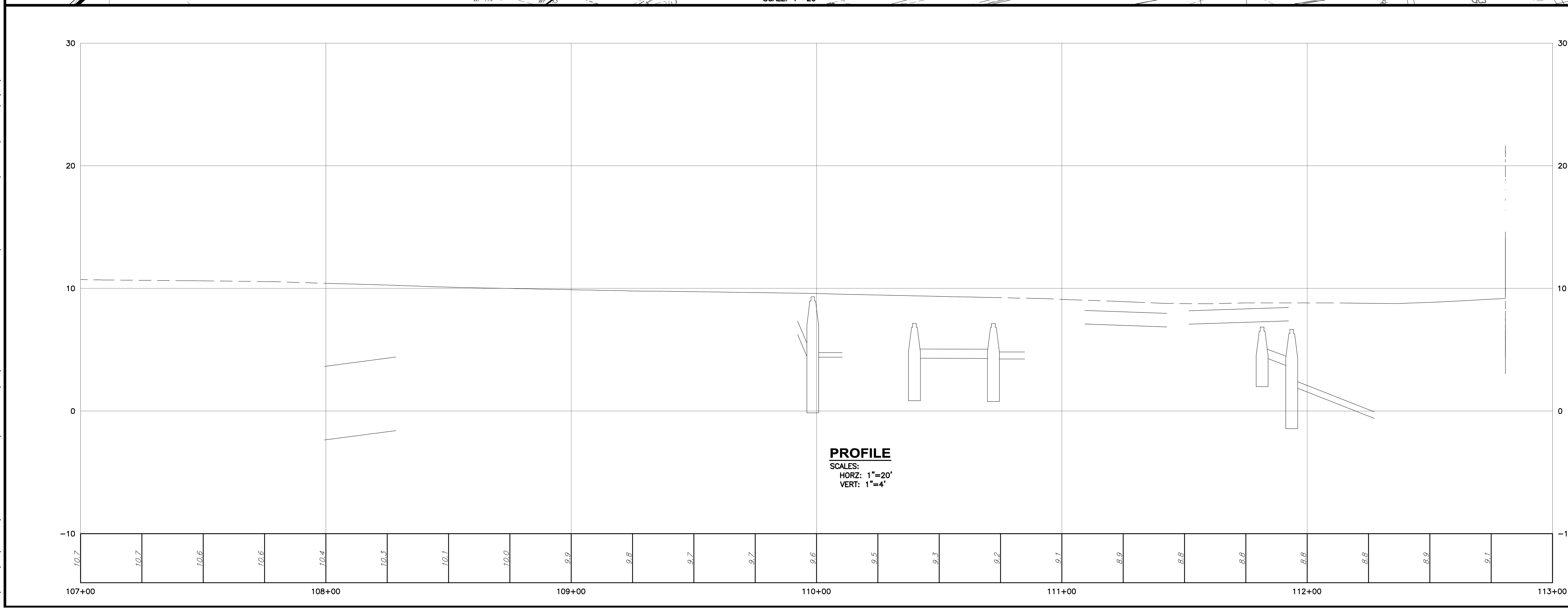
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

PLAN AND PROFILE: WATER STREET
STA 101+00 TO STA 107+00

DRAWING
C-13





NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

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CAD: CMC
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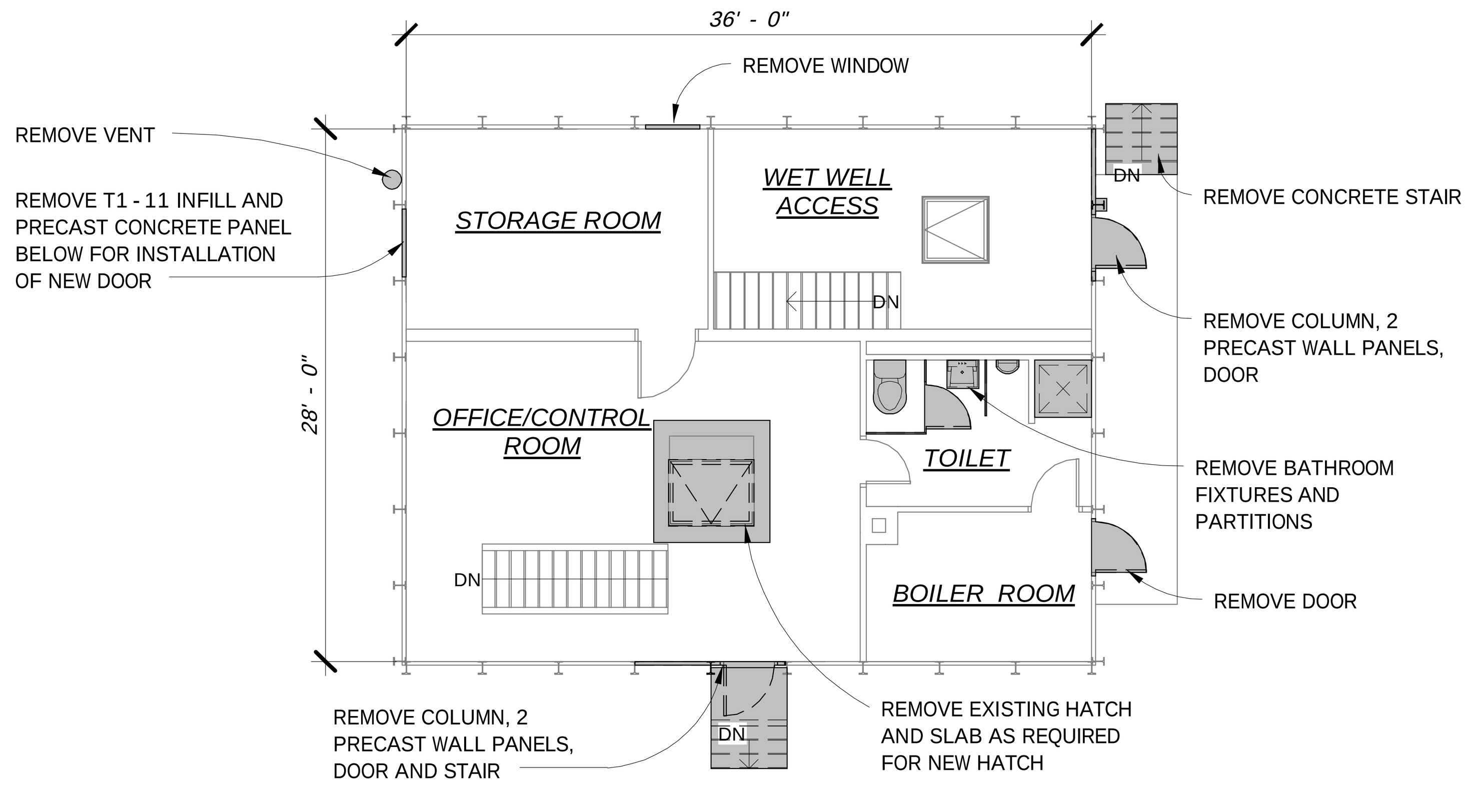
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

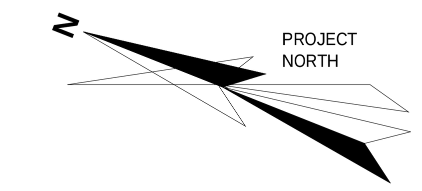
PLAN AND PROFILE: WATER STREET
STA 107+00 TO STA 113+00

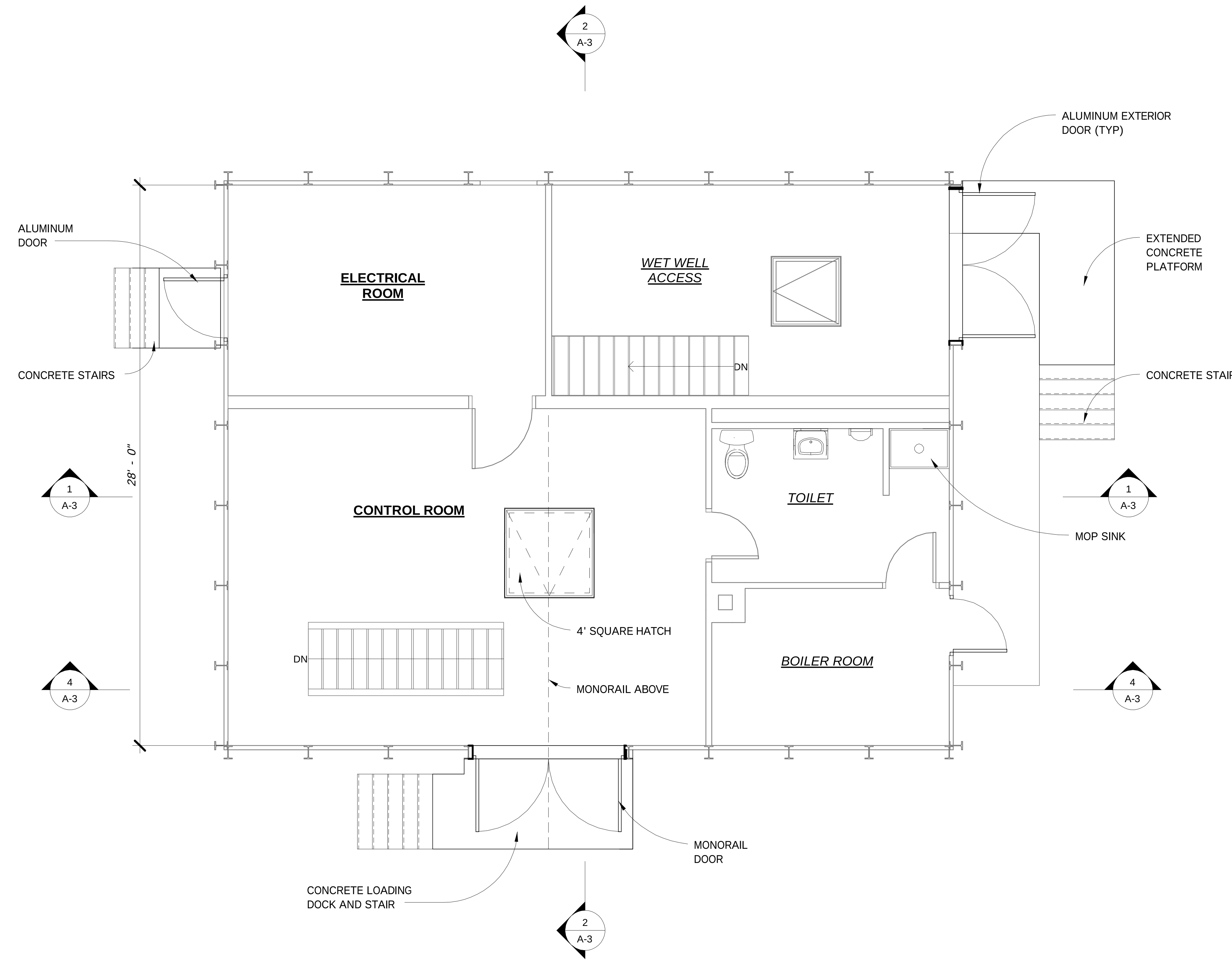
DRAWING
C-14



MAIN FLOOR PLAN DEMO

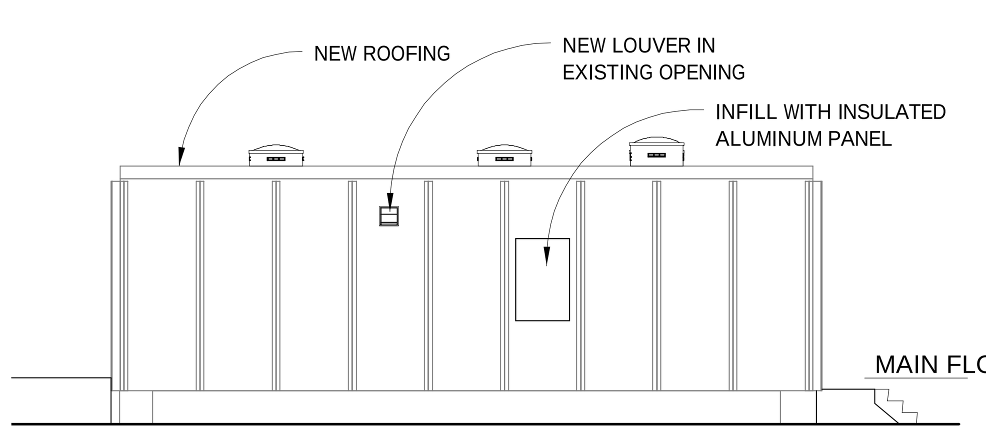
SCALE: 1 / 8" = 1' - 0"





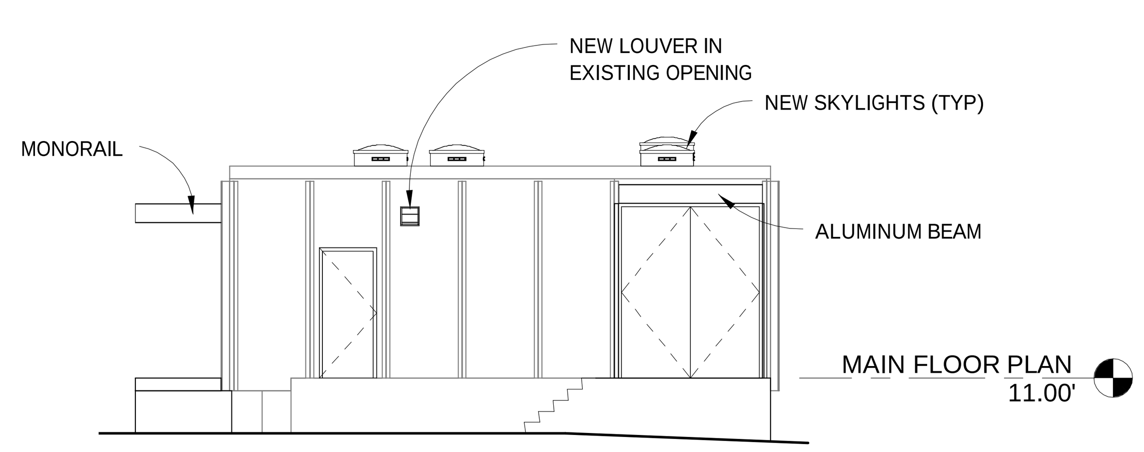
MAIN FLOOR PLAN NEW

SCALE: 1 / 4" = 1' - 0"



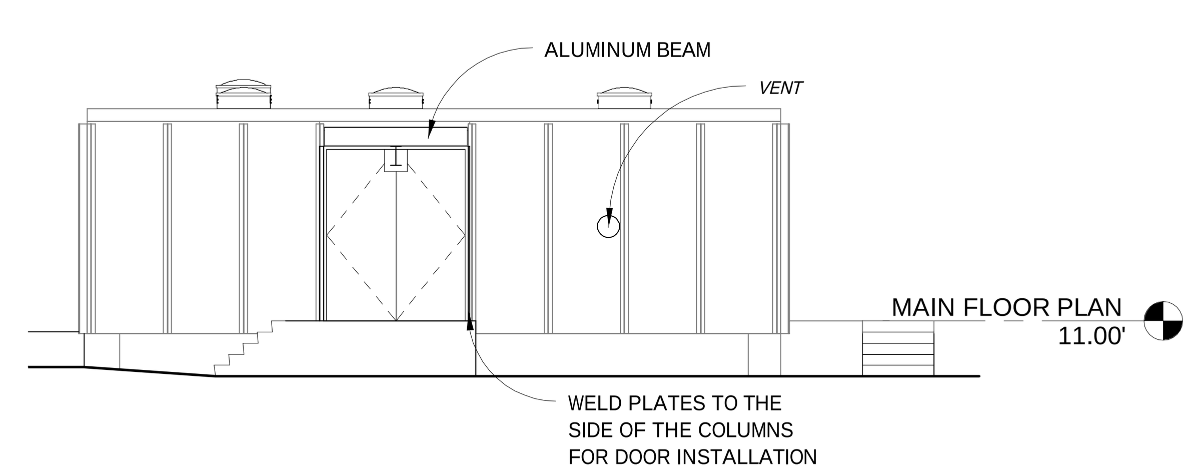
EAST ELEVATION

SCALE: 1 / 8" = 1' - 0"



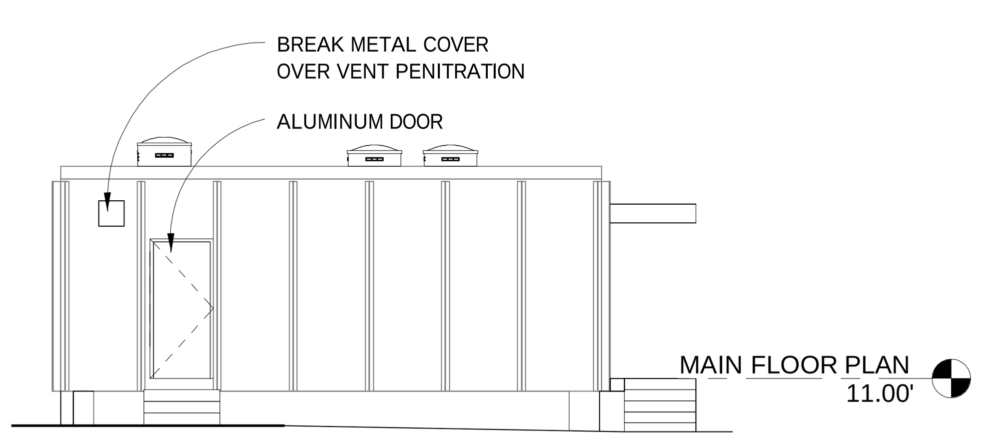
SOUTH ELEVATION

SCALE: 1 / 8" = 1' - 0"



WEST ELEVATION

SCALE: 1 / 8" = 1' - 0"



NORTH ELEVATION

SCALE: 1 / 8" = 1' - 0"

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		
1			
2			
3			
4			

DESIGNED BY: RDW
CAD COORD: APC
CAD: RWD, JWB2
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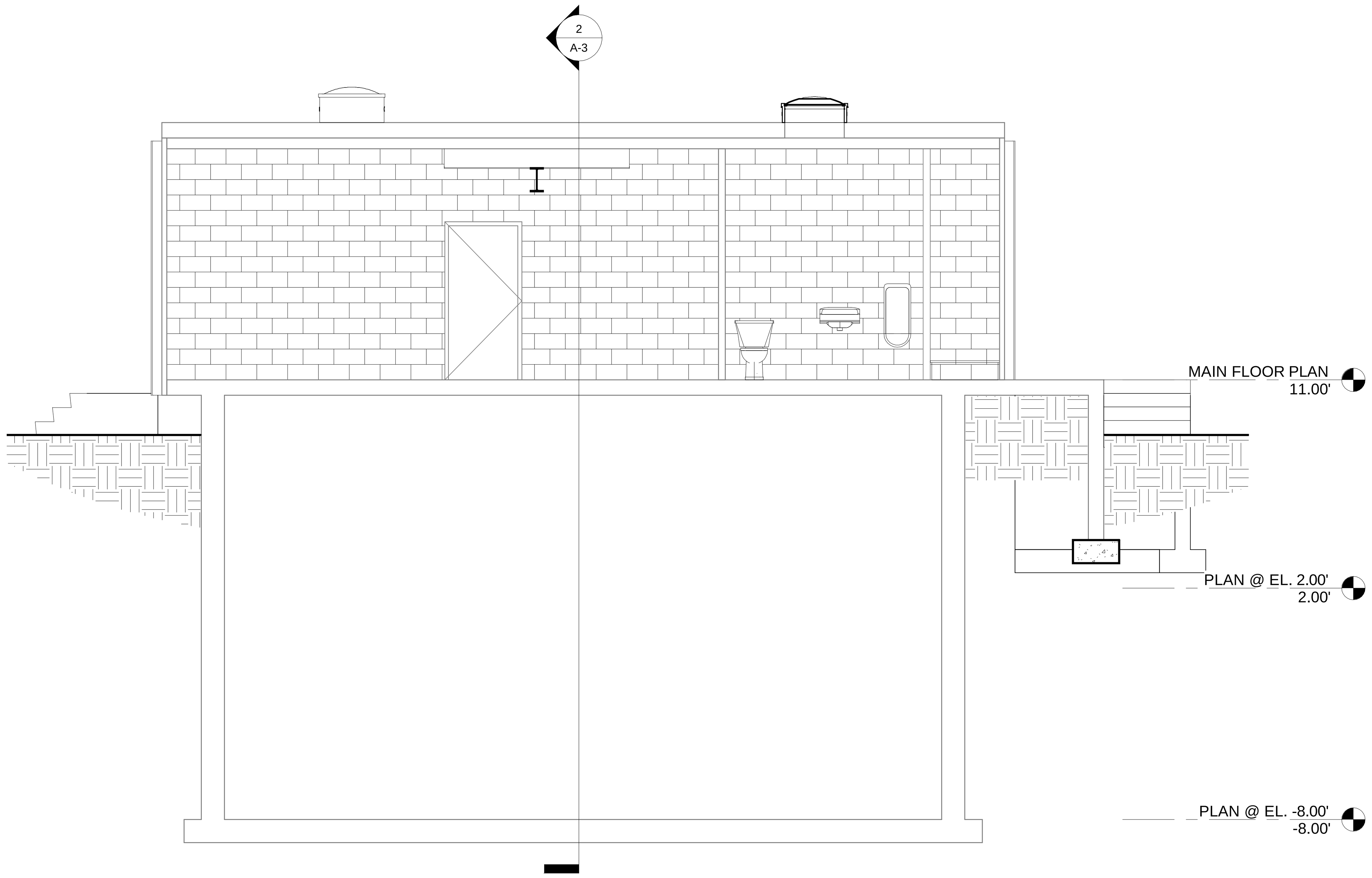
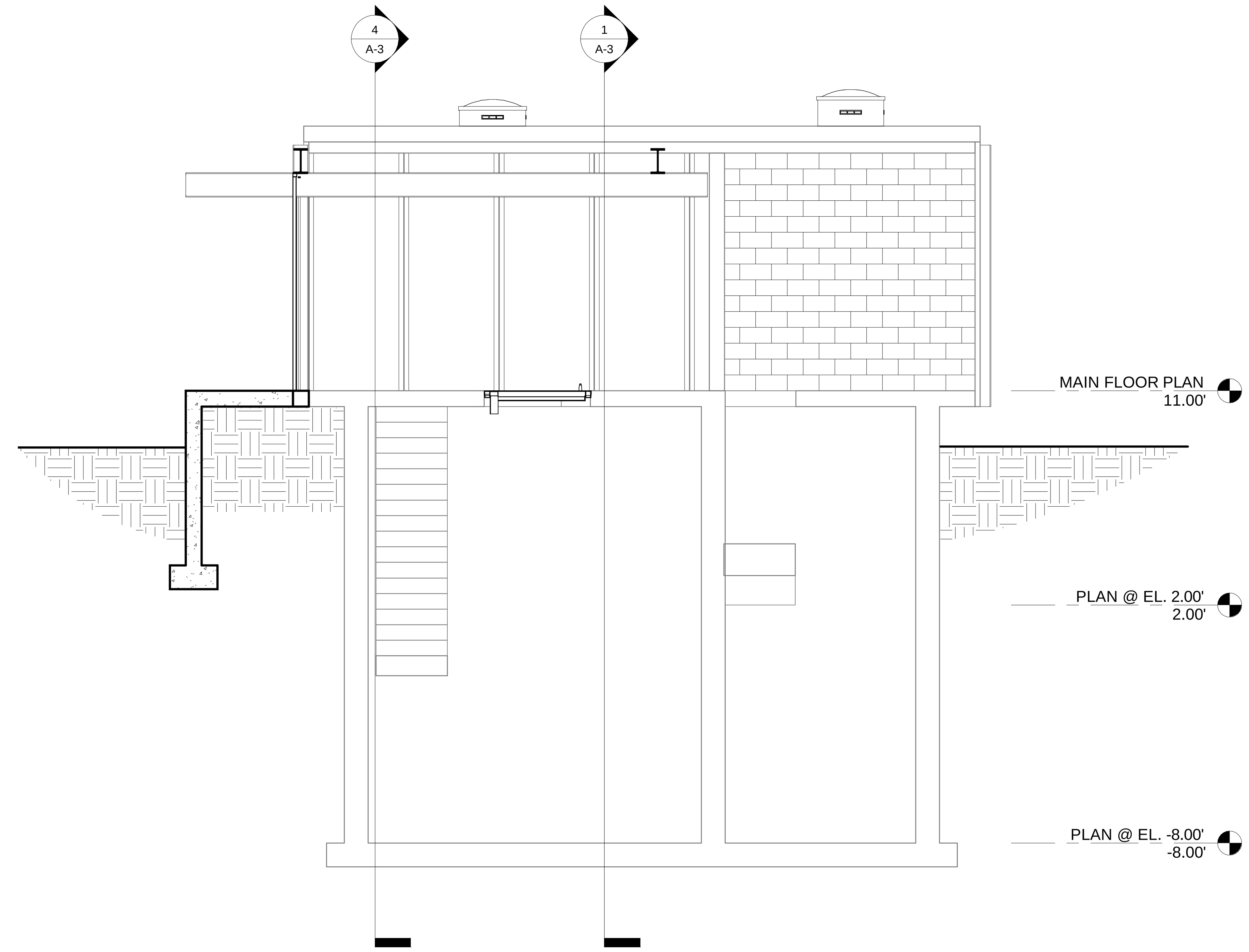
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

FLOOR PLANS AND EXTERIOR ELEVATIONS

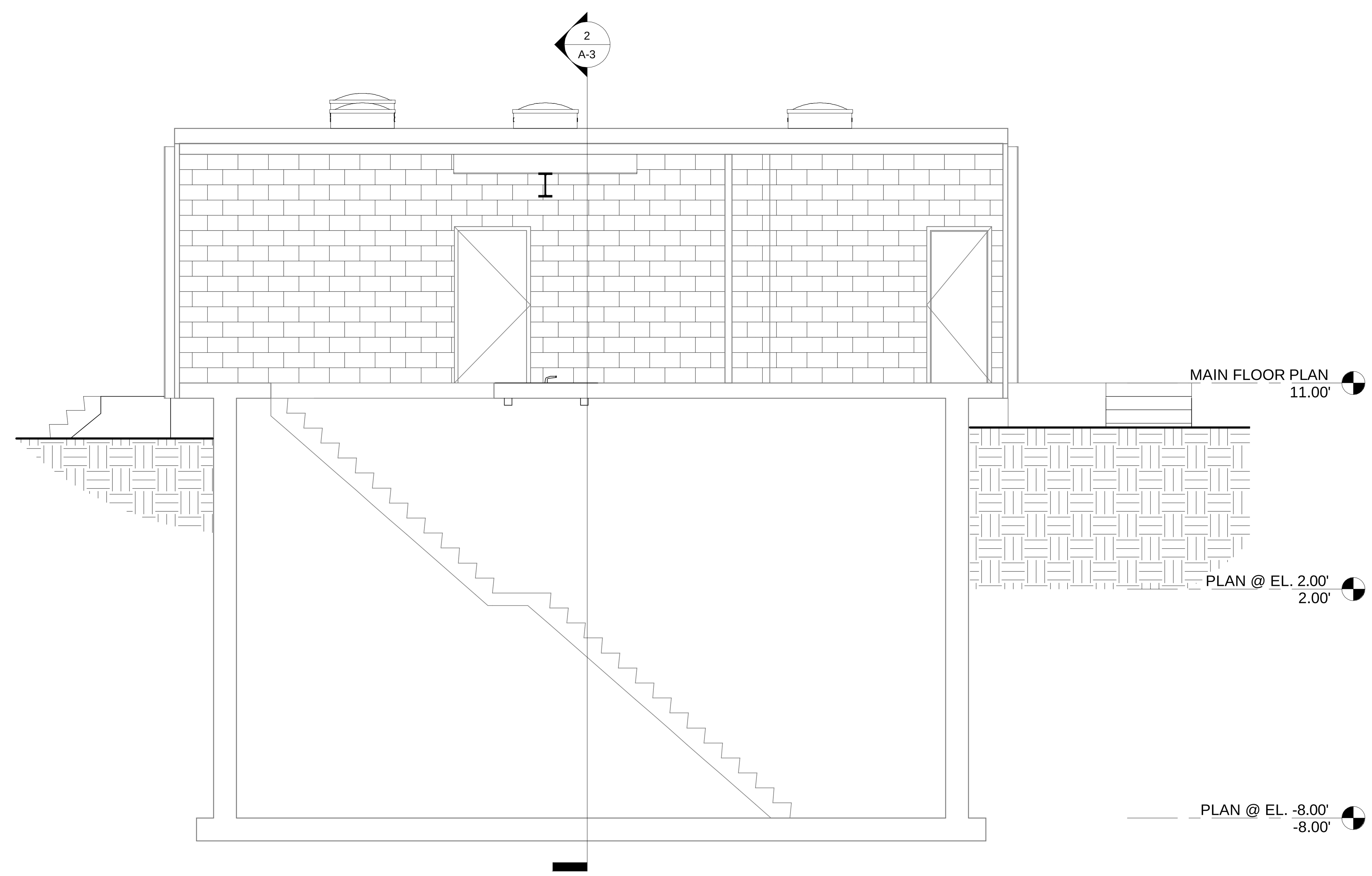
DRAWING
A - 2



1 A-2 **Section 1**
SCALE: 1/4" = 1'-0"



2 A-2 **Section 2**
SCALE: 1/4" = 1'-0"



4 A-2 **Section 4**
SCALE: 1/4" = 1'-0"

NO	SUBMISSIONS / REVISIONS	APP'D	DATE
	PRELIMINIARY DESIGN REPORT		
1			
2			
3			
4			

DESIGNED BY: RDW
CAD COORD: APC
CAD: RDW, JWB2
CHECKED BY: Checker
DATE:
APPROVED BY: Approver
DATE:
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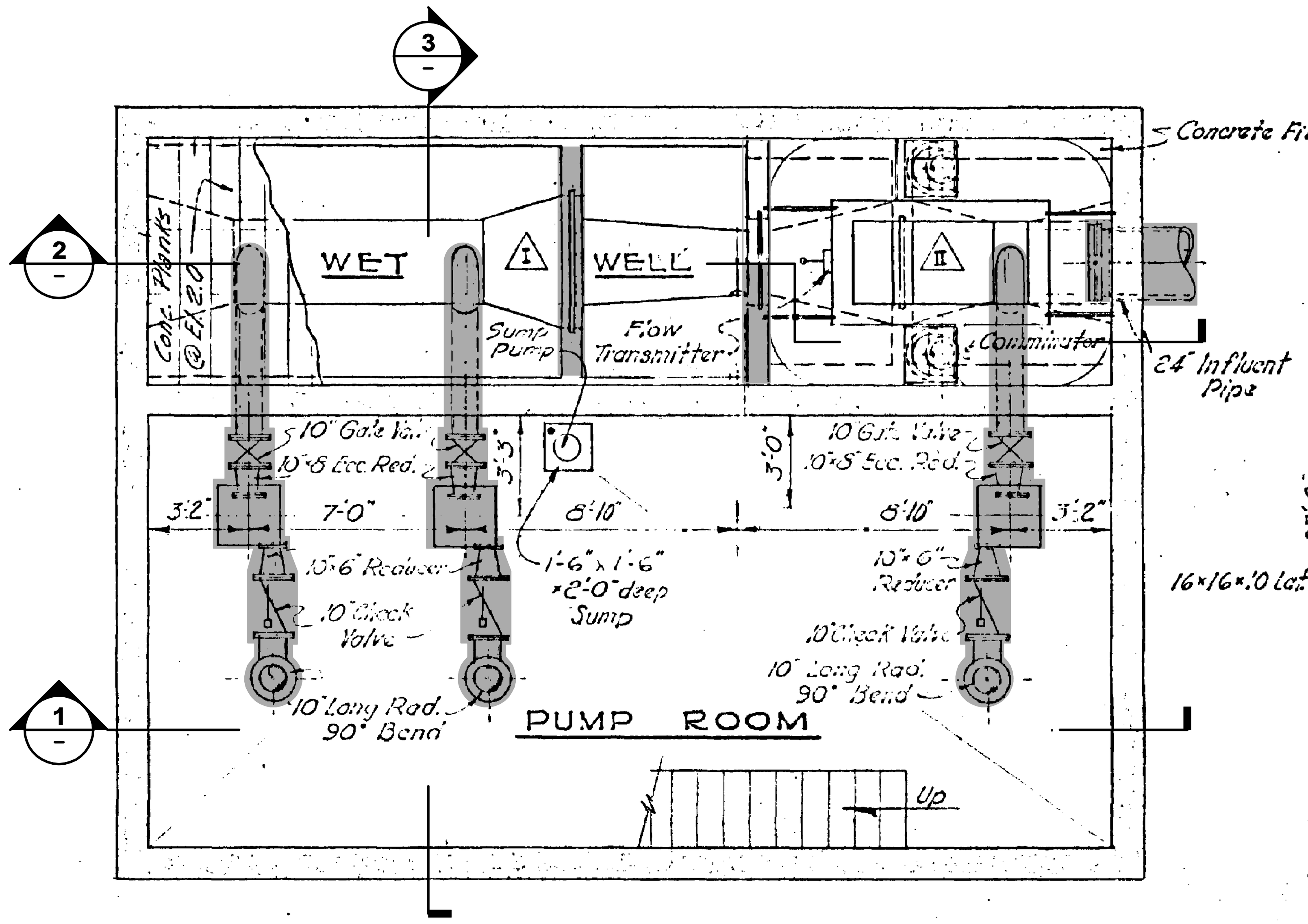
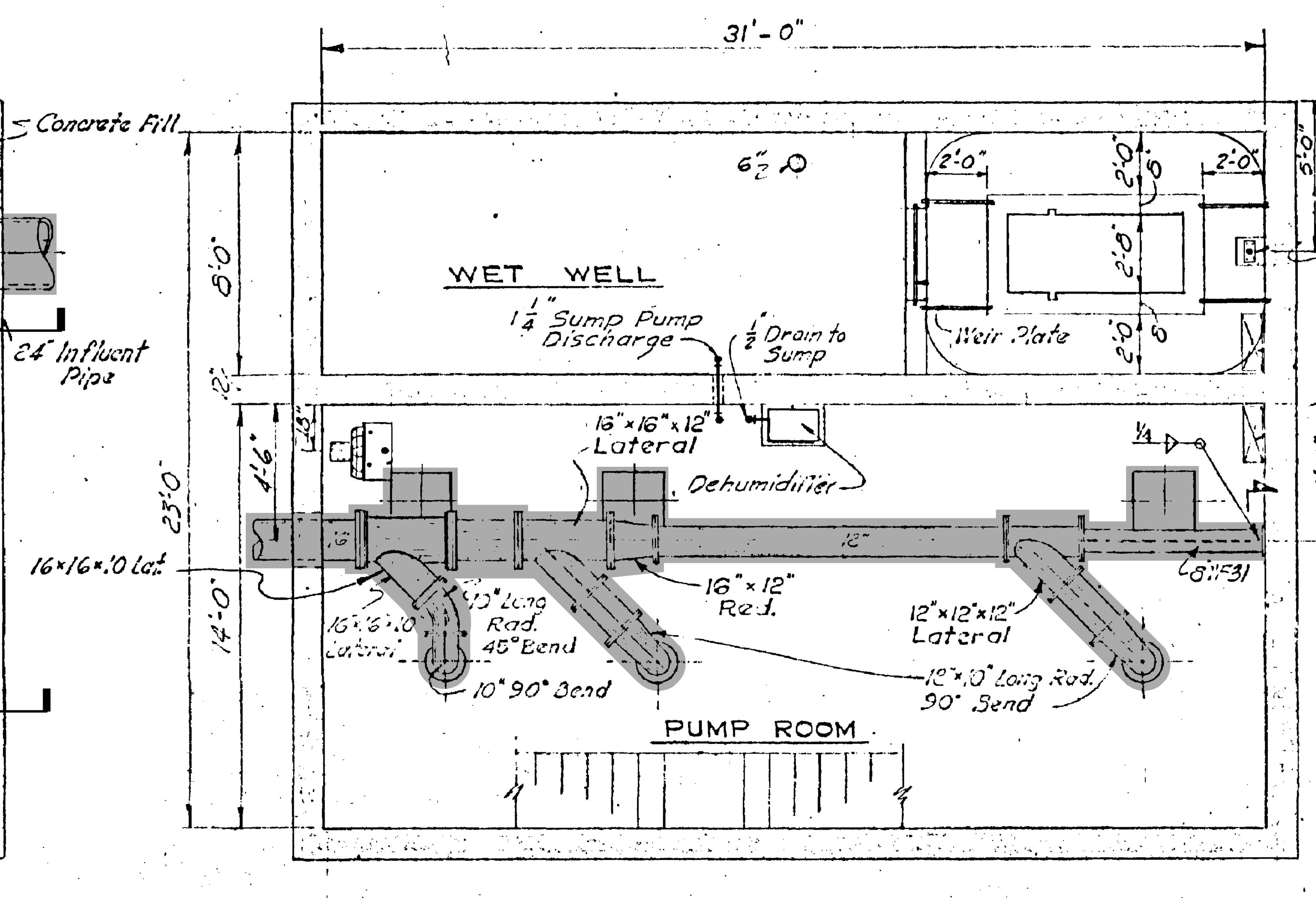
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN,
AND WATER MAIN IMPROVEMENTS

SECTIONS

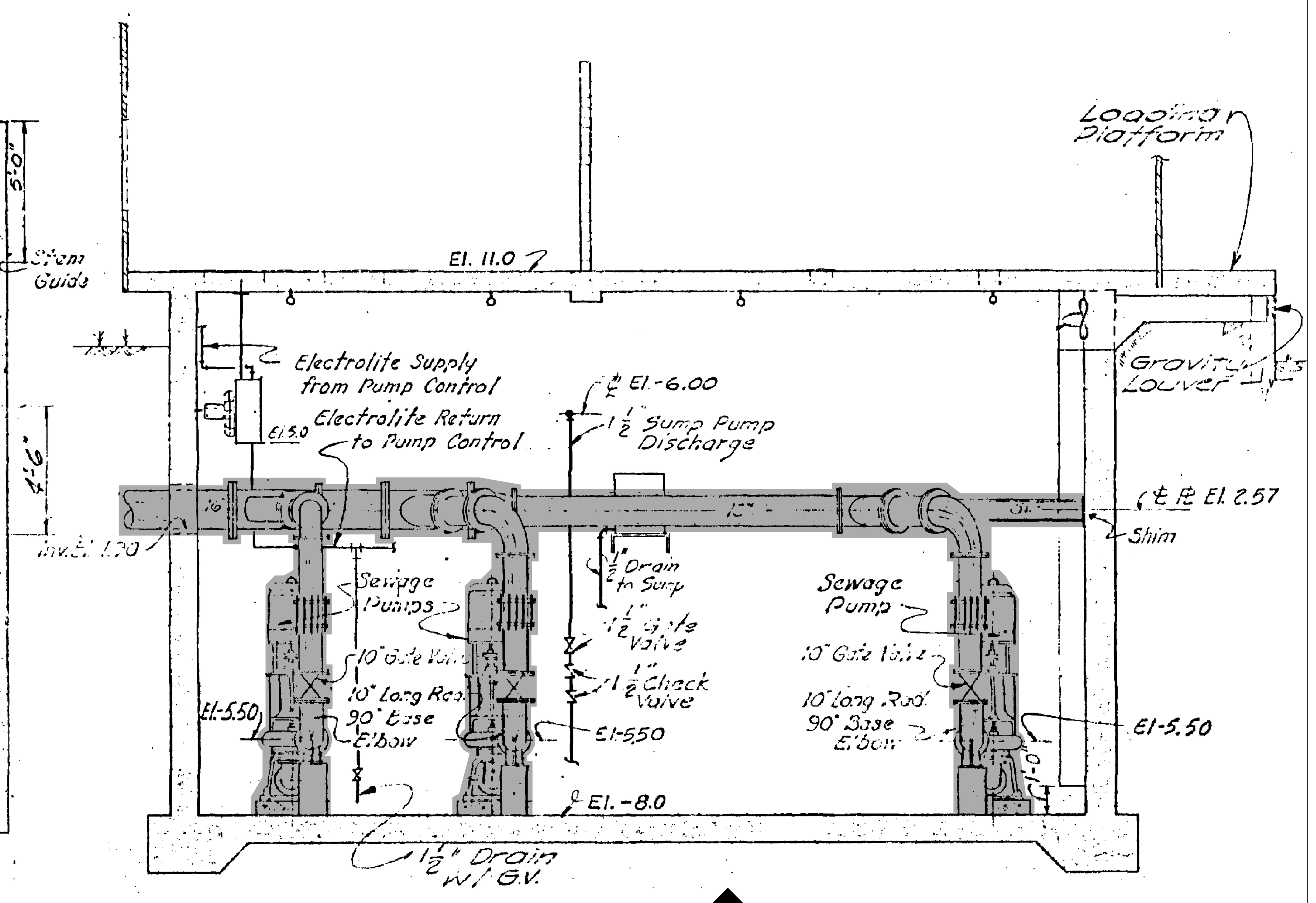
DRAWING
A-3



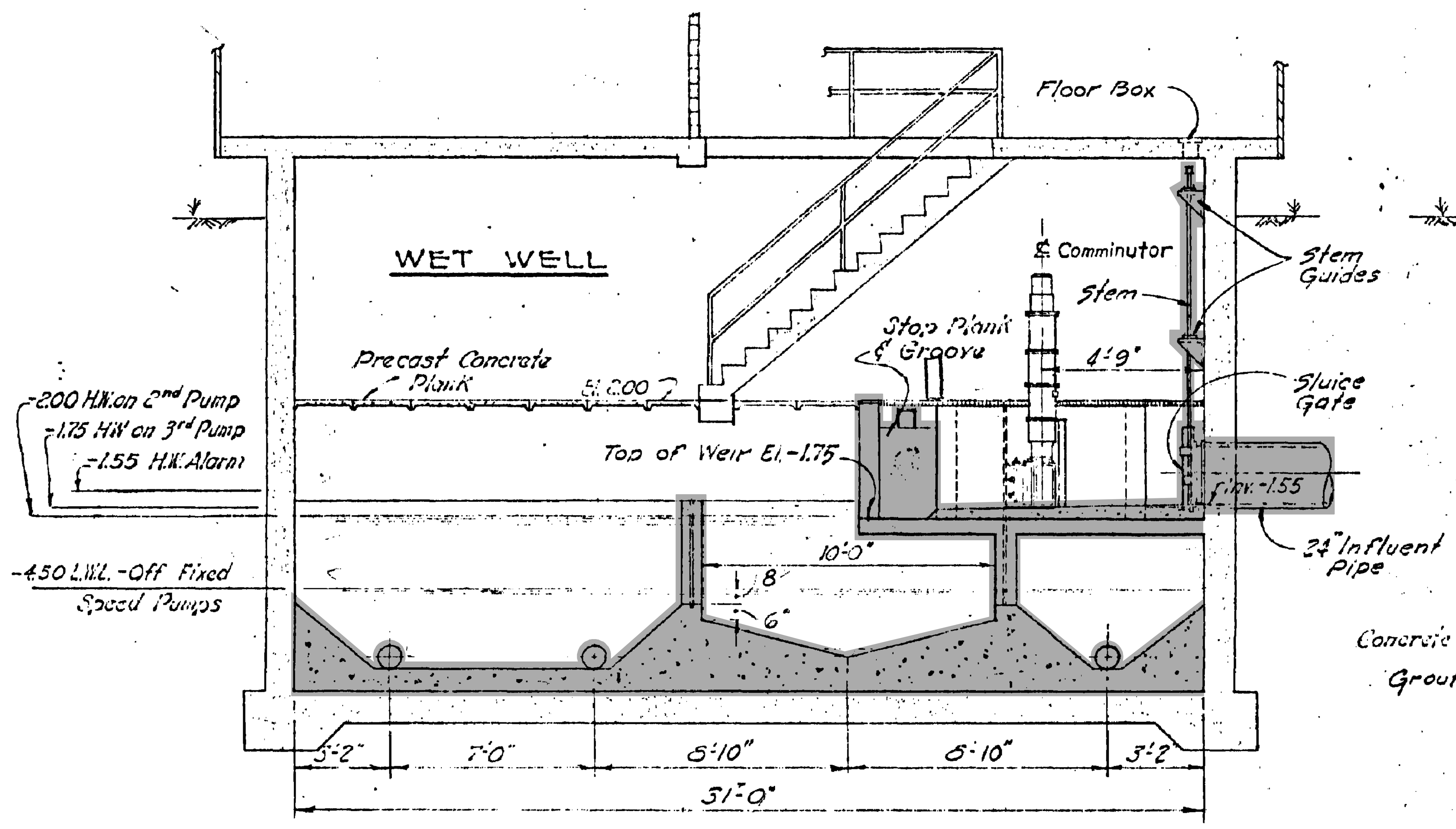
PLAN @ EL -1.50
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")



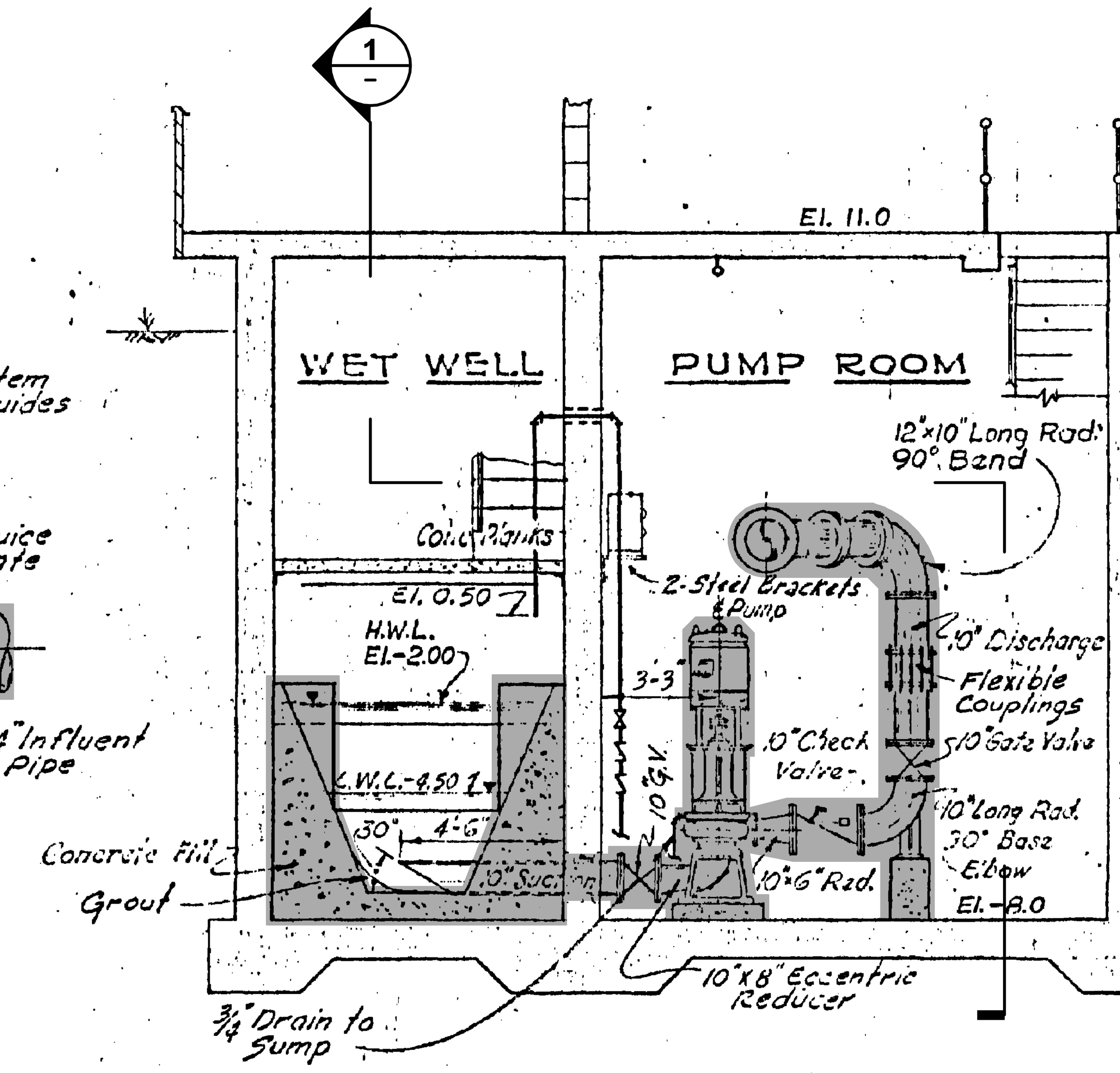
PLAN @ EL 6.00
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")



SECTION 1
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")



SECTION 2
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")



SECTION 3
SCALE: "SCANNED"
(APPROX. 1/4"=1'-0")

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1.
2. CONTRACTOR TO NOTE A SCANNED IMAGE HAS BEEN USED. REFER TO PROCESS GENERAL NOTES ON DRAWING PR-1.

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

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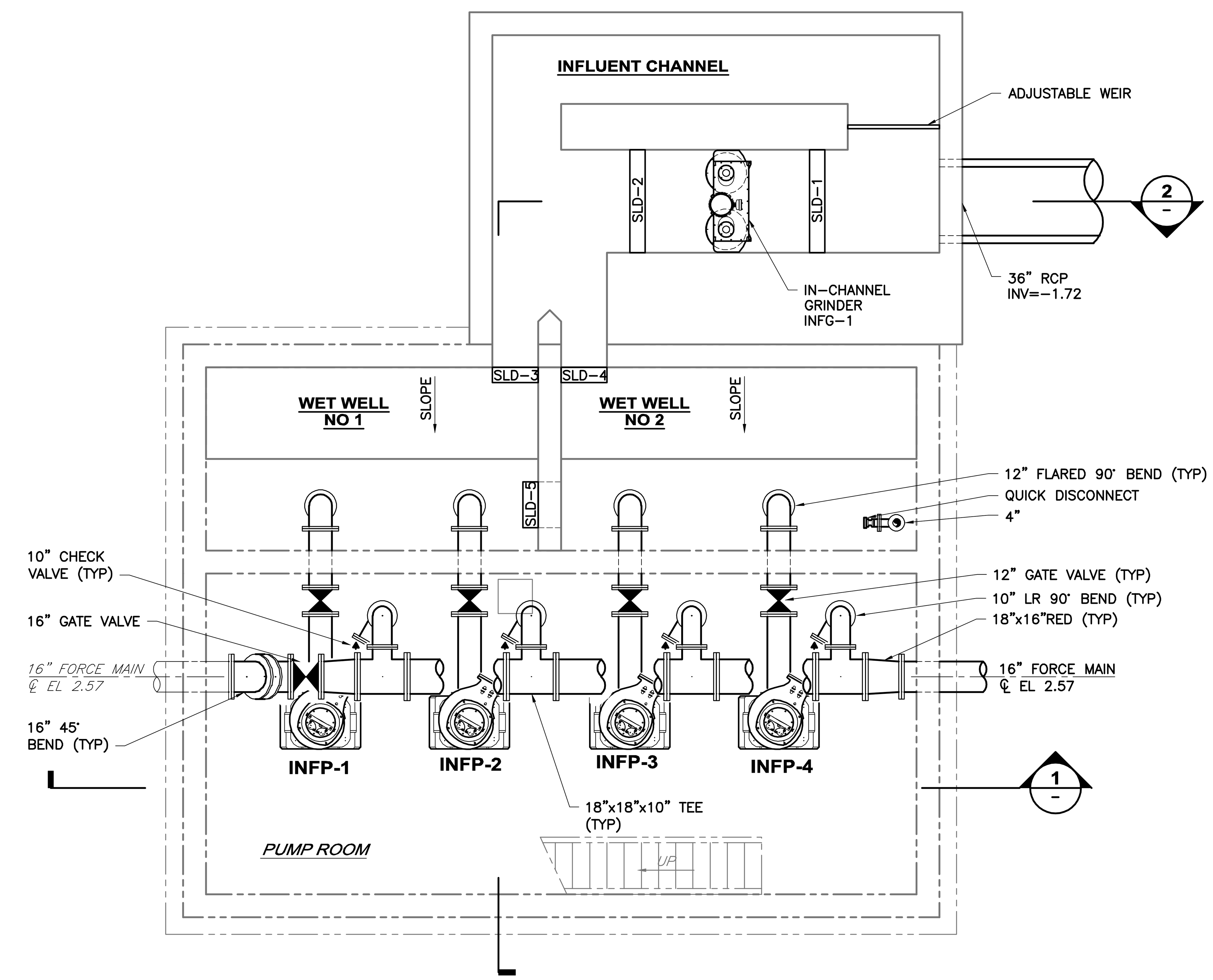
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

MAIN PUMP STATION
DEMOLITION PLANS AND SECTIONS

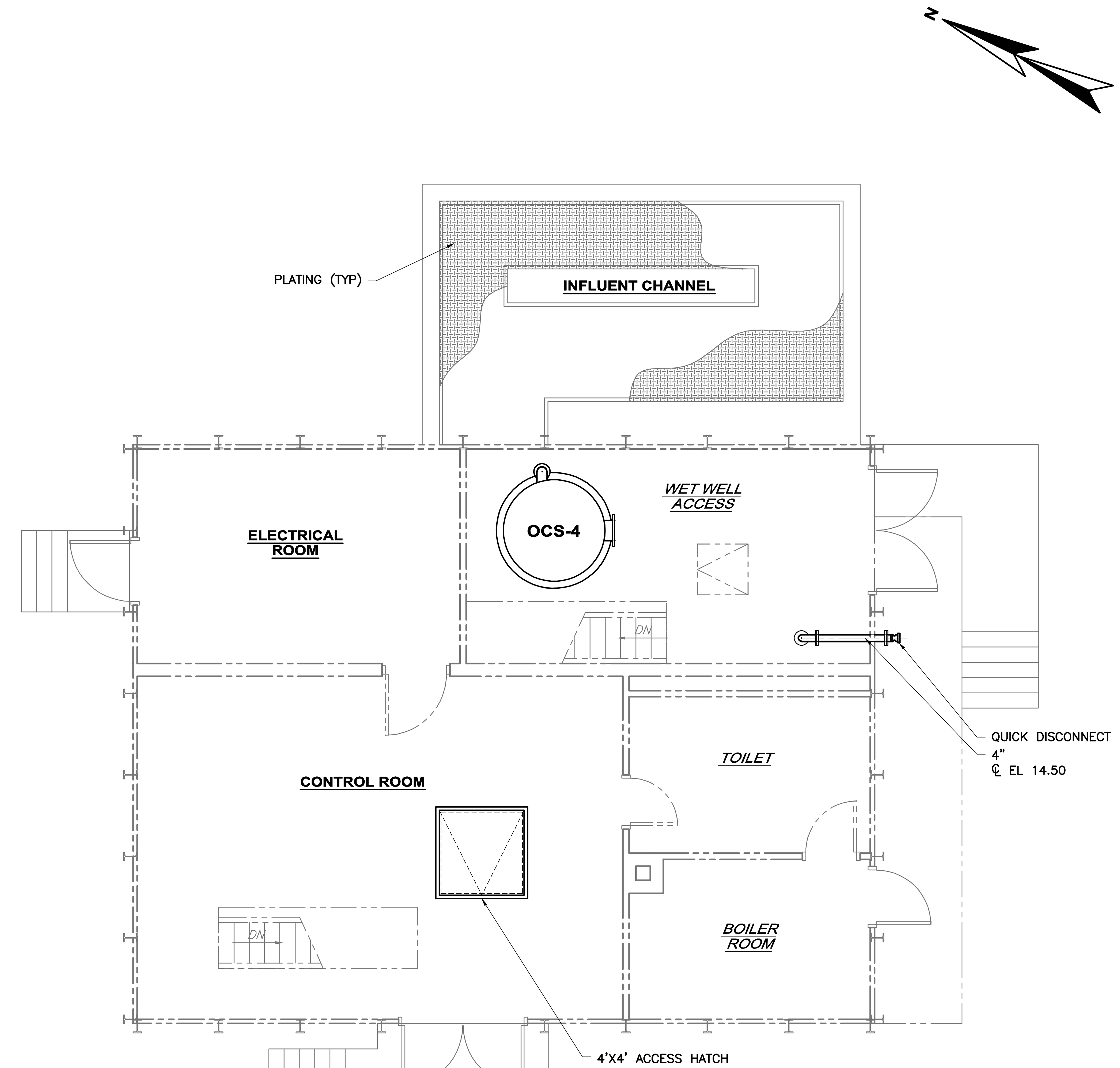
DRAWING
PR-2

LAST SAVED BY: ADAM.COUTURE 9/24/2015 10:51 AM

G:\DWGS\NH\EXETER\12883-PS-UPGRADE\12883-PDR\PRO\12883-PRS-PUMPSTA-MOD.DWG | Plan | 1:10.1236 | ---- | 9/24/2015 11:02:52 AM | ADAM.COUTURE



LOWER PLAN
SCALE: 1/4"=1'-0"
4'



UPPER PLAN
SCALE: 1/4"=1'-0"
4'

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1.

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
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CAD COORD: APC
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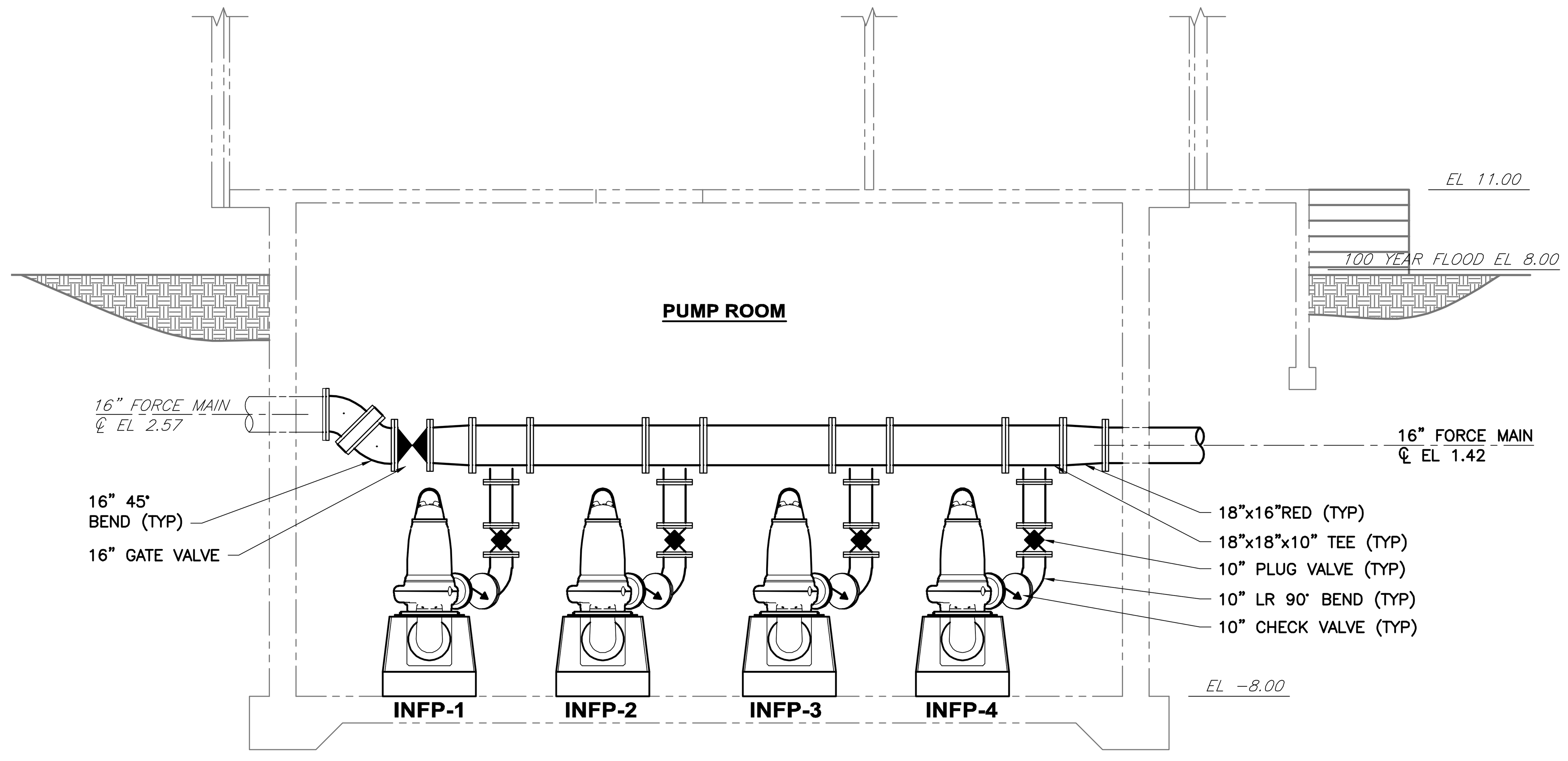
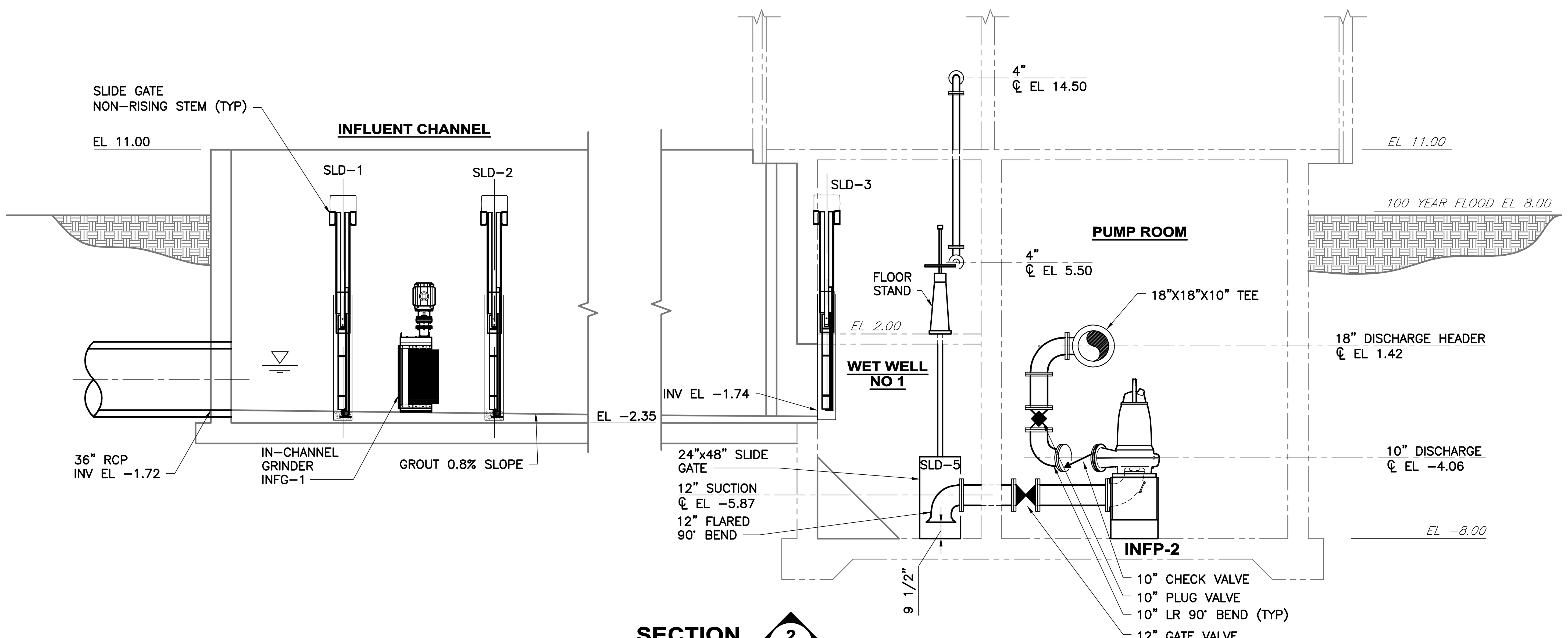
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

MODIFICATION PLANS

DRAWING
PR-3



SECTION 1 / –
SCALE: 1/4"=1'-0"
4'



SECTION 2 / –
SCALE: 1/4"=1'-0"
4'

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1.

NO.	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

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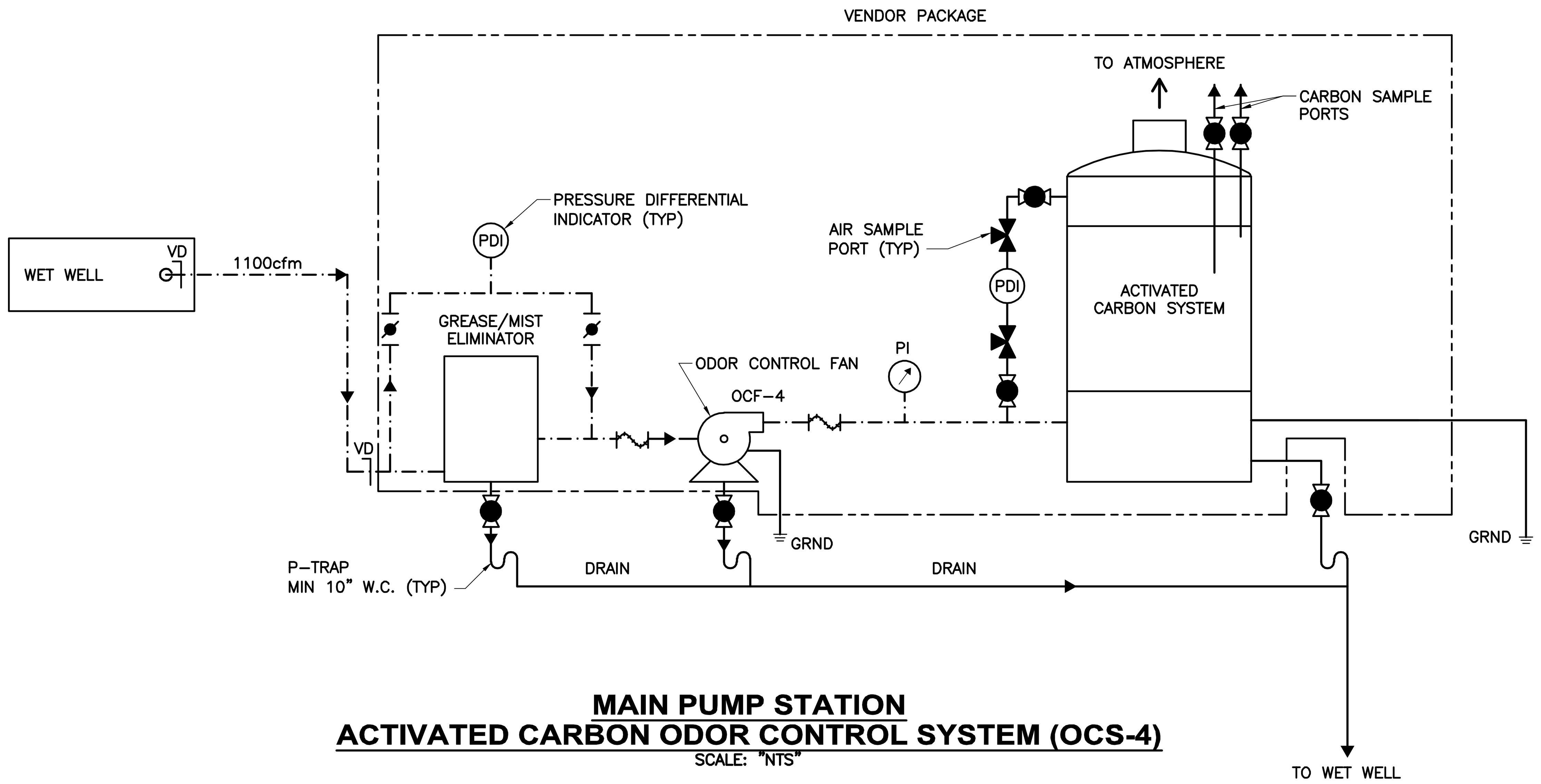
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

MODIFICATION SECTIONS

DRAWING
PR-4



MAIN PUMP STATION
ACTIVATED CARBON ODOR CONTROL SYSTEM (OCS-4)
SCALE: "NTS"

NOTES:

1. FOR GENERAL NOTES, LEGEND, AND ABBREVIATIONS REFER TO DRAWINGS PR-1.

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

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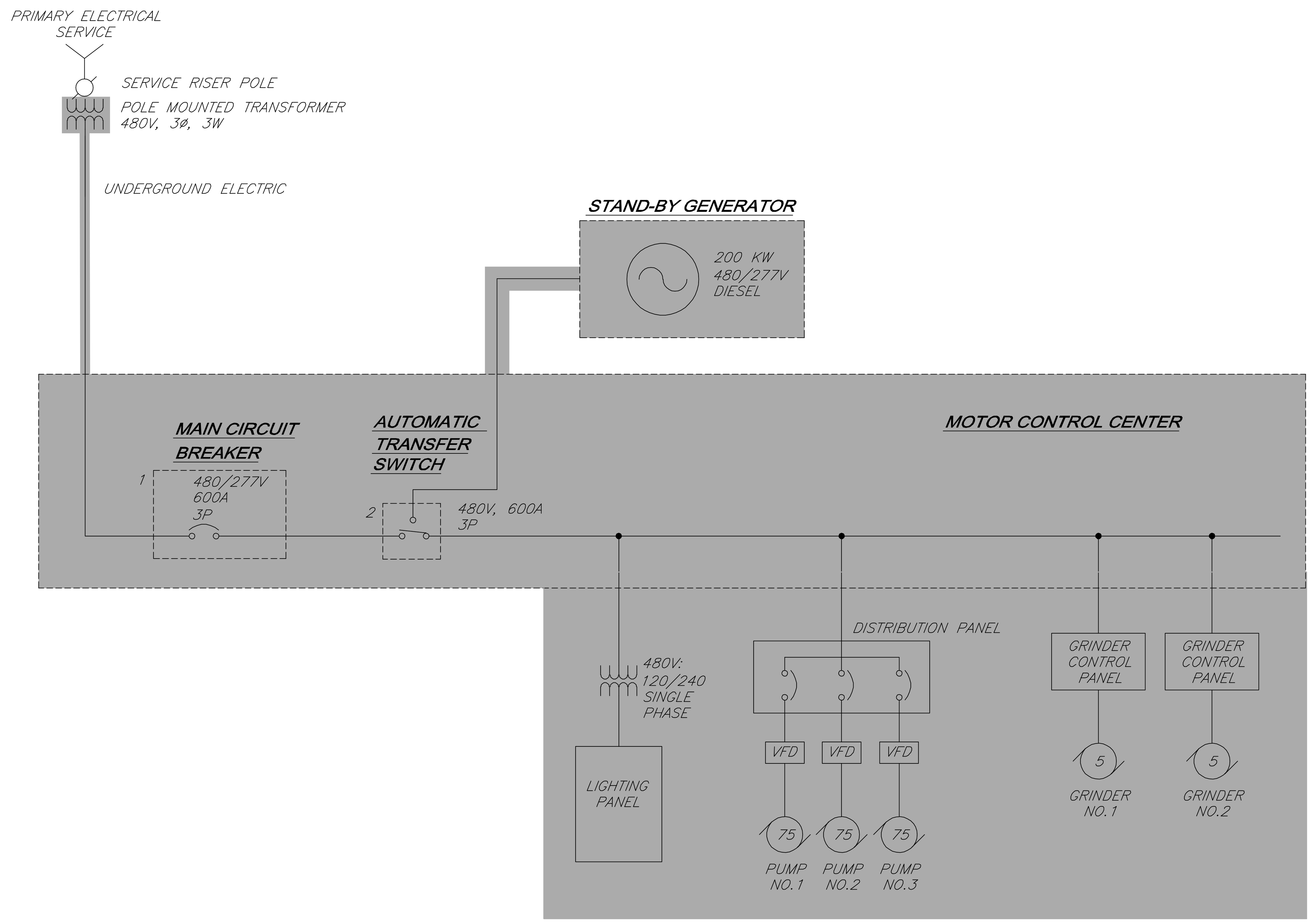
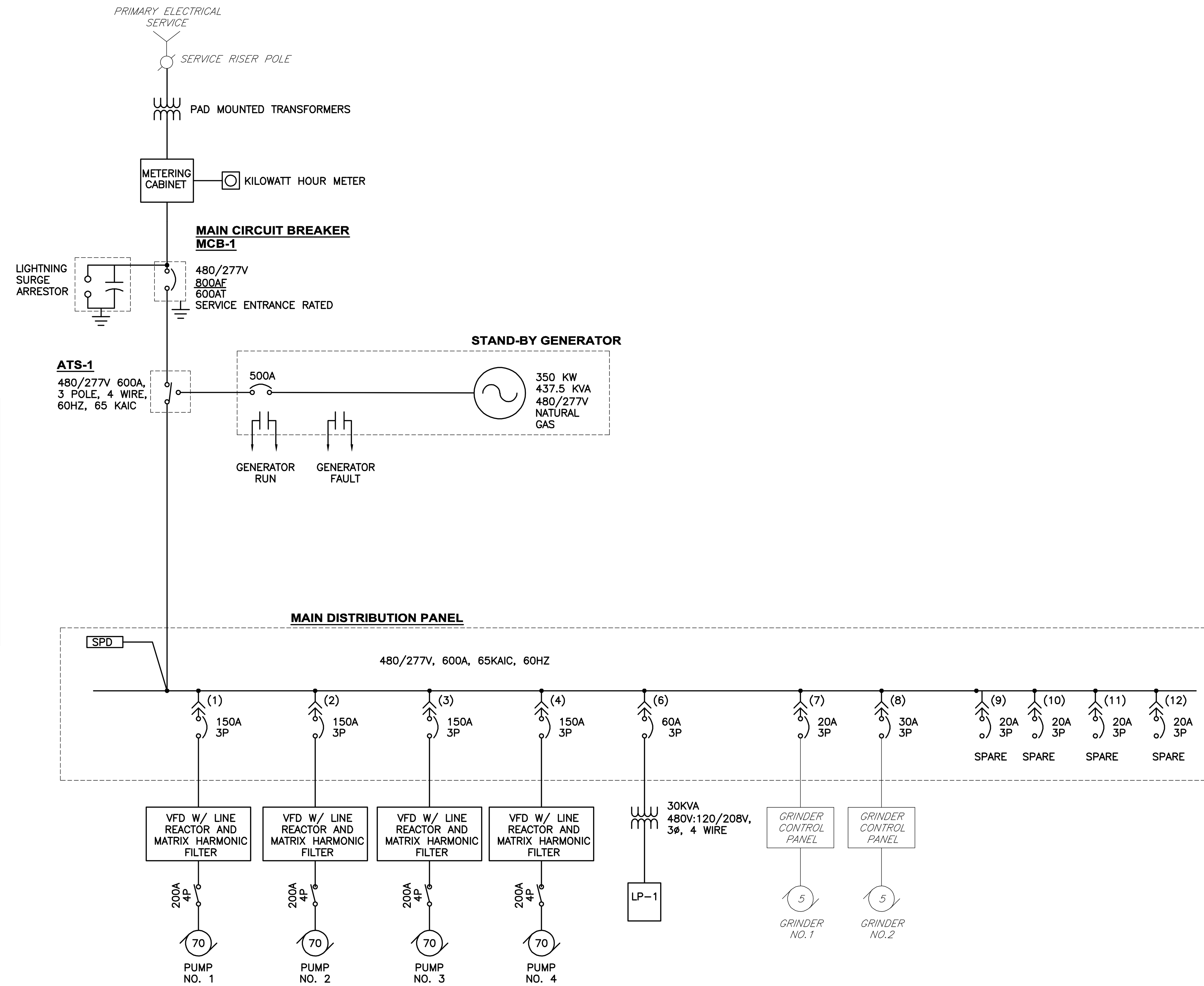
EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

DETAILS I

DRAWING
PR-5



DEMOLITION
SINGLE LINE DIAGRAM
NTS



MODIFICATION
SINGLE LINE DIAGRAM
NTS

NO	SUBMISSIONS/REVISIONS	APP'D	DATE
	PRELIMINARY DESIGN REPORT		

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EXETER, NEW HAMPSHIRE
CONTRACT NO. 2
MAIN PUMP STATION, FORCEMAIN, AND WATER MAIN IMPROVEMENTS

SINGLE LINE DIAGRAMS - DEMOLITION AND MODIFICATIONS

DRAWING
E-4

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