Pennichuck East Utilities, Inc.
DW 21-022
2021 QCPAC - Qualified Capital Project Adjustment Charge
Responses to NH DOE Data Requests – Set 2

Date Request Received: 11/18/21 | Date of Response: 12/1/2021
Request No. Energy 2-1 | Witness: Donald L. Ware

REQUEST: **Re: Company's Response to Energy 1-1(b) and Revised Exhibit DLW-1 (10-28-21), Page 2 (2020 CapEx), Cell P55**: The Company's response to Energy 1-1(b) appears to confirm the originally proposed loan amount of $1,135,409. However, Revised Exhibit DLW-1 (10-28-21), Page 2 indicates a loan amount of $1,136,860 (Cell P55), which is $1,451 greater than the loan amount approved in Commission Order No. 26,507 (8-10-21) in DW 21-102.

a) Please re-confirm the actual amount of the loan from CoBank.
b) Please explain why Revised Exhibit DLW-1, Page 2 indicates an amount of $1,136,860 as the amount borrowed from CoBank.
c) Please reconcile and explain the $1,451 difference noted above.

(Also see Department 2-6)

RESPONSE:

a) The final loan amount was $1,135,409, reflected on Exhibit DLW-1, Page 2, Cell P56 (Attachment DOE 2-1).
b) I have revised Exhibit DLW-1, Page 2 (Attachment DOE 2-1) to reflect a change in the CoBank FALOC interest from in Cell P53 from $17,608 to $16,158 to reflect the amount of the CoBank FALOC interest that was captured by the loan.
c) The difference of $1450 occurred between the 12/31/2020 Interest on CoBank amount of $17,608 that was projected at the time of this Exhibit filing in February 2021, and the actual amount of the interest on the CoBank FALOC as of the loan closing on 9/28/2021 in the amount of $16,158.

Pennichuck East Utilities, Inc.
DW 21-022
2021 QCPAC - Qualified Capital Project Adjustment Charge
Responses to NH DOE Data Requests – Set 2

Date Request Received: 11/18/21 | Date of Response: 12/1/21
Request No. Energy 2-2 | Witness: Donald L. Ware

REQUEST: **Re: Company's Response to Energy 1-2(d) and Attachment DOE 1-2(a), Page 5 (2016), Cell K10**: The Company's response to Energy 1-2(d) references its prior purchase of 569,005 gallons per day of MSDC capacity in 2016. However, should not the Company's response have referred, instead, to its prior purchase of 787,073 gallons per day of MSDC capacity in 2016, as indicated in Cell K10 on Page 5 (2016) of Attachment DOE 1-2(a)? Please confirm and/or explain.

RESPONSE:

Staff is correct. The response should have referenced a prior purchase amount of MSDC capacity by PEU in 2019 in the amount of 787,073 gallons.

Pennichuck East Utilities, Inc.
DW 21-022
2021 QCPAC - Qualified Capital Project Adjustment Charge
Responses to NH DOE Data Requests – Set 2

Date Request Received: 11/18/21	Date of Response: 12/1/21
Request No. Energy 2-3	Witness: Donald L. Ware

REQUEST: **Re: Company's Response to Energy 1-4, Interconnect the W&E CWS to the Town of Salem Water System:** Please provide a copy of the Weston & Sampson Disinfection study ($6,000) referenced on the second page of the response (item #3).

RESPONSE:

Please see Attachment DOE 2-3 for a draft copy of the report from Weston & Sampson requested above and Attachment DOE 2-3a which includes a GIS map of the subject area system.

Pennichuck East Utilities, Inc.
DW 21-022
2021 QCPAC - Qualified Capital Project Adjustment Charge
Responses to NH DOE Data Requests – Set 2

Date Request Received: 11/18/21 Date of Response: 12/1/21
Request No. Energy 2-4 Witness: Donald L. Ware

REQUEST: **Re: Company's Response to Energy 1-4, Revised Exhibit DLW-1 (10-28-21), Page 3 (2021 CapEx), Line 38 and Page 4 (2022 CapEx), Line 13**:

a) Please provide a more detailed explanation with regard to the Company's decision to defer a substantial portion of the total project from 2021 to 2022.
b) The Company's response states that the total project cost is anticipated to be $675,000 (inclusive of a 5% contingency). However, the combined project cost indicated on Revised Exhibit DLW-1 (10-28-21), Page 2, Cell N38 and Page 3, Cell L13 appears to be $705,000 ($175,000 + $530,000); a difference of $30,000. Please reconcile and explain this apparent difference between the Company's response and that which is indicated in Revised Exhibit DLW-1.

RESPONSE:

a) The Company prepared plans and received bids to complete this project in the late summer. After two of the bids were awarded:

1. Work at the Station to dechloraminate the water from Salem.
2. Water main additions and interconnections necessary to deliver water directly from Salem to the W&E Station.

It was determined that the materials necessary to complete the required work would not be available until late December or later. As such the project work needed to be deferred into the Spring of 2021, when the work could be competed without paying a premium to work under winter conditions.

b) The estimated final project cost, inclusive of all contract work, MSDC and Town fees plus internal engineering is expected to be $705,000. The is the amount reflected for this project on Exh DLW-1 (10-28-21) Pages 3 and 4. The $675,000 estimate was provided by our Engineering Department and was missing a $30,000 placeholder for potential connection fees from the Town of Salem for the Salem to W&E connection.

Pennichuck East Utilities, Inc.
DW 21-022
2021 QCPAC - Qualified Capital Project Adjustment Charge
Responses to NH DOE Data Requests – Set 2

Date Request Received: 11/18/21
Request No. Energy 2-5

Date of Response: 12/1/21
Witness: John J. Boisvert

REQUEST: **Re: Company's Response to Energy 1-7, Atkinson Booster Station:** Please briefly recount the history of consideration of whether replacement of this booster station could be avoided by interconnection with the Hampstead Area Water Company system in Atkinson.

RESPONSE:

An interconnection to the Hampstead Area Water Company (HAWC) was considered in 2020. The interconnection would require the installation of approximately 4,875 linear feet of 8-inch water main, including a combination meter and pressure reducing vault at the connection point. The watermain at an estimated cost of $200 per linear foot would total $975,000. The meter and pressure reducing vault may add $35,000 to $50,000 in additional costs to the project for a total of $1,010,000 to $1,025,000. For PEU to own the infrastructure, a franchise exchange would have been required if private residents along the water main route were to connect. If the infrastructure were to be transferred to HAWC to own and operate, CIAC tax implications would add to the overall project cost, although recent changes to the Federal tax laws reinstate CIAC tax exemptions for water utilities. The estimated cost of the interconnection is significantly more than the reconstruction of the booster station.

Pennichuck East Utilities, Inc.
DW 21-022
2021 QCPAC - Qualified Capital Project Adjustment Charge
Responses to NH DOE Data Requests – Set 2

Date Request Received: 11/18/21 | Date of Response: 12/1/21
Request No. Energy 2-6 | Witness: John J. Boisvert

REQUEST: **Re: Company's Response to Energy 1-8, Pelham Water Main Upgrades:** Should "Gage Hill" in the response to part c) be "Williamsburg"? Please confirm or explain.

RESPONSE:

The response to part c) is Williamsburg.

Pennichuck East Utilities, Inc.
DW 21-022
2021 QCPAC - Qualified Capital Project Adjustment Charge
Responses to NH DOE Data Requests – Set 2

Date Request Received: 11/18/21 Date of Response: 12/1/21
Request No. Energy 2-7 Witness: Donald L. Ware

REQUEST: **Re: Company's Response to Energy 1-9, Londonderry Core System and W&E Chloramination:**

a) Please provide a copy of the request from NHDES for a plan to eliminate nitrifying bacteria in the Londonderry core system, as referenced response part b).
b) From the response to part c), it appears the word 'dechloramination' in the final (Explanation) column of the 2021 spreadsheet should be 'rechloramination'. Please confirm or explain.
c) Please provide a copy of the evaluation by an outside engineer referenced in response part d) concerning the lack of chloramine residual in the Londonderry core system.

RESPONSE:

a) Please see Attachment DOE 2-7(a)(i) for the email request from the NHDES regarding the requested nitrification control plan. Also please see Attachments DOE 2-7(a)(ii) and DOE 2-7(a)(iii) for the attachments associated with the NHDES email.
b) The correct term is "dechloramination" as stated. The W&E system is a free chlorination system. The water from Salem will be dechloraminated (all chloramines removed) and then chlorine will be added to this stream of water before it mixes with the chlorinated water from Salem.
c) Please see Attachment DOE 2-7(c)(i) for a copy of the email report from the outside engineer evaluating what it would take to boost the chloramine levels in the water being received from Manchester Water Works. The study was not concerning the lack of chloramine residual as that was already known from weekly bacteria sampling. The study was to evaluate what it would cost to boost chloramine levels in the core Londonderry system in accordance with the NHDES request for a nitrification control plan, one option of which was to boost chloramine residuals to a level where nitrifying bacteria would be controlled. Please also see Attachment DOE 2-7(c)(ii) email containing Excel spreadsheets tracking the nitrification for Southern NH systems, and Attachment DOE 2-7(c)(iii) containing plans for the Mountain Hood Pump Station Design Alternatives.

Pennichuck East Utilities, Inc.
DW 21-022
2021 QCPAC - Qualified Capital Project Adjustment Charge
Responses to NH DOE Data Requests – Set 2

Date Request Received: 11/18/21 Date of Response: 12/1/21
Request No. Energy 2-8 Witness: Donald L. Ware

REQUEST: **Re: Revised Exhibit DLW-1 (10-28-21), Page 1, Cell G16**: The amount of additional debt service on the budgeted 2021 CapEx is indicated as $113,328 (Cell G16) (from Revised Exhibit DLW-1, Page 3 (2021 CapEx), Cell G58). However, should not this amount, instead, be $78,080 as indicated in Cell H58 of Page 3 (2021 CapEx) of Revised Exhibit DLW-1. Please confirm and/or explain.

RESPONSE:

Staff is correct. The cell reference in the Revised Exh DLW-1 (10-28-21) on Page 1 should have been to Cell H58 instead of Cell G58. This incorrect cell reference has been corrected on Attachment DOE 2-1.

Pennichuck East Utilities, Inc.
DW 21-022
2021 QCPAC - Qualified Capital Project Adjustment Charge
Responses to NH DOE Data Requests – Set 2

Date Request Received: 11/18/21 | Date of Response: 12/1/21
Request No. Energy 2-9 | Witness: Donald L. Ware

REQUEST: **Re: Revised Exhibit DLW-1 (10-28-21), Page 1, Lines 12 and 13**: It appears the Company is applying the 4% MOEF proposed in DW 20-156 to all subsequent year's increases in material operating expenses related to the respective 2020 – 2023 QCPAC additions in order to determine its annual QCPAC. However, it is Staff's position that the MOEF should only be applied to the material operating expenses as determined in the Company's general rate proceedings. Staff further notes that the proposed QCPAC calculations for PWW in DW 21-023 do not include application of its approved 9.50% MOEF (DW 19-084) to the subsequent years' increases in material operating expenses related to its 2019 – 2023 QCPAC additions (See Attachment DOE TS 2-2 (Exhibit DLW-1), Page 1 in DW 21-023). Please comment and explain.

RESPONSE:

The Company applied the 4% MOEF in DLW Exh 1 as the expenses that are being incurred as Material Operating expenses. The Company believed that the application of the 4% MOEF was within the context of the rate making formula used to determine rates as proposed in DW20-156. That said, the Company has adjusted the revised Attachment DOE 2-1 to eliminate the application of the 4% MOEF to the projected increases in MOE's on Page 1 of the revised Exh DLW-1.

Pennichuck East Utilities, Inc.
DW 21-022
2021 QCPAC - Qualified Capital Project Adjustment Charge
Responses to NH DOE Data Requests – Set 2

Date Request Received: 11/18/21 | Date of Response: 12/1/21
Request No. Energy 2-10 | Witness: Donald L. Ware

REQUEST: **Re: Revised Exhibit DLW-1 (10-28-21), Page 2 (2020 CapEx), Line 52 – Interest on CoBank FALOC, Cell P52**: Revised Exhibit DLW-1 (10-28-21), Page 2 indicates that $17,608 of interest on the CoBank FALOC was included in the amount of 2020 CapEx financed by the CoBank loan. However, previous iterations of Exhibit DLW-1 (See First Quarterly Update (8-13-21, Page 2, Cell P51) indicate an amount of $16,158 as the amount of CoBank FALOC interest to be financed through the CoBank long-term borrowing; a difference of $1,450.

a) Please provide a detailed explanation with supporting documentation for the indicated $1,450 increase in the CoBank FALOC interest indicated on Page 2 of Revised Exhibit DLW-1.
b) Please explain how the Company financed this apparent $1,450 increase on a long-term basis.

(Also see Department 2-1)

RESPONSE:

a) Please see the Company's response to DOE 2-1c) above.
b) The additional $1450 was not financed or needed since that was based on a February 2021 projection versus the actual amount incurred and financed in the final CoBank loan that closed on September 28, 2021.

Pennichuck East Utilities, Inc.
DW 21-022
2021 QCPAC - Qualified Capital Project Adjustment Charge
Responses to NH DOE Data Requests – Set 2

Date Request Received: 11/18/21 | Date of Response: 12/1/21
Request No. Energy 2-11 | Witness: Donald L. Ware

REQUEST: **Re: Revised Exhibit DLW-1 (10-28-21), Page 5 (2023 CapEx), Line 11 – Wellesley Drive water main replacement**: The 2023 budgeted project amount eligible for QCPAC recovery relative to the Wellesley Drive main replacement project is indicated as $0 (Cell L11). However, a projected property tax expense amount of $1,740 (Cell T11) is also indicated relative to this project during 2023. Please explain.

RESPONSE:

Since the Wellesley Drive main replacement project is no longer planned to occur in 2023 the amount invested will be $0 and there should be no property tax expense. The cell error has been corrected in Cell T12 on Attachment DOE 2-1 on Page 5.

Pennichuck East Utilities, Inc.
DW 21-022
2021 QCPAC - Qualified Capital Project Adjustment Charge
Responses to NH DOE Data Requests – Set 2

Date Request Received: 11/18/21 | Date of Response: 12/1/12
Request No. Energy 2-12 | Witness: John J. Boisvert

REQUEST: **Re: Revised Exhibit DLW-1 (11-16-21), Page 4 (2022 CapEx), Line 16 – Londonderry Mountain Homes Station Improvements:**
Regarding the note in the final (Explanation) column, please elaborate on the need for additional study and the potential expansion of PFOA concerns in Londonderry.

RESPONSE: Private well sampling has been undertaken by the NHDES and other parties in Londonderry. Water system expansion to serve areas of the community with private wells impacted by PFOA is being discussed. Should the expansion option be considered further, the added flow for expansion would need to be considered. The current evaluation only considered existing demand and a modest amount of customer growth within the existing areas served by the water distribution system downstream of the Mountain Homes Booster Station.

Pennichuck East Utilities, Inc.
DW 21-022
Computation of QCPAC Surcharge
2/11/2021
Revised 6/2/2021 per Staff Tech Session DR1.
6/30/2021 Update, Revised 10/28/21 DOE DR1
9/30/2021 Update
Updated for DOE DR2's 12/1/2021

PEU QCPAC Filing
Exhibit DLW-1
Page 1

	Requested DW 20-156 Revenue Requirements		Projected 2020 Qualified Capital Project pro formas		Projected QCPAC Surcharge for 2020 Capital Additions	Projected 2021 Qualified Capital Project pro formas		Projected QCPAC Surcharge for 2021 Capital Additions	Projected 2022 Qualified Capital Project pro formas		Projected QCPAC Surcharge for 2022 Capital Additions	Projected QCPAC For 2023 Capital Additions pro formas		Projected QCPAC Surcharge for 2023 Capital Additions
City Bond Fixed Revenue Requirement (CBFRR)	$ 926,309				$ 926,309	$ -		$ 926,309	$ -		$ 926,309	$ -		$ 926,309
Material Operating Expense Revenue Requirement (MOERR)	$ 6,982,335	(1)	$ 109,255	(5)(11)	$ 7,091,590	$ 28,265	(5)	$ 7,119,855	$ 213	(5)(10)	$ 7,120,068	$ 58,855	(5)	$ 7,178,923
Operating Expense Contingency	1.04	(2)			1.04			1.04			1.04			1.04
Material Operating Expense Revenue Requirement (MOERR)	7,261,628				7,370,883			7,403,518			7,404,862			7,463,726
Non Material Operating Expense Revenue Requirement (NOERR)	$ 7,163				$ 7,163			$ 7,163			$ 7,163			$ 7,163
Amortization Expense (not subject to MOEF)	$ 52,281				$ 52,281			$ 52,281			$ 52,281			$ 52,281
Debt Service Revenue Requirement (DSRR 1.0)	$ 1,744,197	(3)	$ 270,766	(6)(7)	$ 2,014,963	$ 78,080		$ 2,093,043	$ 200,689		$ 2,293,732	$ 166,277		$ 2,460,009
Principal and Interest Coverage Requirement	1.10				1.10			1.10			1.10			1.10
Total Debt Service Revenue Requirement including the .01 DSRR	$ 1,918,617				$ 2,216,460			$ 2,302,348			$ 2,523,106			$ 2,706,010
Revenue Requirement exclusive of NCCRS	$ 10,165,998				$ 10,573,096			$ 10,691,619			$ 10,913,720			$ 11,155,489
Less Other Operating Revenues	$ 30,188	(4)			$ 30,188			$ 30,188			$ 30,188			$ 30,188
Revenues required from Customer Classes exclusive of NCCRS	$ 10,135,810				$ 10,542,908			$ 10,661,431			$ 10,883,532			$ 11,125,301
Revenues subject to QCPAC	$ 10,135,810				$ 10,542,908			$ 10,661,431			$ 10,883,532			$ 11,125,301
Projected QCPAC Increase[8]					4.02%			1.17%			2.19%			2.39%
Cumulative QCPAC increase[9]					4.02%			5.19%			7.38%			9.76%
Cumulative QCPAC monthly increase in average single family residential bill					$ 3.39			$ 4.37			$ 6.22			$ 8.23
Average monthly single family residential bill with QCPAC					$ 87.70			$ 88.68			$ 90.53			$ 92.54

Notes:
(1) Operating Expense Revenue requirement is the sum of the Total Operating Expenses, Property Tax Expense and Amortization Expense being sought in DW20-156.
(2) Material operating expense factor requested in DW20-156.
(3) Annual Principal and interest payments for PEU debt associated with plant in service being sought in DW20-156 less Georgetown project in Lock Lake.
(4) Other Revenues from 2019 Test Year in DW20-156.
(5) QCPAC operating expense proformas are based on the property taxes for plant added during the year.
(6) See Calculation of annual principal and interest payments on spreadsheet titled "2020 QCPAC PEU Additions."
(7) Portion of Annual Principal and interest payments paid to CoBank for debt associated with plant a placed in service between 1/1 and 12/31 for designated year based on a 25 year term loan with an actual total all in interest rate of 5.00% that was not recovered in DW20-156.
(8) QCPAC percent revenue surcharges based on increase in revenues over the revenues requested in DW20-156.
(9) Cumulative surcharge percentage is based on total surcharge revenues collected divided by the revenues requested in DW20-156.
(10) QCPAC operating expense proforma associated with property taxes is reduced by $ 70,000 to reflect reduction in purchased water costs associated with the completion of the Londonderry Storage Tank.
(11) QCPAC operating expense proforma associated with property taxes is reduced by $ 28,000 to reflect reduction in arsenic treatment costs associated with the completion of the Locke Lake raw water well line to the Peacham Road Treatment plant.

Impact on PEU Single Family Residential Home:

Monthly meter charge requested in DW20-156.	$ 22.56	
Average Single Family Consumption (CCF)	6.50	
Consumption Charge requested in DW20-156.	$ 9.50	per CCF
Average Single Family monthly bill with rates requested in DW20-156	$ 84.31	

Pennichuck East Utilities, Inc.
DW 21-022
2020 used and useful QCP's
2/11/2021, Revised 10/28/21 for DOE DR1
9/30/2021 Update
Updated for DOE DR2's 12/1/2021

Project Name/Description	Project Description	Work Order #	Board Approved 2020 Capex Budget	Financing Docket No.	NHPUC Order No.	Date of NHPUC Order	Source of Funding	Eligible for 2021 QCPAC Surcharge	Eligible for 2021 QCPAC Surcharge	Estimated Project Cost as of 6/30/2020	Estimated Project Cost as of 9/30/2020	Estimated Project Cost as of 11/30/2020	Final Project cost as of 12/31/2020	Community	Taxable	Tax Rate (1)	2021 QCPAC Eligible Property Tax Expense	Explanation for Change/Addition/Deletion since Petition Filing
Elevated Storage Tank in Londonderry2	Construct 1.25 MG Elevated Storage Tank.	1818349, 1901641, 2000372	$ 1,545,000	CoBank	Pending Filing		CoBank	No	$ -	$ -	$ -	$ -	$ -	Londonderry	Yes	$ 24.78	$ -	Project deferred to 2021 due to permitting.
Middleton Station Re-build	Re-build Sunrise Estates CWS Station. Existing Station is over 40 years old.	n/a	$ -	CoBank	Pending Filing		CoBank	No	$ -	$ 340,000	$ -	$ -	$ -	MIddleton	Yes	$ 33.55	$ -	Project deferred to 2021 due to the need to install additional treatment due to lower Arsenic standard.
Airstrip alternative arsenic treatment	Raw Water Pipeline from Air Strip well to Peacham Road WTP.	1901642, 2000371	$ 540,000	DW18-132	26,189	11/16/2018	SRF	Yes	$ 540,000	$ 633,000	$ 600,000	$ 633,000	$ 618,531	Barnstead	Yes	$ 27.84	$ 17,220	Based on final low bid and actual construction. Different soil conditions encountered than bid estimate during construction
Georgetown Drive water main replacement	Replace 4600 LF of 4 inch schedule 40 PVC with 6 inch C900 PVC.	2000363	$ 10,000	DW18-132	26,189	11/18/2018	SRF	Yes	$ 10,000	$ 10,000	$ -	$ 1,056,000	$ 966,252	Barnstead	Yes	$ 27.84	$ 26,900	Recovery of these 2019 used and useful Capex was sought in DW20-019 filing. While the projects are completed the Company will not be closing on the loan supporting these capital improvements until June 2021 so it is seeking the P&I associated with these projects in 2021 QCPAC as opposed to the 2020 QCPAC.
Bradford Lane water main replacement	Replace 1825 LF of 4 inch schedule 40 PVC with 6 inch C900 PVC.	2000364	$ 10,000	DW18-132	26,189	11/20/2018	SRF	Yes	$ 10,000	$ 10,000	$ -			Barnstead	Yes	$ 27.84	$ -	
N.Barnstead Road - Eliminate deadend piping	Add 680 LF of 4 inch C-900 PVC to eliminate dead end. Replace 275 LF of 4 inch sch 40 PVC with 6 inch C900 PVC.	2000365	$ 239,000	DW18-132	26,189	11/22/2018	SRF	Yes	$ 239,000	$ 265,620	$ 255,000	$ 255,000	$ 244,214	Barnstead	Yes	$ 27.84	$ 6,799	Based on final low bid and actual construction.
Belmont Drive water main replacement	Replace 500 LF of 4 inch schedule 40 PVC with 6 inch C900 PVC.	2000366	$ 5,000	DW18-132	26,189	11/24/2018	SRF	Yes	$ 5,000	$ 5,000	$ -	$ -	$ -	Barnstead	Yes	$ 27.84	$ -	Deferred
Route 28 Replacement	Replace 720 LF of 2" PE with 720 LF of 4" C-900 PVC.	2000370	$ 80,000	DW18-132	26,189	11/26/2018	SRF	Yes	$ 80,000	$ 59,500	$ 59,500	$ 56,500	$ 69,061	Barnstead	Yes	$ 27.84	$ 1,923	Based on final low bid and actual construction.
Locke Lake Surface Water Treatment[4]	Intake & Treatment Facility Construction	1813409, 1900433, 2000369	$ 835,000	DW18-132	26,189	11/26/2018	SRF	Yes	$ -	$ 1,490,000	$ 1,700,000	$ 2,050,000	$ 2,109,088	Barnstead	Yes	$ 27.84	$ 58,717	Existing Arsenic filters failed in Sept 2020. Increase in price reflects replacement of those filters. More work was completed in 2020 than anticipated, therefore there will be less cost in 2021
Locke Lake Surface Water Treatment[4]	Intake & Treatment Facility Construction	1813409, 1900433, 2000369	$ -	CoBank	Pending Filing		CoBank	Yes					$ 175,334	Barnstead	Yes	$ 27.84	$ 4,881	Locke Lake project investement that exceeds the available loan amount of $4,240,000. The $240,000 of remaining funds available via SRF will be drawn down in 2021.
Rolling Hills Water Main Replacement - Site Restoration from 2019 Project	Replace substandard 2 inch diameter pipe with 4 inch C900 PVC.	2000392	$ 32,000		26,189		CoBank	Yes	$ 32,000	$ 32,000	$ 32,000	$ 32,000	$ 27,400	Plaistow	Yes	$ 26.20	$ 718	
Pelham Main Replacement/Addition	Replace 1600 LF of 3 inch PE with 12 in C-900 and add 775 LF of 12 in C-900 Monticello & Lane.	2001241	$ 285,000	CoBank	Pending Filing		CoBank	Yes	$ 285,000	$ 590,550	$ 658,600	$ 658,600	$ 332,855	Pelham	Yes	$ 24.86	$ 8,275	Project scope expanded for streets listed below over original budget.
Pelham Main Replacement/Addition	Replace Lane Road.	2003563	$ -	CoBank	Pending Filing		CoBank	Yes	$ -	$ -	$ -	$ -	$ 182,102	Pelham	Yes	$ 24.86	$ 4,527	Work on this street is in project total for Monticello & Lane Project above.
Pelham Main Replacement/Addition	Replace Simpson Road.	2003564	$ -	CoBank	Pending Filing		CoBank	Yes	$ -	$ -	$ -	$ -	$ 19,527	Pelham	Yes	$ 24.86	$ 485	Work on this street is in project total for Monticello & Lane Project above.
Pelham Main Replacement/Addition	Replace Andrea Lane.	2003565	$ -	CoBank	Pending Filing		CoBank	Yes	$ -	$ -	$ -	$ -	$ -	Pelham	Yes	$ 24.86	$ -	Work on this street is in project total for Monticello & Lane Project above.
Pelham Main Replacement/Addition	Replace Mount Vernon Drive.	2004325	$ -	CoBank	Pending Filing		CoBank	Yes	$ -	$ -	$ -	$ -	$ 60,561	Pelham	Yes	$ 24.86	$ 1,506	Work on this street is in project total for Monticello & Lane Project above.
1 x revenue investments Normal Run Rate	Per Tariff	n/a	$ 100,000	CoBank	Pending Filing		CoBank	Yes	$ 100,000	$ 40,000	$ 40,000	$ 40,000	$ 62,949	Various	Yes	$ 27.23	$ 1,714	103 Developer Installed Services Installed thru 12/31/2020.
Sunrise Estates	Station Replacement (design)	2003613	$ 40,000	0.1 DSRR			0.1 DSRR	No	$ -	$ -	$ 30,000	$ 30,000	$ 7,805	Middleton	No	$ 33.55	$ -	
Londonderry Core Re-Chloramination	Re-chloramination Evalution and Preliminary Design	2003760	$ 35,000	0.1 DSRR			0.1 DSRR	No	$ -	$ 35,000	$ 35,000	$ 35,000	$ 11,820	Londonderry	No	$ 24.78	$ -	Design costs incorporated into Station rebuild above.
Atkinson Booster pump station design	Atkinson Booster pump station design	2000717	$ 30,000	0.1 DSRR			0.1 DSRR	No	$ -	$ -	$ -	$ 3,000	$ -	Atkinson	Yes	$ 22.84	$ -	Costs incorporated in Atkinson Station rebuild below.
Booster Pump replacement/rebuild	Booster Pump replacement/rebuild	760 - 763 workorders	$ 40,000	CoBank	Pending Filing		CoBank	Yes	$ 40,000	$ 35,000	$ 25,000	$ 18,000	$ 15,241	Various	Yes	$ 27.23	$ 415	5 Booster Pump Replace/Rebuilds through 12/31/2020.
Well Pump replacements	Well Pump replacements	760 - 763 workorders	$ 40,000	CoBank	Pending Filing		CoBank	Yes	$ 40,000	$ 16,000	$ 15,000	$ 15,000	$ 14,665	Various	Yes	$ 27.23	$ 399	4 Well Pumps Repaired/Replaced through 12/31/2020.
Chemical Feed pump replacements	Chemical Feed pump replacements	760 - 763 workorders	$ 10,000	CoBank	Pending Filing		CoBank	Yes	$ 10,000	$ 5,000	$ 2,000	$ 2,000	$ 1,695	Various	Yes	$ 27.23	$ 46	1 Chemical Feed Pump Repaired/Replaced through 12/31/2020.
Install/replace treatment systems in small CWS	Install/replace treatment systems in small CWS.	n/a	$ 25,000	CoBank	Pending Filing		CoBank	Yes	$ 25,000	$ -	$ -	$ -	$ -	Various	Yes	$ 27.23	$ -	None completed during 2020.
Misc. Structural Improvements	Misc. Structural Improvements	n/a	$ 20,000	CoBank	Pending Filing		CoBank	Yes	$ 20,000	$ 10,000	$ 5,000	$ -	$ -	Various	Yes	$ 27.23	$ -	None completed during 2020.
Miscellaneous Fencing and Security projects	Miscellaneous Fencing and Security projects	n/a	$ 10,000	CoBank	Pending Filing		CoBank	Yes	$ 10,000	$ 5,000	$ -	$ -	$ -	Various	Yes	$ 27.23	$ -	None completed during 2020.
Miscellaneous SCADA/Electrical	Miscellaneous SCADA/Electrical	n/a	$ 30,000	CoBank	Pending Filing		CoBank	Yes	$ 30,000	$ 27,602		$ 5,000	$ -	Various	Yes	$ 27.23	$ -	See projects below.
Miscellaneous SCADA/Electrical	Replace Well #1 VFD, Lamplighter Village	2001215	$ -	CoBank	Pending Filing		CoBank	Yes	$ -	$ 2,398	$ 2,398	$ 2,398	$ 2,398	Windham	Yes	$ 23.89	$ 57	
Miscellaneous SCADA/Electrical	Replace Pump #4 VFD, Liberty Tree	2005248	$ -	CoBank	Pending Filing		CoBank	Yes	$ -	$ -	$ 1,735	$ 1,735	$ 1,735	Raymond	Yes	$ 30.53	$ 53	
Miscellaneous SCADA/Electrical	Replace Pump #1 VFD, Liberty Tree	2006387	$ -	CoBank	Pending Filing		CoBank	Yes	$ -	$ -	$ 1,735	$ 1,735	$ 1,735	Raymond	Yes	$ 30.53	$ 53	
Well Rehabilitation	Well Rehabilitation	n/a	$ 60,000	CoBank	Pending Filing		CoBank	No	$ -	$ 15,000	$ 15,000	$ -	$ -	Various	Yes	$ 27.23	$ -	None completed during 2020.
Atkinson Station Rebuild	Station cannot provide requirede fire flow. Hydropneumatic tank is in need of	n/a	$ 500,000	CoBank	Pending Filing		CoBank	No	$ -	$ -	$ -	$ -	$ -	Atkinson	Yes	$ 22.84	$ -	Project deferred into 2021 subject to evaluation of financial analysis of rebuilding the station vs. interconnectoin with HAWC.
Install web based communication equipment, 4 locations.	Install web based communication equipment, 4 locations.	n/a	$ 20,000	CoBank	Pending Filing		CoBank	Yes	$ 20,000	$ 17,901	$ 17,901	$ 17,901	$ -	Various	Yes	$ 27.23	$ -	
Install web based communication equipment, 4 locations.	Fletcher's Corner, Install Cellular Based Communication	2002270	$ -	CoBank	Pending Filing		CoBank	Yes	$ -	$ 2,099	$ 2,099	$ 2,099	$ 2,099	Various	Yes	$ 27.23	$ 57	
Interconnect the W&E CWS to the Town of Salem Water System.	Interconnect the W&E CWS to the Town of Salem Water System.	2004243	$ -	CoBank/Grant	Pending Filing		DWGTF/CoBank	No	$ -	$ 125,000	$ 125,000	$ -	$ -	Windham	Yes	$ 23.89	$ -	Added as part of PEU-Salem Windham Franchise exchange. MSDC charge paid for by PEU. Work will not be Used and Useful in 2020.
New Services (5)	Single Family, Owner Build, New Homes	720 workorders	$ 25,000	CoBank	Pending Filing		CoBank	Yes	$ 25,000	$ 15,000	$ 7,950	$ 10,586	$ 10,586	Various	Yes	$ 27.23	$ 288	2 new services installed through 12/31/2020.
Renewed Services (10)	Replacement of failed services.	721 & 722 workorders	$ 55,000	CoBank	Pending Filing		CoBank	Yes	$ 55,000	$ 1,912	$ 7,014	$ 7,014	$ 10,137	Various	Yes	$ 27.23	$ 276	5 Renewed Service installed through 12/31/2020.
Hydrants (5)	Replacement of non-functional hydrants.	730 & 731 workorders	$ 30,000	CoBank	Pending Filing		CoBank	Yes	$ 30,000	$ 18,000	$ 18,000	$ 6,000	$ -	Various	Yes	$ 27.23	$ -	None completed during 2020.
Meters 5/8"-6" Lead Meter Exchange - PEU (600)	Replace High lead brass meter with new no lead brass meter.	750 workorders	$ 22,000	CoBank	Pending Filing		CoBank	Yes	$ 22,000	$ 30,000	$ 26,000	$ 26,000	$ 25,672	Various	Yes	$ 27.23	$ 699	235 Meters installed/replaced through 12/31/2020 - This is new and replacements together.
Gates (8)	Replacement of Failed Gate Valves	712 workorders	$ 32,000	CoBank	Pending Filing		CoBank	Yes	$ 32,000	$ 6,109	$ 18,000	$ 17,954	$ 17,872	Various	Yes	$ 27.23	$ 487	5 Gates Installed/Repaired through 12/31/2020.
Radios (300)	New Customers (220) and replaced failed radios (80) for meter reading.	754 workorders	$ 32,000	CoBank	Pending Filing		CoBank	Yes	$ 32,000	$ 18,500	$ 15,023	$ 21,000	$ 24,231	Various	Yes	$ 27.23	$ 660	236 Radios installed/replaced through 12/31/2020.
Meters (Growth) 5/8"-2" - PEU (220)	New meters for new customers (220).	750 workorders	$ -	CoBank	Pending Filing		CoBank	Yes	$ -	$ -	$ -		$ -	Various	Yes	$ 27.23	$ -	Incorporated in Row 48 above.
PEU-PWW Interconnection	PEU-PWW Interconnection	2007474	$ -	CoBank	Pending Filing		CoBank	Yes	$ -	$ -	$ -		$ 3,449	Merrimack	Yes	$ 28.84	$ 99	
MSDC Payment to Manchester Water Works	MSDC Payment to Manchester Water Works	2009024	$ -	CoBank	Pending Filing		CoBank	Yes	$ -	$ -	$ -		$ 127,007	Various	No	$ 27.23	$ -	
Interest on CoBank FaLOC	Short term interest from 11/23/2020 - 7/31/2021		$ -	CoBank	Pending Filing		CoBank	Yes	$ -	$ -	$ -	$ 16,000	$ 16,158	Various	No	$ 27.23	$ -	Anticipates closing on CoBank long term loan to pay off CoBank FALOC on 8/1/2021.
Pennichuck East Utilities Projected 2020 Total Capital Expenditure Budget -			**$ 4,737,000**												**Projected annual property tax expenses for QCPAC eligible projects -**		$ 137,255	
Pennichuck East Utilities Projected 2020 QCPAC Eligible Capital Investment less 0.1 DSRR funded projects -									**$ 1,692,000**	**$ 3,861,191**	**$ 3,714,955**	**$ 4,951,522**	**$ 5,142,555**					
Funded with CoBank Loan[3] -									**$ 1,692,000**	**$ 2,371,191**	**$ 2,014,955**	**$ 979,022**	**$ 1,135,409**					
Funded with SRF[4] -									**$ -**	**$ 1,490,000**	**$ 1,700,000**	**$ 3,972,500**	**$ 4,007,147**					

1. Tax rate is the sum of the local community rate plus the Statewide Utility tax rate of $6.60/$1000.
2. The 2020 PEU Capital Expenditures Budget presented were approved by the Board in Janaury 2020.
3. Projected CoBank Loan Terms are 25 Years at 4.2% resulting in P&I of $ 154,686 $ 131,447 $ 63,867 $ 74,069
4. Remainder of Locke Lake Surface Water Treatment project to completed in early 2021 at a total projected cost of $ 232,853
5. Projected SRF Terms for Locke Lake project are 30 Years at 2.704% resulting in P&I of $ 73,139 $ 83,447 $ 194,997 $ 196,697

Total projected P&I on debt incurred to support 2020 used and useful capex - Total projected annual P&I for 2020 used and useful QCP's **$ 227,825 $ 214,894 $ 258,864 $ 270,766**

Pennichuck East Utilities, Inc.
DW 21-022
Projected 2021 QCPAC Capital Expenditures
2/11/2021
6/30/2021 Update, Revised 10/28/21 DOE DR1
9/30/2021 Update

Project Name/Description	Project Description	Work Order #	2021 Board Approved Budgeted	Financing Docket No.	NHPUC Order No.	Date of NHPUC Order	Source of Funding	Eligible for 2021 QCPAC Surcharge	Eligible for 2021 QCPAC Surcharge	Estimated Project Cost as of 6/30/2021	Estimated Project Cost as of 9/30/2021	Community	Taxable	Tax Rate (1)	QCPAC Eligible Property Tax Expense	Explanation for Change/Addition/Deletion since Petition Filing
Locke Lake Surface Water Treatment[4]	Intake & Treatment Facility Construction	2101752	$ 200,000	DW18-132	26,189	11/26/2018	SRF	Yes	$ 200,000	$ 240,000	$ 200,000	Barnstead	Yes	$ 27.84	$ 5,568	Total project cost incurred between 2019 through 2021 when project became Used and Useful.
Pelham Main Replacement/Addition	Replace 1600 LF of 3 inch PE with 12 in C-900 and add 775 LF of 12 in C-900 on Monticello, Mt. Vernon and Lane Road - Finish Paving	2105634	$ 40,000	DW21-102	Pending Filing		CoBank	Yes	$ 40,000	$ 40,000	$ 40,000	Pelham	Yes	$ 24.86	$ 994	
Pelham Main Replacement/Addition	Finish Paving	2105635		DW21-102	Pending Filing		CoBank	Yes	$ -	$ -	$ -	Pelham	Yes	$ 24.86	$ -	included in WO 2105634 final paving
Pelham Main Replacement/Addition	Finish Paving	2105636		DW21-102	Pending Filing		CoBank	Yes	$ -	$ -	$ -	Pelham	Yes	$ 24.86	$ -	included in WO 2105634 final paving
Londonderry System Improvements	Tank, Transmission Main, & Booster Station	2102351	$ 1,600,000	0.1 DSRR				No	$ 1,600,000	$ 100,000	$ 100,000	Londonderry	No	$ 24.78	$ -	Engineering only in 2021 Project delay in permitting will require carry over into 2022
Atkinson Booster pump station design	Atkinson Booster pump station design	2102306	$ 30,000	0.1 DSRR				No	$ 30,000	$ 30,000	$ 30,000	Atkinson	No	$ 22.84	$ -	
Locke Lake Filter Replacement	Replace two failed (structural-collapse of screen supports) iron, manganese, & arsenic filters.	n/a	$ 30,000	DW21-102	Pending Filing		CoBank	Yes	$ 30,000	$ -	$ 10,000	Barnstead	Yes	$ 27.84	$ 278	Completed in 2020
Airstrip Station Decommissioning	Abandon unused wells and Station	2101758	$ 40,000	DW18-132	26,189	11/26/2018	SRF	Yes	$ 40,000	$ 78,000	$ 78,000	Barnstead	No	$ 27.84	$ -	
1 x revenue investments Normal Run Rate	Per Tariff	Routine	$ 100,000	DW21-102	Pending Filing		CoBank	Yes	$ 100,000	$ 170,000	$ 155,000	Various	Yes	$ 27.23	$ 4,220	91 New Developer Installed thru 09/30/21 projecting 20 more
Sunrise Estates	Station Replacement (design)	2102007	$ -	0.1 DSRR			0.1 DSRR	No	$ -	$ 8,000	$ 8,000	Middleton	No	$ 33.55	$ -	Deferred - monies shown for engineering design
Londonderry Core Re-Chloramination	Re-chloramination Evalution and Preliminary Design	2102008	$ -	0.1 DSRR			0.1 DSRR	No	$ -	$ 700	$ 700	Londonderry	No	$ 24.78	$ -	Deferred - monies shown for engineering design
Nesenkeag Well Decomission	Nesenkeag Well Decomission	2104691	$ -	0.1 DSRR			0.1 DSRR	No	$ -	$ 19,600	$ 20,000	Londonderry	No	$ 24.78	$ -	
Londonderry RRA and ERP	Londonderry RRA and ERP	2105486	$ -	0.1 DSRR			0.1 DSRR	No	$ -	$ -	$ 26,150	Londonderry	No	$ 24.78	$ -	Missed in original budget. Required by NHDES under American Water Infrastructure Act
Litchfield RRA and ERP	Litchfield RRA and ERP	2105487	$ -	0.1 DSRR			0.1 DSRR	No	$ -	$ -	$ 26,150	Litchfield	No	$ 28.12	$ -	Missed in original budget. Required by NHDES under American Water Infrastructure Act
Litchfield- Londonderry Evaluation	Litchfield- Londonderry Evaluation	2105687	$ -	0.1 DSRR			0.1 DSRR	No	$ -	$ -	$ 10,000	Lond/Litchfield	No	$ 26.45	$ -	Requested evalution by NHDES - Internal Engineering Staff. Ability to serve water from Nashua
Castle Reach, Replace VFD, Pump #2	Castle Reach, Replace VFD, Pump #2	2107680	$ -	DW21-103	Pending Filing		CoBank	Yes	$ -	$ -	$ 1,300	Windham	Yes	$ 23.89	$ 31	
Booster Pump replacement/rebuild	Booster Pump replacement/rebuild	Routine	$ 40,000	DW21-102	Pending Filing		CoBank	Yes	$ 40,000	$ 30,000	$ 25,000	Various	Yes	$ 27.23	$ 681	Installed/Repaired 5 pumps through 09/30/21, project 2 more
Well Pump replacements	Well Pump replacements	Routine	$ 40,000	DW21-102	Pending Filing		CoBank	Yes	$ 40,000	$ 30,000	$ 30,000	Various	Yes	$ 27.23	$ 817	Installed/Repaired 5 pumps through 09/30/21, project 2 more
Chemical Feed pump replacements	Chemical Feed pump replacements	Routine	$ 10,000	DW21-102	Pending Filing		CoBank	Yes	$ 10,000	$ 8,000	$ 6,000	Various	Yes	$ 27.23	$ 163	Installed/Repaired 2 pumps through 09/30/21, project 1 more
Install/replace treatment systems in small CWS (supplemental Arsenic treatment	Install/replace treatment systems in small CWS (supplemental Arsenic treatment systems).	n/a	$ 50,000	DW21-102	Pending Filing		CoBank	Yes	$ 50,000	$ 27,000	$ 27,000	Various	Yes	$ 27.23	$ 735	
Install Poly Phosphate Sequestration System, Skyview Estates, Pelham	Install Poly Phosphate Sequestration System, Skyview Estates, Pelham	2104065	Install/Replace Treatment - See above					Yes	$ -	$ 3,000	$ 3,000	Pelham	Yes	$ 24.86	$ 75	
Install/replace treatment systems in small CWS (supplemental Arsenic treatment	Install PFAs Removal Treatment System, Harvest Village, Londonderry	2104692	Install/Replace Treatment - See above					Yes	$ -	$ 20,000	$ 20,000	Londonderry	Yes	$ 24.78	$ 496	
Misc. Structural Improvements	Misc. Structural Improvements	n/a	$ 20,000	DW21-102	Pending Filing		CoBank	Yes	$ 20,000	$ 5,750	$ 5,750	Various	Yes	$ 27.23	$ 157	
Misc. Structural Improvements	Pave Access Road to Stone Sled Station	2103983	Misc.. Strucutural Improvements - See above					Yes	$ -	$ 14,250	$ 14,250	Various	Yes	$ 27.23	$ 388	
Miscellaneous Fencing and Security projects	Miscellaneous Fencing and Security projects	n/a	$ 10,000	DW21-102	Pending Filing		CoBank	Yes	$ 10,000	$ 10,000	$ 5,000	Various	Yes	$ 27.23	$ 136	
Miscellaneous SCADA/Electrical	Miscellaneous SCADA/Electrical	n/a	$ 30,000	DW21-102	Pending Filing		CoBank	Yes	$ -	$ 30,000	$ 20,000	Various		$ 27.23	$ -	
Well Rehabilitation	Well Rehabilitation	n/a	$ 60,000	DW21-102	Pending Filing		CoBank	Yes	$ 60,000	$ 60,000	$ 51,610	Various	Yes	$ 27.23	$ 1,405	
Well Rehabilitation	Rehabilitate Well #9, Locke Lake, Barnstead	2102279	$ -	DW21-103	Pending Filing		CoBank	Yes	$ -	$ -	$ 8,390	Barnstead	Yes	$ 27.84	$ 234	
Install web based communication equipment, 4 locations	Install web based communication equipment, 4 locations	n/a	$ 20,000	DW21-102	Pending Filing		CoBank	Yes	$ 20,000	$ 20,000	$ 20,000	Various	Yes	$ 27.23	$ 545	
Interconnect the W&E CWS to the Town of Salem Water System.	Interconnect the W&E CWS to the Town of Salem Water System.	2004243 & 2101750	$ -	CoBank/Grant	Pending Filing		DWGTF/CoBank	Yes	$ -	$ 565,000	$ 175,000	Windham	Yes	$ 23.89	$ 4,181	Added as part of PEU-Salem Windham Franchise exchange. MSDC charge paid for by PEU. Work will not be Used and Useful in 2020. Includes dechloamination. $175,000 in MSDC was budgeted in 2020, missed carry over. Well #3 capacity and quality changed dramatically in 2020 changing this connection from season to year round and requiring the additional $550,000 investment. Pipeline and Station work deferred into 2022 due to materials not being available
New Services (5)	Single Family, Owner Build, New Homes	Routine	$ 25,000	DW21-102	Pending Filing		CoBank	Yes	$ 25,000	$ 15,000	$ 20,000	Various	Yes	$ 27.23	$ 545	Installed 3 new service through 09/30/21, projecting 1 more
Renewed Services (20)	Replacement of failed services (focus on Locke Lake Services).	Routine	$ 110,000	DW21-102	Pending Filing		CoBank	Yes	$ 110,000	$ 50,000	$ 40,000	Various	Yes	$ 27.23	$ 1,089	Renewed 5 services through 09/30/21, projecting 5 more
Hydrants (5)	Replacement of non-functional hydrants	Routine	$ 30,000	DW21-102	Pending Filing		CoBank	Yes	$ 30,000	$ 30,000	$ 12,000	Various	Yes	$ 27.23	$ 327	None replaced to date. Projecting 2 more
Gates (8)	Replacement of Failed Gate Valves	Routine	$ 32,000	DW21-102	Pending Filing		CoBank	Yes	$ 32,000	$ 40,000	$ 35,000	Various	Yes	$ 27.23	$ 953	Installed/Repaired 4 gates through 09/30/21, Projectimg 1 more
Radios (300)	New Customers (220) and replaced failed radios (80) for meter reading.	Routine	$ 31,500	DW21-102	Pending Filing		CoBank	Yes	$ 31,500	$ 27,000	$ 20,000	Various	Yes	$ 27.23	$ 545	Installed/Repaired 99 radios through 09/30/21, projecting 100 more
New meters for new customers (220). Replacement of failed meters (80)	New meters for new customers (220) and replacement meters (80).	Routine	$ 30,000	DW21-102	Pending Filing		CoBank	Yes	$ 30,000	$ 50,000	$ 38,000	Various	Yes	$ 27.23	$ 1,035	Installed/Repaired 172 meters through 09/30/21, projecting 100 more
Meters 5/8"-6" Lead Meter Exchange - PEU (400)	Replace High lead brass meter with new no lead brass meter.	Routine	$ 40,000	DW21-102	Pending Filing		CoBank	Yes	$ 40,000		$ -	Various	Yes	$ 27.23	$ -	Included in line above
2021 Radios (1000)	Year 1 of 7 year replacement of all PEU radios (all initial radios installed in 2007).	2101627	$ 130,000	DW21-102	Pending Filing		CoBank	Yes	$ 130,000	$ 106,000	$ 98,000	Various	Yes	$ 27.23	$ 2,668	Replaced 924 Radios through 09/30/21, projecting 80 more
Interest on CoBank FaLOC	Short term interest from 9/29/2021 - 7/31/2022		$ -	CoBank	Pending Filing		CoBank	Yes	$ -	$ -	$ 13,650	Various	No	$ 26.45	$ -	Anticipates closing on CoBank long term loan to pay off CoBank FALOC on 8/1/2022.

Pennichuck East Utilities Projected 2020 Total Capital Expenditure Budget - $ 2,748,500

Projected annual property tax expenses for QCPAC eligible projects - $ 28,265

		Eligible for 2021 QCPAC Surcharge	Estimated Project Cost as of 6/30/2021	Estimated Project Cost as of 9/30/2021
Pennichuck East Utilities Projected 2020 QCPAC Eligible Capital Investment -		$ 2,718,500	$ 1,669,000	$ 1,171,950
Funded with CoBank Loan[3] -		$ 2,485,647	$ 1,436,147	$ 939,950
Funded with SRF Loan[4] -		$ 232,853	$ 232,853	$ 232,000
Funded with 0.1 DSRR -		$ 30,000	$ 158,300	$ 221,000

1. Tax rate is the sum of the local community rate plus the Statewide Utility tax rate of $6.60/$1000.
2. The 2021 PEU Capital Expenditures Budget presented were approved by the Board in Janaury 2021.

						6/30/2021 Update	9/30/2021 Update
3. Projected CoBank Loan Terms are	25	Years at	5.0%	resulting in P&I of	$ 176,363	$ 101,898	$ 66,692
4. Projected SRF Terms for Locke Lake project are	30	Years at	2.704%	resulting in P&I of	$ 11,430	$ 11,430	$ 11,388
					$ 187,793	$ 113,328	$ 78,080

Pennichuck East Utilities, Inc.
DW 21-022
Projected 2022 QCPAC Capital Expenditures
2/11/2021
6/30/2021 Update - Defer Atkinson Station upgrade. Add in Londonderry System Improvements
Revised 10/28/21 for DOE DR1
9/30/2021 Update

Project Name/Description	Project Description	Work Order #	2022 Approved Budgeted Amount, Revised to reflect 2020 QCPAC activity	Financing Docket No.	NHPUC Order No.	Date of NHPUC Order	Source of Funding	Eligible for 2022 QCPAC Surcharge	Eligible for 2022 QCPAC Surcharge	Community	Taxable	Tax Rate (1)	QCPAC Eligible Property Tax Expense	Explanation for Change/Addition/Deletion since Petition Filing
Wellesley Drive water main replacement4	Replace 1760 LF of 2 inch PE with 1760 LF of C900 PVC.		$ -	CoBank	Pending Filing		CoBank	Yes	$ -	Pelham	Yes	$ 24.86	$ -	Project deferred due to available funds being used for Lonondery Tank and W&E
Radcliffe Drive water main replacement4	Replace 720 LF of 1.5 inch PE with 720 LF of C900 PVC.		$ -	CoBank	Pending Filing		CoBank	Yes	$ -	Pelham	Yes	$ 24.86	$ -	Project deferred due to available funds being used for Lonondery Tank and W&E
Vassar Drive water main replacement4	Replace 1740 LF of 2 inch PE with 1740 LF of C900 PVC.		$ -	CoBank	Pending Filing		CoBank	Yes	$ -	Pelham	Yes	$ 24.86	$ -	Project deferred due to available funds being used for Lonondery Tank and W&E
Londonderry System Improvements	Tank, Transmission Main, & Booster Station	2102351	$ 1,500,000	CoBank	Pending Filing		CoBank	Yes	$ 1,500,000	Londonderry	Yes	$ 24.78	$ 37,170	Project delay in permitting will require carry over into 2022
Interconnect the W&E CWS to the Town of Salem Water System.	Interconnect the W&E CWS to the Town of Salem Water System.		$ 530,000	CoBank	Pending Filing		CoBank	Yes	$ 530,000	Windham	Yes	$ 23.89	$ 12,662	Project bid in fall of 2021, material not available until spring 2022.
1 x revenue investments Normal Run Rate	Per Tariff		$ 100,000	CoBank	Pending Filing		CoBank	Yes	$ 100,000	Various	Yes	$ 27.23	$ 2,723	
Londonderry Mountain Homes Station Improvements	Station Expansion for and including Chemical Feed Facilities for re-chloramination.		$ -	CoBank	Pending Filing		CoBank	Yes	$ -	Londonderry	Yes	$ 24.78	$ -	Project deferred pending additional study and Potential PFOA expansion in Lonondery
Booster Pump replacement/rebuild	Booster Pump replacement/rebuild		$ 40,000	CoBank	Pending Filing		CoBank	Yes	$ 40,000	Various	Yes	$ 27.23	$ 1,089	
Well Pump replacements	Well Pump replacements		$ 40,000	CoBank	Pending Filing		CoBank	Yes	$ 40,000	Various	Yes	$ 27.23	$ 1,089	
Chemical Feed pump replacements	Chemical Feed pump replacements		$ 10,000	CoBank	Pending Filing		CoBank	Yes	$ 10,000	Various	Yes	$ 27.23	$ 272	
Install/replace treatment systems in small CWS.	Install/replace treatment systems in small CWS.		$ 25,000	CoBank	Pending Filing		CoBank	Yes	$ 25,000	Various	Yes	$ 27.23	$ 681	
Miscellaneous Structural Improvements	Misc. Structural Improvements		$ 20,000	CoBank	Pending Filing		CoBank	Yes	$ 20,000	Various	Yes	$ 27.23	$ 545	
Miscellaneous Fencing and Security projects	Miscellaneous Fencing and Security projects		$ 10,000	CoBank	Pending Filing		CoBank	Yes	$ 10,000	Various	Yes	$ 27.23	$ 272	
Miscellaneous SCADA/Electrical	Miscellaneous SCADA/Electrical		$ 30,000	CoBank	Pending Filing		CoBank	Yes	$ 30,000	Various	Yes	$ 27.23	$ 817	
Well Rehabilitation	Well Rehabilitation		$ 60,000	CoBank	Pending Filing		CoBank	Yes	$ 60,000	Various	Yes	$ 27.23	$ 1,634	
New Services (5)	Single Family, Owner Build, New Homes		$ 25,000	CoBank	Pending Filing		CoBank	Yes	$ 25,000	Various	Yes	$ 27.23	$ 681	
Renewed Services (20)	Replacement of failed services (focus on Locke Lake System).		$ 110,000	CoBank	Pending Filing		CoBank	Yes	$ 110,000	Pelham	Yes	$ 24.86	$ 2,735	
Hydrants (5)	Replacement of non-functional hydrants.		$ 30,000	CoBank	Pending Filing		CoBank	Yes	$ 30,000	Pelham	Yes	$ 24.86	$ 746	
Gates (8)	Replacement of Failed Gate Valves.		$ 32,000	CoBank	Pending Filing		CoBank	Yes	$ 32,000	Pelham	Yes	$ 24.86	$ 796	
Radios (300)	New Customers (220) and replaced failed radios (80) for meter reading.		$ 31,500	CoBank	Pending Filing		CoBank	Yes	$ 31,500	Various	Yes	$ 27.23	$ 858	
New meters for new customers (220). Replacement of failed meters (80)	New meters for new customers (220) and replacement meters (80).		$ 30,000	CoBank	Pending Filing		CoBank	Yes	$ 30,000	Various	Yes	$ 27.23	$ 817	
Meters 5/8"-6" Lead Meter Exchange - PEU (400)	Replace High lead brass meter with new no lead brass meter.		$ 40,000	CoBank	Pending Filing		CoBank	Yes	$ 40,000	Various	Yes	$ 27.23	$ 1,089	
2022 Radios (1000)	Year 2 of 7 year replacement of all PEU radios (all initial radios installed in 2007).		$ 130,000	CoBank	Pending Filing		CoBank	Yes	$ 130,000	Various	Yes	$ 27.23	$ 3,540	
Interest on CoBank FALOC	Short term interest from 8/1/2022 - 7/31/2023		$ 35,000	CoBank	Pending Filing		CoBank	Yes	$ 35,000	Various	No	$ 27.23	$ -	Anticipates closing on CoBank long term loan to pay off CoBank FALOC on 8/1/2023.
		Pennichuck East Utilities Projected 2020 Total Capital Expenditure Budget -	**$ 2,793,500**									**Projected annual property tax expenses for QCPAC eligible projects -**	$ 70,213	

Pennichuck East Utilities Projected 2020 QCPAC Eligible Capital Investment - $ 2,828,500
Funded with CoBank Loan[3] - $ 2,828,500

1. Tax rate is the sum of the local community rate plus the Statewide Utility tax rate of $6.60/$1000
2. The 2022 PEU Capital Expenditures Budget presented were approved by the Board in Janaury 2021.
3. Projected CoBank Loan Terms are 25 Years at 5.0% resulting in P&I of $ 200,689
4. The Wellesley, Radcliffe and Vassar Drive water main replacemts will be completed over 2 years with water main replacement occurring in 2022 and final pavement in 2023.

Pennichuck East Utilities, Inc.
DW 21-022
Projected 2023 QCPAC Capital Expenditures
2/11/2021
Revised 6/2/2021 per Staff Tech Session DR1, Revised 10/28/21 DOE DR1
6/30/2021 Update - Add in Atkinson Booster Station replacement. Deferred from 2022
Revised 10/25/2021 for DOE DR1's
9/30/2021 Update
Updated for DOE DR2's 12/1/2021

Project Name/Description	Project Description	Work Order #	2022 Approved Budgeted Amount, Revised to reflect 2020 QCPAC activity	Financing Docket No.	NHPUC Order No.	Date of NHPUC Order	Source of Funding	Eligible for 2023 QCPAC Surcharge	Eligible for 2023 QCPAC Surcharge	Community	Taxable	Tax Rate (1)	QCPAC Eligible Property Tax Expense	Explanation for Change/Addition/Deletion since Petition Filing
Pelham Main Replacement	Monticello & Lane Area Phase 2		$ 700,000	CoBank	Pending Filing		CoBank	Yes	$ 700,000	Pelham	Yes	$ 24.86	$ 17,402	
Wellesley Drive water main replacement	Replace 1760 LF of 2 inch PE with 1760 LF of C900 PVC (paving).		$ 70,000	CoBank	Pending Filing		CoBank	Yes	$ -	Pelham	Yes	$ 24.86	$ -	Project deferred due to available funds being used for Montecello project
Radcliffe Drive water main replacement	Replace 720 LF of 1.5 inch PE with 720 LF of C900 PVC (paving).		$ 50,000	CoBank	Pending Filing		CoBank	Yes	$ -	Pelham	Yes	$ 24.86	$ -	Project deferred due to available funds being used for Montecello project
Vassar Drive water main replacement	Replace 1740 LF of 2 inch PE with 1740 LF of C900 PVC (paving).		$ 70,000	CoBank	Pending Filing		CoBank	Yes	$ -	Pelham	Yes	$ 24.86	$ -	Project deferred due to available funds being used for Montecello project
Atkinson Booster Station	Replace and Upgrade Station for AS treatment and Fire flow.		$ 600,000	CoBank	Pending Filing		CoBank	Yes	$ 600,000	Atkinson	Yes	$ 22.84	$ 13,704	
Locke Lake	Circle & Emmerson Replace 2100 feet of 2 inch PE.		$ 250,000	CoBank	Pending Filing		CoBank	Yes	$ 250,000	Barnstead	Yes	$ 27.84	$ 6,960	
1 x revenue investments Normal Run Rate	Per Tariff		$ 100,000	CoBank	Pending Filing		CoBank	Yes	$ 100,000	Various	Yes	$ 27.23	$ 2,723	
Booster Pump replacement/rebuild	Booster Pump replacement/rebuild		$ 40,000	CoBank	Pending Filing		CoBank	Yes	$ 40,000	Various	Yes	$ 27.23	$ 1,089	
Well Pump replacements	Well Pump replacements		$ 40,000	CoBank	Pending Filing		CoBank	Yes	$ 40,000	Various	Yes	$ 27.23	$ 1,089	
Chemical Feed pump replacements	Chemical Feed pump replacements		$ 10,000	CoBank	Pending Filing		CoBank	Yes	$ 10,000	Various	Yes	$ 27.23	$ 272	
Install/replace treatment systems in small CWS.	Install/replace treatment systems in small CWS.		$ 25,000	CoBank	Pending Filing		CoBank	Yes	$ 25,000	Various	Yes	$ 27.23	$ 681	
Miscellaneous Structural Improvements	Miscellaneous Structural Improvements		$ 20,000	CoBank	Pending Filing		CoBank	Yes	$ 20,000	Various	Yes	$ 27.23	$ 545	
Miscellaneous Fencing and Security projects	Miscellaneous Fencing and Security projects		$ 10,000	CoBank	Pending Filing		CoBank	Yes	$ 10,000	Various	Yes	$ 27.23	$ 272	
Miscellaneous SCADA/Electrical	Miscellaneous SCADA/Electrical		$ 30,000	CoBank	Pending Filing		CoBank	Yes	$ 30,000	Various	Yes	$ 27.23	$ 817	
Well Rehabilitation	Well Rehabilitation		$ 60,000	CoBank	Pending Filing		CoBank	Yes	$ 60,000	Various	Yes	$ 27.23	$ 1,634	
New Services (5)	Single Family, Owner Build, New Homes		$ 25,000	CoBank	Pending Filing		CoBank	Yes	$ 25,000	Various	Yes	$ 27.23	$ 681	
Renewed Services (20)	Replacement of failed services (focus on Locke Lake System).		$ 110,000	CoBank	Pending Filing		CoBank	Yes	$ 110,000	Various	Yes	$ 27.23	$ 2,995	
Hydrants (5)	Replacement of non-functional hydrants.		$ 30,000	CoBank	Pending Filing		CoBank	Yes	$ 30,000	Various	Yes	$ 27.23	$ 817	
Gates (8)	Replacement of Failed Gate Valves		$ 32,000	CoBank	Pending Filing		CoBank	Yes	$ 32,000	Various	Yes	$ 27.23	$ 871	
Radios (300)	New Customers (220) and replaced failed radios (80) for meter reading.		$ 31,500	CoBank	Pending Filing		CoBank	Yes	$ 31,500	Various	Yes	$ 27.23	$ 858	
New meters for new customers (220). Replacement of failed meters (80).	New meters for new customers (220)		$ 30,000	CoBank	Pending Filing		CoBank	Yes	$ 30,000	Various	Yes	$ 27.23	$ 817	
Meters 5/8"-6" Lead Meter Exchange - PEU (400)	Replace High lead brass meter with new no lead brass meter.		$ 40,000	CoBank	Pending Filing		CoBank	Yes	$ 40,000	Various	Yes	$ 27.23	$ 1,089	
2022 Radios (1000)	Year 3 of 7 year replacement of all PEU radios (all initial radios installed in 2007).		$ 130,000	CoBank	Pending Filing		CoBank	Yes	$ 130,000	Various	Yes	$ 27.23	$ 3,540	
Interest on CoBank FALOC	Short term interest from 8/1/2023 - 7/31/2024		$ 30,000	CoBank	Pending Filing		CoBank	Yes	$ 30,000	Various	No	$ 27.23	$ -	Anticipates closing on CoBank long term loan to pay off CoBank FALOC on 8/1/2024.
		Pennichuck East Utilities Projected 2020 Total Capital Expenditure Budget -	**$ 2,533,500**									**Projected annual property tax expenses for QCPAC eligible projects -**	$ 58,855	

Pennichuck East Utilities Projected 2020 QCPAC Eligible Capital Investment - $ 2,343,500
Funded with CoBank Loan[3] - $ 2,343,500

1. Tax rate is the sum of the local community rate plus the Statewide Utility tax rate of $6.60/$1000
2. The 2022 PEU Capital Expenditures Budget presented were approved by the Board in Janaury 2021.
3. Projected CoBank Loan Terms are 25 Years at 5.0% resulting in P&I of $ 166,277
5. The Wellesley, Radcliffe and Vassar Drive water main replacemts will be completed over 2 years with water main replacement occurring in 2022 and final pavement in 2023.

100 International Drive, Suite 152, Portsmouth, NH 03801
Tel: 603.431.3937

MEMORANDUM

TO: Chris Countie, P.E.

FROM: Jeff Provost, P.E., Leah Stanton, P.E.

DATE: January 26, 2021

SUBJECT: W&E Disinfection Blending Options Assessment – **DRAFT MEMO**

Pennichuck East Utilities (PEU) requested Weston & Sampson conduct a brief study to review the options for blending chloraminated Southern New Hampshire Regional Water (SNHRW) supply with the W&E chlorinated water system. The following is the results of our findings.

W&E Water System Background

The W&E water system in Windham is comprised of 225 water customers as of 2019, according to PEU. The following was the 2019 water usage volumes:

- Average Daily Demand: 54,400 gpd (winter)
- Max Daily Demand: 86,000 gpd
- Summer Average Daily Demand (June-September): 65,500 gpd

Currently, PEU does not allow W&E water customers to conduct outdoor summer irrigation or other water usage due to concern about water supply shortages. In an effort to supplement the existing W&E water supply, PEU intends to purchase water from the town of Salem upon the completion of the newly installed water main in Route 111 in Windham between the intersections of Route 28 and Route 111A (Range Road). The town of Salem will be the owner and operator of the Route 111 water main in this part of the SNHRW system.

At the intersection of Route 111 and Route 111A, the new water main in Route 111 will connect with the existing W&E water main in Route 111A. After the water main construction in Route 111 is complete, 17 customers that are currently served by W&E will have their service transferred and be directly served by the town of Salem. Those 17 customers reside on Route 111A between Route 111 and Edgewood Road. In addition, a water meter and pressure reducing vault will be installed at the interface between the Salem and W&E water systems near the intersection of Route 111A and Usha Way.

According to PEU, after the 17 existing customers are removed from the W&E system, the following would be the estimated water demands, based on 2019 usage:

- Average Daily Demand: 40,000 gpd (winter)
- Max Daily Demand: 63,000 gpd (estimate)
- Summer Average Daily Demand (June-September): 55,000 gpd (estimate)

Upon connecting to the Salem water system, at the water meter vault described above, PEU plans to allow W&E customers to irrigate on an odd/even day basis. PEU projects that this could increase water usage by up to 25,000 gpd in the W&E water system during the summer months. As a result, the projected peak day summer usage is anticipated to be as high as 80,000 gpd with irrigation usage included.

PEU has indicated that they will look to purchase up to 30,000 gpd from Salem to supplement a peak day summer usage of 80,000 gpd. The balance, 50,000 gpd, would be supplied by the existing W&E groundwater wells. PEU plans to purchase approximately 800 gpd from Salem during the winter months.

<u>*Salem System Water Quality*</u>

In June 2020, the Salem portion of the SNHRW system was substantially completed and surface water from Lake Massabesic, furnished by Manchester Water Works (MWW) via the town of Derry water system, is capable of being transmitted through the town of Windham along Route 28 (from the Derry town line to the Salem town line). In addition to the pipeline necessary to connect the Derry and Salem water systems, a pressure reducing and chemical feed station was constructed in Windham near the Derry town line on Northland Road. The purpose of this station is to reduce the hydraulic grade line to 420' in the town of Windham, to boost monochloramine levels at that point in the SNHRW system and to adjust the pH of MWW's water supply for better compatibility with Salem's existing corrosion control practices.

During the summer and fall of 2020, a significant nitrification event developed in the SNHRW system. As a result of the microbiology activity monochloramine levels could not be maintained in several areas of the SNHRW distribution system especially in the water supply entering Northland Station and in the water after Northland Station that was transmitted down Route 28 in Windham prior to entering the Salem water system. Although Northland Station is equipped with chemical feed systems that allow Salem to produce monochloramines at Northland Station, the water quality that entered Northland Station contributed to an accelerated decomposition of monochloramine.

During nitrification events, ammonia oxidizing bacteria and nitrite oxidizing bacteria are present in the water supply. Since monochloramines are produced by the combination of free chlorine and ammonia, the ammonia-portion of the monochloramine chemical is an available food source for the ammonia oxidizing bacteria. The byproduct of such a reaction is nitrite. Subsequently, the nitrite becomes a food source for the nitrite oxidizing bacteria and nitrate is formed. During these reactions, the chlorine and ammonia that had bonded to form monochloramine disassociate. As stated above, the ammonia can and does become a food source for bacteria. The chlorine portion of the monochloramine is then consumed by varying constituents in the water that impart a chlorine demand.

In addition to the loss of monochloramine levels during nitrification, the following conditions can also occur:

- Reduction in pH levels
- Reduction in alkalinity levels
- Formation of biofilm on the interior of pipelines
- Formation of dichloramine and trichloramine

Nitrification is most often a water temperature dependent phenomenon in New England. During the summer and fall of 2020, water temperatures in the SNHRW system reached 75 degrees Fahrenheit. By December 2020, the nitrification event had ended, water temperatures had dropped to approximately 45 degrees Fahrenheit and monochloramine levels had stabilized and were maintaining anticipated residual levels.

The following is the range of water quality parameters that could be expected in the Windham-portion of the Salem water system year-round that will be available to W&E:

Parameter	Range	Units
Nitrite	0 – 0.3	mg/L
Total Chlorine	3.0 - 0	mg/L
Monochloramine	2.8 - 0	mg/L
Free Ammonia	0.05 – 0.3	mg/L
pH	9.0 – 7.5	NTU
Alkalinity	25 - 15	mg/L
HPC	0 - 800	CFU
Temperature	45 - 75	F

Blending Chlorinated and Chloraminated Water Supplies

As discussed above, PEU is interested in supplementing W&E's chlorinated water supply with chloraminated SNHRW system water furnished by Salem. The mixing of chloraminated water with chlorinated water is a practice that occurs on in some potable water systems in New England. Most notably, the Massachusetts Water Resource Authority (MWRA) in Massachusetts furnishes chloraminated water to several Massachusetts municipalities that chlorinate their primary source of drinking water but require MWRA chloraminated water to meet demand.

Mixing of chlorinated and chloraminated water can produce several unwanted water quality issues. In the transition zone, where chlorine and monochloramines mix, water quality complaints from customers can be numerous. Low chlorine residuals, bad taste and odor issues and high levels of disinfection byproducts are often present in these areas. It should also be noted that the transition zone can migrate depending on the demand patterns in the system making it challenging to monitor all areas being impacted.

On July 13, 2018 representatives from Weston & Sampson, NHDES and UNH attended a presentation at MWRA by Dr. Mandu Inyang and Dr. Betsy Reilly on the Impacts of Blending on Distribution System Water Quality. The following is a brief summary of key issues that the MWRA identified for a water system that blends chloraminated water with chlorinated water:

- Controlling water age in the distribution system is important. High water age is more susceptible to nitrification issues.
- Water age issues are even more critical in areas of unlined cast iron water mains.
- Eliminate closed valves in the distribution system that are meant to be normally open. This will minimize potential water age issues.
- Maintain optimal storage tank cycling/turnover. Water age can become an issue in tanks that do not properly cycle.
- Maintaining an adequate level of secondary disinfectant whether it be free chlorine or chloramines is also a key parameter in controlling many of the concerns including nitrification, taste, odor and color issues, biofilms and increased bacterial counts as well as potential corrosion control issues from changing oxidation-reduction potential (ORP) in the system.
- Mixing chloramines with chlorine can increase free chlorine levels in the distribution system if breakpoint chlorine is reached during blending. If disinfection byproduct precursors (e.g. organic carbons) are present in the distribution system, increasing free chlorine levels could impact the formation of disinfection byproducts. Nitrogen products can also be released from the breakdown of chloramines if breakpoint chlorination occurs during blending.
- Water quality blending impacts are compounded by different corrosion control strategies and disinfection types. The corrosivity potential of the blended water may be impacted (positively or negatively) after the water is blended. Interior pipe coatings, maintained as part of a routine corrosion control practice, could also be impacted.
- Discolored water is the most frequent water customer complaint in areas where transitional changes occur in water quality. For instance, if high manganese is present in a water system, there may be precipitation of the manganese that occurs at the mixing zone. Odor and taste complaints might also be expected.
- A public information/education plan should be developed that informs the water customers of impending changes to the water system and the potential for temporary water quality impacts.

The following is a summary of monitoring strategies that the MWRA recommends and/or has observed among the chlorinated water communities they furnish chloraminated water to:

- At a minimum, ***daily*** sampling at selected total coliform rule (TCR) sites is recommended for chlorine residual (free and total), pH, turbidity, temperature and conductivity. Monitoring these parameters is important to assess any impacts that may develop on water corrosivity after the two different waters blend. Alkalinity should also be monitored especially at the mixing zones.
- Calculating corrosion indices based on current water quality data for the two water systems will be helpful to determine if water corrosivity is increased by blending the two waters.
- Heterotrophic plate counts (HPCs) sampling should be conducted if chlorine residual is undetectable. Otherwise, HPC testing should be conducted from time to time. Monitoring for HPCs provides an indication of microbial presence and growth within the distribution system. Rising HPC values may be an indication of nitrogen levels in the distribution system (due to the breakdown of chloramines) or ineffective disinfection (low chlorine residual).
- Microbial monitoring, (e.g. E.coli and total coliform) is performed by communities at TCR sites as part of their routine sampling protocol. Typical monitoring frequency is daily or weekly at these sites. If routine TCR sites are also used for monitoring water corrosivity (see above) then additional E.coli and total coliform testing within the distribution system would most likely not be necessary. If other sites (not designated for TCR monitoring) are chosen for monitoring for water corrosivity, then additional E.coli and total coliform sampling should be considered at those sites.
- Disinfection byproduct (DBP) formation is a concern if either blended water source is high in total organic carbon content. A stringent DBP monitoring program should be conducted initially to develop a baseline and level of understanding of the DBP formation potential within the distribution system.

American Water Works Association (AWWA) Distribution System Monitoring

If simple "Tier I" screening data (such as the monitoring described above) show trends of concern then further evaluation needs to occur involving chlorine to ammonia ratio, nitrite-nitrogen and nitrate-nitrogen. The following is an excerpt from an American Water Works Association (AWWA) technical memo regarding distribution system monitoring:

> "Chloramination and Nitrification Monitoring
>
> There is not one single parameter that can be used for chloramination and nitrification monitoring that will provide comprehensive information about the water's chemistry. Whether in the plant or in the distribution system, testing a combination of parameters is required to fully understand and control the process. Areas where chloramination and nitrification parameters are tested are recommended to include the treatment plant where monochloramine is being formed, areas in the distribution system that may be at higher risk for nitrification, and any area in the system where disinfectant residual may be boosted. A

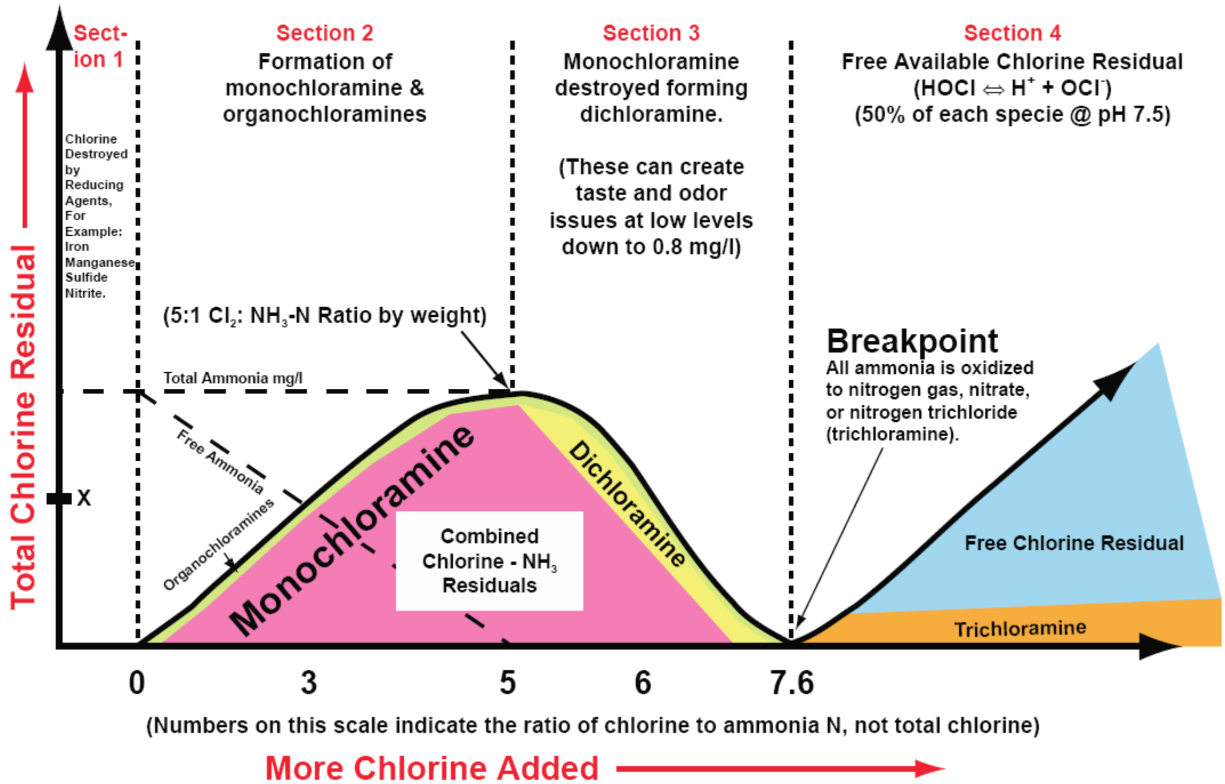
distribution system hydraulic model may assist in identifying and locating these sampling sites. Examples of key sampling sites for nitrification monitoring include:

- Water treatment plant (point of monochloramine formation for process control)
- Distribution system storage tanks
- Pressure zone boundaries
- Areas with the potential for high water age and/or low usage
- Dead ends

Parameters recommended for monitoring chloramine formation and nitrification include the following:

- Chlorine residual
    - Monitoring for free and total chlorine is recommended in many cases. However operators should be aware that accurately measuring free chlorine in the presence of total chlorine using the colorimetric DPD chemistry can be challenging. Even when running a test using free chlorine reagent, total chlorine can react to oxidize DPD, potentially resulting in a false positive result. Consult the reagent manufacturer for more information about performing tests in this application.
- Monochloramine
- Free ammonia
- Total ammonia
- Nitrite
- pH
- HPC

A single monochloramine or total chlorine measurement does not provide sufficient information about water chemistry to identify where the water is relative to the chloramination curve (see figure below). Without additional information, the same total chlorine results could indicate incomplete monochloramine formation, dichloramine and trichloramine formation, or even breakpoint chlorination. The combination of multiple parameters listed above, for example monochloramine, total chlorine, and free/total ammonia, allows utilities to better understand where they reside on the chloramination curve, their level of nitrification risk, and steps that must be taken to maintain process or system control. Field, bench, and continuously monitoring instrumentation is available for the analysis of these parameters, and utilities are encouraged to select the analysis platform that best fits their needs.



There are many steps that can be taken to prevent and control nitrification. For example, nitrification prevention can begin at the water treatment plant by maintaining a chlorine to ammonia ratio that is optimal for monochloramine formation. Steps can be taken to reduce water age in the distribution system. Tank stratification can be prevented by the addition of mixing. Once established, nitrification may require steps such as flushing to restore water quality.

In any case, utilities that chloraminate should consider developing action plans and procedures to address the potential for nitrification and take steps to proactively address issues that occur. Many systems develop tiered action plans, in which different actions are to be taken depending on the relative concentrations of different parameters in the system. As with any procedure, staff should be trained in its implementation to help ensure that it is carried out correctly.

Good understanding of nitrification, its causes, and its impact on distribution system water quality and operations give utilities the tools they need to work towards achieving optimization.

References

This article presents a brief overview of chloramination and nitrification. Many comprehensive resources exist to provide more detailed information about these topics including:

Water Chlorination Principles and Practices – AWWA Manual M20

Nitrification Prevention and Control in Drinking Water – AWWA Manual M56"

<u>*Chloraminated and Chlorinated Water System Case Studies*</u>

The following is a listing of a few communities that blend MWRA water with their own water on an emergency or temporary basis. Each community listed below maintains their own sources of supply and their own disinfection and corrosion control practices, as applicable. It should be noted that each community has their own monitoring protocols which are highly dependent on the capabilities of the individual community. While some communities monitor several parameters on a frequent basis other communities may only monitor a couple of parameters:

- ***Burlington, MA*** – Burlington is a chloraminated system which receives chloraminated MWRA water on an emergency basis. While receiving MWRA water, Burlington performs weekly sampling at TCR sites for the following parameters: chlorine residual (free and total), pH, turbidity, temperature, color, fluoride, iron, manganese and nitrate/nitrite.
- ***Lynn, MA*** – MWRA conducted a bench top study of Lynn's water system to study the impacts of corrosion control when blending MWRA water with Lynn water sources. Lynn chlorinated their surface water supply (with a target of 0.8 – 1.4 mg/L of free chlorine residual leaving their water treatment plant (WTP)) at the time of the MWRA study. MWRA chloraminates their surface water supply with a target of 2.5 – 3.0 mg/L total chlorine residual leaving their WTP. Lynn uses zinc orthophosphate for their corrosion control with a target of 0.5 -0.6 mg/L of phosphate residual. The target pH in the Lynn distribution system is 7.2. MWRA uses soda ash for their corrosion control practices and targets a pH of 9.5 in the distribution system. The purpose of the MWRA study was to understand water quality impacts from blending MWRA water with local water sources in emergency-supplied communities and to determine corrosion control impacts or potential pipe scale modification in the distribution system.

  The MWRA study looked at four source water blending ratios; 100% Lynn/0% MWRA, 75% Lynn/25% MWRA, 50% Lynn/50% MWRA, 0% Lynn/100% MWRA. Water quality parameters such as pH, alkalinity, sulfate, free and total chlorine and phosphate were measured. In addition, the following four corrosion indices of the blended water samples were assessed; chloride to sulfate mass ratio (CSMR), Larson Ratio (LR), Langelier Saturation Index (LSI), Rzynar Saturation Index (RSI). For each corrosion index, the blended water became less corrosive when more MWRA water was introduced. For this study, MWRA water tended to precipitate calcium carbonate which made the Lynn water less corrosive. However, a reduction in zinc and phosphate levels from zinc phosphate used for corrosion control was observed with increasing MWRA water blend which may be impactful to distribution pipe coating in the Lynn distribution system.
- ***Peabody, MA*** – Peabody chloraminates their surface water supplies. A fire at the Coolidge Avenue Water Treatment Plant in Peabody shut down the WTP. As a result, Peabody increased the MWRA supply in the area of the distribution system served by the Coolidge Avenue plant from 25% MWRA/75% Coolidge water

to 100% MWRA water. Desktop modeling predicted that the increase to 100% MWRA water could modify the potential mineral deposits in this portion of the Peabody distribution system. As a result, additional sampling was performed in the distribution system to identify if the increase in mineral deposits would occur. Several parameters (e.g. Aluminum, Calcium, Chloride, Nitrate, Potassium, Sulfate and Zinc) were found to be significantly elevated at one sampling site. Upon investigation, a buried, closed gate valve was found causing stagnation conditions in the pipe. Upon opening the gate valve, all water quality parameters at the sampling site returned to levels comparable to the levels measured at all other sampling sites in the distribution system. Water age should therefore be closely monitored (and minimized where possible) in all areas of a distribution system to avoid the potential for elevated levels of water quality parameters.

W&E Water System Blending Options

As discussed above, the connection between the Salem water system and the W&E water system will occur at a meter pit located on Route 111A near the intersection with Usha Way. As of the writing of this memorandum, no other infrastructure is proposed for connecting and blending the chloraminated SNHRW system water with chlorinated W&E water. The following provides a brief discussion regarding different options for PEU to consider:

1. *Uncontrolled Blending of the Two Water Supplies*

For this option, chloraminated Salem water would enter the chlorinated W&E water system and blend in an uncontrolled manner within the piping of the W&E distribution system. When this form of blending occurs, PEU could expect the following conditions:

- Varying water demand by W&E water customers will mean a shifting mixing boundary/zone between chlorine and monochloramine disinfection types. PEU will have little to no control over the location of this boundary/mixing zone under this scenario.
- Elevated free ammonia, elevated nitrite, ammonia oxidizing bacteria (AOB), biofilm formation potential, heterotrophic bacteria, dichloramine and trichloramine, corrosion control compatibility and loss of disinfection residual are all factors that could occur and will need to be monitored in the mixing zone between chlorinated W&E water and Salem chloraminated water.
- In an uncontrolled blend of water supplies, maintaining the chlorine to ammonia ratio for optimal chloramine maintenance in the distribution system becomes challenging. As the chlorine to ammonia ratio increases above 5:1, the formation of dichloramine and trichloramine develops. Once dichloramine and trichloramine are present, taste and odor complaints could be made by water customers.
- Maintaining chloraminated water in the W&E system will require PEU to develop and maintain a

nitrification action plan (NAP). If nitrite levels rise above various predetermined thresholds (as defined in the plan), PEU should implement the corresponding action associated with each nitrite level threshold in an effort to reduce the rising nitrite levels. As nitrite levels rise, the effects of nitrification can become more detrimental to maintaining a disinfectant residual. Approximately five parts of chloramine oxidizes one part of nitrite so the more nitrite present in the distribution system the more chloramine is depleted. It should be noted that a primary action most chloraminated water systems use to mitigate the onset of nitrification events is to flush the respective water systems. These water systems have hydrants that allow the operators to conduct flushing activities. It is Weston & Sampson's understanding that the W&E water system does not have hydrants and would therefore need to install hydrants or other infrastructure to enable flushing of the water system.

2. Controlled Blending of the Two Water Supplies

For this option, chloraminated Salem water would enter the chlorinated W&E water system and blend in a controlled manner. Additional infrastructure would most likely be necessary to achieve a controlled blend of the two water supplies. In this option, the W&E operators would achieve a uniformly blended water prior to the first W&E water customer. However, much of the same concerns listed in the Uncontrolled Blend option above would continue to be present for a controlled blend of the two water supplies. Water quality from the Salem-portion of the SNHRW system would predominantly dictate the degree of complexity in maintaining a disinfection residual in a portion of the W&E water system and other water quality concerns (such as taste and odor complaints, discolored water, nitrogen species, etc) described in the sections above.

3. Physically Isolate a portion of the W&E Water System

Physically isolating a portion of the W&E system through in-line valve closures so that one area of the W&E system is supplied only chloraminated Salem water while the remaining portion of the distribution system is supplied chlorinated W&E water is an option. The water system separation could be seasonal or permanent. The following could be expected upon separating the W&E system:

- If a portion of the W&E system is physically isolated from the remainder of the system, the desired contribution from each source (Salem and W&E) may not be recognized. PEU has indicated that they would like to supplement the W&E water system with up to 30,000 gpd of Salem water during the summer months and approximately 700 gpd of Salem water during the winter months. PEU could review customer water use records to locate the ideal locations of the physical closures to maintain the desired water supply ratio between Salem and W&E.

- The chloraminated portion of the W&E distribution system would still be subjected to monitoring and sampling requirements (such as implementation and execution (as needed) of an NAP, changes in corrosion control practices and temporary loss of disinfectant residual).

4. Breakpoint Chlorinate the Salem Water Supply

In lieu of blending the chloraminated and chlorinated water supplies through physical means only, PEU could treat the Salem water with chlorine to oxidize all chloramine species and other constituents imparting a chlorine demand (such as nitrite, free ammonia and microbial colonies). This is the practice known as break point chlorinating described above and would allow PEU to convert the Salem water supply from a chloraminated water supply to a chlorinated supply. In this example, PEU could adjust the disinfection residual of the Salem supply to desired levels prior to entrance into the W&E water system. For this option, PEU could install a chlorine chemical feed system at or near the meter pit at the boundary of the two water systems or transmit the Salem chloraminated water to the W&E water treatment plant (WTP) and apply chlorine dosing within the existing facility. In either example, the following conditions would need to be considered by PEU:

- Free chlorine in the presence of the Salem water supply may form disinfection by products (DBPs) due to organic precursors present in the Lake Massabesic water source. PEU will need to sample for DBPs in the W&E distribution system if the Salem water supply that enters the W&E system is converted to free chlorine disinfection.

5. Add Ammonia to the W&E Water Supply

Instead of chlorinating the Salem water supply, PEU could form monochloramine at the W&E WTP by feeding ammonia into the W&E water supply and converting the current secondary disinfection from free chlorine to monochloramine. As a result, the entire W&E system would be converted to a chloraminated system allowing the Salem chloraminated water supply to blend with a chloraminated W&E water supply. In this option, PEU would avoid the potential for detrimental water quality conditions caused by free chlorine and monochloramine mixing. However, all of the sampling and monitoring discussed above for monochloramine disinfection in a distribution system would be applicable.

N

Pennichuck Water Works GIS

December 9, 2020

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From: Unger, Michael <Michael.C.Unger@des.nh.gov>
Sent: Friday, January 29, 2021 3:25 PM
To: Unger, Michael <Michael.C.Unger@des.nh.gov>
Cc: Skarinka, Rick <RICHARD.C.SKARINKA@des.nh.gov>; Klevens, Cynthia <CYNTHIA.M.KLEVENS@des.nh.gov>; Suozzo, Randal <Randal.A.Suozzo@des.nh.gov>
Subject: [EXTERNAL] Controlling Nitrification in Chloraminated Water Systems - NHDES Guidance Document and Template

Dear Water System Owner or Operator,

You are receiving this email because your public water system uses chloramines for disinfection in the distribution system. In 2020, New Hampshire experienced the most widespread and impactful occurrence of nitrification in chloraminated water systems to-date. In response, the NHDES Drinking Water and Groundwater Bureau (DWGB) is increasing our outreach to chloraminated water systems about the potential risks of nitrification and how you can be proactive to prevent nitrification or respond early to correct it.

The attached Guidance Document and Nitrification Monitoring and Control Plan (NMCP) template describes the risks of nitrification and provides tools to help you prepare and respond to nitrification in your systems. All water systems using chloramines for disinfection are susceptible to nitrification. Nitrification, if left unchecked, can result in significant public health risks and violations of drinking water standards. Preparing and implementing a NMCP will make your water system more likely to detect nitrification early and respond quickly to prevent the most significant water quality impacts.

NHDES strongly recommends every water system using chloramines – either producing chloramines themselves or purchasing chloraminated water from another system – develop a NMCP and implement it. Implementation is a continuous process of monitoring, responding if sample results are outside goal ranges, and updating the plan based on lessons learned. **Even small and very small Public Water Systems using chloramines should have a NMCP specific to their system.** The plan should be prepared by individuals who are most familiar with the water system's operation and water quality monitoring. The template is simply a tool to help you prepare your own plan. Some systems require customizations to meet their needs.

DWGB is organizing a virtual training to be scheduled for early March, which will provide practical advice on how to prepare a NMCP, how to conduct sampling and analysis for nitrification parameters, how to interpret the data you collect, and how to respond if sample results are outside goal ranges. Please be on the lookout for notices to register for that training.

In the meantime, with questions about nitrification in chloraminated drinking water systems or this guidance document and NMCP template, you can contact me:

Michael Unger, PE
Water Engineer
(603) 271-0779
Michael.Unger@des.nh.gov
www.nhdes.gov → search for "Drinking Water"

Thank you for all you do to provide safe and reliable drinking water to the people of New Hampshire.

Mike

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Learn more: https://www4.des.state.nh.us/nh-dwg-trust/ and www.des.nh.gov

CONTROLLING NITRIFICATION IN CHLORAMINATED DRINKING WATER SUPPLIES

Guidance Document and

Nitrification Monitoring and Control Plan Template

January 2021

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

Drinking Water and Groundwater Bureau

Purpose

The purpose of this guidance document and Nitrification Monitoring and Control Plan (NMCP) template is to inform owners and operators of chloraminated water systems of the risks of nitrification and provide tools to prepare and respond to nitrification in their systems. All water systems using chloramines for disinfection are susceptible to nitrification. Nitrification, if left unchecked, can result in significant public health risks and violations of drinking water standards. Preparing and implementing a NMCP will make your water system more likely to detect nitrification early and respond quickly to prevent the most significant water quality impacts.

How to Use this Document

Section 1 explains the basics of nitrification. Section 2 describes the key elements of a NMCP and provides guidance on using the template to prepare your water system's NMCP.

NHDES strongly recommends every water system using chloramines – either producing chloramines themselves or purchasing chloraminated water from another system – develop a NMCP and implement it. Implementation is a continuous process of monitoring, responding if sample results are outside goal ranges, and updating the plan based on lessons learned. **Even small and very small Public Water Systems using chloramines should have a NMCP specific to their system.**

The plan should be prepared by individuals who are most familiar with the water system's operation and water quality monitoring. The template is simply a tool to help you prepare your own plan. Some systems require customizations to meet their needs.

With questions about nitrification in chloraminated drinking water systems or this guidance document and NMCP template, contact the New Hampshire Department of Environmental Services (NHDES) Drinking Water and Groundwater Bureau (DWGB):

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(603) 271-0779
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www.nhdes.gov → search for "Drinking Water"

Section 1 – Background

What is Nitrification?

Nitrification is a microbial process by which reduced nitrogen compounds (primarily ammonia) are sequentially oxidized to nitrite and nitrate. The nitrification process is primarily accomplished by two groups of nitrifying bacteria, one that converts ammonia to nitrite and another that converts nitrite further to nitrate. Ammonia is either present in drinking water naturally in source water or added during chloramine production.

Why are chloraminated water systems susceptible to nitrification?

Chloramines are produced in a reaction between free chlorine (hypochlorite) and ammonia. Chloramines include monochloramine, dichloramine, trichloramine, and organochloramines. For disinfection purposes, monochloramine is the preferential form.

Monochloramine breaks down (decays) naturally into free ammonia, nitrogen gas, and chloride. This process is often referred to as "autodecomposition". The free ammonia is then available for nitrifying bacteria to convert to nitrite and further to nitrate.

Under most circumstances and operating conditions, an equilibrium is maintained in the distribution system. As some monochloramine decays, free ammonia is consumed by nitrifying bacteria, but growth of those bacteria is controlled by the total chlorine residual still present in the water.

However, in some instances, nitrifying bacteria can multiply exponentially. The bacteria then exert an increasing chlorine demand, which consumes and reduces monochloramine disinfectant levels, which in turn releases more free ammonia. Additional free ammonia allows the nitrifying bacteria to grow and reproduce even faster, creating a feedback loop. Eventually, the total chlorine residual can be completely consumed.

What are the concerns associated with nitrification?

1. **Loss of disinfectant residual, bacteria regrowth, total coliform and/or *E. coli* "hits", and growth of other pathogens.** As explained above, the presence of nitrifying bacteria and the nitrification process can cause an accelerated decay of disinfectant residuals due to an increase in the microbial population, nitrite, and other chloramine-demanding substances. Reduced total chlorine residual can allow for bacterial regrowth and the detection of regulated indicator organisms total coliforms and *E. coli*. Cases of Legionella and the "brain eating amoeba" *Naegleria fowleri* have also been associated with nitrification in chloraminated water systems.
2. **Corrosion of pipe materials, lead and copper release, and colored water.** Oxidation of ammonia to nitrite and nitrate releases acid, which can consume alkalinity and cause pH to drop, especially in low alkalinity waters. Decreases in pH can result in the shift of the chloramine species from monochloramine to di- and tri-chloramines, which are less stable, further reducing oxidation reduction potential (ORP). Lower pH and ORP can lead to the corrosion of distribution system materials and cause release of lead and copper above regulated Action Levels and may corrode iron water mains resulting in main breaks, leaks, and colored water.
3. **Taste and odor.** Di- and tri-chloramine species form during nitrification because the chlorine:ammonia ratio is thrown out of balance. These chloramine species have a much stronger taste and odor than monochloramine. High amounts of biological growth and decay can also result in noticeable taste and odor from natural organic matter.

What conditions contribute to nitrification?

1. **High water age.** Uncontrolled nitrification occurs when the natural equilibrium between monochloramine disinfectant and nitrifying bacteria is disrupted. This can happen in areas of high water age (i.e. dead-ends, stagnant pockets in storage tanks, etc.) because older water is not being replaced with fresh water with higher monochloramine residuals. Therefore, most nitrification control measures focus on reducing water age and ensuring a consistently strong monochloramine residual throughout the distribution system.
2. **High water temperature.** Higher water temperatures provide more energy to the biological and chemical processes that drive nitrification. So water systems need to be especially vigilant during warmer months.
3. **Other factors.** Nitrification in chloraminated water systems is a complicated combination of chemical and biological processes. Scientific research is ongoing to better understand the underlying factors, such as pH, pipe materials, and others. However, most factors are interrelated, so steps taken to control nitrification will typically address multiple underlying causes, and, except in extreme and unusual cases, the common corrective actions described below are successful at controlling nitrification without requiring detailed and specialized investigation.

Section 2 – Nitrification Monitoring and Control Plan (NMCP)

What is a Nitrification Monitoring and Control Plan (NMCP)?

The purpose of a Nitrification Monitoring and Control Plan (NMCP), is to ensure that chloramine disinfection is successful by preventing and/or responding to nitrification. An NMCP should include:

1. Sampling Locations.
2. Parameters to be monitored and sampling frequency.
3. Goals, Trigger Levels, and Action levels for key parameters.
4. Corrective Actions (responses) to be taken if a parameter exceeds a Trigger or Action Level.
5. Communication Plan for notifying customers, consecutive water systems, and NHDES.

NHDES strongly recommends every water system using chloramines – either producing chloramines themselves or purchasing chloraminated water from another system – develop a NMCP and implement it. Implementation is a continuous process of monitoring, responding if sample results are outside goal ranges, and updating the plan based on lessons learned. **Even small and very small Public Water Systems using chloramines should have a NMCP specific to their system.**

Sampling Locations

The monitoring can be broken into two parts: *treatment monitoring* (if producing chloraminated water) and *distribution system monitoring*. Both components are essential in ensuring proper chloramine residual production, stability, and maintenance. The parameters and frequency selected will vary among the monitoring locations, both in the treatment process and distribution system, based on the purpose of the parameters selected, industry standards, and historical data.

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The following list provides some guidance in selecting distribution system nitrification sampling locations:

- Routine coliform and/or disinfectant residual sites may be used for NMCP sample sites.
- For systems serving more than 1,000 people, NMCP sampling sites should be established at entry point(s), average water age, and maximum water age locations.
- Sites should be chosen to determine the impact of blending multiple sources, if applicable.
- Tanks (both fill and draw cycles).

Each distribution system is unique. There is not a set number of sample locations to be identified. Using the suggestions listed above, a water system should identify a sufficient and reasonable number of locations to accurately characterize its system and identify disinfectant degradation and nitrification issues.

The NMCP should include a **map** of sampling locations to clearly identify them and show their relation to treatment, storage, and the rest of the distribution system.

Key Parameters, Sampling Frequency, and Methods

Refer to industry guidelines, such as the American Water Works Association (AWWA) Manual M56 – *Nitrification, Prevention and Control in Drinking Water*, to assist with determining the appropriate and industry accepted treatment and distribution system monitoring parameters and frequencies.

The following is a partial list of recommended water quality parameters to monitor at treatment and in the distribution system. **It is important to note that these are only suggestions. If there are specific regulatory monitoring requirements or site-specific permit conditions, those requirements and conditions must be followed.** Outside of applicable regulatory and permit requirements, it is ultimately the responsibility of the utility to determine which parameters to monitor. The references at the end of this document can be consulted for guidance. Consecutive systems should coordinate with the selling system on baseline values/ranges in the part of the distribution system serving the consecutive system.

Parameter to Monitor	**Reasons to Monitor**
Total Chlorine (mg/L as Cl_2)	Total chlorine is the sum of all active chlorine species. It is the regulated parameter. The Surface Water Treatment Rule (SWTR) requires that a measurable total chlorine residual be maintained at all locations in the distribution system. The **maximum** residual disinfectant level (MRDL) for total chlorine is 4.0 mg/L based on the running annual average of all samples collected in distribution.
Monochloramine (mg/L as Cl_2)	Monochloramine is the strongest disinfecting species of chloramines. Ideally, all of the total chlorine will be present as monochloramine. Significant differences between the monochloramine and total chlorine concentrations (i.e. when total chlorine is considerably greater than monochloramine) can indicate an improper ratio of chlorine to ammonia during the chloramine generation process.

New Hampshire Department of Environmental Services

Free Chlorine[1] (mg/L as Cl_2)	Monitoring free chlorine can be helpful to ensure the proper formation of monochloramine. Evaluated alongside other parameters, it can help understand whether the chlorine:ammonia ratio is optimized for monochloramine. Ideally, there should be no free chlorine present because it has reacted with ammonia to form monochloramine.
Free Ammonia (mg/L as N)	As monochloramine decays, free ammonia is released and can be consumed by nitrifying bacteria. Ideally, no free ammonia should be present, but it is helpful to maintain a trace to know that a system is not over-chlorinated.
Total Ammonia (mg/L as N)	Like free chlorine, total ammonia can be helpful to ensure the proper formation of monochloramine. Evaluated alongside other parameters, it can help understand where the chlorine:ammonia ratio is optimized for monochloramine. Ideally, the ratio of total chlorine to total ammonia will be between 4:1 and 5:1.
Nitrite (mg/L as N)	Nitrite is formed by ammonia-oxidizing bacteria, which consume ammonia. It is the first byproduct of nitrification. **Presence of nitrite above levels in the source water indicates nitrification has begun and corrective action is needed.** Your lab's standard detection limit may be too high to be useful for nitrification control, so request a detection limit of 0.005 mg/L or lower.
Nitrate (mg/L as N)	Nitrate is formed by nitrite-oxidizing bacteria, which consume nitrite. **Presence of nitrate above levels in the source water indicates <u>significant</u> nitrification is already occurring and corrective action is needed.**
pH	A decrease in pH can indicate nitrification and can lead to corrosion of distribution system materials.
Temperature (deg C or F)	Chloramine decays and nitrifying bacteria grow and reproduce faster at higher water temperatures. Monitoring temperature can alert a system to a potential nitrification problem as temperatures increase. Variations in temperature throughout the distribution system can be a sign of sub-optimal distribution system management, such as poor tank mixing, issues with a sampling site, or even contamination of the distribution system.
HPC (cfu/mL)	Heterotrophic Plate Counts can be used to gauge the biological activity that is occurring within the distribution system. Increasing HPCs within the distribution system can indicate the onset of nitrification and, at a minimum, increasing biological activity, which can result in an increase in disinfectant demand. For small systems where cost is a concern, HPCs can be used for troubleshooting if other parameters start to indicate a water quality concern.

[1] Note that accurate evaluation of free chlorine following ammonia addition is generally not feasible via standard colorimetric testing methods. Therefore, it is important to ensure that the method used can accurately quantify the concentration of free chlorine, without interference from monochloramine.

Sampling frequencies will be system-specific, based on the size, complexity, and sample collection and analysis capabilities of the individual utility. A system may choose to increase the monitoring frequencies for specific parameters, or include additional, non-routine parameters, if the monitoring indicates the possible onset of nitrification. Systems may also consider the potential benefits of continuous monitoring for as many parameters as feasible. Continuous monitoring can provide real time data for treatment processes. It can also provide real time data at key locations in the distribution system, such as tanks or booster pumping stations, to provide an early warning of the onset of nitrification. This data can be used to optimize operations, such as chemical feed rates at treatment locations or distribution system flushing.

Analytical methods will depend on the size and analytical capability of the system. Whatever methods are selected, they should be consistent for a given parameter at all locations to minimize variability in results. For example, if you use an online monochloramine analyzer either at the treatment plant or within the distribution system, you should also take grab samples using the same field test instrument you use for other distribution system locations. For nitrite analysis, your lab's standard detection limit may be too high to be useful for nitrification control, so request a **detection limit of 0.005 mg/L** or lower.

Goals, Alert Levels, and Action Levels

As with monitoring, the goals, alert levels, and action levels for key water quality parameters can be broken into two parts: *treatment* (if producing chloraminated water) and *distribution system*.

It is important to establish system-specific *treatment* goals and action levels and system-specific *distribution system* goals, alert levels, and action levels. **Treatment "Red" Action Levels** trigger operational responses such as treatment chemical dose adjustments. ("Yellow" Alert Levels are not recommended for treatment because proper monochloramine production is critical to maintaining acceptable water quality, and deviations of key parameters from goal levels requires immediate response.)

Distribution System "Yellow" Alert Levels are somewhat out of the norm, indicating that nitrification may have started. Additional monitoring such as increased sampling frequency or adding additional parameters is recommended. Some action to get back to normal is needed, but it is probably a routine type of action like flushing. **Distribution System "Red" Action Levels** happen when it becomes difficult to maintain a compliant total chlorine residual, and there is a strong possibility that nitrification is the culprit. If routine actions don't get the system back to normal, more intense action will be needed. If a **"Red" Action Level** trigger occurs, sampling should be continued and/or adjusted to monitor the effectiveness of the operational response, and DES should be notified.

The following is a list of recommendations for setting goals for *some* of the parameters listed. **It is important to note that these are only suggestions. If there are specific regulatory monitoring requirements or site-specific permit conditions, those requirements and conditions must be followed.** Outside of applicable regulatory and permit requirements, it is ultimately the responsibility of the utility to determine suitable goals and action levels for the individual utility for ***all*** parameters being monitored. The water system should have a complete understanding of how to interpret all of the data collected and utilize the established action levels in order to make sound, data-based decisions. The references at the end of this document can be consulted for guidance.

- The total chlorine and monochloramine goals can be set at the same value because they will ideally be about the same.
- The entry point total chlorine and monochloramine goals should be high enough so that the maximum water age site can achieve its goal.
- Ideally, water at entry points just after treatment will have zero free ammonia because it is “food” for the nitrifying bacteria. Having a trace of free ammonia is good because it shows that the water is not over-chlorinated.
- Free ammonia naturally increases with time. Therefore, free ammonia goals in average and high water age locations should represent normal operating conditions based on historical records.
- The nitrite and nitrate goals at treatment and in the distribution system should always be the same as the source water. The only things that can increase nitrite and nitrate levels are nitrification, cross connections, or source water changes.

Corrective Actions/ Responses

The NMCP should include the responses the water system will take if “Yellow” Alert Levels or “Red” Action Levels are met. The Response Plan should identify the individual(s) responsible to decide when and how to implement corrective actions.

The following is a list of typical operational responses to nitrification in the distribution system common in the literature. **It is important to note that these are only suggestions. If there are specific regulatory monitoring requirements or site-specific permit conditions, those requirements and conditions must be followed.** Outside of applicable regulatory and permit requirements, it is ultimately the responsibility of the utility to determine suitable corrective action. Refer to industry guidelines such as the AWWA Manual M56 to assist with determining the appropriate and industry accepted responses to nitrification occurring within the distribution system.

- Flush affected areas of the distribution system.
- Increase tank turnover by deep cycling and/or lowering tank levels.
- Add tank mixing or confirm mixers are operating properly.
- Increase monochloramine concentration at the entry point.

If the above operational responses are not successful in correcting the nitrification, the system should consider a **chlorine switchover** (sometimes referred to as a chlorine “burn”) for part or all of the distribution system. This involves stopping ammonia feed and adding only free chlorine (hypochlorite) in sufficient concentrations to achieve breakpoint chlorination, which drives all ammonia out of the system and leaves only a free chlorine residual. During a chlorine switchover, nitrifying bacteria are starved of their food and are subjected to a more consistent chlorine residual, thereby breaking the cycle of monochloramine decay, free ammonia release, and bacterial growth and reproduction.

Chlorine switchovers are regularly performed in many chloraminated water systems, especially in warm climates. However, a chlorine switchover is still a significant treatment change, which **requires pre-approval by the NHDES Drinking Water and Groundwater Bureau**. Customers should also be notified as far in advance as possible. Properly conducted free chlorine conversions can often cause the water to have a different taste and/or odor than when using chloramine for disinfection, and customers will likely be able to notice the difference. There may also be an increase in the level of disinfection by-products (DBPs) being formed. Since DBP compliance is based on a running annual average, and known health concerns are based on prolonged exposure, a short-term increase in DBPs should be acceptable. But the utility should consider this effect when deciding whether to implement a chlorine switchover. If the switchover lasts longer than a few weeks, non-compliance DBP samples should be taken.

Communications Plan

Finally, the NMCP should include a Communication Plan which describes the conditions under which the water system will notify its customers, consecutive water systems, and NHDES. The Communication Plan should identify the individual(s) responsible to decide when and how to issue external communications.

Consecutive water systems should be notified of any “Yellow” Alert Level or “Red” Action Level occurrence at treatment or in the part of the distribution system near the connection point, so the consecutive system can respond accordingly.

NHDES should be notified of any “Red Alarm” Action Level occurrence. **Pre-approval by the NHDES Drinking Water and Groundwater Bureau is required** for any changes in treatment and/or construction of water system improvements in accordance with NH Administrative Rules Env-Dw 400 through 407.

Customers should be notified of any condition that may likely affect public health and/or result in a noticeable change in aesthetics.

Resources

American Water Works Association (AWWA) Manual M56 – *Nitrification, Prevention and Control in Drinking Water*

USEPA Office of Water (4601M) Distribution System Issue Paper “Nitrification” (2002)
https://www.epa.gov/sites/production/files/2015-09/documents/nitrification_1.pdf

With questions about nitrification in chloraminated drinking water systems or this guidance document and NMCP template, contact the New Hampshire Department of Environmental Services (NHDES) Drinking Water and Groundwater Bureau (DWGB):

Michael Unger, PE
Water Engineer
(603) 271-0779
Michael.Unger@des.nh.gov
www.nhdes.gov → search for “Drinking Water”

NITRIFICATION MONITORING AND CONTROL PLAN TEMPLATE FOR CHLORAMINATED WATER SYSTEMS

PART 1: GENERAL SYSTEM INFORMATION

Water System Name:		PWSID:	
Mailing Address:		Date of Most Recent Revision:	
Contact Person:	Phone:	Email:	
System Type:	☐ **CWS** ☐ **NTNC** ☐ **TNC**	Population Served:	
Source Types: (check all that apply)	☐ **Surface Water (SW)** ☐ **Purchased SW** ☐ **Groundwater (GW)** ☐ **Purchased GW**	If sources include purchased water, indicate PWSIDs of all selling systems.	
Do you sell water to any other public water system?	☐ **Yes** ☐ **No**	If **Yes**, indicate PWSIDs of all consecutive systems.	
Treatment: (check all that apply)	☐ **No treatment** (Purchase and distribute chloraminated water only) *Chloramines:* ☐ **Chloramine Production (treating raw water)** ☐ **Booster Chloramination (in treated water)** *Free Chlorine:* ☐ **Planned Temporary Free Chlorine Conversion**[1] ☐ **Booster Chlorination**[2]		
Blending:	Do chloraminated water and chlorinated water from different sources blend within your distribution system? (Note: This is not recommended and requires specific approval by NHDES Drinking Water and Groundwater Bureau.) ☐ **Yes** ☐ **No**		

1 Routine (e.g. annual) temporary conversion to free chlorine for system-wide nitrification control.
2 Continuous conversion of chloraminated water to free chlorine (breakpoint chlorination) to a consecutive system or isolated distribution system service area.

PART 2A: MONITORING PLAN FOR CHLORAMINE TREATMENT

This part is only for water systems that produce chloramines, booster chloraminate, or booster chlorinate.

Monitoring Locations, Parameters, and Frequencies

Treatment Plant ID[3]:			
Parameter	**Analytical Method**	**Pre-Treatment Frequency (Prior to chlorine and ammonia addition)** Monitoring Location Description: ________________________________	**Post-Treatment Frequency (After ammonia addition and prior to entry into the distribution system)** Monitoring Location Description: ________________________________
Total Chlorine[5] (mg/L as Cl_2)			
Monochloramine[5] (mg/L as Cl_2)			
Free Chlorine[4,5] (mg/L as Cl_2)			
Free Ammonia[6] (mg/L as N)			
Total Ammonia (mg/L as N)			
Nitrite (mg/L as N)			
Nitrate (mg/L as N)			
pH			
Temperature (deg C or F)			
Other Parameters: (Please list below)			

3 Make additional copies of this table as necessary if there is more than one treatment plant that produces or treats chloraminated water associated with the PSWID.

4 Caution must be used when using N,N-diethyl-p-phenylenediamine (DPD) methods after monochloramine formation due to the positive interference from monochloramine, other oxidants, and oxidized manganese.

5 Pre-treatment sampling for chlorine species is only necessary for locations boosting chloramine or chlorine in treated water, not for plants treating raw water.

6 Elevated source water free ammonia levels may contribute to an increased differential between monochloramine and total chlorine concentrations due to the conversion of ammonia to trichloramine during breakpoint chlorination.

PART 2B: MONITORING PLAN FOR CHLORAMINATED DISTRIBUTION SYSTEMS

		Monitoring Locations[7] Include a **Map** showing these locations relative to treatment and storage					
Parameter	**Method**	**Frequency**					
Total Chlorine (mg/L as Cl_2)							
Monochloramine (mg/L as Cl_2)							
Free Chlorine[8] (mg/L as Cl_2)							
Free Ammonia (mg/L as N)							
Total Ammonia (mg/L as N)							
Nitrite (mg/L as N)							
Nitrate (mg/L as N)							
pH							
Temperature (deg C or F)							
HPCs (cfu/100mL)							
Other Parameters: (Please list below)							

7 Make additional copies of this table as necessary if the number of monitoring locations exceeds the spaces provided.
8 Caution must be used when using N,N-diethyl-p-phenylenediamine (DPD) methods due to the positive interference from monochloramine, other oxidants, and oxidized manganese.

PART 3A: RESPONSE PLAN FOR CHLORAMINE TREATMENT

This part is only for water systems that produce chloramines, booster chloraminate, or booster chlorinate.

Post-Treatment Goals, Action Levels, and Responses
After ammonia addition and prior to entry into the distribution system

Parameter	Goal	Action Level	Response
Total Chlorine (mg/L as Cl_2)			
Monochloramine (mg/L as Cl_2)			
Free Chlorine[9] (mg/L as Cl_2)			
Free Ammonia (mg/L as N)			
Total Ammonia (mg/L as N)			
Nitrite (mg/L as N)			
Nitrate (mg/L as N)			
pH			
Temperature (deg C or F)			
Other Parameters: (Please list below)			

9 Caution must be used when using N,N-diethyl-p-phenylenediamine (DPD) methods due to the positive interference from monochloramine, other oxidants, and oxidized manganese.

PART 3B: RESPONSE PLAN FOR CHLORAMINATED DISTRIBUTION SYSTEMS

Distribution System Goals, Alert Levels, and Action Levels

Parameter	Goal	Alert Level	Action Level
Total Chlorine (mg/L as Cl_2)			
Monochloramine (mg/L as Cl_2)			
Free Chlorine[10] (mg/L as Cl_2)			
Free Ammonia (mg/L as N)			
Total Ammonia (mg/L as N)			
Nitrite (mg/L as N)			
Nitrate (mg/L as N)			
pH			
Temperature (deg C or F)			
HPCs (cfu/100mL)			
Other Parameters: (Please list below)			

10 Caution must be used when using N,N-diethyl-p-phenylenediamine (DPD) methods due to the positive interference from monochloramine, other oxidants, and oxidized manganese.

Distribution System Response Plan

Provide a brief explanation of what responses will be taken if Alert Levels or Action Levels are exceeded in the distribution system.

If corrective actions will be taken in a stepwise fashion, explain what will determine when to move to the next step (length of time, concentration of key parameters, etc.)?

Who is responsible for deciding to implement these responses? Primary certified operator? Management?

PART 4: COMMUNICATIONS PLAN

Provide a Communication Plan for notifying consecutive water systems and customers. What are the specific water quality parameters and concentrations that would prompt communication to consecutive water systems?

NITRIFICATION MONITORING AND CONTROL PLAN TEMPLATE FOR CHLORAMINATED WATER SYSTEMS

PART 1: GENERAL SYSTEM INFORMATION

Water System Name:		PWSID:	
Mailing Address:		Date of Most Recent Revision:	
Contact Person:	Phone:	Email:	
System Type:	☐ **CWS** ☐ **NTNC** ☐ **TNC**	Population Served:	
Source Types: (check all that apply)	☐ **Surface Water (SW)** ☐ **Purchased SW** ☐ **Groundwater (GW)** ☐ **Purchased GW**	If sources include purchased water, indicate PWSIDs of all selling systems.	
Do you sell water to any other public water system?	☐ **Yes** ☐ **No**	If **Yes**, indicate PWSIDs of all consecutive systems.	
Treatment: (check all that apply)	☐ **No treatment** (Purchase and distribute chloraminated water only) *Chloramines:* ☐ **Chloramine Production (treating raw water)** ☐ **Booster Chloramination (in treated water)** *Free Chlorine:* ☐ **Planned Temporary Free Chlorine Conversion**[1] ☐ **Booster Chlorination**[2]		
Blending:	Do chloraminated water and chlorinated water from different sources blend within your distribution system? (Note: This is not recommended and requires specific approval by NHDES Drinking Water and Groundwater Bureau.) ☐ **Yes** ☐ **No**		

1 Routine (e.g. annual) temporary conversion to free chlorine for system-wide nitrification control.
2 Continuous conversion of chloraminated water to free chlorine (breakpoint chlorination) to a consecutive system or isolated distribution system service area.

PART 2A: MONITORING PLAN FOR CHLORAMINE TREATMENT

This part is only for water systems that produce chloramines, booster chloraminate, or booster chlorinate.

Monitoring Locations, Parameters, and Frequencies

Treatment Plant ID[3]:			
Parameter	**Analytical Method & Detection Limit**	**Pre-Treatment Frequency (Prior to chlorine and ammonia addition)** Monitoring Location Description: ________________	**Post-Treatment Frequency (After ammonia addition and prior to entry into the distribution system)** Monitoring Location Description: ________________
Total Chlorine[5] (mg/L as Cl_2)			
Monochloramine[5] (mg/L as Cl_2)			
Free Chlorine[4,5] (mg/L as Cl_2)			
Free Ammonia[6] (mg/L as N)			
Total Ammonia (mg/L as N)			
Nitrite (mg/L as N)			
Nitrate (mg/L as N)			
pH			
Temperature (deg C or F)			
Other Parameters: (Please list below)			

3 Make additional copies of this table as necessary if there is more than one treatment plant that produces or treats chloraminated water associated with the PSWID.

4 Caution must be used when using N,N-diethyl-p-phenylenediamine (DPD) methods after monochloramine formation due to the positive interference from monochloramine, other oxidants, and oxidized manganese.

5 Pre-treatment sampling for chlorine species is only necessary for locations boosting chloramine or chlorine in treated water, not for plants treating raw water.

6 Elevated source water free ammonia levels may contribute to an increased differential between monochloramine and total chlorine concentrations due to the conversion of ammonia to trichloramine during breakpoint chlorination.

PART 2B: MONITORING PLAN FOR CHLORAMINATED DISTRIBUTION SYSTEMS

		Monitoring Locations[7] Include a **Map** showing these locations relative to treatment and storage					
Parameter	**Method & Detection Limit**	**Frequency**					
Total Chlorine (mg/L as Cl_2)							
Monochloramine (mg/L as Cl_2)							
Free Chlorine[8] (mg/L as Cl_2)							
Free Ammonia (mg/L as N)							
Total Ammonia (mg/L as N)							
Nitrite (mg/L as N)							
Nitrate (mg/L as N)							
pH							
Temperature (deg C or F)							
HPCs (cfu/100mL)							
Other Parameters: (Please list below)							

7 Make additional copies of this table as necessary if the number of monitoring locations exceeds the spaces provided.

8 Caution must be used when using N,N-diethyl-p-phenylenediamine (DPD) methods due to the positive interference from monochloramine, other oxidants, and oxidized manganese.

PART 3A: RESPONSE PLAN FOR CHLORAMINE TREATMENT

This part is only for water systems that produce chloramines, booster chloraminate, or booster chlorinate.

Post-Treatment Goals, Action Levels, and Responses
After ammonia addition and prior to entry into the distribution system

Parameter	Goal	Action Level	Response
Total Chlorine (mg/L as Cl_2)			
Monochloramine (mg/L as Cl_2)			
Free Chlorine[9] (mg/L as Cl_2)			
Free Ammonia (mg/L as N)			
Total Ammonia (mg/L as N)			
Nitrite (mg/L as N)			
Nitrate (mg/L as N)			
pH			
Temperature (deg C or F)			
Other Parameters: (Please list below)			

9 Caution must be used when using N,N-diethyl-p-phenylenediamine (DPD) methods due to the positive interference from monochloramine, other oxidants, and oxidized manganese.

PART 3B: RESPONSE PLAN FOR CHLORAMINATED DISTRIBUTION SYSTEMS

Distribution System Goals, Alert Levels, and Action Levels

Parameter	Goal	Alert Level	Action Level
Total Chlorine (mg/L as Cl_2)			
Monochloramine (mg/L as Cl_2)			
Free Chlorine[10] (mg/L as Cl_2)			
Free Ammonia (mg/L as N)			
Total Ammonia (mg/L as N)			
Nitrite (mg/L as N)			
Nitrate (mg/L as N)			
pH			
Temperature (deg C or F)			
HPCs (cfu/100mL)			
Other Parameters: (Please list below)			

10 Caution must be used when using N,N-diethyl-p-phenylenediamine (DPD) methods due to the positive interference from monochloramine, other oxidants, and oxidized manganese.

Distribution System Response Plan

Provide a brief explanation of what responses will be taken if Alert Levels or Action Levels are exceeded in the distribution system.

If corrective actions will be taken in a stepwise fashion, explain what will determine when to move to the next step (length of time, concentration of key parameters, etc.)?

Who is responsible for deciding to implement these responses? Primary certified operator? Management?

PART 4: COMMUNICATIONS PLAN

Provide a Communication Plan for notifying consecutive water systems and customers. What are the specific water quality parameters and concentrations that would prompt communication to consecutive water systems?

From:	Provost, Jeffrey
To:	Boisvert, John
Subject:	[EXTERNAL] RE: Londonderry Design Flows
Date:	Thursday, December 24, 2020 9:31:49 AM
Attachments:	image001.png

Hi John

As we have discussed previously, Mountain Homes pump station is similar to the newly constructed Northland PRV and chemical feed station located near the Windham/Derry town line as it pertains to the hydraulic distance from Lake Massabesic and the MWW water treatment plant. As we have learned this past summer and fall, the Southern NH Regional Water system, like most chloraminated water systems, is subject to nitrification events, especially as water temperatures increase during the summer months. As water entered the Northland Station over the last six months, chloramine residual levels were at or near zero for a majority of the time while nitrite levels were elevated, often times over 0.3 mg/L. The rule of thumb with nitrite is for every part of nitrite, five parts of chloramine are consumed. The intent of Northland Station's chemical feed systems is to boost chloramine at that point along the SNHRW route. While chloramines were boosted at Northland Station (to approximately 2.0 mg/L), the impact of nitrite levels in exceedance of 0.3 mg/L was chloramine levels at or near zero approximately 24 hours after water left Northland (as measured at the Windham/Salem town line at a point where all the water that left Northland traveled plug flow through the town of Windham down Route 28 via a mostly 20-inch water main without services or any branch lines currently installed).

Similarly, at the Salem/Atkinson town line, a booster and chemical feed station (Westside Drive station) was constructed for the HAWC water system. The chemical feed systems at Westside are similar to what was installed at Northland and the intent of that station is to boost chloramines as water from Salem enters the HAWC water system.

At both Northland and Westside, three chemical feed systems were installed; sodium hypochlorite, ammonium sulfate and sodium hydroxide. The sodium hypochlorite and ammonium sulfate systems provide each water system with the ability to boost chloramine to the desired level prior to water entering their respective systems. The sodium hydroxide enabled each water system to raise the pH, as necessary, primarily for corrosion control purposes as a new water source (Lake Massabesic) mixed with existing sources in both Salem and HAWC. In addition to corrosion control, pH adjustment also enables each water system to raise pH for optimal chloramine production and serves as a tool to combat nitrification. Raising the pH of the water to 9.0 or slightly greater has proven to be an action that a water system can take to slow/curtail the increase in nitrite levels by establishing an unfavorable environment for nitrifying bacteria.

Nitrifying bacteria form nitrite by converting available free ammonia that is present in the water system. Chloramines experience autodecomposition due to water age and other factors and as a result, the ammonia that was bound to sodium hypochlorite when the chloramine was produced becomes unbound from the sodium hypochlorite making ammonia present in the water as free ammonia.

Due to all the conditions described above, we envision Mountain Homes pump station with the following chemical feed systems; sodium hypochlorite, ammonium sulfate and sodium hydroxide. As MWW water enters Mountain Homes PS, we recommend continuous in-line analyzers measure free ammonia and monochloramine levels, at a minimum. Total chlorine, free chlorine, pH and nitrite should be measured daily, too. Based on the water quality that enters Mountain Homes, PEU would utilize the three chemical feed systems described above to produce the necessary/desired water quality leaving the Mountain Homes PS. Measuring free ammonia and chloramine levels will enable the operators to adjust the proper amount of both ammonium sulfate and sodium hypochlorite to achieve the desired chloramine level at the optimal chlorine to ammonia ratio. Free ammonia and chloramine levels can often be variable and having programming in place to auto-adjust the chemical feed is recommended. Adjusting pH to approximately 8.3 is the ideal setpoint for producing monochloramine and the sodium hydroxide chemical feed system will allow PEU to do this as necessary (and be available to temporarily increase pH during imminent nitrification events). It should be noted that additional assessment is necessary to ensure pH adjust does not impact any corrosion control measures that are currently maintained in the Londonderry system. MWW adds a phosphate to the finished water at the Massabesic WTP and raising pH can reduce the levels of phosphate present in the water.

In order to expand the existing Mountain Homes PS building, to house the chemical feed systems, we envision an extension to the building that matches the existing width (18 feet). Based upon final design and layout, we envision the length of the addition to be between 18- and 24-feet. Contained within this space would be all three chemical feed systems (including primary and redundant chemical feed pumps, chemical feed control panels and chemical spill containment sized to meet 110% containment requirements) additional SCADA panels (as necessary), emergency eye wash systems including a water heater for tempered water on demand and enough available wall space to install all inlet and outlet analyzers.

Using as-bid construction costs for the Northland and Westside stations, we developed a budgetary project cost estimate for Mountain Homes PS. The project cost includes estimated construction costs, estimated engineering (including design and construction administration only; no bidding or resident engineering fee) and 20% contingency. The costs presented below assume engineering design is complete by August 2021 and the bid opening for the project occurs in September 2021. Any deviation of these dates would most likely alter the projected costs.

The budgetary project cost is $1,100,000 - $1,200,000.

I hope you have a Merry Christmas and a Happy New Year, John! Let’s discuss the cost estimate further in the New Year!

Jeff

From: Boisvert, John <john.boisvert@PENNICHUCK.com>
Sent: Monday, December 7, 2020 8:47 AM
To: Provost, Jeffrey <provostj@wseinc.com>
Subject: Londonderry Design Flows

Jeff

Please use the following in your analysis.

Future average day: 870,000 gpd
Future maximum day: 1,200,000 gpd

Figure a flow rate of 800 to 1,000 gpm from/through Mountain Homes.

Regards,
John

John J. Boisvert, P.E.
Chief Engineer
Pennichuck Water
25 Walnut Street
P.O. Box 428
Nashua, New Hampshire 03061-0428
Ph: (603) 913-2328

From: Countie, Chris
To: Ware, Don
Subject: FW: [EXTERNAL] So. NH nitrification control charts
Date: Monday, November 22, 2021 3:38:45 PM
Attachments: image001.png
Excel Control Chart Key and Directions.docx
Derry Control Charts.xlsx
HAWC Control Charts.xlsx
Manchester Control Charts.xlsx
Salem Control Charts.xlsx

Chris Countie
Director, Water Supply and Community Systems
Pennichuck Water
25 Walnut St.
Nashua, New Hampshire 03061-0428
Ph: (603) 913-2372

From: Unger, Michael <Michael.C.Unger@des.nh.gov>
Sent: Thursday, June 24, 2021 12:33 PM
To: Miller,David <DMiller@manchesternh.gov>; cwood@manchesternh.gov; Carrier, Tom <tomcarrier@derrynh.org>; Eugene Forbes <eforbes@underwoodengineers.com>; Devon Smith <dsmith@underwoodengineers.com>; Sorenson, Roy <rsorenson@salemnh.gov>; Fred Wallace (FWallace@salemnh.gov) <FWallace@salemnh.gov>; McClure, Jeffrey <mcclurej@wseinc.com>; Provost, Jeffrey <provostj@wseinc.com>; Kenney, Samuel <kenneys@wseinc.com>; Charlie Lanza <Charlie@hampsteadwater.com>; Rich Bibeau <RBibeau@hampsteadwater.com>; Stephen Fournier <SFournier@hampsteadwater.com>; Klevens, Cynthia <CYNTHIA.M.KLEVENS@des.nh.gov>; Skarinka, Rick <RICHARD.C.SKARINKA@des.nh.gov>; Suozzo, Randal <Randal.A.Suozzo@des.nh.gov>; Countie, Chris <chris.countie@PENNICHUCK.com>; Day, Matthew <matt.day@PENNICHUCK.com>; Malley, James <Jim.Malley@unh.edu>; Croasdale, Philip <PCroasdale@manchesternh.gov>; Elardo, Nicola <Nicola.Elardo@unh.edu>; Poor, Maria <mpoor@salemnh.gov>; akr1019@wildcats.unh.edu
Subject: [EXTERNAL] So. NH nitrification control charts

Hi All,
Please find attached Control Charts for tracking nitrification data. Nicola has also updated the directions for how to use the spreadsheets. If you have questions, I'll volunteer Nicola to help you out. She's copied on this email Nicola.Elardo@unh.edu.
Mike

6/9/2021

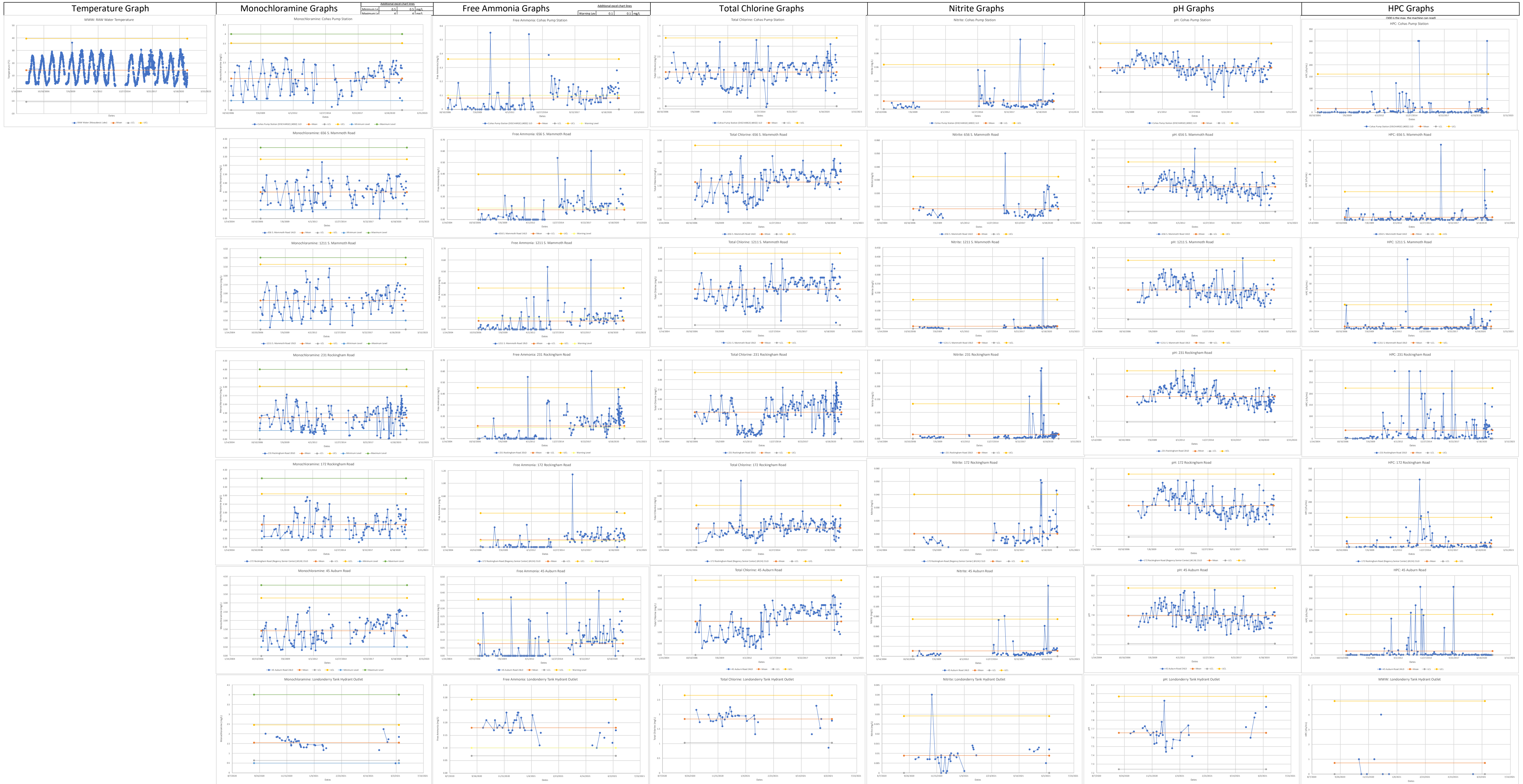
Excel Control Chart Key and Directions

Key
Yellow cells = Edit with dates/data
Green cells = Do not edit, location
Blue cells = Do not edit, parameter
Gray cells = Do not edit, set excel equations
Orange cells = Edit with current date

Directions
Adding data:

1. Select a location tab
2. Scroll to the right
3. Add the date in the top row
4. Add the data for the parameter in the correct row
5. Change the “end” date for the most recent date with data
6. Select “Control Charts” to see updated control chart

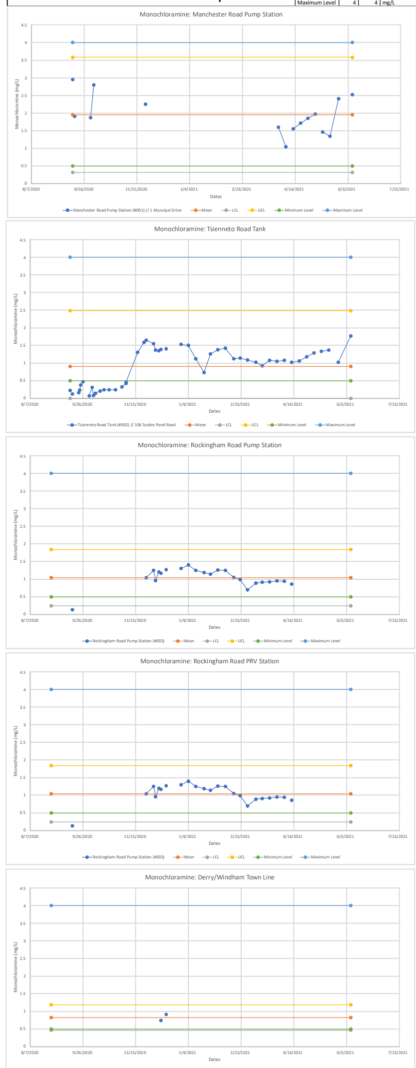
Temperature Graph	Monochloramine Graphs	Free Ammonia Graphs	Total Chlorine Graphs	Nitrite Graphs	pH Graphs	HPC Graphs



Monochloramine Graphs

Additional excel chart lines

Minimum Level	0.5	0.5	mg/L
Maximum Level	4	4	mg/L

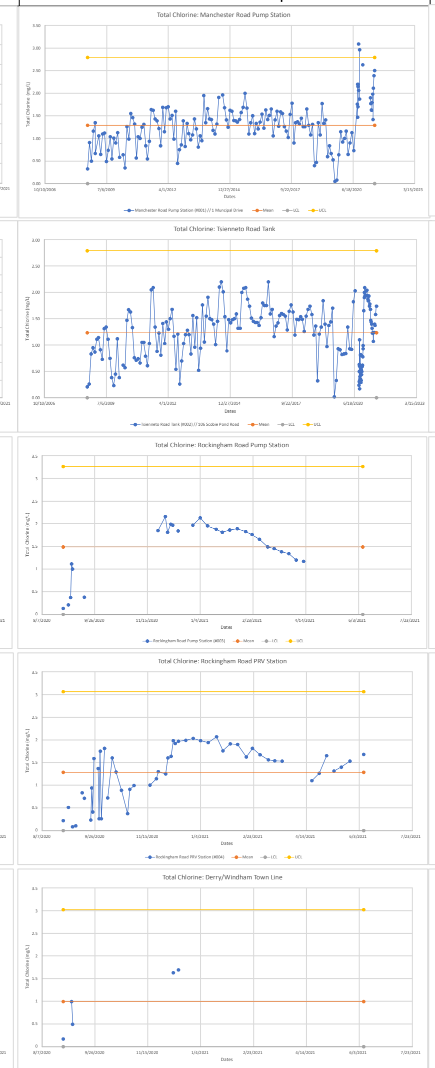


Free Ammonia Graphs

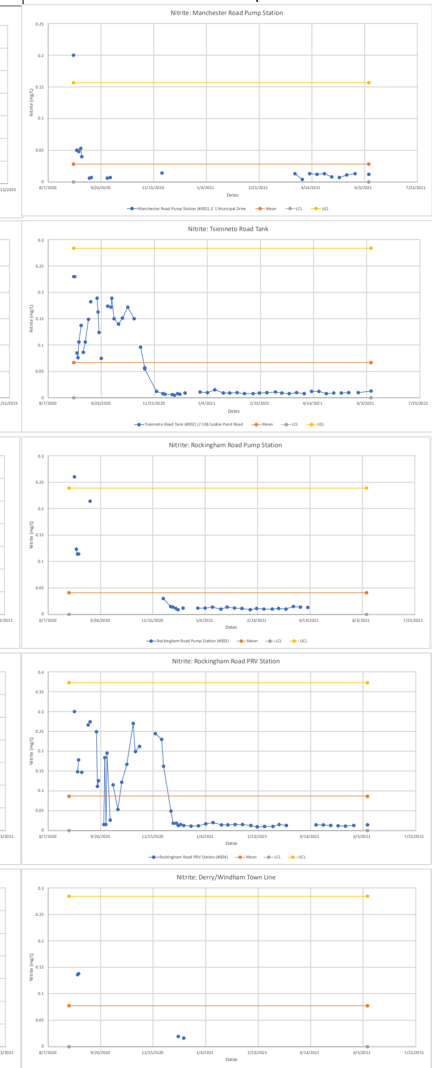
Additional excel chart lines

Warning Level	0.1	0.1	mg/L

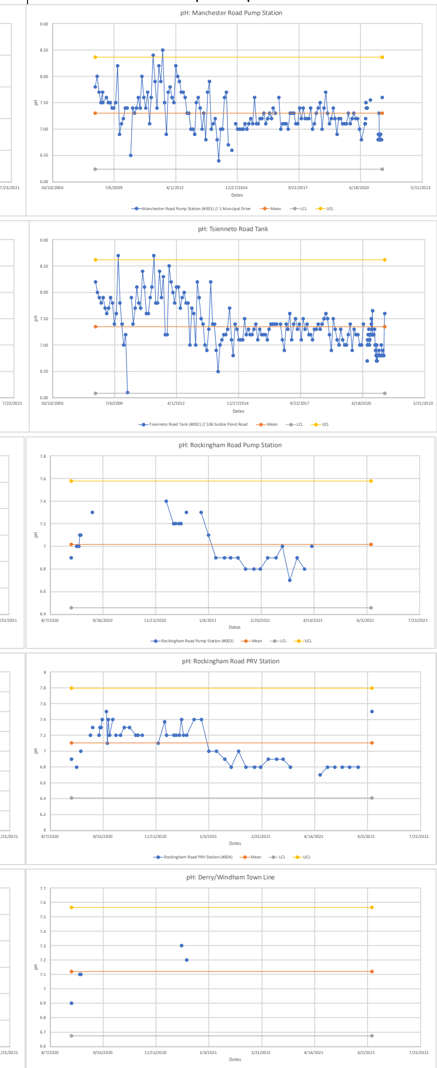
Total Chlorine Graphs



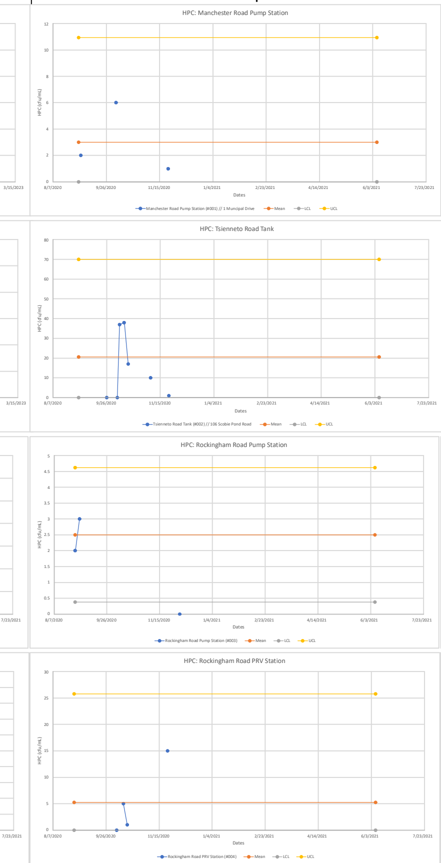
Nitrite Graphs



pH Graphs

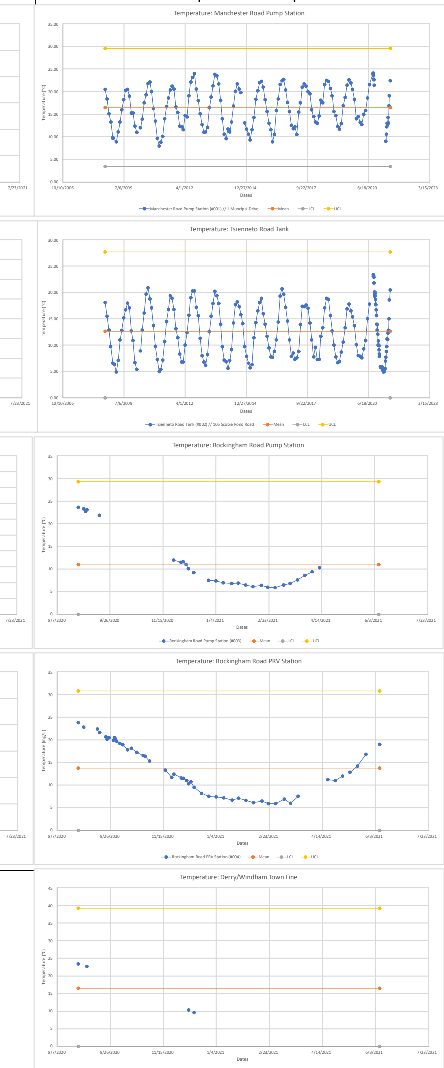


HPC Graphs



No data available

Temperature Graphs



Monochloramine Graphs | Free Ammonia Graphs | Total Chlorine Graphs | Nitrite Graphs | pH Graphs | HPC Graphs | Temperature Graphs

Monochloramine Graphs

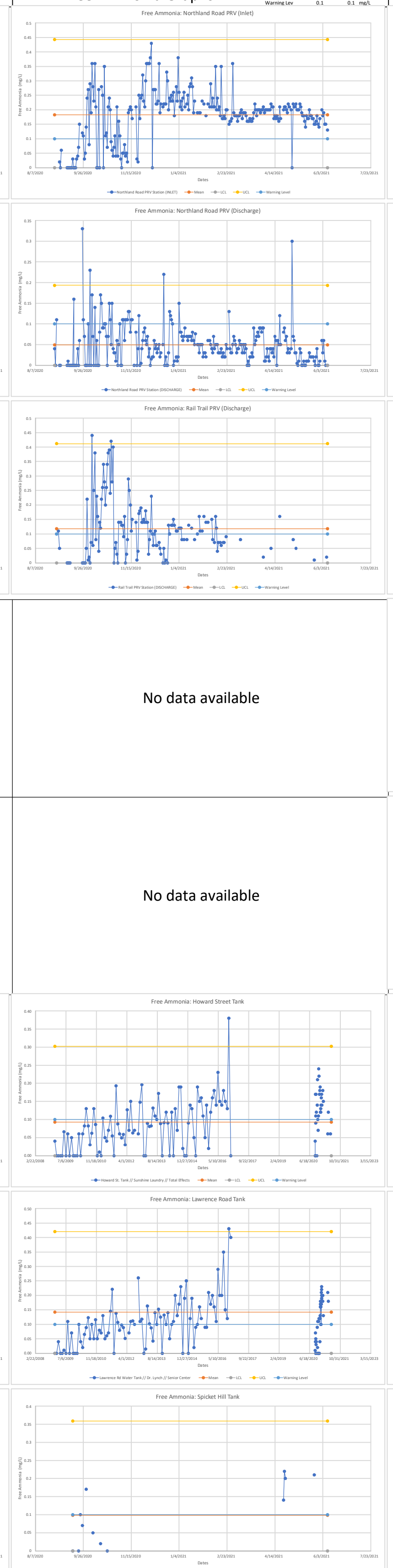
Additional excel chart lines

Minimum Le	0.5	0.5	mg/L
Maximum Le	4	4	mg/L

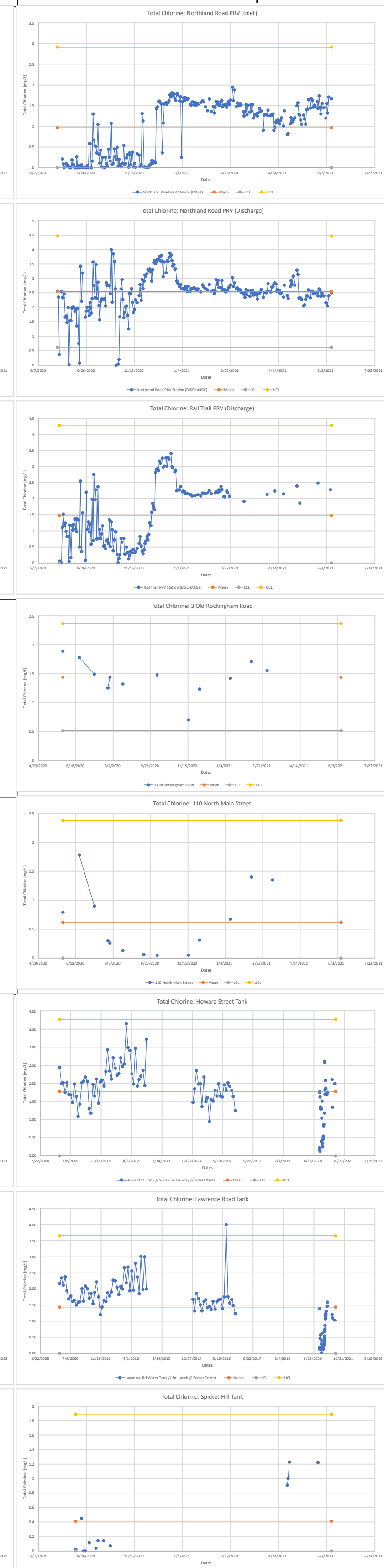
Free Ammonia Graphs

Additional excel chart lines

Warning Lev	0.1	0.1	mg/L

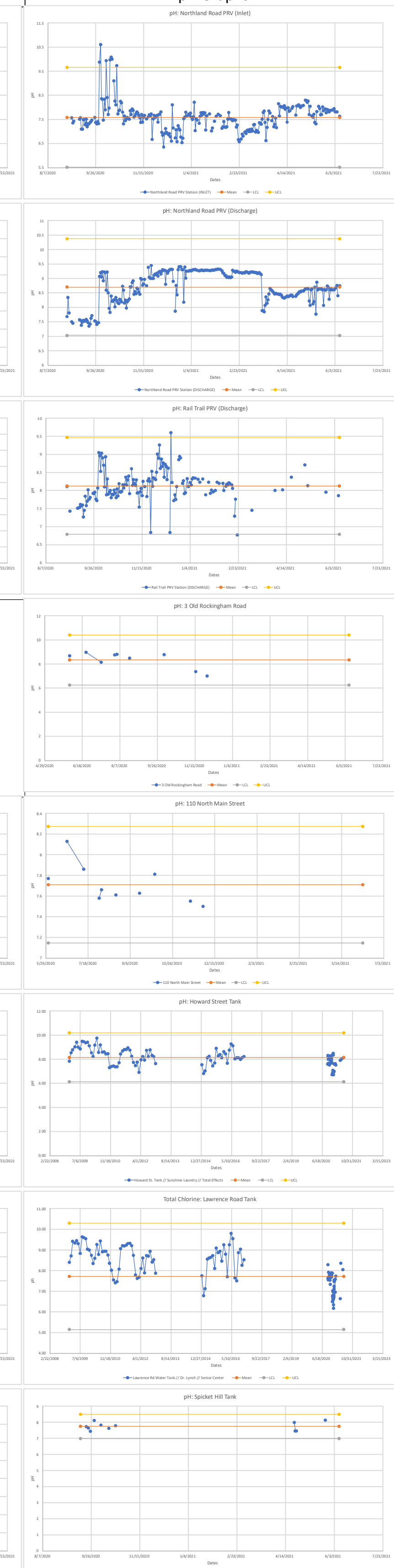


Total Chlorine Graphs

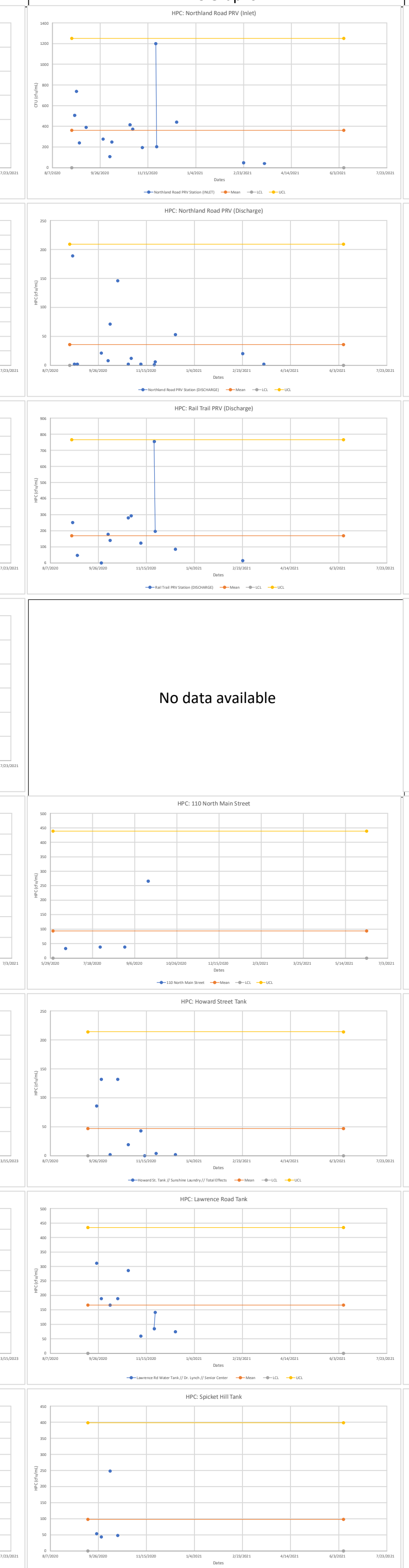


Nitrite Graphs

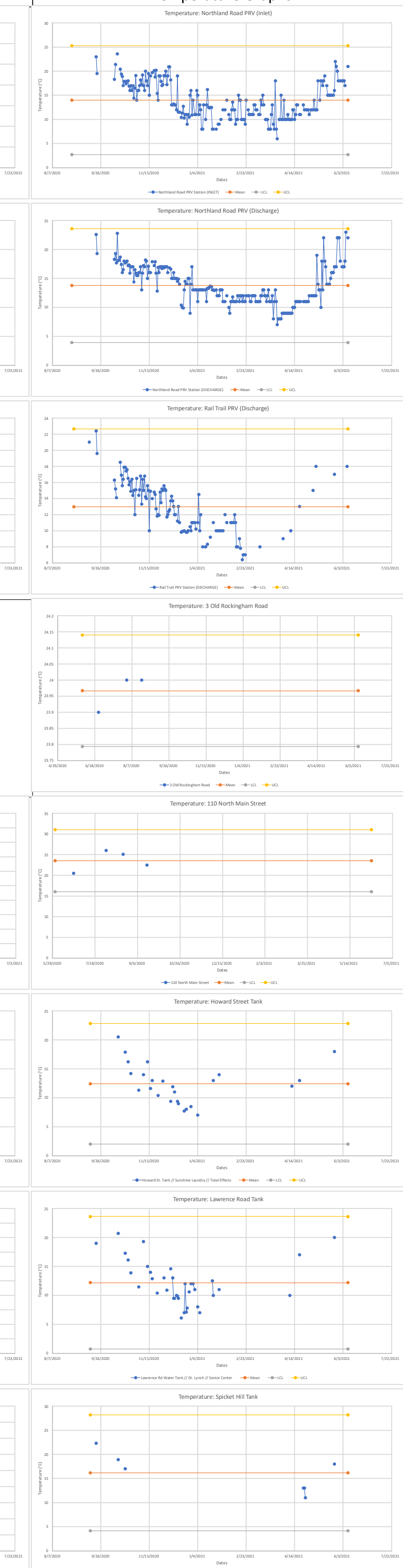
pH Graphs

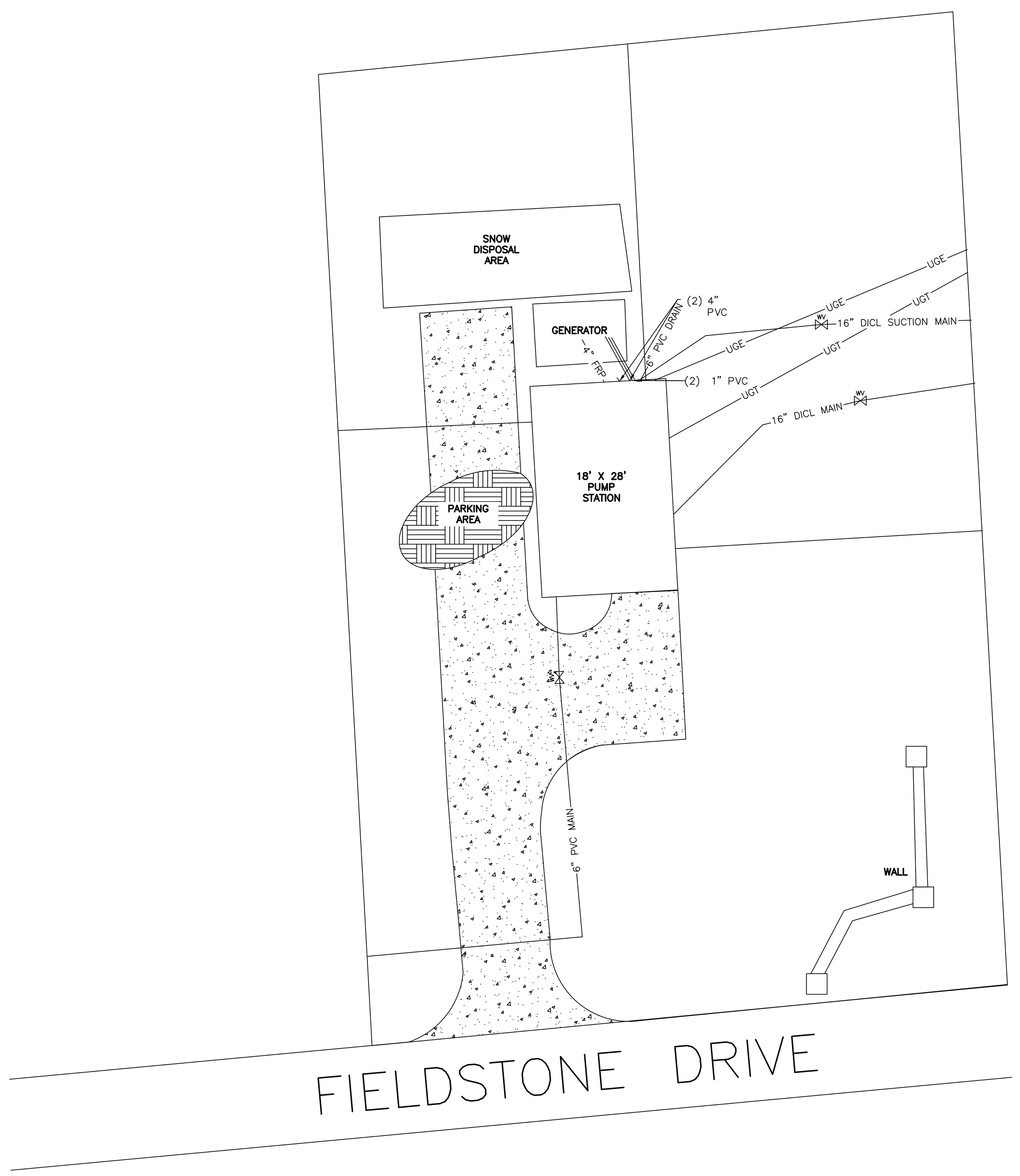


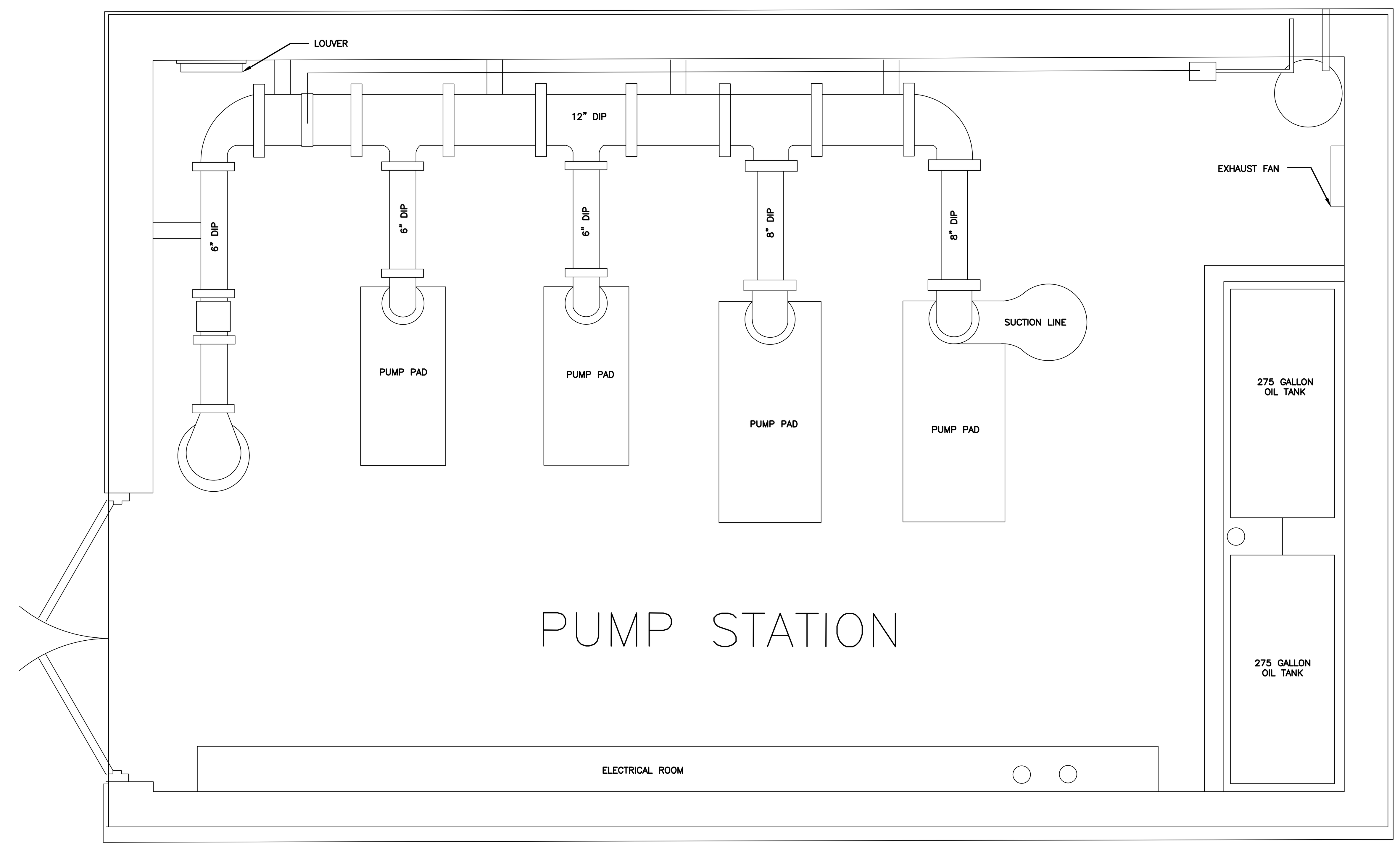
HPC Graphs



Temperature Graphs







EXISTING SITE

Project:
MOUNTAIN HOOD PUMP STATION DESIGN ALTERNATIVES

PENNICHUCK WATER

MOUNTAIN HOME ESTATES
BOOSTER STAION
LONDONDERRY, NH

Weston & Sampson
55 Walkers Brook Drive, Suite 100
Reading, MA 01867
tel: 978-532-1900
westonandsampson.com

Consultants:

Seal:

Revisions:

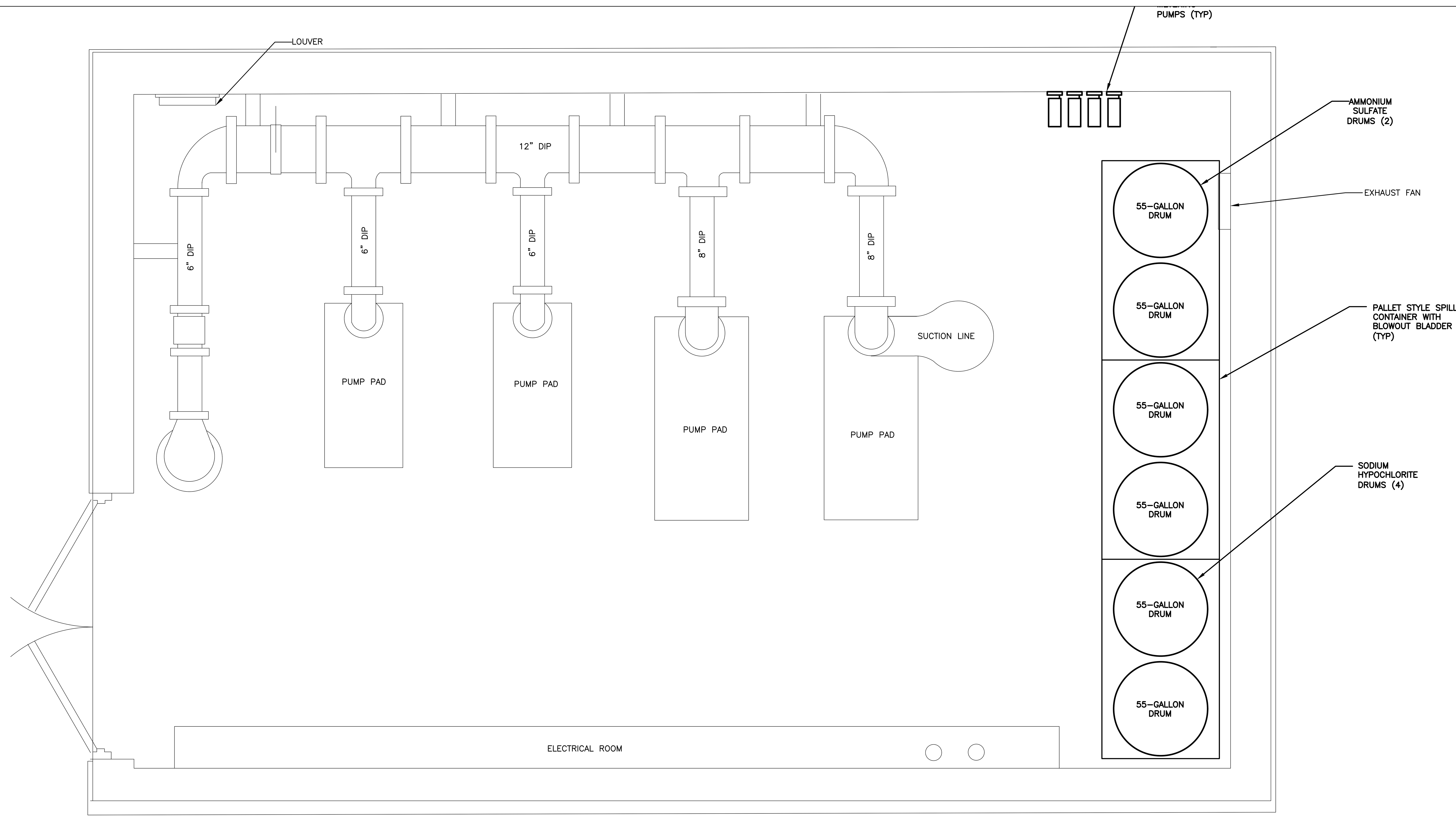
Rev	Date	Description

Issued For: DRAFT

Date:	JULY 20, 2020
Drawn By:	SKF
Reviewed By:	KDH
Approved By:	JCP
W&S Project No:	ENG20-0175

Drawing Title:
EXISTING SITE

Sheet Number:
M-1



OPTION 1 — NO ADDITION

ADVANTAGES

- NO BUILDING ADDITION
- LOWEST CAPITAL COST

DISADVANTAGES

- NO ROOM FOR EMERGENCY SHOWER
- DIFFICULTY MOVING DRUMS ON NARROW PALLETS
- OIL TANKS WOULD NEED TO BE RELOCATED OUTSIDE OF THE BUILDING, PRIVACY SCREEN WOULD BE NEEDED
- NEED TO IDENTIFY WALL SPACE FOR PUMP CONTROL PANELS AND CLEARANCE REQUIREMENTS

Project:

MOUNTAIN HOOD PUMP STATION DESIGN ALTERNATIVES

PENNICHUCK WATER

MOUNTAIN HOME ESTATES BOOSTER STAION LONDONDERRY, NH

Weston & Sampson
55 Walkers Brook Drive, Suite 100
Reading, MA 01867
tel: 978-532-1900
westonandsampson.com

Consultants:

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Issued For: DRAFT

Date: JULY 20, 2020

Drawn By: SKF

Reviewed By: KDH

Approved By: JCP

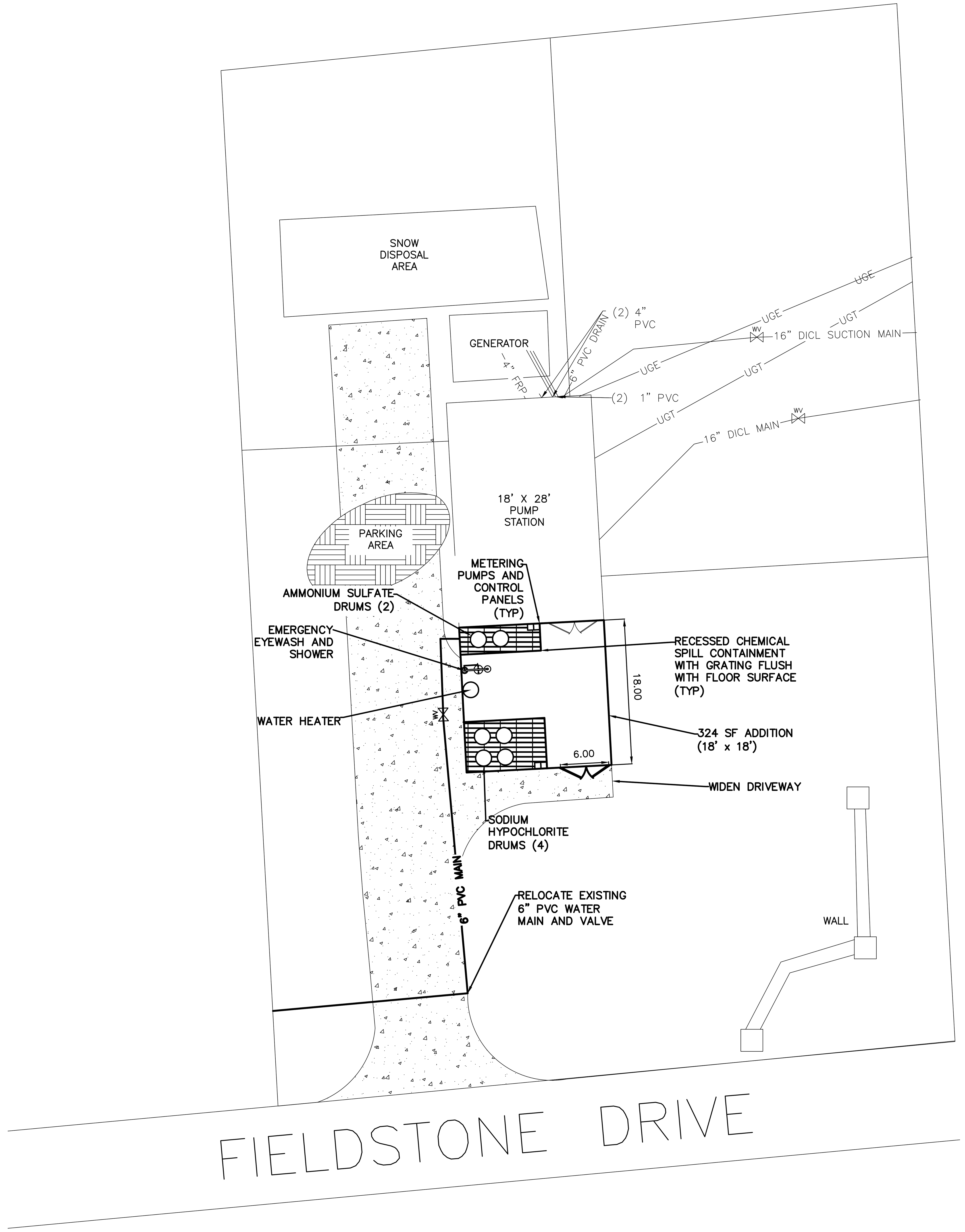
W&S Project No: ENG20-0175

Drawing Title:

ALTERNATIVE DESIGN OPTION 1

Sheet Number:

M-2



OPTION 2 – ADDITION ON FRONT

ADVANTAGES

1. LIMITED IMPACTS TO EXISTING EQUIPMENT
2. AMPLE SPACE FOR NEW EQUIPMENT
3. RECESSED CONTAINMENT HELPS WITH MOVEMENT OF DRUMS

DISADVANTAGES

1. NEED TO BE AWARE OF BUILDING AESTHETICS
2. REDUCES VEHICLE TURNAROUND
3. NEED TO WIDEN DRIVEWAY

Project:
MOUNTAIN HOOD PUMP STATION DESIGN ALTERNATIVES

PENNICHUCK WATER

MOUNTAIN HOME ESTATES
BOOSTER STAION
LONDONDERRY, NH

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Consultants:

Seal:

Revisions:

Rev	Date	Description

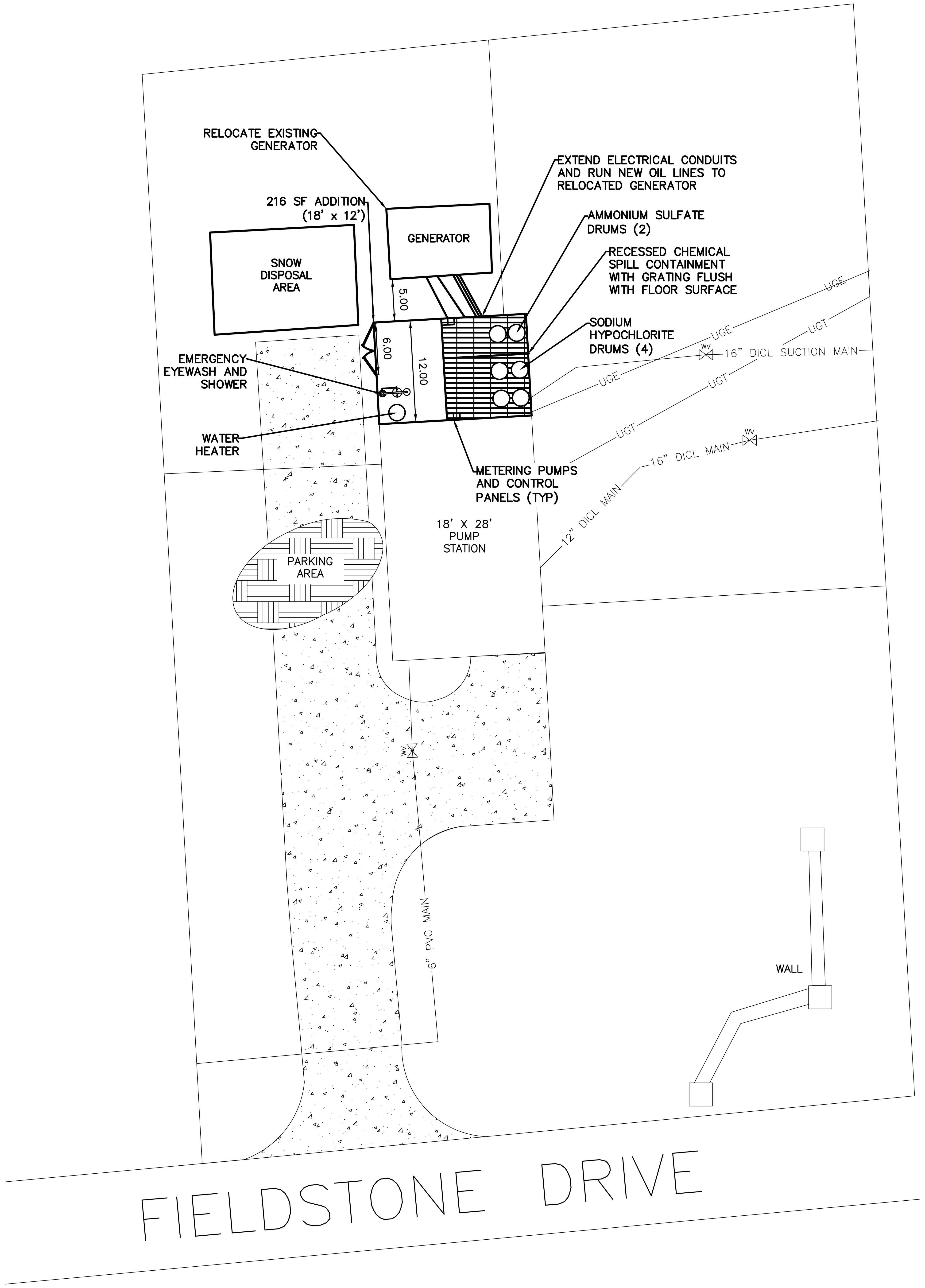
Issued For: DRAFT

Date: JULY 20, 2020
Drawn By: SKF
Reviewed By: KDH
Approved By: JCP
W&S Project No: ENG20-0175

Drawing Title:
ALTERNATIVE DESIGN OPTION 2

Sheet Number:
M-3

\\wse03.local\WSE\Projects\NH\Pennichuck Water\On-Call Engineering\Chloramine Feed Sizing\Pump Station Alternative Designs.dwg

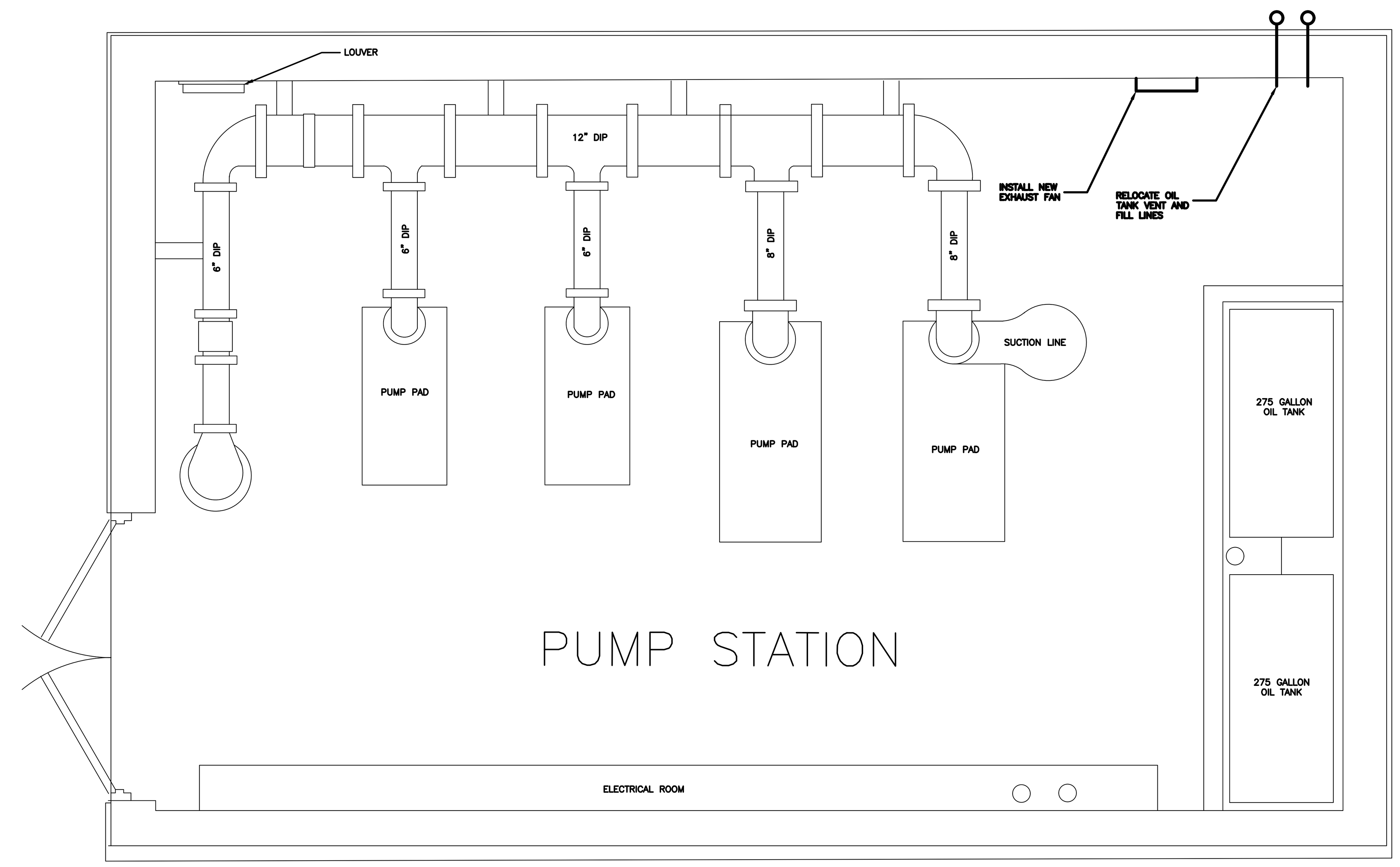


ADVANTAGES

1. SEPARATE ACCESS FROM MAIN ENTRANCE ALLOWS FOR SMALLER FOOTPRINT.
2. AMPLE ROOM FOR NEW EQUIPMENT.
3. RECESSED CONTAINMENT AND FLUSH MOUNTED GRATING ALLOWS FOR EASIER MOVEMENT OF DRUMS.
4. WOULD NOT IMPACT AESTHETICS OF FRONT OF BUILDING.

DISADVANTAGES

1. RELOCATION OR MODIFICATION OF EXISTING GENERATOR, CONDUIT, AND FUEL LINES.
2. ADDITION WILL BE BUILT ON TOP OF EXISTING BURIED PIPING THAT CANNOT BE EASILY RELOCATED.
3. 12' LENGTH OF ADDITION DOES NOT ALLOW FOR WINDOW SPACING IDENTICAL TO EXISTING BUILDING.



OPTION 3 – ADDITION ON BACK

Project:
MOUNTAIN HOOD PUMP STATION DESIGN ALTERNATIVES

PENNICHUCK WATER

MOUNTAIN HOME ESTATES
BOOSTER STAION
LONDONDERRY, NH

Weston & Sampson
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tel: 978-532-1900
westonandsampson.com

Consultants:

Seal:

Revisions:

Rev	Date	Description

Issued For: DRAFT

Date: JULY 20, 2020
Drawn By: SKF
Reviewed By: KDH
Approved By: JCP
W&S Project No: ENG20-0175

Drawing Title:
ALTERNATIVE DESIGN OPTION 3

Sheet Number:
M-4

\\wseb3\local\WSE\Projects\NH\Pennichuck Water\On-Call Engineering\Chloramine Feed Sizing\Pump Station Alternative Designs.dwg