



Delaware River Basin Commission Nitrogen Reduction Cost Estimation Study Addendum Technical Memorandum

To: John Yagecic, P.E.

From: Timothy D. Bradley, P.E.

Date: September 6, 2022

cc: Namsoo Suk, Tom Amidon, Tushar Roy, Erin Dovel

Re: **Nitrogen Reduction Cost Estimation Study Addendum Technical Memorandum**

1.0 Introduction

Kleinfelder, Inc. (Kleinfelder) is pleased to present this Nitrogen Reduction Cost Estimation Study Technical Memorandum as an addendum to the previously completed Nitrogen Reduction Cost Estimation Study Final Summary Report (Nitrogen Reduction Cost Study), DRBC Technical Report No. 2021-1. Recently, the Delaware River Basin Commission (DRBC) received a Docket Modification Application for the Delaware County Regional Water Quality Control Authority (DELCORA) Western Regional Treatment Plant (WRTP) to expand its permitted capacity from 50 mgd to 70 mgd.

This Technical Memorandum presents updated cost estimates, cost graphs, and biochemical oxygen demand (BOD) load reduction estimates for the DELCORA WRTP based on a permitted capacity of 70 mgd. The updated costs will remain in 2019 dollars and can be updated in the future using the Engineering News Record (ENR) construction cost index. Also presented is a data discrepancy correction to the Morrisville Borough Municipal Authority (MA). The Technical Memorandum is arranged into the following sections:

- Section 1.0 – Introduction
- Section 2.0 – Section 6.5.9 Update
- Section 3.0 – Table 7-2 Update
- Section 4.0 – Appendix J Update
- Section 5.0 – Data Correction to the Morrisville Borough MA Cost Estimation
- Section 6.0 – Summary

2.0 Section 6.5.9 Update

This section presents an update of Section 6.5.9 of the Nitrogen Reduction Cost Study. The DELCORA WRTP specific costs are summarized in Table 6-12. The corresponding cost curves, based on total present costs and total annualized costs, follow Table 6-12 as Figures 6-17 and 6-18, respectively.

Table 6-12: DELCORA Plant Specific Cost Estimates

Effluent Level	Present Cost (Million \$, 2019)			Annualized Present Cost (Million \$/year, 2019)		
	Capital	O&M Present Worth	Total Present Worth Cost	Debt Service	Annual O&M	Total
NH ₃ -N - 10 mg/L	48	10	58	3	0.5	4
NH ₃ -N - 5 mg/L	128	50	178	8	2	11
NH ₃ -N - 1.5 mg/L	143	93	235	9	4	14
TN - 4 mg/L	267	197	464	17	9	27

Figure 6-17: DELCORA Plant Specific Total Present Cost Curve

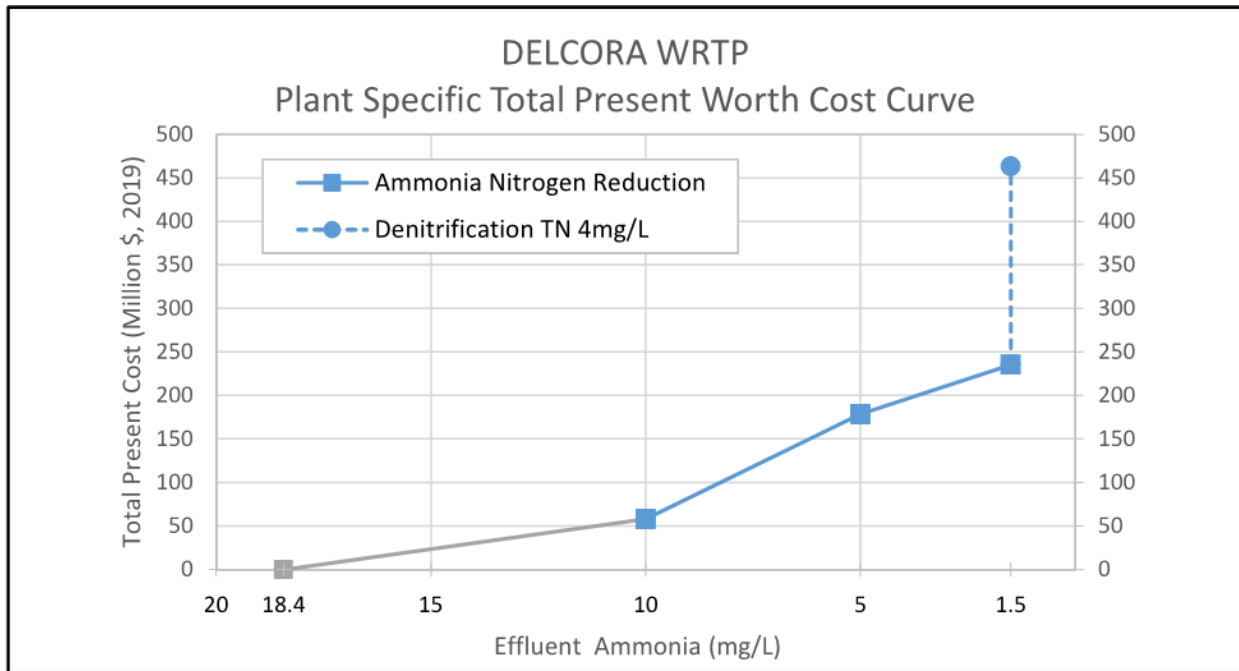
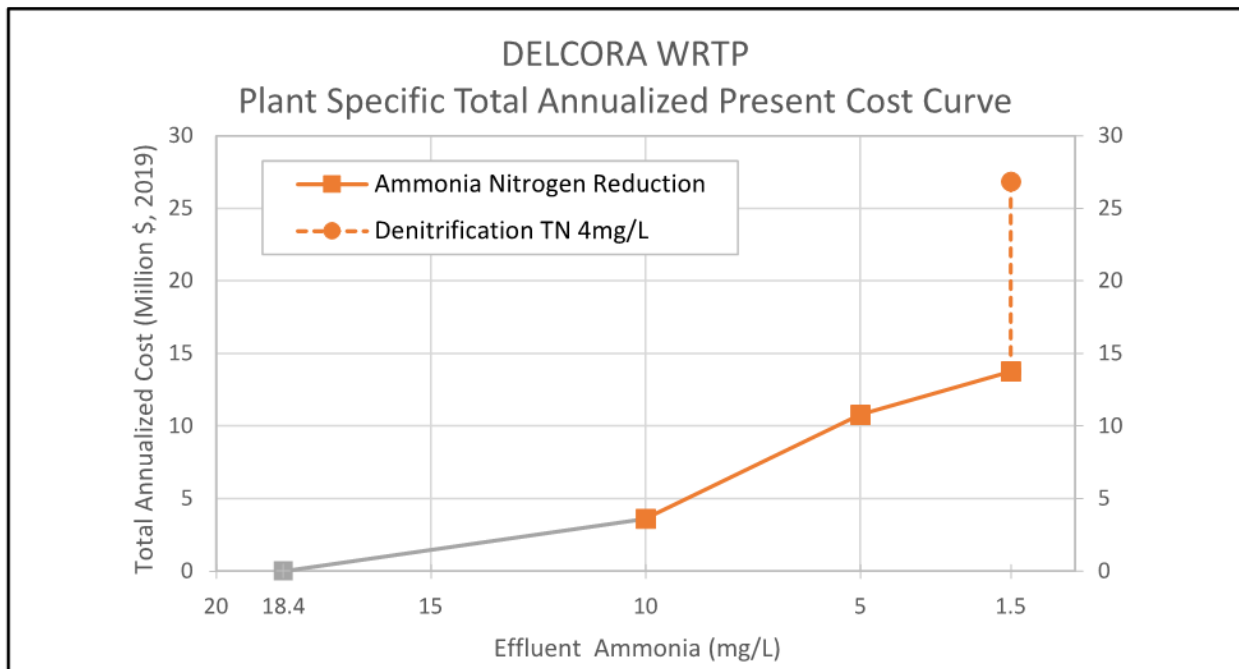


Figure 6-18: DELCORA Plant Specific Total Annual Cost Curve



The site-specific information, issues and factors that served as the basis for the plant specific costs presented in the DELCORA plant specific cost summary table are based upon the following factors:

- A requested permitted capacity of 70 mgd and corresponding maximum average monthly flow of 86 mgd.
- A maximum monthly summer average effluent ammonia concentration of 18.43 mg/L is approximately the same strength as the generic conventional activated sludge plant's maximum monthly summer average effluent ammonia concentration. As a result, and because the DELCORA WRTP is also currently operating at a mixed liquor suspended solids (MLSS) concentration of approximately 3,000 mg/L consistent with the MLSS concentration of the generic conventional activated sludge plant, the improvements for the DELCORA plant to achieve each effluent level will be the same as the generic conventional activated sludge plant, i.e., additional final clarifiers, increased process air capacity and return activated sludge (RAS) pumping improvements for the 10 mg/L effluent ammonia level and integrated fixed-film activated sludge (IFAS) for the 5 mg/L and 1.5 mg/l. effluent levels.
- Additional final clarifier surface area is required at a requested permitted capacity of 70 mgd.
- Groundwater will be encountered at a depth of approximately 10 ft. with dewatering required for major structures (assuming well point dewatering).
- Pile-supported foundations are required for all new structures.
- Sheet piling is required for all structure excavation.
- Reduction in productivity factor due to confined work area.

3.0 Table 7-2 Update

The following Table 7-2 presents an update to the anticipated BOD reduction for the DELCORA WRTP at a permitted flow of 70 mgd.

Table 7-2: Plant Specific Summary of Anticipated BOD Reduction

	DELCORA WRTP
Design Flow (MGD)	70
Average Annual Effluent BOD 2016-2018 (mg/l)	8.53
Portion of Flow Sent to BAF (if applicable)	
Nh3-N - 10 mg/l	N/A
Nh3-N - 5 mg/l	N/A
Nh3-N - 1.5 mg/l	N/A
Nh3-N - 1.5 mg/l , TN - 4 mg/l	N/A
BOD after Improvements (mg/l)	
Nh3-N - 10 mg/l	7.53
Nh3-N - 5 mg/l	6.53
Nh3-N - 1.5 mg/l	5.53
Nh3-N - 1.5 mg/l , TN - 4 mg/l	3.00
BOD Reduction (Effluent BOD - Improvements BOD, mg/l)	
Nh3-N - 10 mg/l	1.00
Nh3-N - 5 mg/l	2.00
Nh3-N - 1.5 mg/l	3.00
Nh3-N - 1.5 mg/l , TN - 4 mg/l	5.53
BOD Load Reduction (lbs/day)	
Nh3-N - 10 mg/l	584
Nh3-N - 5 mg/l	1,168
Nh3-N - 1.5 mg/l	1,751
Nh3-N - 1.5 mg/l , TN - 4 mg/l	3,230

4.0 Appendix J Update

This section presents an update to Appendix J of the Nitrogen Reduction Cost Study. Breakdowns of capital and operation and maintenance (O&M) costs for each effluent level are presented below along with two (2) conceptual aerial site plans, the first depicting the size and conceptual location of major new structures to achieve a 1.5 mg/L effluent NH₃-N concentration and the second depicting the size and location of major new structures to achieve the 4 mg/L effluent total nitrogen (TN) concentration.

DRBC Nitrogen Reduction Cost Estimation Study

DELCORA

Effluent Level: NH₃-N = 10 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 35,000,000
<i>subtotal</i>	\$ 35,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 70 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 18.43 mg/L	
Final Clarifier required footprint increase from generic plant	\$ 1,682,850
<i>subtotal</i>	\$ 36,682,850
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 6,579,360
Rock Excavation	\$ -
Sheeting during Construction	\$ 2,028,636
Construction Dewatering	\$ 493,452
Land Acquisition	\$ -
<i>subtotal</i>	\$ 9,101,448
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 2,060,293
TOTAL PRESENT WORTH CAPITAL COST	47,845,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ -
Additional chemical costs	\$ 3,249
Additional energy costs	\$ 375,280
Additional sludge disposal costs	\$ 75,740
Additional maintenance costs	\$ 40,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 494,000
TOTAL PRESENT WORTH O&M COSTS	\$ 10,235,000
GRAND TOTAL PRESENT WORTH COST	\$ 58,080,000

¹See Generic Plant Capital Cost Estimates Technical Memorandum

²For plant specific costs not included in generic plant capital cost estimates

³For generic plant costs not required in plant-specific cost estimate

DRBC Nitrogen Reduction Cost Estimation Study

DELCORA

Effluent Level: NH3-N = 5 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 112,000,000
<i>subtotal</i>	\$ 112,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 70 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 18.43 mg/L	
Final Clarifier required footprint increase from generic plant	\$ 1,682,850
<i>subtotal</i>	\$ 113,682,850
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 6,579,360
Rock Excavation	\$ -
Sheeting during Construction	\$ 2,028,636
Construction Dewatering	\$ 493,452
Land Acquisition	\$ -
<i>subtotal</i>	\$ 9,101,448
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 5,525,293
TOTAL PRESENT WORTH CAPITAL COST	<i>128,310,000</i>
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 88,000
Additional chemical costs	\$ 1,501,520
Additional energy costs	\$ 514,873
Additional sludge disposal costs	\$ 107,299
Additional maintenance costs	\$ 188,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 2,400,000
TOTAL PRESENT WORTH O&M COSTS	\$ 49,727,000
GRAND TOTAL PRESENT WORTH COST	\$ 178,037,000

¹See Generic Plant Capital Cost Estimates Technical Memorandum

²For plant specific costs not included in generic plant capital cost estimates

³For generic plant costs not required in plant-specific cost estimate

DRBC Nitrogen Reduction Cost Estimation Study

DELCORA

Effluent Level: NH3-N = 1.5 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 126,000,000
<i>subtotal</i>	\$ 126,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 70 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 18.43 mg/L	
Final Clarifier required footprint increase from generic plant	\$ 1,682,850
<i>subtotal</i>	\$ 127,682,850
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 6,579,360
Rock Excavation	\$ -
Sheeting during Construction	\$ 2,028,636
Construction Dewatering	\$ 493,452
Land Acquisition	\$ -
<i>subtotal</i>	\$ 9,101,448
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 6,155,293
TOTAL PRESENT WORTH CAPITAL COST	142,940,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 88,000
Additional chemical costs	\$ 3,248,872
Additional energy costs	\$ 765,517
Additional sludge disposal costs	\$ 129,390
Additional maintenance costs	\$ 233,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 4,465,000
TOTAL PRESENT WORTH O&M COSTS	\$ 92,513,000
GRAND TOTAL PRESENT WORTH COST	\$ 235,453,000

¹See Generic Plant Capital Cost Estimates Technical Memorandum

²For plant specific costs not included in generic plant capital cost estimates

³For generic plant costs not required in plant-specific cost estimate

DRBC Nitrogen Reduction Cost Estimation Study

DELCORA

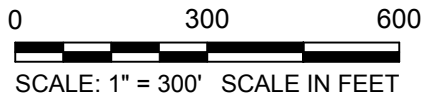
Effluent Level: NH₃-N = 1.5 mg/L and TN = 4.0 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 238,000,000
<i>subtotal</i>	\$ 238,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 70 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 18.43 mg/L	
Final Clarifier required footprint increase from generic plant	\$ 1,682,850
<i>subtotal</i>	\$ 239,682,850
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 11,379,360
Rock Excavation	\$ -
Sheeting during Construction	\$ 3,508,636
Construction Dewatering	\$ 853,452
Land Acquisition	\$ -
<i>subtotal</i>	\$ 15,741,448
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 11,494,093
TOTAL PRESENT WORTH CAPITAL COST	266,918,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 264,000
Additional chemical costs	\$ 5,838,872
Additional energy costs	\$ 1,502,190
Additional sludge disposal costs	\$ 1,433,936
Additional maintenance costs	\$ 452,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 9,491,000
TOTAL PRESENT WORTH O&M COSTS	\$ 196,650,000
GRAND TOTAL PRESENT WORTH COST	\$ 463,568,000

¹See Generic Plant Capital Cost Estimates Technical Memorandum

²For plant specific costs not included in generic plant capital cost estimates

³For generic plant costs not required in plant-specific cost estimate



PROJECT NO. 6736
DRAWN BY: ELD
CHECKED BY: TDB
DATE: 05-20-2020
REVISED: 08-16-2022

DELCORA WRTP
CONCEPTUAL SITE PLAN
NH3-N = 1.5 mg/l

NITROGEN REDUCTION
COST ESTIMATION STUDY
DELAWARE RIVER BASIN COMMISSION

FIGURE
J-1

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0 300 600
 SCALE: 1" = 300' SCALE IN FEET

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PROJECT NO. 6736
 DRAWN BY: ELD
 CHECKED BY: TDB
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DELCORA W RTP
 CONCEPTUAL SITE PLAN
 NH3-N = 1.5 mg/l & TN = 4.0 mg/l

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE
 J-2

5.0 Data Correction to the Morrisville Borough MA Cost Estimation

During the public review period after issuance of the draft Nitrogen Reduction Cost Study, a comment was received indicating that revised maximum monthly summer average ammonia for the Morrisville MA is 11.69 mg/L. Kleinfelder relied on a maximum monthly summer average ammonia of 21.0 mg/L, obtained from the Pennsylvania Department of Environmental Protection's (PADEP's) Electronic Discharge Monitoring Reports (EDMRs). After reviewing this public comment and cost implications, Kleinfelder continued to use the ammonia value of 21.0 mg/L for the purposes of the study.

Subsequently, the final Nitrogen Reduction Cost Study erroneously reported a maximum monthly summer average ammonia of 11.69 mg/L in Appendix A, and instead should reflect a maximum monthly summer average ammonia of 21.0 mg/L, on which all cost calculations are based.

6.0 Summary

This Technical Memorandum is an addendum to the Nitrogen Reduction Cost Study, specifically to assess the costs of the DELCORA WRTP at a requested permitted flow of 70 mgd and corresponding maximum monthly flow of 86 mgd. This addendum should be used to supplement the information presented in the Nitrogen Reduction Cost Study, DRBC Technical Report No. 2021-1.