



Technical Memorandum - Draft

To: John R. Yagecic, P.E.

From: Timothy D. Bradley, P.E.

Date: May 22, 2020

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

Re: Nitrogen Reduction Cost Estimation Study
Plant Specific Cost Estimates

1.0 INTRODUCTION

This draft Technical Memorandum presents the plant specific cost estimates and corresponding cost curves for achieving the three (3) agreed upon effluent levels for ammonia nitrogen ($\text{NH}_3\text{-N}$) reduction and the one (1) agreed upon effluent level for total nitrogen (TN) at the twelve (12) plants listed below by plant type that discharge to the lower Delaware River.

Conventional Activated Sludge

- City of Wilmington
- Delaware County Regional Water Authority Western Regional Treatment Plant (DELCORA)
- Gloucester County Utilities Authority (GCUA)
- Philadelphia Water Department Southeast WPCP (PWD SEWPCP)
- PWD Northeast WPCP (PWD NEWPCP)
- Lower Bucks County Joint Municipal Authority (LBCJMA)

Pure Oxygen Activated Sludge

- PWD Southwest WPCP (PWD SWWPCP)
- Delaware #1 WPCP / Camden County Municipal Utilities Authority (CCMUA)
- Morrisville Borough Municipal Authority (MMA)

Fixed Film

- Trenton Sewer Utility
- Willingboro MUA Water Pollution Control Plant (Willingboro MUA)
- Hamilton Township Water Pollution Control Facility (Hamilton Township)

Plant specific cost estimates were developed through a two-step process beginning with preparation of generic plant capital cost estimates for the agreed upon technologies to achieve the agreed upon effluent levels for the three (3) generic plants as presented in the Generic Plant Capital Cost Estimates Technical Memorandum dated October 25, 2019. The three (3) generic plants reflect the average conditions of the individual plants within the three categories of plant types, i.e., Conventional Activated Sludge, Pure Oxygen Activated Sludge, and Fixed Film.

A summary of the agreed upon technologies and effluent levels for the three (3) generic plants is presented in Table 1 and a summary of the generic plant capital cost estimates and the corresponding capital cost on a \$/gpd of capacity basis are presented in Table 2.

Table 1: Final Technology and Effluent Level Recommendations

Effluent Level	Generic Conventional Activated Sludge Plant	Generic Pure Oxygen Activated Sludge Plant	Generic Fixed Film (RBC and TF) Plant
NH ₃ -N – 10 mg/L	Replace process air system, construct additional final clarifiers and modify RAS system	Add downstream BAF sized for approximately 50% of plant flow	Add downstream BAF sized for approximately 45% of plant flow
NH ₃ -N – 5 mg/L	Conversion to IFAS with medium level of media addition to aeration tanks	Add downstream BAF sized for approximately 75% of plant flow	Add downstream BAF sized for approximately 70% of plant flow
NH ₃ -N – 1.5 mg/L	Conversion to IFAS with high level of media addition to aeration tanks	Add downstream BAF sized for 100% of plant flow	Add downstream BAF sized for 100% of plant flow
TN – 4 mg/L	Conversion to IFAS with high level of media addition plus downstream DF	Add downstream BAF sized for 100% of plant flow plus DF	Add downstream BAF sized for 100% of plant flow plus DF

BAF = biological aerated filter

IFAS = integrated fixed film activated sludge

DF = denitrification filter

RAS = return activated sludge

Table 2: Summary of Generic Plant Capital Costs

Effluent Level	Capital Cost Estimate	\$/gpd of capacity
Generic Pure Oxygen Activated Sludge Plant (Avg Flow: 83 mgd)		
NH ₃ -N = 10 mg/L	\$80 million	1.0
NH ₃ -N = 5 mg/L	\$105 million	1.3
NH ₃ -N = 1.5 mg/L	\$134 million	1.6
TN = 4 mg/L	\$336 million	4.0
Generic Fixed Film Plant (Avg Flow: 9 mgd)		
NH ₃ -N = 10 mg/L	\$23 million	2.5
NH ₃ -N = 5 mg/L	\$28 million	3.1
NH ₃ -N = 1.5 mg/L	\$33 million	3.7
TN = 4 mg/L	\$57 million	6.3

Generic Conventional Activated Sludge Plant (Avg Flow: 72 mgd)		
NH ₃ -N = 10 mg/L	\$35 million	0.5
NH ₃ -N = 5 mg/L	\$113 million	1.6
NH ₃ -N = 1.5 mg/L	\$130 million	1.8
TN = 4 mg/L	\$243 million	3.4

The generic plant capital cost estimates on a \$/gpd of capacity basis for each effluent level were used as the starting point to develop the plant specific capital cost estimates. Adjustments were made as appropriate based on significant differences in flow and current performance between the generic plant and the specific plant. Additional capital costs were then added as appropriate based on the specific plant's issues, constraints, and needs, such as the need for pile foundations, sheeting, dewatering, rock excavation, purchase of additional land and reduced construction productivity on confined sites. Similarly, cost deductions were applied when a specific plant was already achieving one or more of the effluent levels.

As further described in the Effluent Levels Technical Memorandum dated July 19, 2019, the plant upgrade improvements were sized to achieve the effluent levels each month of the summer season defined as May 1 through October 31, rather than each month of the year. Therefore, the improvements for each effluent level are sized for the maximum monthly average (i.e., maximum 30-day average flow) corresponding to the annual average flow and are sized for the minimum temperature that occurs in the summer season rather than the minimum temperature that occurs in the winter.

A summary of key plant data is presented in Appendix A.

As further described in the Generic Plant Capital Cost Estimates Technical Memorandum dated October 25, 2019, the generic plant cost estimates are consistent with the American Association of Cost Estimating (AACE) Level 4 estimate, which is the appropriate level for the study phase of a project. Therefore, the generic plant capital cost estimates are budgetary estimates with an accuracy of +/- 30%.

The generic plant capital cost estimates are in 2019 dollars corresponding to an Engineering News Record (ENR) Twenty City Cost Index of 11311. This index can be used in the future to update the budgetary 2019 costs due to the inflation of construction costs between 2019 and the future date. Because the plant specific cost estimates are largely based on the generic plant capital cost estimates, they should also be viewed as budgetary capital cost estimates in 2019 dollars corresponding to an Engineering News Record (ENR) Twenty City Cost Index of 11311.

Plant specific operations and maintenance (O&M) cost estimates were also developed, as further described below, along with the resulting total present costs and total annualized costs. The plant specific total present cost is the sum of the plant specific capital cost plus the present worth of annual O&M costs (in 2020 dollars). Plant specific total annualized costs is the sum of the annual debt service cost (associated with amortization of capital costs) plus annual O&M costs.

Plant specific cost curves show the relationship between effluent level and the total present costs and between effluent level and total annualized costs.

2.0 PLANT SPECIFIC CAPITAL COST ADJUSTMENT FACTORS

The following unit costs not included in the generic plant capital cost estimates were developed for use in adjusting the plant specific capital cost estimates where appropriate based on site specific information. The unit costs include percentages for contractor overhead and profit and contingency, as applicable.

- Pile Foundations – \$120/SF
- Rock Excavation – \$200/CY
- Sheet piling – \$37/SF
- Dewatering setup and operation - \$9/SF (assuming a 2-year dewatering period)
- Productivity reduction factor for confined sites – 4.5% of total construction costs
- Land Acquisition:
 - Low value - \$30/SF
 - High value - \$150/SF

Unit costs for pile foundations, rock excavation, sheet piling, and dewatering were estimated from RS Means construction estimating information and from actual costs of recently completed projects. An upper and lower range of land values was estimated from assessments of adjacent land values at each of the twelve (12) plants.

3.0 OPERATIONS AND MAINTENANCE COST ESTIMATION METHODOLOGY

Plant specific annual O&M cost estimates for each level of nutrient removal upgrade incorporate the following categories of O&M costs:

- Additional Staffing Needs
- Chemicals
- Energy
- Sludge Processing and Disposal
- Maintenance

The assumptions and methodology related to each O&M cost category are presented below.

3.1 ADDITIONAL STAFFING

The anticipated number of additional full-time staff for each level of upgrade for the pure oxygen, fixed film, and conventional activated sludge plants are summarized in Tables 3, 4, and 5, respectively.

Table 3: Anticipated Additional Staff Needs for Pure Oxygen Plants

Scenario	Pure Oxygen Plants		
	MMA	PWD SWWPCP	CCMUA
NH₃-N – 10 mg/L			
Operator	1	2	1
Maintenance	0	1	1
NH₃-N – 5 mg/L			
Operator	1	2	1
Maintenance	0	1	1
NH₃-N – 1.5 mg/L			
Operator	1	2	1
Maintenance	1	2	1
NH₃-N – 1.5 mg/L and TN – 4.0 mg/L			
Operator	1	3	2
Maintenance	1	2	1

Table 4: Anticipated Additional Staff Needs for Fixed Film Plants

Scenario	Fixed Film Plants		
	Trenton Sewer Utility	Hamilton Township WPCF	Willingboro MUA WPCP
NH₃-N – 10 mg/L			
Operator	0	1	0
Maintenance	0	0	0
NH₃-N – 5 mg/L			
Operator	1	1	0
Maintenance	0	0	0
NH₃-N – 1.5 mg/L			
Operator	1	1	1
Maintenance	1	1	0
NH₃-N – 1.5 mg/L and TN – 4.0 mg/L			
Operator	1	1	1
Maintenance	1	1	0

Table 5: Anticipated Additional Staff Needs for Conventional Activated Sludge Plants

Scenario	Pure Oxygen Plants					
	PWD NEWPCP	Wilmington	DELCORA W RTP	GCUA	LBCJMA	PWD SEWPCP
NH₃-N – 10 mg/L						
Operator	0	0	0	0	0	1
Maintenance	0	0	0	0	0	1
NH₃-N – 5 mg/L						
Operator	1	1	1	0	0	1
Maintenance		1	0	0	0	1
NH₃-N – 1.5 mg/L						
Operator	2	1	0	0	0	1
Maintenance	1	1	0	0	0	1
NH₃-N – 1.5 mg/L and TN – 4.0 mg/L						
Operator	3	2	2	1	1	2
Maintenance	2	2	1	1	1	1

A total salary cost (salary plus fringe benefits) of \$88,000 per year per additional plant staff was utilized based on a survey of position postings in New Jersey, Eastern Pennsylvania and

Northern Delaware, indicating a salary (excluding fringe benefits) of \$55,000 to which was added 60% for fringe benefits.

3.2 CHEMICALS

Chemical costs were estimated based on the following assumptions:

- Alkalinity addition to nitrifying systems utilizing magnesium hydroxide as the external source of alkalinity.
- Carbon addition to denitrifying systems utilizing methanol as the external carbon source.
- Additional polymer consumption for processing additional sludge produced by higher levels of treatment.

Magnesium hydroxide demand was calculated based on an alkalinity consumption of 7.14 lbs per pound of $\text{NH}_3\text{-N}$ nitrified. A unit cost of \$625 per ton was assumed delivered as a minimum 55% (w/w) solution with 98% magnesium content. Methanol demand was calculated based on a dose of 3.5 lbs per pound of nitrate denitrified in the denitrifying filters. A methanol cost of \$1.15/gal was assumed. For each of the sludge thickening and dewatering unit processes, polymer consumption was assumed to be 12 pounds per ton of dry solids. A polymer cost of \$1.5 per pound was assumed.

3.3 ENERGY

Energy consumption, on a horsepower (hp) per mgd basis, was developed for each of the following plant components:

- IFAS system process air blowers - 80 hp/mgd.
- BAF system feed pumps - 15 hp/mgd.
- Denitrification (Denite) Filter feed pumps - 12 hp/mgd.
- BAF system blowers (rotary lobe for flows up to 20 mgd) – 25 hp/mgd
- BAF system blowers (turbo blowers for flow greater than 20 mgd) – 16.4 hp/mgd.
- BAF backwash return pumps (for flows up to 20 mgd) – 1 hp/mgd.
- BAF backwash return pumps (for flows greater than 20 mgd) – 1.5 hp/mgd.
- Magnesium hydroxide feed system (for flows up to 20 mgd) – 0.5 hp/mgd.
- Magnesium hydroxide feed system (for flows greater than 20 mgd) – 1 hp/mgd.
- Methanol feed system (for flows up to 20 mgd) – 0.5 mgd.
- Methanol feed system (for flows greater than 20 mgd) – 1 hp/mgd.
- (Denite filter backwash air blower (for flows less than 20 mgd) – 16 hp/mgd.

- Denite filter backwash air blower (for flows greater than 20 mgd) – 14 hp/mgd.
- Denite filter backwash pump (for flows less than 20 mgd) – 4 hp/mgd.
- Denite filter backwash pump (for flows greater than 20 mgd) – 1 hp/mgd.
- Denite filter mudwell pump (for flows less than 20 mgd) – 0.6 hp/mgd.
- Denite filter mudwell pump (for flows greater than 20 mgd) – 0.3 hp/mgd.
- Allowance for miscellaneous buildings (HVAC and lighting), site lighting, valve actuators, etc. – 10% of total additional hp.

Based on the plant specific average flow, the total hp was calculated using the hp-per-mgd power consumption factors. The corresponding total annual energy cost was then calculated based on an assumed energy cost of \$0.08 per KWHr, inclusive of demand charges.

3.4 SLUDGE PROCESSING AND DISPOSAL

The impact of each upgrade scenario on sludge production was evaluated based on the following assumptions:

- Additional TSS removed through the various filter technologies is based on the difference between current average plant effluent TSS and effluent TSS associated with the specific treatment technology used.
- For nitrification using the BAF process, effluent TSS was assumed to be 10 mg/l.
- For denitrification filters, effluent TSS was assumed to be 5 mg/l.
- For conventional activated sludge plants:
 - Additional waste activated sludge from removal of additional BOD in the IFAS system is based on a VSS yield of 0.6 pounds per pound of soluble BOD removed, and a corresponding TSS yield based on 85% VSS. The effluent SBOD from a nitrifying IFAS system assumed to be 1 mg/L.
 - Biological growth in denitrification filters attributable to carbon (methanol) addition is assumed to be 0.18 pounds of VSS produced per pound of COD applied, based on 1.5 lb COD per pound of methanol added for denitrification. The VSS assumed to be 85% of TSS.
- In pure oxygen activated sludge and trickling filter plants:
 - Additional waste sludge from removal of additional soluble BOD in nitrifying BAF is based on a VSS yield of 0.6 pounds per pound of soluble BOD removed, and a corresponding TSS yield based on 85% VSS. The SBOD to BAF is assumed to be equal to the effluent total BOD, minus the particulate BOD, which is assumed

to be equal to 60% of the effluent TSS. The SBOD from nitrifying BAF is assumed to be 1 mg/L.

- Sludge yield in the BAF nitrification filter was assumed to be 0.12 lb of VSS per pound of ammonia nitrogen oxidized. The VSS assumed to be 85% of TSS.
- Growth in denitrification filter attributable to carbon (methanol) addition is assumed to be 0.18 pounds of VSS produced per pound of COD applied, based on 1.5 lb COD per pound of methanol added for denitrification. The VSS assumed to be 85% of TSS.
- Backwash water produced from BAF and Denite filters is assumed to be returned to head of the plant. TSS associated with the backwash water was assumed to settle in primary clarifiers.
- Primary sludge and thickened sludge solids concentrations were assumed to be 5%.
- Aerobic or anaerobic sludge digestion process, where applicable, was assumed to reduce volatile solids by 50%.
- Dewatering operation was assumed to produce sludge cake with 20% total solids (TS) concentration for offsite disposal.

The cost to dispose of the additional sludge produced is based on the following assumptions:

- Transportation and disposal fees of \$0.08/gal for thickened sludge.
- Transportation and disposal fees of \$90/wet ton for sludge cake.
- Transportation and disposal fees of \$80/ton for dried biosolids.

The cost of polymer to thicken and dewater the additional sludge was calculated and included as a chemical cost.

3.5 MAINTENANCE

An annual maintenance cost for consumables (oil, grease, etc.), and scheduled replacement of component parts, etc. is calculated based on 1% of total direct capital material costs.

4.0 PRESENT WORTH, PRESENT COST, ANNUALIZED PRESENT COST ESTIMATING METHODOLOGY

The present worth of annual operating costs is calculated assuming a 25-year operating period, an interest rate of 5% and an inflation rate of 2.5%, resulting in a discount rate of 1.5% (5% minus 3.5%). Based on $i = 1.5\%$ and $n = 25$ years, the uniform series present worth factor is 20.7, therefore, the present worth of the O&M costs are 20.7 times the annual O&M costs.

The total present cost is equal to the sum of the plant specific capital costs plus the present worth of annual O&M costs.

The total annualized cost is the sum of the debt service corresponding to the plant specific capital cost plus the annual operations and maintenance cost. Debt service on capital cost assumes a bond term of 30 years at an interest rate of 5%.

5.0 PLANT SPECIFIC COST ESTIMATE SUMMARIES AND COST CURVES

This section summarizes the plant specific capital cost, total present cost (capital plus present worth of annual O&M costs), and total annualized cost (annual debt service cost plus annual O&M cost) to achieve the three (3) effluent levels for $\text{NH}_3\text{-N}$ reduction and the one (1) effluent level for TN at each plant. Also included are the resulting cost curves for total present costs and for total annualized cost. A summary of the site-specific issue and factors that served as the basis for the plant specific costs are also described.

All plant specific costs are in 2019 dollars corresponding to an Engineering News Record (ENR) Twenty City Cost Index of 11311.

The plants are in order of flow capacity within each category of plant type beginning with the pure oxygen activated sludge plants.

PURE OXYGEN ACTIVATED SLUDGE PLANTS

5.1 MORRISVILLE MUNICIPAL AUTHORITY

MMA's plant specific costs are summarized in Table 6. The corresponding cost curves, based on total present costs and total annualized costs follow Table 6 as Figures 1 and 2, respectively. Breakdowns of capital and O&M cost for each effluent level are presented in Appendix B 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 $\text{NH}_3\text{-N}$ concentration and the second depicting the size and location of major new structures to achieve the 4 mg/l effluent TN concentration.

Table 6: MMA Plant Specific Cost Estimates

Effluent Level	Present Cost (Million \$, 2019)			Annualized Present Cost (Million \$/year, 2019)		
Scenario	Capital	O&M Present Worth	Total Present Worth Cost	Debt Service	Annual O&M	Total
NH ₃ -N - 10 mg/L	25	9	34	2	0.4	2
NH ₃ -N - 5 mg/L	28	12	40	2	1	2
NH ₃ -N - 1.5 mg/L	31	16	46	2	1	3
TN - 4 mg/L	55	28	83	4	1	5

Figure 1: MMA Plant Specific Total Present Cost Curve

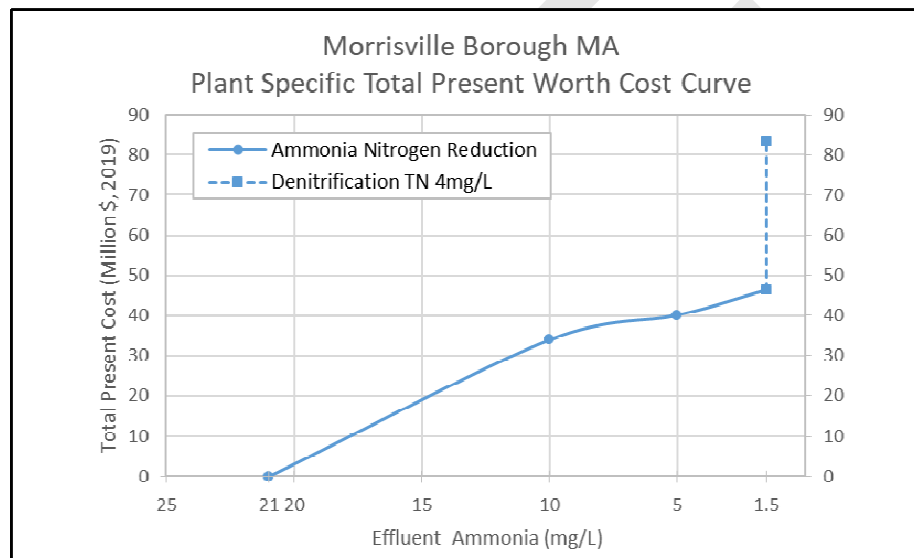
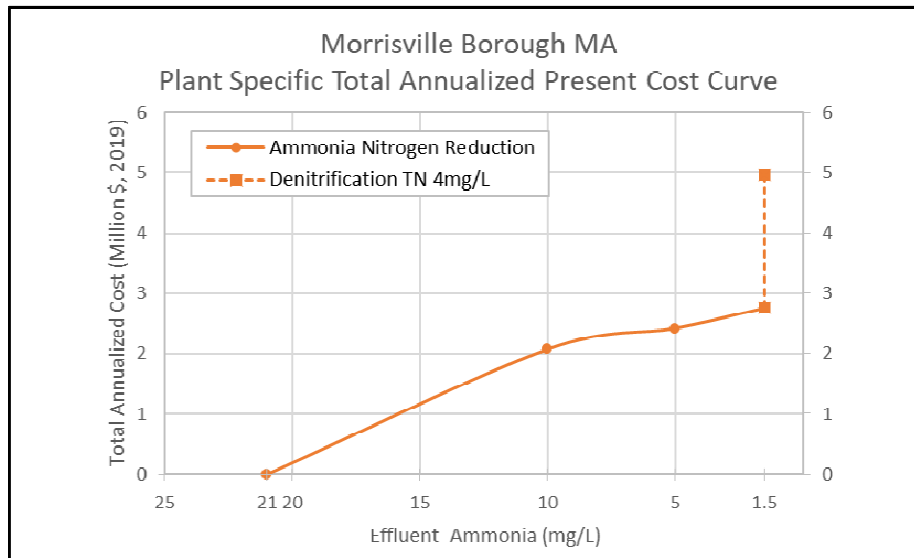


Figure 2: MMA Plant Specific Total Annual Cost Curve



The MMA site-specific information, issues and factors that served as the basis for the plant specific costs and resulting cost curves are listed below.

PERMITTED CAPACITY: 8.70 MGD
2018 ANNUAL AVG FLOW: 5.98 MGD
2016-2018 MAXIMUM MONTHLY FLOW: 7.77 MGD

- Because the permitted capacity of 8.7 mgd exceeds the 2018 maximum monthly average flow of 7.77 mgd, the permitted capacity was conservatively used to size the improvements.
- A maximum monthly summer average ammonia concentration of 21.0 mg/l which is lower in strength than the generic plant's maximum monthly average concentration.
- The effluent flow rate requiring BAF treatment to achieve the targeted effluent ammonia concentrations by blending with non-BAF treated secondary effluent as summarized below.
-

NH ₃ -N Treatment Level	Flow (mgd) to be treated by BAF
10 mg/L	4.9
5 mg/L	7.2
1.5 mg/L	8.7

- All major structures (BAF building, denitrification building, and associated pump stations) will be constructed to a depth of approximately 20 ft.
- Groundwater will be encountered at a depth of approximately 10 ft, with dewatering required for major structures (assuming well point dewatering).
- Pile supported foundations will be required for all new structures.
- Sheet piling will be required for all structure excavation.
- No reduction in productivity factor due to confined work area.

5.2 CCMUA

CCMUA's plant specific costs are summarized in Table 7. The corresponding cost curves, based on total present costs and total annualized costs follow Table 7 as Figures 3 and 4, respectively. Breakdowns of capital and O&M cost for each effluent level are presented in Appendix C 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 $\text{NH}_3\text{-N}$ concentration and the second depicting the size and location of major new structures to achieve the 4 mg/l effluent TN concentration.

Table 7: CCMUA Plant Specific Cost Estimates

Effluent Level	Present Cost (Million \$, 2019)			Annualized Present Cost (Million \$/year, 2019)		
Scenario	Capital	O&M Present Worth	Total Present Worth Cost	Debt Service	Annual O&M	Total
$\text{NH}_3\text{-N}$ - 10 mg/L	94	128	221	6	6	12
$\text{NH}_3\text{-N}$ - 5 mg/L	114	164	278	7	8	15
$\text{NH}_3\text{-N}$ - 1.5 mg/L	129	189	318	8	9	18
TN - 4 mg/L	310	316	626	20	15	35

Figure 3: CCMUA Plant Specific Total Present Cost Curve

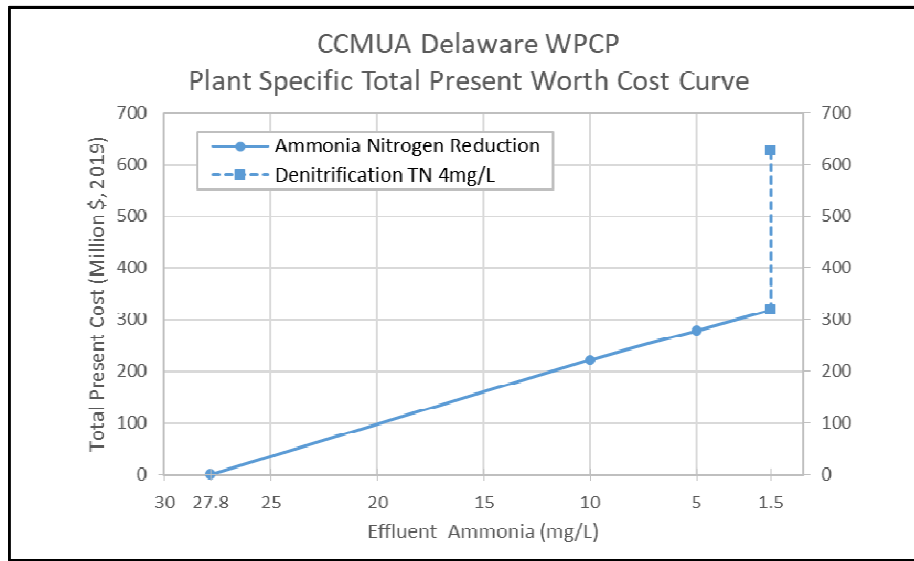
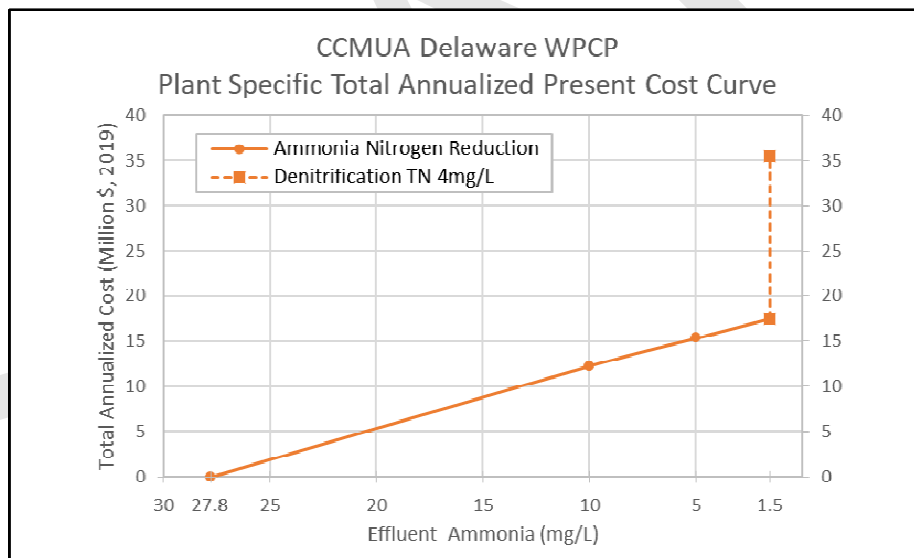


Figure 4: CCMUA Plant Specific Total Annual Cost Curve



The site-specific information, issues and factors that served as the basis for the plant specific costs presented in the CCMUA plant specific cost summary table are listed below.

PERMITTED CAPACITY:	80.00 MGD
2018 ANNUAL AVG FLOW:	58.66 MGD
2016-2018 MAXIMUM MONTHLY FLOW:	71.50 MGD

- Because the permitted capacity of 80 mgd exceeds the 2018 maximum monthly average flow of 71.5 mgd, the permitted capacity was used to conservatively size the improvements.
- A maximum monthly summer average ammonia concentration of 27.8 mg/l which is nominally higher than the generic plant's maximum monthly summer average ammonia concentration.
- The effluent flow rate requiring BAF treatment to achieve the targeted effluent ammonia concentrations by blending with non-BAF treated secondary effluent as summarized below.
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NH₃-N Treatment Level	Flow (mgd) to be treated by BAF
10 mg/L	54.2
5 mg/L	69.45
1.5 mg/L	80.00

- All major structures (BAF building, denitrification building, and associated pump stations) will be constructed to a depth of approximately 20 ft.
- Groundwater will be encountered at a depth of approximately 10 ft, with dewatering required for major structures (assuming well point dewatering).
- Pile supported foundations will be required for all new structures.
- Sheet piling will be required for all structure excavation.
- Reduction in productivity factor due to confined work area.
- Land acquisition required for the BAF and denitrification structures using adjacent Property values in the area.

5.3 PWD SWWPCP

PWD's SWWPCP plant specific costs are summarized in Table 8. The corresponding cost curves, based on total present costs and total annualized costs follow Table 8 as Figures 5 and 6, respectively. Breakdowns of capital and O&M cost for each effluent level are presented in Appendix D 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 TN concentration.

Table 8: PWD SWWPCP Plant Specific Cost Estimates

Effluent Level	Present Cost (Million \$, 2019)			Annualized Present Cost (Million \$/year, 2019)		
Scenario	Capital	O&M Present Worth	Total Present Worth Cost	Debt Service	Annual O&M	Total
NH ₃ -N - 10 mg/L	209	272	481	14	13	27
NH ₃ -N - 5 mg/L	270	360	630	18	17	35
NH ₃ -N - 1.5 mg/L	313	425	739	20	21	41
TN - 4 mg/L	788	735	1,523	51	35	87

Figure 5: PWD SWWPCP Plant Specific Total Present Cost Curve

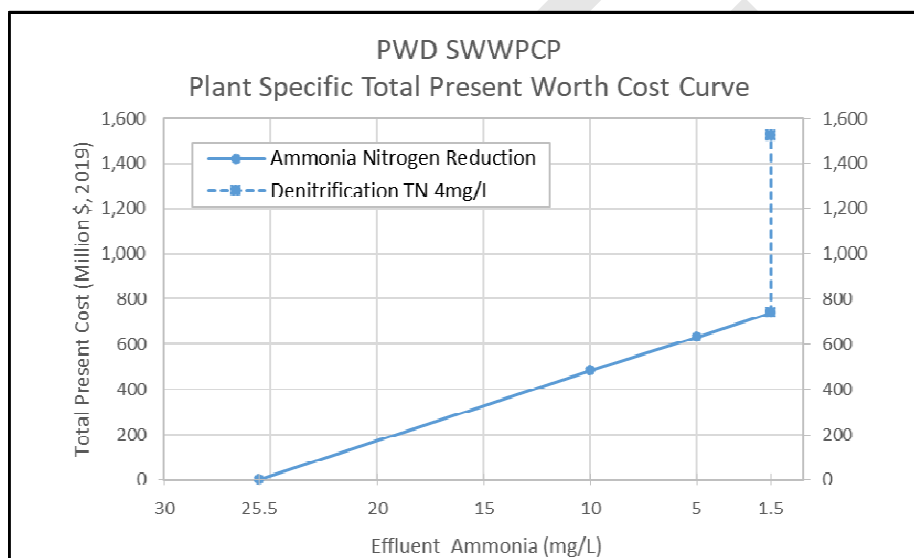
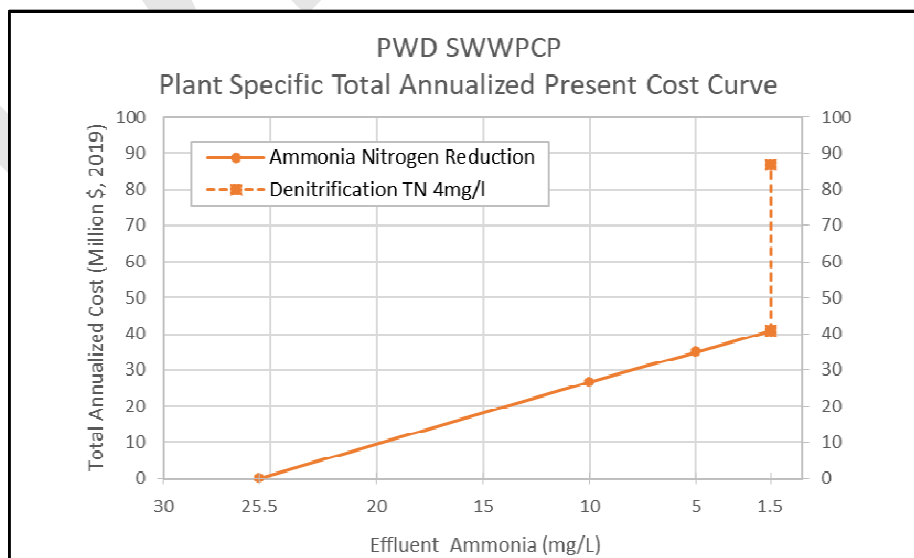


Figure 6: PWD SWWPCP Plant Specific Total Annual Cost Curve



The site-specific information, issues and factors that served as the basis for the plant specific costs presented in the PWD SWWPCP plant specific cost summary table are listed below.

PERMITTED CAPACITY: 200.00 MGD
2018 ANNUAL AVG FLOW: 183.17 MGD
2016-2018 MAXIMUM MONTHLY FLOW: 212.00 MGD

- The 2018 maximum monthly average flow of 212 mgd was used to size the improvements.
- A maximum monthly summer average effluent ammonia concentration of 25.5 mg/l which is essentially the same as for the generic pure oxygen activated sludge plant.
- The effluent flow rate requiring BAF treatment to achieve the targeted effluent ammonia concentrations by blending with non-BAF treated secondary effluent as summarized below.

NH₃-N Treatment Level	Flow (mgd) to be treated by BAF
10 mg/L	129.23
5 mg/L	170.86
1.5 mg/L	212.00

- All major structures (BAF building, denitrification building, and associated pump stations) will be constructed to a depth of approximately 20 ft.
- Groundwater will be encountered at a depth of approximately 10 ft with dewatering required for major structures (assuming well point dewatering).
- Pile supported foundations will be required for all new structures.
- Sheet piling will be required for all structure excavation.
- No reduction in productivity factor due to confined work area.
- Land acquisition required for the BAF and denitrification structures.

FIXED FILM PLANTS

5.4 WILLINGBORO MUA

The Willingboro MUA's plant specific costs are summarized in Table 9. The corresponding cost curves, based on total present costs and total annualized costs follow Table 9 as Figures 7 and 8, respectively. Breakdowns of capital and O&M cost for each effluent level are presented in

Appendix E 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 $\text{NH}_3\text{-N}$ concentration and the second depicting the size and location of major new structures to achieve the 4 mg/L effluent TN concentration.

Table 9: Willingboro MUA Plant Specific Cost Estimates

Effluent Level	Present Cost (Million \$, 2019)			Annualized Present Cost (Million \$/year, 2019)		
Scenario	Capital	O&M Present Worth	Total Present Worth Cost	Debt Service	Annual O&M	Total
$\text{NH}_3\text{-N}$ - 10 mg/L	0	0	0	0	0	0
$\text{NH}_3\text{-N}$ - 5 mg/L	0	0	0	0	0	0
$\text{NH}_3\text{-N}$ - 1.5 mg/L	26	5	31	2	0.3	2
TN - 4 mg/L	40	12	52	3	1	3

Figure 7: Willingboro MUA Plant Specific Total Present Cost Curve

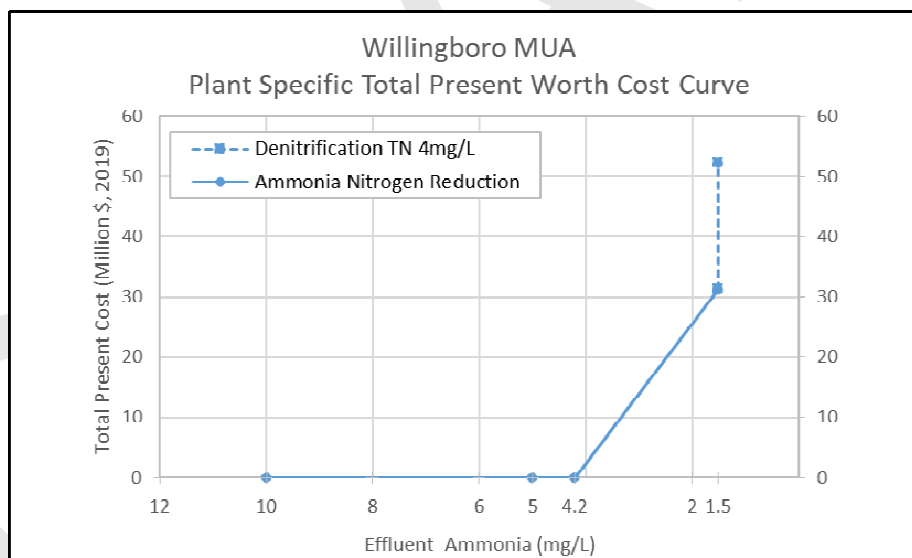
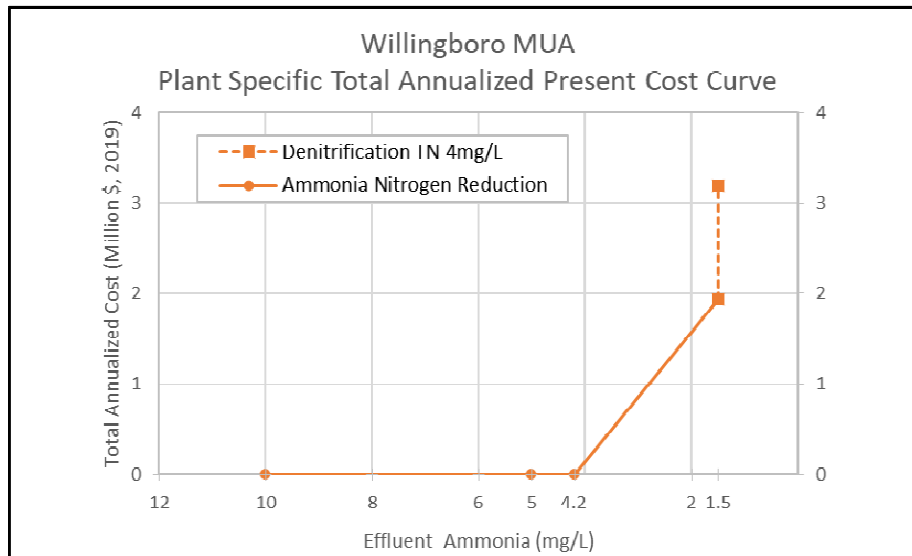


Figure 8: Willingboro MUA Plant Specific Total Annual Cost Curve



The site-specific information, issues and factors that served as the basis for the plant specific costs presented in the Willingboro MUA plant specific cost summary table are listed below.

PERMITTED CAPACITY: 5.22 MGD
2018 ANNUAL AVG FLOW: 4.10 MGD
2016-2018 MAXIMUM MONTHLY FLOW: 5.22 MGD

- The maximum monthly average flow, which equaled the permitted capacity, was used to size the plant improvements.
- Based on the maximum monthly summer average effluent ammonia concentration of 4.20 mg/l; the Willingboro MUA plant does not need to implement improvements to achieve the 10 mg/L or 5 mg/L effluent NH₃-N levels.
- The effluent flow rate requiring BAF treatment to achieve the targeted effluent ammonia concentration of 1.5 mg/l by blending with non-BAF treated secondary effluent is presented below.
-

NH ₃ -N Treatment Level	Flow (mgd) to be treated by BAF
10 mg/L	0
5 mg/L	0
1.5 mg/L	5.22

- All major structures (BAF building, denitrification building, and associated pump stations) will be constructed to a depth of approximately 20 ft.
- Groundwater will be encountered at a depth of approximately 10 ft, with dewatering required for major structures (assuming well point dewatering).
- Pile supported foundations will be required for all new major structures.
- Sheet piling will be required for all structure excavation.
- No reduction in productivity factor due to confined work area.

5.5 HAMILTON TOWNSHIP

The Hamilton Township plant specific costs are summarized in Table 10. The corresponding cost curves, based on total present costs and total annualized costs follow Table 10 as Figures 9 and 10, respectively. Breakdowns of capital and O&M cost for each effluent level are presented in Appendix F 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 TN concentration.

Table 10: Hamilton Township Plant Specific Cost Estimates

Effluent Level	Present Cost (Million \$, 2019)			Annualized Present Cost (Million \$/year, 2019)		
Scenario	Capital	O&M Present Worth	Total Present Worth Cost	Debt Service	Annual O&M	Total
NH ₃ -N - 10 mg/L	30	26	56	2	1	3
NH ₃ -N - 5 mg/L	33	32	66	2	2	4
NH ₃ -N - 1.5 mg/L	35	39	74	2	2	4
TN - 4 mg/L	58	62	120	4	3	7

Figure 9: Hamilton Township Plant Specific Total Present Cost Curve

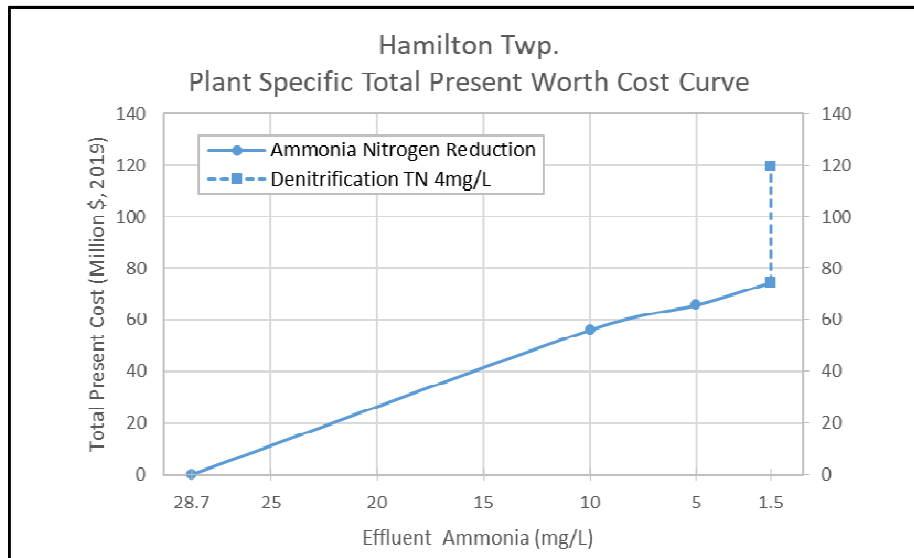
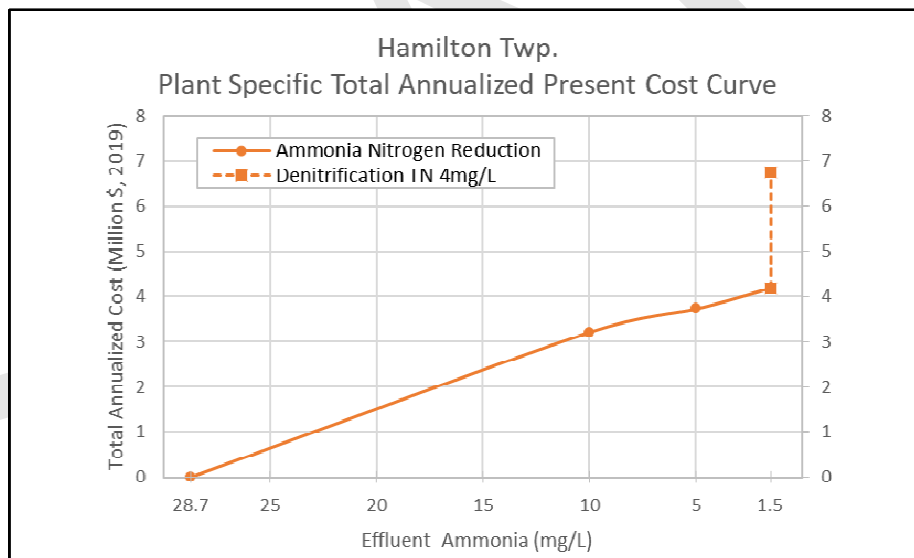


Figure 10: Hamilton Township Plant Specific Total Annual Cost Curve



The site-specific information, issues and factors that served as the basis for the plant specific costs presented in the Hamilton Township WPCP plant specific cost summary table are listed below.

PERMITTED CAPACITY:	16.00 MGD
2018 ANNUAL AVG FLOW:	9.01 MGD
2016-2018 MAXIMUM MONTHLY FLOW:	12.03 MGD

- The Mercer County Wastewater Management Plan indicates a buildout future flow for the Hamilton Township WPCP of 12.74 mgd which nominally exceeds the maximum monthly average flow of 12.03 mgd and will be used to size the improvements.
- A maximum monthly summer average ammonia effluent concentration of 28.7 mg/l; which is significantly higher than the generic fixed film plant's maximum monthly summer average effluent ammonia concentration.
- The effluent flow rate requiring BAF treatment to achieve the targeted effluent ammonia concentrations by blending with non-BAF treated secondary effluent is presented below:

NH₃-N Treatment Level	Flow (mgd) to be treated by BAF
10 mg/L	8.8
5 mg/L	11.1
1.5 mg/L	12.74

- All major structures (BAF building, denitrification building, and associated pump stations) will be constructed to a depth of approximately 20 ft.
- Groundwater will be encountered at a depth of approximately 10 ft, with dewatering required for major structures (assuming well point dewatering).
- Approximately 10 feet of rock excavation will be required for the major structures.
- Sheet piling is required for all structure excavation.
- No reduction in productivity factor due to confined work area.

5.6 TRENTON SEWER UTILITY

The Trenton Sewer Utility plant specific costs are summarized in Table 11. The corresponding cost curves, based on total present costs and total annualized costs follow Table 11 as Figures 11 and 12, respectively. Breakdowns of capital and O&M cost for each effluent level are presented in Appendix G 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 TN concentration.

Table 11: Trenton Sewer Utility Plant Specific Cost Estimates

Effluent Level	Present Cost (Million \$, 2019)			Annualized Present Cost (Million \$/year, 2019)		
Scenario	Capital	O&M Present Worth	Total Present Worth Cost	Debt Service	Annual O&M	Total
NH ₃ -N - 10 mg/L	1	0.5	2	0.1	0.02	0.1
NH ₃ -N - 5 mg/L	31	8	38	2	0.4	2
NH ₃ -N - 1.5 mg/L	39	14	53	3	1	3
TN - 4 mg/L	64	29	93	4	1	6

Figure 11: Trenton Sewer Utility Plant Specific Total Present Cost Curve

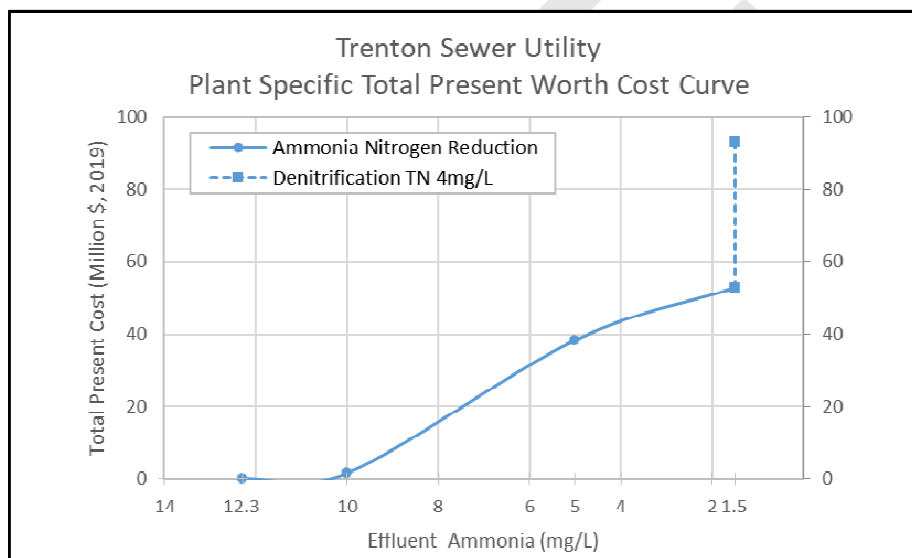
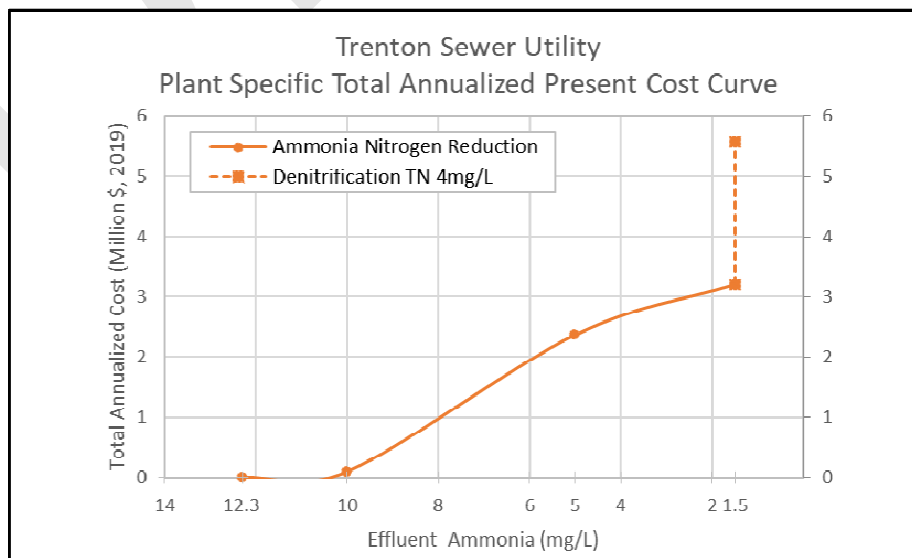


Figure 12: Trenton Sewer Utility Plant Specific Total Annual Cost Curve



The site-specific information, issues and factors that served as the basis for the plant specific costs presented in the Trenton Sewer Utility plant specific cost summary table are listed below.

PERMITTED CAPACITY: 20.00 MGD
2018 ANNUAL AVG FLOW: 12.38 MGD
2016-2018 MAXIMUM MONTHLY FLOW: 14.85 MGD

- The Mercer County Wastewater Management Plan indicates a future buildout flow for Trenton Sewer Utility at 12.88 mgd which is less than the maximum monthly average flow of 14.85 mgd. Therefore, the improvements were sized for a maximum monthly average flow of 14.85 mgd.
- The maximum monthly summer average effluent ammonia concentration of 12.3 mg/l is lower than the generic fixed film plant's maximum monthly average effluent concentration.
- By placing the third trickling filter into continuous operation, the 10 mg/L effluent level will be achieved without the need to construct improvements.
- The effluent flow rate requiring BAF treatment to achieve the targeted effluent ammonia concentrations by blending with non-BAF treated secondary effluent are presented below:

NH₃-N Treatment Level	Flow (mgd) to be treated by BAF
10 mg/L	0
5 mg/L	8.7
1.5 mg/L	14.85

- All major structures (BAF building, denitrification building, and associated pump stations) will be constructed to a depth of approximately 20 ft.
- Groundwater will be encountered at a depth of approximately 10 ft, with dewatering required for major structures (assuming well point dewatering).
- Pile supported foundations will be required for all new structures.
- Sheet piling will be required for all structure excavation.
- No reduction in productivity factor due to confined work area.

CONVENTIONAL ACTIVATED SLUDGE PLANTS

5.7 LBCJMA

The LBCJMA plant specific costs are summarized in Table 12. The corresponding cost curves, based on total present costs and total annualized costs follow Table 12 as Figures 13 and 14, respectively. Breakdowns of capital and O&M cost for each effluent level are presented in Appendix H 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 $\text{NH}_3\text{-N}$ concentration and the second depicting the size and location of major new structures to achieve the 4 mg/L effluent TN concentration.

Table 12: LBCJMA Plant Specific Cost Estimates

Effluent Level	Present Cost (Million \$, 2019)			Annualized Present Cost (Million \$/year, 2019)		
Scenario	Capital	O&M Present Worth	Total Present Worth Cost	Debt Service	Annual O&M	Total
$\text{NH}_3\text{-N}$ - 10 mg/L	9	18	27	0.6	0.9	1
$\text{NH}_3\text{-N}$ - 5 mg/L	9	27	37	1	1	2
$\text{NH}_3\text{-N}$ - 1.5 mg/L	9	34	43	1	2	2
TN - 4 mg/L	38	59	97	2	3	5

Figure 13: LBCJMA Plant Specific Total Present Cost Curve

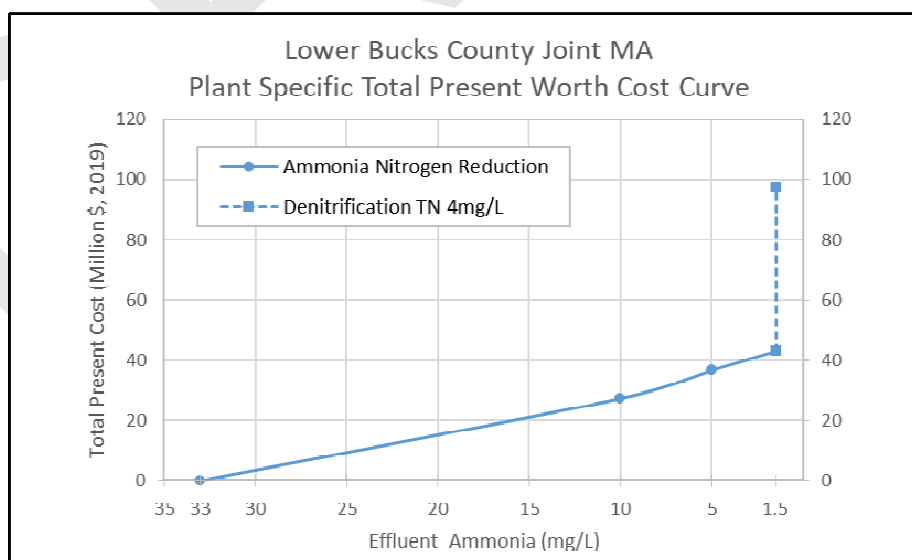
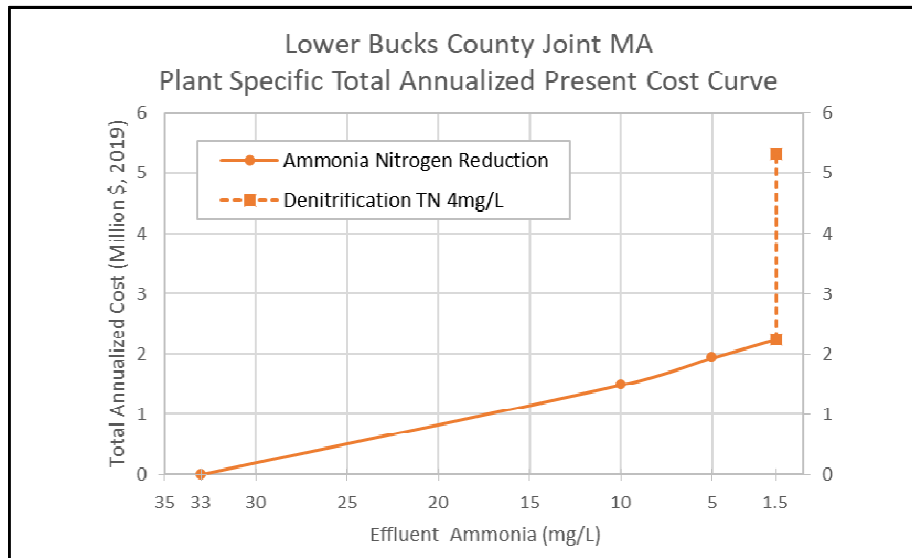


Figure 14: LBCJMA Plant Specific Total Annual Cost Curve



The site-specific information, issues and factors that served as the basis for the plant specific costs presented in the LBCJMA plant specific cost summary table are listed below.

PERMITTED CAPACITY: 11.20 MGD
2018 ANNUAL AVG FLOW: 8.42 MGD
2016-2018 MAXIMUM MONTHLY FLOW: 11.20 MGD

- The maximum monthly average flow of 11.2 mgd, which equaled the permitted capacity, was used to size the improvements.
- A maximum monthly summer average effluent ammonia concentration of 33.00 mg/l; which is higher than the generic conventional activated sludge plant's maximum summer average effluent ammonia concentration.
- Based on preliminary process modeling utilizing Biowin process simulation software, operating the existing activated sludge system aeration tanks at a higher mixed liquor suspended solids (MLSS) concentration of approximately 3,000 mg/L during the summer months will result in full nitrification and a summer monthly average effluent ammonia concentration less than 1.5 mg/L. The improvements required to enable operation at a higher MLSS concentration of approximately 3,000 mg/L are the same as the generic conventional activated sludge plant improvements summarized in Table 1 for an effluent ammonia level of 10 mg/L, i.e., additional final clarifiers, higher capacity process air system (blowers and fine bubble diffusers), increase in return activated sludge pumping capacity and supplemental alkalinity feed system (magnesium hydroxide).

- To achieve an effluent TN level of 4 mg/L, a denitrification filter will be added to the system.
- Groundwater will be encountered at a depth of approximately 10 ft, with dewatering required for major structures (assuming well point dewatering).
- Pile supported foundations will be required for all new structures.
- Sheet piling will be required for all structure excavation.
- Reduction in productivity factor due to confined work area.

5.8 GCUA

The GCUA plant specific costs are summarized in Table 13. The corresponding cost curves, based on total present costs and total annualized costs follow Table 13 as Figures 15 and 16, respectively. Breakdowns of capital and O&M cost for each effluent level are presented in Appendix I 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 TN concentration.

Table 13: GCUA Plant Specific Cost Estimates

Effluent Level	Present Cost (Million \$, 2019)			Annualized Present Cost (Million \$/year, 2019)		
Scenario	Capital	O&M Present Worth	Total Present Worth Cost	Debt Service	Annual O&M	Total
NH ₃ -N - 10 mg/L	19	41	61	1	2	3
NH ₃ -N - 5 mg/L	19	64	84	1	3	4
NH ₃ -N - 1.5 mg/L	19	80	99	1	4	5
TN - 4 mg/L	67	132	199	4	6	11

Figure 15: GCUA Plant Specific Total Present Cost Curve

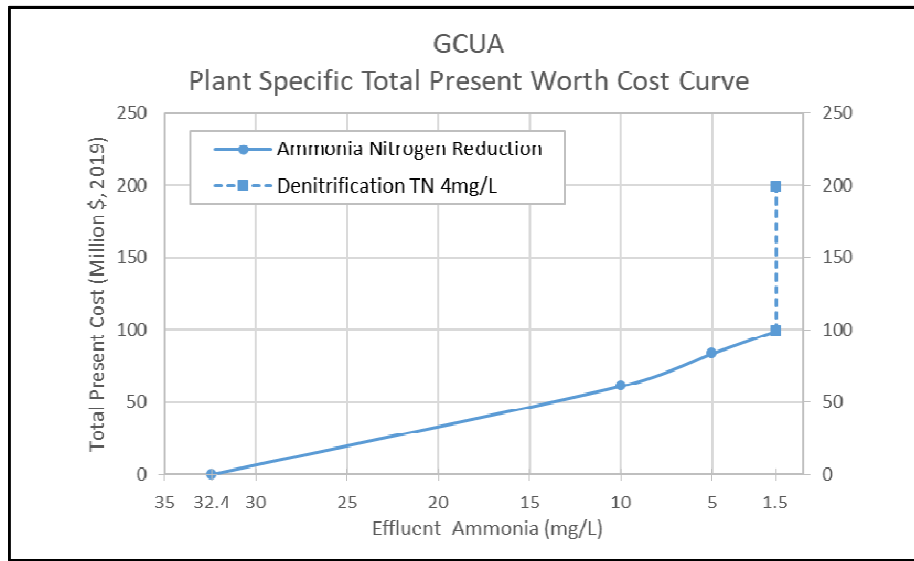
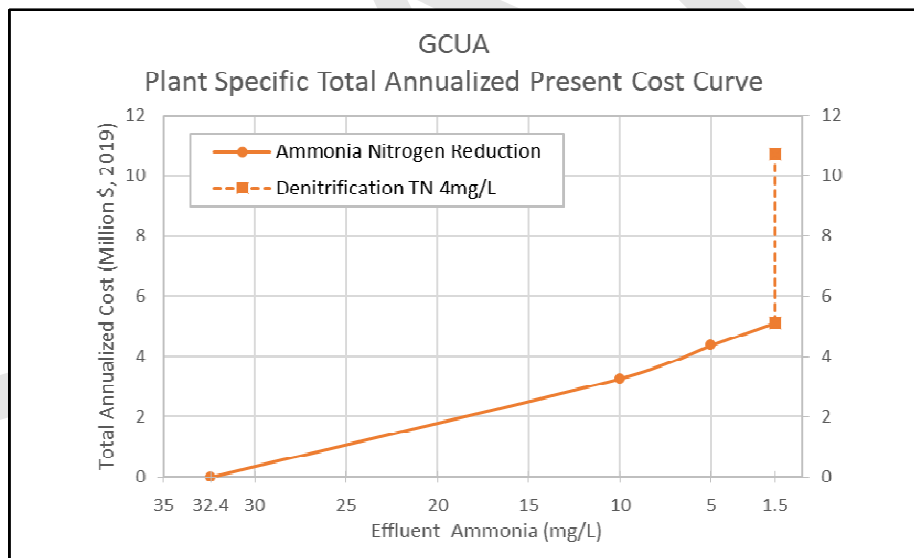


Figure 16: GCUA Plant Specific Total Annual Cost Curve



The site-specific information, issues and factors that served as the basis for the plant specific costs presented in the GCUA plant specific cost summary table are listed below.

PERMITTED CAPACITY:	27.00 MGD
2018 ANNUAL AVG FLOW:	20.43 MGD
2016-2018 MAXIMUM MONTHLY FLOW:	25.10 MGD

- Because the permitted capacity is only nominally greater than the current maximum monthly average flow, the permitted flow (27 mgd) was used to size the improvements.
- A maximum monthly summer average effluent ammonia concentration of 32.40 mg/l which is higher in concentration than the generic conventional activated sludge plant's maximum monthly summer average effluent concentration.
- Based on preliminary process modeling utilizing Biowin process simulation software, operating the existing activated sludge system aeration tanks at a higher MLSS concentration of approximately 3,000 mg/L during the summer months will result in full nitrification and a summer monthly average effluent ammonia concentration less than 1.5 mg/L. The improvements required to enable operation at a higher MLSS concentration of approximately 3,000 mg/L are the same as the generic conventional activated sludge plant improvements summarized in Table 1 for an effluent ammonia level of 10 mg/L, i.e. additional final clarifiers, higher capacity process air system (blowers and fine bubble diffusers), increase in return activated sludge pumping capacity and supplemental alkalinity feed system (magnesium hydroxide)
- To achieve an effluent TN level of 4 mg/L, a denitrification filter will be added to the system.
- Groundwater will be encountered at a depth of approximately 10 ft, with dewatering required for major structures (assuming well point dewatering).
- Pile supported foundations will be required for all new structures.
- Sheet piling will be required for all structure excavation.
- Reduction in productivity factor due to confined work area.

5.9 DELCORA

The DELCORA plant specific costs are summarized in Table 14. The corresponding cost curves, based on total present costs and total annualized costs follow Table 14 as Figures 17 and 18, respectively. Breakdowns of capital and O&M cost for each effluent level are presented in Appendix J 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 $\text{NH}_3\text{-N}$ concentration and the second depicting the size and location of major new structures to achieve the 4 mg/L effluent TN concentration.

Table 14: DELCORA Plant Specific Cost Estimates

Effluent Level	Present Cost (Million \$, 2019)			Annualized Present Cost (Million \$/year, 2019)		
Scenario	Capital	O&M Present Worth	Total Present Worth Cost	Debt Service	Annual O&M	Total
NH ₃ -N - 10 mg/L	31	7	39	2	0.4	2
NH ₃ -N - 5 mg/L	89	36	125	6	2	8
NH ₃ -N - 1.5 mg/L	99	65	164	6	3	10
TN - 4 mg/L	189	142	331	12	7	19

Figure 17: DELCORA Plant Specific Total Present Cost Curve

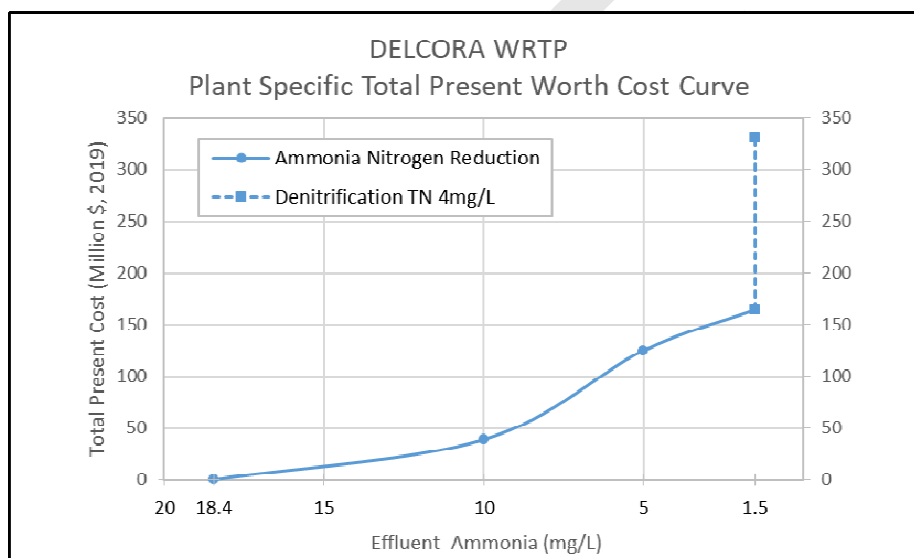
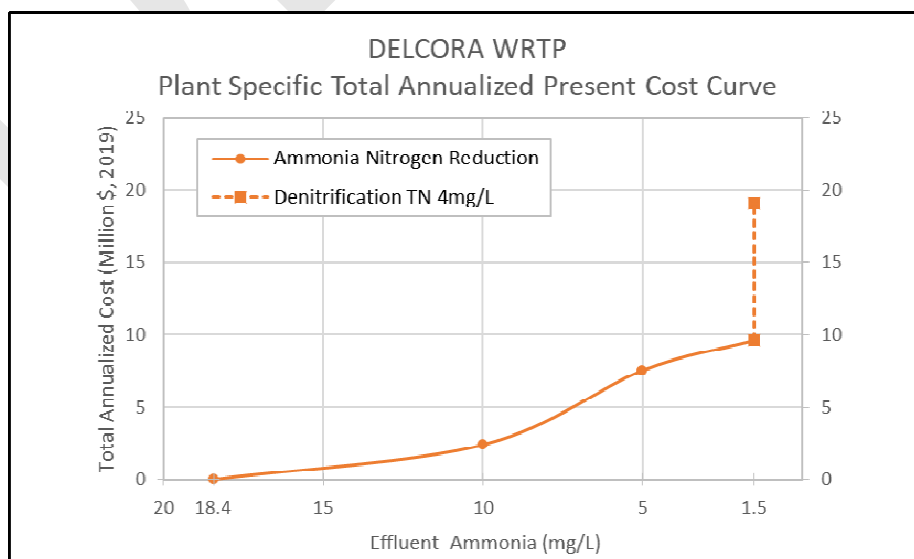


Figure 18: DELCORA Plant Specific Total Annual Cost Curve



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 listed below.

PERMITTED CAPACITY:	50.00 MGD
2018 ANNUAL AVG FLOW:	38.03 MGD
2016-2018 MAXIMUM MONTHLY FLOW:	47.96 MGD

- Because the permitted capacity is only nominally greater than the current maximum monthly average flow, the permitted flow (50 mgd) was used to size the improvements.
- A maximum monthly summer average effluent ammonia concentration of 18.43 mg/l which 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 W RTP is also currently operating at a 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 listed in Table 1 for the generic conventional activated sludge plant, i.e., additional final clarifiers, increased process air capacity and RAS pumping improvements for the 10 mg/L effluent ammonia level and IFAS for the 5 mg/L and .5 mg/l. effluent levels.
- 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.

5.10 PWD SEWPCP

The PWD SEWPCP plant specific costs are summarized in Table 15. The corresponding cost curves, based on total present costs and total annualized costs follow Table 15 as Figures 19 and 20, respectively. Breakdowns of capital and O&M cost for each effluent level are presented in Appendix K 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 TN concentration.

Table 15: PWD SEWPCP Plant Specific Cost Estimates

Effluent Level	Present Cost (Million \$, 2019)			Annualized Present Cost (Million \$/year, 2019)		
Scenario	Capital	O&M Present Worth	Total Present Worth Cost	Debt Service	Annual O&M	Total
NH ₃ -N - 10 mg/L	66	8	73	4	0.4	5
NH ₃ -N - 5 mg/L	66	19	85	4	1	5
NH ₃ -N - 1.5 mg/L	209	28	237	14	1	15
TN - 4 mg/L	406	111	517	26	5	32

Figure 19: PWD SEWPCP Plant Specific Total Present Cost Curve

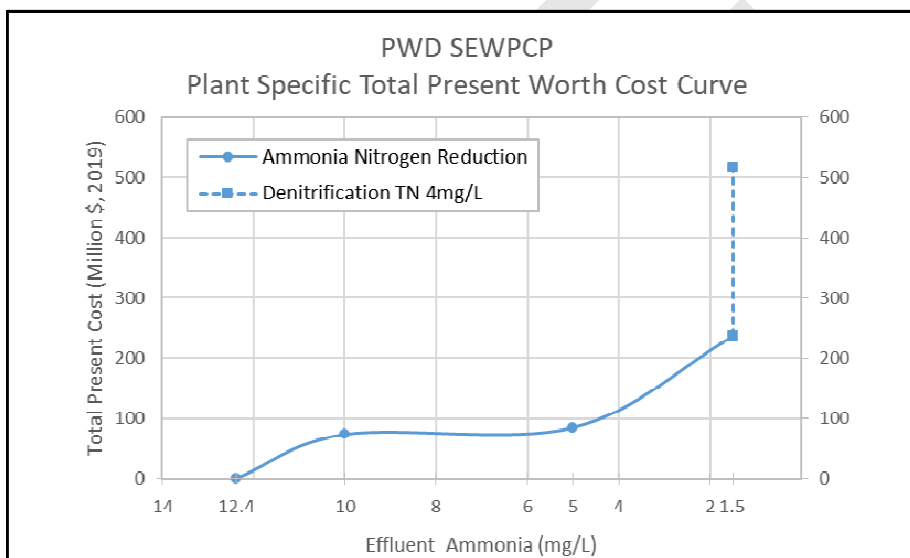
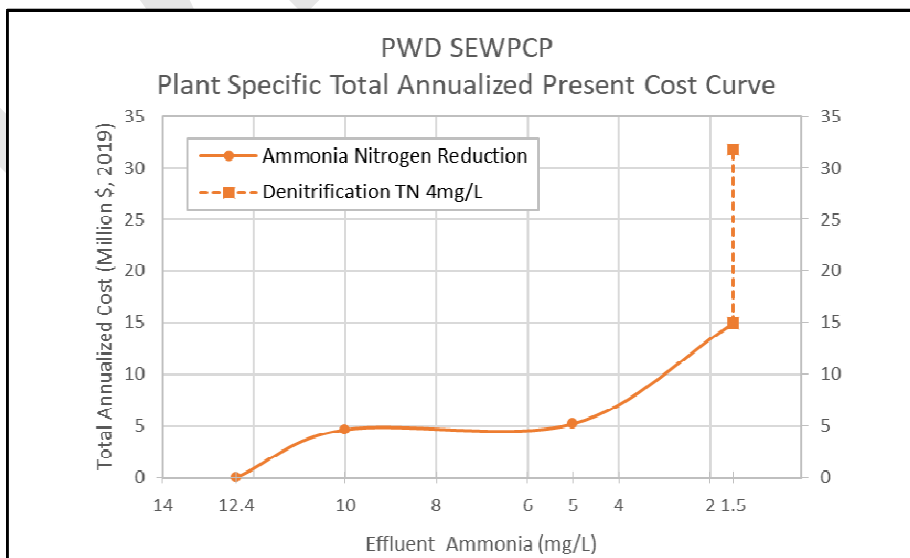


Figure 20: PWD SEWPCP Plant Specific Total Annual Cost Curve



The site-specific information, issues and factors that served as the basis for the plant specific costs presented in the PWD SEWPCP plant specific cost summary table are listed below.

PERMITTED CAPACITY:	110.00 MGD
2018 ANNUAL AVG FLOW:	88.58 MGD
2016-2018 MAXIMUM MONTHLY FLOW:	103.00 MGD

- Because the permitted capacity is only nominally greater than the current maximum monthly average flow, the permitted flow (110 mgd) was used to size the improvements.
- A maximum monthly summer average effluent ammonia concentration of 12.38 mg/L; which is less than the generic conventional activated sludge systems maximum monthly summer average effluent ammonia concentration.
- Based on preliminary process modeling utilizing Biowin process simulation software, operating the existing activated sludge system aeration tanks at a higher MLSS concentration of approximately 3,000 mg/L during the summer months will result in partial nitrification and a summer monthly average effluent ammonia concentration of approximately 3 mg/L, which will achieve both the 10 mg/L and 5 mg/L effluent levels for ammonia, but will not achieve the 1.5 mg/L level.
- The improvements required to enable operation at a higher MLSS concentration to achieve the 10 mg/L and 5 mg/L effluent levels are the same as the generic conventional activated sludge plant improvements summarized in Table 1 for an effluent ammonia level of 10 mg/L, i.e. additional final clarifiers, higher capacity process air system (blowers and fine bubble diffusers), increase in return activated sludge pumping capacity and supplemental alkalinity feed system (magnesium hydroxide).
- The improvements to achieve the 1.5 mg/L effluent level will be the same as presented in Table 1 for generic conventional activated sludge plant to achieve a 1.5 mg/L effluent level, i.e. FAS with the volume of IFAS media required to reduce the summer effluent ammonia level to 1.5 mg/L.
- Groundwater will be encountered at a depth of approximately 10 ft, with dewatering required for major structures (assuming well point dewatering).
- Pile supported foundations will be required for all new structures.
- Sheet piling will be required for all structure excavation.
- No reduction in productivity factor due to confined work area.

5.11 WILMINGTON

The Wilmington plant specific costs are summarized in Table 16. The corresponding cost curves, based on total present costs and total annualized costs follow Table 16 as Figures 21 and 22, respectively. Breakdowns of capital and O&M cost for each effluent level are presented in Appendix L 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 TN concentration.

Table 16: Wilmington Plant Specific Cost Estimates

Effluent Level	Present Cost (Million \$, 2019)			Annualized Present Cost (Million \$/year, 2019)		
Scenario	Capital	O&M Present Worth	Total Present Worth Cost	Debt Service	Annual O&M	Total
NH ₃ -N - 10 mg/L	74	22	95	5	1	6
NH ₃ -N - 5 mg/L	221	108	330	14	5	20
NH ₃ -N - 1.5 mg/L	248	186	434	16	9	25
TN - 4 mg/L	474	360	834	31	17	48

Figure 21: Wilmington Plant Specific Total Present Cost Curve

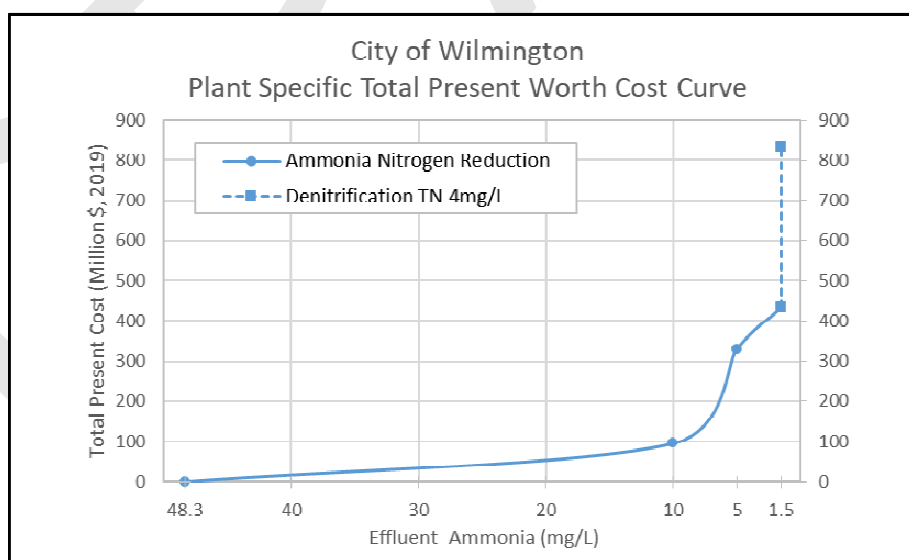
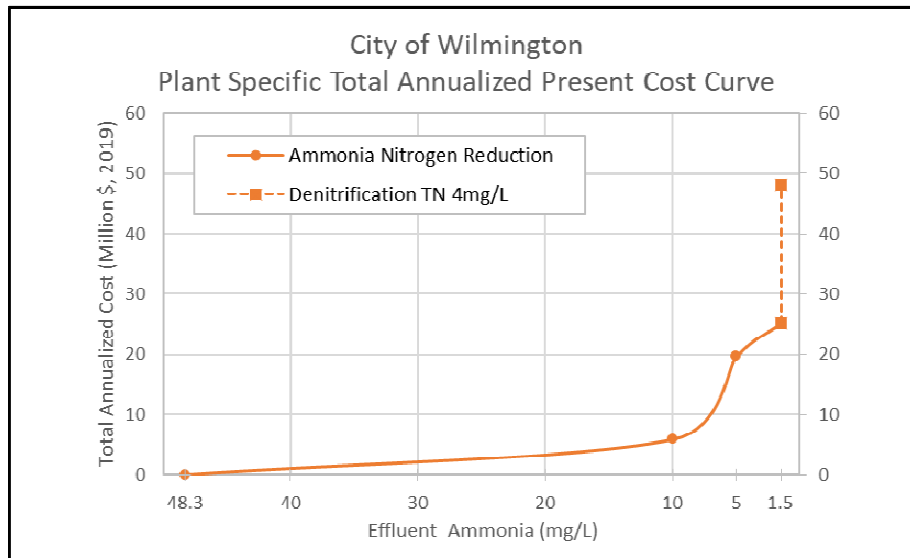


Figure 22: Wilmington Plant Specific Total Annual Cost Curve



The site-specific information, issues and factors that served as the basis for the plant specific costs presented in the Wilmington plant specific cost summary table are listed below.

PERMITTED CAPACITY: 134.00 MGD
2018 ANNUAL AVG FLOW: 76.43 MGD
2016-2018 MAXIMUM MONTHLY FLOW: 97.67 MGD

- The permitted flow of 134 mg was conservatively used to size the improvements.
- A maximum monthly summer average effluent ammonia concentration of 48.30 mg/L; which is significantly greater than the generic conventional activated sludge plant's maximum monthly summer average effluent ammonia concentration.
- Based on preliminary process modeling utilizing Biowin process simulation software, operating the existing activated sludge system aeration tanks at a higher MLSS concentration of approximately 3,000 mg/L during the summer months will result in partial nitrification and a summer monthly average effluent ammonia concentration of approximately 9 mg/L, which will achieve both the 10 mg/L effluent level for ammonia, but will not achieve the 5 mg/L or 1.5 mg/L level.
- The improvements required to enable operation at a higher MLSS concentration to achieve the 10 mg/L effluent levels are the same as the generic conventional activated sludge plant improvements summarized in Table 1 for an effluent ammonia level of 10 mg/L, i.e. additional final clarifiers, higher capacity process air system (blowers and fine

- bubble diffusers), increase in return activated sludge pumping capacity and supplemental alkalinity feed system (magnesium hydroxide).
- The improvements to achieve the 5 mg/L effluent level for ammonia will be the same as presented in Table 1 for generic conventional activated sludge plant to achieve a 5 mg/L effluent level, i.e. FAS with the volume of IFAS media required to reduce the summer effluent ammonia level to 5 mg/L.
 - The improvements to achieve the 1.5 mg/L effluent level will be the same as presented in Table 1 for generic conventional activated sludge plant to achieve a 1.5 mg/L effluent level, i.e. FAS with the volume of IFAS media required to reduce the summer effluent ammonia level to 1.5 mg/L.
 - Groundwater will be encountered at a depth of approximately 10 ft, with dewatering required for new structures (assuming well point dewatering).
 - Pile supported foundations will be required for all new structures.
 - Sheet piling will be required for all structure excavation.
 - No reduction in productivity factor due to confined work area.

5.12 PWD NEWPCP

The PWD NEWPCP plant specific costs are summarized in Table 17. The corresponding cost curves, based on total present costs and total annualized costs follow Table 17 as Figures 23 and 24, respectively. Breakdowns of capital and O&M cost for each effluent level are presented in Appendix M 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 TN concentration.

Table 17: PWD NEWPCP Plant Specific Cost Estimates

Effluent Level	Present Cost (Million \$, 2019)			Annualized Present Cost (Million \$/year, 2019)		
Scenario	Capital	O&M Present Worth	Total Present Worth Cost	Debt Service	Annual O&M	Total
NH ₃ -N - 10 mg/L	0	0	0	0	0	0
NH ₃ -N - 5 mg/L	125	39	164	8	2	10
NH ₃ -N - 1.5 mg/L	383	61	444	25	3	28
TN - 4 mg/L	728	259	987	47	13	60

Figure 23: NEWPCP Plant Specific Total Present Cost Curve

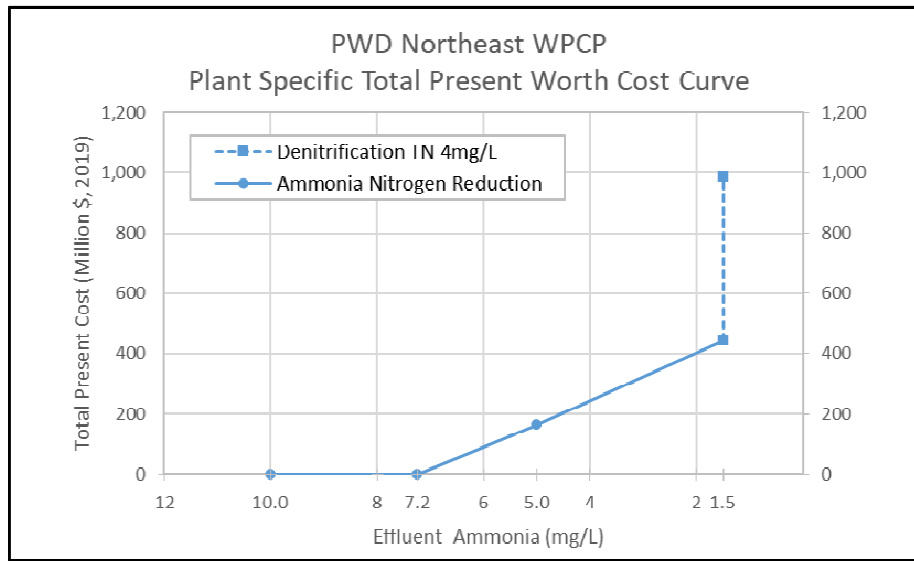
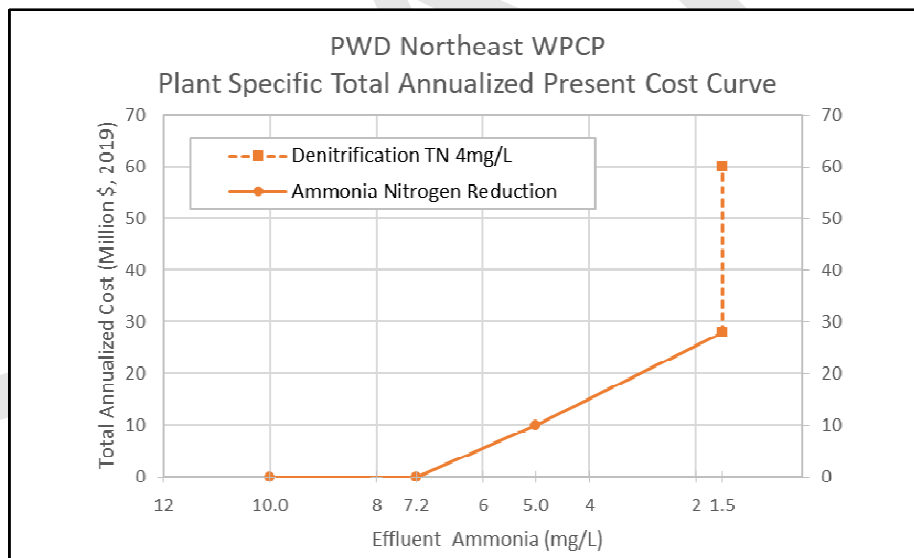


Figure 24: NEWPCP Plant Specific Total Annual Cost Curve



The site-specific information, issues and factors that served as the basis for the plant specific costs presented in the PWD NEWPCP plant specific cost summary table are listed below.

PERMITTED CAPACITY:	210.00 MGD
2018 ANNUAL AVG FLOW:	200.33 MGD
2016-2018 MAXIMUM MONTHLY FLOW:	235.00 MGD

- The maximum monthly flow of 235 mgd was used to size the improvements.

- A maximum monthly summer average ammonia concentration of 7.24 mg/L; which is below the 10 mg/L effluent level. Therefore, improvements are not required to achieve the 10 mg/L effluent level.
- Based on preliminary process modeling utilizing Biowin process simulation software, operating the existing activated sludge system aeration tanks at a higher average MLSS concentration of approximately 3,000 mg/L during the summer months will increase the extent of partial nitrification resulting in a summer monthly average effluent ammonia concentration of approximately 4 mg/L., which will achieve 5 mg/L effluent level for ammonia, but will not achieve the 1.5 mg/L level.
- The improvements required to enable operation at a higher MLSS concentration to achieve the 5 mg/L effluent level are the same as the generic conventional activated sludge plant improvements summarized in Table 1 for an effluent ammonia level of 10 mg/L, i.e. additional final clarifiers, higher capacity process air system (blowers and fine bubble diffusers), increase in return activated sludge pumping capacity and supplemental alkalinity feed system (magnesium hydroxide).
- The improvements to achieve the 1.5 mg/L effluent level will be the same as presented in Table 1 for generic conventional activated sludge plant to achieve a 1.5 mg/L effluent level, i.e. FAS with the volume of IFAS media required to reduce the summer effluent ammonia level to 1.5 mg/L.
- Groundwater will be encountered at a depth of approximately 10 ft, with dewatering required for new structures (assuming well point dewatering).
- Pile supported foundations will be required for all new structures.
- Sheet piling will be required for all structure excavation.
- No reduction in productivity factor due to confined work area.

6.0 OVERALL SUMMARY OF PLANT SPECIFIC COSTS

The overall summary of plant specific costs is presented in Table 18. The costs presented in this table are the summation of the plant specific costs for the twelve (12) individual plants and thus represents the total program costs for achieving the three (3) agreed upon effluent levels for $\text{NH}_3\text{-N}$ and the one (1) agreed upon effluent level for TN utilizing the agreed upon treatment technologies. The corresponding cost curves, based on total present costs and total annualized costs are presented as figures 25 and 26, respectively.

Table 18: Overall Summary of Plant Specific Costs

Effluent Level	Present Cost (Million \$, 2019)			Annualized Present Cost (Million \$/year, 2019)		
Scenario	Capital	O&M Present Worth	Total Present Worth Cost	Debt Service	Annual O&M	Total
NH ₃ -N - 10 mg/L	559	530	1,090	36	26	62
NH ₃ -N - 5 mg/L	1,007	869	1,876	65	42	107
NH ₃ -N - 1.5 mg/L	1,541	1,142	2,683	100	55	155
TN - 4 mg/L	3,217	2,244	5,461	209	108	318

Figure 25: Overall Summary of Plant Specific Total Present Cost Curve

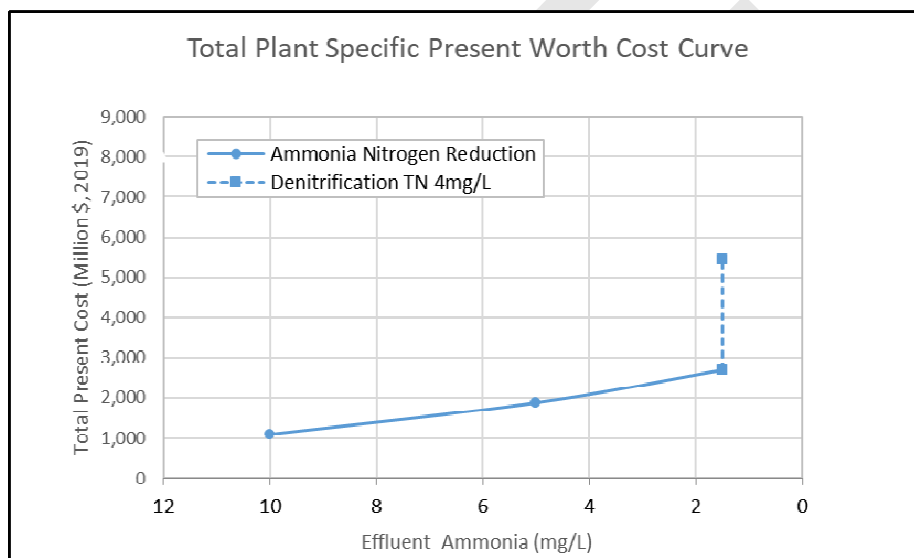
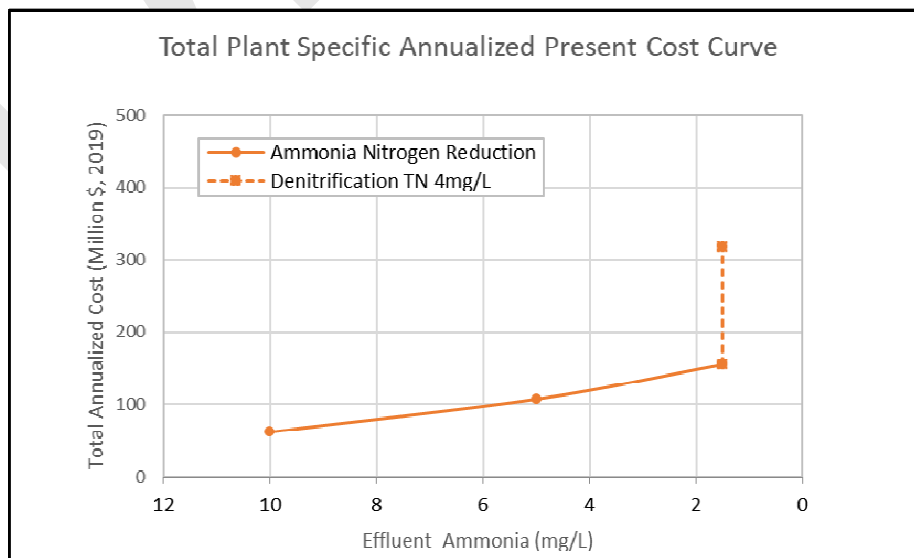


Figure 26: Overall Summary of Plant Specific Total Annual Cost Curve



Appendix A
Plant Data Summary

		Conventional Activated Sludge						Pure Oxygen			Fixed Film		
		PWD NEWPCP ¹	City of Wilmington ^{1,6}	DELCORA WRTP ¹	GCUA ¹	Lower Bucks County Joint MA ¹	PWD SEWPCP ²	Morrisville Borough MA ¹	PWD SWWPCP ¹	CCMUA Delaware WPCP ¹	Trenton Sewer Utility ²	Hamilton Twp. ²	Willingboro MUA ²
Permit Number		PA0026689-001	DE0020320-001	PA0027103-001	NJ0024686-001A	PA0026468-001	PA0026662-001	PA0026701-001	PA0026671-001	NJ0026182-001A	NJ0020923-001A	NJ0026301-001A	NJ0023361-001A
Permitted Flow (MGD)		210	134	50	27	10	110	8.7	200	80	20	16	5.22
Flow (MGD)													
Effluent Annual Average ³	2018	200.33	76.43	38.03	20.43	8.42	88.58	5.98	183.17	58.66	12.38	9.01	4.10
	2017	152.58	61.85	30.98	16.52	6.44	72.83	4.73	149.67	50.54	10.25	7.35	3.11
	2016	148.75	64.92	30.91	16.71	6.07	75.75	4.31	152.75	52.60	10.07	7.76	3.38
12 Month Max Rolling Avg		200.33	76.43	38.03	20.43	8.42	88.58	5.98	183.17	58.66	12.38	9.01	4.10
Max Month		235.00	97.67	47.96	25.10	11.20	103.00	7.77	212.00	71.50	14.85	12.03	5.22
Max Day		380.00	245.64	80.00	33.91	17.00	221.00	11.11	387.00	114.00	20.87	14.84	8.95
BOD or CBOD (mg/l)													
Effluent Annual Average ³	2018	5.92	6.42	8.18	7.92	5.43	10.25	8.42	2.75	6.33	17.14	25.00	10.17
	2017	4.92	5.60	9.58	6.17	5.47	9.00	8.75	3.17	5.25	17.29	24.05	11.83
	2016	4.75	5.86	7.83	7.27	5.31	8.33	18.06	4.33	3.83	17.83	20.33	12.50
Max Year(mg/l)		5.92	6.42	9.58	7.92	5.47	10.25	18.06	4.33	6.33	17.83	25.00	12.50
TSS (mg/L)													
Effluent Annual Average ³	2018	9.83	7.67	12.75	14.17	7.98	7.25	5.67	4.25	11.17	9.12	16.67	13.25
	2017	5.08	6.17	12.50	13.21	7.75	6.00	7.33	4.08	7.33	10.12	15.67	14.67
	2016	5.50	7.35	11.25	13.74	8.08	5.75	20.83	4.50	5.25	8.48	12.75	14.50
Max Year (mg/l)		9.83	7.67	12.75	14.17	8.08	7.25	20.83	4.50	11.17	10.12	16.67	14.67
Ammonia (mg/l)													
Effluent Annual Average ³	2018	6.37	18.63	5.34	22.44	22.48	8.43	9.42	18.52	20.29	8.26	24.98	2.18
	2017	7.63	22.26	10.86	24.06	26.67	10.10	12.25	21.97	24.57	10.20	25.92	3.38
	2016	6.42	17.36	5.21	28.22	28.83	9.87	15.50	23.50	25.64	10.58	25.25	3.16
Max. Monthly Average		13.90	48.30	21.00	35.40	33.00	12.98	24.00	30.70	30.70	17.30	30.00	8.10
Max. Monthly Summer Avg (May - Oct)		7.24	48.30	18.43	32.40	33.00	12.38	21.00	25.52	27.80	12.30	28.70	4.20
Average Summer (May - Oct)		5.44	19.06	4.83	22.96	25.45	9.48	11.11	20.72	23.84	7.76	25.65	1.53
Average Winter (Nov - April)		8.17	20.62	9.45	26.85	26.35	9.46	13.67	21.93	23.16	11.60	25.11	4.28
Effluent Annual Average ⁴	2013	6.43	18.60	2.74	16.62	21.02	7.83	10.32	17.71	21.46	8.10	27.92	5.06
	2012	6.68	14.73	5.83	18.06	22.80	8.97	9.00	20.18	18.75	7.01	28.04	6.98
	2011	5.34	14.77	0.58	18.00	17.87	9.20	7.44	21.40	21.43	4.10	28.57	7.44
Average Summer (May - Oct)		5.82	15.90	4.24	17.68	20.18	8.60	9.69	16.68	19.45	5.55	24.49	5.27
Average Winter (Nov - April)		7.01	17.64	3.47	17.34	22.92	8.42	9.37	21.86	20.81	8.56	30.86	6.86
2018 Avg Ammonia Load (lb/day) ⁵		10,641.48	11,872.58	1,693.61	3,822.88	1,578.88	6,229.19	469.70	28,283.70	9,926.90	852.75	1,876.34	74.38
% Ammonia Contribution		13.76%	15.35%	2.19%	4.94%	2.04%	8.06%	0.61%	36.58%	12.84%	1.10%	2.43%	0.10%
% Ammonia Contribution by Plant Type		46.35%						50.02%			3.63%		

¹Reported in CBOD

²Reported in BOD

³Flow, Ammonia, BOD/CBOD, and TSS data for 2016 through 2018 is from DMR data

⁴2011-2013 Ammonia Data from DRBC Study, data set does not necessarily include data for each month of the year

⁵Load calculated from 2018 Effluent Annual Average Flow and Concentration

⁶Effluent Ammonia compiled from additional sampling, not DMR data, 2018 sampling consisted of 4 samples

2018 Sum of Average Flows (MGD)	705.52
2018 Sum of Ammonia Load (lb/day)	77,322
2018 Average Ammonia Conc (mg/l)	13.14

Appendix B
MMA Plant Specific Cost Estimates
and
Conceptual Site Plans

DRBC Nitrogen Reduction Cost Estimation Study

Morrisville Borough MA
Effluent Level: NH₃-N = 10 mg/L

<i>Description</i>	<i>Amount</i>
Base capital cost¹:	\$ 8,700,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 8.70 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 21.00 mg/L	
<i>subtotal</i>	\$ 24,719,785
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 522,720
Rock Excavation	\$ -
Sheeting during Construction	\$ 161,172
Construction Dewatering	\$ 39,204
Land Acquisition	\$ -
<i>subtotal</i>	\$ 723,096
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	25,443,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 88,000
Additional chemical costs	\$ 192,619
Additional energy costs	\$ 118,537
Additional sludge disposal costs	\$ 5,321
Additional maintenance costs	\$ 9,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 413,000
TOTAL PRESENT WORTH O&M COSTS	\$ 8,557,000
GRAND TOTAL PRESENT WORTH COST	\$ 34,000,000

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

Morrisville Borough MA
Effluent Level: NH₃-N = 5 mg/L

<i>Description</i>	<i>Amount</i>
Base capital cost¹:	\$ 11,310,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 8.70 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 21.00 mg/L	
<i>subtotal</i>	\$ 27,383,323
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 748,920
Rock Excavation	\$ -
Sheeting during Construction	\$ 230,917
Construction Dewatering	\$ 56,169
Land Acquisition	\$ -
<i>subtotal</i>	\$ 1,036,006
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	28,419,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 88,000
Additional chemical costs	\$ 280,173
Additional energy costs	\$ 172,417
Additional sludge disposal costs	\$ 7,739
Additional maintenance costs	\$ 17,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 565,000
TOTAL PRESENT WORTH O&M COSTS	\$ 11,707,000
GRAND TOTAL PRESENT WORTH COST	\$ 40,126,000

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

Morrisville Borough MA
Effluent Level: NH3-N = 1.5 mg/L

<i>Description</i>	<i>Amount</i>
Base capital cost¹:	\$ 13,920,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 8.70 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 21.00 mg/L	
<i>subtotal</i>	\$ 29,247,800
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 929,280
Rock Excavation	\$ -
Sheeting during Construction	\$ 286,528
Construction Dewatering	\$ 69,696
Land Acquisition	\$ -
<i>subtotal</i>	\$ 1,285,504
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	30,533,304
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 176,000
Additional chemical costs	\$ 341,461
Additional energy costs	\$ 210,133
Additional sludge disposal costs	\$ 9,432
Additional maintenance costs	\$ 27,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 764,000
TOTAL PRESENT WORTH O&M COSTS	\$ 15,830,000
GRAND TOTAL PRESENT WORTH COST	\$ 46,363,000

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

Morrisville Borough MA

Effluent Level: NH₃-N = 1.5 mg/L and TN = 4 mg/L

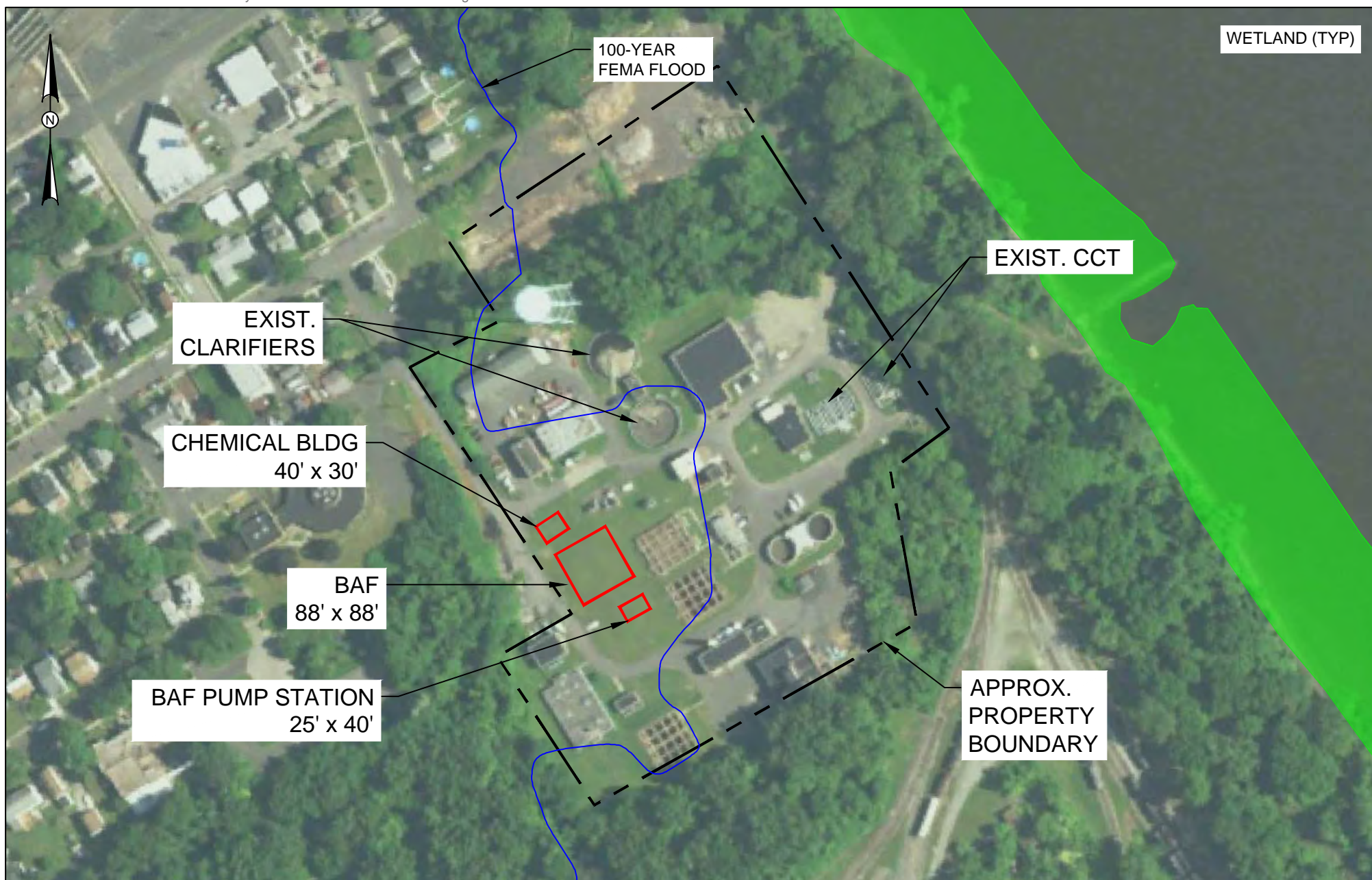
<i>Description</i>	<i>Amount</i>
Base capital cost¹:	\$ 34,800,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 8.70 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 21.00 mg/L	
<i>subtotal</i>	\$ 52,344,340
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 2,129,280
Rock Excavation	\$ -
Sheeting during Construction	\$ 656,528
Construction Dewatering	\$ 159,696
Land Acquisition	\$ -
<i>subtotal</i>	\$ 2,945,504
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	55,290,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 176,000
Additional chemical costs	\$ 643,759
Additional energy costs	\$ 375,738
Additional sludge disposal costs	\$ 97,036
Additional maintenance costs	\$ 65,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 1,358,000
TOTAL PRESENT WORTH O&M COSTS	\$ 28,137,000
GRAND TOTAL PRESENT WORTH COST	\$ 83,427,000

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

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



0 200 400



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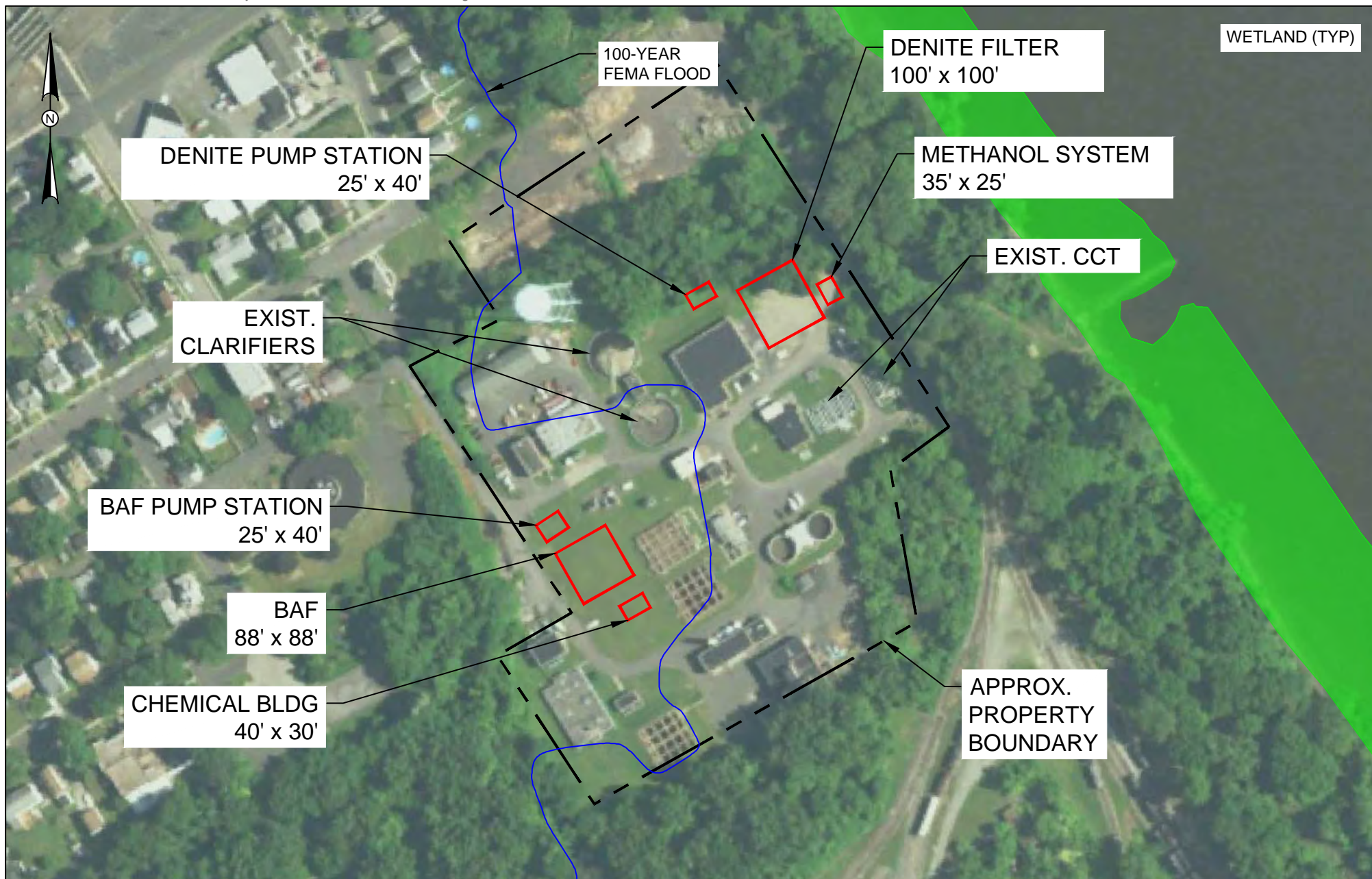
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MORRISVILLE BORO MA
CONCEPTUAL SITE PLAN
NH3-N = 1.5 mg/l

NITROGEN REDUCTION
COST ESTIMATION STUDY
DELAWARE RIVER BASIN COMMISSION

FIGURE

B-1



0 200 400



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MORRISVILLE BORO MA
 CONCEPTUAL SITE PLAN
 NH₃-N = 1.5 mg/l & TN = 4.0 mg/l

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE

B-2

Appendix C
CCMUA Plant Specific Cost Estimates
and
Conceptual Site Plans

DRBC Nitrogen Reduction Cost Estimation Study

CCMUA (Delaware #1 WPCP)
Effluent Level: NH₃-N = 10 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 80,000,000
<i>subtotal</i>	\$ 80,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 80.00 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 27.8 mg/L	
<i>subtotal</i>	\$ 83,508,517
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 3,587,040
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,106,004
Construction Dewatering	\$ 269,028
Land Acquisition	\$ 1,120,950
<i>subtotal</i>	\$ 6,083,022
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 4,031,619
TOTAL PRESENT WORTH CAPITAL COST	93,623,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 176,000
Additional chemical costs	\$ 4,751,225
Additional energy costs	\$ 1,039,983
Additional sludge disposal costs	\$ 100,498
Additional maintenance costs	\$ 100,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 6,168,000
TOTAL PRESENT WORTH O&M COSTS	\$ 127,799,000
GRAND TOTAL PRESENT WORTH COST	\$ 221,422,000

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

CCMUA (Delaware #1 WPCP)

Effluent Level: NH₃-N = 5 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 104,000,000
<i>subtotal</i>	\$ 104,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 80.00 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 27.8 mg/L	
<i>subtotal</i>	\$ 101,668,213
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 4,588,800
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,414,880
Construction Dewatering	\$ 344,160
Land Acquisition	\$ 1,434,000
<i>subtotal</i>	\$ 7,781,840
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 4,925,252
TOTAL PRESENT WORTH CAPITAL COST	<i>114,375,000</i>
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 176,000
Additional chemical costs	\$ 6,085,839
Additional energy costs	\$ 1,332,113
Additional sludge disposal costs	\$ 128,727
Additional maintenance costs	\$ 169,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 7,892,000
TOTAL PRESENT WORTH O&M COSTS	\$ 163,519,000
GRAND TOTAL PRESENT WORTH COST	\$ 277,894,000

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

CCMUA (Delaware #1 WPCP)
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	\$ 128,000,000
<i>subtotal</i>	\$ 128,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 80.00 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 27.8 mg/L	
<i>subtotal</i>	\$ 114,380,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 5,273,640
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,626,039
Construction Dewatering	\$ 395,523
Land Acquisition	\$ 1,648,013
<i>subtotal</i>	\$ 8,943,215
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 5,549,545
TOTAL PRESENT WORTH CAPITAL COST	<i>128,873,000</i>
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 176,000
Additional chemical costs	\$ 7,020,069
Additional energy costs	\$ 1,536,604
Additional sludge disposal costs	\$ 148,488
Additional maintenance costs	\$ 250,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 9,131,000
TOTAL PRESENT WORTH O&M COSTS	\$ 189,191,000
GRAND TOTAL PRESENT WORTH COST	\$ 318,064,000

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

CCMUA (Delaware #1 WPCP)

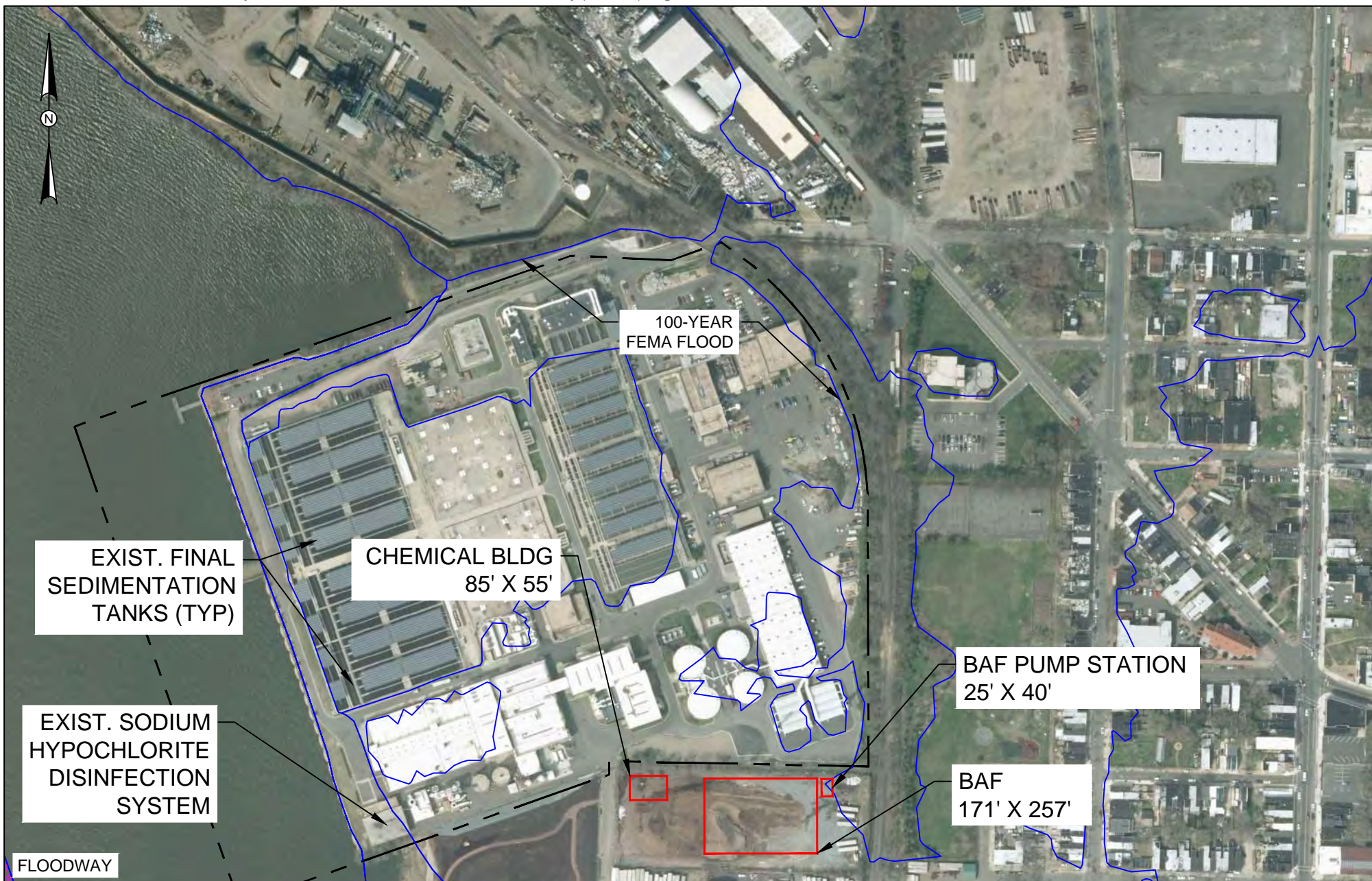
Effluent Level: NH₃-N = 1.5 mg/L and TN = 4.0 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 320,000,000
<i>subtotal</i>	\$ 320,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 80.00 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 27.8 mg/L	
<i>subtotal</i>	\$ 275,612,863
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 12,473,640
Rock Excavation	\$ -
Sheeting during Construction	\$ 3,846,039
Construction Dewatering	\$ 935,523
Land Acquisition	\$ 3,898,013
<i>subtotal</i>	\$ 21,153,215
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 13,354,473
TOTAL PRESENT WORTH CAPITAL COST	<i>310,121,000</i>
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 264,000
Additional chemical costs	\$ 10,819,252
Additional energy costs	\$ 2,378,516
Additional sludge disposal costs	\$ 1,192,222
Additional maintenance costs	\$ 599,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 15,253,000
TOTAL PRESENT WORTH O&M COSTS	\$ 316,036,000
GRAND TOTAL PRESENT WORTH COST	\$ 626,157,000

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



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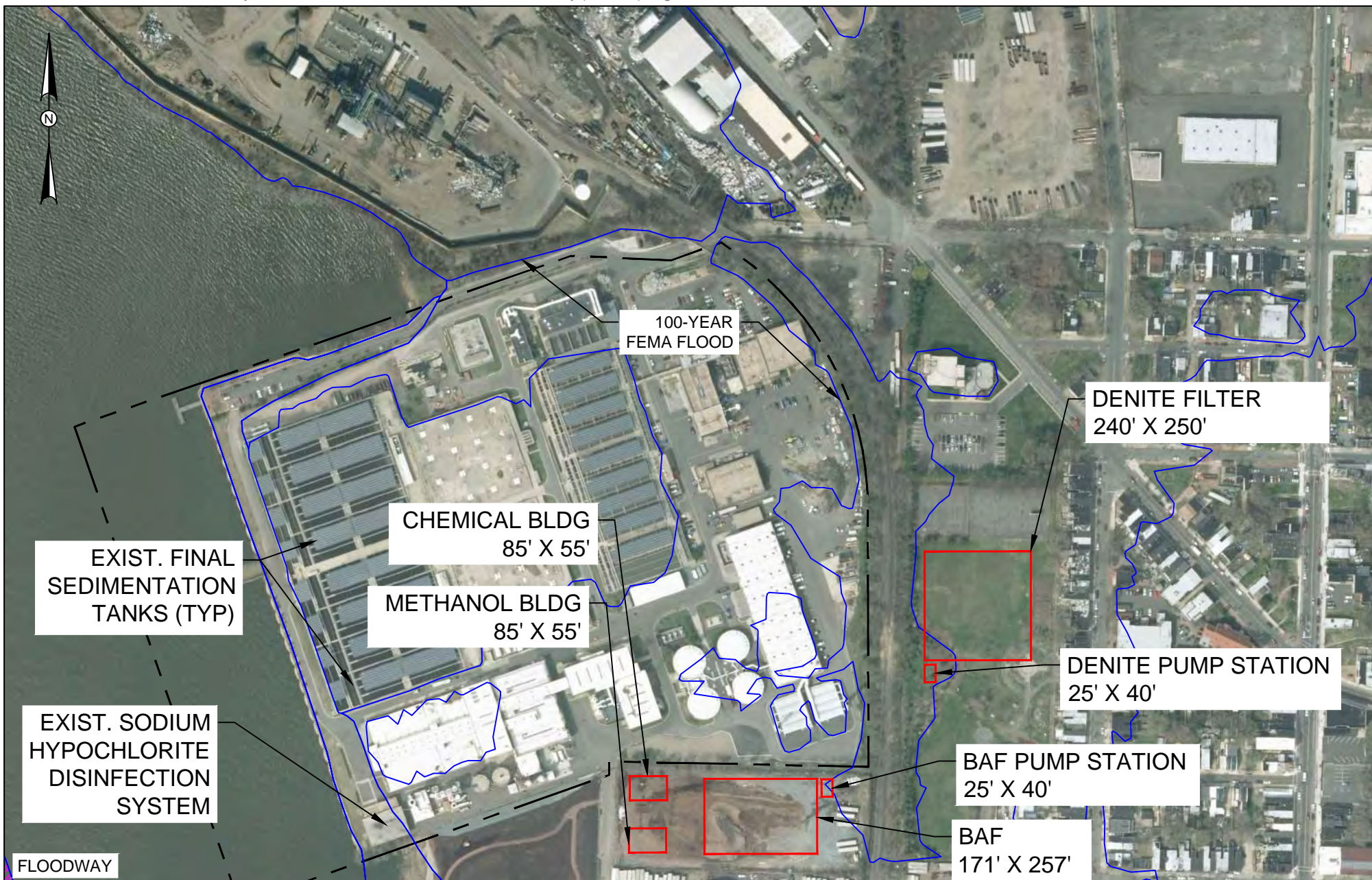
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DELAWARE #1 WPCF (CCMUA)
 CONCEPTUAL SITE PLAN
 NH₃-N = 1.5 mg/l

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE

C-1



0 300 600



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DELAWARE #1 WPCF (CCMUA)
 CONCEPTUAL SITE PLAN
 NH₃-N = 1.5 mg/l & TN = 4.0 mg/l

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE

C-2

Appendix D
PWD SWWPCP Plant Specific Cost Estimates
and
Conceptual Site Plans

DRBC Nitrogen Reduction Cost Estimation Study

PWD Southwest WPCP
Effluent Level: NH₃-N = 10 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 212,000,000
<i>subtotal</i>	\$ 212,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 212 (Maximum Month)	
Max. Monthly Summer Average Ammonia (May-Oct) = 25.5 mg/L	
<i>subtotal</i>	\$ 182,413,146
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 9,055,920
Rock Excavation	\$ -
Sheeting during Construction	\$ 2,792,242
Construction Dewatering	\$ 679,194
Land Acquisition	\$ 14,149,875
<i>subtotal</i>	\$ 26,677,231
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	209,090,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 264,000
Additional chemical costs	\$ 9,790,969
Additional energy costs	\$ 2,631,035
Additional sludge disposal costs	\$ 182,936
Additional maintenance costs	\$ 253,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 13,122,000
TOTAL PRESENT WORTH O&M COSTS	\$ 271,883,000
GRAND TOTAL PRESENT WORTH COST	\$ 480,973,000

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

PWD Southwest WPCP
Effluent Level: NH₃-N = 5 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 275,600,000
<i>subtotal</i>	\$ 275,600,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 212 (Maximum Month)	
Max. Monthly Summer Average Ammonia (May-Oct) = 25.5 mg/L	
<i>subtotal</i>	\$ 235,104,236
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 11,961,720
Rock Excavation	\$ -
Sheeting during Construction	\$ 3,688,197
Construction Dewatering	\$ 897,129
Land Acquisition	\$ 18,690,188
<i>subtotal</i>	\$ 35,237,234
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	270,341,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 264,000
Additional chemical costs	\$ 12,945,276
Additional energy costs	\$ 3,478,662
Additional sludge disposal costs	\$ 241,872
Additional maintenance costs	\$ 441,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 17,371,000
TOTAL PRESENT WORTH O&M COSTS	\$ 359,920,000
GRAND TOTAL PRESENT WORTH COST	\$ 630,261,000

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

PWD Southwest WPCP
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	\$ 339,200,000
<i>subtotal</i>	\$ 339,200,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 212 (Maximum Month)	
Max. Monthly Summer Average Ammonia (May-Oct) = 25.5 mg/L	
<i>subtotal</i>	\$ 271,988,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 14,026,320
Rock Excavation	\$ -
Sheeting during Construction	\$ 4,324,782
Construction Dewatering	\$ 1,051,974
Land Acquisition	\$ 21,916,125
<i>subtotal</i>	\$ 41,319,201
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	313,307,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 352,000
Additional chemical costs	\$ 15,153,290
Additional energy costs	\$ 4,072,002
Additional sludge disposal costs	\$ 283,126
Additional maintenance costs	\$ 663,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 20,523,000
TOTAL PRESENT WORTH O&M COSTS	\$ 425,229,000
GRAND TOTAL PRESENT WORTH COST	\$ 738,536,000

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

PWD Southwest WPCP

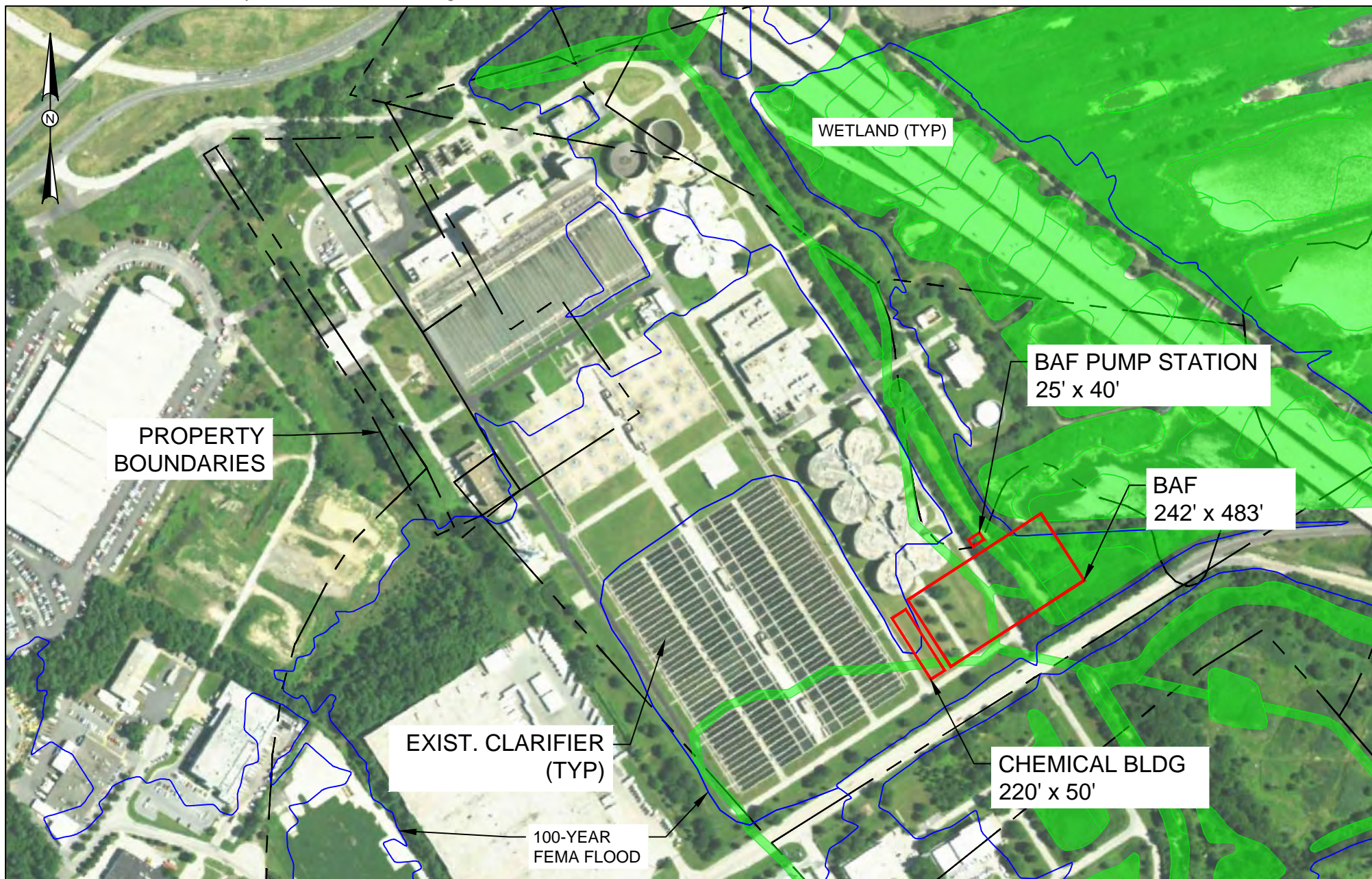
Effluent Level: NH₃-N = 1.5 mg/L & TN = 4.0 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 848,000,000
<i>subtotal</i>	\$ 848,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 212 (Maximum Month)	
Max. Monthly Summer Average Ammonia (May-Oct) = 25.5 mg/L	
<i>subtotal</i>	\$ 688,957,113
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 33,526,320
Rock Excavation	\$ -
Sheeting during Construction	\$ 10,337,282
Construction Dewatering	\$ 2,514,474
Land Acquisition	\$ 52,384,875
<i>subtotal</i>	\$ 98,762,951
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	787,720,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 440,000
Additional chemical costs	\$ 24,315,332
Additional energy costs	\$ 6,303,068
Additional sludge disposal costs	\$ 2,837,384
Additional maintenance costs	\$ 1,588,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 35,484,000
TOTAL PRESENT WORTH O&M COSTS	\$ 735,215,000
GRAND TOTAL PRESENT WORTH COST	\$ 1,522,935,000

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



0 400 800



SCALE: 1" = 400' SCALE IN FEET

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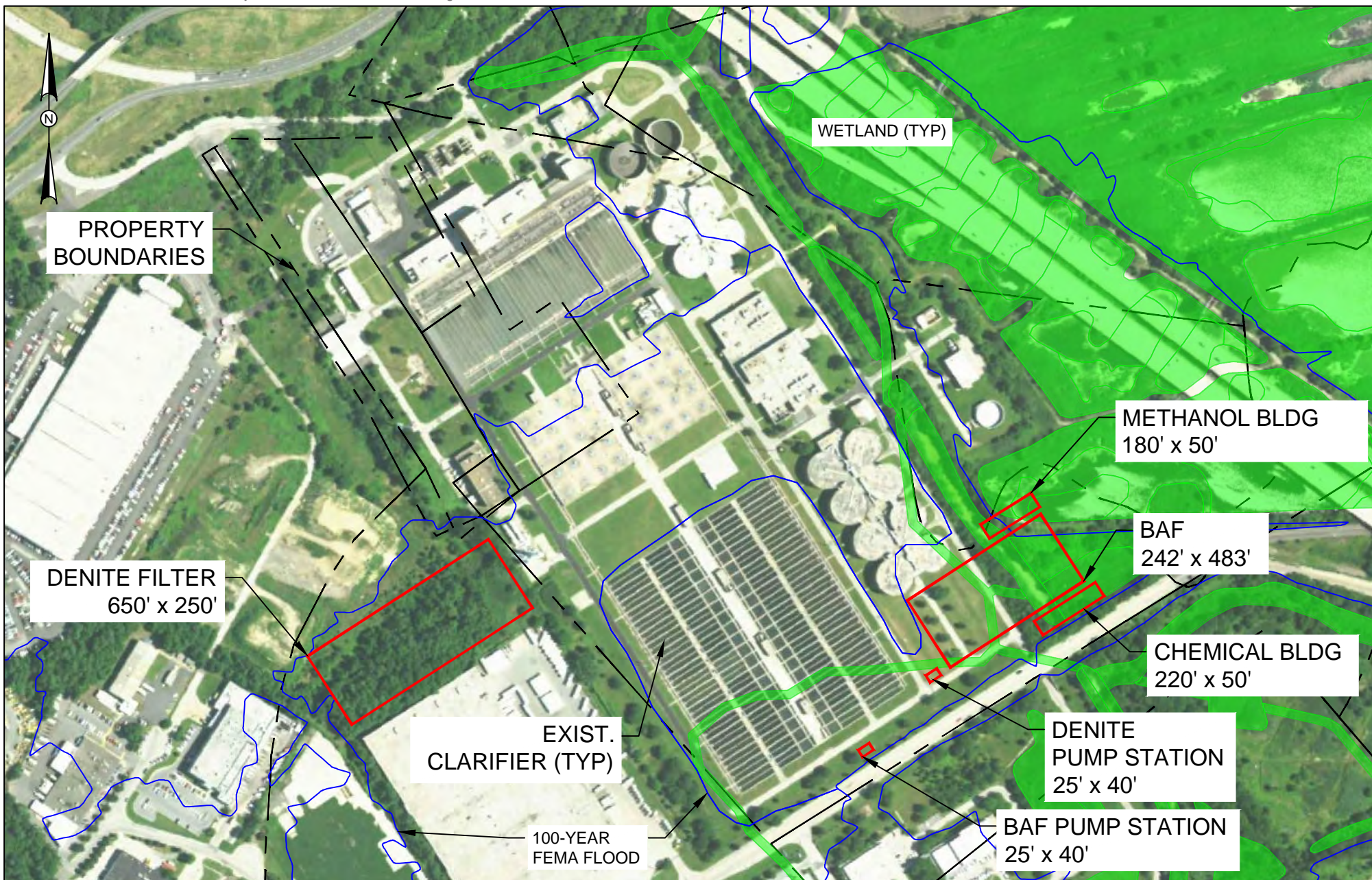
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PWD SOUTHWEST WPCP
CONCEPTUAL SITE PLAN
NH₃-N = 1.5 mg/l

NITROGEN REDUCTION
COST ESTIMATION STUDY
DELAWARE RIVER BASIN COMMISSION

FIGURE

D-1



0 400 800



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PWD SOUTHWEST WPCP
 CONCEPTUAL SITE PLAN
 NH₃-N = 1.5 mg/l & TN = 4.0 mg/l

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE

D-2

Appendix E
Willingboro MUA Plant Specific Cost Estimates
and
Conceptual Site Plans

DRBC Nitrogen Reduction Cost Estimation Study

Willingboro MUA WWTP
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	\$ 19,314,000
<i>subtotal</i>	\$ 19,314,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 5.22 (Permitted Flow)	
Max. Monthly Summer Average Ammonia (May-Oct) = 4.2 mg/L	
<i>subtotal</i>	\$ 25,092,680
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 554,880
Rock Excavation	\$ -
Sheeting during Construction	\$ 171,088
Construction Dewatering	\$ 41,616
Land Acquisition	\$ -
<i>subtotal</i>	\$ 767,584
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	<i>25,860,000</i>
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 88,000
Additional chemical costs	\$ 278
Additional energy costs	\$ 126,080
Additional sludge disposal costs	\$ 6,951
Additional maintenance costs	\$ 37,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 258,000
TOTAL PRESENT WORTH O&M COSTS	\$ 5,346,000
GRAND TOTAL PRESENT WORTH COST	\$ 31,206,000

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

Willingboro MUA WWTP

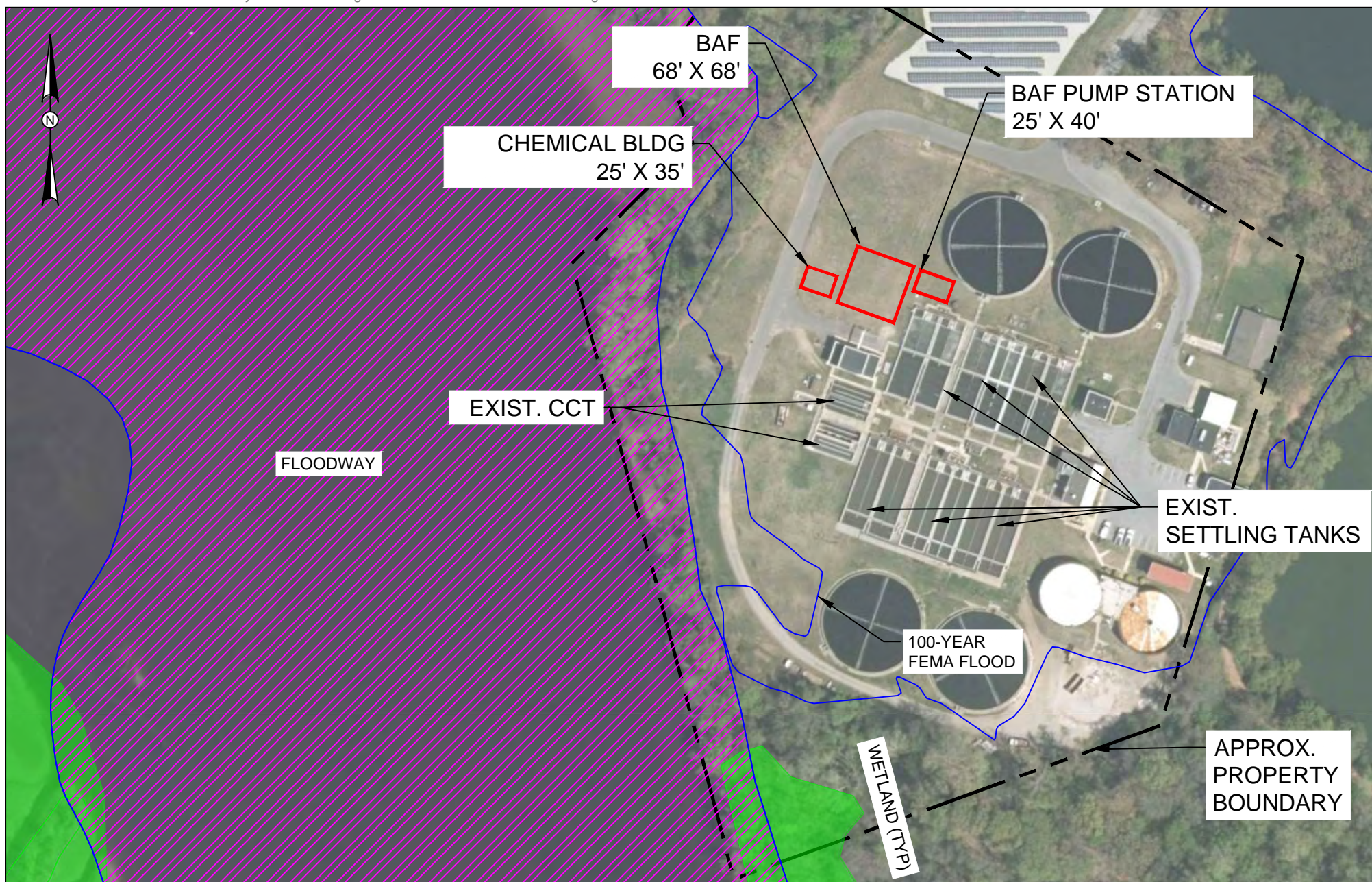
Effluent Level: NH₃-N = 1.5 mg/L and TN = 4.0 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 32,886,000
<i>subtotal</i>	\$ 32,886,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 5.22 (Permitted Flow)	
Max. Monthly Summer Average Ammonia (May-Oct) = 4.2 mg/L	
<i>subtotal</i>	\$ 38,803,858
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 1,034,880
Rock Excavation	\$ -
Sheeting during Construction	\$ 319,088
Construction Dewatering	\$ 77,616
Land Acquisition	\$ -
<i>subtotal</i>	\$ 1,431,584
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	40,235,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 88,000
Additional chemical costs	\$ 157,202
Additional energy costs	\$ 225,443
Additional sludge disposal costs	\$ 53,799
Additional maintenance costs	\$ 56,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 580,000
TOTAL PRESENT WORTH O&M COSTS	\$ 12,017,000
GRAND TOTAL PRESENT WORTH COST	\$ 52,252,000

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



0 150 300



SCALE: 1" = 150' SCALE IN FEET

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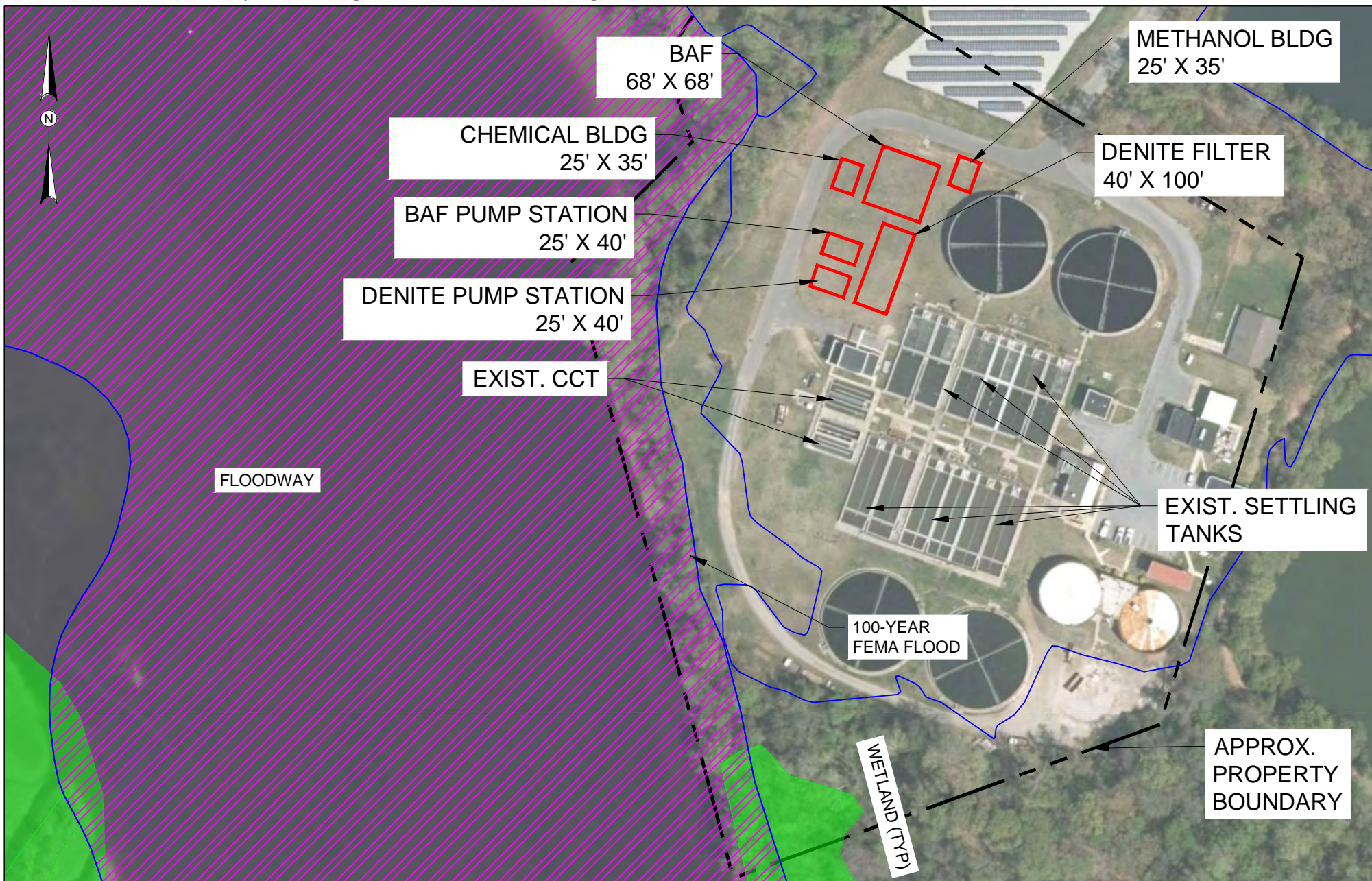
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WILLINGBORO WPCF
 CONCEPTUAL SITE PLAN
 NH₃-N = 1.5 mg/l

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE

E-1



0 150 300



SCALE: 1" = 150' SCALE IN FEET

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WILLINGBORO WPCF
 CONCEPTUAL SITE PLAN
 NH₃-N = 1.5 mg/l & TN = 4.0 mg/l

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE

E-2

Appendix F
Hamilton Township Plant Specific Cost Estimates
and
Conceptual Site Plans

DRBC Nitrogen Reduction Cost Estimation Study

Hamilton Twp WWTP
Effluent Level: NH₃-N = 10 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 31,850,000
<i>subtotal</i>	\$ 31,850,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 12.74 (Build-out Flow)	
Max. Monthly Summer Average Ammonia (May-Oct) = 28.7 mg/L	
<i>subtotal</i>	\$ 29,317,948
Plant-specific base capital cost additions²:	
Pile Foundations	\$ -
Rock Excavation	\$ 573,630
Sheeting during Construction	\$ 286,528
Construction Dewatering	\$ 69,696
Land Acquisition	\$ -
<i>subtotal</i>	\$ 929,854
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	30,248,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 88,000
Additional chemical costs	\$ 827,203
Additional energy costs	\$ 211,582
Additional sludge disposal costs	\$ 73,926
Additional maintenance costs	\$ 43,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 1,244,000
TOTAL PRESENT WORTH O&M COSTS	\$ 25,775,000
GRAND TOTAL PRESENT WORTH COST	\$ 56,023,000

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

Hamilton Twp WWTP
Effluent Level: NH₃-N = 5 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 39,494,000
<i>subtotal</i>	\$ 39,494,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 12.74 (Build-out Flow)	
Max. Monthly Summer Average Ammonia (May-Oct) = 28.7 mg/L	
<i>subtotal</i>	\$ 32,114,190
Plant-specific base capital cost additions²:	
Pile Foundations	\$ -
Rock Excavation	\$ 726,000
Sheeting during Construction	\$ 362,637
Construction Dewatering	\$ 88,209
Land Acquisition	\$ -
<i>subtotal</i>	\$ 1,176,846
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	33,291,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 88,000
Additional chemical costs	\$ 1,048,168
Additional energy costs	\$ 268,101
Additional sludge disposal costs	\$ 93,674
Additional maintenance costs	\$ 66,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 1,564,000
TOTAL PRESENT WORTH O&M COSTS	\$ 32,405,000
GRAND TOTAL PRESENT WORTH COST	\$ 65,696,000

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

Hamilton Twp WWTP
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	\$ 47,138,000
<i>subtotal</i>	\$ 47,138,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 12.74 (Build-out Flow)	
Max. Monthly Summer Average Ammonia (May-Oct) = 28.7 mg/L	
<i>subtotal</i>	\$ 34,071,560
Plant-specific base capital cost additions²:	
Pile Foundations	\$ -
Rock Excavation	\$ 837,778
Sheeting during Construction	\$ 418,470
Construction Dewatering	\$ 101,790
Land Acquisition	\$ -
<i>subtotal</i>	\$ 1,358,038
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	35,430,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 176,000
Additional chemical costs	\$ 1,203,032
Additional energy costs	\$ 307,712
Additional sludge disposal costs	\$ 107,514
Additional maintenance costs	\$ 89,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 1,883,000
TOTAL PRESENT WORTH O&M COSTS	\$ 39,015,000
GRAND TOTAL PRESENT WORTH COST	\$ 74,445,000

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

Hamilton Twp WWTP

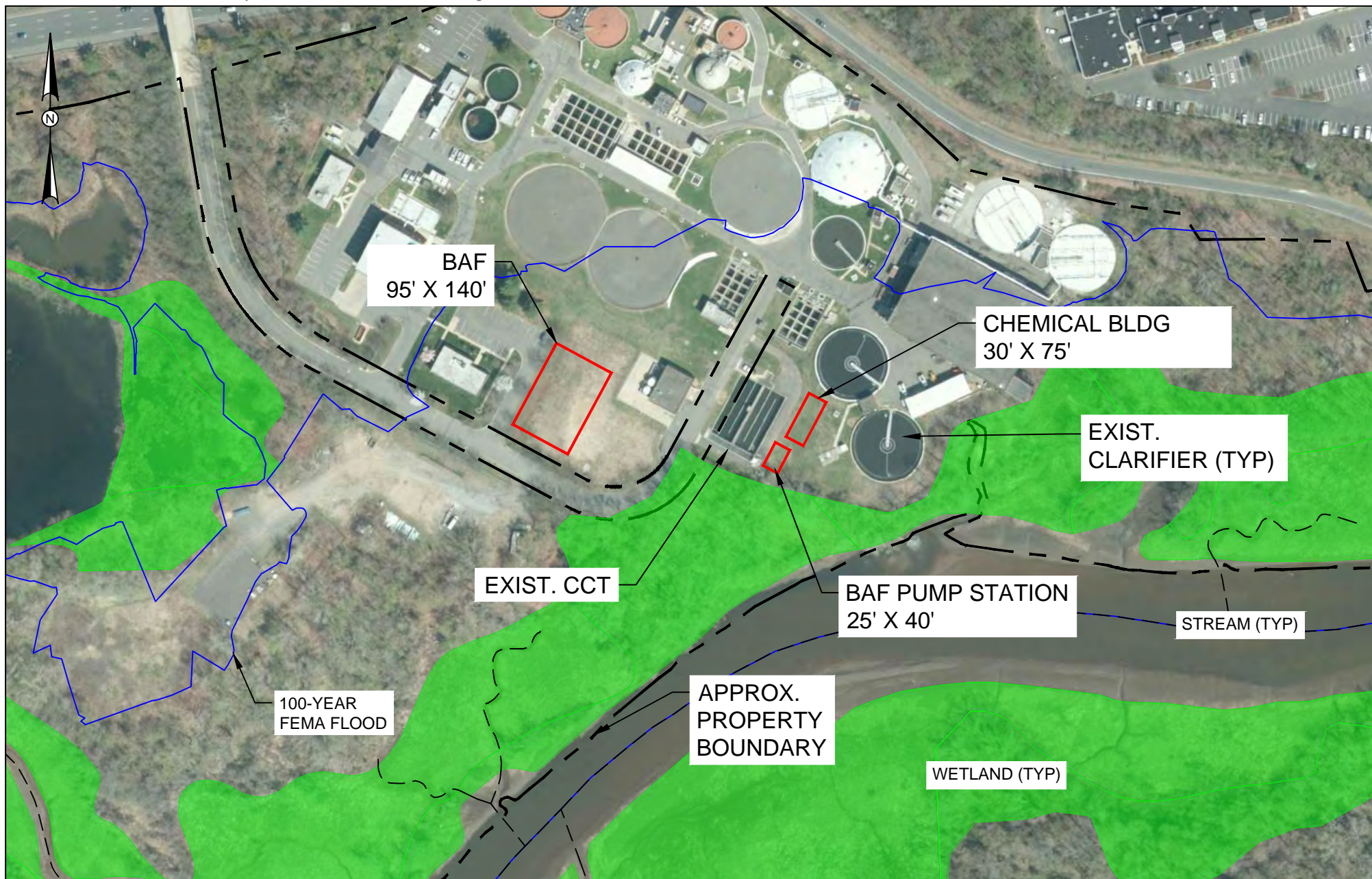
Effluent Level: NH₃-N = 1.5 mg/L and TN = 4 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 80,262,000
<i>subtotal</i>	\$ 80,262,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 12.74 (Build-out Flow)	
Max. Monthly Summer Average Ammonia (May-Oct) = 28.7 mg/L	
<i>subtotal</i>	\$ 55,501,939
Plant-specific base capital cost additions²:	
Pile Foundations	\$ -
Rock Excavation	\$ 1,504,444
Sheeting during Construction	\$ 751,470
Construction Dewatering	\$ 182,790
Land Acquisition	\$ -
<i>subtotal</i>	\$ 2,438,704
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	57,941,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 176,000
Additional chemical costs	\$ 1,829,539
Additional energy costs	\$ 550,218
Additional sludge disposal costs	\$ 278,749
Additional maintenance costs	\$ 137,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 2,972,000
TOTAL PRESENT WORTH O&M COSTS	\$ 61,579,000
GRAND TOTAL PRESENT WORTH COST	\$ 119,520,000

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



0 200 400



SCALE: 1" = 200' SCALE IN FEET

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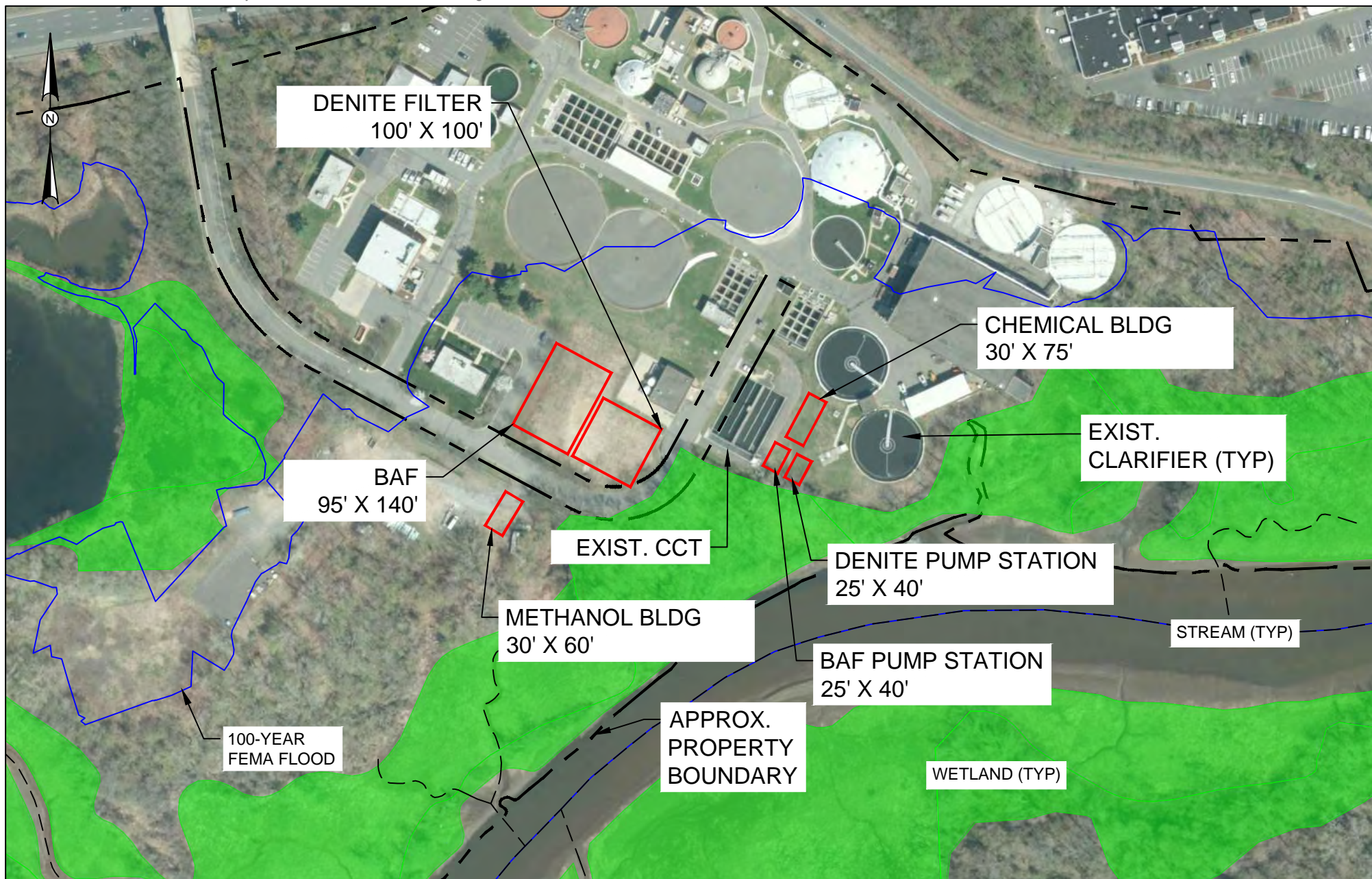
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HAMILTON TWP WPCF
 CONCEPTUAL SITE PLAN
 NH₃-N = 1.5 mg/l

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE

F-1



0 200 400



SCALE: 1" = 200' SCALE IN FEET

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HAMILTON TWP WPCF
 CONCEPTUAL SITE PLAN
 NH₃-N = 1.5 mg/l & TN = 4.0 mg/l

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE

F-2

Appendix G
Trenton Sewer Utility Plant Specific Cost Estimates
and
Conceptual Site Plans

DRBC Nitrogen Reduction Cost Estimation Study

Trenton Sewer Utility
Effluent Level: NH₃-N = 10 mg/L

Description	Amount
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 37,125,000
<i>subtotal</i>	\$ 37,125,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 15.46 (Future Flow multiplied by peaking factor)	
Max. Monthly Summer Average Ammonia (May-Oct) = 12.3 mg/L	
Assumed that the 3rd trickling filter would treat to 10 mg/L, no need for BAF; perform upgrades to Alkalinity Storage feed system	
<i>subtotal</i>	\$ 1,100,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ -
Rock Excavation	\$ -
Sheeting during Construction	\$ -
Construction Dewatering	\$ -
Land Acquisition	\$ -
<i>subtotal</i>	\$ -
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	1,100,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ -
Additional chemical costs	\$ 76
Additional energy costs	\$ 20,817
Additional sludge disposal costs	\$ 1,899
Additional maintenance costs	\$ -
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 23,000
TOTAL PRESENT WORTH O&M COSTS	\$ 477,000
GRAND TOTAL PRESENT WORTH COST	\$ 1,577,000

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

Trenton Sewer Utility
Effluent Level: NH₃-N = 5 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 46,035,000
<i>subtotal</i>	\$ 46,035,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 15.46 (Future Flow multiplied by peaking factor)	
Max. Monthly Summer Average Ammonia (May-Oct) = 12.3 mg/L	
<i>subtotal</i>	\$ 29,289,941
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 929,280
Rock Excavation	\$ -
Sheeting during Construction	\$ 286,528
Construction Dewatering	\$ 69,696
Land Acquisition	\$ -
<i>subtotal</i>	\$ 1,285,504
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	30,575,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 88,000
Additional chemical costs	\$ 890
Additional energy costs	\$ 211,099
Additional sludge disposal costs	\$ 22,256
Additional maintenance costs	\$ 52,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 374,000
TOTAL PRESENT WORTH O&M COSTS	\$ 7,749,000
GRAND TOTAL PRESENT WORTH COST	\$ 38,324,000

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

Trenton Sewer Utility
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	\$ 54,945,000
<i>subtotal</i>	\$ 54,945,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 15.46 (Future Flow multiplied by peaking factor)	
Max. Monthly Summer Average Ammonia (May-Oct) = 12.3 mg/L	
<i>subtotal</i>	\$ 36,590,900
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 1,562,400
Rock Excavation	\$ -
Sheeting during Construction	\$ 481,740
Construction Dewatering	\$ 117,180
Land Acquisition	\$ -
<i>subtotal</i>	\$ 2,161,320
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	38,752,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 176,000
Additional chemical costs	\$ 1,513
Additional energy costs	\$ 358,675
Additional sludge disposal costs	\$ 37,815
Additional maintenance costs	\$ 104,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 678,000
TOTAL PRESENT WORTH O&M COSTS	\$ 14,048,000
GRAND TOTAL PRESENT WORTH COST	\$ 52,800,000

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

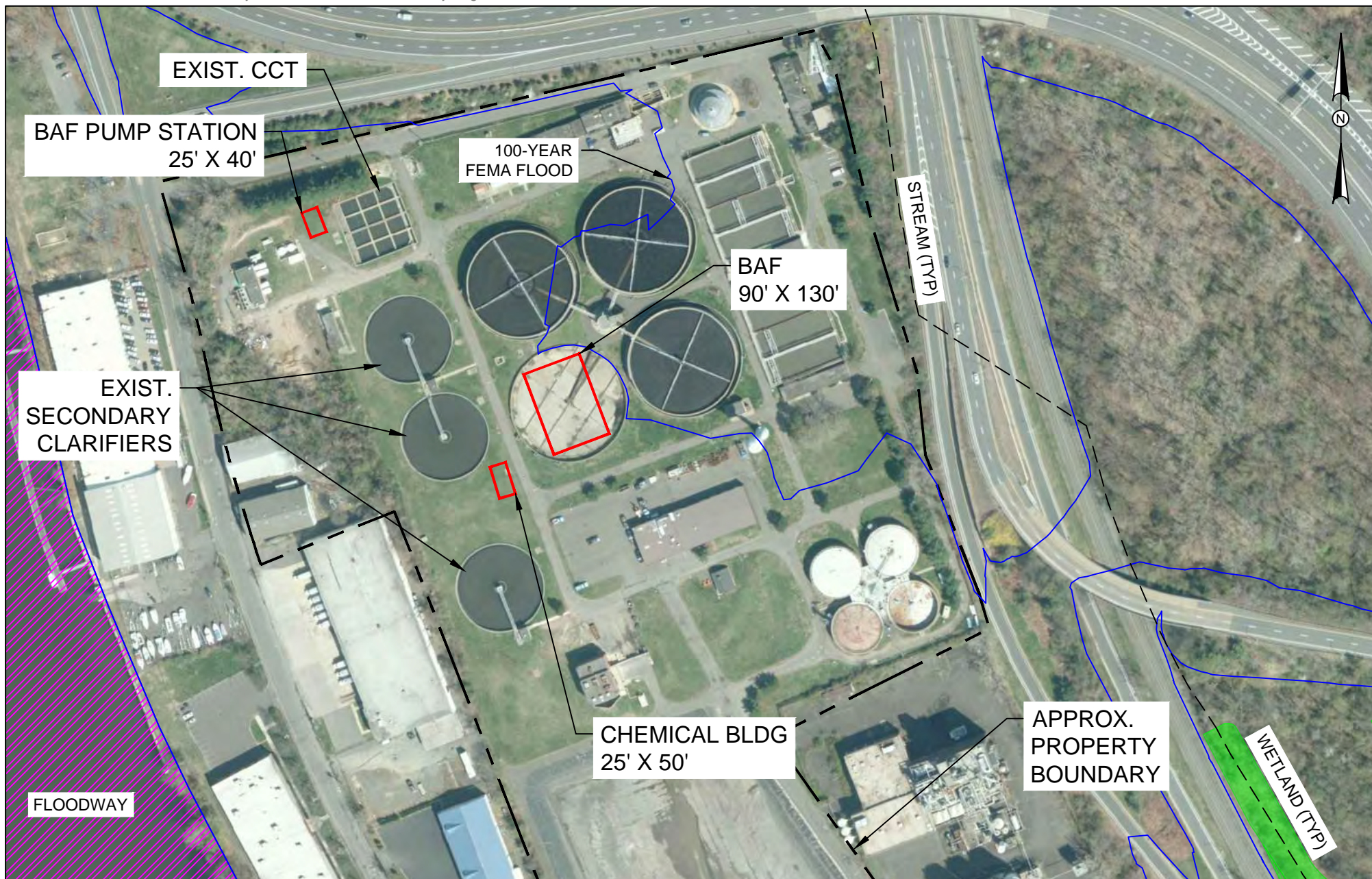
Trenton Sewer Utility
Effluent Level: NH₃-N = 1.5 mg/L and TN = 4.0 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 93,555,000
<i>subtotal</i>	\$ 93,555,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 15.46 (Future Flow multiplied by peaking factor)	
Max. Monthly Summer Average Ammonia (May-Oct) = 12.3 mg/L	
<i>subtotal</i>	\$ 60,536,913
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 2,762,400
Rock Excavation	\$ -
Sheeting during Construction	\$ 851,740
Construction Dewatering	\$ 207,180
Land Acquisition	\$ -
<i>subtotal</i>	\$ 3,821,320
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	64,358,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 176,000
Additional chemical costs	\$ 275,399
Additional energy costs	\$ 641,345
Additional sludge disposal costs	\$ 130,777
Additional maintenance costs	\$ 159,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 1,383,000
TOTAL PRESENT WORTH O&M COSTS	\$ 28,655,000
GRAND TOTAL PRESENT WORTH COST	\$ 93,013,000

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



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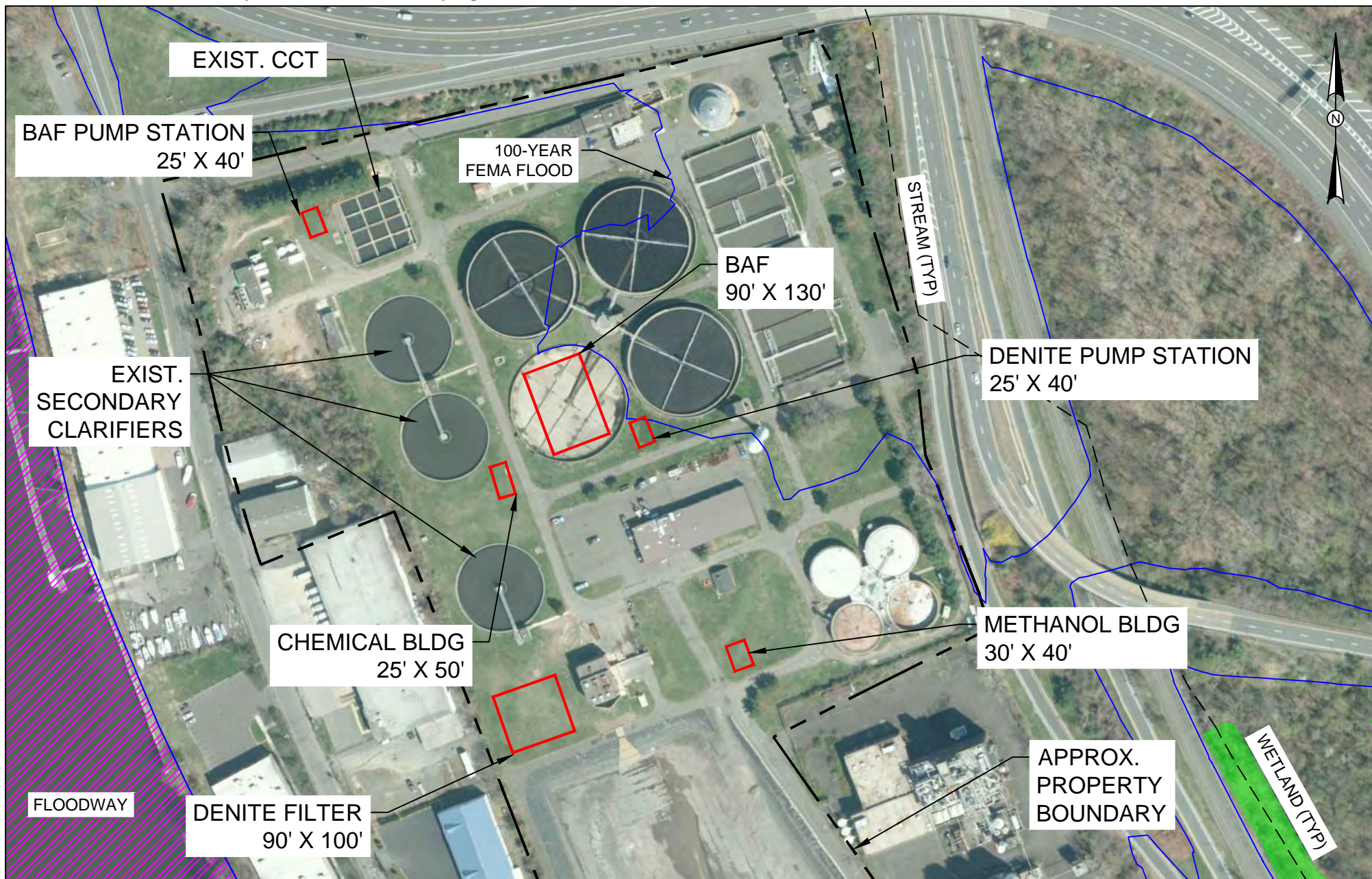
PROJECT NO. 6736
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 DATE: 05-20-2020
 REVISED: ---

TRENTON SEWER UTILITY
 CONCEPTUAL SITE PLAN
 NH₃-N = 1.5 mg/l

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE

G-1



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TRENTON SEWER UTILITY
 CONCEPTUAL SITE PLAN
 NH₃-N = 1.5 mg/l & TN = 4.0 mg/l

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE

G-2

Appendix H
LBCJMA Plant Specific Cost Estimates
and
Conceptual Site Plans

DRBC Nitrogen Reduction Cost Estimation Study

Lower Bucks County Joint MA WWTP

Effluent Level: NH₃-N = 10 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 5,600,000
<i>subtotal</i>	\$ 5,600,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 11.2 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 33 mg/L	
<i>subtotal</i>	\$ 5,600,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ -
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,139,156
Construction Dewatering	\$ 277,092
Land Acquisition	\$ 2,032,008
<i>subtotal</i>	\$ 3,448,256
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 407,172
TOTAL PRESENT WORTH CAPITAL COST	9,455,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ -
Additional chemical costs	\$ 719,093
Additional energy costs	\$ 127,977
Additional sludge disposal costs	\$ 14,322
Additional maintenance costs	\$ 6,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 867,000
TOTAL PRESENT WORTH O&M COSTS	\$ 17,964,000
GRAND TOTAL PRESENT WORTH COST	\$ 27,419,000

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

Lower Bucks County Joint MA WWTP

Effluent Level: NH₃-N = 10 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 5,600,000
<i>subtotal</i>	\$ 5,600,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 11.2 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 33 mg/L	
<i>subtotal</i>	\$ 5,600,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ -
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,139,156
Construction Dewatering	\$ 277,092
Land Acquisition	\$ 2,032,008
<i>subtotal</i>	\$ 3,448,256
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 407,172
TOTAL PRESENT WORTH CAPITAL COST	9,455,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ -
Additional chemical costs	\$ 1,118,396
Additional energy costs	\$ 155,098
Additional sludge disposal costs	\$ 17,436
Additional maintenance costs	\$ 30,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 1,321,000
TOTAL PRESENT WORTH O&M COSTS	\$ 27,371,000
GRAND TOTAL PRESENT WORTH COST	\$ 36,826,000

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

Lower Bucks County Joint MA WWTP

Effluent Level: NH₃-N = 10 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 5,600,000
<i>subtotal</i>	\$ 5,600,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 11.2 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 33 mg/L	
<i>subtotal</i>	\$ 5,600,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ -
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,139,156
Construction Dewatering	\$ 277,092
Land Acquisition	\$ 2,032,008
<i>subtotal</i>	\$ 3,448,256
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 407,172
TOTAL PRESENT WORTH CAPITAL COST	9,455,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ -
Additional chemical costs	\$ 1,397,908
Additional energy costs	\$ 174,083
Additional sludge disposal costs	\$ 19,616
Additional maintenance costs	\$ 37,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 1,629,000
TOTAL PRESENT WORTH O&M COSTS	\$ 33,752,000
GRAND TOTAL PRESENT WORTH COST	\$ 43,207,000

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

Lower Bucks County Joint MA WWTP

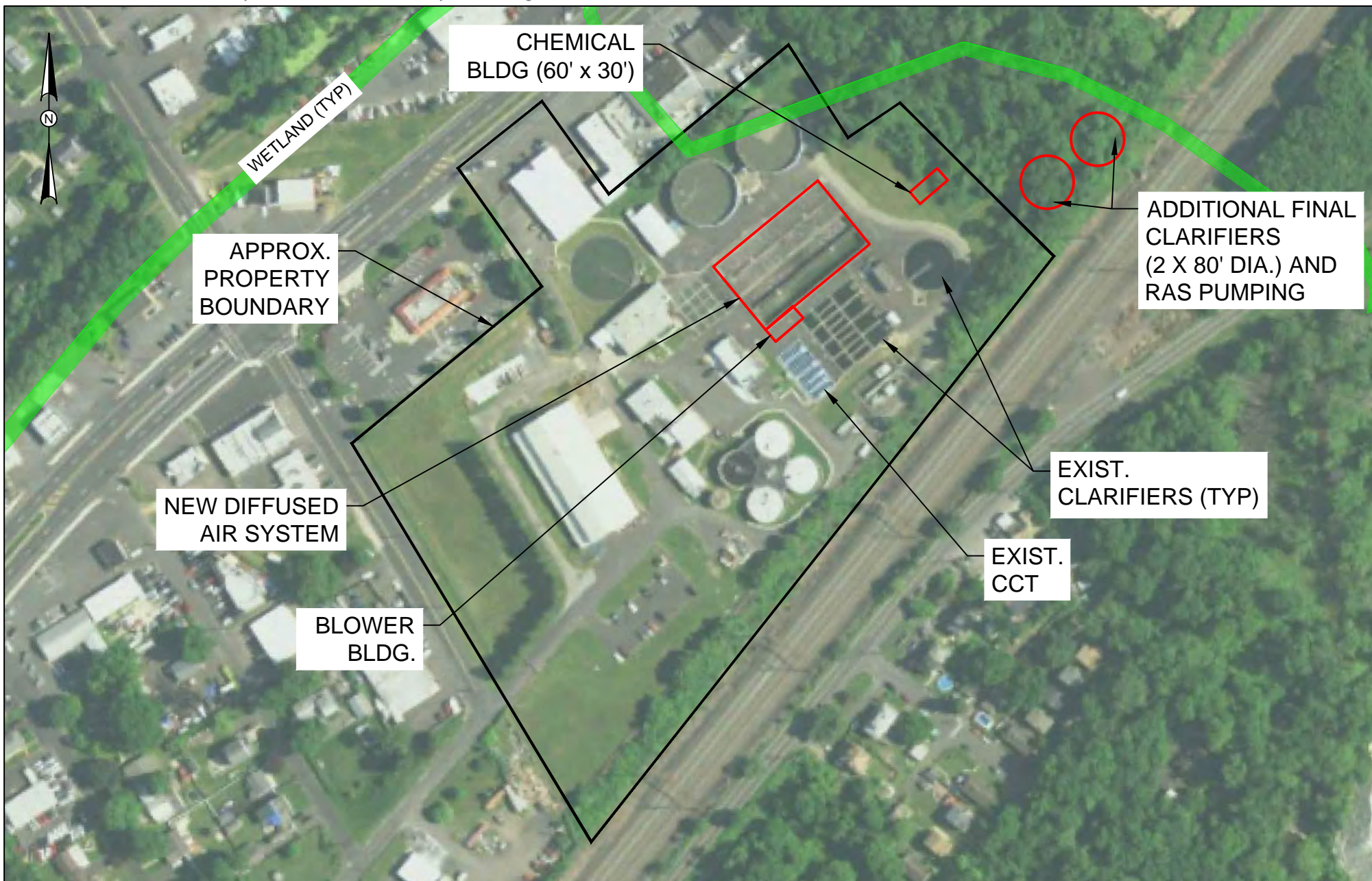
Effluent Level: NH₃-N = 10 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 26,978,695
<i>subtotal</i>	\$ 26,978,695
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 11.2 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 33 mg/L	
<i>subtotal</i>	\$ 26,978,695
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 4,774,560
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,472,156
Construction Dewatering	\$ 358,092
Land Acquisition	\$ 2,626,008
<i>subtotal</i>	\$ 9,230,816
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 1,629,428
TOTAL PRESENT WORTH CAPITAL COST	37,839,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 176,000
Additional chemical costs	\$ 2,038,933
Additional energy costs	\$ 387,275
Additional sludge disposal costs	\$ 191,239
Additional maintenance costs	\$ 72,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 2,865,000
TOTAL PRESENT WORTH O&M COSTS	\$ 59,362,000
GRAND TOTAL PRESENT WORTH COST	\$ 97,201,000

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



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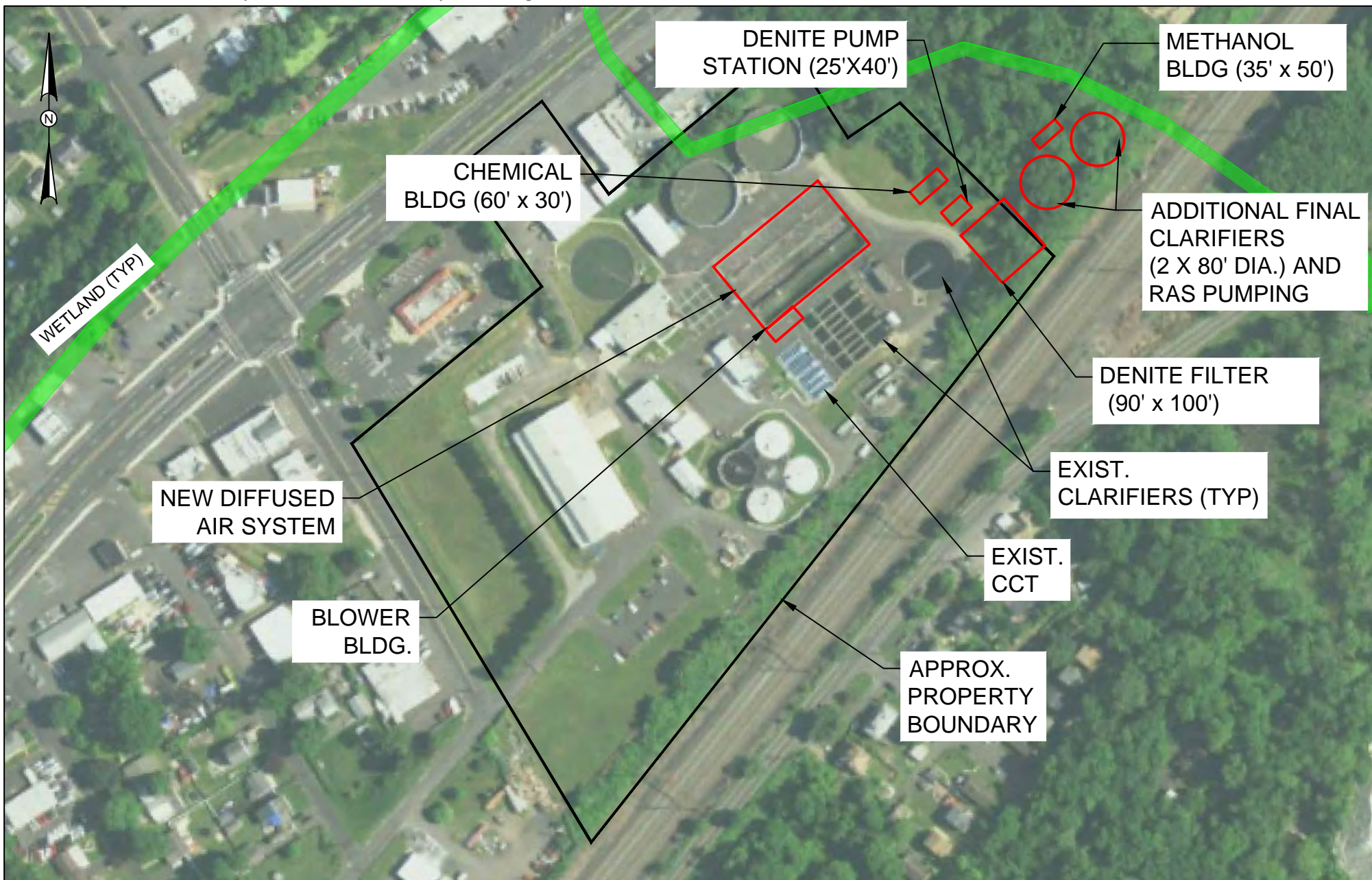
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LOWER BUCKS COUNTY JOINT MA
CONCEPTUAL SITE PLAN
NH₃-N = 1.5 mg/l

NITROGEN REDUCTION
COST ESTIMATION STUDY
DELAWARE RIVER BASIN COMMISSION

FIGURE

H-1



0 200 400



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LOWER BUCKS COUNTY JOINT MA
CONCEPTUAL SITE PLAN
NH₃-N = 1.5 mg/l & TN = 4.0 mg/l

NITROGEN REDUCTION
COST ESTIMATION STUDY
DELAWARE RIVER BASIN COMMISSION

FIGURE

H-2

Appendix I
GCUA Plant Specific Cost Estimates
and
Conceptual Site Plans

DRBC Nitrogen Reduction Cost Estimation Study

GCUA

Effluent Level: NH₃-N = 10 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 13,500,000
<i>subtotal</i>	\$ 13,500,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 27 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 32.40 mg/L	
<i>subtotal</i>	\$ 13,500,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 3,694,560
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,139,156
Construction Dewatering	\$ 277,092
Land Acquisition	\$ -
<i>subtotal</i>	\$ 5,110,808
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 837,486
TOTAL PRESENT WORTH CAPITAL COST	<i>19,448,000</i>
Plant-specific annual O&M costs:	
Additional personnel costs	\$ -
Additional chemical costs	\$ 1,618,016
Additional energy costs	\$ 330,965
Additional sludge disposal costs	\$ 33,627
Additional maintenance costs	\$ 15,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 1,998,000
TOTAL PRESENT WORTH O&M COSTS	\$ 41,398,000
GRAND TOTAL PRESENT WORTH COST	\$ 60,846,000

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

GCUA

Effluent Level: NH₃-N = 5 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 13,500,000
<i>subtotal</i>	\$ 13,500,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 27 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 32.40 mg/L	
<i>subtotal</i>	\$ 13,500,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 3,694,560
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,139,156
Construction Dewatering	\$ 277,092
Land Acquisition	\$ -
<i>subtotal</i>	\$ 5,110,808
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 837,486
TOTAL PRESENT WORTH CAPITAL COST	19,448,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ -
Additional chemical costs	\$ 2,580,621
Additional energy costs	\$ 401,376
Additional sludge disposal costs	\$ 41,133
Additional maintenance costs	\$ 73,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 3,096,000
TOTAL PRESENT WORTH O&M COSTS	\$ 64,148,000
GRAND TOTAL PRESENT WORTH COST	\$ 83,596,000

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

GCUA

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	\$ 13,500,000
<i>subtotal</i>	\$ 13,500,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 27 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 32.40 mg/L	
<i>subtotal</i>	\$ 13,500,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 3,694,560
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,139,156
Construction Dewatering	\$ 277,092
Land Acquisition	\$ -
<i>subtotal</i>	\$ 5,110,808
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 837,486
TOTAL PRESENT WORTH CAPITAL COST	19,448,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ -
Additional chemical costs	\$ 3,254,444
Additional energy costs	\$ 450,663
Additional sludge disposal costs	\$ 46,387
Additional maintenance costs	\$ 90,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 3,841,000
TOTAL PRESENT WORTH O&M COSTS	\$ 79,584,000
GRAND TOTAL PRESENT WORTH COST	\$ 99,032,000

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

GCUA

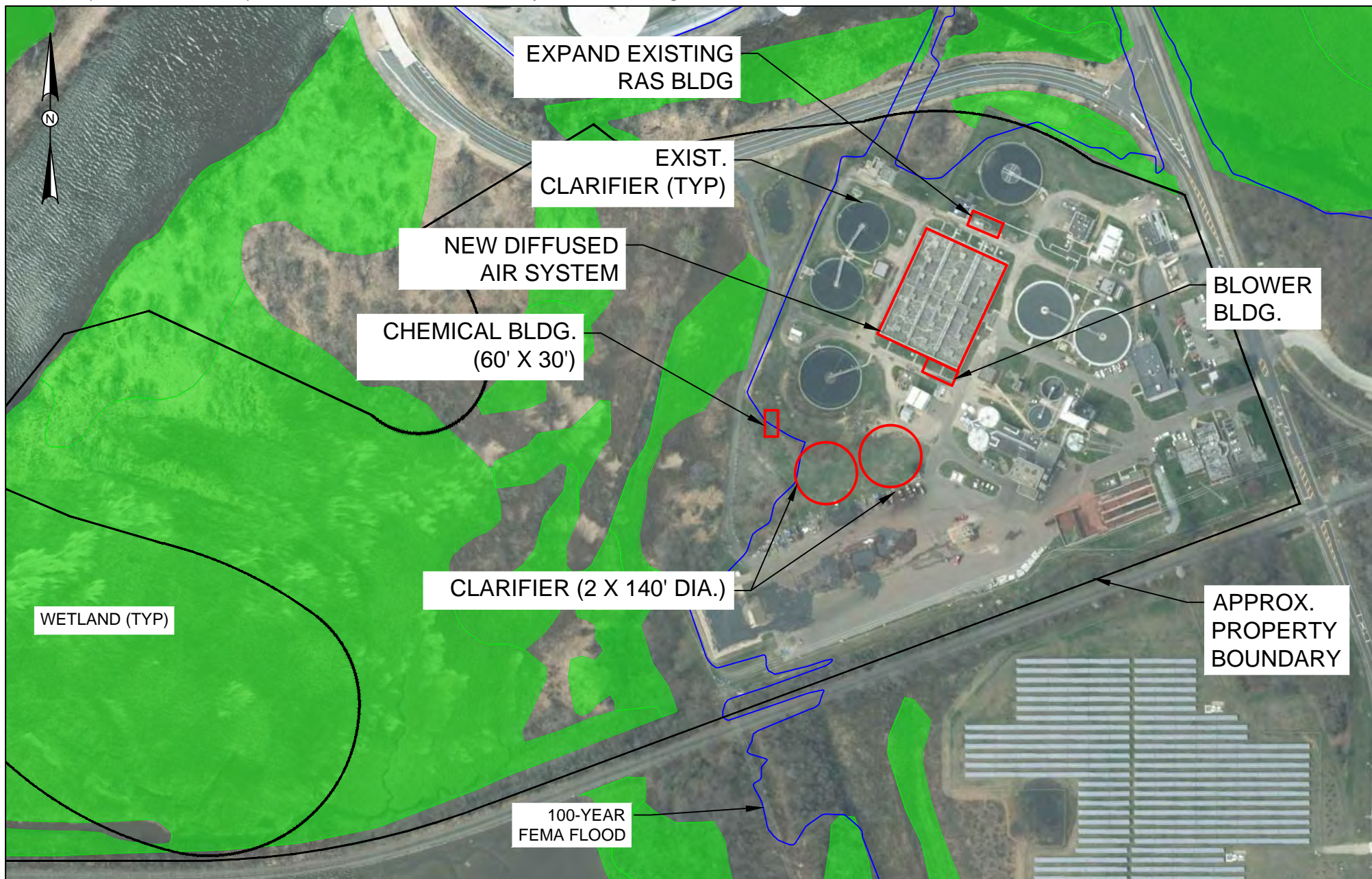
Effluent Level: NH₃-N = 1.5 mg/L and TN = 4.0 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 56,233,380
<i>subtotal</i>	\$ 56,233,380
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 27 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 32.40 mg/L	
<i>subtotal</i>	\$ 56,233,380
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 5,806,560
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,790,356
Construction Dewatering	\$ 435,492
Land Acquisition	\$ -
<i>subtotal</i>	\$ 8,032,408
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 2,891,960
TOTAL PRESENT WORTH CAPITAL COST	<i>67,158,000</i>
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 176,000
Additional chemical costs	\$ 4,771,115
Additional energy costs	\$ 734,808
Additional sludge disposal costs	\$ 495,561
Additional maintenance costs	\$ 174,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 6,351,000
TOTAL PRESENT WORTH O&M COSTS	\$ 131,590,000
GRAND TOTAL PRESENT WORTH COST	\$ 198,748,000

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



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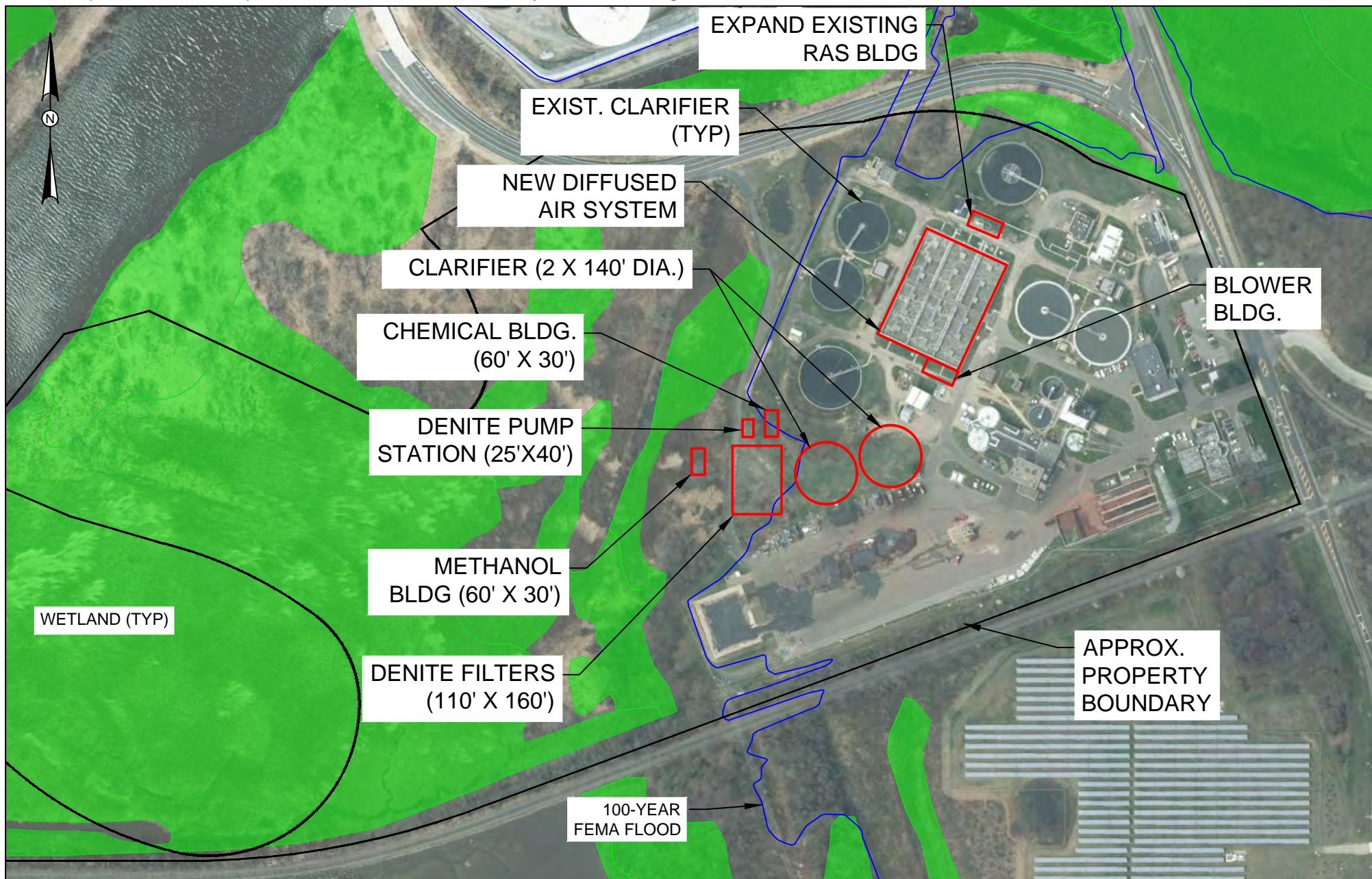
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GCUA
 CONCEPTUAL SITE PLAN
 NH₃-N = 1.5 mg/l

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE

I-1



0 300 600



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GCUA
 CONCEPTUAL SITE PLAN
 NH₃-N = 1.5 mg/l & TN = 4.0 mg/l

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE

I-2

Appendix J
DELCORA Plant Specific Cost Estimates
and
Conceptual Site Plans

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	\$ 25,000,000
<i>subtotal</i>	\$ 25,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 50 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 18.43 mg/L	
<i>subtotal</i>	\$ 25,000,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 3,694,560
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,139,156
Construction Dewatering	\$ 277,092
Land Acquisition	\$ -
<i>subtotal</i>	\$ 5,110,808
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 1,354,986
TOTAL PRESENT WORTH CAPITAL COST	31,466,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ -
Additional chemical costs	\$ 2,321
Additional energy costs	\$ 268,057
Additional sludge disposal costs	\$ 54,100
Additional maintenance costs	\$ 28,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 352,000
TOTAL PRESENT WORTH O&M COSTS	\$ 7,293,000
GRAND TOTAL PRESENT WORTH COST	\$ 38,759,000

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	\$ 80,000,000
<i>subtotal</i>	\$ 80,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 50 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 18.43 mg/L	
<i>subtotal</i>	\$ 80,000,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 3,694,560
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,139,156
Construction Dewatering	\$ 277,092
Land Acquisition	\$ -
<i>subtotal</i>	\$ 5,110,808
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 3,829,986
TOTAL PRESENT WORTH CAPITAL COST	88,941,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 88,000
Additional chemical costs	\$ 1,072,515
Additional energy costs	\$ 367,766
Additional sludge disposal costs	\$ 76,642
Additional maintenance costs	\$ 134,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 1,739,000
TOTAL PRESENT WORTH O&M COSTS	\$ 36,031,000
GRAND TOTAL PRESENT WORTH COST	\$ 124,972,000

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	\$ 90,000,000
<i>subtotal</i>	\$ 90,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 50 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 18.43 mg/L	
<i>subtotal</i>	\$ 90,000,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 3,694,560
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,139,156
Construction Dewatering	\$ 277,092
Land Acquisition	\$ -
<i>subtotal</i>	\$ 5,110,808
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 4,279,986
TOTAL PRESENT WORTH CAPITAL COST	99,391,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ -
Additional chemical costs	\$ 2,320,623
Additional energy costs	\$ 558,974
Additional sludge disposal costs	\$ 92,421
Additional maintenance costs	\$ 166,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 3,138,000
TOTAL PRESENT WORTH O&M COSTS	\$ 65,018,000
GRAND TOTAL PRESENT WORTH COST	\$ 164,409,000

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	\$ 170,000,000
<i>subtotal</i>	\$ 170,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 50 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 18.43 mg/L	
<i>subtotal</i>	\$ 170,000,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 7,534,560
Rock Excavation	\$ -
Sheeting during Construction	\$ 2,323,156
Construction Dewatering	\$ 565,092
Land Acquisition	\$ -
<i>subtotal</i>	\$ 10,422,808
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ 8,119,026
TOTAL PRESENT WORTH CAPITAL COST	188,542,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 264,000
Additional chemical costs	\$ 4,170,623
Additional energy costs	\$ 1,085,169
Additional sludge disposal costs	\$ 1,024,240
Additional maintenance costs	\$ 323,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 6,867,000
TOTAL PRESENT WORTH O&M COSTS	\$ 142,282,000
GRAND TOTAL PRESENT WORTH COST	\$ 330,824,000

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



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

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE

J-1



0 300 600



SCALE: 1" = 300' SCALE IN FEET

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PROJECT NO. 6736
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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

Appendix K
PWD SEWPCP Plant Specific Cost Estimates
and
Conceptual Site Plans

DRBC Nitrogen Reduction Cost Estimation Study

PWD Southeast WPCP
Effluent Level: NH₃-N = 10 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 55,000,000
<i>subtotal</i>	\$ 55,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 110.0 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 12.38 mg/L	
<i>subtotal</i>	\$ 55,000,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 3,694,560
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,139,156
Construction Dewatering	\$ 277,092
Land Acquisition	\$ 5,772,750
<i>subtotal</i>	\$ 10,883,558
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	65,884,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 176,000
Additional chemical costs	\$ 245
Additional energy costs	\$ 120,630
Additional sludge disposal costs	\$ 6,116
Additional maintenance costs	\$ 62,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 365,000
TOTAL PRESENT WORTH O&M COSTS	\$ 7,563,000
GRAND TOTAL PRESENT WORTH COST	\$ 73,447,000

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

PWD Southeast WPCP
Effluent Level: NH₃-N = 5 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 55,000,000
<i>subtotal</i>	\$ 55,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 110.0 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 12.38 mg/L	
<i>subtotal</i>	\$ 55,000,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 3,694,560
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,139,156
Construction Dewatering	\$ 277,092
Land Acquisition	\$ 5,772,750
<i>subtotal</i>	\$ 10,883,558
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	65,884,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 176,000
Additional chemical costs	\$ 1,468
Additional energy costs	\$ 407,487
Additional sludge disposal costs	\$ 36,696
Additional maintenance costs	\$ 295,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 917,000
TOTAL PRESENT WORTH O&M COSTS	\$ 19,000,000
GRAND TOTAL PRESENT WORTH COST	\$ 84,884,000

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

PWD Southeast WPCP
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	\$ 198,000,000
<i>subtotal</i>	\$ 198,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 110.0 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 12.38 mg/L	
<i>subtotal</i>	\$ 198,000,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 3,694,560
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,139,156
Construction Dewatering	\$ 277,092
Land Acquisition	\$ 5,772,750
<i>subtotal</i>	\$ 10,883,558
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	208,884,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 176,000
Additional chemical costs	\$ 2,324
Additional energy costs	\$ 755,952
Additional sludge disposal costs	\$ 58,102
Additional maintenance costs	\$ 366,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 1,358,000
TOTAL PRESENT WORTH O&M COSTS	\$ 28,137,000
GRAND TOTAL PRESENT WORTH COST	\$ 237,021,000

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

PWD Southeast WPCP

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	\$ 374,000,000
<i>subtotal</i>	\$ 374,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 110.0 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 12.38 mg/L	
<i>subtotal</i>	\$ 374,000,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 10,894,560
Rock Excavation	\$ -
Sheeting during Construction	\$ 3,359,156
Construction Dewatering	\$ 817,092
Land Acquisition	\$ 17,022,750
<i>subtotal</i>	\$ 32,093,558
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	406,094,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 264,000
Additional chemical costs	\$ 1,763,135
Additional energy costs	\$ 1,913,581
Additional sludge disposal costs	\$ 684,095
Additional maintenance costs	\$ 710,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 5,335,000
TOTAL PRESENT WORTH O&M COSTS	\$ 110,539,000
GRAND TOTAL PRESENT WORTH COST	\$ 516,633,000

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



0 400 800



SCALE: 1" = 400' SCALE IN FEET

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PWD SOUTHEAST WPCP
 CONCEPTUAL SITE PLAN
 NH₃-N = 1.5 mg/l

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE

K-1



0 400 800



SCALE: 1" = 400' SCALE IN FEET

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PWD SOUTHEAST WPCP
 CONCEPTUAL SITE PLAN
 NH₃-N = 1.5 mg/l & TN = 4.0 mg/l

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE

K-2

Appendix L
Wilmington Plant Specific Cost Estimates
and
Conceptual Site Plans

DRBC Nitrogen Reduction Cost Estimation Study

City of Wilmington WWTP
Effluent Level: NH₃-N = 10 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 67,000,000
<i>subtotal</i>	\$ 67,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 134 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 48.30 mg/L	
Two Final Clarifiers, Diam. = 160' Ea. (increased from 140' Diam.)	\$ 120,000
<i>subtotal</i>	\$ 67,120,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 4,776,960
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,472,896
Construction Dewatering	\$ 358,272
Land Acquisition	\$ -
<i>subtotal</i>	\$ 6,608,128
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	73,728,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ -
Additional chemical costs	\$ 3,653
Additional energy costs	\$ 872,508
Additional sludge disposal costs	\$ 91,320
Additional maintenance costs	\$ 76,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 1,043,000
TOTAL PRESENT WORTH O&M COSTS	\$ 21,611,000
GRAND TOTAL PRESENT WORTH COST	\$ 95,339,000

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

City of Wilmington WWTP
Effluent Level: NH₃-N = 5 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 214,400,000
<i>subtotal</i>	\$ 214,400,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 134 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 48.30 mg/L	
Two Final Clarifiers, Diam. = 160' Ea. (increased from 140' Diam.)	\$ 120,000
<i>subtotal</i>	\$ 214,520,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 4,776,960
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,472,896
Construction Dewatering	\$ 358,272
Land Acquisition	\$ -
<i>subtotal</i>	\$ 6,608,128
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	221,128,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 176,000
Additional chemical costs	\$ 3,116,288
Additional energy costs	\$ 1,455,463
Additional sludge disposal costs	\$ 128,572
Additional maintenance costs	\$ 360,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 5,236,000
TOTAL PRESENT WORTH O&M COSTS	\$ 108,488,000
GRAND TOTAL PRESENT WORTH COST	\$ 329,616,000

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

City of Wilmington WWTP
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	\$ 241,200,000
<i>subtotal</i>	\$ 241,200,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 134 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 48.30 mg/L	
Two Final Clarifiers, Diam. = 160' Ea. (increased from 140' Diam.)	\$ 120,000
<i>subtotal</i>	\$ 241,320,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 4,776,960
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,472,896
Construction Dewatering	\$ 358,272
Land Acquisition	\$ -
<i>subtotal</i>	\$ 6,608,128
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	247,928,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 176,000
Additional chemical costs	\$ 6,460,447
Additional energy costs	\$ 1,726,379
Additional sludge disposal costs	\$ 154,648
Additional maintenance costs	\$ 446,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 8,963,000
TOTAL PRESENT WORTH O&M COSTS	\$ 185,710,000
GRAND TOTAL PRESENT WORTH COST	\$ 433,638,000

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

City of Wilmington WWTP

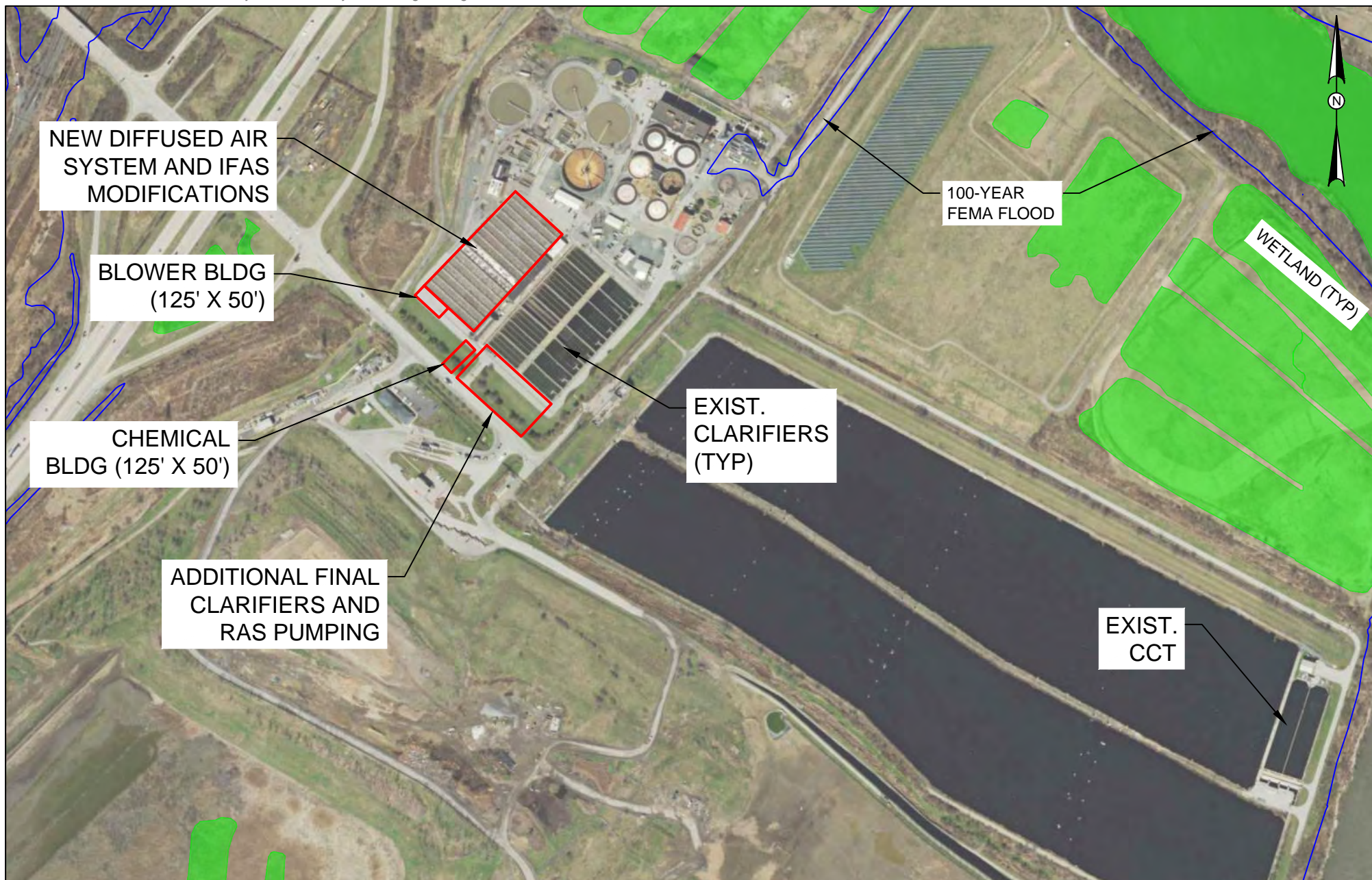
Effluent Level: NH₃-N = 1.5 mg/L and TN = 4.0 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 455,600,000
<i>subtotal</i>	\$ 455,600,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 134 (Permitted Capacity)	
Max. Monthly Summer Average Ammonia (May-Oct) = 48.30 mg/L	
Two Final Clarifiers, Diam. = 160' Ea. (increased from 140' Diam.)	\$ 120,000
<i>subtotal</i>	\$ 455,720,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 13,176,960
Rock Excavation	\$ -
Sheeting during Construction	\$ 4,062,896
Construction Dewatering	\$ 988,272
Land Acquisition	\$ -
<i>subtotal</i>	\$ 18,228,128
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	473,948,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 352,000
Additional chemical costs	\$ 11,432,214
Additional energy costs	\$ 3,136,582
Additional sludge disposal costs	\$ 1,577,695
Additional maintenance costs	\$ 865,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 17,363,000
TOTAL PRESENT WORTH O&M COSTS	\$ 359,755,000
GRAND TOTAL PRESENT WORTH COST	\$ 833,703,000

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



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SCALE: 1" = 500' SCALE IN FEET

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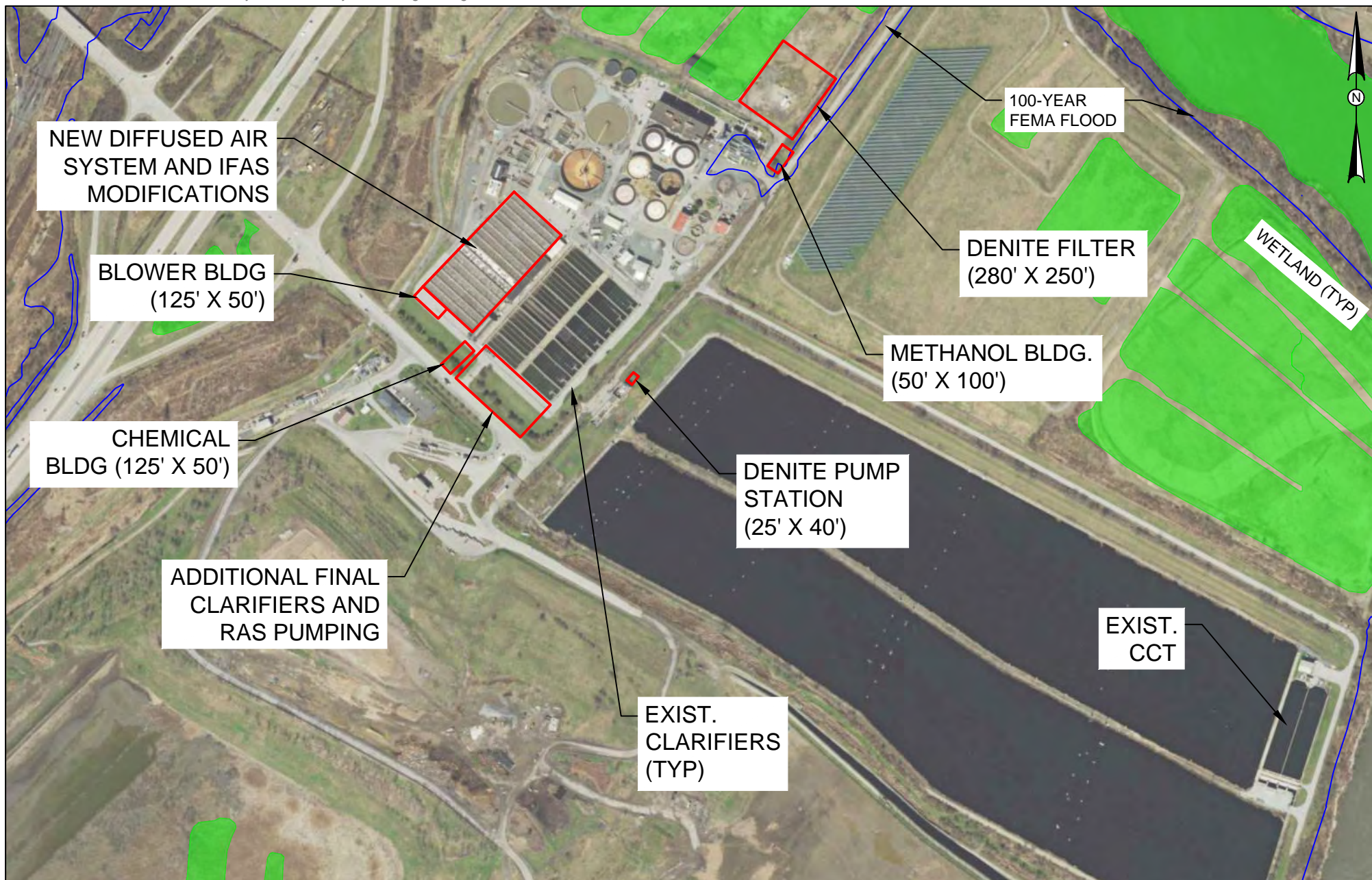
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CITY OF WILMINGTON STP
CONCEPTUAL SITE PLAN
NH₃-N = 1.5 mg/l

NITROGEN REDUCTION
COST ESTIMATION STUDY
DELAWARE RIVER BASIN COMMISSION

FIGURE

L-1



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CITY OF WILMINGTON STP
 CONCEPTUAL SITE PLAN
 NH₃-N = 1.5 mg/l & TN = 4.0 mg/l

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE

L-2

Appendix M
PWD NEWPCP Plant Specific Cost Estimates
and
Conceptual Site Plans

DRBC Nitrogen Reduction Cost Estimation Study

PWD Northeast WPCP
Effluent Level: NH₃-N = 5 mg/L

<i>Description</i>	<i>Amount</i>
Plant-specific base capital cost¹:	
Base capital cost per generic plant	\$ 117,500,000
<i>subtotal</i>	\$ 117,500,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 235 (Max Month)	
Max. Monthly Summer Average Ammonia (May-Oct) = 7.24 mg/L	
Two Final Clarifiers, Diam. = 164' Ea. (increased from 140' Diam.)	\$ 150,000
<i>subtotal</i>	\$ 117,650,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 5,097,600
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,571,760
Construction Dewatering	\$ 382,320
Land Acquisition	\$ -
<i>subtotal</i>	\$ 7,051,680
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	124,702,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 88,000
Additional chemical costs	\$ 4,181
Additional energy costs	\$ 1,045,634
Additional sludge disposal costs	\$ 104,527
Additional maintenance costs	\$ 631,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 1,873,000
TOTAL PRESENT WORTH O&M COSTS	\$ 38,808,000
GRAND TOTAL PRESENT WORTH COST	\$ 163,510,000

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

PWD Northeast WPCP
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	\$ 376,000,000
<i>subtotal</i>	\$ 376,000,000
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 235 (Max Month)	
Max. Monthly Summer Average Ammonia (May-Oct) = 7.24 mg/L	
Two Final Clarifiers, Diam. = 164' Ea. (increased from 140' Diam.)	\$ 150,000
<i>subtotal</i>	\$ 376,150,000
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 5,097,600
Rock Excavation	\$ -
Sheeting during Construction	\$ 1,571,760
Construction Dewatering	\$ 382,320
Land Acquisition	\$ -
<i>subtotal</i>	\$ 7,051,680
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	383,202,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 264,000
Additional chemical costs	\$ 6,010
Additional energy costs	\$ 1,738,853
Additional sludge disposal costs	\$ 150,258
Additional maintenance costs	\$ 782,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 2,941,000
TOTAL PRESENT WORTH O&M COSTS	\$ 60,936,000
GRAND TOTAL PRESENT WORTH COST	\$ 444,138,000

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

PWD Northeast WPCP

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	\$ 699,858,354
<i>subtotal</i>	\$ 699,858,354
Plant-Specific Issues Requiring Cost Adjustments	
Design Flow = 235 (Max Month)	
Max. Monthly Summer Average Ammonia (May-Oct) = 7.24 mg/L	
Two Final Clarifiers, Diam. = 164' Ea. (increased from 140' Diam.)	\$ 150,000
<i>subtotal</i>	\$ 700,008,354
Plant-specific base capital cost additions²:	
Pile Foundations	\$ 20,097,600
Rock Excavation	\$ -
Sheeting during Construction	\$ 6,196,760
Construction Dewatering	\$ 1,507,320
Land Acquisition	\$ -
<i>subtotal</i>	\$ 27,801,680
Plant-specific base capital cost deductions³:	
None	
<i>subtotal</i>	\$ -
Reduced productivity adjustment	\$ -
TOTAL PRESENT WORTH CAPITAL COST	727,810,000
Plant-specific annual O&M costs:	
Additional personnel costs	\$ 440,000
Additional chemical costs	\$ 4,648,501
Additional energy costs	\$ 4,211,969
Additional sludge disposal costs	\$ 1,693,396
Additional maintenance costs	\$ 1,517,000
TOTAL PLANT-SPECIFIC ANNUAL O&M COSTS	\$ 12,511,000
TOTAL PRESENT WORTH O&M COSTS	\$ 259,223,000
GRAND TOTAL PRESENT WORTH COST	\$ 987,033,000

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



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SCALE: 1" = 500' SCALE IN FEET

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PROJECT NO. 6736

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REVISED: ---

PWD NORTHEAST WPCP
CONCEPTUAL SITE PLAN
NH₃-N = 1.5 mg/l

NITROGEN REDUCTION
COST ESTIMATION STUDY
DELAWARE RIVER BASIN COMMISSION

FIGURE

M-1



0 500 1000
 SCALE: 1" = 500' SCALE IN FEET

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PWD NORTHEAST WPCP
 CONCEPTUAL SITE PLAN
 NH₃-N = 1.5 mg/l & TN = 4.0 mg/l

NITROGEN REDUCTION
 COST ESTIMATION STUDY
 DELAWARE RIVER BASIN COMMISSION

FIGURE

M-2